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Stockton Sand Quarry Dredging | State Significant Development

ENVIRONMENTAL IMPACT STATEMENT

Prepared for Boral Resources (NSW) Pty Ltd | February 2020



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Stockton Sand Quarry Dredging

STATE SIGNIFICANT DEVELOPMENT | ENVIRONMENTAL IMPACT STATEMENT

Prepared for Boral Resources (NSW) Pty Ltd
21 February 2020

PR63

	Prepared by	Reviewed by
Name	Luke Farrell	Mark Roberts
Company	Element Environment	Element Environment
Position	Senior Environmental Consultant	Senior Environmental Consultant
Project Role	Lead EIS Author	Technical Reviewer
Signature		
Date	18 February 2020	19 February 2020

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DOCUMENT CONTROL

Revision	Date	Description	Prepared by	Reviewed by
0	23 September 2019	For Boral review	Element Environment	Boral Resources (NSW) Pty Ltd
1	18 December 2019	For submission to DPIE	Element Environment	Boral Resources (NSW) Pty Ltd
2	21 February 2020	Revised following DPIE adequacy review	Element Environment	Boral Resources (NSW) Pty Ltd

Environmental Impact Statement Certification

Submission of Environmental Impact Statement (EIS) prepared under Part 4 of the *New South Wales Environmental Planning and Assessment Act 1979*.

Aspect	Details	
Name	Luke Farrell	Mark Roberts
Position	Senior Environmental Consultant	Senior Environmental Consultant
Project role	Lead EIS Author	Technical Reviewer
Qualifications	Bachelor of Environmental Science	Bachelor of Environmental Science
Address	Element Environment Pty Ltd PO Box 1563, Warriewood, NSW, 2012	
In respect of	Stockton Sand Quarry Dredging, State Significant Development – Environmental Impact Statement	
Applicant name	Boral Resources (NSW) Pty Ltd	
Responsible person/applicant	Rachael Snape	
Responsible person/applicant address	Triniti 2, 39 Delhi Road North Ryde, NSW, 2113	
Proposed development	Stockton Sand Quarry Dredging	
Land to be developed	The Stockton Sand Quarry (the quarry) covers approximately 246 hectares and will be on land identified as: ▪ Lot 1 DP 1006399; ▪ Lot 2 DP 1006399; and ▪ Lot 3 DP 664552. Access to the quarry is via a Crown land title (Lot 7300 DP 1130730) under licence agreement with the NSW Department of Planning, Industry and Environment. The development will cover approximately 37 hectares and be restricted to a former sand extraction area within Lot 1 DP 1006399 and Lot 3 DP 664552.	
Proposed development description	Boral is seeking approval through a State significant development application to extract sand from the inland vegetated dunes. Initial extraction will occur by front-end loader/excavator to relative level (RL) 4 m Australian Height Datum (AHD) within Stage 1 followed by dredging to RL – 15 m AHD of Stages 2 – 6 inclusive. Boral seeks to increase the site wide transportation limit to 750,000 tpa per year until the windblown project lapses in 2028 when transportation limits will reduce to 500,000 tpa.	
Environmental assessment	This EIS addresses all matters in accordance with Part 4 of the NSW *Environmental Planning & Assessment Act 1979*.	
Preparation	This EIS has been prepared by Element Environment Pty Ltd on behalf of Boral. In preparing the EIS, Element Environment Pty Ltd has relied on data, designs and plans and other information provided by Boral and other individuals and organisations referenced herein.	
Declaration	Pursuant to clause 6(f), Part 3, Schedule 2 of the NSW Environmental Planning and Assessment Regulation 2000, I declare that this EIS: ▪ has been prepared in accordance with the requirements of the NSW *Environmental Planning and Assessment Act 1979*, NSW Environmental Planning and Assessment Regulation 2000, and the Secretary's environmental assessment requirements (SEARs) (SSD-9490) dated 16 November 2018; ▪ contains all available information that is relevant to the environmental assessment of the proposed development to which the document relates; and ▪ is true in all material particulars and does not, by its presentation or omission of information, materially mislead.	

Aspect		Details
Signature		
Name	Luke Farrell	Mark Roberts
Date	18 February 2020	19 February 2020

Executive Summary

Introduction

Due to current and future demand for sand in the Hunter and Sydney regions, Boral Resources (NSW) Pty Ltd (Boral) is seeking development consent for a State significant development (SSD 9490) to continue and expand operations at its Stockton Sand Quarry (the project).

Stockton Sand Quarry is owned and operated by Boral and is legally described as Lots 1 and 2 in Deposited Plan (DP) 1006399 and Lot 3 DP 664552 (the site).

The site is approximately 246 hectares (ha) and has been used for the purposes of extractive industries (sand quarrying) since the 1970s. There site currently supports an active quarry on the windblown (transgressive) sand dunes of Stockton Bight which produces up to 500,000 tonnes per annum (tpa) of sand for use in landscaping and construction (the existing operation).

The project will involve the progressive extraction of sand from the inland vegetated dunes of the site using both dry and wet extraction methods. Stage 1 will involve removal of sand by front-end loader/excavator to a depth of 4 metres (m) Australian Height Datum (AHD) all subsequent stages (2 to 6) dredging from 4 m AHD to -15 m AHD.

The development application seeks to increase the site-wide transport limit to 750,000 tpa (i.e. the windblown sand extraction area and the project operations combined) until 2028, after which the site wide limit will reduce to no more than 500,000 tpa.

This environmental impact statement (EIS) has been prepared for submission to the Department of Planning, Industry and Environment (DPIE) to satisfy the provisions of Part 4 of the NSW *Environmental Planning & Assessment Act 1979* (EP&A Act).

Description of the site and surrounds

The site (refer to **Figure E.1**) is in Fullerton Cove, approximately 9.8 kilometres (km) north-north-east of the Newcastle central business district (CBD) and is located in the Port Stephens local government area (LGA).

The site is accessed via Coxs Lane, a local road which connects with a private road over the adjacent Crown reserve. Coxs Lane intersects Nelson Bay Road, a major arterial road which links the Newcastle CBD to Newcastle Airport, Nelson Bay and the wider Port Stephens area to the north.

The project is in the central portion of the site and contains all areas to be disturbed by project operations and covers an area of approximately 37 ha.

The site is zoned RU2 – Rural Landscape under the Port Stephens Local Environmental Plan (LEP) 2013 and extractive industries are permitted with consent.

Access to the site is via a road over an adjacent parcel of Crown land. This lot is zoned RE1 - Public Recreation. No physical works are proposed within the Crown reserve and Boral has an existing licence for access with Crown Lands.

Land to the north, south and east of the site is zoned E1 – National Parks and Nature Reserves, and this land comprises the environmental conservation areas of Stockton Bight. A portion of land adjacent to the north-east of the site is also zoned as E3 – Environmental Management.

Figure E.1
Regional context

STOCKTON SAND QUARRY DREDGING
ENVIRONMENTAL IMPACT STATEMENT



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Project overview

Sand was formerly removed from the inland dunes under a previous consent that ceased in 2008. Under this consent, sand was only extracted to 5 m AHD.

The project seeks to undertake extraction generally within the area of previous disturbance to access an estimated 9 million tonnes of sand resource from the existing ground level (5 m AHD) to a depth of -15 m AHD. As extraction will intercept the groundwater table (at 1-2 m AHD) the primary method of sand extraction will be dredging.

The project is outlined in **Figure E.2**, which also depicts the location of the existing operations at the site and the location of the project site in comparison to these existing operations.

The project seeks a site wide dispatch limit of 750,000 tpa (i.e. the windblown sand extraction area and the project operations combined) up to 2028, after which the site wide limit will reduce to no more than 500,000 tpa. The increase in the site wide dispatch limit is sought to permit maximum flexibility across the existing and proposed sand extraction areas (located on the same quarry site). Boral is seeking consent to operate the SSD for 25 years to account for fluctuations in demand.

The project will continue to operate in accordance with existing operating hours.

The project involves progressive extraction of sand over six operational stages as illustrated in **Figure E.3**. Site preparation will involve clearing and grubbing of established vegetation from previous rehabilitation and possible screening of accumulated leaf litter and organic matter. Cleared vegetation will be mulched or stockpiled on-site for later use in rehabilitation. Similarly, any stripped topsoil will be retained for use in rehabilitation.

Stage 1 will involve dry extraction to a depth of 4 m AHD. The sand will then be screened and stockpiled before a front-end loader loads road trucks in-pit with screened raw sand for transport off-site via the weighbridge.

A pond will be created in the area of Stage 2 following initial dry extraction of sand in Stage 1. The pond will be large enough to float a dredge and accommodate freshwater pumping for the proposed wash plant. The dredge will move progressively through the extraction area in a south-westerly direction in a staged process. Extraction will then move to the east and culminate with relocation of the proposed processing and stockpile area to a confined area in Stage 1 and subsequent dredging of most of the Stage 1 extraction area (to be known as Stage 6).

Sand will be extracted to approximately -15 m AHD.

Minimal site establishment works are required given existing operations, infrastructure and services. New or augmented infrastructure will be established in Stage 1 and will comprise:

- Construction of a new entry road. The new road will link to the existing haul road in the south-eastern extent of Stage 1 and enable continued access to the windblown sand extraction area. The road will be two-way and a separated exit road will be constructed to allow exiting vehicles to cross the weighbridge.
- A pad for the wash plant and diesel generators will be constructed after vegetation removal and sand extraction in the northern portion of Stage 1. The wash plant pad will generally have a fixed location during Stages 2 to 5, after which, it will be relocated in Stage 6 to allow for extraction from the remaining body of Stage 6.
- Relocation of the existing parking area to the south and relocation of the security gates northward across the entry road which will enclose the parking area and the new entry road. The docketing kiosk registering vehicles entering the site will also be relocated.

The existing site depot will also be reconfigured to support the project and will comprise:

- installation of a new prefabricated office building;

- relocation of onsite materials storage;
- replacement of roofing for the workshop; and
- installation of a 30,000 litre water storage tank for potential firefighting efforts.

A processing and stockpile area will be established in the Stage 1 area. The area will be used to stockpile topsoil, vegetation and sand.

Extracted sand will be transported to the Stage 1 area and screened for immediate sale, or stockpiled. Stockpile volume and duration will be minimised to limit the loss of resource.

Sand/water pumped from the dredge will be passed over an initial screen in the wash plant to separate oversize organic matter or debris and into a large wash tank to float out any fines (<75 micrometres). After washing, the sand will be pumped through a cyclone and stockpiled for further dewatering.

Dewatered sand will be loaded with a front-end loader and/or excavator into trucks for dispatch.

The project will provide continued direct employment for existing employees and provide additional employment opportunities, including flow on employment opportunities for numerous Boral and customer truck drivers and service personnel.

Figure E.2
The Project

STOCKTON SAND QUARRY DREDGING
ENVIRONMENTAL IMPACT STATEMENT

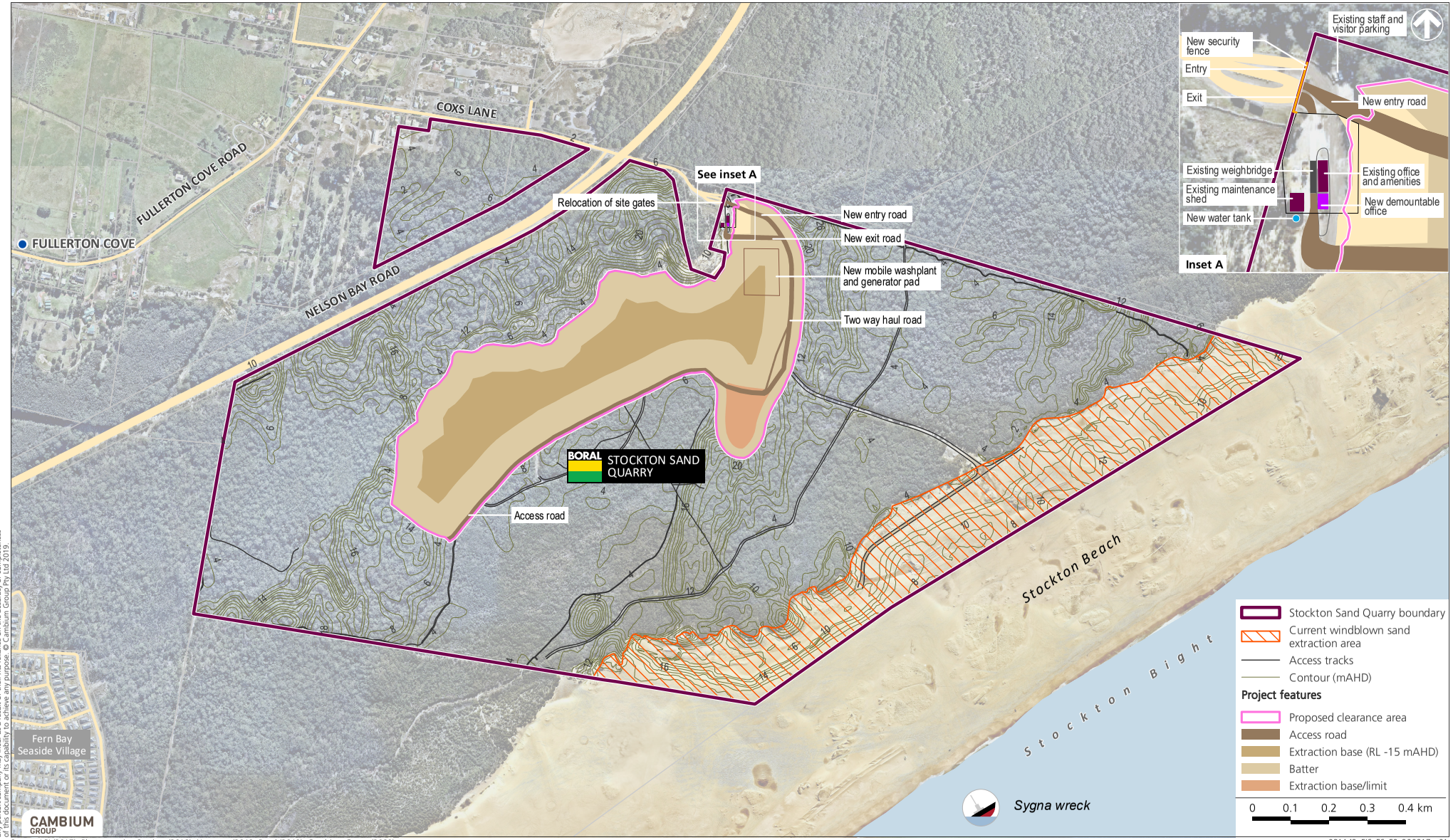

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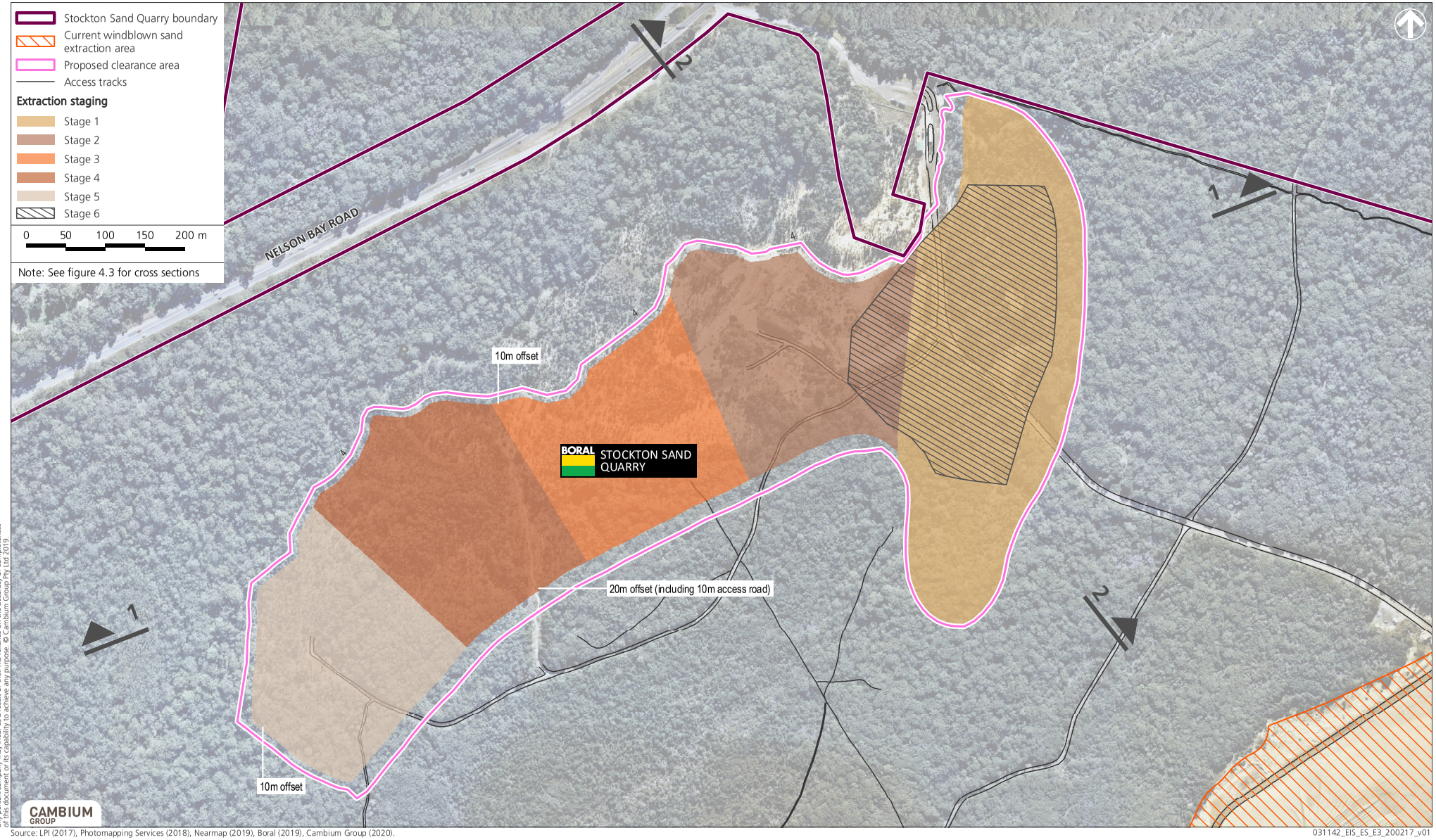
Figure E.3
Extraction staging plan

STOCKTON SAND QUARRY DREDGING
ENVIRONMENTAL IMPACT STATEMENT



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Impact assessment

The project has undergone extensive environmental assessment from a range a technical specialists informed by government policy, consultant and community feedback.

Groundwater

Hydrogeological investigation was undertaken to establish the baseline environment for the Stockton Sandbeds and Tomago Sandbed aquifer systems including definition of water balance for the aquifer to determine the potential effect of the project on the groundwater system under varying climatic conditions.

The baseline environment was established through reviews of existing data supplemented by a field investigation of the project site comprising:

- installation of a groundwater monitoring bore network;
- physical aquifer testing on installed bores to determine aquifer parameters; and
- changes in groundwater levels and chemistry in monitoring data over time under varying climatic conditions were determined.

The findings of the investigations are set out in the Hydrogeological Impact Assessment (HIA) report.

The HIA concluded that potential physical impacts to the aquifer will be minor to negligible as the project site represents a small contribution to the overall catchment water balance, and there are no potential receptors to groundwater discharge down-gradient of the project site other than the ecosystems of the Pacific Ocean and Fullerton Cove.

The existing groundwater management plan for the site will be updated to include the management and monitoring measures in the HIA.

Biodiversity

A Biodiversity Development Assessment Report (BDAR) was prepared in accordance with Office of Environment and Heritage's (OEH) (2017) *Biodiversity Assessment Method* (BAM). This comprised assessing the project site's landscape features, native vegetation and threatened species and populations, followed by an impact assessment considering avoidance and minimisation of impacts, impact and offset thresholds and offset requirements.

Public databases, vegetation mapping and the BAM Calculator were used to predict the threatened flora and fauna species, and threatened ecological communities, which could exist in or frequent the project site.

Field surveys for the project confirmed vegetation in the project site mainly comprised native regeneration associated with rehabilitation of the former inland extraction area. The project site was found to comprise two plant community types (PCT):

- PCT1646 - Smooth-barked Apple/Blackbutt/Old Man Banksia woodland on coastal sands of the Central and Lower North Coast; and
- PCT1644 - Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower North Coast.

No threatened ecological communities (TEC) as defined by the NSW *Biodiversity Conservation Act 2016* (BC Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) have been identified at the project site.

The following direct impacts would result from the project:

- clearing of native vegetation and associated habitat, conservatively estimated to be 35.66 ha, including 32.75 ha of previously rehabilitated areas;
- clearing of approximately 2.48 ha of exotic vegetation; and
- clearing of 26.59 ha of associated species credit fauna habitat for the Squirrel Glider.

Mitigation and management measures will be implemented to avoid or minimise impacts to biodiversity in and adjacent to the project site. Additionally, a strategy will be developed to offset the vegetation clearing impacts on biodiversity, which will be based on the following credit requirements:

- Ecosystem credit requirements:
  - 396 ecosystem credits to offset removal of the Smooth-barked Apple - Blackbutt - Old Man Banksia woodland on coastal sands of the Central and Lower North Coast PCT; and
  - 37 ecosystem credits to offset removal of the Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower North Coast PCT.
- Species credit requirements:
  - Squirrel glider (*Petaurus norfolcensis*) – 521 credits.

Air quality

An air quality impact assessment was undertaken to consider from the effects of the project on nearby sensitive receivers. The assessment included the contribution of existing local emission sources and was undertaken in accordance with the NSW Environment Protection Authority's (EPA) (2017) *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*. Total suspended particulates, deposited dust, PM_{10} and $PM_{2.5}$ (particulate matter with an aerodynamic diameter of 10 µm and 2.5 µm or less) will be the primary emissions from the project. Other air pollutants potentially associated with the project are nitrogen dioxide (NO_2) and sulphur dioxide (SO_2), which could be generated by vehicle emissions.

Worst case pollutant generation scenarios for the project were assessed using emissions reduction factors, which assume the application of management measures.

The project, in combination with other local emissions sources, will not result in exceedances of particulate matter and dust deposition criteria at any privately-owned sensitive receivers. The assessment of cumulative 24-hour average PM_{10} concentrations found that the project, in conjunction with surrounding third-party extractive operations, will not increase the number of days above the 24-hour average criteria for $PM_{2.5}$ and PM_{10} at any sensitive receiver.

An air quality management plan will be prepared prior to the start of project operations. The plan will outline the measures to manage dust emissions at the site and include key performance indicators, response mechanisms, compliance reporting and complaints management.

Noise

A noise assessment was undertaken to determine the potential effect of the project on nearby sensitive receivers. The assessment was undertaken in accordance with the EPA (2017) *Noise Policy for Industry* (NPI), the former NSW Department of Environment, Climate Change and Water's (DECCW) (2011) Road Noise Policy (RNP), and considered the requirements of the existing environment protection licence (EPL) for the established quarry.

The worst case scenario for the project was identified as being the operating periods between 7 am and 6 pm (day time) and 6 am to 7 am (night time). In accordance with the NPI, project 'trigger levels' (operating noise criteria) were developed for the project and potential noise generation modelled, using details of machinery and its location on site. This assessment also incorporated noise enhancing weather conditions as it was determined that given the project will involve commencement of dredging operations prior to 7 am, which is the morning shoulder of the night period, the project will be subject to temperature inversions, which occur during the night time, as well as prevailing winds which occur during the evening and night periods.

The assessment determined that predicted noise levels for proposed day time and morning shoulder operations will comply with the operational noise trigger levels at all locations. The highest predicted noise level during the morning shoulder, which could interrupt sleep at the

nearest receiver, was estimated to be less than the maximum noise trigger level. As such, the project would not disturb sleep.

The project will achieve compliance with all road traffic noise criteria.

The residual noise impact is the exceedance of the project noise trigger level after all feasible and reasonable mitigation measures have been considered. No residual impacts are predicted at any privately-owned receivers and, therefore, receiver-based treatments or controls are not required.

Boral will continue its noise compliance monitoring and community consultation and will implement measures if an exceedance is detected or a complaint is received from a member of the community.

Traffic and transport

A traffic assessment was undertaken to determine the potential effect of the project on the capacity of the local and regional road network. A road safety audit was also completed.

Boral currently operates an existing quarry from the site, this quarry has consent to dispatch up to 500,000 tonnes per annum. The project seeks to increase this limit to a maximum of 750,000 tpa across both quarries (the project area and the existing windblown project). The increase in volumes is sought until 2028 when the existing quarry operation will cease.

Accordingly, the traffic assessment was based on the maximum potential traffic generation associated with the dispatch of up to 750,000 tpa and 70,000 tpa of Virgin Excavated Natural Material. The projected change in maximum traffic volumes on a peak day is summarised in **Table E.1**.

Table E.1: Comparison of traffic generation between existing quarry operations and the project.

Element	Existing (windblown sand extraction area)	Project to 2028 (windblown sand extraction and project)	Project beyond 2028 (project only)
Tonnes transport per annum	500,000	750,000	500,000
VENM imports per annum	Nil	70,000	70,000
Vehicle movements (in/out)	152	284	208

Up to 284 two-way heavy vehicle trips could occur in the maximum or peak day to 2028. This will be an increase of 132 two-way heavy vehicle trips per day compared to the existing operation. Up to 56 additional two-way heavy vehicle trips could occur from the maximum or peak day after 2028.

The project will generate 30 inbound and 30 outbound heavy vehicle trips during the maximum hour of operation for product transport and VENM importation (60 two way heavy vehicle trips).

Traffic modelling has indicated that the project will maintain the existing level of service at all intersections along transport routes to be used by Boral.

All intersections along transport routes to be used by Boral will have sufficient capacity for background traffic growth as well as project related traffic for the next 10 years.

The project will not result in any negative impacts to other road users, and will not require any upgrades to road infrastructure.

Social impacts

State significant resource projects can have both positive and negative social influence on receiving communities. To determine the nature of influence likely to arise as a consequence of

the project a social impact assessment (SIA) was undertaken in accordance with the Guidelines published by DPIE. The SIA considered the potential for the project' to change people's way of life; community; access to and use of infrastructure, services and facilities; culture; health and wellbeing; surroundings; personal and property rights; decision making systems; and fears and aspirations.

The community was extensively consulted in 2018 and 2019 via correspondence, meetings, the media and social media to understand attitudes towards the existing quarry,project, and issues of most importance to the community. Issues of concern to the community were general in nature and predominantly associated with road safety and traffic impacts. The majority of community members consulted were unaware of the existing quarry and as such had no concerns around acoustic or visual amenity.

A social impact scoping exercise was undertaken using a variety of methods to determine how the project would interact with the human or natural environment, whether these interactions would generate an impact (positive or negative), how the potential impacts may be assessed and they degree of assessment required.

In the context of Stockton, the scoping exercise was based on the feedback received through early engagement with stakeholders. This process identified six areas of potential social impact including amenity, access, built environment, heritage, community and economics.

It was determined that some of these potential impacts required detailed assessment of impacts without management measures in the form of consultation with residents (noise, visual and dust impacts), consultation with Aboriginal stakeholders (heritage impacts), visual impact assessment, ethnographic content analysis (ECA – traffic impacts), participant observation (unauthorised access to the site) and interviews with stakeholders (visual impacts).

The project was predicted to have a positive impact on personal and property rights, specifically mitigation of a shortfall in natural sand supply for the local and regional economies, and employment benefits for employees and their households.

The following negative impacts were predicted:

- Access to and use of infrastructure, services and facilities – cumulative and perceived risk of increased traffic volumes and impact to the condition of roadways.
- Health and wellbeing – perceived personal safety risks for members of the public who access the site without authority.

All potential social impacts associated with the project will be managed via the implementation of mitigation, monitoring and management measures set forth in this EIS, coupled with ongoing community consultation and liaison, including notification of the exhibition of the EIS to potentially affected landowners.

Soils and land resources

The EIS has investigated the soil and land resources to determine the potential for acid sulfate soils (ASS) to occur on site, soil type with respect to agricultural capacity combined with changes in landform and topography as a result of the project.

Soils in the project site are mapped as containing a risk of ASS. The potential for ASS to occur in the project site was assessed including the drilling of four boreholes and subsequent soil sampling. Of the 44 soil samples collected and analysed from the project site only one had a moderate risk of ASS.

The risk for ASS was identified at a depth between 2.0 m to 2.5 m below the ground surface. Soil samples obtained above and below this depth in the borehole did not indicate ASS potential, and as such it was concluded the potential for ASS at the identified depth was a localised occurrence. The remainder of the project site was not identified to be at risk of ASS.

An ASS management plan will be prepared and implemented for the project in accordance with ASSMAC's (1998) *Acid Sulfate Soils Assessment Guidelines*.

The extraction of sand will alter existing landform and topography in the project site. As it would not be possible to reinstate the pre-existing landform and topography of the project site following completion of the project, the final land use objectives of the project site will aim to ensure that all landforms are adequately stabilised.

The project will not impact the beach, foredune, deflation basin and mobile transverse dunes of Stockton Bight as the project site is physically removed from, and downwind of these environments.

The majority of the project will be on land with Class 8 land and soil capability. Land in this class has extremely low capability and is incapable of agricultural land use. The central southern portion of the project is mapped as Class 5, with moderate to low capability and potential for limited agricultural land use such as grazing land.

The project will have minimal negative impact on the overall land capability given it will be in a previously disturbed quarry pit and on land with low land and soil capability and use of the site for extractive industry will not detract from other agricultural land use.

The potential for contamination is considered low given historical land use at the project site, which comprised vegetation clearing and sand extraction. Following which, the disturbed area was rehabilitated when sand extraction ceased in 2008 and any introduced fill material was verified as VENM.

Notwithstanding, there could have been localised spills and leaks from equipment. However, as vehicle movements are typically contained to existing haul roads and this material, if removed prior to extraction of Stage 1, would not be reused on or off site.

Based on the low risk of contamination combined with a known and continuing use of the land for extractive industry, no further assessment of contaminated land or land remediation is considered necessary.

Aboriginal heritage

The project site is generally consistent with the footprint of an earlier quarrying operation. Previous archaeological investigations undertaken to support this earlier project indicated a low potential for subsurface Aboriginal archaeological material in the project area. Since that time, the project site was quarried to 5 m AHD and was considered to be highly disturbed with no Aboriginal archaeological sites known to be present within the project site.

Notwithstanding the above, an Aboriginal Cultural Heritage Assessment (ACHA) was undertaken to determine the likelihood for Aboriginal archaeological sites and artefacts to occur within the project area.

As part of the ACHA, the Aboriginal Heritage Information Management System (AHIMS) was searched for previous records of sites in and adjacent to the project site, combined with surveying the project site for new Aboriginal objects and consulting Aboriginal parties.

Surveying of the project site included visual inspection by the archaeologist and Aboriginal parties to confirm the extent and nature of previous disturbance. Previously disturbed areas had little to no archaeological potential given the previous removal of the dune mass.

Therefore, it was concluded that no further detailed investigation (test excavation) was warranted.

Aboriginal objects are known to occur in adjacent landforms and these are to be avoided by all project operations. The boundary of the project site will be clearly delineated and Aboriginal heritage avoidance measures will be included in Boral's existing environmental management strategy for the site.

Visual

The project site is located approximately 700 m from the nearest public vantage point and 480 m from the nearest sensitive receiver. The topography of the site and surrounds can be described as undulating with dunes reaching up to 20 metres in height. In comparison the project area sites at 5 m AHD.

Due to factors of distance from common boundaries, topography and vegetation, the project site remains predominantly visually obscured. The potential for visual impact associated with the project considered key vantage points and concluded the following:

- the project site will not be visible from Nelson Bay Road or surrounding residential areas; and
- the project may be partially visible from one vantage point immediately adjacent to Boral's seaward boundary, in particular those people accessing the top of the remnant hind dune on Stockton Beach.

From the vantage point at the remnant hind dune, users would be looking through Boral's existing quarry on the transgressive dunes. The change in the landscape and visual amenity would be transient and short term with impacts likely to dissipate following the completion of Stage 1 (expected to last up to two years dependant on the rate of extraction). As the project progresses and excavation reduces the ground level will retreat below the sight line of those using the dunes.

Notably, business operators who use this section of Stockton Bight for recreational ventures were consulted during the social impact assessment process and provided feedback that they had grown accustomed to Boral operations associated with the windblown sand extraction area and did not envisage that the project will have any negative implications for their business.

Surface water management

Surface water runoff from the project site will infiltrate the porous sandy soils to the underlying aquifer or directly drain to the newly formed dredge pond. There will be no discharge of surface water off the project site.

Given that rainfall infiltrates into the sandy soils quickly, the potential for erosion is negligible. However, access roads and the embankments of the proposed dredge pond will require VENM or other engineering fill that contain clays and other soil types of smaller particle sizes that are more erodible than existing sand material at the project site.

Erosion and sediment controls will be required for areas where VENM or other erodible material are imported to limit sediment movement into the dredge pond or into adjoining native vegetation.

Water demands for the project including dust suppression and drinking water will continue to be sourced via a water cart contractor, which sources water supply from the potable water network. Rainwater captured in an existing water storage tank will continue to be stored for on-site ablutions, which will be sufficient to supply water for the site depot.

The water balance comprised the following:

- direct water consumption and wastewater generation at the site depot;
- water consumption for dust suppression as required over the project site; and
- alterations to landscape conditions, primarily comprising removal of vegetation and transformation of dune areas to a dredge pond, as well as losses associated with the moisture content of extracted material leaving the quarry.

Water leaving the project site will include water lost to the atmosphere via evaporation of the dredge pond and water exported from the site as moisture content in the outgoing sand.

The quantity of water extracted will generally increase over time as the dredge pond surface area expands, peaking at an average 100 megalitres per annum (ML/y) in the final years of the project. As the dredge pond is created, direct rainfall to the aquifer will increase, as will evaporation and moisture losses in the exported sand.

The water balance model demonstrated the net extraction of water is more likely than net import to the aquifer from above average rainfall. Generally, the project will only contribute a net import of water to the Stockton Groundwater Source in years when rainfall is at or above the 90th percentile.

The project will expose the aquifer and result in extraction of groundwater resources via evaporation of the open dredge pond and outgoing moisture content of dispatched sand products. Groundwater extraction and aquifer interference activities are permitted via an aquifer interference approval under Section 91 of the NSW *Water Management Act 2000* (WM Act), and require an authorisation under the water sharing plan (WSP) via a water access licence (WAL) or some form of exemption.

The project will comprise a minimal impact on the quantity of the Stockton Groundwater Source. The available water in the Stockton Groundwater Source is 14,000 ML/y and after existing landholder rights and allocations are accounted for approximately 12,000 ML/y remains. The estimated annual extraction associated with the project is approximately 1% of the available allocations from the Stockton Groundwater Source.

Boral has previously been issued a WAL under the WM Act for the site, however, it has a zero share allocation for the Stockton Groundwater Source. Boral will therefore be required to obtain sufficient water share allocations from DPIE prior to the commencement of the project to account for the projected quantity of water extraction. These allocations can be obtained either through the trading of existing allocations, or through application for new allocations under Section 65 of the WM Act.

Mitigation and management measures, including monitoring regimes, would be implemented to ensure appropriate surface water management at the project site. Boral will ensure that the project is licensed under the WM Act, and implement strategies to minimise the quantity of water lost to evaporation and reduce the quantity of groundwater resource removed from the Stockton Groundwater Source for other potential users under the water sharing plan.

Historic heritage

Commonwealth, State and local heritage databases were searched to determine the presence of registered historic heritage items in the project site and surrounds. The project will not impact a registered heritage item/place protected under the NSW *Heritage Act 1977* or Port Stephens LEP.

The only listed heritage item within 500 m of the project is the ‘Stockton Beach Dune System’, which is listed on the Port Stephens LEP and is directly adjacent (north-east and south-east) to the quarry boundary. Despite proximity to the Stockton beach dune system, the project will not impact the beach, foredune, deflation basin and mobile transverse dunes of Stockton Bight as the project site is physically removed from, and downwind of these environments. As such, the project will not impact upon the natural landscape features comprising the listing.

The project site has been subject to previous surface disturbance and is unlikely to contain any unknown historic heritage items.

Waste management

The project will not generate significant quantities of general solid, hazardous or liquid waste. Any waste that is generated will be managed in accordance with the waste hierarchy in the NSW *Waste Avoidance and Resource Recovery Act 2001*.

Hazards and risks

The project will present some minimal hazards and risks, including storage and management of hazardous substances and dangerous goods.

The site will continue to store fuels associated with the operation of plant. All fuels will be stored safely in self-bunded areas and refuelling of plant only occurs within the depot site to reduce the incidence of spills impacting on soil and water health.

Hazardous substances to be used at the site were screened against the thresholds in DPE's (2011) *Applying SEPP 33* to determine if the project will be hazardous or offensive development under State Environmental Planning Policy No. 33 – Hazardous and Offensive Development (SEPP 33). The quantities of dangerous goods proposed to be stored and handled at the project will be below the thresholds in *Applying SEPP 33*. Therefore, the project will not be a hazardous development.

The project site is on bushfire prone land. Detailed assessment has identified several points of upgrade to ensure protection of the site as well the provision of infrastructure to support firefighting efforts by the NSW Rural Fire Service. The implementation of these measures will protect Boral assets and improve protection of surrounding land.

Boral will update the existing pollution and incident response management plan, along with emergency and bushfire management procedures to reflect the project, which will continue to be implemented at the site to reduce hazards and risk associated with the continuation of sand extraction operations.

Economics

The project was considered for economic effects at a local and regional scale. The methods of determining economic effects were a cost benefit analysis (CBA) model that included consideration of the project not proceeding and the site operations ending in 2028.

CBA is concerned with whether the incremental benefits of the project exceed the incremental costs and, therefore, whether the community would, in aggregate, be better off 'with' the project compared to 'without' it. The CBA compared the production and environmental costs with the production benefits, such as the value of the sand resource and residual land values at the end of the project.

The CBA determined the project will have net social benefits to Australia of $41 million (M) and to NSW of $17 M including employment benefits and a 7% discount rate. Any unquantified residual impacts of the project after mitigation, offset and compensation would need to be valued at greater than these amounts for the project to be questionable from a national and NSW economic efficiency perspective.

Given this would not be the case, the project is desirable and justified from an economic efficiency perspective.

Rehabilitation

The project site is generally consistent with the footprint of the previous inland extraction area, which has and continues to be subject to rehabilitation in accordance with the *Rehabilitation and Landscape Management Plan* (ERM, 2010). The rehabilitation and landscape management plan outlines rehabilitation methods comprising species selection, weed and pest management measures, and monitoring and reporting requirements for rehabilitated areas.

A project specific rehabilitation strategy has been formulated, which aims to integrate the successful aspects of previous rehabilitation efforts at the site.

Upon completion, the project site will be left as a freshwater pond and rehabilitation will comprise:

- rehabilitating the pond edge, to provide additional habitat for native fauna;
- plant species planted along the edges of the pond will be selected to maximise the bank stability; and
- stabilising re-profiled areas as soon as possible, minimise potential erosion and degradation of areas of exposed topsoil.

In the initial phases of work, rehabilitation will primarily aim to stabilise the edge of the pond and where necessary continued use of a poly pipe to form a floating boom system at the exposed pond edge to minimise erosion.

Disturbed areas will be progressively rehabilitated to achieve the final landform. The general rehabilitation objectives are:

- rehabilitated land will be geotechnically stable and will not present a greater safety hazard than surrounding land to land-users, the public and native fauna accessing or transiting the post-quarried area;
- land capability will, as far as possible, be returned to a class similar to that existing prior to project commencement (class 5 or 8).
- rehabilitated landforms will be visually compatible with the surrounding natural landscape;
- rehabilitated landforms will be designed to drain surface runoff without causing excessive erosion or increasing downstream sedimentation;
- re-establishment of vegetation community which reflects the endemic ecology of the region and minimises the potential for weed invasion or vegetation community collapse; and
- rehabilitated landforms will not negatively impact visual amenity for nearby residents, thoroughfare motorists of Nelson Bay Road, or recreational users of Stockton Bight.

The objectives set out above would be reflected in an appropriate rehabilitation and landscape management plan.

Justification and conclusion

The Stockton Sand Quarry is a strategically important asset for Boral, as it supplies natural sand which has unique structural characteristics when compared to manufactured sand and is essential to meet design specifications on many infrastructure projects in Sydney, the Hunter region and other parts of NSW.

The project will provide the following benefits:

- supply of essential natural sand to major infrastructure and associated development projects;
- continued employment of four full time employees, one casual employee and truck/transportation drivers, with an additional two full time positions and two casual positions also created along with further employment benefits created through flow-on effects;
- optimal use of a regionally significant resource; and
- economic benefits to the nation, State and local community, including net benefits of $41 M and $17 M to NSW, along with employment benefits.

All potential amenity impacts from the project on sensitive receivers, comprising noise, air quality, visual and traffic impacts, will be below relevant criteria or have low residual impacts. The project will not have significant impacts on biophysical aspects such as surface and groundwater, and soil resources. However, the project will have residual impacts on terrestrial biodiversity, which will be compensated through the proposed biodiversity offset strategy.

The project will also have low residual impacts on groundwater quality and bushfire risk.

The project will have significant economic and social benefits and is in the public interest.

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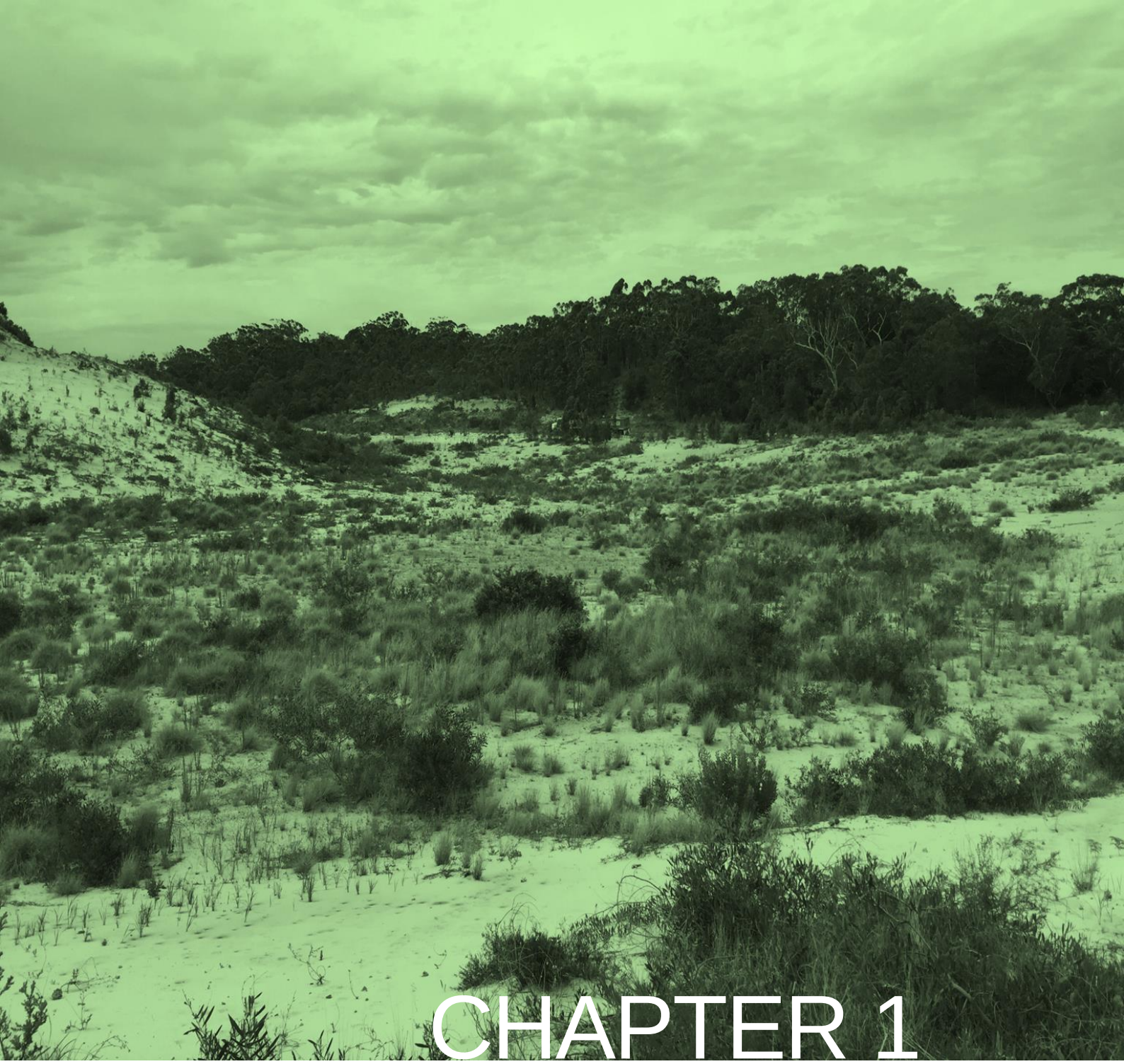


CHAPTER 1

INTRODUCTION

1 INTRODUCTION

1.1 Overview

Stockton Sand Quarry, located on Coxs Lane, Fullerton Cove is owned and operated by Boral Resources (NSW) Pty Ltd (Boral) and is legally described as Lots 1 and 2 in Deposited Plan 1006399 and Lot 3 DP 664552 ('the site').

The site has an area of approximately 246 hectares (ha) and has been used for the purposes of extractive industries (sand quarrying) since the 1970s. At present there is an existing quarry located on the windblown (transgressive) sand dunes of Stockton Bight which transports up to 500,000 tonnes per annum (tpa) of sand product for use in the building, landscaping and construction (the existing operation).

Due to current and future demand for sand in the Hunter and Sydney regions, Boral is seeking approval for continued and expanded operations at the site through a State significant development (SSD) application.

The proposed development (the 'project') involves the extraction of sand from the inland vegetated dunes of the quarry in a staged process by front-end loader/excavator to a depth of 4 metres (m) Australian Height Datum (AHD) in Stage 1 and subsequent dredging from 4 m AHD to -15 m AHD in stages 2-6.

The 'project site' contains all areas to be disturbed by project operations and covers an area of approximately 37 ha.

The application seeks permission for a site-wide increase on the transport limit to 750,000 tpa (i.e. the windblown sand extraction area and the project operations combined) until 2028, after which the site wide limit will reduce to no more than 500,000 tpa. The project will operate up to 25 years.

This environmental impact statement (EIS) has been prepared by Element Environment Pty Ltd (Element), on behalf of Boral for submission to the Department of Planning, Industry and Environment (DPIE) to satisfy the provisions of Part 4 of the NSW *Environmental Planning & Assessment Act 1979* (EP&A Act).

1.2 Project need, justification and alternatives

This section outlines the strategic need and justification for the project, and describes the alternative options considered during conception of the project.

1.2.1 Need and justification

Boral is a leading producer and supplier of building and construction materials in the country. Accordingly, a significant amount of development in NSW, including many of NSW's best known structures, are underpinned by Boral-supplied concrete, cement, asphalt and construction materials such as natural sand.

The leading suppliers of natural sand are under pressure to meet increased demand from approved infrastructure projects in Sydney, Newcastle and other parts of NSW as natural sand has unique structural characteristics to manufactured sand and is essential to meet design specifications on many infrastructure and associated development projects.

The project will provide:

- supply of essential natural sand to major infrastructure and associated development projects;

- continued employment of four full time employees, one casual employee and truck/transportation drivers, with an additional two full time positions and two casual positions also created along with further employment benefits created through flow-on effects;
- optimal use of a regionally-significant resource; and
- economic benefits to the nation, State and local community, including net benefits of $41 million (M) and $17 M to NSW, along with employment benefits.

Resource quality

Sand suitable for use in the construction and foundry industries occurs in the Stockton Bight dunes. Although the entire sand unit possesses some potential for a particular use, there are optimum areas from which these materials can be obtained. Previous resource investigations carried out at the quarry in 2013 and 2016 confirm the sand within Boral's land holding comprises a fine to medium grained sand suitable for use as a fine aggregate in concrete.

Sand suitable for concrete use must comply with relevant Australian Standards, and factors such as grain shape, composition and grading of the sand must be considered. The sand must be clean, fine to medium grained, and free of deleterious materials including friable particles, organic impurities, structurally weak substances, and alkali reactive materials. The sand in Boral's land holding meets these requirements and the main use proposed for the sand is concrete production within Boral's own concrete plants in the Hunter region and NSW beyond.

Leaching of the upper layers of vegetated dune sands, by organic acids, produces white, low iron sand below the organically enriched sandy topsoil layer. The leached white sand layer on Boral's property is of variable thickness but is generally thin. Below this thin white sandy capping there is a zone of iron enrichment, the sandy material within this zone being commonly termed ‘coffee rock’ or ‘waterloo rock’. This material varies in character from a thin crusty layer of loosely bound iron coated sand grains to a thick layer of moderately iron stained amber-brown sand. ‘Coffee rock’ or ‘waterloo rock’ is unsuitable for concrete production and (where it occurs) is blended with the thin white sand layer above (where it occurs) to produce a fill sand or is reused elsewhere on site for the purposes of rehabilitation. .

Fill sand is used in numerous construction applications, including use as a support filler under house slabs, as a filter material for pipe bedding and as a drainage layer under roads. Sand used for this purpose does not have to conform to the rigid specifications outlined for specialised sands. The sand, however, needs to be reasonably 'clean' (some impurities such as charcoal, shell material, and iron-staining can be tolerated) and not too fine grained.

In the manufacture of concrete, the fine aggregate component is achieved by blending fine sand with a coarse sand. In Boral’s case, the coarse sand is manufactured sand, which is a made from further processing of quarry dust which is a by-product of the crushing process.

Stockton fine sand is ideally matched to manufactured sand from Boral’s Peppertree Quarry, which supplies most of Boral’s concrete production requirements in the Hunter and Sydney regions. This means that Stockton sand allows the greatest utilisation of manufactured sand in the concrete blend, and therefore better utilises this scarce resource over a greater volume of total production than would otherwise have been produced with a less superior grading.

In this regard, Boral’s Stockton sand resource reduces the natural fine sand usage, and avoids the need to find and develop a more resource intensive source of fine sand.

Locational factors

In terms of weight and volume, more sand products have to be quarried and transported to construction sites than any other type of resource material. It is for these reasons that extractive sand sources need to be located as close as possible to the point of usage. The value to weight ratio is very low, making transport costs to the market highly sensitive.

Establishing sand extraction operations close to the construction market represents considerable savings in terms of construction and associated transport costs for projects in the Hunter region and greater Sydney that are to be serviced by the quarry. Over the life of the quarry this represents a significant benefit to the local community and the state in terms of reduced transport and associated infrastructure maintenance costs.

Alternative materials

Minor quantities of manufactured sand are derived from quarrying and processing of hard rock (quarry dust). Manufactured sand is assisting to prolong the life of the natural sand reserves, however manufactured sand is generally not suitable for use in concrete on its own and is typically either used in road base or blended with natural sand to produce an acceptable grade concrete sand.

Future demand

The demand for construction materials in major infrastructure and construction projects in the Lower Hunter Region and Sydney has been high in recent years and is expected to be strong for the foreseeable future.

Fine sand is a major component of concrete, particularly for domestic applications. For example, an average three bedroom brick veneer home on a concrete slab foundation, with concrete paths and driveways, consumes in the order of 50 cubic metres (m^3) of concrete, which contains 13 tonnes (t) of fine sand.

Boral uses sand extracted from the site as the fine sand component in concrete production. The future demand for fine grained sand will correlate with anticipated growth in residential development, commercial development, and major infrastructure and construction projects in the Hunter Region and Sydney during the next 15-20 years.

The growth of development in the Hunter region is driven by the Hunter Regional Plan 2036 (NSW Department of Planning and Environment, 2016). As detailed in the plan, the Hunter region is the largest regional economy in Australia, with the population of the region expected to grow by approximately 600,000 people over 20 years. The plan estimates an additional 70,000 dwellings would be required by 2036 to house the expanding population, together with forecast major commercial and health infrastructure development including proposed expansions of the University of Newcastle and John Hunter Hospital, and upgrades to transport infrastructure at Newcastle Airport, Port of Newcastle and strategic road networks (e.g. Nelson Bay Road duplication and extension of the Newcastle Inner City Bypass).

These projects would be reliant on concrete and other construction materials, of which fine sand resources, such as those to be extracted at the site, are a vital component.

Life of operation

Boral proposes to extract approximately 9 million tonnes (Mt) of sand for up to 25 years.

Taking into account the site's existing operation, Boral is seeking a maximum site transport limit of 750,000 tpa (over the two projects) to 2028 when the extraction on the transgressive dunes is due to cease. At this time the transport limit will reduce to 500,000 tpa.

To allow for flexibility between the two projects, the project has been assessed based on a site wide maximum extraction and transport rate of 750,000 tpa.

1.2.2 Project alternatives

The following options were considered during formation of the preferred project.

Do nothing

Sand extracted from the quarry is used in the Hunter and Sydney regions. Boral's sand resource across all assets have been substantially depleted due to sustained demand across the building and construction industry.

The quarry will cease to operate in approximately three years' time if the project is not approved due to demand trends for natural sand products. This will result in loss of employment, reduced revenue to local service providers, reduced regional expenditure in the Port Stephens and Newcastle local government areas (LGA), sterilisation of a valuable resource and shortages of raw materials for essential infrastructure projects in the Hunter and Sydney regions, including provision of concrete and raw sand for road and rail upgrades, industrial development, and commercial and residential developments to be driven by the Hunter Regional Plan 2036.

The sand deposit at the site is highly suitable for use in concrete and is close to the source of demand.

Given that local demand for natural construction sand is unlikely to diminish, and the site is ideally located at the southern end of Stockton Bight to supply the Lower Hunter and Sydney market, it is most likely that other Stockton Bight sand suppliers further to the north will take up a shortfall in Boral's production if the quarry closes. As such, there is a possibility that sand will be purchased from elsewhere, likely further away from the end use. In this case, it is likely that road transport impacts will be compounded, and will increase the cost of sand and concrete.

Additionally, Boral will be required to purchase sand from other approved or yet to be approved Stockton Bight quarries. While it is not possible to clearly compare environmental impacts in this case, the project has a limited environmental effect as it is confined to an area which has been disturbed by quarrying operations in the past.

Additionally, because of the likelihood of alternate supply source being of a different grading, there is a greater likelihood that more fine sand will be required for extraction and transport in order to produce one cubic metre of concrete, when compared to the combination of fine sand resource extracted from Stockton Sand Quarry combined with Boral's manufactured sand source.

In summary, should the project not proceed, Boral will close the quarry in due course and have to rely on other sand sources locally or further afield, depleting those resources sooner. Importantly, not proceeding will mean that the community will lose the opportunity to allow the further development of an existing quarry operation with minimal environmental impacts. Conversely, alternative developments may require the disturbance of greenfield land parcels with more inherent environmental risks.

Alternative locations

As outlined earlier, the quarry is one of Boral's few remaining natural sand quarries. Boral's natural sand quarries are operating at full capacity in response to the significant increase in demand for natural sand.

The quarry is an ideal site to meet current and predicted future demand for natural sand as it has a substantial remaining natural sand resource and is relatively close to Boral's existing Hunter and Sydney supply contracts.

Other sand resources on Stockton Bight lie on Crown lands and, to a lesser extent, on freehold lands. Most sand deposits on freehold lands are already owned or being extracted by the construction sand industry. A few isolated sand bearing properties remain but the size of the sand deposits are generally too small for economical development.

Many millions of tonnes of sand lie on Crown lands on Stockton Bight but are unavailable for extraction by virtue of environmental protection zoning. Sand on Crown lands closer to Anna Bay

which have appropriate zoning for extraction is generally too fine grained for concrete, being more suited to foundry applications and glass manufacture.

The dune sands on Stockton Bight need little or no processing to produce a grain size grading suitable for concrete manufacture. The only other source of sand in the region is the processing of soft rock. Friable sandstones at Blackhill, matrix sand from conglomerates at Teralba and overburden sediments in coal mines are examples, but in each of these cases, the cost of extraction and processing to produce suitably graded sand will be considerably higher than extracting the loose, naturally graded sands of Stockton Bight.

There are millions of tonnes of remaining sand suitable for production of concrete at the site. Several alternative scenarios were explored for the development of this remaining sand, culminating in the conclusion that the project represents the most environmentally, socially and economically sensible option.

Alternative materials

There are few alternative materials to replace natural sand in the production of concrete. Alternative materials are emerging, which represent viable supplements to natural sands, but not as replacements to natural sands. In recognition of the value of such alternatives, Boral is increasing its recycling and production of manufactured sand.

Manufactured sand created from quarry dust generated by the crushing of hard rock. Quarry dust is mainly blended into road bases, but many quarries process some of the dust to produce coarse sand for blending with finer grained natural sands to produce acceptable grade concrete sand.

Therefore, the alternative manufactured sand option is already being used to extend the life of natural fine grained sand sources. The inability of manufactured sand to be a complete replacement for natural sands is due to several factors. Quarry dust generally has a particle shape that is angular and often elongated, making concrete flow and concrete workability very difficult. Quarry dust also tends to be deficient in the fine end of the particle range and the addition of fine grained natural sand is required to fill out the grading. The addition of fine grained natural sand also helps concrete workability as the natural sands are often rounded.

Barmac crushing can be used to produce a dust with a better particle shape, but this in turn produces greater volumes of dust. A compromise is usually made, which invariably requires the use of natural sand to even out grain shape and particle size deficiencies.

Boral is engaged in ongoing research and development into the production of manufactured sand to supplement the natural sand market. In the immediate term Boral is investigating options to utilise glass sand or recovered sand from virgin excavated natural material (VENM). However, these sources are yet to receive approvals.

In the case of glass sand, commercial production levels are low (as a new recovered resource and burgeoning industry) and the planning approvals necessary to permit the importation and blending of these materials to create building products is not widely accepted by consent authorities.

Additionally, recovered sand product from processing VENM does not typically yield the same high-quality product as that proposed to be extracted from the quarry. Cumulatively this will impact on the production of key building materials, in particular the production of concrete which will have wider implications for the building and construction industry in the Hunter and Sydney regions.

Alternative non-naturally occurring materials exist which can substitute to some extent for the naturally occurring construction sand sources. Examples are recycled building and demolition waste, granulated blast furnace slag and fly ash from coal fired power stations. However, these alternatives generally have high handling, transport and processing costs, although they are commonly used for road base and other applications.

Boral is actively involved in construction and demolition recycling with a major plant at Wetherill Park in Sydney and approved operations at Somersby on the Central Coast and Kooragang Island. The products from these operations supplement the natural sand market.

Whilst new innovation in alternative materials is emerging, the need for constant supply of fine natural sands for concrete production remains integral.

Alternative project design

Various options were considered when formulating the preferred concept of the project. Such options included:

- Extension of the extraction footprint beyond the 1996 development consent boundary, and subsequent extraction and dredging of this footprint. This option will maximise access to sand resource but increase the degree of environmental impacts from the site.
- Extension of the extraction footprint beyond the 1996 development consent boundary, inclusive of sand extraction to 4 m AHD with no dredging operations. This option will reduce the degree of ground disturbance as is experienced with dredging but will also increase the area of environmental impact and fail to maximise use of the sand resource beneath 4 m AHD.

Confinement of the project to the previously disturbed inland extraction area development consent boundary will result in the least environmental and social impacts.

There are no standardised industry guidelines that inform sand quarrying methods, and as such there is no definitive source that advocates dry extraction methods over wet extraction methods. The method employed is driven by the accessibility, quality and location of an identified resource.

To date, dry extraction methods have typically been adopted to extract sand from the site and other operating sand quarries within the Port Stephens and Newcastle LGAs. However, despite this localised dominance of dry extraction methods, in land sand dredging (i.e. dredging outside marine, estuarine or river environments) is an accepted approach to quarry operations and can be undertaken to achieve ‘best practice’. An example of this is Boral’s Dunmore Sand and Soils has been operating on the south coast of NSW for over 30 years without incident.

In relation to the project, the quarrying approach or method has been developed and selected with the view to avoiding impacts where possible. This avoidance strategy has informed the analysis and identification of options at every step of the project from site selection to plant material identified for use on site. The project approach adopted by Boral in the context of the site is considered to be reflective of best practice.

Table 1.1 outlines the various options considered for the project design and reasoning as to why the preferred project was selected.

Table 1.1: Project design considerations

Project element	Options	Considerations	Why the preferred option?
Source/location of works	Existing site; New site; or Land based extraction or marine extraction	There are several other sand reserves and operations within proximity to the site. These are currently owned by Boral competitors and are not viable options. Boral has and continues to investigate alternative resource sites across NSW. Investigations have not been identified as suitable alternative to date due to the following: ▪ capital costs; ▪ availability of an alternate site with the appropriate sand quality; and ▪ legal and planning framework. Marine based sand extraction is not currently supported by existing legal frameworks.	Investigations of the south coast of NSW failed to identify a new site or resources that were suitably zoned or located near transport infrastructure or customers. On balance, there was a lack of availability of viable new sites. Accordingly, Boral selected to progress an option to maximise the use and value of an existing asset. The benefits of utilising the existing site include: ▪ maximisation of an existing asset; ▪ permissible/consistency with established planning framework; and ▪ previous disturbance on the site results in reduced potential for new or additional impacts, particularly in relation to archaeology/biodiversity etc.
Extraction methodology	Dry extraction or wet extraction	To obtain the same volume of sand resource using dry extraction would require works to stay at RL 4 m AHD, thereby requiring removal of approximately 106 ha of vegetation. This alternate footprint would expand to include areas to the west of the preferred project site, extending towards Nelson Bay Road and east south east along the shared Worimi lands boundary towards Stockton Bight and the existing windblown sand extraction area. The majority of this land has not been previously disturbed by earlier extractive industries. Increasing the disturbance footprint would increase the environmental impacts (e.g.	Wet extraction techniques support a reduced disturbance footprint that can be contained to an area that has been previously disturbed. The smaller footprint avoids unnecessary harm to biodiversity and potential archaeology, and minimises visual amenity, noise, air quality and social impacts. Wet extraction techniques generally have less residual environmental impacts involving minimal truck movements to extract the material, and minimal air emissions as wet stockpiled material does not generate dust.

Project element	Options	Considerations	Why the preferred option?
		vegetation removal, noise, air quality, visual impacts, social, heritage/archaeology). Increased use of water required to minimise windblown sand. Visual impacts – to achieve the same volume of resource, dry extraction techniques would require an increase in the area of land cleared.	
Wet extraction methods	Possible methods for wet extraction: ▪ dredge; or ▪ dewater aquifer (to support dry extraction).	The option to dewater the aquifer would have increased impacts by lowering the aquifer by pumping water from the aquifer for storage in water tanks or similar. These techniques remove water from the aquifer until dry extraction methods can be used, thereby compounding the potential for adverse and increased environmental and social impacts. The range of impacts that could arise from a dewatering method would include those associated with lowering of the water table including, increased potential for the generation of ASS, impact on groundwater dependent ecosystems, impact on other groundwater users, and impact on groundwater and surface water recharge and the water cycle.	It is evident from the potential array of impacts likely to result from dewatering that dredging is the best outcome based on the reduced potential for adverse environmental impact. It also presents as the most practical option, as the water is not required to removed and stored elsewhere while operations progress.
Dredge type	There are multiple dredge types, including: ▪ mechanical; ▪ hydraulic; and/or ▪ electric.	Mechanical – not appropriate for fine sand material types, increased costs; noise from heavy plant; intensity of operation (management issues). Hydraulic dredge better than mechanical when working with fine material. However, requires the use of more oils and required to be stored on a pontoon in the dredge pond. The option to use an electric dredge reduces the need to introduce oils to water there by reducing the potential for water pollution.	The electric dredge will not reduce the need to use oils and lubricants that can pose a potential impact to groundwater quality. This type of dredge is also well suited to working with fine grained sand material.
Electric dredge types	Options considered: ▪ suction dredge; or	Cutter-suction dredges are typically used on hard surface materials such as gravel. The cutting action increases noise generation and	The fine to medium grained sand material present at the site is better suited to the use of a suction dredge as it

Project element	Options	Considerations	Why the preferred option?
	▪ cutter suction dredge	contributes to increased turbidity (lowering water quality). Use of a cutter-section dredge is not suitable for the material type due to free flowing nature of sand not requiring cutting.	is relatively free flowing and does not require cutting. The suction dredge, in part due to the material, will have low noise operating levels and will not increase turbidity in the same manner.
Wash plant	Options considered: ▪ cyclone (dewater); ▪ screw (dewater); and/or ▪ dewatering screen.	The process of washing sand ensures a higher quality of product allowing the resource to be used for a broader range of end uses. The following matters were considered in identifying the preferred washplant/dewatering plant: ▪ Product quality; ▪ Efficiency of the plant and capacity to remove excess moisture from product; and ▪ Cost of maintaining and operating plant **Screw/sludge dewatering** relies on gravity for water and sand to be separated. The resultant moisture content in the sand tends to be higher, requiring longer stockpiling times and potentially increases the volumes of trucks required to move product (as a higher moisture content will increase the weight thereby reducing product volume able to be moved).	The preferred wash/dewatering plant is the pre-screen; cyclone dewatering screen. The method of washing the sand has been selected with the aim of improving the quality of the end resource as well as removing as much water/moisture content as possible. Dewatering using cyclone is more efficient achieves a lower moisture content than screw or gravity dewatering process. Allowing for material to be removed and dispatched faster while negating the need to stockpile large quantities of material for long periods of time (thereby avoiding material being lost through wind erosion or affecting local air quality).
Utilities (power)	Diesel generators or electricity network supply	The depot is currently connected to the local power grid. Investigations were made into extending power further into the site to reduce reliance on diesel, which would have an improved emissions outcome and reduce the volume of and use of fuels on site. However, in the short term this option is not financially viable.	In the short term use of diesel fuels to support the generators and operation of the dredging plant will be implemented. To ensure the protection of the underground aquifer refuelling techniques including handfilling will be adopted, which are known to have a reduced incidence of spillages.

Project element	Options	Considerations	Why the preferred option?
		Furthermore, dependant on the alignment of the electricity conduits there is potential for increased impact on vegetation.	All refuelling of mobile plant will occur within the depot where there is permanent, impervious surface and bunding to prevent the migration of fuels through sand to the aquifer.
Stacker options, used to stockpile product (affixed to the washplant)	Options considered included: ▪ telescopic stacker (fully automated); and/or ▪ radial/fixed stacker.	Radial fixed stackers stockpile material in a standard conical fashion with the arm of the stacker static over a single position until the stockpile height is achieved. This method results multiple conical stockpiles and in issues of product segregation (course to medium material located at the base and around the edges with finer grain material centralised to the centre conical), thereby resulting in a poorly blended and degraded material. Radial fixed stackers also result in higher levels of dust as re-blending is typically required. The process of re-blending would result in increased environmental impacts associated increased vehicle movements and formation of the stockpiles (separated finer material at the top is more susceptible to windblown losses). Less vehicle movements would be required as no double handling (reduced vehicles; reduced dust so improved air quality).	The telescopic stacker stockpiles in specification material and limits the need for re-blending. This in turn reduces the generation of dust and improves air quality as the product is not unnecessarily moved around or 'processed'. The telescopic conveyor builds layered windrows to minimise material segregation, and can increase stockpile capacities by 30%.
Waste management – screened material	Options considered included: ▪ Dispose off-site; and/or ▪ Reuse on site.	Option to reuse on site as road base on haul roads (maintenance and construction) or direct to landfill off-site. Disposing of material off-site contributes to increased costs, truck volumes and associated noise and potential traffic impacts.	Reuse is the most practical and viable outcome in relation to avoiding unnecessary costs in terms of disposal and transportation. Reuse avoids unnecessary environmental impacts associated with additional truck movements, noise, dust and the like.
Vegetation clearing	Options considered: ▪ clear all vegetation in a single stripping campaign; or	Increased areas of clearing have the potential to increase the rate of erosion by wind, impacting on air quality, local amenity and resource quantities.	Undertaking clearing efforts progressively reduces potential air quality impacts and prevents loss of resource.

Project element	Options	Considerations	Why the preferred option?
	▪ progressive campaign vegetation removal.		

1.3 Project objectives

The project has the following main objectives:

1. enable the continuation of sand extraction at a long standing quarry in an environmentally, socially and economically sustainable and ethical manner;
2. ensure the continued supply of essential natural sand to major infrastructure and associated development projects in the Hunter and Sydney regions;
3. continue the employment of four full time employees, one casual employee and truck/transportation drivers, with an additional two full time positions and two casual positions also created, along with further employment benefits created through flow-on effects;
4. promote optimal use of a regionally-significant resource; and
5. facilitate economic benefits to the local community through the purchase of goods and services and local expenditure both directly and indirectly through employee wages.

1.4 Project overview

The project is summarised in **Table 1.2** and described in detail in **Chapter 4**.

Table 1.2: Project summary

Project component	Summary of the project
Extraction method	Sand will be extracted from the inland vegetated dunes of the quarry to a depth of 4 m AHD in Stage 1 and subsequent dredging from 4 m AHD to -15 m AHD in Stages 2-6.
Resource	Approximately 9,032,138 tonnes of sand will be extracted.
Project site	The project site contains all areas to be disturbed by project operations plus ancillary areas such as the depot upgrades. It covers approximately 37 ha.
Transport (dispatch) limit	Up to 750,000 tpa of sand will be dispatched until 2028 when transport limits will reduce to 500,000 tpa.
Project life	25 years.
General infrastructure	The existing quarry comprises access and haul roads, administration offices and visitor/employee car parking facilities, weighbridge, electricity supply and distribution, utility infrastructure, workshop, stores and ablution buildings. New or augmented infrastructure will be constructed in Stage 1 will comprise: ▪ Construction of a new entry road. ▪ Construction of pad for the wash plant and diesel generators after vegetation removal and sand extraction in the northern portion of Stage 1. ▪ Relocation of the parking area and the security gates northward across the entry road to enclose the parking area and the new entry road. The docketing kiosk registering vehicles entering the site will also be relocated. Reconfiguration of the existing depot, to include: ▪ installation of a new prefabricated office building; ▪ relocation of onsite materials storage; ▪ replacement of roofing for the workshop; and ▪ installation of a 30,000 litre (L) water storage tank for firefighting.
Water use	Water will be supplied as follows: ▪ Water used for dust suppression purposes will be supplied via a water cart contractor from the potable water supply;

Project component	Summary of the project
	▪ Rainwater will be stored in a 10,000 L yank and used for on-site ablutions. It will be supplemented with purchased water supplied in bulk, as required; and ▪ drinking water will be imported to site in 20 L containers. The long-term average water use for existing dust suppression is approximately 12 megalitres (ML) per annum. However, there may be additional water use for dust suppression when there are higher than average dry days and the length of internal haul roads increase. A 30,000 L tank will be purchased to provide water for firefighting. Surface water runoff from active operational areas will infiltrate through the porous sandy soils to the underlying aquifer or directly drain to the newly formed dredge pond.
Operational workforce	Six full time and three casual employees.
Hours of operation	The project will continue to operate in accordance with the following approved hours of operation in the 2006 development consent: ▪ Monday to Friday – 6:15 am to 5:00 pm; ▪ Saturday – 6:15 am to 12 noon; and ▪ no operation on Sundays or Public Holidays. The site is also approved to operate extended hours during major supply contracts as follows: ▪ Monday to Friday – 6:15 am to 6:00 pm; ▪ Saturday – 6:15 am to 3:00 pm; and ▪ no operation on Sundays or Public Holidays.
Key environmental impacts and mitigation measures	The following potential key project impacts have been assessed: ▪ surface water and hydrology; ▪ groundwater; ▪ air quality; ▪ noise; ▪ Aboriginal heritage; ▪ biodiversity; ▪ traffic; ▪ economics; ▪ acid sulfate soils (ASS); and ▪ social. These assessments have identified environmental management and mitigation measures which will be implemented during establishment and operational phases of the project, to minimise environmental, social and economic impacts associated with the project.
Capital investment value	$3.43 million.

1.5 The applicant

Boral Resources (NSW) Pty Ltd is a wholly owned subsidiary of Boral Limited and is the applicant for the project. Boral Limited is an international building and construction materials group, headquartered in North Sydney, Australia. Boral's competitive position is underpinned by being a market leader in cement and construction materials in Australasia, Plasterboard in Australia and Asia and Cladding and Roof Tiles in the USA.

The Boral Australia division employs over 5,000 employees in its quarry, concrete, asphalt, concrete placing and cement operations. The business is a major supplier of products to the dwelling, commercial construction, and roads and engineering.

Boral Australia operates over 110 quarries producing products such as concrete aggregates, crushed rock, asphalt and sealing aggregates, road base materials, sand and gravels for the Australian construction materials industry.

1.6 Document purpose

The project is SSD pursuant to Schedule 1 of State Environmental Planning Policy (State and Regional Development) 2011 (SRD SEPP). Accordingly, approval is required under Part 4, Division 4.2 of the EP&A Act.

This EIS has been prepared by Element on behalf of Boral to support the SSD application for development consent under Section 4.12(8) of the EP&A Act. It has been prepared in accordance with the form and content requirements in clauses 6 and 7 of Schedule 2 of the NSW Environmental Planning and Assessment Regulation 2000 (EP&A Regulation).

The primary objective of this EIS is to inform the public, government authorities and other stakeholders about the project and the measures that will be implemented to mitigate, manage and/or monitor potential impacts, together with a description of the remaining (residual) social, economic and environmental impacts.

It addresses the specific requirements in the Secretary's environmental assessment requirements (SEARs) issued by DPIE on 16 November 2018. The SEARs are in **Appendix A** along with a table identifying where each requirement has been addressed in the EIS. The EIS has also been prepared with input from several technical specialists.

1.7 Secretary's environmental assessment requirements

The SEARs and references to the relevant chapter and/or section of the EIS where they have been addressed are listed in **Table 1.3**. The requirements relevant to each environmental aspect are also provided at the introduction of each chapter for ease of reference. The SEARs (including government agency requirements) are reproduced in **Appendix A**.

Table 1.3: Project SEARs

SEARs	EIS reference/section
GENERAL	
The Environmental Impact Statement (EIS) for the development must meet the form and content requirements in Clauses 6 and 7 of Schedule 2 of the *Environmental Planning and Assessment Regulation 2000*. In particular, the EIS must include:	Section 6.3.6
▪ a standalone executive summary;	Executive Summary
▪ a full description of the project, including: - a summary of the regional and local geology;	Chapter 2
- the history of past production undertaken in proximity to the proposed development	Chapter 3
- the resource to be extracted, including the amount, type, quality and composition;	Section 1.2.1 and 4.3
- the site layout and extraction plan, including cross sections;	Chapter 4

SEARs	EIS reference/section
- the production process and processing activities, including the in-flow and out-flow of materials and points of discharge to the environment;	Chapter 3 and 4
- surface infrastructure and facilities (including any infrastructure that would be required for the development, but the subject of a separate approvals process);	Chapter 2, 3 and 4
- a waste (overburden, rejects, tailings etc) management strategy;	Chapter 19
- a water management strategy;	Chapter 17
- a rehabilitation strategy to apply during, and after completion of, extraction operations, and proposed final use of site;	Chapter 22
- the likely interactions between the development and any existing, approved or proposed development in the vicinity of the site; and	Chapter 3 and 4
- a proposed production and transportation cap based on the maximum annual tonnage extracted;	Section 4.2.8
▪ a strategic justification for the development focussing on site selection and suitability of the proposed site;	Section 1.2
▪ a list of any approvals that must be obtained under any other Act or law before the development may commence;	Section 6.5
▪ an assessment of the likely impacts of the development on the environment, focussing on the specific issues identified below, including:	Chapters 8-22
▪ a description of the existing environment likely to be affected by the development, using sufficient baseline data;	Chapter 2
▪ an assessment of the potential impacts of all stages of the development, including any cumulative impacts, taking into consideration relevant laws, environmental planning instruments, guidelines, policies, plans and industry codes of practice;	Chapters 8-22
▪ a description of the measures that would be implemented to mitigate and/or offset the potential impacts of the development, and; an assessment of: - whether these measures are consistent with industry best practice, and represent the full range of reasonable and feasible mitigation measures that could be implemented;	Chapters 8-22, Chapter 23
- the likely effectiveness of these measures; and	As above
- whether contingency plans would be necessary to manage any residual risks;	As above
▪ a description of the measures that would be implemented to monitor and report on the environmental performance of the development;	Chapter 23
▪ a consolidated summary of all the proposed environmental management and monitoring measures, highlighting commitments included in the EIS;	Chapter 23
▪ consideration of the development against all relevant environmental planning instruments (including Part 3 of the State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007); and	Chapter 6
▪ the reasons why the development should be approved having regard to:	Section 1.2, Section 6.3.2, Chapters 8-22
- relevant matters for consideration under the *Environmental Planning and Assessment Act 1979*, including the objects of the Act;	Section 6.3.1
- the biophysical, economic and social impacts of the project, including the principles of ecologically sustainable development;	Chapter 13 and 21, Section 6.3.2
- the suitability of the site with respect to potential land use conflicts with existing and future surrounding land uses;	Section 6.4.1

SEARs	EIS reference/section
- feasible alternatives to the development (and its key components), including the consequences of not carrying out the development;	Section 1.2
▪ a signed declaration from the author of the EIS, certifying that the information contained within the document is neither false nor misleading.	EIS Certification
While not exhaustive, Attachment 1 of the DP&E SEARS contains a list of some of the environmental planning instruments, guidelines, policies, and plans that may be relevant to the environmental assessment of this development. In addition to the matters set out in Schedule 1 of the *Environmental Planning and Assessment Regulation 2000*, the development application must be accompanied by a signed report from a suitably qualified expert that includes an accurate estimate of the: ▪ capital investment value (as defined in Clause 3 of the Environmental Planning and Assessment Regulation 2000) of the development, including details of all the assumptions and components from which the capital investment value calculation is derived; and	To be provided to DPIE separately to this EIS.
The EIS must address the following key issues:	
WATER	
▪ a detailed site water balance, including a description of site water demands, water disposal methods (inclusive of volume and frequency of any water discharges), water supply infrastructure and water storage structures;	Chapter 8 and 17, Appendix D and L
▪ identification of any licensing requirements or other approvals under the *Water Act 1912* and/or *Water Management Act 2000*;	
▪ demonstration that water for the construction and operation of the development can be obtained from an appropriately authorised and reliable supply in accordance with the operating rules of any relevant Water Sharing Plan;	
▪ a description of the measures proposed to ensure the development can operate in accordance with the requirements of any relevant Water Sharing Plan or water source embargo; and	
▪ an assessment of any likely flooding impacts of the development;	
▪ an assessment of the likely impacts on the quality and quantity of existing surface and ground water resources (having regard to the Williamtown RAAF Base Contamination Broader Management Zone), including a detailed assessment of proposed water discharge quantities and quality against receiving water quality and flow objectives;	
▪ a detailed description of the proposed water management system (including sewage), water monitoring program and other measures to mitigate surface and groundwater impacts.	
AIR QUALITY	
▪ detailed air quality impact assessment (AQIA) of potential construction and operational impacts, in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, and with a particular focus on dust emissions including PM2.5 and PM10, and having regard to the Voluntary Land Acquisition and Mitigation Policy.	Chapter 11, Appendix F
NOISE	
▪ a detailed assessment of the likely construction, operational and off-site transport noise impacts of the development in accordance with the Interim Construction Noise Guideline, NSW Noise Policy for Industry and the NSW Road Noise Policy respectively, and having regard to the Voluntary Land Acquisition and Mitigation Policy.	Chapter 10, Appendix G
BIODIVERSITY	
▪ accurate predictions of any vegetation cleared on-site;	Chapter 9, Appendix E

SEARs	EIS reference/section
▪ a detailed assessment of the likely biodiversity impacts of the development, paying particular attention to threatened species, populations and ecological communities and groundwater dependent ecosystems, undertaken in accordance with the Biodiversity Assessment Method and documented in a Biodiversity Development Assessment Report; and	
▪ a strategy to offset any residual impacts of the development in accordance with the offset rules under the Biodiversity Offsets Scheme.	
HERITAGE	
▪ an assessment of the potential impacts on Aboriginal heritage (cultural and archaeological), including evidence of appropriate consultation with relevant Aboriginal communities/parties and documentation of the views of these stakeholders regarding the likely impact of the development on their cultural heritage; and	Chapter 15, Section 5.4
▪ identification of historic heritage in the vicinity of the development and an assessment of the likelihood and significance of impacts on heritage items, having regard to the relevant policies and guidelines listed in Attachment 1 of the DP&E SEARs.	Chapter 18
VISUAL	
▪ an assessment of the potential visual impacts of the development on private landowners in the vicinity of the development and key vantage points in the public domain, paying particular attention to any new landforms.	Chapter 16
TRAFFIC AND TRANSPORT	
▪ accurate predictions of the road traffic generated by the construction and operation of the development, including a description of the types of vehicles likely to be used for transportation of quarry products;	Chapter 12, Appendix H
▪ a detailed assessment of potential traffic impacts on the capacity, condition, safety and efficiency of the local and State road network, paying particular attention to the intersections of Nelson Bay Road (MR108) / Coxs Lane (local road) and Nelson Bay Road / Seaside Boulevard (local road) (using SIDRA or a similar traffic model), including a road safety audit;	
▪ a description of the measures that would be implemented to mitigate any impacts;	
LAND RESOURCES	
▪ potential impacts on the broader coastal environment and dune system;	Section 14.2.2
▪ potential impacts on soils and land capability (including potential erosion and land contamination);	Section 14.1, Section 14.2.3, Section 14.2.4
▪ potential impacts on landforms (topography), paying particular attention to the long term geotechnical stability of any new landforms;	Section 4.2.5 and Section 14.2.1
▪ the compatibility of the development with other land uses in the vicinity of the development in accordance with the requirements in Clause 12 of State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007; and	Section 6.6.1
▪ impacts to any Crown land including Crown roads, reserves and tenures;	Section 6.5.2
HAZARDS	
▪ identification of contamination hotspots;	Section 14.2.4
▪ an assessment of the likely risks to public safety, paying particular attention to potential bushfire risks (including the identification of potential ignition sources during construction and operation) and	Chapter 20

SEARs	EIS reference/section
the transport, handling, storage and use of any chemicals, fuels and, hazardous or dangerous goods; and	
▪ proposed bushfire protection measures including vegetation management, fire suppression capabilities and operational access for firefighting appliances to the site;	Section 20.3
WASTE	
▪ estimates of the quantity and nature of the waste streams that would be generated or received by the development and any measures that would be implemented to minimise, manage or dispose of these waste streams;	Chapter 19
SOCIAL	
▪ a detailed assessment of the potential social impacts of the development that builds on the findings of the Social Impact Assessment Scoping Report, in accordance with the Social impact assessment guideline for State significant mining, petroleum production and extractive industry development, paying particular consideration to:	Chapter 13, Appendix I
- the full range of categories of potential social impacts identified in Section 1.1 of the SIA guideline;	
- how impacts (positive and negative) may be distributed among different groups in the affected communities;	
- the principles in Section 1.3 of the SIA guideline;	
- ensuring that the person preparing the SIA has appropriate qualification and experience as outlined in the Box 4 of the SIA guideline; and	
- the review questions in Appendix D of the SIA guideline.	
ECONOMICS	
▪ a detailed assessment of the likely economic impacts of the development, in accordance with the Guidelines for the economic assessment of mining and coal seam gas proposals 2015, paying particular attention to:	Chapter 22, Appendix N
- the significance of the resource;	
- the costs and benefits of the project; identifying whether the development as a whole would result in a net benefit to NSW, including consideration of fluctuation in commodity markets and exchange rates; and	
- the demand for the provision of local infrastructure and services.	
REHABILITATION	
▪ the proposed rehabilitation strategy for the site having regard to the key principles in the Strategic Framework for Mine Closure, including:	Chapter 22, Appendix O
- rehabilitation objectives, methodology, monitoring programs, performance standards and proposed completion criteria;	
- nominated final land use, having regard to any relevant strategic land use planning or resource management plans or policies; and	
- the potential for integrating this strategy with any other rehabilitation and/or offset strategies in the region.	
STAKEHOLDER CONSULTATION	
During the preparation of the EIS, you must consult with relevant local, State and Commonwealth Government authorities, service providers, community groups and affected landowners.	Chapter 5

SEARs	EIS reference/section
▪ in particular, you must consult with: - affected landowners; - community groups; - Port Stephens Council; - Office of Environment and Heritage (including the Heritage Branch); - Environment Protection Authority; - Division of Resources and Geoscience within the Department; - Department of Primary Industries (including NSW Forestry, Agriculture and Fisheries); - Department of Industry (including the Crown Lands and Water Division); - Hunter Local Land Services; - Hunter Water; - NSW Health; - NSW Rural Fire Service; and - Roads and Maritime Services; and	Chapter 5, Appendix B
▪ The EIS must	
- identify where the design of the development has been amended and/or mitigation proposed to address issues raised; and	Section 5.2
- describe the issues raised;	Section 5.2
- describe the consultation process used and demonstrate that effective consultation has occurred;	Section 5.2
- otherwise demonstrate that issues raised have been appropriately addressed in the assessment.	Section 5.2 and 5.3

1.8 Document structure

This EIS includes the main report that describes the project in the context of the existing environment, the planning framework, key environmental issues, potential impacts, proposed mitigation measures and residual impacts. It is informed by the technical assessment reports in the appendices and summarises these documents.

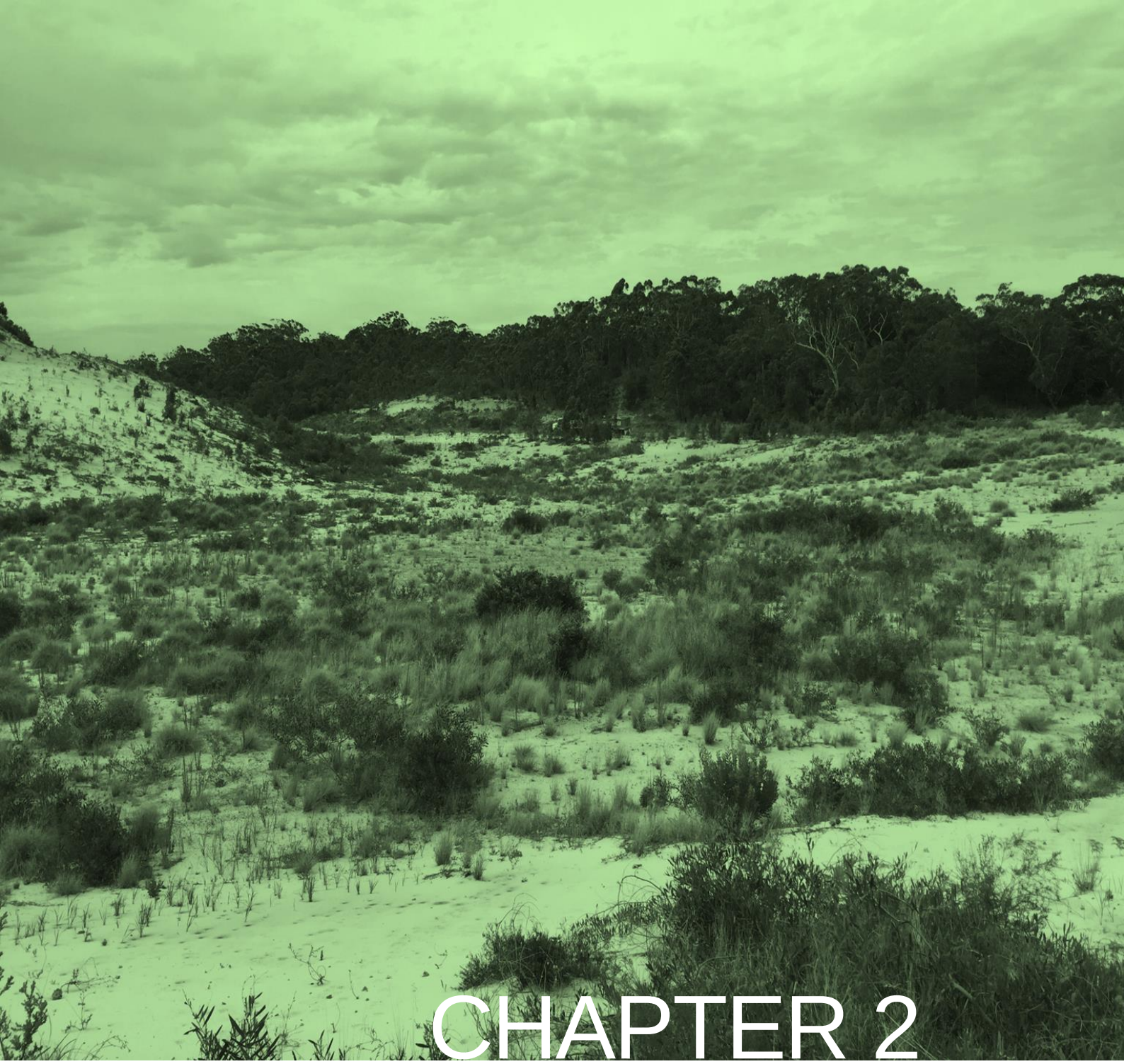
The structure of the EIS is summarised in **Table 1.4**.

Table 1.4: EIS structure

Chapter	Description
Main report	
Preliminary	▪ EIS certification. ▪ Executive summary.
Chapter 1: Introduction	▪ Discusses the background to the project. ▪ Introduces the project and the applicant. ▪ Discusses the justification for the project. ▪ Provides the document structure. ▪ Provides an overview of the approval process and SEARs issued for the project.
Chapter 2: Context and site analysis	▪ Provides an outline and description of the existing site status, location, land use and a description of the surrounding environment.
Chapter 3: Background and site operations	▪ Provides a description of the historical site ownership, planning approval history, existing quarry operations and current environmental management system.

Chapter	Description
Chapter 4: The project	▪ Describes the project including construction and operational parameters.
Chapter 5: Stakeholder engagement	▪ Discusses the engagement strategies of the project. ▪ Details how consultation has been addressed in the EIS.
Chapter 6: Legislative framework	▪ Identifies the applicable local and regional environmental planning instruments, the relevant State and Commonwealth environment and planning legislation and regulations and discusses other approvals and permits that may be applicable to the project.
Chapter 7: Environmental assessment approach	▪ Introduces the approach taken by the project team to identify key environmental, social and economic issues associated with the project and how these issues were considered in the environmental assessment process.
Chapter 8-22: Environmental impact assessment	▪ These chapters assess key environmental issues, and the potential impact of the project. ▪ Describes the management measures proposed to mitigate and reduce potential adverse environmental risk of the project and/or offset any unavoidable impacts.
Chapter 23: Environmental management, monitoring and reporting	▪ Provides a consolidated summary of all recommended management and mitigation measures identified by the EIS, and outlines Boral's approach to responsible environmental management, monitoring and reporting of the project.
Chapter 24: Conclusion	▪ Draws conclusions based on the overall impacts and benefits of the project.
Chapter 25: References	▪ Contains references used throughout this EIS.
Chapter 26: Abbreviations	▪ Abbreviations.
Appendices	
Appendix A: SEARs and Government Agency Requirements	▪ Secretary's environmental assessment requirements (November 2018) including Government Agency response letters to the preliminary environmental assessment (PEA) and SEARs. ▪ Table summarising SEARs and government agency comments in response to the SEARs and references to where requirements are addressed in the EIS.
Appendix B: Stakeholder Consultation	▪ Correspondence to and responses from government agencies consulted for the project.
Appendix C: Desktop and background searches	▪ Results of public environmental database searches.
Appendix D: Hydrogeological Impact Assessment Report	▪ Hydrogeological Impact Assessment Report (EES 2019a).
Appendix E: Biodiversity Development Assessment Report	▪ Biodiversity Development Assessment Report (Niche 2019).
Appendix F: Air Quality Impact Assessment Report	▪ Air Quality Impact Assessment Report (TAS 2019).
Appendix G: Noise Impact Assessment Report	▪ Noise Impact Assessment Report (Wilkinson Murray 2019).
Appendix H: Traffic Impact Assessment Report	▪ Traffic Impact Assessment Report (TUP 2019).
Appendix I: Social Impact Assessment Report	▪ Social Impact Assessment Report (Element 2019).

Chapter	Description
Appendix J: Acid Sulfate Soil Impact Assessment Report	▪ Acid Sulfate Soil Impact Assessment Report (EES 2019b).
Appendix K: Aboriginal Cultural Heritage Assessment Report	▪ Aboriginal Cultural Heritage Assessment Report (KNC 2019).
Appendix L: Surface Water Impact Assessment Report	▪ Surface Water Impact Assessment Report (Southeast 2019)
Appendix M: Bushfire Hazard Assessment Report	▪ Bushfire Hazard Assessment Report (NBC 2019).
Appendix N: Economics Assessment Report	▪ Economics Assessment Report (Gillespie 2019).
Appendix O: Rehabilitation Strategy Report	▪ Rehabilitation Strategy (EES 2019c).



CHAPTER 2

CONTEXT AND SITE ANALYSIS

2 CONTEXT AND SITE ANALYSIS

2.1 Location

The site is in Fullerton Cove, approximately 9.8 kilometres (km) north-north-east of the Newcastle central business district (CBD) and in the Port Stephens LGA (refer to **Figure 2.1**).

The site is on Coxs Lane, a local road which connects with a private road over the adjacent Crown Reserve. Coxs Lane intersects Nelson Bay Road, a major arterial road which links the Newcastle CBD to Newcastle Airport, Nelson Bay and the wider Port Stephens area to the north (refer to **Figure 2.2**).

2.2 Land ownership

The site is owned and operated by Boral and covers approximately 246 ha. The land which comprises the site is defined in **Table 2.1** and shown on Figure **2.2**.

Table 2.1: Land comprising the site

Legal description	Location	Area (ha)	Ownership
Lot 1 DP 1006399	Eastern side of Nelson Bay Road, and a small portion on the western side of Nelson Bay Road	234	Boral
Lot 2 DP 1006399	Western side of Nelson Bay Road, with a small portion on the eastern side of Nelson Bay Road (formerly Part Lot 167, Part Portion 167)	10.4	Boral
Lot 3 DP 664552	Eastern side of Nelson Bay Road	1.6	Boral

Access to the site from Coxs Lane is over a Crown land title, legally described as Lot 7300 DP 1130730, with access permitted via licence agreement with the Crown Lands Division of DPIE.

2.3 Land use and zoning

Most of the site is zoned RU2 – Rural Landscape under the Port Stephens Local Environmental Plan (LEP) 2013. The portion of Crown land is zoned RE1 - Public Recreation, in which extractive industry is prohibited. The quarry is wholly located on land zoned RU2. The permissibility of the project and relevant aims and objectives of the RU1 and RE1 zones are discussed in **Section 6.3.1**.

Land to the north, south and east of the site is zoned E1 – National Parks and Nature Reserves, and this land is associated with environmental conservation areas of Stockton Bight. A portion of land adjacent to the north-east of the site is also zoned as E3 – Environmental Management.

Figure 2.3 shows the zones near the site.

2.4 Existing operations

Boral currently extracts sand from the transgressive dunes, referred to as the windblown sand extraction area (refer to **Figure 2.8**). Sand extraction commenced in 2008 in accordance with development consent DA 140-6-2005.

The development consent permits transportation of up to 500,000 tpa of sand products over 20 years.

The approved scope of works and method comprise:

- extraction of sand through regular harvesting of windblown sand and dry excavation of the dune mass;
- processing at the pit face by mobile power screen;
- maintenance of the haul road to transport sand from extraction area;
- transportation of 500,000 tonnes of sand from the site per year;
- haulage of product from existing depot/weighbridge to Nelson Bay Road and the wider road network; and
- progressive rehabilitation of extraction areas.

2.4.1 Site depot

There is a fenced depot at the site which contains:

- an amenities/office building providing an office, lunchroom, toilet and shower;
- weighbridge;
- designated parking area for employees and visitors; and
- maintenance shed for the front-end loader and 4,200 L above ground bunded fuel tank.

Power and telecommunications are connected to the depot and water is collected in rainwater tanks and wastewater is collected in a septic system.

2.4.2 Hours of operation

The site operates in accordance with the following approved hours of operation in DA 140-6-2005:

- Monday to Friday – 6:15am to 5:00pm;
- Saturday – 6:15am to 12 noon; and
- no operation on Sundays or Public Holidays.

The quarry is also approved to operate extended hours during major supply contracts as follows:

- Monday to Friday – 6:15am to 6:00pm;
- Saturday – 6:15am to 3:00pm; and
- no operation on Sundays or Public Holidays.

2.4.3 Site access and product transport

As highlighted in **Section 2.1**, access to the site is via Nelson Bay Road and Coxs Lane. Coxs Lane is a local roadway which terminates at the entrance to the quarry.

Boral transports up to 500,000 tpa of sand products by road from the quarry to local and regional consumers.

Boral uses the following transport routes:

1. **Newcastle supply contracts –** trucks exit the site and travel south along Nelson Bay Road towards Kooragang Island and Newcastle via Cormorant Road and Tourle Street.
2. **Central Coast, Sydney and Hunter Valley supply contracts –** trucks exit the site and travel south along Nelson Bay Road to the intersection with Seaside Boulevard, where the trucks perform a U-turn at the roundabout before travelling north along Nelson Bay Road, west along Cabbage Tree Road and Tomago Road, and then left onto the Pacific Highway and M1 south towards Sydney via Hexham. Trucks may also proceed via the New England Highway and/or Hunter Valley Expressway to the Hunter Valley and beyond.
3. **North Coast supply contracts –** trucks exit the site and travel south along Nelson Bay Road to the intersection with Seaside Boulevard, where the trucks perform a U-turn at the

roundabout before travelling north along Nelson Bay Road, and Medowie Road, and then right onto the Pacific Highway northbound.

4. **Port Stephens supply contracts –** on rare occasions (approximately 5% of supply contracts), trucks exit the site and travel south along Nelson Bay Road to the intersection with Seaside Boulevard, where the trucks perform a U-turn at the roundabout before proceeding north and then east along Nelson Bay Road towards Port Stephens.

2.4.4 Plant and equipment

Mobile equipment operated at the site comprises:

- a front-end loader (capacity nine tonnes);
- a dozer (part time);
- a water truck (13,000 L capacity); and
- a mobile screen (20 millimetre (mm) mesh screen and a 5 m^3 capacity receiving bin).

2.4.5 Employment

Boral employs four full time staff along with one casual staff member in the operation of the existing quarry. The existing operation also provides employment opportunities for numerous Boral and customer truck drivers and associated service personnel.

Figure 2.1
Regional context

STOCKTON SAND QUARRY DREDGING
ENVIRONMENTAL IMPACT STATEMENT



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Source: LPI (2018), Boral (2018), Cambium Group (2020).

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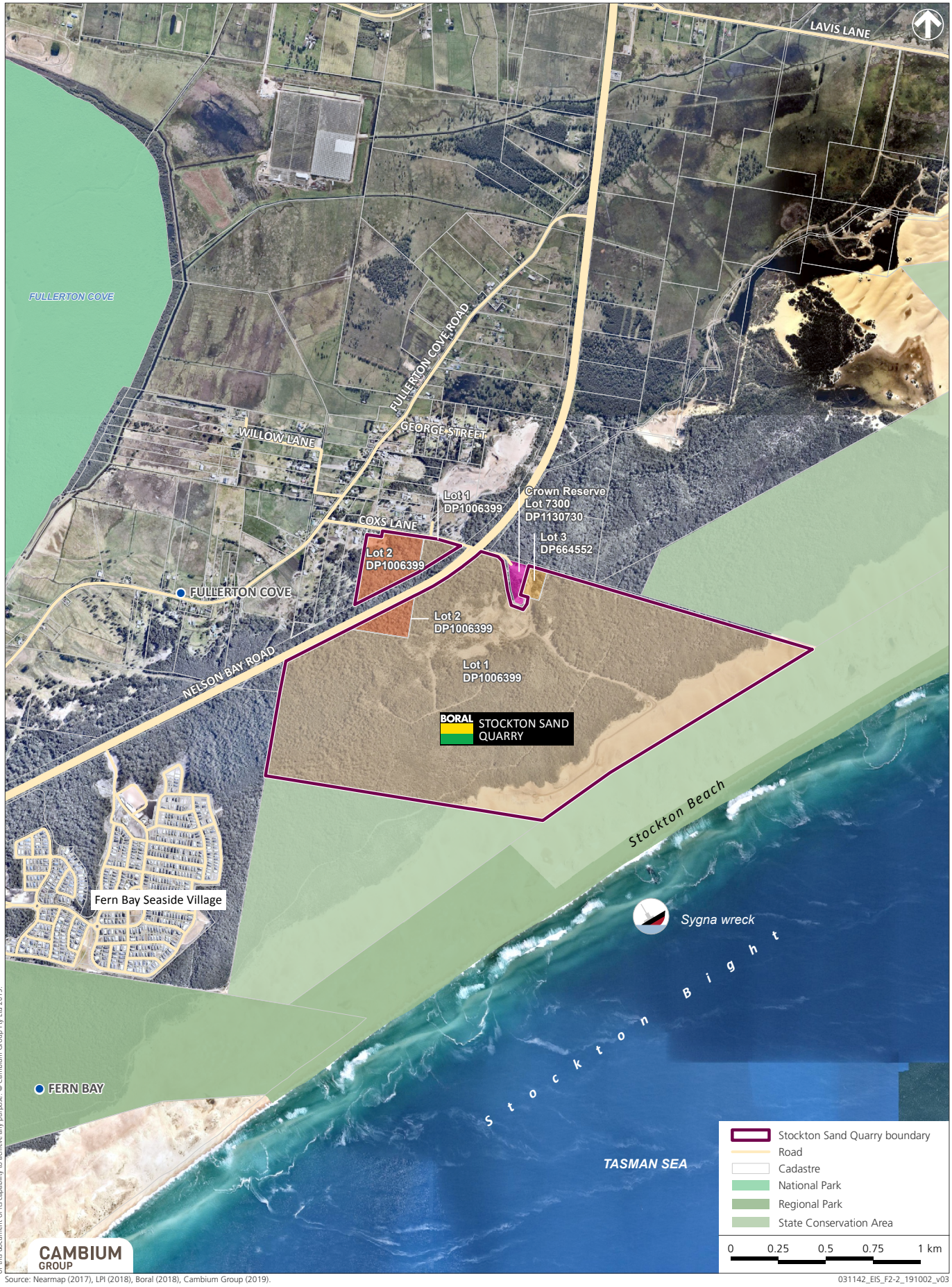
Figure 2.2
Local context

STOCKTON SAND QUARRY DREDGING
ENVIRONMENTAL IMPACT STATEMENT



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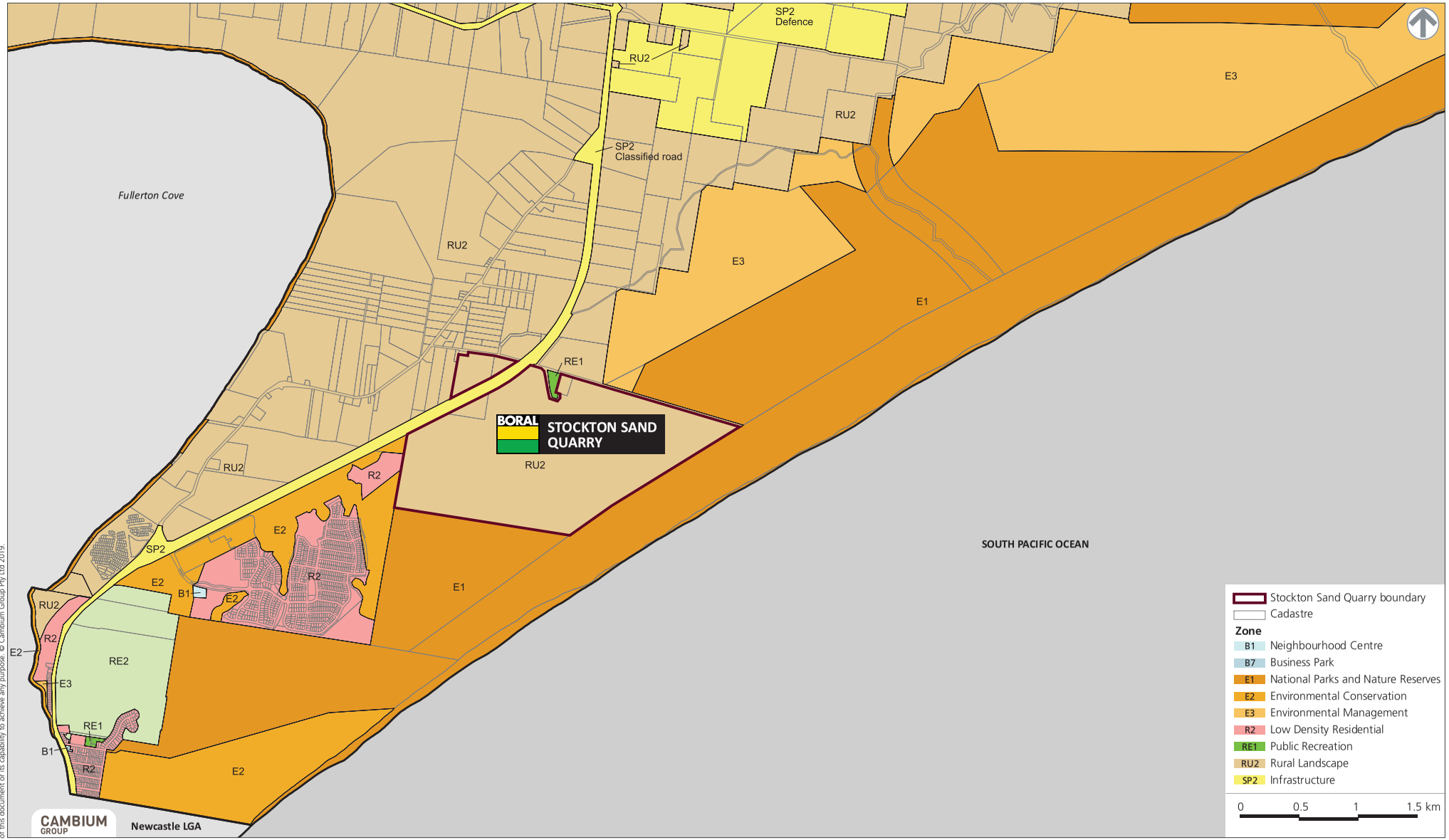
Source: Nearmap (2017), LPI (2018), Boral (2018), Cambium Group (2019).

Figure 2.3
Zoning

STOCKTON SAND QUARRY DREDGING
ENVIRONMENTAL IMPACT STATEMENT



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Source: Port Stephens Council. LZN_004 (Amendment No 15) and LZN_004A (Amendment No 9).

2.5 Biophysical factors

2.5.1 Climate

Rainfall and temperature data were obtained from Bureau of Meteorology (BoM) Station 061055 (Newcastle Nobbys Signal Station), located approximately 8.3 km to the south-west of the quarry.

The mean maximum and minimum temperature reaches their peak in January (25.6ºC and 19.3ºC respectively), while the mean maximum and minimum temperature are lowest in July (16.8ºC and 8.5ºC respectively).

Average annual rainfall is 1127.8 mm. A review of 149 years of rainfall data indicates rainfall is relatively evenly spread over the first six months of the year, with average rainfall ranging from 89.0 mm in January to 119.2 mm in March. The latter half of the year is typically drier, with average rainfall ranging from 70.9 mm in November to 92.3 mm in July.

A review of 2018 rainfall data indicated the highest monthly rainfall for the year was 301.4 mm in June. The total 2018 rainfall of 968 mm was below the historical annual mean of 1127.8 mm.

2.5.2 Air quality

The main influences of ambient air quality in the area include agricultural, extractive industry and heavy industrial land uses, commercial activities, motor vehicle exhaust, and natural sources such as the local sand dunes and wave break from Stockton Bight. The dominant influence for air quality at the site is the presence of sea salt aerosol from wave break along Stockton Bight.

Atmospheric pollutants in the region may include:

- deposited dust;
- total suspended particulate (TSP) matter, which is nominally taken to be less than 30 micrometres (µm) in diameter and refers to all suspended particles in the air;
- PM_{10}, which is a subset of TSP and have a diameter of 10 micrograms (µm) or less;
- $PM_{2.5}$, which is a subset of TSP and have a diameter of 2.5 µm or less;
- crystalline silica; and
- pollutants generated through the combustion of fuel in vehicle engines (oxides of nitrogen and sulfur (NO_2 and SO_2), PM_{10} and $PM_{2.5}$).

There is no air quality monitoring data for the site. Therefore, background levels for the project site were estimated as part of the air quality impact assessment (refer to **Chapter 8**) using data from the Stockton, Beresfield and Wallsend monitoring stations, which are maintained by DPIE (formerly OEH) and are in in areas similar to/representing the quarry. Whilst there are other monitoring stations in Newcastle, these stations are subject to local industrial and urban sources, which are not typically representative of the project site.

The ambient air quality monitoring data indicated that:

- PM_{10} annual average levels were below the criterion of 25 µg/m³ with the exception of the Stockton monitor which exceeded the criterion in each year reviewed. The 24-hour average PM_{10} levels were on occasion above the criterion of 50 µg/m³;
- PM_{10} concentrations peak in spring and summer, with the warmer weather raising the potential for drier ground and elevating the occurrence of windblown dust. Elevated PM_{10} concentrations at the Stockton monitor were attributed to heavily salt laden air or particulates blowing from the east along the surf break of Stockton Bight, and occasional bushfires;
- Annual average $PM_{2.5}$ levels were below the advisory reporting standard of 8 µg/m³ with the exception of the Stockton monitor, and the Beresfield monitor in 2008. The 24-hour average $PM_{2.5}$ levels were on occasion above the criterion of 25 µg/m³;

- $PM_{2.5}$ concentrations were relatively consistent throughout the year, with elevated $PM_{2.5}$ concentrations at the Stockton monitor also attributed to heavily salt laden air or particulates blowing from the east along the surf break of Stockton Bight, along with occasional bushfire events; and
- Annual average and maximum one hour nitrogen dioxide (NO_2) levels were below the criteria of 62 and 246 µg/m³ respectively.

2.5.3 Noise

The site is adjacent to rural and environmental conservation land uses, which contain the following background noise sources:

- natural (e.g. wave break along Stockton Beach, birdsong, insects, road noise and livestock);
- extractive industry (Fullerton Cove Quarry to the north-west);
- residential (Fern Bay Seaside Estate to the south-west); and
- infrastructure (Nelson Bay Road to the north-west, and aircraft noise from nearby RAAF Base and Newcastle Airport).

Unattended noise monitoring was conducted between 3 and 17 December 2018 at representative locations to establish the ambient noise environment at the nearest sensitive receivers.

The rating background levels (RBLs) were determined using these noise levels in accordance with the EPA's (2017) *Noise Policy for Industry* (NPI). The ambient noise levels are in **Table 2.2**.

Table 2.2 : Ambient noise levels

Monitoring location	Address	Time of day[1]	Noise levels (dBA)	
			RBL	L_{Aeq}
M1 (Receiver R11)	4 Coxs Lane, Fullerton Cove	Morning shoulder (5 am – 7 am)	38	48
		Day	41	56
		Evening	36	47
		Night	33	46
M2	157 Cabbage Tree Road, Williamtown	Morning shoulder (5 am – 7 am)	48	67
		Day	46	66
		Evening	41	62
		Night	33	62
M3	1051 Nelson Bay Road, Fern Bay	Morning shoulder (5 am – 7 am)	49	71
		Day	55	71
		Evening	47	67
		Night	38	66

[1] Daytime (7.00am-6.00pm); evening (6.00pm-10.00pm); night time (10.00pm-7.00am) (NPI).

2.5.4 Topography

Elevations of the dunes adjacent to the quarry range from 8-16 m AHD, with some in excess of 20 m AHD, while the lowest interdunal areas are approximately 4 m AHD (RPS, 2016).

Topography in the project site forms the shape of a basin, reflective of former sand extraction in this area. Topography ranges from 2.0-5.5 m AHD in the centre of the project site and is enclosed by higher topography ranging from a maximum of 29 m AHD (north), 8.8 m AHD (south), 27 m AHD (east) and 12 m AHD (west).

2.5.5 Geology and soils

Geology

The site is part of a dual sand barrier system known as the Stockton Bight.

Stockton Bight is a wide south facing coastal embayment bordered by Nobbys Head at Newcastle in the south, and Birubi Point at Anna Bay in the north. The beach is approximately 32 km long and extends up to 10 km inland (ERM 2005).

The bedrock of Nobbys Head and the higher relief of Newcastle CBD border the southern side of Stockton Bight. The rocks consist of Permian aged coal measures and some sandstone. The Hunter River has been deflected to the south by the Stockton Bight sand barrier system and enters the sea at Nobbys Head.

The Bight sediments abut the sedimentary Permian rocks of the Tomago coal measures and Mulbring siltstone between Raymond Terrace and Big Swan Bay, and at the northern end of the Bight abut the Carboniferous Nerong Volcanics at Birubi Point. Between the Stockton training wall of the Hunter River and Birubi Point is the Stockton sand barrier system (ERM, 2005).

Soils

The site contains three soil landscapes, described as Stockton Beach soil landscape, Boyces Track soil landscape and Hawks Nest soil landscape. Most of the project area is confined to the Boyces Track soil landscape unit, with the central southern portion of the project site encompassing the Hawks Nest soil landscape unit.

The soils of the area are highly susceptible to wind erosion when exposed.

The Stockton Beach soil landscape is characterised by beaches and the active unvegetated dune field in the eastern portion of the site. The soil in this landscape is deep unstratified fine to medium grained loose aeolian sand with shell fragment inclusions (ERM, 2005).

The Stockton Beach soil landscape active transgressive dune is gradually engulfing the Boyces Track soil landscape and Hawks Nest soil landscape. Boyces Track is an aeolian landscape characterised by steep Quaternary Holocene sand dunes on the Tomago Coastal Plain, with tall open forest. Soils are deep (>300 centimetres (cm)) well-drained, weakly developed podzols (ERM 2005).

The soil landscape in the low-lying swales and low dunes immediately west of the active transgressive dune is the Hawks Nest soil landscape. Hawks Nest is an aeolian landscape characterised by low Holocene sandsheets and low transgressive dunes of the Tomago Coastal Plain, with dry scrubland, woodland and tall open forest. There are small shallow swamps that occur in the low-lying, poorly drained swales and depressions. Soils are deep (>300 cm) well-drained podzols and siliceous sands and podzols on dunes (ERM, 2005).

Acid sulfate soils (ASS) generally occur in low lying areas in and around coastal swamps, estuaries, and other coastal water bodies. If these soils are disturbed or exposed to oxygen, they have the potential to oxidise over time, resulting in acidic water leaching from these soils and scalding vegetation or killing aquatic fauna. ASS can also react with concrete and steel infrastructure.

The ASS maps in the Port Stephens LEP 2013 categorise most of the project site as risk Class 4 (in which ASS is likely to be found beyond two metres depth), while pockets of the southern extent

of the proposed extraction area are mapped within risk Class 3 (in which ASS is likely to be found beyond one metre depth).

The project site was also reviewed in the Port Stephens 1:50,000 Acid Sulfate Soils Map (1996) produced by NSW Department of Land and Water Conservation. The project site is in an area of low probability of ASS occurring. The southern boundary of the project site has low probability of ASS between 1–3 m Below Ground Level (BGL) whilst the remainder and majority of the project site has low probability that ASS occurs >3 m BGL.

According to the *Strategic Agricultural Land Map - Sheet STA_047* (DP&E, October 2013), the nearest BSAL is approximately 13.2 km to the north west of the project site, west of Raymond Terrace.

The project will not impact any areas of BSAL, nor land resources suited to agricultural land use.

2.5.6 Coastal sand dune system

Coastal sand dunes are wind deposited accumulations of sand blown inland from a beach, and consist of fine to medium sand, as coarser sand cannot be moved by wind. When coastal sand dunes are bare of vegetation they are arranged in shape by prevailing winds.

When the sand is at least 10 m thick they are arranged in ‘transverse’ dunes, being dune ridges aligned perpendicular to the wind. The ridges range from 5-20 m high and are spaced at 100- 200 m. The transverse dunes move downwind at rates ranging from 5-15 m per year and occur commonly along the Australian coast.

Stockton Bight has the largest coastal sand dune field in NSW and includes a 24 km long series of 150 transverse dunes, spaced on average 160 m apart.

The site is towards the southern end of a 32 km long coastal sand barrier consisting of Stockton Bight and the backing sand dunes that extend up to 3 km inland, which are in turn backed by a swampy inter-barrier depression (Fullerton Cove) and an inner barrier (Tomago Sands) extending up to 12 km inland (Coastal Studies, 2019).

The inner barrier was deposited by waves and wind during the last sea level high stand approximately 120,000 years ago. The modern outer sand barrier has evolved over the past 7,000 years following the inundation of Stockton Bight by the rising sea level that stabilised around its present level approximately 6,500 years ago. At that time sand was supplied to the initial beach by waves transporting material shoreward from the inner continental shelf and spreading it the length of the embayment to link the Hunter River entrance, with Birubi Point in the north.

As sand continued to be supplied to the coast, the shoreline built seaward by up to 2 km. The prograding shoreline was capped by a series of well vegetated undulating foredune ridges and swales with an elevation between 5-10 m (Coastal Studies, 2019).

The sand supply continued until about 5,000 years ago, following which was the first of three phases of dune instability and landward migration of bare mobile sand dunes and shoreline recession. The evolution of the system is summarised as follows:

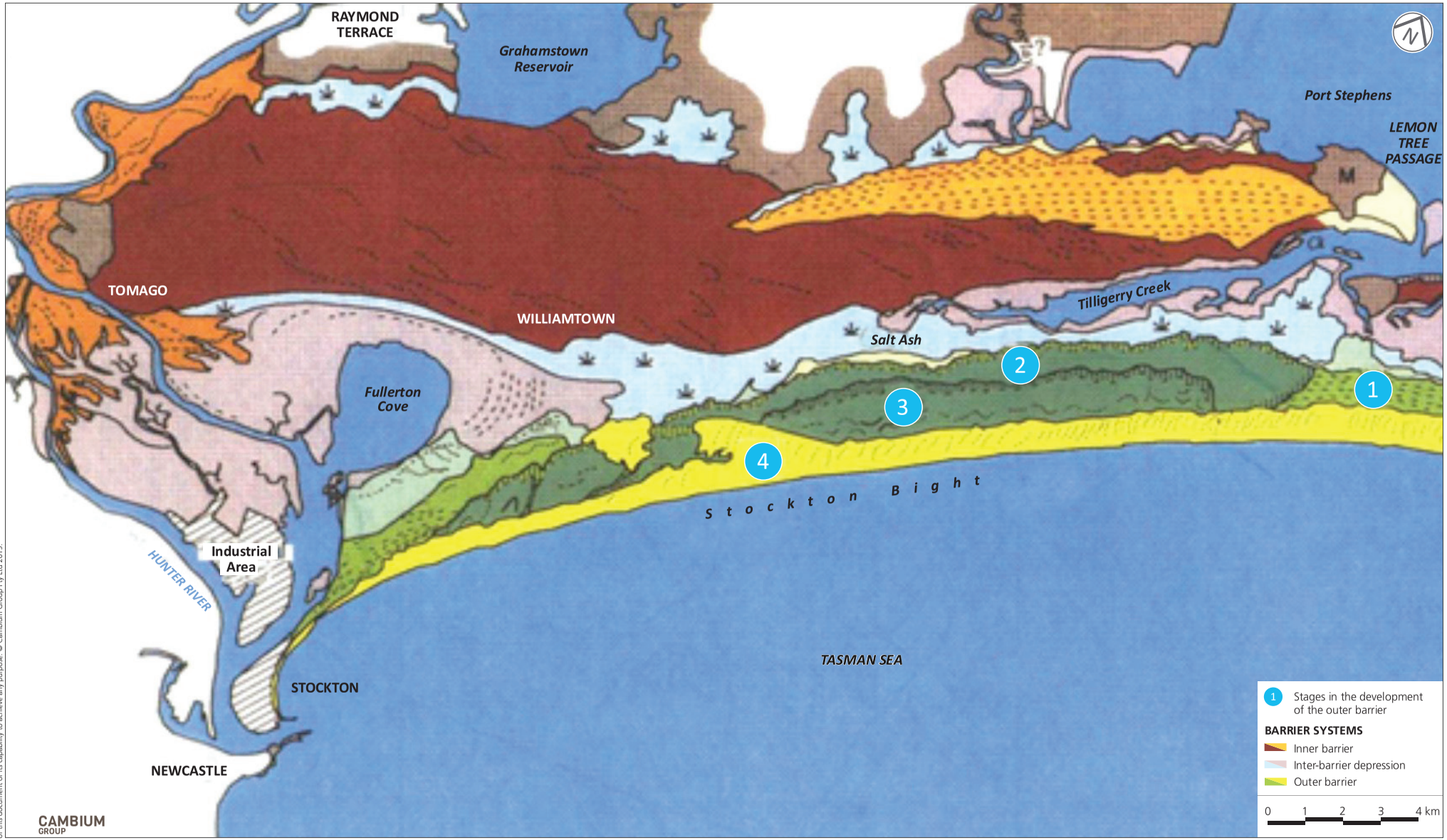
- The first phase (Phase I) of mobile dunes occurred between 5,200 and 4,000 years ago. These dunes moved up to 2 km inland and rose to elevations reaching 20 m. They moved over and completely buried the former foredune ridges, before stabilising with dense vegetation.
- The second phase (Phase II) of mobile dune activity occurred approximately 2,000 years ago. These dunes moved up to 1.5 km inland partially burying the Phase I dunes and the foredune ridges, before again stabilising with vegetation.
- The third phase (Phase III) commenced approximately 500 years ago and remains active today. The phase includes bare mobile sand extending on average several hundred metres inland (up to 2 km inland to the east of Williamtown), and occupying 12% of the total Stockton

barrier system. The remaining original foredune ridges and Phase I and II dunes (comprising 88% of the dunes), are well vegetated and stable.

Figure 2.4 presents an illustration of the geomorphology of the Stockton Bight.

Figure 2.4
Stockton Bight quaternary geomorphology

STOCKTON SAND QUARRY DREDGING
ENVIRONMENTAL IMPACT STATEMENT



Source: Thom, et al. (1992)

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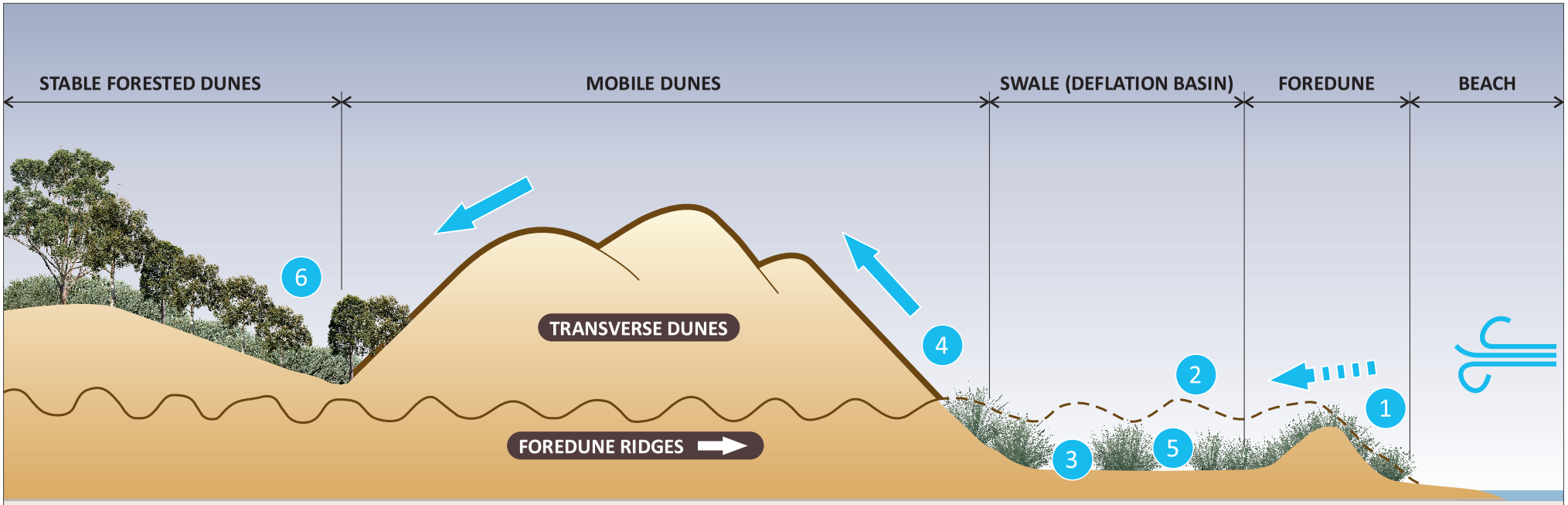
Figure 2.4 shows:

- **Stage 1 –** between 6,500-5,000 years ago waves delivered sand to the shore, and the shoreline built 3 km seaward as a series of undulating foredune ridges. The ridges extended the length of the Stockton Bight and were fully vegetated. The only ridges visible today are at the north-eastern end of the Stockton Bight.
- **Stage 2 –** most of the foredune ridges were then buried between 5,200-4,000 years ago by Phase I dunes as they migrated up to 3 km inland. The Phase I dunes were then vegetated and stabilised.
- **Stage 3 –** approximately 2,000 years ago Phase II dunes migrated approximately 2 km inland and were then vegetated and stabilised.
- **Stage 4 –** approximately 500 years ago the present Phase III dunes started moving inland as bare sand, excavating the outer foredune ridges and burying Phase II dunes. The Phase III dunes have now moved several hundred metres inland producing the present dune environment.

Components of Stockton Bight sand dunes

A schematic illustration of the Stockton Bight dune system is provided in **Figure 2.5**.

Figure 2.5
Cross section of the Stockton Bight sand dunes



The Stockton dunes are a highly dynamic system with sand moving from the beach into the dune system in the following manner.

1	2	3	4	5	6
Sand is blown from beach to foredune by strong onshore (south to southeast winds), where it is either trapped by vegetation in the foredune or blown through gaps into the deflation basin.	Sand is blown from the unstable and/or unvegetated foredune areas into the deflation basin.	During storms like the June 2016 storm, waves can wash across the beach and through gaps in the foredune to flood parts of the deflation basin. As some of this water returns seaward it can scour channels down the beach. The channels will be filled in during periods of calmer waves.	Sand is blown from the deflation basin into mobile transverse dunes, exposing the dark soil horizon which marks the crest of the buried foredune ridges.	Deflation basin is lowered/deflated until a cohesive surface is reached (shell lag, wet sand, reeds). It cannot deflate below the water table.	The strong onshore southeast winds move the transverse dunes towards the northwest and into the vegetation and burying Phase II dunes, while strong west to northwest winds move them to the northeast, parallel to the shore arranged as transverse dunes.

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Source: Modified from OEH (2015): Plan of Management, Cambium Group (2019)

Figure 2.5 shows Stockton Bight has an exposed 30-50 m wide high energy beach composed of medium to fine quartz sand. Sand from the beach is blown into the approximately 100 m wide, 4-10 m high foredune that parallels the rear of the beach, and in places, though gaps in the foredune into the 100-300 m wide deflation basin, which has an elevation between 2-6 m. Sand is exported from the deflation basin by strong southerly winds and deposited in the 5-20 m high bare mobile dune field (the Phase III dunes), which in the vicinity of the quarry are between 200-300 m wide.

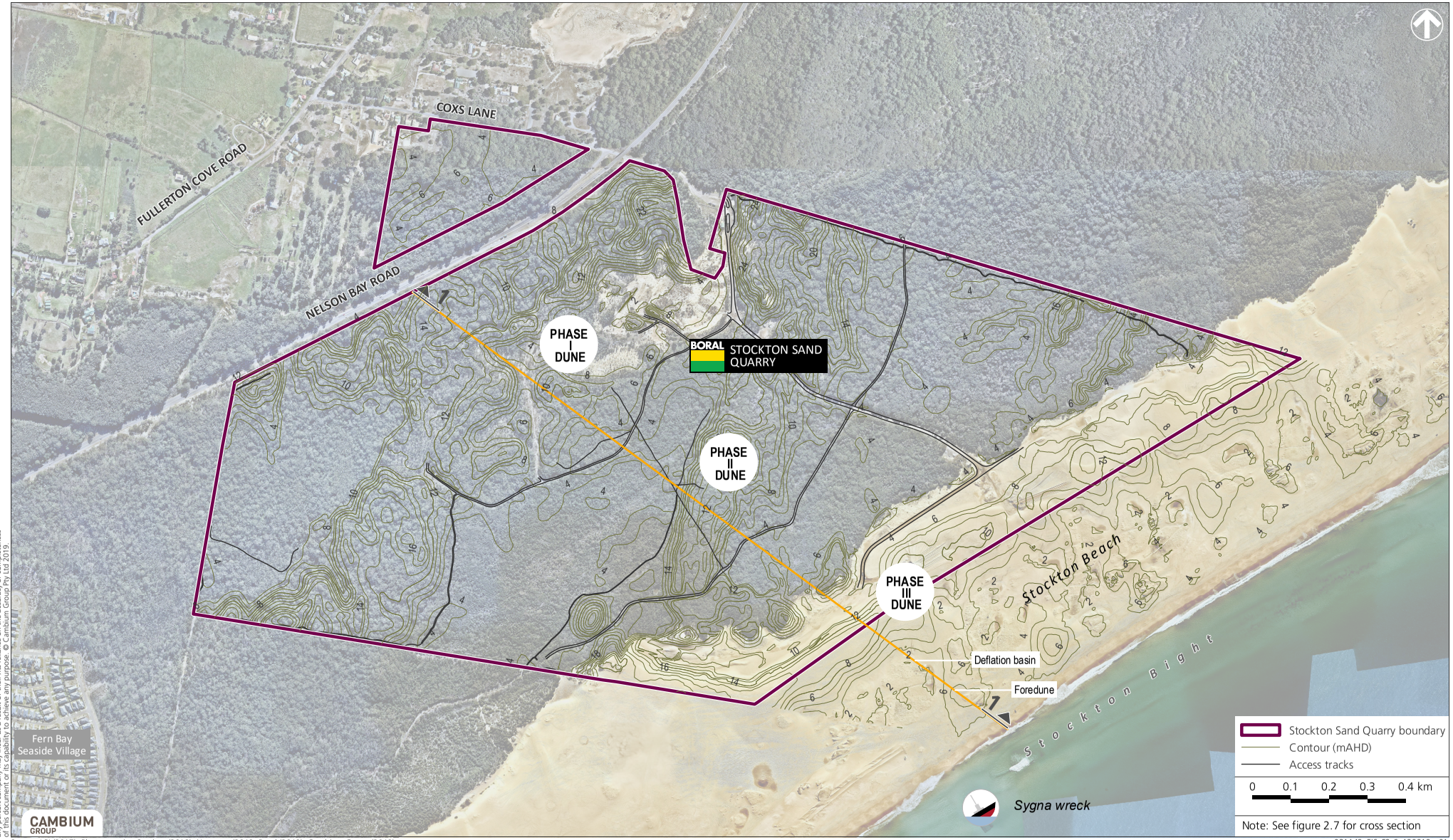
As the sand moves out of the deflation basin, it erodes the western wall of the basin, exposing the long buried foredune ridges and their buried dark soil horizon and remnant vegetation. The mobile dune field has been arranged by strong south westerly winds into transverse dunes, with crests aligned south-east to north-west.

The transverse dunes average 15 m in height and are spaced between 100-200 m apart. Strong southerly winds cause the transverse dunes to migrate to the north-east at rates between 5-15 m per year, and to the north-west at rates between 3-5 m per year. In the process, the dunes move into and bury the vegetated hind dunes (Phases II and I). This third phase of dune activity is natural and has been operating at this scale for approximately the past 500 years. However, off-road vehicle activity is presently exacerbating the dune instability in the areas it is permitted.

ERM (1994) examined the age of the dune system within the previous inland extraction area. The study identified that the majority of the inland extraction area, and hence the project site, is positioned within the dune system estimated to be between 1200- 2300 years old (Phase II transgression), with a small portion of the extraction area along the northern boundary of the quarry adjacent to Nelson Bay Road identified to be around 4500 years old (Phase I transgression). The location of Phase I, II and III dunes on the quarry property is illustrated in **Figure 2.6** and **Figure 2.7**.

Figure 2.6
Location of Phase I, II and III dunes

STOCKTON SAND QUARRY DREDGING
ENVIRONMENTAL IMPACT STATEMENT



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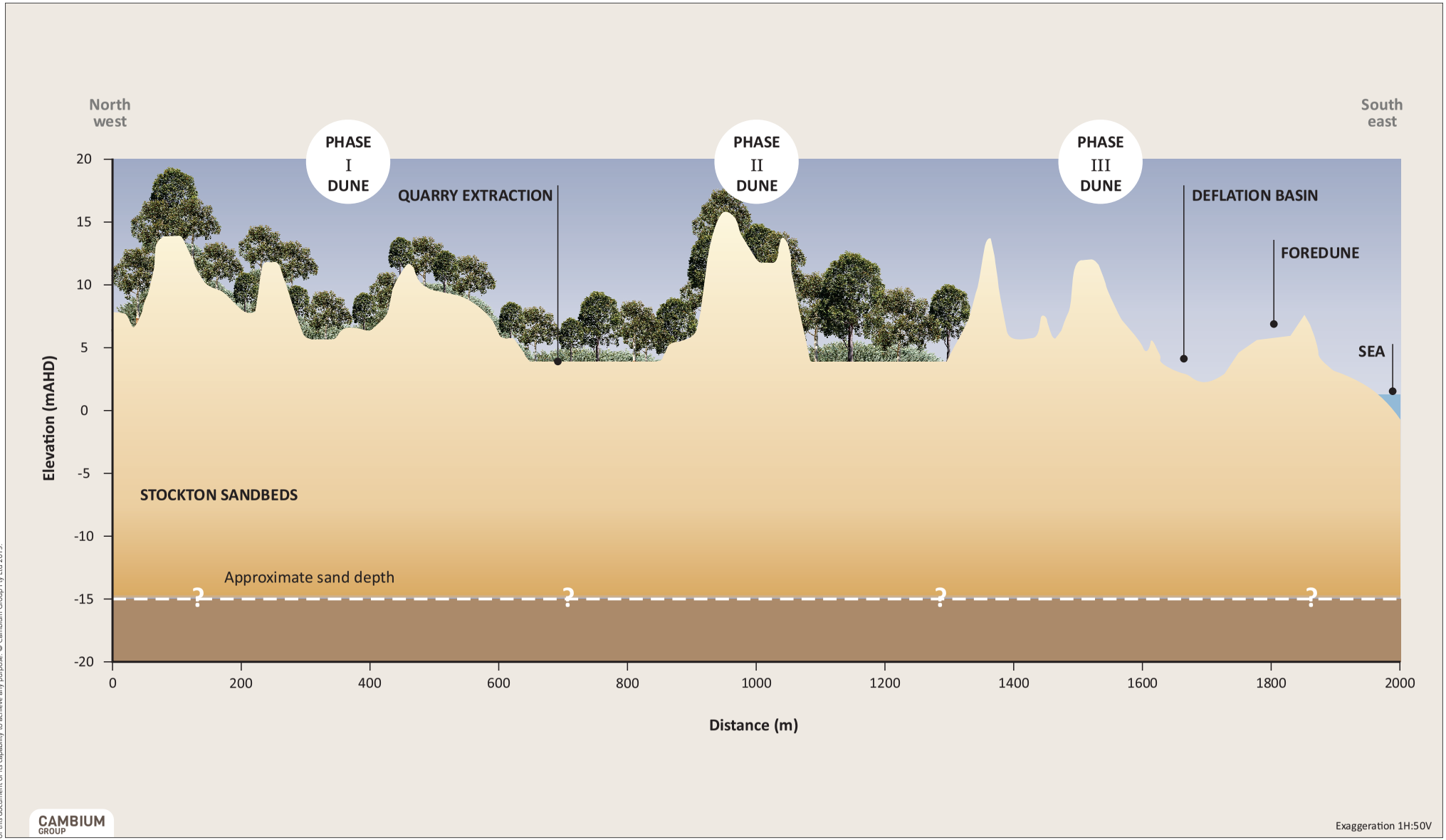
Source: LPI (2017), Photomapping Services (2018), Nearmap (2019, Boral (2019), Cambium Group (2019).

Figure 2.7
Cross section of the sand dunes at Stockton Sand Quarry



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Source: Boral (2019), Cambium Group (2019)

As highlighted above, the site consists of the beach, foredune, deflation basin, transverse dunes (Phase III dune) and vegetated hind dunes (Phase I and II dunes).

2.5.7 Groundwater

The site is in the 'Stockton Sandbeds', which consists of quartzose sand deposits and forms an outer barrier dune system. The 'Tomago Sandbeds', which form the inner barrier dune system, is north-west of the site (ERM, 2005).

The site is in a north-east to south-west oriented dune ridge that forms part of the outer barrier dune system and composes a thick deposit of fine to medium sand. As such, the sand has a high infiltration capacity likely to be in excess of 100 mm per hour resulting in 90-95% of rainfall infiltrating directly to the underlying unconfined aquifer (ERM, 2005).

The Stockton Sandbeds and transgressive dune sands are the main aquifer at the quarry and comprise the Stockton Groundwater Source of the Water Sharing Plan for the North Coast Coastal Sands Groundwater Sources (RPS 2016). Underlying and hydraulically connected with the Stockton Sandbeds are the Tomago Sandbeds of the Tomago Groundwater Source.

Permeability of the Stockton Sandbeds aquifer is likely to be quite high but will be variable due to the variation in sediment size. Hydraulic properties are likely to be similar to those of the Tomago Sandbeds, which have average hydraulic conductivity around 23 m per day (RPS, 2016).

The dominant recharge of the aquifer is via direct infiltration of rainfall and surface runoff. The former NSW Department of Industry (Water) applied an average rainfall recharge component of 22% for the Stockton Groundwater Source in assessing the volume of water that percolates to the water table each year. However, localised recharge rates in dune environments with predominantly closed drainage systems are likely to be significantly higher.

Environmental Earth Sciences Pty Limited was engaged to assess the potential impacts of the project on groundwater in the project site and region, with the report attached to this EIS in **Appendix D**. The results of the groundwater assessment are summarised in **Chapter 8**.

Groundwater flow

Groundwater flow is influenced by topography, the dune system and regional recharge/discharge zones, with water draining either to Fullerton Cove to the north-west of the site or Stockton Beach to the south-east. Therefore, there is a north-east to south-west orientated groundwater drainage axis along the length of the Stockton Sandbeds aquifer. At the site, the drainage axis is approximately 1.5 km inland from the coast and is approximately in the centre of the project site.

Regional groundwater flow is primarily horizontal, with some downward flow due to the relatively high recharge rate. Groundwater is inferred to flow towards the coast to the south-east and to Fullerton Cove to the north-west of the project site.

The Tomago Sandbeds aquifer is to the west of the Stockton Sandbeds aquifer and is separated by Tilligerry Creek and associated drainage network in this low-lying estuarine region. Groundwater from both the Tomago Sandbeds aquifer and the Stockton Sandbeds aquifer discharge into this low-lying region that ultimately directs discharge to Fullerton Cove.

Groundwater in the Tomago Sandbeds Aquifer has been impacted by per- and poly-fluoroalkyl chemicals (PFAS and PFOA) associated with the Royal Australian Air Force (RAAF) base at Williamtown. As a result, a NSW Environment Protection Agency (EPA) Investigation Area has been implemented near the RAAF Base.

The 'Risk Zone C' boundary is along the low-lying drainage area that the Tomago and Stockton Sandbed aquifers drain into. The Stockton Sandbeds aquifer at the site is in a separate groundwater and surface water catchment to the RAAF base.

Saline interface

A saline interface marks the transition from predominantly fresh groundwater to predominantly saline groundwater in the Stockton Sandbeds aquifer.

The interface is likely to comprise a broad zone of dispersion and mixing that will also be dependent on the rate of flow through the aquifer.

Geoscience Australia reviewed the vulnerability of different groundwater aquifers across the nation to seawater intrusion in 2013. Coastal sand aquifers were found to be particularly vulnerable to excessive pumping due to the low amounts of groundwater storage relative to rainfall recharge. It was reported that there was no increase in salinity observed at the seaward coastline despite water having migrated southwards to the Tomago, Tomaree and Stockton Sandbeds from Tilligerry Creek as a result of an extensive drainage network on the southern banks of the estuary.

Water sources and users

There are seven bores registered within a 3 km radius of the project site, which are for domestic water supply, irrigation and extractive industry purposes.

Groundwater dependent ecosystems

A search of the Groundwater Dependent Ecosystems (GDE) Atlas in August 2019 did not identify any aquatic GDE near the project site. There are potential for terrestrial GDEs to the south and south-east (seaward) and north-west (inland) of the site.

The seaward terrestrial GDEs comprise small ephemeral and mobile shallow deflation basin lakes vegetated with a variety of grasses, sedges and reeds. These lakes provide an ephemeral habitat for several invertebrates and other species (ERM, 2005).

The inland terrestrial GDEs are primarily swamp forests in the dune swales and low-lying heath.

Groundwater monitoring

Boral installed 10 permanent groundwater monitoring wells at the quarry, which are sampled in accordance with DA 140-5-2006. Boral installed additional groundwater monitoring wells in 2017 to gain an understanding of the biophysical properties of the project site and surrounds (MW_X1 to MW_X6). These groundwater wells have provided background information for hydrogeological impact assessment of the project (refer to **Chapter 8**).

Data has been collected on the underlying aquifer from the groundwater monitoring well network since 2007, and supporting monitoring well networks since April 2017, meaning that there are at least two years of baseline data prior to the SSD application to comply with the *NSW Aquifer Interference Policy* (AIP) (NSW Government, 2012b).

Two groundwater monitoring networks are in place as part of the program to monitor:

- GDEs; and
- water quality and levels (single bores).

The GDE monitoring comprises three bores (GW2, GW3 and GW4). These bores have existed since the former mineral sands mining operations were underway. There are seven water quality and water level monitoring bores (MW1, MW2, MW5, MW6, MW7, MW8 and MW9).

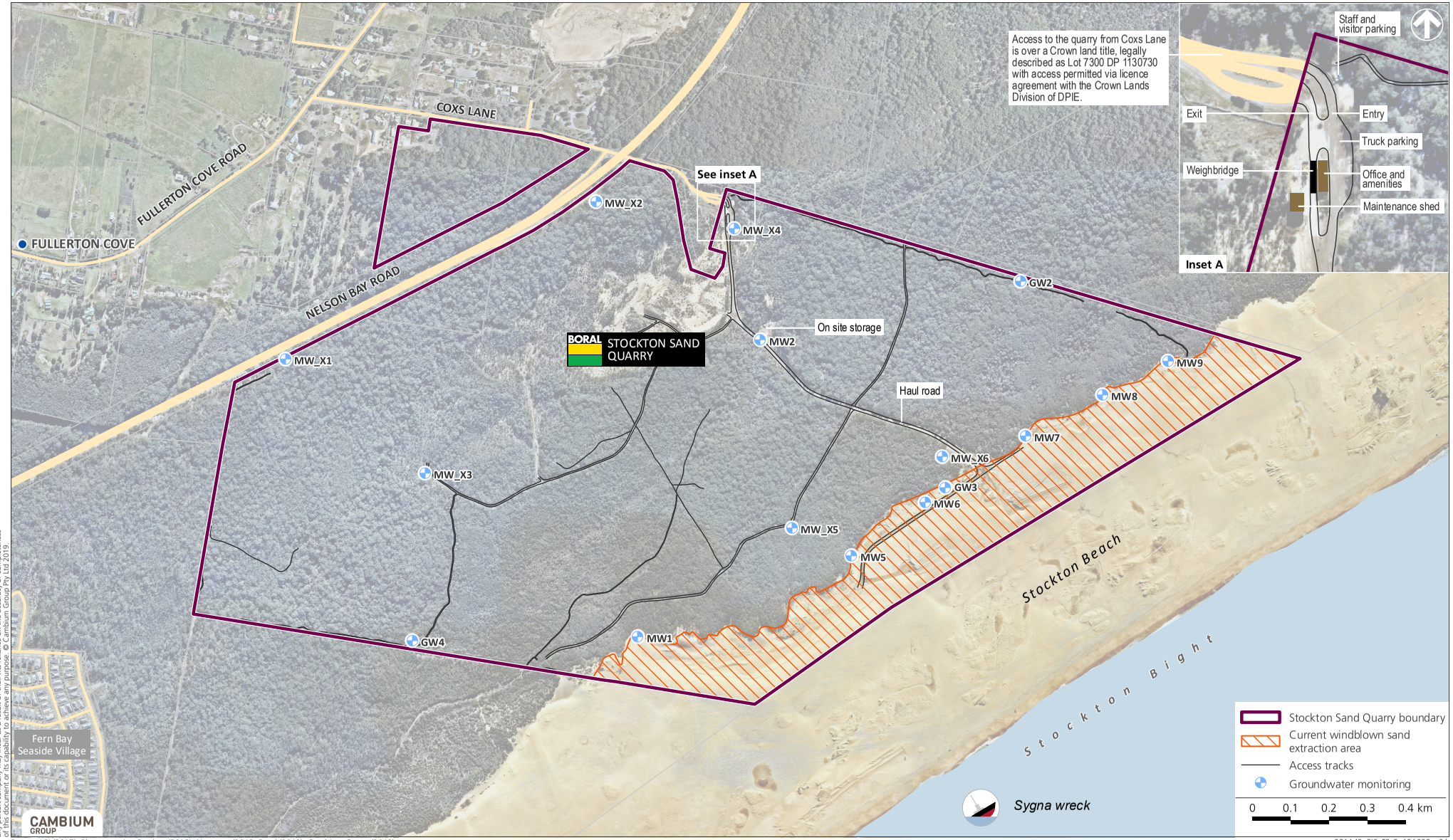
The existing groundwater monitoring locations for the quarry are shown on **Figure 2.8**.

The results of groundwater monitoring during 2018 indicate groundwater levels displayed commonality with historical trends in that levels continued to fluctuate naturally in response to rainfall recharge and seasonal patterns and were not impacted by quarrying.

Groundwater monitoring during the 2018 reporting period confirmed that the groundwater setting remained consistent with historical patterns observed to date. Minor and short-term exceedances of site-based trigger levels remain consistent with historical data.

Figure 2.8
Existing operations layout and groundwater monitoring locations

STOCKTON SAND QUARRY DREDGING
ENVIRONMENTAL IMPACT STATEMENT



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Source: LPI (2017), Photomapping Services (2018), Nearmap (2019, Boral (2019), Cambium Group (2019).

2.5.8 Surface water

There are no permanent streams or waterbodies in the site indicating that surface runoff is minimal, and infiltration occurs quickly through porous sands. This contributes to high groundwater recharge.

Some temporary ponding of water is evident in the dune system in the project site and along Stockton Bight to the south-east of the site. However, it is likely this ponding is associated with naturally low lying interdunal swales where there is interaction with shallow groundwater.

The Pacific Ocean is approximately 1.3 km east of the project site, and surface water at the quarry predominantly infiltrates to the underlying aquifer, which ultimately flows towards Fullerton Cove in the north-west or the Pacific Ocean to the south-east.

2.5.9 Biodiversity

The following section describes the existing elements of biodiversity present on the site.

Previous assessments of the site and adjacent areas were reviewed during preparation of the biodiversity development assessment report (BDAR) to characterise the existing environment and develop a flora and fauna survey strategy.

Vegetation

The site was surveyed as part of ERM (1994) and ERM (2005) to validate existing vegetation mapping and identify threatened biodiversity. The vegetation surrounding the project site was consistent with the Coastal sand apple-blackbutt vegetation community.

The BDAR confirmed the project site mainly comprised of native regeneration associated with rehabilitation of the former inland extraction area. The project site was found to comprise two plant community types (PCT):

- PCT1646 - Smooth-barked Apple/Blackbutt/Old Man Banksia woodland on coastal sands of the Central and Lower North Coast; and
- PCT1644 - Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower North Coast.

No threatened ecological communities (TEC) as defined by the NSW *Biodiversity Conservation Act 2016* (BC Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) have been identified at the site.

Threatened flora

The likelihood of threatened or significant flora occurring on the site was determined by ERM (2005) which considered the type and condition of vegetation and habitats, and analysed database records. The results of other previous ecological investigations at the site were also used in determining the likelihood of occurrence of threatened flora, in particular the threatened orchids *Diuris arenaria* and *Diuris praecox*.

Targeted surveys were undertaken during the BDAR and identified no threatened flora in the project site.

Threatened fauna

The BDAR confirmed that 16 threatened and migratory fauna species, including those specified above, are considered to have a moderate or high likelihood of occurrence within the project site, however most of these species were determined to only utilise the project site for foraging on an

intermittent basis. Of these species, only the Squirrel Glider (*Petaurus norfolcensis*) was assumed to be present within the project site.

2.6 Cultural factors

The following section describes the existing heritage and archaeology context of the site, including both Aboriginal and historic heritage.

2.6.1 Aboriginal heritage

The Aboriginal Heritage Information System (AHIMS) was searched on 25 July 2019 for the *Stockton Sand Quarry Dredging Project – Aboriginal cultural heritage assessment* report (Kelleher Nightingale Consulting, 2019) (ACHA) to identify existing recorded Aboriginal sites in the area.

75 registered AHIMS sites were identified, comprising a diverse range of site types, the most common of which being open context occurrences of artefacts and shell (middens).

The presence of numerous recorded sites near the project site demonstrates that the local landscape was used by Aboriginal people in the past and that material traces of this landscape use have survived in the form of Aboriginal objects and archaeological deposit.

There are no registered AHIMS sites in the project site, although several are present on the wider quarry property. The quarry also contains one unregistered site identified during a previous survey.

The site and adjacent land have been subject to several detailed archaeological investigations for previous sand extraction activities, as well as larger scale regional studies of the Stockton Bight.

The findings of these investigations are summarised in Section 5.3 of the ACHA. Potential impacts to Aboriginal heritage are summarised in **Chapter 15**.

2.6.2 Historic heritage

The following Commonwealth, State and local heritage databases were searched to determine the presence of registered historic heritage items in the project site and surrounds:

- National Heritage Register made under the EPBC Act;
- Commonwealth Heritage Register made under the EPBC Act;
- State Heritage Register made under the NSW *Heritage Act 1977* (Heritage Act);
- Heritage and Conservation Register (s170 Register) made under the Heritage Act;
- Schedule 5 of the Port Stephens Local Environment Plan 2013; and
- State Heritage Inventory, which is a central collection of statutory heritage listings in NSW.

The only listed heritage item within 500 m of the project is the ‘Stockton Beach Dune System’, which is listed on the Port Stephens LEP and is directly adjacent (north-east and south-east) to the quarry boundary.

The heritage assessment for ERM (2005) identified no historic heritage items in the project site or along the upgraded haul road route.

A military bunker, known locally as the 'Sygna Hilton', was observed in the Boral land holding and dates from the early 1940s when the area was used for military training. The bunker is made of mass concrete and has small firing slits and twin doorways. It may have been a defensive position built to repel Japanese invaders or used for training. The bunker is located within Boral's property, near the southern quarry boundary and approximately 70 m north of the windblown sand extraction area.

The structure lies well outside the project site and will not be impacted and is not listed under any of the identified heritage registers.

2.7 Socio-economic factors

The following section describes the socio-economic profile and demographics of the surrounding community.

2.7.1 Community profile

Socio-economic data derived from the 2016 Australian Census of Population and Housing provides a snapshot of the population profile in the local area. The local area has been defined to include Fern Bay (SSC or State Suburb) and Stockton-Fullerton Cove (SA2 or Statistical Area 2) census geographies were selected as the basis of the census data analysis.

Refer to Chapter 5 of the Social Impact Assessment (**Appendix I**) for a more detailed social baseline of the surrounding community.

Socio-economic indicators

Table 2.3 provides a comparison of Fern Bay, the Stockton – Fullerton Cove and NSW populations in respect to a range of socio-economic indicators.

Table 2.3: Socio-economic indicators

Socio-economic indicator	Fern Bay	Stockton - Fullerton Cove (SA2)	NSW
Total population	2,763	566	7,467,527
Male	49.50%	49.90%	49.30%
Female	50.50%	50.10%	50.70%
Median age	53	51	38
Average children per family for families with children	1.8	1.7	1.9
Average people per household	2.2	2.3	2.6
Median weekly household income	$1,049	$1,164	$1,486
Median monthly mortgage repayments	$2,167	$2,000	$1,986
Median weekly rent	$430	$330	$380
Average motor vehicles per dwelling	1.6	1.6	1.7

The populations do not differ markedly in terms of gender. It is clear that an older population resides in the Fern Bay and the Stockton – Fullerton Cove areas, in comparison to broader NSW. The average number of children per household, people per household, incomes, and motor vehicles per dwelling are smaller when compared to NSW averages.

The median age of 53 for Fern Bay, and 51 for Fullerton Cove, suggests that the two are aging suburbs catering to established members of the workforce or retirees. This position is corroborated by the fact that 55% of community members in Fern Bay and 45.8% of community members in Fullerton Cove own their homes outright, and only 23% of homes in Fern Bay and 27.2% of homes in Fullerton Cove are owned with a mortgage.

Accordingly, the family structure of Fern Bay favours families without children (58.1%) over families with children (32.1%). This is echoed in Fullerton Cove with composition of families

comprising 50.2% of couples without children compared to 34.0% of couples with children. The aging status of the community is further substantiated by the fact that 41.6% of couple families are not working in Fern Bay and 34.7% in Fullerton Cove.

Population

During 2016, the Port Stephens LGA population was 74,100, and is forecast to grow to 92,650 by 2036. Total households and implied dwellings will follow the growth trajectory predicted for the population. The rate of growth in each case is predicted to plateau slightly from 2031.

Family composition

Family composition in the LGA is compared to NSW in **Table 2.4**

Table 2.4: Family composition

Family composition	Stockton - Fullerton Cove	%	Fern Bay	%	New South Wales	%
Couple family without children	1,010	50.2	465	58.1	709,524	36.6
Couple family with children	683	34	257	32.1	887,358	45.7
One parent family	292	14.5	74	9.2	310,906	16
Other family	25	1.2	4	0.5	32,438	1.7

Across NSW there are more families (either couples or single parents) with children than in the Fullerton Cove and Fern Bay areas. These statistics underscore the older demograhic and the relatively smaller number of dependent children in the local area.

Employment

Employment status data derived from the Census and reproduced in **Table 2.5,** indicates that both Fern Bay and Stockton-Fullerton Cove residents maintain similar working patterns. The main inconsistency between the two resident groups is the proportion of residents that stated both parents in couple families were not working.

A greater proportion (41.6%) of Fern Bay residents reported this status, compared to 34.7% of the population in Stockton-Fullerton Cove. Overall, the data illustrates that smaller proportions of the Fern Bay and Stockton-Fullerton Cove residents are working, relative to the collective NSW population.

Table 2.5: Employment status

Employment Status of Parents in Couple Families	Fern Bay (%)	Fern Bay (No.)	Stockton-Fullerton Cove SA2 (%)	Stockton-Fullerton Cove SA2 (No.)	NSW (%)	NSW (No.)
Both Employed, Worked full-time	14.8	108	15.9	270	22.6	360,916
Both employed, worked part time	2.1	15	2.7	46	4.0	63,106

Employment Status of Parents in Couple Families	Fern Bay (%)	Fern Bay (No.)	Stockton-Fullerton Cove SA2 (%)	Stockton-Fullerton Cove SA2 (No.)	NSW (%)	NSW (No.)
One employed full-time, one part time	15.3	112	18.6	315	20.6	329,567
One employed full time, other not working	10.7	78	10.7	181	15.0	240,084
One employed part time, other not working	4.1	30	4.9	84	6.1	96,933
Both not working	41.6	304	34.7	590	21.0	334,742
Other (includes away from work)	4.2	31	4.8	81	5.1	80,905
Labour force not stated (by one or both parents in a couple family)	7.3	53	7.7	131	5.7	90,630

The industries that provide most employment opportunities for the Stockton - Fullerton Cove and Fern Bay workforces are identified in **Table 2.6**.

Table 2.6: Employment by industry

Industry of employment	Stockton - Fullerton Cove	%	Fern Bay	%	New South Wales	%
Defence	126	4.9	82	9.8	21,848	0.6
Aged care residential services	83	3.2	30	3.6	67,209	2
State government administration	66	2.6	25	3	45,546	1.3
Hospitals (except psychiatric hospitals)	95	3.7	22	2.6	119,350	3.5

It is clear that Defence is a strong employment industry for both local populations, given proximity to the RAAF base. The same may be said for State government administration data, presuming the base also provides administrative opportunities for the civilian population. The prominence of the Aged Care Residential Services industry is consistent with the older demographic in the area, which promotes a demand for such services.

Social disadvantage

The ABS' Index of Relative Disadvantage identifies and ranks areas in terms of people's access to material and social resources, including their ability to participate in society. The Port Stephens LGA is identified as an area with a low level of relative socio-economic disadvantage.

2.8 Surrounding Land Uses

Land use surrounding the site is a mix of rural, residential, public recreation and environmental conservation areas.

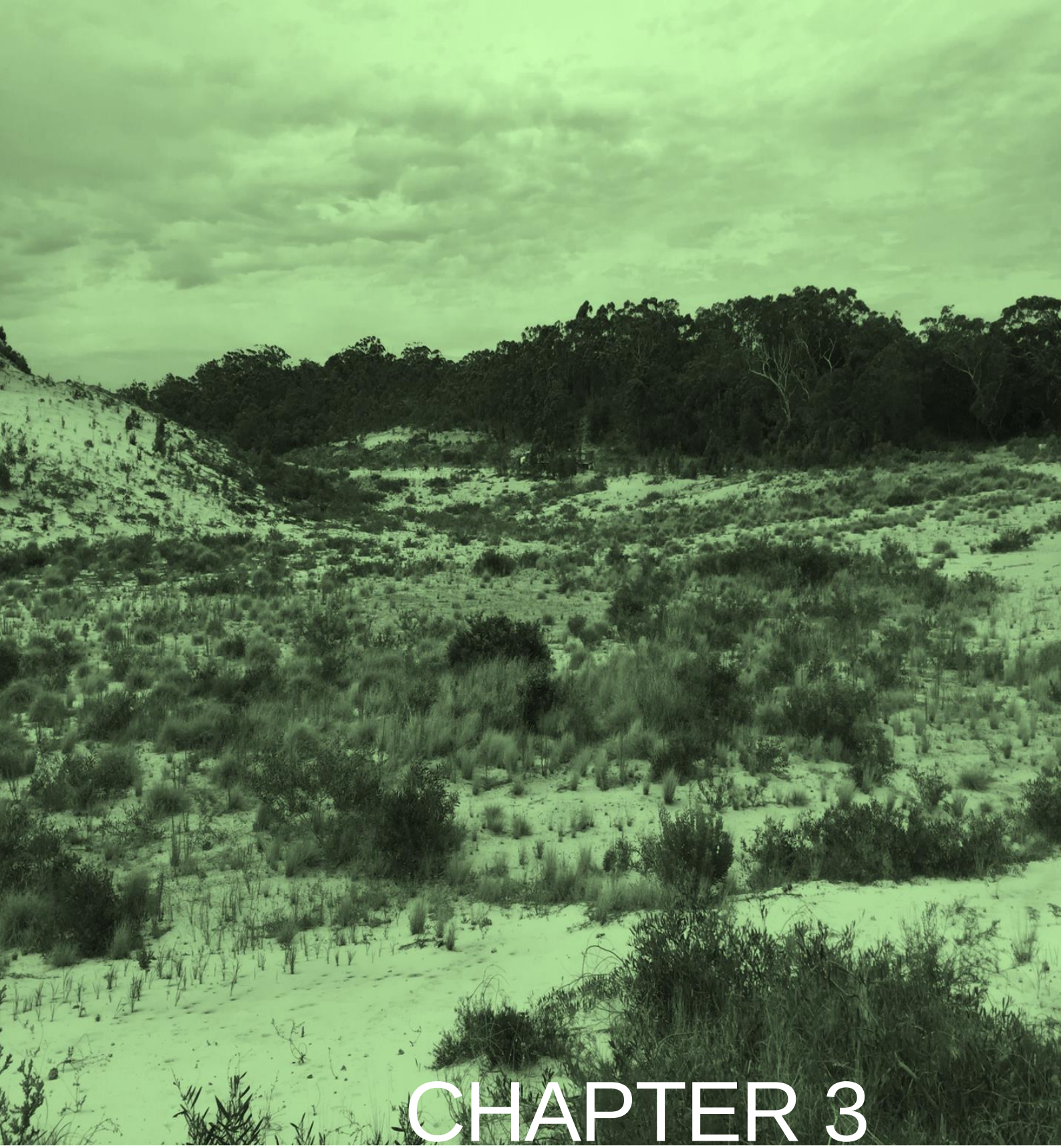
To the north-west of Nelson Bay Road is the rural residential area of Fullerton Cove, which comprises a mix of residential properties and commercial premises. The main access for these properties is via Fullerton Cove Road and Coxs Lane to and from Nelson Bay Road.

These properties are separated from the quarry by Nelson Bay Road, with the closest approximately 480 metres (m) from the entrance to the quarry. A new residential development at Fern Bay (Fern Bay Seaside Village) is approximately 1.5 km to the west-south-west of the quarry. Sensitive receiver areas are shown in **Figure 2.2**.

Most of the environmental conservation areas near the site are Crown land and extend along the Stockton Bight beach and dune system. The beach and dune area are used for recreation including fishing, four-wheel driving, quad bike riding, hiking and horse riding.

Public access to Stockton Bight dunes and beach is via Lavis Lane near Williamtown, and a new access in Seaside Estate at Fern Bay.

The former Sygna shipwreck is near the quarry and was a significant landmark visited by tourist operators. The shipwreck has recently been eroded into the sea.



CHAPTER 3

BACKGROUND AND SITE OPERATIONS

3 BACKGROUND AND SITE OPERATIONS

Sand extraction has taken place in various locations on the quarry since 1976 when G. Hawkins and Sons was initially granted consent.

The eastern (i.e. the seaward edge) section of the quarry was previously dredged for mineral sands by Mineral Deposits Limited between late 2000 and 2003, before the dredge was dismantled in early 2004.

Boral acquired the site in 1992. Under Boral's ownership there have been two primary development consents granted, namely:

- DA 2010/94: The 'inland extraction area' (also known as pits 1-6) granted by Port Stephens Council in May 1996; and
- DA 140-6-2005: The 'windblown sand extraction area' (also known as pit 7) located on the transgressive dunes adjoining Stockton Bight granted by the NSW Department of Planning in 2006.

The inland extraction operation on the vegetated dunes occurred above 5 m AHD and ceased in 2008 and rehabilitation has been ongoing. This former inland extraction area is generally consistent with the project site and is the focus of this SSD application.

The windblown sand extraction area started operations in 2008 and in accordance with Condition 5 of the development consent has 20-year life, due to cease in 2028.

3.1 Approvals history

The following section presents the licences and approvals that Boral hold to operate the quarry.

The quarry has been the subject of several more recent development consents and various licences as outlined in **Tables 3.1** and **3.2**.

3.1.1 Planning approvals

Table 3.1: Planning approval history

Development consent	Approval date	Details	Status
DA No. 140-6-2005	24 January 2006	A new extraction area on the un-vegetated windblown sand dunes (above 2.5 m AHD) adjoining the beach to the east. The site was limited to a maximum transportation limit of 500,000 tpa for 20 years following commencement of operations.	Current and operational.
	10 May 2006	Modification 1 to the 2006 development consent to remove reference to a portion of land incorrectly specified under the 2006 consent and permit extraction of windblown sand on Lots 1 and 2 DP1006399 and Lot 3 DP 664552.	Current and operational.
	24 June 2011	Modification 2 to the 2006 development consent, including more appropriate controls to manage interactions with the public in active extraction areas.	Current and operational.
	Development application submitted	Modification 3 sought to expand the 2006 windblown sand extraction area by removing a portion of the 15 m wide buffer along the seaward and part of the south- western return boundaries, allowing for the extraction of up 475,000 t of additional sand resource. The modification also includes minor amendments to the rehabilitation plan.	Under assessment by DPIE.
DA No. 2010/94	1 May 1996	Sand extraction on the vegetated dunes in the middle of the site above 5 m AHD and road transport up to 500,000 tpa for a period of 13 years. This development consent has now lapsed.	Not operational.
	6 March 2006	Modification to the original 1996 development consent was approved by Port Stephens Council. The modification amended certain administrative conditions of consent and imposed additional conditions regarding heavy vehicle movements and a restriction to extract no more than 500,000 tpa (inclusive of the DA 2010/94 and DA 140-6-2005 extraction areas).	Not operational.

3.1.2 Other licences and consents

Table 3.2 contains a summary of other licences and consents relevant the existing operation and the proposed development.

Table 3.2: Other licences

Description	Licence number and authority	Comments
Crown Land Licence	LI 196915	Licence agreement for Crown land title (Lot 7300 DP1130730).
Surface Water Licence	20AL213136	Boral received a water access licence (WAL) in January 2015 with a zero share allocation for the Stockton Groundwater Source under the WSP. The WAL permits extraction of groundwater, however as the WAL has a zero share component and all existing allocations within the source are unavailable, Boral is not yet able to extract from the aquifer. Boral intends to retain this WAL whilst it investigates water access options for the quarry, which are a requirement for the project.
Bore Licence	20BL171772	Ten monitoring bore licences issued on 4 March 2008 in perpetuity.
Environment Protection Licence (EPL)	EPL 10132	Permits the scheduled activity of 'extractive activities'. The EPL permits the extraction, storage and processing of 100,000-500,000 tpa.

3.2 Former inland extraction area (Pits 1-6)

As set out in **Table 3.1**, Boral extracted sand from the inland extraction area from 1996 to 2008 in accordance with development consent DA 2010/94. The development consent permitted extraction and transportation of up to 500,000 tpa of sand products.

The approved scope of works and method generally included the following.

3.2.1 Site clearing and preparation

A dozer was used to clear native vegetation within the extraction area. Felled vegetation was stockpiled for later re-use in rehabilitation efforts on the site. The dozer was then used to strip understorey vegetation and topsoils typically 50 m ahead of the advancing extraction area.

Topsoils from the cleared area were stripped using the dozer and initially stored in stockpiles or windrows adjoining the extraction area. The depth of topsoil removed was dependent on slope, however, typically ranged 100-300 mm.

As extraction proceeded, topsoils were spread over previously extracted areas to a minimum depth of 200 mm.

3.2.2 Sand extraction

Recycled road base from Boral's Kooragang Island recycling facility was imported where required to provide an inert stable base for haul roads and the floor of the operating extraction area.

Sand was removed via a front-end loader which pushed into the exposed sand face. As the sand was relatively free-flowing, material fell towards the front-end loader at the natural angle of repose.

The face of sand extraction was typically 150 m wide, and a 0.5 m high vegetated bund was maintained along the perimeter of the extraction area to assist with containment of stormwater runoff.

Sand was dry screened in order to remove roots and minor naturally occurring coal fragments.

A front-end loader or excavator loaded road trucks in-pit with screened raw sand for transport off-site via the weighbridge.

3.3 Existing operation: windblown sand extraction area (Pit 7)

As set out in **Table 3.1** and **Figure 2.8**, Boral currently extracts sand from the transgressive dunes, referred to as the windblown sand extraction area. Sand extraction commenced in 2008 in accordance with development consent DA 140-6-2005.

The development consent permits extraction and transportation of up to 500,000 tpa of sand products over a 20-year period.

The approved scope of works and method comprise:

- extraction of sand annually through regular harvesting of windblown sand and dry excavation of the dune mass;
- transportation of up to 500,000 tonnes of sand;
- campaign mobile screening, where required;
- maintenance of the haul road to transport sand from extraction area;
- haulage of product from existing depot/weighbridge to Nelson Bay Road and the wider road network; and
- progressive stabilisation of windblown vegetation edge.

3.4 Site infrastructure

Boral established a fenced site depot as part of its previous inland extraction area project, and this depot has been maintained for the existing operations. The fenced depot contains the following infrastructure:

- an amenities/office building providing an office, lunchroom, toilet and shower;
- weighbridge;
- designated parking area for employees and visitors; and
- maintenance shed for the front-end loader and 4,200 L above ground bunded fuel tank.

3.4.1 Utilities and services

The following section sets out the availability of existing services and utilities at the site.

Water

Rainwater tanks were installed adjacent to site buildings to capture up to 10,000 L water for use in on-site ablutions. A water truck is also used on a campaign basis to provide dust suppression.

Electricity

The site office and workshop was established and connected to mains electricity providing power to both the office and workshop and for security lighting and monitoring.

Wastewater

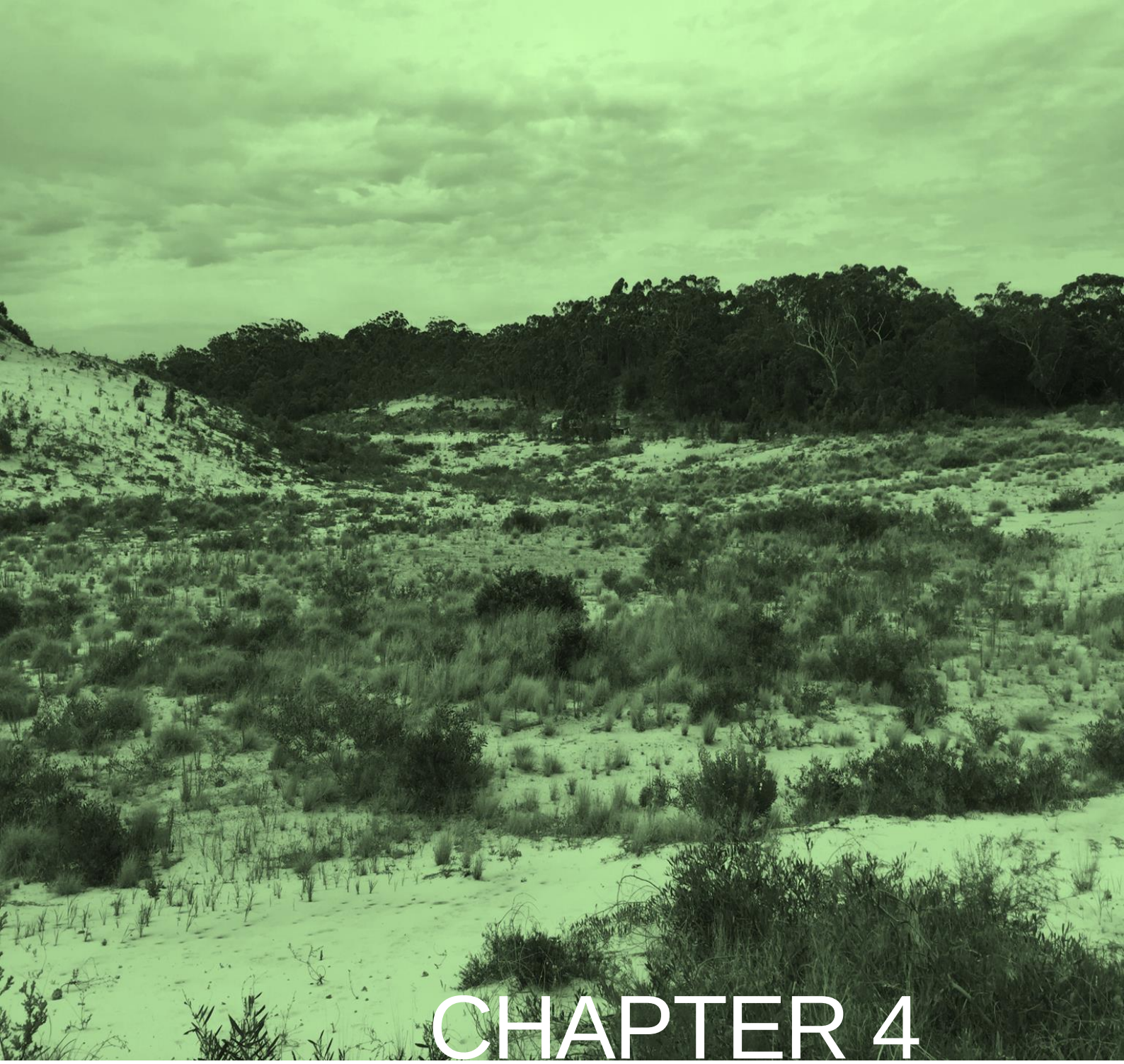
A septic tank was installed to capture wastewater generated by the site office and amenities buildings.

3.5 Environmental management

Environmental management and monitoring at the quarry is in accordance with the following documents, previously prepared and approved in accordance with DA 140-6-2005:

- *Environmental Management Strategy* (ERM, 2007a);
- *Erosion and Sediment Management Plan* (ERM, 2007b);
- *Groundwater Monitoring Program* (ERM, 2008); and
- *Rehabilitation and Landscape Management Plan* (ERM, 2007c).

The quarry has a complaints hotline, with all community or regulator complaints logged in a complaints register and investigated and actioned immediately.



CHAPTER 4

THE PROJECT

4 THE PROJECT

This chapter describes the location of the project and proposed development to be undertaken by Boral.

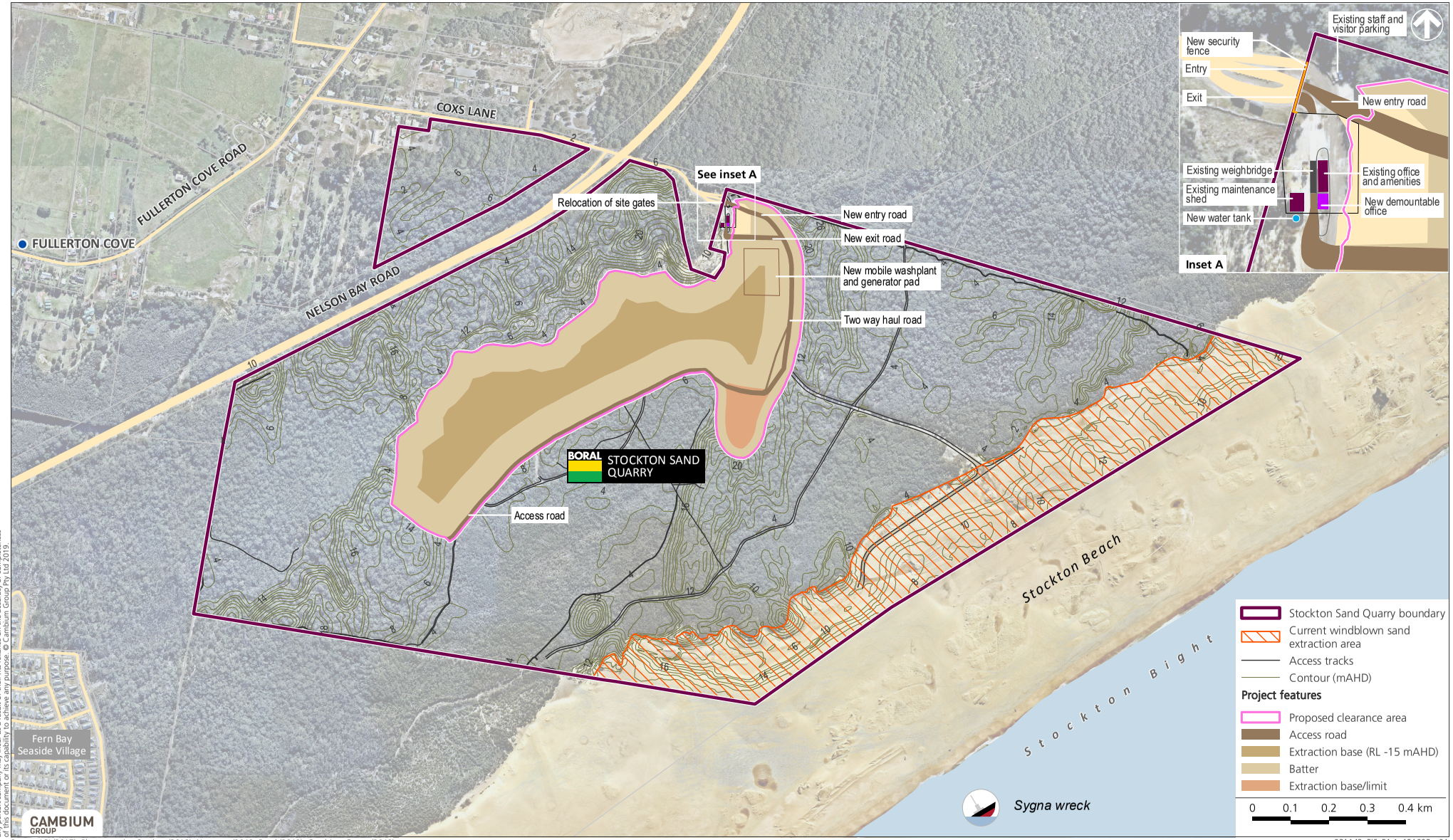
4.1 Project Site

The project site contains all areas to be disturbed by project operations and covers an area of approximately 37 ha. The 'proposed clearance area' as identified in **Figure 4.1** includes all areas to be disturbed by sand extraction operations, including areas of vegetation clearing. The project site includes the 'proposed clearance area' together with ancillary activities including alterations to the site depot.

The project site is generally consistent with the former inland extraction area footprint approved under the 1996 development consent except for areas to east and south-east of Lot 3 and along the southern edge to allow for the construction of new haul roads.

Figure 4.1
The Project

STOCKTON SAND QUARRY DREDGING
ENVIRONMENTAL IMPACT STATEMENT



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4.2 Project description

Sand from the former inland extraction area was only extracted to 5 m AHD under the original 1996 development consent. The sand resource above 5 m AHD was exhausted in 2008 and in accordance with the conditions of consent the operations have ceased.

The project involves the extraction of sand from the former inland extraction area (inclusive of pits 1-6) from the existing ground level to a depth of -15 m AHD. As extraction will intercept the groundwater table (at 1-2 m AHD) the primary method of sand extraction will involve dredging.

There is an estimated 9 Mt of sand resource in the project site. The project seeks permission for a site wide increase on the dispatch limit to 750,000 tpa (i.e. the windblown sand extraction area and the project operations combined) up to 2028, after which the site wide limit will reduce to no more than 500,000 tpa.

The increase in the site wide dispatch limit is sought to permit maximum flexibility across the two sand extraction areas (on the same quarry site).

Mobile plant and equipment will operate across both project areas and a docket system at the weighbridge will monitor outgoing product as a quarry total.

To account for fluctuations in demand, Boral is seeking consent to operate the project for 25 years.

4.2.1 Site establishment

Minimal site establishment works are required given existing operation, infrastructure and services at the site.

Where new or augmented infrastructure is required, this will be delivered as part of Stage 1 of the project and will generally include:

- construction of a new entry road. The new road will link to the existing haul road in the south-eastern extent of Stage 1 and enable continued access to the windblown sand extraction area. The road will be two way configuration (i.e. trucks moving in and out) and a separated exit road will be constructed to allow exiting vehicles to cross the weighbridge (refer to **Figure 4.1**);
- a pad for the wash plant and diesel generators will be constructed as soon as practicable after vegetation removal and sand extraction in the northern portion of Stage 1; and
- relocation of the parking area to the south and relocation of the security gates northward across the entry road which will enclose the parking area and the new entry road. The docketing kiosk registering vehicles entering the site will also be relocated.

To limit the loss of sand product, site establishment activities requiring the clearing of vegetation and removal and stockpiling of topsoil will only occur as necessary.

The existing site depot will also be reconfigured to support the project and will include the following:

- installation of a new prefabricated office building;
- relocation of onsite materials storage;
- replacement of roofing for the workshop;
- and installation of a 30,000 L water storage tank for potential firefighting efforts.

4.2.2 Internal access roads

The proposed internal access roads for the project are outlined in **Figure 4.1**.

A new haulage route will be constructed during site establishment works in Stage 1 which will extend around the north, east and southern perimeter of Stage 1 and link to the existing haul road to the windblown sand extraction area. The new road will create a one way entry and exit from the site, the rest of the road will be two-way.

The perimeter haul road around the southern edge of the formed stages 2 to 5 dredge pond will be constructed progressively as sand extraction progresses.

A turning head will be constructed at the end of the perimeter haul road to allow vehicles to turn and travel back along the perimeter haul road and out of the site via the newly constructed exit road. The exit road will pass via the existing depot and weighbridge.

The perimeter haul road will be up to 10 m wide and when complete (at the end of Stage 5) will enable movement of vehicles around the southern perimeter of the dredge pond and be used to support access for rehabilitation works and future site management.

4.2.3 Sand extraction and staging overview

The project will progress in six stages. **Figure 4.2** shows the extraction staging plan.

Site preparation will involve clearing and grubbing of established vegetation from previous rehabilitation and possible screening of accumulated leaf litter and organic matter. Cleared vegetation will be mulched or stockpiled on-site for later use in rehabilitation. Similarly, any stripped topsoil will be retained for use in rehabilitation.

Stage 1 will involve dry extraction to a depth of 4 m AHD. A front-end loader will push into the exposed sand face and as the sand is relatively free-flowing, material will fall towards the front-end loader at the natural angle of repose.

The sand will then be screened and stockpiled before a front-end loader loads road trucks in-pit with screened raw sand for transport off-site via the weighbridge.

A pond will be created in the area of Stage 2 following initial dry extraction of sand in Stage 1. The pond will be large enough to float a dredge and accommodate freshwater pumping for the proposed wash plant.

The dredge will move progressively through the extraction area in a south-westerly direction in a staged process. Extraction will then move to the east and culminate with relocation of the proposed processing and stockpile area to a confined area in Stage 1 and subsequent dredging of the majority of the Stage 1 extraction area (to be known as Stage 6).

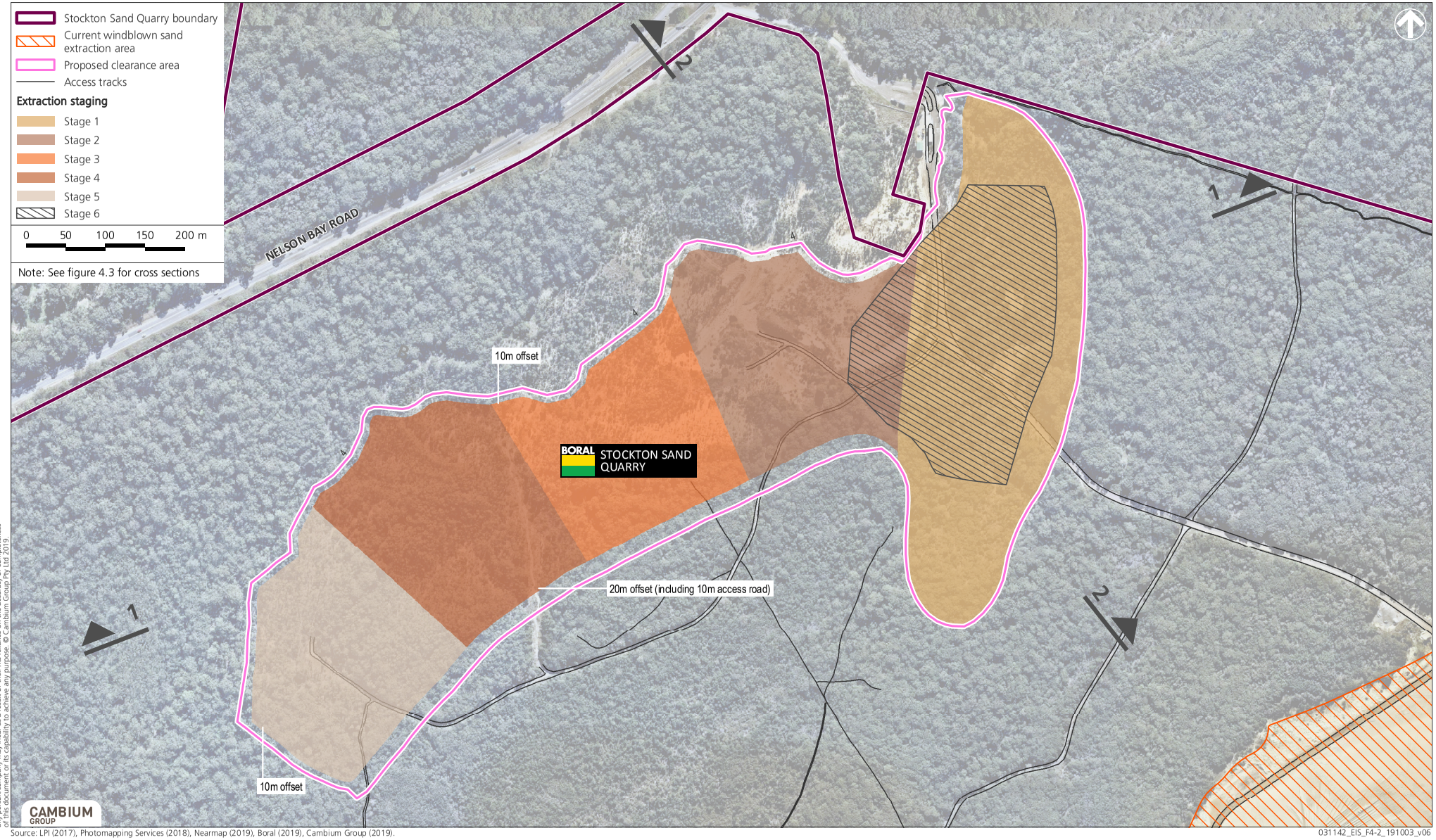
In most cases, the sand in each extraction stage will be fully extracted unless constraints are encountered.

The dredge will move backwards and forwards across the active dredge pond, sucking the underwater sand face. The sand/water mix will be pumped directly from the dredge via a pontoon-mounted pipeline to the wash plant in the processing area. The dredge will manoeuvre around the pond and its position will be stabilised by wire ropes connected to the pond banks.

Sand will be extracted to a maximum depth of approximately -15 m AHD.

Figure 4.2
Extraction staging plan

STOCKTON SAND QUARRY DREDGING
ENVIRONMENTAL IMPACT STATEMENT



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Stage 1

The Stage 1 extraction area is along the eastern portion of the project site (refer to **Figure 4.2**).

Stage 1 of the project will comprise:

- removal of vegetation from across the whole footprint of the Stage 1 extraction area and a small portion of land to the north-east of the existing depot to allow for the construction of a new haul route that will extend around the north, east and southern perimeter of Stage 1 and link to the existing haul road to the windblown sand extraction area;
- where present, stripping topsoil and store on site within designated stockpile areas;
- extraction of sand in the Stage 1 extraction area via front end loader and excavator to a depth of 4 m AHD;
- screening and stockpiling sand;
- levelling of the Stage 1 extraction area as required;
- establishing a level pad at the north-western boundary of Stage 1 and establishing the wash plant and diesel generators; and
- delivery and installation of a prefabricated office building and commencement of other alterations to the existing site depot.

The moisture content of dry extracted sand leaving the quarry will not exceed 3%.

Stage 2

As Stage 1 is nearing completion, Stage 2 will be commenced. To limit the loss of sand to wind erosion, a maximum extent of 200-300 m of vegetation and ground cover will be cleared at any one time. The general area of Stage 1 will be used for stockpiling of processed sand ready for dispatch.

The typical method for sand extraction in Stage 2 will be:

- progressive stripping of areas in 200-300 m segments across the stage;
- excavation of an initial dredge window to allow for a suitable water to sand ratio to develop, and may involve excavation from 2-6 m AHD;
- once a suitable sand/water ratio has been established the dredge will be floated. The dredge will be fixed to a pontoon which is connected to the wash plant via a pipeline;
- a sand/water mix will be dredged by suction to the wash plant, where sand will be extracted, and excess water will be returned via a separate pipeline to dredge pond;
- the wash plant will screen out oversize material in excess of 20 mm in size; and
- dredging will be to a maximum depth of 15 m below sea level.

Sand will be stockpiled once washed to allow for water to free drain back into the aquifer and reducing the moisture content to as low as possible. The moisture content of dredged sand leaving the quarry will not exceed 5%.

Stages 3-5

The method described in Stage 2 will be repeated in each subsequent stage to the completion of Stage 5.

At the completion of Stage 5 progressive rehabilitation of the Stages 2-5 dredge pond banks will commence. Initial rehabilitation will not include the Stage 1 extraction area as this will continue to be disturbed for Stage 6 of the project.

Stage 6

Except for the southern portion of Stage 1, containing the wash plant and generator, the Stage 1 extraction area will be excavated to reveal the groundwater table and subsequently dredged in an identical manner to Stages 2-5. The Stage 2-5 dredge pond will be extended into the Stage 1 extraction area and dredging of the pond will also be to a depth of 15 m below the water table.

4.2.4 Processing, blending and stockpiling

A processing and stockpile area will be established generally within area of Stage 1 of the project area. Sand extracted by front-end loader and/or excavator will be transported to the Stage 1 area, dry screened for immediate sale or stockpiled.

A pad will be created for the wash plant within the northern portion of the Stage 1 area. The location of the wash plant will be fixed during Stages 2 to 5, after which, it will be relocated within Stage 6 in order to maximise the remaining extraction from the body of Stage 6. The indicative position of the wash plant and stockpile area on **Figure 4.1** has been formulated to represent the closest point to sensitive receivers in Fullerton Cove to the north-west of Nelson Bay Road.

The wash plant will entail sand/water pumped from the dredge passing over an initial screen to separate oversize organic matter or debris and into a large wash tank to float out any fines (<75 micrometres). After washing, the sand will be pumped through a cyclone and stockpiled for further dewatering.

The proposed stockpile area is located generally within area of Stage 1 of the project area and will encompass stockpiles of topsoil, vegetation and sand products. Stockpiling of material will be limited in terms of volume and timeframe to limit the loss of resource.

Stockpiles of cleared/mulched vegetation will be minimal as this material will be reused on site for the purposes of rehabilitation on the windblown dunes and stabilisation works in other areas across the project site.

Dewatered sand will be loaded with a front-end loader and/or excavator into trucks for dispatch.

4.2.5 Stabilisation measures

The dredge pond batters will be designed as follows:

- A batter slope of 2H:1V (Horizontal:Vertical) above 4 m AHD;
- A batter slope of 3H:1V from 4 m AHD on the sides of the dredge pond to 15 m below the water table at the base. The batter slope of 3H:1V will range from 3-9 m AHD on the southern and eastern perimeters of the dredge pond and also extend to 15 m below the water table at the base.
- On the southern and eastern sides of the proposed dredge pond the perimeter haul road will follow existing topography and may require some earthworks as required to achieve 10H:1V and facilitate safe access for heavy vehicles.

Refer to **Figure 4.3** for indicative cross sections for the project.

The stabilisation of the edges of the dredge pond will rely on batters at an angle of natural repose. Preliminary geotechnical advice has been provided by Pells Sullivan Meynick Pty Ltd, which recommended regular inspection of the batters to ensure management responses are taken. Where necessary, a protective layer of appropriate VENM may be used to stabilise the embankments.

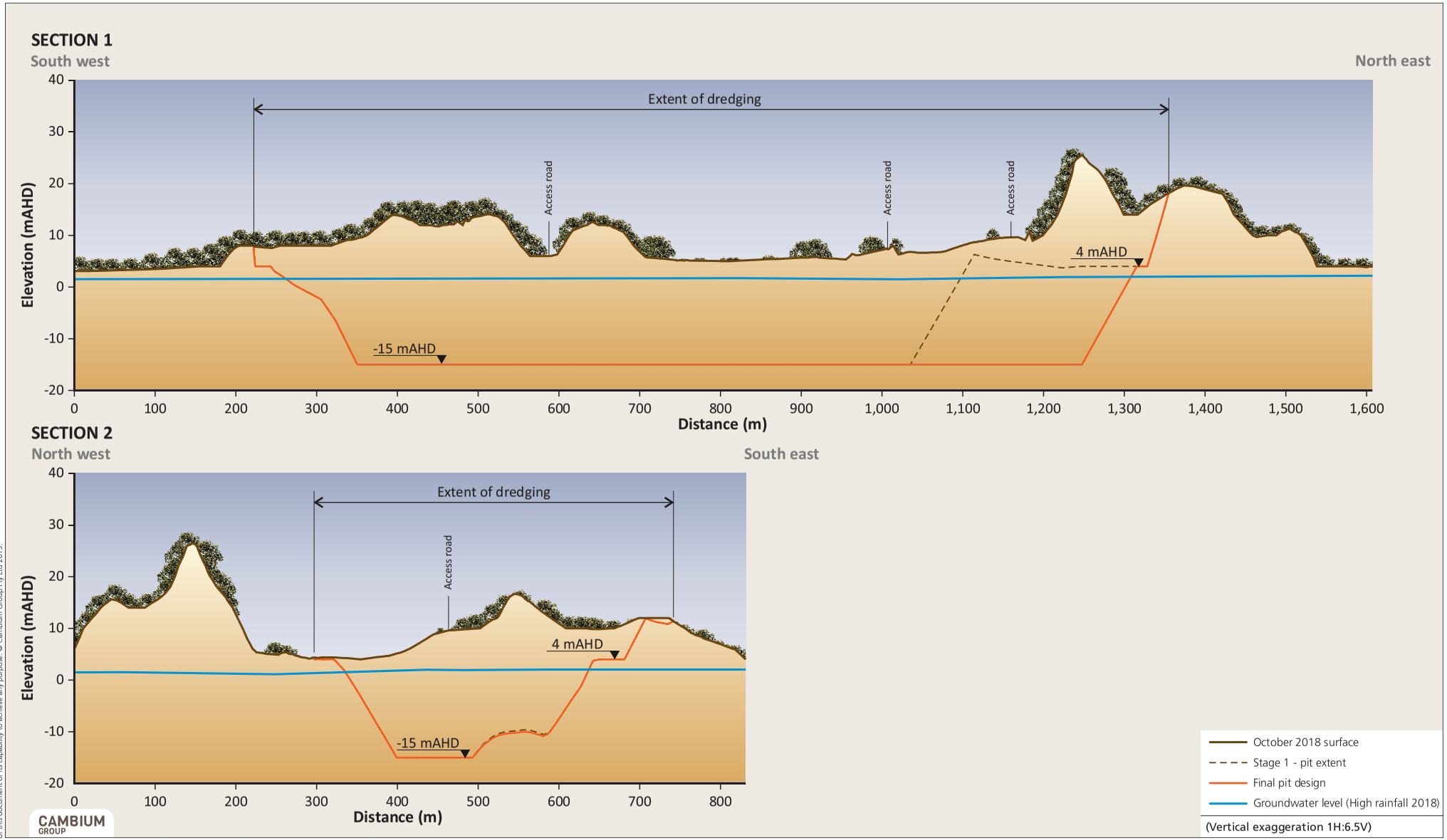
Management options for stabilisation and embankment erosion will be:

- progressive rehabilitation using planted edges; and/or
- VENM emplacement, including application of 450 mm rock (refer to **Section 4.2.7**).

In the initial phases of work, the aim will be to stabilise the edge of the pond and where necessary to prevent wave action induced erosion at the pond edge.

Figure 4.3
Sections

STOCKTON SAND QUARRY DREDGING
ENVIRONMENTAL IMPACT STATEMENT



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4.2.6 Dust suppression

A water cart will be used to suppress dust during initial site establishment works when necessary, focussing on the existing and proposed haulage routes and the Stage 1 extraction area.

Except for Stage 1, progressive sand extraction will limit exposed ground surfaces to 200-300 m at any one time so that sand is not lost to wind.

Additional water to current demand will likely not be required for dust suppression given the reduction in sand extraction at the windblown extraction area and eventual cessation of activities in this area.

4.2.7 VENM Importation

Boral proposes to import up to 70,000 tpa of VENM by road to stabilise slopes and batters as required.

4.2.8 Dispatch limit

Boral is seeking a site wide dispatch limit (i.e. the existing windblown extraction area and proposed dredging extraction areas) of no more than 750,000 tpa. The project will not alter the directional split of traffic movements to or from the quarry, with trucks travelling both north and south along Nelson Bay Road and beyond. Most trucks will be truck and dog combination, with an average of 34 t.

Boral will limit the total exportation of product via road to 750,000 tpa until the windblown sand development consent lapses in 2028. At this point, the dispatch and transportation of product will reduce to 500,000 tpa.

4.2.9 Transport

The project will generate 30 heavy vehicle movements per hour during a maximum hour of production, equating to approximately 284 laden vehicle movements per day.

The maximum traffic generation for the project comprises 26 heavy vehicles transporting sand product per hour, and four heavy vehicles importing VENM to the project site per hour.

4.2.10 Plant and equipment

The plant and equipment currently operated at the quarry (refer to **Section 2.4.4**) will be used during the project.

In addition, the following plant and equipment will be acquired and used:

- suction dredge (as described in **Section 4.2.3**);
- a wash plant (as described in **Section 4.2.4**); and
- two diesel generators.

4.2.11 Hours of operation

The project will continue to operate in accordance with the following approved hours in the 2006 development consent:

- Monday to Friday – 6:15 am to 5:00 pm;
- Saturday – 6:15 am to 12 noon; and

- no operation on Sundays or Public Holidays.

The site is also approved to operate extended hours during major supply contracts as follows:

- Monday to Friday – 6:15 am to 6:00 pm;
- Saturday – 6:15 am to 3:00 pm; and
- no operation on Sundays or Public Holidays.

Boral seeks the continuation of the existing hours of operation including extended operations as and when required. The potential additional one hour Monday to Friday, and three hours on a Saturday allow for a limited range of flexibility in operations to meet fluctuating project demands over time.

4.2.12 Employment

The project will provide employment for an additional two full time personnel and two casual employees, bringing the total employment for the quarry to six full time and three casual employees. The quarry will continue to provide flow on employment opportunities for numerous Boral and customer truck drivers and associated service personnel.

4.2.13 Rehabilitation

Upon completion, the project site will be left as a freshwater pond and rehabilitation will comprise:

- rehabilitating the pond edge;
- plant species planted along the edges of the pond will be selected to maximise the bank stability; and
- stabilising re-profiled areas as soon as possible, minimise potential erosion and degradation of areas of exposed topsoil.

In the initial phases of work, the aim of rehabilitation will be to stabilise the edge of the pond.

4.3 Production schedule

Boral proposes to extract approximately 9 Mt of sand. At a maximum extraction rate of 750,000 tpa up to 2028 and then 500,000 tpa thereafter the reserve would last for approximately 19 years. However, as there is no guarantee that the current extraction/sales rate will be maintained due to the vagaries of the market, a 25 year consent will enable the resource to be fully extracted and account for fluctuations in the market demand.

The indicative schedule for the stages of the project is summarised in **Table 4.1**. The table is based on the extraction occurring at maximum capacity every year over each stage of the project.

Table 4.1: Production schedule

Stage	Reserve (tonnes)	Duration (years)	Approximate dates
Existing windblown sand extraction area	1,500,000 (maximum)	3-9 years	2019-2028
1	1,640,000	2-3	2020-2022
2	1,327,138	2-3 years	2022-2025
3	1,354,000	2-3 years	2025/2026-2028/2029
4	1,901,000	3- 4 years	2030- 2034

Stage	Reserve (tonnes)	Duration (years)	Approximate dates
5	1,483,000	3 years	2037
6	1,326,000	3 years	2039/40
Total (Stages 2-6)	9,032,138	19 years	-

4.4 Comparison against existing operations

A comparative summary of the key project elements in comparison to the existing windblown sand extraction operations is provided in **Table 4.2** below.

Table 4.2: Comparison against existing operations.

Aspect	Existing windblown sand operations	The project
Land use	Extractive industry	Extractive Industry
Location on site	Windblown (transgressive) dunes	Inland dunes
Hours of operation	**Standard hours:** ▪ Monday to Friday - 6.15 am to 5.00 pm; ▪ Saturday - 6.15 am to 12.00 pm (noon) ▪ Sunday and public holidays - no operations. **Extended hours:** ▪ Monday to Friday - 6.15 am to 6.00 pm; ▪ Saturday - 6.15 am to 3.00 pm; and ▪ Sunday and public holidays - no operations.	**Standard hours:** ▪ Monday to Friday - 6.15 am to 5.00 pm; ▪ Saturday - 6.15 am to 12.00 pm (noon) ▪ Sunday and public holidays - no operations. **Extended hours:** ▪ Monday to Friday - 6.15 am to 6.00 pm; ▪ Saturday - 6.15 am to 3.00 pm; and ▪ Sunday and public holidays - no operations.
Consent period	20 year life, due to cease in 2028	25 years from the date of commencement
Transport limits	500,000 tpa	750,000 tpa (inclusive of both the windblown sand operations and the project) until the windblown sand development consent lapses in 2028. At this point, the dispatch and transportation of product will reduce to 500,000 tpa.
Extraction method	Dry extraction only.	Dry extraction of the stage 1 area followed by wet extraction (dredge) stages 2 – 6 (inclusive)
Processing	Minimal – sand is typically loaded directly into trucks for dispatch	Stage 1 – as needed dry screen prior to dispatch (dependant on quality).

Aspect	Existing windblown sand operations	The project
		Stages 2 – 6 (inclusive) sand is dredged and processed through a wash plant prior to being stockpiled using a telescopic stacker
VENM Importation	Nil	70,000 tpa
Site infrastructure	Established depot at the site which contains: ▪ an amenities/office building providing an office, lunchroom, toilet and shower; ▪ weighbridge; ▪ designated parking area for employees and visitors; and ▪ maintenance shed; and ▪ 4,200 L above ground bunded fuel tank.	Retain all existing improvements and augment/upgrade to include: ▪ new prefabricated office building; ▪ relocation of onsite materials storage (currently in the footprint of proposed stage 1); ▪ replacement of roofing for the workshop; and ▪ new 30,000 L water storage tank.
Utilities	▪ depot connected to the grid; ▪ tank water; and ▪ septic system.	▪ depot connection maintained and extended to connect to the proposed office building; and ▪ two generators to power proposed wash plant and stacker.
Plant and equipment	Mobile equipment operated at the site comprises: ▪ a front-end loader (capacity nine tonnes); ▪ a dozer (part time); ▪ a water truck (13,000 L capacity); and ▪ a mobile screen (20 mm mesh screen and a 5 m^3 capacity receiving bin).	Existing mobile equipment to be retained, with additional plant and equipment to include: ▪ potential use of mobile screen; ▪ suction dredge; ▪ a wash plant; and ▪ telescopic stacker.
Truck movements	152	284 (maximum)

Boral seeks consent for the project as a standalone consent that would operate in accordance with project specific controls and criteria. Like any new and incoming development these criteria have been established taking into account all existing sources (including the windblown sand operations).

In this regard it is noted that the points of commonality or crossover occur only in relation to the following aspects of the development:

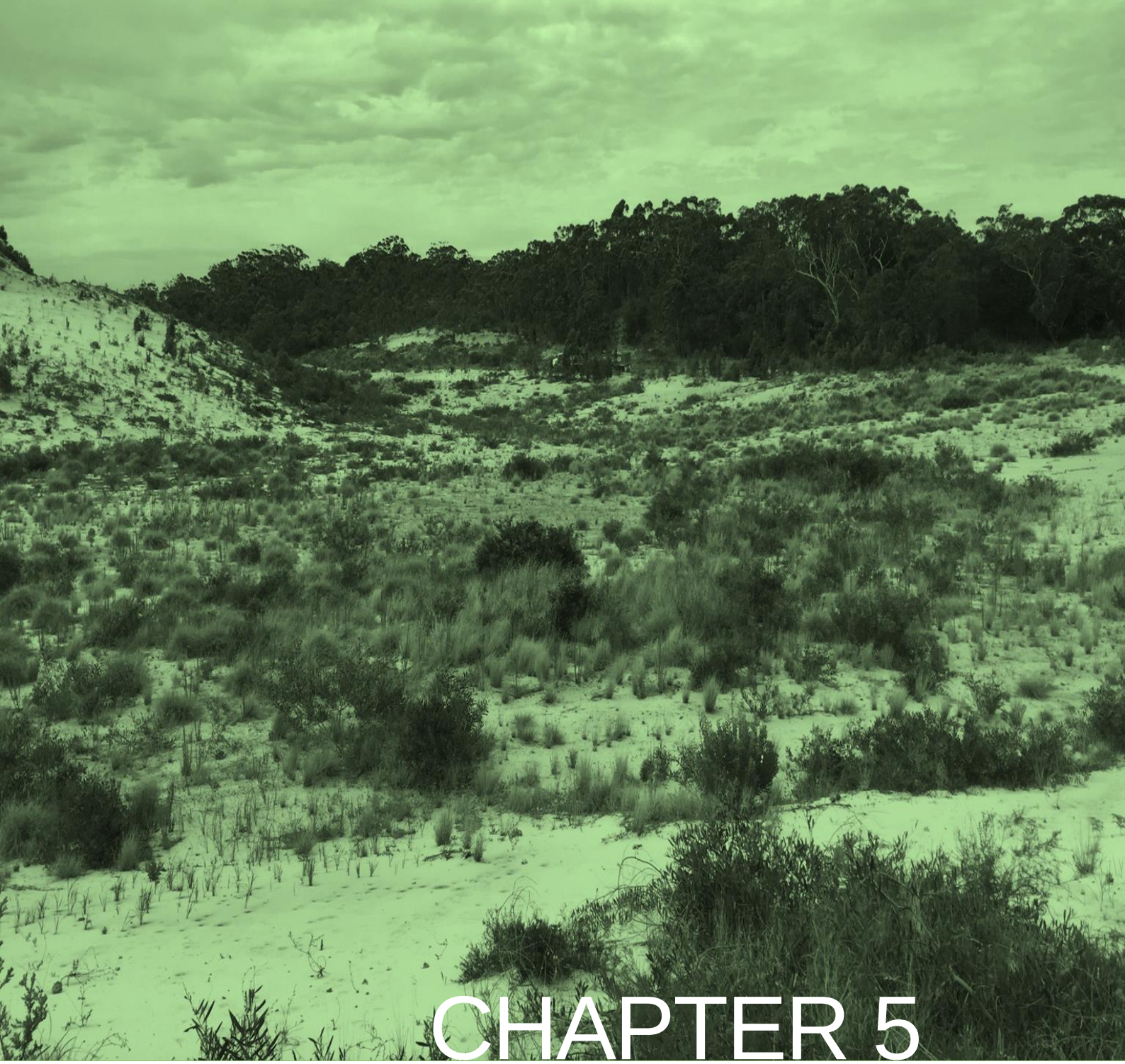
- access roads (predominately those located in the north west of the site);

- site depot amenities and infrastructure;
- fuel storage; and
- transport limits.

In all other respects the project will operate independent of the windblown sand operations. The minor nature of the shared elements are unlikely to give rise to inconsistencies in the project approvals that would impact on management of the site.

In all other respects project compliance would be tracked as individually in accordance with project specific, environmental management, compliance and reporting mechanisms.

As highlighted above, Boral will limit the total exportation of product via road to 750,000 tpa until the windblown sand development consent lapses in 2028. At this point, the dispatch and transportation of product will reduce to 500,000 tpa. This may require a minor modification to the existing windblown sand development consent prior to commencement of the project approval.



CHAPTER 5

STAKEHOLDER ENGAGEMENT

5 STAKEHOLDER ENGAGEMENT

Successful completion of the EIS required consultation with several key stakeholders. This chapter provides a summary of the stakeholders engaged for the project.

5.1 Assessment requirements

The SEARs in **Table 5.1** require consultation with relevant stakeholders during the preparation of the EIS and documentation of the outcomes of the stakeholder engagement process.

Table 5.1: Stakeholder engagement related SEARs

Requirement	Section and appendix where addressed
During the preparation of the EIS, you must consult with relevant local, State and Commonwealth Government authorities, service providers, community groups and affected landowners.	Chapter 5, Chapter 13, Appendix B
in particular, you must consult with: • affected landowners; • community groups; • Port Stephens Council; • Office of Environment and Heritage (including the Heritage Branch); • Environment Protection Authority; • Division of Resources and Geoscience within the Department; • Department of Primary Industries (including NSW Forestry, Agriculture and Fisheries); • Department of Industry (including the Crown Lands and Water Division); • Hunter Local Land Services; • Hunter Water; • NSW Health; • NSW Rural Fire Service; and • Roads and Maritime Services.	Section 5.2 and 5.3, Appendix B
The EIS must: • describe the consultation process used and demonstrate that effective consultation has occurred; • describe the issues raised; • identify where the design of the development has been amended and/or mitigation proposed to address issues raised; and • otherwise demonstrate that issues raised have been appropriately addressed in the assessment.	Section 5.2 and 5.3

5.2 Stakeholder engagement strategy

Having operated the quarry for a long time, Boral has a sound understanding of the key stakeholders that have an interest in the operations. A detailed stakeholder engagement strategy and program was developed at the start of the SSD process to guide stakeholder engagement activities.

The focus of the stakeholder engagement program was to identify any relevant concerns stakeholders may have about the project, ensure these concerns are appropriately considered by the project team, and where necessary, address these through changes or refinements to the design of the project and associated infrastructure.

The SEARs also require an "assessment of the likely social impacts of the development" in accordance with the *Social impact assessment guideline – for State significant mining, petroleum production and extractive industry development* (NSW Department of Planning and Environment, 2017).

To inform the social impact assessment (SIA) for the project thorough engagement was required with potentially affected neighbours, landowners along Coxs Lane and in Fullerton Cove, non-government organisations, government agencies, Council and the general public. The SIA report in **Appendix I** and summarised in **Chapter 13** of the EIS, provide a summary of all key stakeholder engagement including:

- who was consulted;
- when they were consulted;
- what they were consulted about;
- what issues were raised;
- where follow up consultation or additional research was required to further investigate any issues raised; and
- how these issues were considered in the project design, and development of impact avoidance, minimisation and management measures.

The key community engagement activities carried out for the SIA and outcomes of this engagement are summarised in **Section 13.2.3**.

The site shares a boundary with Worimi Conservation Lands (WCL) and as such consultation with WCL has been a key focus of the stakeholder engagement strategy. WCL were consulted during the ACHA process as further detailed in **Section 5.4**. WCL participated in the site inspection for the ACHA and were invited to provide comment on the assessment methodology and draft ACHA report. No response was received from WCL. Despite this, consultation with WCL is an ongoing focus for Boral and at the time of writing, an additional meeting is being sought with WCL to discuss the project.

5.3 Government agency consultation

Table 5.2 provides a summary of government agency consultation and any key issues raised and provides a reference to where in the EIS these issues have been addressed. It captures key outputs from government agency consultation. Where no key outputs arose from government agency consultation, consultation with that government agency has not been captured.

Each government agency was issued a letter introducing the project in July 2019. The letter advised that the EIS was being prepared and the agency was invited to discuss the project, advise if it required any additional considerations beyond the SEARs in the EIS, or state whether it had no comments and would like to await exhibition of the EIS.

Table 5.2: Summary of government agency consultation

Stakeholder	Comments	Response/EIS Section Reference
DPIE	The development application was lodged with DPIE and a subsequent preliminary environmental assessment (Element, 2018) was lodged with DPIE in September 2018. The SEARs for the project were issued un 16 November 2018 by DPIE.	Refer to **Section 1.7**, **Appendix A** and the start of chapters of the EIS for DPIE SEARs and where addressed by this EIS.
Port Stephens Council (Council)	A response was received from Council (contact Emmilia Johnstone) on 23 July 2019 stating that there were no additional comments from Council and it would await exhibition of the EIS.	Refer to **Appendix A** for Council SEARs and where addressed by this EIS. Refer to correspondence from Council in **Appendix B**.
DPIE – Water, Lands and Primary Industry Division (formerly NSW Department of Industry – Water and NSW Department of Primary Industries, Agriculture and Fisheries Division)	Given there are no state forests near the quarry, it was considered that consultation with DPI Forestry was not warranted. A response was received from DPI Fisheries Division (contact Scott Carter) on 17 July 2019 stating that there were no fisheries concerns for this development application. A response was received from DPI Agriculture Division (contact Tory Lawrence) on 18 July 2019 stating that there were no comments from the Division and it would await exhibition of the EIS.	Refer to correspondence from DPI in **Appendix B**.
DPIE – Water, Lands and Primary Industries Division (formerly NSW Department of Industry, Crown Lands Division	A response was received from Crown Lands (contact Mark Grace) on 26 July 2019 highlighting the current licence agreement would require amendment to reflect the proposed access arrangements to the quarry. A meeting was held between Boral and Crown Lands on 8 August 2019 to discuss the licence agreement. Licensing arrangements will be resolved directly with Crown Lands.	Refer to correspondence from DPIE in **Appendix B**.
DPIE – Division of Resources and Geoscience (DRG)	DRG provided a response on 8 August stating that there were no additional comments and it would await exhibition of the EIS.	Refer to **Appendix A** for DRG SEARs and where addressed by this EIS. Refer to correspondence from DPIE in **Appendix B**.

Stakeholder	Comments	Response/EIS Section Reference
EPA	A response was received from EPA (contact Lisa Richards) on 31 July 2019 stating that there were no additional comments from the EPA and they would await exhibition of the EIS.	Refer to **Appendix A** for EPA SEARs and where addressed by this EIS. Refer to correspondence from the EPA in **Appendix B**.
DPIE – Environment, Energy and Science Division (formerly NSW Office of Environment and Heritage)	A response was received from DPIE (contact Steven Cox) on 2 August 2019 stating that there were no additional comments from the Division and it would await exhibition of the EIS.	Refer to **Appendix A** for DPIE – Environment, Energy and Science Division SEARs and where addressed by this EIS. Refer to correspondence from DPIE in **Appendix B**.
Hunter Local Land Services (HLLS)	A response was received from HLLS (contact Brett Miners) on 17 July 2019 stating that there were no comments from HLLS.	Refer to correspondence from HLLS in **Appendix B**.
Hunter Water	Follow up correspondence was issued to Hunter Water on 31 July 2019 and 8 August 2019. A letter response was received from Hunter Water on 15 August 2019. Hunter water recommended that extractive operations are designed and carried out in a manner which ensure protection of water sources and facilitates sustainable future land uses. Hunter Water also suggests that the EIS demonstrates how dredging operations would not adversely impact the aquifer, and recommend development of a monitoring and management program to assess and mitigate any effects on groundwater level or quality. The EIS should also demonstrate that site operations would not contaminate the aquifer and include management of wastewater and stormwater. The rehabilitation and future land use of the site to protect the aquifer as a potential source of drinking water in future should also be addressed.	Refer to correspondence to Hunter Water in **Appendix B**. The EIS has addressed Hunter Water concerns in relation to groundwater resources as detailed in **Chapter 8**, **Chapter 17**, **Appendix D** and **Appendix L**.
NSW Rural Fire Service (RFS)	Follow up correspondence was issued to RFS on 8 August 2019. Despite repeated attempts at consultation, no response was received from RFS.	Refer to **Appendix A** for RFS SEARs and where addressed by this EIS. Refer to correspondence to RFS in **Appendix B**.

Stakeholder	Comments	Response/EIS Section Reference
Roads and Maritime Services (RMS)	A response was received from RMS (contact Peter Marlor) on 22 July 2019 stating that there were no additional comments from RMS and it would await exhibition of the EIS.	Refer to **Appendix A** for RMS SEARs and where addressed by this EIS. Refer to correspondence from RMS in **Appendix B**.
NSW Health – Hunter New England Local Health District	A response was received from NSW Health on 17 July 2019 stating that there were no comments and the Department would await exhibition of the EIS.	Refer to correspondence from NSW Health in **Appendix B**.
Natural Resources Access Regulator (NRAR)	The NRAR was consulted during the preparation of the EIS and provided advice that the exposure of the aquifer to the atmosphere and subsequent direct evaporation from the aquifer must be accounted for as groundwater extraction.	Refer to **Chapter 17** for consideration of groundwater extraction quantities and water licensing requirements.

5.4 Aboriginal community groups

The Aboriginal heritage specialists (Kelleher Nightingale Consulting Pty Ltd) consulted the Aboriginal community in accordance with *Aboriginal Cultural Heritage Consultation Requirements for Proponents* (DECCW, 2010).

Each private Aboriginal organisation or individual who responded with a written request to be registered for consultation is referred to as a 'registered aboriginal party' (RAP). Government agencies who registered interest were also consulted in parallel with RAPs.

Details of consultation are provided in Appendix A and Appendix B of the ACHA (**Appendix K**).

5.4.1 Stage 1 – notification and registration of Aboriginal parties

Agency contact

A letter requesting advice on which Aboriginal parties to invite for consultation and all known heritage matters to be taken into consideration was posted to the NSW Office of Environment and Heritage on 15 February 2019.

Press advertisement

A public notice was placed in the *Port Stephens Examiner* newspaper on 7 March 2019 seeking registrations of interest from Aboriginal parties. A copy of the notice is in Appendix A of the ACHA.

Invitation to register to Aboriginal stakeholder groups

Letters were sent via post and email to the parties listed by the government agencies, inviting written registration on 19 February 2019. Those letters which did not receive a response were followed up with a phone call and email where these details were provided.

Registered Aboriginal Parties

The RAPs who registered an interest in being consulted for the project are in **Table 5.3**.

Table 5.3: List of RAPs for the project

Organisation	Contact Name
Worimi Local Aboriginal Land Council (LALC)	Jamie Merrick
Murra Bidgee Mullangari Aboriginal Corporation	Ryan Johnson
Didge Ngunawal Clan	Paul Boyd and Lilly Carroll
Merrigarn Indigenous Corporation	Shaun Carroll
Muragadi Heritage Indigenous Corporation	Anthony Johnson
Nur-Run-Gee Pty Ltd	Leonard Anderson OAM
Lower Hunter Wonnarua Cultural Services	Tom Miller
Worimi Traditional Owners Indigenous Corporation	Candy Towers
A1 Indigenous Services	Carolyn Hickey
Murrooma Incorporated	Anthony Anderson
Karuah Indigenous Corporation	David Feeney
Widescope Indigenous Group	Steven Hickey

Organisation	Contact Name
Worimi Conservation Lands (WCL Board of Management c/o Graeme Russell)	Graeme Russell
Amanda Hickey Cultural Services	Amanda Hickey
Aboriginal stakeholder (details withheld)[1]	Aboriginal stakeholder
Aboriginal stakeholder (details withheld)[1]	Aboriginal stakeholder

[1] Aboriginal stakeholder requested their details not be released in accordance with item 4.1.5 of the *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010.*

5.4.2 Stages 2 and 3 – presentation of information and request for cultural information

Distribution of information

A letter presenting information about the project and describing the proposed assessment method was issued on 3 April 2019 via email to all RAPs.

Responses to the proposed assessment method were received from seven RAPs as detailed in Section 2.3 of the ACHA.

Site inspection

The RAPs were invited to attend a site inspection of the project site with the archaeologist and Boral representatives, which was on 27 June 2019.

Representatives from 13 RAPs participated in the site inspection, which included a discussion of the site history and previous quarry disturbance, further discussion of the project, proposed extraction staging, remediation and archaeological context of the local area, including location of nearby previously recorded sites.

5.4.3 Stage 4 – review of draft Aboriginal cultural heritage report

Distribution of draft report

The draft ACHA was issued to RAPs on 9 September 2019, with a 28 day review period. Towards the end of the review period telephone calls were made to the RAPs to request a response, answer questions and offer more time if required.

Response to comments

The issues raised in response to the draft report are provided in the RAP letters and consultant's responses in Appendix C of the ACHA.

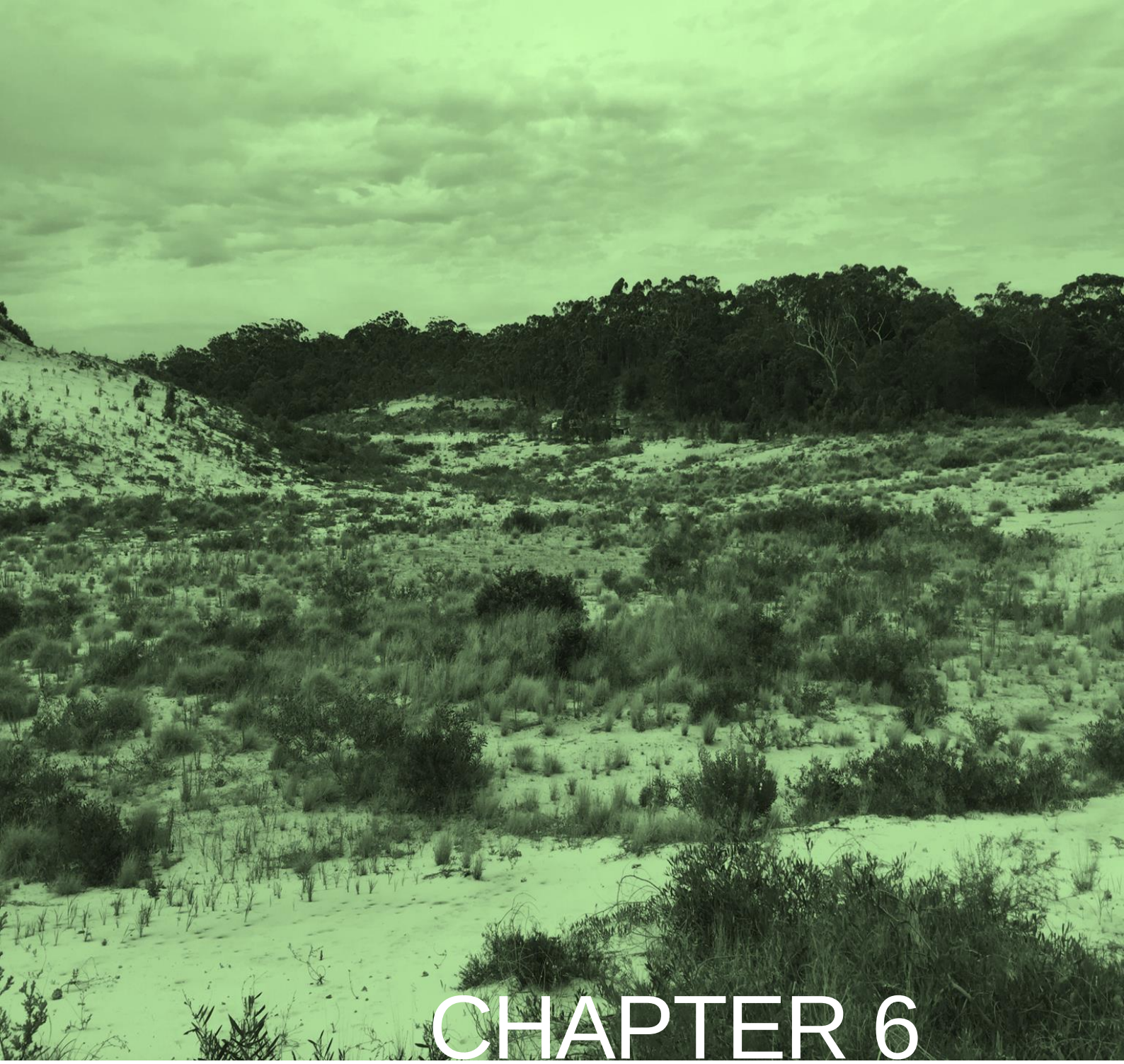
5.5 Continuation of stakeholder engagement

The EIS will be placed on public exhibition to allow for government agencies, organisations, interest groups, stakeholders and community members to review the EIS, seek clarification with Boral on the content of the EIS and provide written submissions if required.

Once the EIS has been exhibited, Boral will prepare a response to submissions report, if required, to address any written submissions, prior to determination of the SSD application.

All relevant stakeholders and the local community will be advised of the public exhibition of the EIS and will continue to be engaged during the remainder of the SSD process in accordance with the stakeholder engagement strategy and to achieve recommendations from the SIA outlined in **Chapter 13** and **Appendix I**, including that when the EIS is placed on public exhibition:

- Fullerton Cove residents will be notified in writing about exhibition of the EIS, the increased heavy vehicle volumes derived from the project, where these matters are addressed in the EIS, SIA and technical studies, how/where they can easily view the documentation, and an invitation to contact Boral to discuss any residual or additional concerns they may have; and
- Boral will place a notification on their website (and other media channels typically used throughout the SSD stakeholder engagement process) to notify of the EIS exhibition process as outlined above.



CHAPTER 6

PLANNING FRAMEWORK

6 LEGISLATIVE FRAMEWORK

This chapter summarises the Commonwealth and NSW regulatory and policy framework for SSD and identifies other approvals under State and Commonwealth legislation which are required.

6.1 Assessment requirements

The SEARs require the EIS to address legislative and policy requirements, which are listed in **Table 6.1.**

Table 6.1: Legislation and policy related SEARs

Requirement	Section and appendix where addressed
the EIS for the development must meet the form and content requirements in Clauses 6 and 7 of Schedule 2 of the Environmental Planning and Assessment Regulation 2000.	Section 6.4
a list of any approvals that must be obtained before the development may commence;	Section 6.5.12
consideration of the development against all relevant environmental planning instruments (including Part 3 of the State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007);	Section 6.6.1
the reasons why the development should be approved, having regard to relevant matters for consideration under the Environmental Planning and Assessment Act 1979, including the objects of the Act;	Section 6.3.1

6.2 Commonwealth legislation

6.2.1 Commonwealth Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act is the primary environmental legislation at the Federal level. The EPBC Act is administered by the Commonwealth Department of the Environment and Energy (DoEE), and provides a legal framework to protect and manage national and international important flora, fauna, ecological communities and heritage places, defined under the EPBC Act as matters of national environmental significance (MNES). The EPBC Act also confers jurisdiction over actions that have a significant impact on the environment where the actions affect, or are taken on, Commonwealth land.

An action that has, will have or is likely to have a significant impact on a MNES or Commonwealth land, may not be undertaken without prior approval from the Commonwealth Minister, as provided under Part 9 of the EPBC Act.

The Protected Matters Search Tool (PMST) is managed by DoEE and is used to identify MNES near or potentially impacted by a development. A 10 km radius of the site was searched for MNES in March 2019. Results of this search are presented in **Table 6.2** and **Appendix C**. This data, combined with local knowledge and records and further technical studies where relevant, has been used to assess whether the project will have, or is likely to have, a significant impact upon a MNES or on Commonwealth land.

Table 6.2: MNES considered in the EPBC Act

Matters of National Environmental Significance	Commentary
World heritage properties	There are no World Heritage properties in the search radius.
National heritage places	There are no National Heritage properties in the search radius.
Wetlands of international importance (listed under the Ramsar Convention)	The Hunter Estuary wetlands are listed under the Ramsar Convention. The Hunter Estuary wetlands are divided into two components, Kooragang Nature Reserve and the Hunter Wetlands Centre, are listed for three criteria. The Kooragang component includes wetlands at Kooragang Island and Fullerton Cove. Fullerton Cove wetlands are approximately 2.2 km west of the project site. As highlighted in **Chapter 8**, the project will not significantly impact the Fullerton Cove wetlands.
Listed threatened species and ecological communities	There are four TECs recorded in the search area, namely: ▪ Central Hunter Valley Eucalypt Forest and Woodland (critically endangered); ▪ Coastal Swamp Oak Forest of NSW and South East Queensland (endangered); ▪ Lowland Rainforest of Subtropical Australia (critically endangered); and ▪ Subtropical and Temperate Coastal Saltmarsh (vulnerable). 73 threatened species have been previously recorded in the search radius. These TECs have not been identified at the site.
Migratory species protected under international agreements	74 migratory species have been previously recorded in the search radius. Potential impacts of the project on these listed migratory species have been assessed (**Chapter 9** and **Appendix E**). No migratory species will be significantly impacted by the project.
Commonwealth marine area	There are no Commonwealth marine areas in the search radius.
The Great Barrier Reef Marine Park	The Great Barrier Reef Marine Park is not in the search radius.
Nuclear actions (including uranium)	There are no nuclear actions in the search radius.
A water resource, in relation to coal seam gas development and large coal mining development	This is not applicable to the project.

6.2.2 Commonwealth Native Title Act 1993

The Commonwealth *Native Title Act 1993* recognises that Aboriginal people have rights and interests to land and waters which derive from their traditional laws and customs. Native title may be recognised in places where Indigenous people continue to follow their traditional laws and customs and have maintained a link with their traditional country. It can be negotiated through a native title claim, an indigenous land use agreement or future act agreements.

The National Native Title Register, Register of Native Title Claims, Unregistered Claimant Applications register, and Register of Indigenous Land Use Agreements were searched in August 2019 for reported native title claimants in the LGA. There were no results for declared native title in the LGA.

6.2.3 National Greenhouse and Energy Reporting Act 2007

The Commonwealth *National Greenhouse and Energy Reporting Act 2007* (NGER Act) provides a single national framework for the reporting and dissemination of information about the greenhouse gas emissions, greenhouse gas projects, and energy use and production of corporations. It makes registration and reporting mandatory for corporations whose energy production, energy use or greenhouse gas emissions meet specified thresholds.

Boral triggers the threshold for reporting under the NGER Act, and reports energy use and greenhouse gas emissions from its operations, including the quarry.

The project is anticipated to generate minimal quantities of greenhouse gas emissions due to the selected extraction methodology, minimal use of electricity for the site depot, and limited use of fuels and other combustible resources at the site. Regardless, Boral will continue to monitor and report energy use and greenhouse gas emissions associated with the project under its obligations under the NGER Act.

6.3 NSW legislation

The following sections address relevant NSW state legislation.

6.3.1 Environmental Planning and Assessment Act 1979

The EP&A Act provides the statutory framework for planning approval and environmental assessment in NSW. Implementation of the EP&A Act is the responsibility of the Minister for Planning, statutory authorities and local councils. It contains three parts that impose requirements for planning approval.

Part 4 of the EP&A Act provides for control of ‘development' that requires development consent from the relevant consent authority. A division of Part 4 (Division 4.7) provides for the assessment of SSD where the Minister for Planning (or delegate) or the Independent Planning Commission is the consent authority.

State significant development

Part 4, Division 4.7 of the EP&A Act relates to the assessment of development deemed to be significant to the State (i.e. SSD). Under Section 4.36(2) a development is SSD if it is declared by a SEPP. The relevant SEPP to the project is the SRD SEPP.

In relation to SSD, Clause 8(1) of the SRD SEPP states the following:

8 Declaration of State significant development: Section 4.36

1. *Development is declared to be State significant development for the purposes of the Act if:*

    1. *the development on the land concerned is, by the operation of an environmental planning instrument, not permissible without development consent under Part 4 of the Act, and*
    2. *the development is specified in Schedule 1 or 2.*

Clause 7 of Schedule 1 of the SRD SEPP declares the following development to be SSD:

1. *Development for the purpose of extractive industry that:*

    a. *extracts more than 500,000 tonnes of extractive materials per year, or*
    b. *extracts from a total resource (the subject of the development application) of more than 5 million tonnes, or*
    c. *extracts from an environmentally sensitive area of State significance.*

The project will involve sand extraction from a natural sand resource estimated at 9 Mt. Therefore, the project is SSD and Division 4.7 of Part 4 of the EP&A Act is the appropriate assessment pathway.

Under Section 4.36 of the EP&A Act, the Minister for Planning is the consent authority for SSD.

A development application (DA) for SSD must be accompanied by an EIS in accordance with Section 4.12(8) of the EP&A Act and the EIS must be prepared in accordance with the EP&A Regulation. Before preparing an EIS, an applicant must request the SEARs, which specify the issues to be addressed in the EIS. The SEARs for the project were issued by DPIE on 16 November 2018 and are provided in **Appendix A**, which also identifies the sections of the EIS where the SEARs have been addressed.

The relevant factors in the assessment and determination of the project are addressed in the following sections.

Permissibility

The project site is in the Port Stephens LGA. The project area is wholly located on land zoned RU2 – Rural Landscape under the Port Stephens LEP 2013. Extractive industries are permissible in this zone with consent.

The portion of Crown land that is used to provide access to the site is zoned RE1 - Public Recreation. No development works are proposed on this portion of land and roads are a permissible use. The use of this land is subject to a licence agreement between Boral and Crown Lands.

Objectives of the Act

The objects of the EP&A Act are specified in Section 1.3 of the Act, and seek to promote the management and conservation of natural and artificial resources, while also permitting appropriate development to occur. The consistency of the project with the objects of the Act is considered in **Table 6.3**.

Table 6.3: Objectives of the EP&A Act

Objectives of the EP&A Act	Consistency of the project
To promote the social and economic welfare of the community and a better environment by the proper management, development and conservation of the State's natural and other resources,	The project will enable the continued use of a long established and operating quarry site that will contribute $17 M to the NSW economy and maintain direct employment for six people and indirect employment for many others.

Objectives of the EP&A Act	Consistency of the project
	The project has been assessed by a range of environmental specialists and where necessary appropriate management frameworks identified to ensure environmental conservation.
To facilitate ecologically sustainable development by integrating relevant economic, environmental and social considerations in decision-making about environmental planning and assessment,	The project is consistent with the principles of ecological sustainable development (ESD) as outlined in **Section 6.3.2**.
To promote the orderly and economic use and development of land,	The orderly and economic use of land is best served by development which is permissible under the relevant environmental planning instruments and generally in accordance with planning controls. The project comprises a permissible development which is consistent with the statutory control and strategic planning directions. The project is also geographically separated from incompatible land uses so as to avoid potential amenity impacts. As detailed in this EIS, the project will result in positive economic impacts through continued employment and contribution of $17 M to the NSW economy. The project has been formulated to maximise re-use of existing infrastructure and thus reduce capital expenditure. Additionally, the project would be confined to areas previously disturbed thereby minimising environmental and social impacts. Potential environmental risks associated with the project have been subject to thorough and rigorous specialist assessment, including subsequent refinement of project parameters to result in beneficial outcomes. As demonstrated in this EIS, all noise and air emissions generated by the project would comply with relevant assessment criteria at all times of operation. Traffic generated by the project would not result in detrimental impact to the surrounding and arterial road network. Appropriate mitigation measures and management strategies have been proposed to reduce any adverse residual environmental and social impacts.
To promote the delivery and maintenance of affordable housing,	Not applicable to the project.
To protect the environment, including the conservation of threatened and other species of native animals and plants, ecological communities and their habitats,	The project area has been sited over an area of previous disturbance to avoid, preserve and protect areas of established vegetation and fauna habitat. Detailed flora and fauna assessments have been completed and are addressed in **Appendix E** and **Chapter 9**. Despite the partial loss of two native vegetation communities and threatened species habitat in the project site, a biodiversity offset strategy has been

Objectives of the EP&A Act	Consistency of the project
	formulated to ensure compensatory land is protected into perpetuity. A residual risk of indirect impacts to biodiversity remains. However, the project has provided all possible and necessary measures to ensure the risk is as low as practicable.
To promote the sustainable management of built and cultural heritage (including Aboriginal cultural heritage),	There are no items of non-Aboriginal heritage present within the site nor is project likely to adversely impact those located within proximity (refer to **Chapter 18).** A specialist consultant has assessed potential impacts on Aboriginal cultural heritage, as described in **Chapter 15**. As the project is contained to an area of previous disturbance it is unlikely the project would result in unsustainable management of cultural heritage (Aboriginal or non-Aboriginal). Management measures will be implemented to ensure the protection of unidentified objects.
To promote good design and amenity of the built environment,	Specialist consultants have assessed potential noise and air quality, as described in **Chapters 10** and **11**. The project has been designed in a manner which aims to avoid the potential for impacts in the first instance (e.g. positioning of the wash plant infrastructure as far as practical from the nearest sensitive receivers), and management measures are proposed to mitigate and manage residual impacts, where necessary.
To promote the proper construction and maintenance of buildings, including the protection of the health and safety of their occupants,	The project will not require the construction of new buildings other than installation of a portable site office, and replacement of roofing for the maintenance shed as recommended for bushfire hazard mitigation for the site. All built structures for the project would comply with relevant building standards and be implemented to improve the health, well-being and safety of site personnel. Existing buildings at the site depot will be maintained for the project and any potentially hazardous substances managed in accordance with relevant legislation as described in **Chapter 20**.
To promote the sharing of the responsibility for environmental planning and assessment between the different levels of government in the State,	The Port Stephens LEP aims to make local environmental planning provisions for land in the LGA in accordance with Section 3.31 of the EP&A Act. In doing so, the State government promotes the assessment and approval of environmental planning and development at the local government level. The project is subject to the provisions of Part 4 of the EP&A Act, and the Minister for Planning is the consent authority. Despite development consent to be granted by the State government, Port Stephens Council, as local government authority, has been regularly consulted throughout the planning phase of the project and preparation of this EIS (refer to **Chapter 5**).

Objectives of the EP&A Act	Consistency of the project
To provide increased opportunity for community participation in environmental planning and assessment.	As outlined in **Chapter 5**, Boral has consulted with government agencies, the local community and other stakeholders. Consultation is ongoing.

6.3.2 Ecologically sustainable development

One of the objects in Section 1.3 of the EP&A Act is "to facilitate ecologically sustainable development by integrating relevant economic, environmental and social considerations in decision-making about environmental planning and assessment". Section 1.4 (Definitions) of the EP&A Act defers to the NSW *Protection of the Environment Administration Act 1991* (POEA Act) for a definition of ESD. Section 6.2(2) of the POEA Act defines ESD as:

> *…ecologically sustainable development requires the effective integration of social, economic and environmental considerations in decision-making processes. Ecologically sustainable development can be achieved through the implementation of the following principles and programs:*
>
> 1. *the precautionary principle—namely, that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.*
>
>   *In the application of the precautionary principle, public and private decisions should be guided by:*
>
>   1. *careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment, and*
>   2. *an assessment of the risk-weighted consequences of various options,*
>
> 2. *inter-generational equity—namely, that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations,*
> 3. *conservation of biological diversity and ecological integrity—namely, that conservation of biological diversity and ecological integrity should be a fundamental consideration,*
> 4. *improved valuation, pricing and incentive mechanisms—namely, that environmental factors should be included in the valuation of assets and services, such as:*
>
>   1. *polluter pays—that is, those who generate pollution and waste should bear the cost of containment, avoidance or abatement,*
>   2. *the users of goods and services should pay prices based on the full life cycle of costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste,*
>   3. *environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms, that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems.*

The following sections set out how the project aligns with the principles of ESD and how these principles have been incorporated into the design of the project.

Precautionary principle

Where there are threats of serious or irreversible environmental damage, a lack of full scientific certainty should not be used as a reason for postponing measures to prevent such damage.

As described in **Chapter 2**, baseline groundwater characteristics have been monitored at the site since 2007 to understand the condition of the existing groundwater resource at and surrounding the quarry, and to understand the environmental impacts of existing operations. This extensive baseline data has been used by the technical specialist to predict the environmental impacts of the project.

As described in **Chapter 7**, there was a preliminary assessment of environmental risks associated with the project in terms of size and duration of impact. Potential risks were rated as described in the PEA and the level of assessment detail for each risk was proportional to the risk rating.

As highlighted in this EIS, the potential noise and air emissions associated with the project would comply with relevant assessment criteria. The project is not anticipated to result in impacts to the quantity and quality of available surface and groundwater resources, and the implementation of recommended management and monitoring measures would minimise the potential for residual impacts associated with the project.

Despite the unavoidable loss of native vegetation communities and threatened fauna habitat, compensatory measures would be implemented in the form of a biodiversity offset strategy, with long term biodiversity impacts likely to be minimised via the implementation of a successful rehabilitation strategy for the project site.

Where serious or irreversible damage to the environment is likely to be unavoidable, management measures and/or compensatory measures (for example a biodiversity offset strategy) have been proposed.

Inter-generational equity

Inter-generational equity is the concept that the present generation should ensure the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.

As described in **Chapters 8**, **10**, **14**, and **17**, the project will not have significant impacts on surface and groundwater availability or quality, air quality or agricultural land. Therefore, the project will not detract from future generation's access to and equal enjoyment of water, air and agricultural resources.

As described in **Chapter 9**, the project will have a significant impact on habitat for a threatened species and two native vegetation communities. However, biodiversity offsets will be provided to compensate for these impacts, which protect other areas of native vegetation into perpetuity for the enjoyment of future generations.

Conservation of biological diversity and ecological integrity

This is the concept that conservation of biological diversity and ecological integrity should be a fundamental consideration.

As described in **Chapter 9**, the project will remove previously rehabilitated native vegetation and result in unavoidable impact on habitat for a threatened species and two native vegetation communities. However, biodiversity offsets will be provided to compensate for these impacts, which will assist in the conservation of biodiversity and ecological integrity for other areas of native vegetation within NSW.

The project has been designed to confine operations to a previously disturbed and rehabilitated area and avoids the disturbance of large areas of remnant vegetation. As such, the design is the most effective way to maintain biological diversity and ecological integrity at the site and surrounding locality, with alternatives considered to result in more severe biodiversity impact.

The rehabilitation strategy has been devised using similar principles of previous successful and high-quality restoration outcomes at the site in order to promote the chances of success of rehabilitation initiatives following completion of the proposed project.

Improved valuation, pricing and incentive mechanisms

This is the concept that environmental factors should be included in the valuation of assets and services.

Cost benefit analysis (CBA) was used to estimate the economic benefit of the project to Australia and NSW, which is in **Appendix N** and summarised in **Chapter 21**. It subtracted the production and environmental costs from the production benefits of the project to determine the net cost/benefit to society. The costs of water extraction, installation of additional site infrastructure and purchase and maintenance of biodiversity offsetting were included in the capital and operating costs of the project.

Other environmental aspects such as noise, air quality and visual impacts to sensitive receivers were not costed as there will not be any residual impacts related to these aspects.

The CBA determined the project will have a maximum net benefit of $41 M to Australia and $17 M to NSW. Any unquantified residual impacts of the project after mitigation, offset and compensation will need to be valued at greater than these amounts for the project to be questionable from an economic efficiency perspective.

6.4 Environmental Planning and Assessment Regulation 2000

Section 4.39 of the EP&A Act refers to the EIS form and content provisions of the EP&A Regulation. Schedule 2, Clauses 6 and 7 of the EP&A Regulation describes the requirements for the form and content of an EIS, which are considered in **Table 6.4**.

Table 6.4: EIS requirements

Details	Commentary
Clause 6 - Form of environmental impact statement: An environmental impact statement must contain the following information:	
1) The name, address and professional qualifications of the person by whom the statement is prepared;	Certification page
2) The name and address of the responsible person;	Certification page
3) The address of the land: a) in respect of which the development application is to be made, or b) on which the activity or infrastructure to which the statement relates is to be carried out,	Section 2.1
4) A description of the development, activity or infrastructure to which the statement relates;	Section 1.3, Chapter 4
5) An assessment by the person by whom the statement is prepared of the environmental impact of the development, activity or infrastructure to which the statement relates, dealing with the matters referred to in this Schedule; and	Chapters 8-22
6) A declaration by the person by whom the statement is prepared to the effect that: a) the statement has been prepared in accordance with this Schedule,	Certification page

Details	Commentary
b) the statement contains all available information that is relevant to the environmental assessment of the development, activity or infrastructure to which the statement relates, and c) that the information contained in the statement is neither false nor misleading.	
Clause 7 – Content of environmental impact statement 7) An environmental impact statement must also include each of the following:	
a) a summary of the environmental impact statement;	Executive summary
b) a statement of the objectives of the development, activity or infrastructure;	Section 1.4
c) an analysis of any feasible alternatives to the carrying out of the development, activity or infrastructure, having regard to its objectives, including the consequences of not carrying out the development, activity or infrastructure;	Chapter 1
d) an analysis of the development, activity or infrastructure, including: i) a full description of the development, activity or infrastructure;	Chapter 4
ii) a general description of the environment likely to be affected by the development, activity or infrastructure, together with a detailed description of those aspects of the environment that are likely to be significantly affected;	Chapter 2, Chapters 8-22
iii) the likely impact on the environment of the development, activity or infrastructure;	Chapters 8-22
iv) a full description of the measures proposed to mitigate any adverse effects of the development, activity or infrastructure on the environment; and	Chapters 8-22, Chapter 23
v) a list of any approvals that must be obtained under any other Act or law before the development, activity or infrastructure may lawfully be carried out.	Section 6.5.12
e) a compilation (in a single section of the environmental impact statement) of the measures referred to in item (d) (iv),	Chapter 23
f) the reasons justifying the carrying out of the development, activity or infrastructure in the manner proposed, having regard to biophysical, economic and social considerations, including the principles of ecologically sustainable development set out in subclause (4).	Section 1.2, Section 6.3.2, Section 7.1
8) Not applicable to the project. 9) Not applicable to the project.	
10) The principles of ecologically sustainable development [ESD] are as follows:	Section 6.3.2
a) the **precautionary principle,** namely, that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, public and private decisions should be guided by: i) careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment, and ii) an assessment of the risk-weighted consequences of various options.	As above

Details	Commentary
b) **Inter-generational equity**, namely, that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations,	As above
c) **conservation of biological diversity and ecological integrity**, namely, that conservation of biological diversity and ecological integrity should be a fundamental consideration,	As above
d) **improved valuation, pricing and incentive mechanisms**, namely, that environmental factors should be included in the valuation of assets and services, such as: i) polluter pays, that is, those who generate pollution and waste should bear the cost of containment, avoidance or abatement, ii) the users of goods and services should pay prices based on the full lifecycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste, iii) environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms, that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems.	As above

6.4.1 Section 4.15 matters for consideration

The consent authority is required to consider the matters in Section 4.15 of the EP&A Act when determining a DA for SSD. Matters relating to the project are considered in the following pages.

Environmental planning instruments

The SRD SEPP is considered in **Section 6.3.1** and other EPIs are considered in **Section 6.6**.

The regulations

The requirements of the EP&A Regulation are considered in **Section 6.4**.

Likely impacts of the development

Impacts to the natural and built environments and social and economic impacts have been assessed (**Appendices D** to **O** and summarised in **Chapters 8** to **22**). The assessments used the most recent and accurate scientific data relevant to the project and adopted conservative assumptions so the upper limit of likely impacts could be assessed.

The project will not result in significant residual impacts on most environmental aspects, including amenity impacts associated with noise, air quality and visual exposure.

The project will have residual impacts on terrestrial biodiversity; however such impacts have been minimised by focusing extraction in areas of previous disturbance and avoiding removal of established vegetation. All vegetation proposed to be removed will be offset in accordance with NSW policy. This offsetting will have the benefit of protecting areas of similar native vegetation communities into perpetuity.

The economic analysis of the project demonstrated that it will be socio-economically beneficial to the nation, State and local community. The project will have net social benefits to Australia of $41 M and to NSW of $17 M including employment benefits.

Suitability of the site

The project site is suitable for the proposed development as it contains a sand resource as described in **Section 1.2** and is the site of an existing quarry with infrastructure that will continue to be used for the project as described in **Chapters 3** and **4**.

As highlighted in this EIS, the project is in a location which maximises the use of a previously disturbed area, which is geographically separated from adjacent land uses and sensitive receivers. The project thereby minimises the potential for adverse environmental and social impacts, which would otherwise be compounded if the project were to proceed in an alternative location.

On the basis of the above, it is considered that the site is suitable for the proposed development.

Submissions

This EIS will be placed on public exhibition by DPIE and submissions will be sought from Council, government agencies and the community. Any submissions received by DPIE will be reviewed and forwarded to Boral for consideration in a response to submissions report.

Public interest

This EIS has been prepared on the basis of detailed investigations aimed at defining the current social, biophysical and economic environment. Detailed assessment undertaken by appropriate technical specialises demonstrates that on balance the proposed development is unlikely to have significant impact on the receiving environment. On this basis, the proposed development is not considered to be contrary to the public interest.

6.5 Other NSW legislation

In addition to the requirements under Part 4 of the EP&A Act, the project will require additional approvals, licences and/or authorisation under various other pieces of NSW legislation, which are summarised in this section.

6.5.1 Protection of the Environment Operations Act 1997

The POEO Act aims to protect, restore and enhance the quality of the environment in the context of ecologically sustainable development and to reduce risks to human health and prevent degradation of the environment.

Section 48 of the POEO Act outlines that an EPL is required for any scheduled activities at a premise at which Schedule 1 of the Act indicates that a licence is required.

Crushing, grinding or separating activities with a capacity to process more than 150 t of materials per day or 30,000 tpa, and land based extractive activities involving the extraction, processing or storage of more than 30,000 tpa of extractive materials, are scheduled activities under the Act.

EPL 10132 applies to existing operations at the quarry. A variation to the EPL will be required to increase the permitted limit to a maximum of 750,000 tpa.

6.5.2 Crown Lands Act 1989

The *NSW Crown Lands Act 1989* provides for the administration and management of Crown land in the eastern and central divisions of NSW. Crown land may not be occupied, used, sold, leased, dedicated, reserved, or otherwise dealt with unless authorised by this act or the *NSW Crown Land (Continued Tenured) Act 1989*.

The quarry site is accessed via a portion of Crown Reserve over which Boral has an existing and valid lease agreement with DPIE (Crown Lands Division).

Crown Lands indicated during consultation that the existing licence agreement will need to be amendment for the proposed access arrangements.

6.5.3 Water Management Act 2000

The *NSW Water Management Act 2000* (WM Act) regulates the management of water by granting licences, approvals for taking and using water, and trading groundwater and surface water. The WM Act applies to those areas where a water sharing plan has commenced. Alternatively, if a water sharing plan has not yet commenced, the *NSW Water Act 1912* (Water Act) applies. The WM Act is progressively replacing the Water Act as relevant water sharing plans are introduced across the State.

Water sharing plans (WSP) have commenced for most of NSW. Licensing of monitoring bores continues under the Water Act until a regulation for aquifer interference gives a mechanism to approve these activities. Licensing of reinjection into groundwater systems is also still currently managed under the Water Act.

Groundwater in the project site is managed under the Stockton Groundwater Source zone of the Water Sharing Plan for the North Coast Coastal Sands Groundwater Sources.

The project will expose the aquifer and result in extraction of groundwater resources via evaporation of the open dredge pond and outgoing moisture content of dispatched sand products. Groundwater extraction and aquifer interference activities are permitted via an aquifer interference approval under Section 91 of the WM Act, and require an authorisation under the WSP via a WAL or some form of exemption. As specified in Section 129A of the Water Act, as the project will require an aquifer interference approval under the WM Act, the Water Act is not applicable.

Boral holds a “zero share” WAL for the quarry and is investigating options to acquire the necessary share allocation.

The project’s water licensing requirements are discussed in **Chapter 17**.

6.5.4 Biodiversity Conservation Act 2016

The BC Act replaced the *Threatened Species Conservation Act 1995*, *Native Vegetation Act 2003* and the flora and fauna provisions of the *NSW National Parks and Wildlife Act 1979* (NPW Act).

As the project is SSD, it is required to consider biodiversity impacts in accordance with the Biodiversity Offset Scheme of the BC Act. The offset scheme requires impacts to first be avoided and then mitigated before being offset in accordance with the scheme.

A biodiversity assessment has been completed for the project and is summarised in **Chapter 9**.

A biodiversity offset strategy will be prepared in accordance with the requirements of the Biodiversity Assessment Method (2017) (BAM). Boral proposes to offset the project using one of the following options:

1. purchase of offset credits on the market, in which if credits become available Boral may pursue this option;
2. payment into the Biodiversity Conservation Fund (BCF), in which Boral would pay the equivalent credit costs into the BCF; and/or
3. utilise existing Boral landholdings to investigate potential for a biodiversity stewardship site to reduce a portion, or all the offset credits.

6.5.5 National Parks and Wildlife Act 1979

The NPW Act contains provisions for the protection and management of national parks, historic sites, nature reserves and Aboriginal heritage. The NPW Act provides statutory protection for Aboriginal objects by making it illegal to move, damage, deface or destroy a relic without written permission from DPIE.

Under Section 86 of the NPW Act, a person must not harm or desecrate an Aboriginal object or place. In cases where harm to Aboriginal objects or places cannot be avoided, an Aboriginal heritage impact permit (AHIP) may be sought under Section 90 of the Act. However, Section 4.41 of the EP&A Act, SSD does not require an AHIP.

Potential impacts to Aboriginal heritage were assessed (refer to **Chapter 15**).

6.5.6 Heritage Act 1977

Non-Aboriginal historical archaeological relics, buildings, structures, archaeological deposits and features are protected under the *NSW Heritage Act 1977*.

The only listed non-Aboriginal heritage item located within 500 m of the project is the 'Stockton Beach Dune System', which has a 'local' heritage listed on the Port Stephens LEP. The curtilage of the heritage listing is adjacent to the north-east and south-east boundaries of the site.

As highlighted in **Chapter 18**, the proposed extraction area will not be immediately adjacent to the Stockton beach dune system and will be in the same disturbance footprint as the previous inland extraction area. As such, the project will not impact upon this listing and is unlikely to impact on any other unknown historic heritage item.

6.5.7 Roads Act 1993

Consent is required from the relevant road authority under Section 138 of the *NSW Roads Act 1993* (Roads Act) for any work in, on or over a public road.

No upgrades will be required to the local road network to accommodate the project and therefore a separate consent is not required under the Roads Act.

6.5.8 Contaminated Land Management Act 1997

The *NSW Contaminated Land Management Act 1997* (CLM Act) establishes a process for investigating, and where required remediating contaminated lands, that pose a risk to human health and the environment.

The EPA's Contaminated Land Record and List of Contaminated Sites notified to the EPA in the Port Stephens LGA was searched in August 2019. There quarry site is not recorded or identified on the relevant registers.

6.5.9 Hunter Water Act 1991

The *NSW Hunter Water Act 1991* (HW Act) establishes the Hunter Water Corporation (Hunter Water) and a framework for the identification, protection and management of drinking water.

The drinking water catchments of Hunter Water are in the Port Stephens LGA.

Under Section 51 of the HW Act, consent authorities, including DPIE, are required to refer DAs that may significantly impact on water quality in the drinking water catchments to Hunter Water for comment.

Following the introduction of the NSW Hunter Water Regulation 2015, Hunter Water published the *Guidelines for developments in drinking water catchments* (Hunter Water, 2017) to provide guidance for development activities within the drinking water catchments and to consent authorities about matters of concern to Hunter Water regarding protection of drinking water quality.

The project site is not in a drinking water catchment. However, it is to the immediate south of the 'Stockton Sandbeds Catchment Area'. The Tomago and Stockton Sandbed aquifers which lie below the site are listed by Hunter Water as a potential water supply in times of extreme drought and may be hydrologically connected to the Stockton Sandbeds catchment area.

In accordance with the guidelines, development which warrants referral to Hunter Water under Section 51 of the HW Act include development for the purpose of extractive industries. Potential impacts to the underlying aquifers listed as a potential source of drinking water in extreme drought have been considered in **Chapters 8** and **17**.

6.5.10 Coastal Management Act 2016

The objectives of the *NSW Coastal Management Act 2016* (CM Act) are to manage the coastal environment of NSW in a manner consistent with the principles of ESD for the social, cultural and economic well-being of the people of the State.

The CM Act defines the coastal zone, comprising four coastal management areas:

1. coastal wetlands and littoral rainforests area;
2. coastal vulnerability area;
3. coastal environment area; and
4. coastal use area.

The CM Act establishes management objectives specific to each of these management areas, reflecting their different values to coastal communities.

The CM Act is supported by the State Environmental Planning Policy (Coastal Management) 2018, which maps coastal zones within NSW. The site is in a mapped coastal environment area as further detailed in **Section 6.6.1**.

6.5.11 Waste Avoidance and Resource Recovery Act 2001

The purpose of the *NSW Waste Avoidance and Resource Recovery Act 2001* (WARR Act) is to encourage the most efficient use of resources and to reduce environmental harm in accordance with the principles of ESD. This Act provides for the making of policies and strategies to achieve this.

This Act promotes a hierarchy of avoidance of unnecessary resource consumption; resource recovery (including reuse, reprocessing, recycling and energy recovery), and disposal (as a last resort).

As described in **Chapter 19**, the following management strategies have been developed in accordance with the WARR Act:

- purchasing recycled products where appropriate;
- developing and implementing waste management procedures to minimise the generation of waste and where unavoidable, re-use waste on-site;
- recycling as many wastes as practically possible through appropriate handling, separation, storage, and collection; and
- where waste cannot be re-used or recycled, transportation and disposal of waste off-site at an appropriately licensed facility.

6.5.12 Summary of approval requirements

Licences, approvals and permits that are likely to be required for the project are summarised in **Table 6.5**.

Table 6.5: Summary of approval requirements

Legislation	Authorisation	Consent of approving authority
EP&A Act	Development consent	Minister or IPC
POEO Act	Amended EPL for extractive industries	EPA
WM Act	Aquifer interference approval	DPIE

6.6 Environmental planning instruments

Environmental planning instruments are legal documents that regulate land use and development.

6.6.1 State environmental planning policies

The relevant state environmental planning policies (SEPPs) which have been considered in relation to the project are summarised below.

State Environmental Planning Policy (State and Regional Development) 2011

The SRD SEPP, amongst other matters, defines whether a development is SSD. The applicability of the SEPP is considered in **Section 6.3.1**.

State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007

The proposed development is permissible under the local environmental planning instrument and as such does not rely of the provisions of the Mining SEPP to enable the making of an application. Notwithstanding this, the Mining SEPP contains provisions that are relevant in the assessment of an application for extractive industries. These are contained in clauses 12 and 12A.

Part 3 (Clauses 12 to 17) of the Mining SEPP stipulate matters for consideration by the consent authority before determining an extractive industry development application, which are addressed below.

Clause 12

As detailed in **Section 6.8.1**, the strategic planning for land in the Hunter Region is set out in the Hunter Regional Plan 2036 (NSW Department of Planning and Environment, 2016).

Direction 13 of the Hunter Regional Plan (HRP) identifies that, whilst ongoing investment in rural and resource industries underpins the sustainable growth, economic prosperity and ongoing productivity of the Hunter region, the continued growth of rural and resource industries can result in potential for land use compatibility issues to arise.

In particular, it identifies that there is also potential for conflict if new housing encroaches into rural and resource areas, leading to increased management costs. Conflict could also affect the potential to sustain or grow rural and resource industries. The expansion of rural and resource industries can also affect established urban activities if not managed appropriately. Land use planning can provide greater certainty for investment in rural and resource industries by establishing clear parameters and transparent processes to support new development.

Land uses near the quarry are described in **Section 2.8**, and include extractive industry, rural residential and environmental conservation. Potential impacts on these land uses have been assessed in this EIS, demonstrating that the project will not have a significant impact on existing and approved land uses around the project. Following consultation with Port Stephens Council, there are no immediate plans to establish residential land uses within immediate proximity to the site.

Clause 12A

The Mining SEPP requires consent authorities to consider applicable provisions of the Voluntary Land Acquisition and Mitigation Policy (VLAMP) before determining a DA.

The VLAMP establishes a framework for ensuring that when noise or dust impacts from a proposal exceed the relevant assessment criteria, landowners are provided with:

- a negotiated agreement between the landowner and the proponent; or
- obligations on the proponent to offer mitigation of impacts on the land, or acquisition of the land, in accordance with conditions of a project approval.

As described in **Chapters 10** and **11**, the noise and air emissions generated by the project will not exceed the relevant assessment criteria, and therefore further consideration of the VLAMP is not required.

Clause 13

Clause 13 of the Mining SEPP relates to matters a consent authority must take into consideration when determining applications for development that is:

- near an existing mine, petroleum production facility or extractive industry;
- identified on a map as being the location of State or regionally significant resources of minerals, petroleum or extractive materials; or
- identified by an environmental planning instrument as being the location of significant resources of minerals, petroleum or extractive materials.

The intent of Clause 13 is to protect operating extractive industries from incompatible land uses which may be approved by relevant consent authorities.

Land surrounding the site is used for extractive industry, rural, residential and environmental conservation.

Fullerton Cove Quarry, owned by Coastal Sands Pty Ltd, is on Coxs Lane approximately 495 m to the north of the quarry, opposite Nelson Bay Road. There are no additional mining, petroleum production or extractive industries near the quarry, with the majority of extractive industry

operations centred around Bobs Farm and Salt Ash further to the north. The independent continued operation of the quarry will not impact operations of Fullerton Cove Quarry or other extractive industries further to the north, nor impede access to geological resources extracted at these operations. The project is therefore compatible with other extractive industries in the region.

There are no geological deposits covered under third party exploration licences issued under the *NSW Mining Act 1992* near the quarry.

Clause 14

Clause 14(1) of the Mining SEPP requires that before granting consent for development for the purposes of extractive industry, the consent authority must consider whether or not the consent should be issued subject to conditions aimed at ensuring that the development is undertaken in an environmentally responsible manner, including conditions to ensure the following:

- that impacts on significant water resources, including surface and groundwater resources, are avoided, or are minimised to the greatest extent practicable;
- that impacts on threatened species and biodiversity, are avoided, or are minimised to the greatest extent practicable; and
- that greenhouse gas emissions are minimised to the greatest extent practicable.

The assessments of water resources and biodiversity are summarised in **Chapters 8**, **9** and **17** respectively. As highlighted in **Section 6.2.3**, the generation of greenhouse gases would be minimised during the project due to the limited use of electricity for the site depot and fuels for generators and mobile equipment.

Clause 15

Clause 15 of the Mining SEPP requires the consent authority to consider the efficiency of resource recovery.

As outlined in **Section 1.2.1**, the project has been designed to maximise the efficiency of extracting fine sand resources found at the site. The methodology and plant selected for the project is considered the most efficient method available to effective extract sand resources in a cost effective manner whilst minimising potential impacts on the environment and community surrounding the site.

Clause 16

Clause 16 of the Mining SEPP requires the consent authority to consider the implications of transport of materials from the development on public roads.

The project involves the transport of up to 750,000 tpa of materials along Nelson Bay Road, and the wider public road network including Cabbage Tree Road. Traffic impacts from road transportation are addressed in **Chapter 12** and demonstrates that the project will not have a significant impact on the road network.

Clause 17

Clause 17 of the Mining SEPP requires that before granting consent for development for the purposes of mining, petroleum production or extractive industry, the consent authority must consider whether or not the consent should be issued subject to conditions aimed at ensuring the rehabilitation of land that will be affected by the development.

The project will be rehabilitated as described in **Chapter 22**.

State Environmental Planning Policy No 33 – Hazardous and Offensive Development

State Environmental Planning Policy No. 33 – Hazardous and Offensive Development (SEPP 33) requires the consent authority to consider whether a development proposal is a potentially hazardous industry or a potentially offensive industry.

The project is not classified as hazardous or offensive industry under SEPP 33. As such, the preparation of a preliminary hazard analysis (PHA) report is not required.

State Environmental Planning Policy No 44 – Koala Habitat Protection

State Environmental Planning Policy No 44 – Koala Habitat Protection (SEPP 44) provides for the protection of koala habitat by ensuring that areas subject to development proposals are considered for their value as habitat or potential habitat for koalas. The Port Stephens LGA is listed under Schedule 1 of SEPP 44 as areas to which the SEPP applies.

Under SEPP 44, potential Koala habitat includes: *'areas of native vegetation where the trees of the types listed in Schedule 2 constitute at least 15% of the total number of trees in the upper or lower strata of the tree component'*.

The BDAR found that of the trees listed in Schedule 2, only *Eucalyptus robusta* was recorded in and near the quarry. The presence of *Eucalyptus robusta* does not meet at least 15% of the total number of trees within the project site, and, therefore, the habitat present is not potential Koala habitat under SEPP 44.

Given the vegetation present within the project site does not meet the definition of potential Koala habitat, it does not meet the criteria of 'core Koala habitat' as defined under SEPP 44.

State Environmental Planning Policy (Koala Habitat Protection) 2019

State Environmental Planning Policy (Koala Habitat Protection) 2019 (SEPP KPH) was published on 20 December 2019. In accordance with Part 1, clause 2 SEPP KPH will not commence until 1 March 2020.

The key changes under SEPP KPH include:

- new definitions for both "koala habitat" and "core koala habitat";
- a revision of schedule 1 to reflect current Local Government Names and boundary changes;
- a revision and expansion of the range of feeder trees listed in schedule 2; and
- changes in the development assessment processes prescribed by Part 2.

The provisions of SEPP KPH have been considered in the BDAR prepared by Niche and it was concluded that the project site is still unlikely to provide core koala habitat. Notwithstanding the above, the savings and transitional provisions of SEPP KPH, specifically Part 4, Clause 15, provide that a development application made prior to the commencement of the instrument is to be determined as though the policy had not commenced.

State Environmental Planning Policy No 55 – Remediation of Land

State Environmental Planning Policy No 55 – Remediation of Land (SEPP 55) aims to provide a state-wide planning approach to the remediation of contaminated land and to reduce the risk of harm to human health and the environment by consideration of contaminated land as part of the planning process. Under SEPP 55, a consent authority must not consent to the carrying out of development on land unless it has considered potential contamination issues.

Extractive industries are listed in Table 1 of *Managing Land Contamination: Planning Guidelines SEPP 55 – Remediation of Land* (Department of Urban Affairs and Planning, 1998) as an activity that may cause contamination.

Despite this, as described under the CLM Act above, there is no known contamination on the site and no duty to report identified contamination to the EPA under Section 60(3) of the CLM Act. If previously unidentified contaminated land is identified during construction or operation of the project, the requirements of SEPP 55 will be complied with.

State Environmental Planning Policy (Infrastructure) 2007

The State Environmental Planning Policy (Infrastructure) 2007 (SEPP Infrastructure) provides a consistent planning regime for infrastructure and the provision of services across NSW, along with providing for consultation with relevant public authorities during the assessment process. SEPP Infrastructure facilitates the development of State infrastructure, including telecommunication facilities, sewerage works and storm water management, and specified when development consent is (and is not required) for such development when carried out in certain zones.

Under SEPP Infrastructure, DPIE is required to formally forward development applications to RMS for certain developments listed in Column 2 and 3 of Schedule 3 of the Policy and consider any representations made by the RMS.

The project does not trigger traffic generating development under Schedule 3 of the SEPP. Regardless, RMS has been consulted by DPIE during formation of the SEARs and further consulted by Boral during preparation of the EIS. The RMS requirements have been addressed in **Chapter 12**.

State Environmental Planning Policy (Coastal Management) 2018

The aim of the State Environmental Planning Policy (Coastal Management) 2018 (Coastal SEPP) is to promote an integrated and co-ordinated approach to land use planning in the coastal zone in a manner consistent with the objects of the CM Act.

A review of the Coastal SEPP mapping indicates the project is adjacent to a coastal environment area in Stockton Bight and the Coastal SEPP is not directly applicable to the project. However, indirect impacts on the adjacent coastal environment area have been considered in **Chapters 8**, **9**, **14**, **16** and **17**.

In accordance with Clause 13 of the Coastal SEPP, prior to granting consent to a proposed development, a consent authority must be satisfied that the proposed development will not have an adverse impact upon:

(a) the integrity and resilience of the biophysical, hydrological (surface and groundwater) and ecological environment,

(b) coastal environmental values and natural coastal processes,

(c) the water quality of the marine estate (within the meaning of the Marine Estate Management Act 2014), in particular, the cumulative impacts of the proposed development on any of the sensitive coastal lakes identified in Schedule 1,

(d) marine vegetation, native vegetation and fauna and their habitats, undeveloped headlands and rock platforms,

(e) existing public open space and safe access to and along the foreshore, beach, headland or rock platform for members of the public, including persons with a disability,

(f) Aboriginal cultural heritage, practices and places,

(g) the use of the surf zone.

Development consent must not be granted unless the consent authority is satisfied that:

(a) the development is designed, sited and will be managed to avoid an adverse impact referred to in subclause (1), or

(b) if that impact cannot be reasonably avoided—the development is designed, sited and will be managed to minimise that impact, or

(c) if that impact cannot be minimised—the development will be managed to mitigate that impact.

The project design has responded to the attributes of the site, including biophysical, social and cultural values. As set out in the environmental assessment chapters, the project will not adversely impact other attributes listed in Clause 13 of the Coastal SEPP.

Notwithstanding the above, where appropriate, management measures as outlined in this EIS will be implemented to reduce impacts to biodiversity, Aboriginal cultural heritage and hydrological regimes.

6.6.2 Port Stephens Local Environment Plan 2013

As set out in **Section 2.3**, "extractive industries" are permissible with consent in the RU2 – Rural Landscape zone under the Port Stephens LEP.

As set out in **Section 6.6.1**, the Mining SEPP applies to the land and the form of development described. In accordance with Clause 8 of the Mining SEPP the application is not subject to the provisions of the LEP nor will those provisions have any effect in the determination of the application.

Notwithstanding the above, the project has been considered against the objectives of the RU2 Rural Landscape zone in **Table 6.6**, as adopted under clause 2.3 of the LEP.

Table 6.6: Consideration of land use zone objectives

Zone objective	Consistency
To encourage sustainable primary industry production by maintaining and enhancing the natural resource base.	Extractive industries are a form of primary industry involving the removal and use of raw materials. The approach and methodology adopted for the project seeks to achieve sustainable management through effect avoidance, management and mitigation of potential impacts associated with noise, dust, erosion and water quality. The development does not compromise or impact on any adjacent holdings or primary industry operations.
To maintain the rural landscape character of the land	The quarry is sited at a low point within the broader landholding surrounded by high vegetated dunes that will be maintained throughout the operation. As set out in **Chapter 16**, which considers the potential for visual amenity impacts, the operation will be largely obscured from the view of the public. As such, the landscape character of the site when viewed from adjacent public or private land will not be visibly altered. Rehabilitation works will ensure that the final landform is compatible with the landscape character.
To provide for a range of compatible land uses, including extensive agriculture	The proposed extractive industry is considered compatible with the surrounding land uses. As

Zone objective	Consistency
	demonstrated by this EIS, the development will not give rise to adverse amenity impacts or compromise/conflict with other adjacent land uses.

The LEP lists various development considerations, including provisions for heritage conservation, bushfire hazard reduction, ASS, flood planning, drinking water catchments, wetlands, essential services and public infrastructure. The aforementioned provisions have been considered in the EIS and relevant specialist studies where appropriate.

6.7 Other plans and policies

6.7.1 Strategic Regional Land Use Policy

The Strategic Regional Land Use Policy (NSW Government, 2012a) sets out a range of initiatives to better balance growth in the extractive industry with the need to protect agricultural land and water resources. The Policy includes a package of measures including the following key elements:

- the preparation of strategic regional land use plans (SRLUPs) for both the Upper Hunter and the New England North West regions of NSW which identify and map strategic agricultural land (SAL) and critical industry clusters (equine and viticulture land uses) within these areas;
- the introduction of the AIP (see below); and
- the requirement for agricultural impact statements to accompany SSD applications for mining projects that have the potential to affect agricultural resources.

The gateway process of the Strategic Regional Land Use Policy is not applicable to extractive developments.

The existing SRLUPs do not apply to the project site. Notwithstanding, matters relating to soil landscapes, land use impacts, land capability and agricultural suitability have been addressed in **Chapter 14**.

The project site does not contain any land that has been mapped as BSAL. Furthermore, there is no land area in or adjoining the project site that is used for commercial horse breeding or contains vineyards.

6.7.2 Aquifer Interference Policy

The AIP was released by the NSW Office of Water in 2012. It defines the regime for protecting and managing the impacts of aquifer interference activities (such as dredging) on water resources. The AIP seeks to strike a balance between the water needs of towns, farmers, industry and the environment.

The AIP clarifies water licensing and impact assessment requirements for aquifer interference activities under NSW legislation, principally the Water Act and WM Act. This includes defining criteria or ‘minimal impact considerations’ for water table, pressure and quality that are to be applied in assessing the potential impacts of aquifer interference activities on water resources. That is, to evaluate whether more than minimal impacts might occur to a water-dependent asset as defined in the AIP, for example a water supply work or high priority groundwater dependent ecosystem.

The AIP also sets out the information that must be provided by the applicant to enable appropriate assessment of the activity by the Minister for Lands and Water.

The project has been assessed in accordance with the AIP, as described in **Chapter 8**.

6.7.3 Port Stephens Development Contributions Plan 2007

The Port Stephens Development Contributions Plan 2007 applies to all 'industry, rural industry, extractive industry and mining' development in the LGA. The plan requires these developments to contribute to a road maintenance levy for the upgrade and maintenance of roads within the LGA.

Boral's existing windblown project that has consent to transport 500,000 tonnes of product by road annually has previously been granted an exemption from the payment of contributions by Port Stephen's Council. The exemption was granted as other than the short section of Coxs Lane, the Boral fleet utilise the state road network. Given the project will utilise the same road network and involves a site wide increase of 250,000 tpa. It is proposed that this exemption continue to the applied.

6.7.4 Port Stephens Koala Plan of Management

The Port Stephens Council Comprehensive Koala Plan of Management (CKPoM) has been prepared by Port Stephens Council and the Australian Koala Foundation (AKF) for the Port Stephens LGA. The CKPoM has an aim to '*encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas, to ensure permanent free-living populations over their present range and to reverse the current trend of population decline*'.

The CKPoM includes a Koala habitat map for the Port Stephens LGA, which classifies Koala habitat into different categories based off a range of attributes and survey results. The project site is mapped as 'Supplementary' Koala habitat. This habitat is regarded in the CKPoM as 'important to the long-term conservation of Koalas in Port Stephens and thus also requires protection, albeit with less restrictions on development than 'Preferred Koala Habitat'.

The CKPoM also includes performance criteria to assist development applications in the Port Stephens LGA to demonstrate that developments are consistent with the objectives associated with the CKPoM. Given the project is SSD rather than a local government development application, the performance criteria are not relevant to the project, however Boral has considered the aims and objectives of the performance criteria to minimise potential impact to the Koala as detailed in the BDAR.

Given the project will predominantly impact upon the rehabilitated inland extraction area, and will avoid decreasing the width of a wildlife corridor along Nelson Bay Road, the project is not anticipated to result in an impact to a Koala population in the Port Stephens LGA. The project will also implement a series of management and mitigation measures to avoid any potential indirect impacts to surrounding habitat.

6.8 Strategic planning policies

6.8.1 Hunter Regional Plan 2036

By 2036, an additional 600,000 people are expected to be living in the Hunter region (NSW Department of Planning and Environment, 2016). The HRP aims to guide the delivery of homes, jobs, infrastructure and services to support the growing and changing needs of the Hunter. The HRP provides an overarching framework to guide development and investment in the Hunter region to 2036.

In preparing the HRP, the NSW Government has acknowledged the growing importance of Greater Newcastle and set the following regionally focused goals:

- the leading regional economy in Australia;

- a biodiversity-rich natural environment;
- thriving communities; and
- greater housing choice and jobs.

The Hunter region has an estimated 322,000 jobs and this is projected to increase to 384,000 by 2036. The HRP aims to strengthen the region's economic resilience, protect its well-established economic and employment bases and build on its existing strengths to foster greater market and industry diversification.

In particular, the completion of the Pacific Highway upgrade has cut travel times offering opportunities for industries to expand and supply products to Greater Newcastle and Sydney. This will act as a catalyst for employment growth. Attracting new industries and growing existing industries that can leverage the accessibility provided by the Pacific Highway will support economic growth. To this effect, by establishing the project, Boral is seeking to further invest in the regional economy by contributing to direct and indirect employment opportunities, and contributing $17 M to the NSW economy

As detailed in the HRP, the Hunter region is the largest regional economy in Australia. In order to house the expanding population, the HRP estimates an additional 70,000 dwellings would be required by 2036, together with forecast major commercial development including proposed expansions of the University of Newcastle and John Hunter Hospital, and upgrades to transport infrastructure at Newcastle Airport, Port of Newcastle and strategic road networks (e.g. Nelson Bay Road duplication and extension of the Newcastle Inner City Bypass).

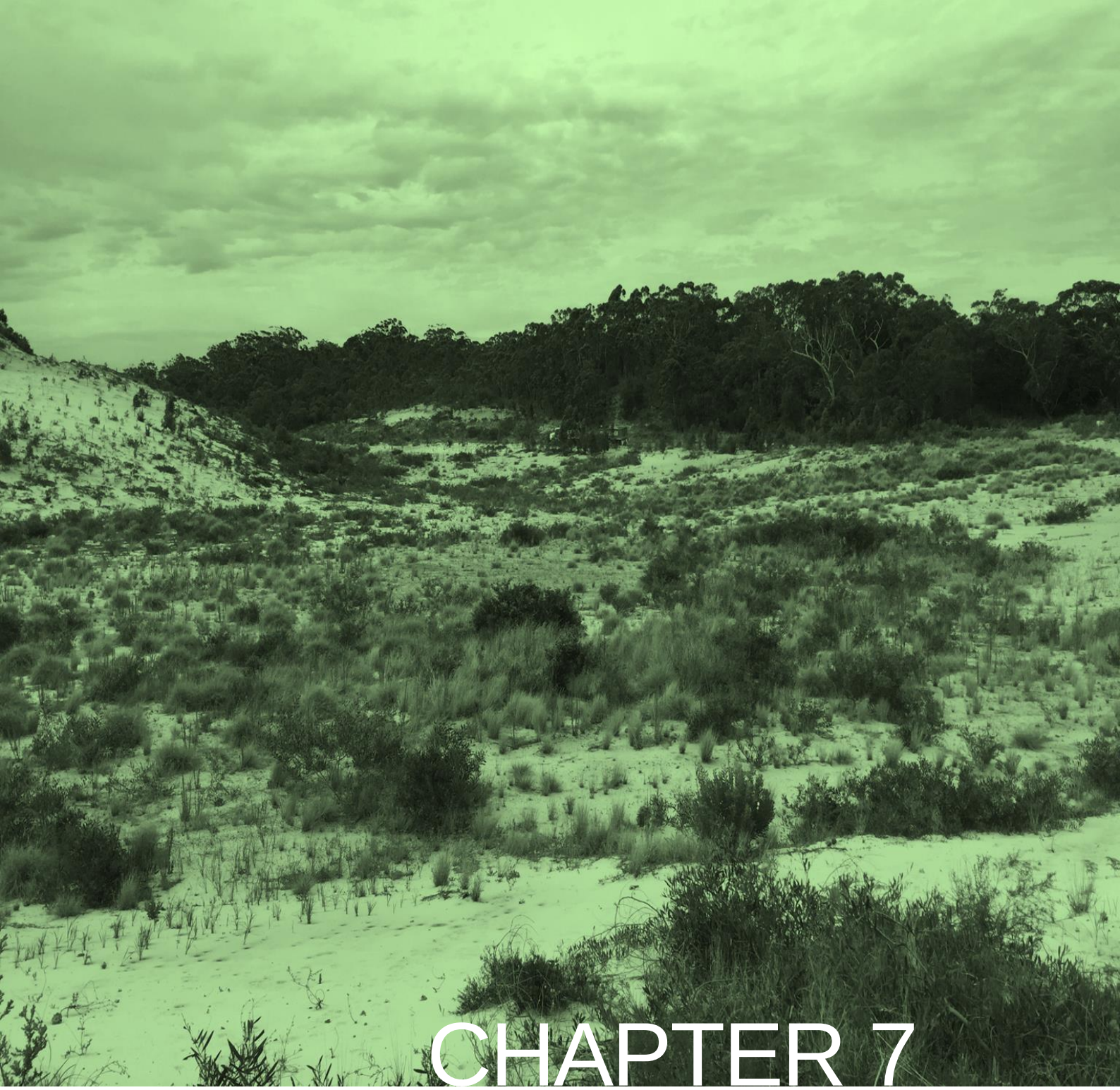
The aforementioned residential, commercial and infrastructure projects would all be reliant upon concrete and other construction materials, of which fine sand resources, such as those to be extracted at the site, are a vital component. As such, Boral plays a part in a larger supply chain to delivering essential services that will support the delivery of key infrastructure, jobs and housing in the region.

The project is consistent with the relevant directions and actions associated with Goal 1 of the HRP, in that it would play a part in promoting the Hunter region to be the leading regional economy in Australia.

Direction 6 of Goal 1 aims to grow the economy of the Port Stephens LGA by promoting the growth of industries that can leverage the accessibility of the Pacific Highway corridor. The project will achieve this directive given that outgoing sand products will be transported via the Pacific Highway corridor, particularly south towards the Lower Hunter Valley and Sydney regions.

Direction 14 of the HRP identifies the need to protect biodiversity and connect natural areas. The HRP promotes protection of biodiversity by maintaining and, where possible, enhancing the existing protection of high environmental value areas; implementing appropriate measures to conserve validated high environmental value areas; developing local strategies to avoid and minimise the impacts of development on areas of high environmental value and biodiversity corridors; and identifying offsets or other mitigation measures for unavoidable impacts. Thorough assessment of biodiversity values of the site has been carried out for the project, including identification of opportunities to avoid or reduce harm to biodiversity, and where impacts are unavoidable implement offsetting initiatives for cleared vegetation. By positioning the project in an area previously disturbed as part of the inland extraction area, impacts to remnant vegetation would be avoided and ensure that areas of high environmental value continue to be protected.

Direction 15 of the HRP identifies the need to protect the quality and security of the region's water supplies. Planning to manage development is a priority within the Hunter's drinking water catchments to balance the needs of growing towns and villages, and rural and resource industries. The site is located adjacent to the Stockton Sandbeds Catchment Area drinking water catchment, and a comprehensive assessment of water quality has been undertaken to ensure no adverse impacts to the water supply will result from the project.



CHAPTER 7

ENVIRONMENTAL ASSESSMENT APPROACH

7 ENVIRONMENTAL ASSESSMENT APPROACH

This chapter outlines the approach taken to assess the potential environmental and social impacts of the project.

7.1 Environmental risk assessment

It is integral to consider the environmental impacts of a proposed development early in the planning of the project. Careful planning of the development can avoid, or reduce, the likelihood of a significant impact on the environment. Where possible and practical, it is best to avoid impacts. If impacts cannot be avoided, they should be minimised or mitigated as much as possible.

The purpose of the environmental impact assessments of the project were to determine whether the project will result in significant impacts to the environment. Where a significant impact is likely, the project needs to be planned to avoid, manage, mitigate or offset this impact.

As such, the approach for the environmental impact assessments have considered the hierarchy of avoid, manage, mitigate and offset. Specifically:

- during preliminary planning, where environmental features with high value and significance or areas of potential sensitivity were identified that could be avoided, Boral revised the project design to avoid impacts to these areas by refining the disturbance footprint and relocating infrastructure (such as moving the processing plant to an area within the site that is further to the north, away from the nearest sensitive receivers and to support improved operational outcomes); and
- where environmental features could not be avoided and will be directly impacted, it was assumed that these areas will be impacted, and the EIS prepared on this basis with a view to identify best practice measures to manage, mitigate or offset the impact.

Chapters 8–22 summarise the assessments of key environmental issues, including the SEARs issued by DPIE, assessment methods, results of site surveys, potential construction and operational environmental impacts, and the proposed management and mitigation measures to be implemented for the project in order to minimise the potential for adverse environmental impacts or risks.

7.1.1 Preliminary environmental risk analysis

Potential environmental risks associated with the project were summarised in *Stockton Sand Quarry Dredging Preliminary Environmental Assessment* (Element Environment, 2018). The preliminary risk analysis was informed by, early stakeholder and community engagement, early project planning and specialist study desktop research and site-based investigations.

Environmental risks were assessed with rankings allocated to each environmental issue based on the likelihood of occurrence and the perceived consequence of effects if left unmanaged. The preliminary analysis did not consider the potential outcomes of specialist technical assessments and the application of mitigation measures to manage the environmental issue. In most cases, suitable mitigation measures are likely to minimise any potential impacts.

For those environmental factors that achieved a high or medium risk rating, further assessment was proposed to be undertaken as part of this EIS, generally in the form of specialist technical investigations. For those environmental factors that achieved a low risk rating, no further specialist

technical assessment was required, as these non-key issues could largely be addressed using appropriate environmental safeguards and management measures, as detailed in this EIS.

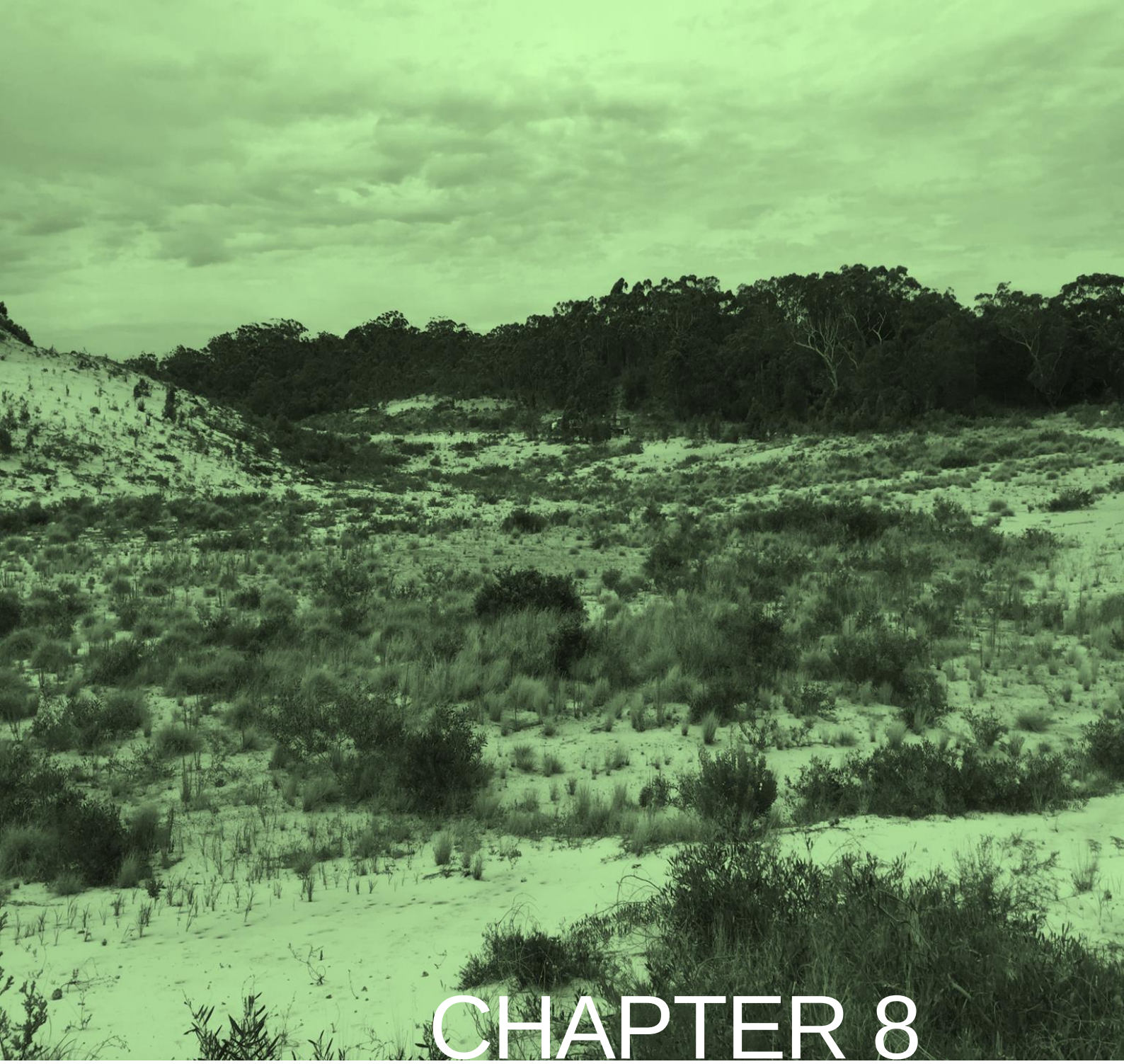
7.2 Structure of environmental assessment

The SEARs state that an assessment of the likely impacts of the development on the environment, focussing on the key identified issues, must be undertaken, and include:

- a description of the existing environment likely to be affected by the development, using sufficient baseline data;
- an assessment of the potential impacts of all stages of the development, including any cumulative impacts, taking into consideration relevant laws, environmental planning instruments, guidelines, policies, plans and industry codes of practice;
- a description of the measures that will be implemented to mitigate and/or offset the potential impacts of the development, and an assessment of:
    - whether these measures are consistent with industry best practice, and represent the full range of reasonable and feasible mitigation measures that could be implemented;
    - the likely effectiveness of these measures;
    - whether contingency plans will be necessary to manage any residual risks; and
- a description of the measures that will be implemented to monitor and report on the environmental performance of the development if it is approved.

Where relevant, existing environment and baseline data for the project site and surrounding areas is summarised in **Chapter 2**.

The environmental impact assessment chapters set out the findings of key investigations into those elements of the project that were identified as having a high to medium risk rating. The assessment chapters summarise the relevant legislation, guidelines, policies and plans relevant to each key environmental aspect, desktop and site investigations, assessments of the potential construction and operational impacts of the project prepared by technical specialists to address the regulatory requirements. Where suitable, the project design has been adapted to avoid impacts and reduce risk ratings, where unavoidable impacts have been identified management and mitigation measures have been developed that will be implemented by Boral to ensure any residual environmental impacts are minimised.



CHAPTER 8

GROUNDWATER

8 GROUNDWATER

8.1 Introduction

This section summarises the hydrogeological impact assessment (HIA) report, which is in **Appendix D**. It describes the potential impacts on groundwater resources from the project and provides mitigation and management measures to minimise impacts.

The hydrogeological setting of the project site is summarised in **Section 2.5.7**.

8.1.1 Assessment guidelines and requirements

The SEARs require an assessment of the likely impacts of the project on groundwater (**Table 8.1**).

Table 8.1: Groundwater related SEARs

Requirement	Section and appendix where addressed
a detailed site water balance, including a description of site water demands and intakes, water disposal methods (inclusive of volume and frequency of any water discharges), water supply infrastructure and, water storage structures	8.3.1, Appendix D
identification of any licensing requirements or other approvals under the *Water Act 1912* and/or *Water Management Act 2000*	6.5.3, Appendix D
an assessment of the likely impacts on the quality and quantity of existing surface and ground water resources (having regard to the Williamtown RAAF Base Contamination Broader Management Zone), including a detailed assessment of proposed water discharge quantities and quality against receiving water quality and flow objectives	8.4, Appendix D
a detailed description of the proposed water management system (including sewage), water monitoring program and other measures to mitigate surface and groundwater impacts	Section 8.5

The following guidelines were used during the assessment:

- NSW Aquifer Interference Policy (NSW Government, 2012b);
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Australian and New Zealand Environment and Conservation Council, 2000);
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality: National Water Quality Management Strategy (Australian and New Zealand Governments, 2018).

8.2 Field investigation

8.2.1 Data collection and review

Existing data for the Stockton Sandbed and Tomago Sandbed aquifer systems was reviewed and a water balance for the aquifer determined. Potential impacts from proposed works under varying climatic conditions were assessed.

The review of existing data was supplemented by a field investigation of the project site comprising:

- installation of a bore network;
- physical aquifer testing on installed bores to determine aquifer parameters; and
- review of the ongoing groundwater monitoring program to assess changes in groundwater levels and chemistry over time under varying climatic conditions.

Four bores were drilled in March 2018 to provide baseline groundwater data for the project site and investigate potential ASS (refer to **Chapter 14**). The bore data supplemented historical data from Boral's groundwater monitoring program elsewhere on the quarry (refer to **Section 3.5**).

Groundwater was encountered in all bores at shallow depths between 1.5-5.5 m below ground level (BGL), or 0.59-1.25 m AHD.

Submersible data loggers were installed in eight bores outside the project site to provide continuous monitoring data of groundwater levels across the quarry, and assess groundwater level responses to climatic conditions.

Water samples were obtained from bore MW_X3 in March 2018 and analysed in the field for:

- oxidation reduction potential (ORP);
- pH;
- dissolved oxygen (DO);
- electrical conductivity (EC); and
- temperature.

Groundwater samples collected from bore MW_X3 were sent to a National Association of Testing Authorities (NATA) accredited laboratory and analysed for the following parameters:

- full ionic balance suite – pH, total dissolved solids (TDS), cations (Na, Ca, Mg, K), anions (Cl, SO_4, HCO_3, PO_4, F) and nutrients (NH_3, NO_3 and NO_2); and
- dissolved metals / metalloids including aluminium (Al), arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), manganese (Mn), mercury (Hg), nickel (Ni) and zinc (Zn).

8.2.2 Hydraulic parameter testing

As part of the groundwater monitoring program, 'slug-tests' (or falling head tests) were undertaken at the two bores at MW_X3 in March 2018. Slug tests require piezometers to have the screens fully submerged beneath the piezometric surface. This method was used to determine the *in situ* hydraulic conductivity (K).

The tests involve causing an instantaneous change in water level in a section of the piezometer by introducing a known volume (i.e. a 'slug') and then measuring the recovery of the water level over time.

Values for hydraulic conductivity, transmissivity and groundwater velocity were determined for the aquifer using the data from these tests.

8.3 Results

8.3.1 Recharge rates and water balance

The aquifer is recharged by direct infiltration from the surface.

As highlighted in **Section 2.5.7**, groundwater flows either to the north-west towards Fullerton Cove and the Tomago Groundwater Source, or south-east towards Stockton Beach and the Pacific Ocean. Groundwater which flows towards Tomago Groundwater Source may also be intercepted by surface waterbodies such as the Ten Foot Drain and then divert towards Fullerton Cove.

An average of 416 ML of rain falls on the 37 ha project site per annum, 30% of which (126 ML) recharges the aquifer. Evapotranspiration is approximately 70% of recharge (88 ML).

During the project, when the dredge pond is at its maximum extent, recharge to the aquifer via groundwater inflow and direct rainfall will be an estimated 303 ML per year. Evaporation from the dredge pond is estimated at 322 ML per year, with evapotranspiration an additional 33 ML per year. The moisture content in outgoing sand product will also result in an estimated loss of 15 ML per year from the aquifer.

A water balance is summarised in **Table 8.2**. This water balance is supplemented by an additional surface water balance summarised in **Chapter 17**. The surface water balance examines groundwater extraction associated with the dredge pond evaporation and outgoing moisture content only and does not consider natural outflow of the aquifer system or evapotranspiration elsewhere on the quarry. As such, the two balances differ in assumptions, however, both conclude a deficit to the aquifer. Given that the net deficit predicted by the surface water balance is higher, this would form the licensing requirements for the project under the WM Act.

Table 8.2: Groundwater balance

Parameter	Inflow (ML/annum)	Outflow (ML/annum)
Existing conditions		
Recharge	126	-
Groundwater inflow	219	-
Evapotranspiration	-	88
Groundwater outflow	-	219
Total	**345**	**307**
Project conditions		
Recharge	303	-
Groundwater inflow	219	-
Evaporation	-	322
Evapotranspiration	-	33
Sand extraction	-	15
Groundwater outflow	-	219
Total	**522**	**589**

As highlighted above, under existing conditions there is an estimated 38 ML net inflow to the aquifer per year, however, during the peak of the project, there will be an estimated 67 ML annual outflow from the aquifer.

As sand extraction proceeds, the extraction of groundwater is expected to be altered gradually over time as recharge increases due to direct rainfall onto the dredge pond, offset by increased direct evaporation from the surface water body.

Calculations indicate that the water extracted from the aquifer in outgoing sand product contributes approximately 4% of total groundwater outflows, with the moisture content replacing a portion of the natural groundwater discharge (outflow) from the project site towards either the north-west or south-east. As up to half of this discharge is to the ocean, it could be viewed that such extraction of groundwater is only partially impacting on downgradient surface water ecosystems given it is partially recharging a marine water body.

8.3.2 Groundwater chemistry

Results of the field chemical assessment are provided in Appendix E of the HIA and correlate well with field observations.

The data indicate a distinction between groundwater within the south-east of the quarry (east of the groundwater flow divide) and in the north-west of the quarry (west of the groundwater flow divide).

To the west of the groundwater flow divide (bores GW1, GW2, GW4, MW_X1, MW_X2, MW_X3 and MW_X4) the groundwater chemistry is sodium and chloride dominant, with a typically more acidic with a pH range between 4.2 and 6.3.

A neutral to slightly alkaline pH range of 6.8 – 7.8 was reported for the bores east of the groundwater divide (MW_X5 and MW_X6). A relationship exists between pH and salinity in these bores due to the presence of carbonate material (marine shells and other exoskeletons) in the aquifer, resulting in higher pH to the south-east of the project site, and deeper in the aquifer.

The following observations are made based on a review of historical monitoring data across the quarry:

- Salinity (EC) between monitoring locations varies significantly, with average salinities ranging from 330 microsiemens per centimetre (µS/cm) at bore MW1 to 805 µS/cm at bore MW11.
- Salinity also varies significantly per monitoring location, with bore MW5 showing a range of 796 µS/cm over the past three years.
- It is noted that the largest increases in salinity occur following significant rainfall events and are inferred to be due to recharge flushing salt from above the water table.
- The pH values are shown to typically range from 6.0 to 8.0. A few readings below pH 6.0 are noted at bores MW5, MW9 and MW1 in the past. The pH values are otherwise relatively stable. A slight increasing trend over the last three years is noted at bores MW5 and MW9 (moving toward a more neutral pH).

Comparison to water quality criteria

The groundwater samples collected from the unconfined aquifer were also analysed for 11 heavy metals and PFAS compounds.

The shallow bores to the east of the groundwater flow divide (MW_X3 and MW_X4) reported acidic pH ranges that exceeded the Australian and New Zealand Government (2018) guideline values for 95% protection of freshwater aquatic ecosystems. As established in **Section 2.5.5**, acidic soil groups are a feature of the natural environment at the project site and it is deemed that groundwater results reflect this.

All concentrations of total dissolved solids (TDS) across the monitoring network within the data review period were reported below the guidelines.

Arsenic exceeded guidelines for drinking in bore MW_X6, however this is considered a natural occurrence and this area is not within a drinking water zone. Dissolved metals including Al, Cu, Zn, As and Pb exceeded guideline values for ecosystem protection (freshwater and marine). Elevated concentrations of dissolved metals may also be associated with natural background concentrations.

All analysis for PFAS compounds at bores MW_X1, MW_X2, MW_X7 and GW4 reported no concentrations above the laboratory limit or reporting between January and June 2018.

Two water samples were analysed in December 2018 for radium, uranium and thorium, with no positive result above the limit of reporting recorded.

The groundwater quality results are generally considered to be representative of baseline groundwater quality in the project site and will provide a good basis for comparison against results for monitoring throughout the life of the project and into closure.

8.3.3 Groundwater usage and receptors

The groundwater resource beneath the site is of relatively useful yield and quality, and is therefore suitable for a number of potential beneficial uses.

Potential beneficial uses of an aquifer are directly associated with potential yield (sustainable or otherwise) and quality. All groundwater, regardless of yield or quality, is required to be protective of the natural ecosystem within which it resides and in particular discharges to, including any GDEs. There are no aquatic GDEs within the quarry, however terrestrial GDEs are located within the quarry within proximity to the project site.

The HIA determined that the relevant beneficial users of groundwater from a risk assessment perspective (in order of priority and importance) are:

- the freshwater and marine ecosystems of local surface water features and nearby ephemeral creek systems;
- stock watering;
- recreational, direct contact and aesthetic use;
- possible irrigation; and
- project use (dust suppression).

Ecosystem protection is the primary beneficial use of the aquifer, as swamps and wetlands down gradient of the project to the north-west are receptors for groundwater discharge.

The local groundwater is not considered to have potential beneficial use as drinking water or recreational use, whilst use for irrigation is not currently occurring and is considered unlikely.

8.4 Potential impacts

The nature of the groundwater flow system (i.e. a local flow system discharging to the Pacific Ocean and Fullerton Cove) means that all potential impacts of the project are locally constrained.

8.4.1 Site establishment

Physical impacts

Once vegetation is cleared from the project site there will be increased opportunity for direct recharge of rainfall to the water table via established high infiltration rates of sandy soils.

The mechanism for water table recharge (i.e. direct infiltration of surface water) will be improved which, along with reduced evapotranspiration following vegetation removal, may result in

localised water table elevations beneath the project site and vicinity. The consequence of such an impact will be minor to negligible and may even be beneficial by increasing groundwater flow rates from the project site towards Fullerton Cove to the north-west.

Chemical impacts

Due to the reduction of evapotranspiration rates following the removal of vegetation and the potential resultant localised water table elevations beneath the project site, chemical impact from the establishment of the project is expected to be limited to potential increases in freshwater recharge to the aquifer. Any chemical alteration is therefore likely to be beneficial.

8.4.2 Dredging operations

Physical impacts

The extraction of groundwater via evaporation and outgoing moisture content in sand product will have very little physical impact on the Stockton groundwater source, due to the fact that the disturbance footprint of the project makes up a small proportion (<0.1%) of the overall 39,100 ha (391 km^2) Stockton Sandbeds catchment.

Whilst the likelihood of any change in water table levels as a result of dredging and consequent alteration of recharge and discharge mechanisms for groundwater at the project site is possible, the consequence is minor. This is because the groundwater inflows and outflows are not expected to alter significantly, primarily as the proposed sand extraction will not alter the water table gradient, nor permeability or porosity of the sediments outside the project site, and as a result groundwater flux will remain stable. Changes in the water table level in the immediate vicinity of the dredge pond will not have a physical consequence for the aquifer or its potential receptors.

Potential terrestrial GDEs south-east of the project site include mobile and ephemeral vegetated deflation basins consisting of a variety of reeds, grasses and sedges, which provide habitat to invertebrates. Swamp forests, dunes swales and low-lying heath are the primary GDEs north-west of the project site. It was concluded that given the proposed depth of sand extraction and maintenance of water levels of the aquifer, the risk of physical impacts to these GDEs will be low.

Chemical impacts

The removal of alluvial sediments by excavation and dredging has the potential to chemically impact on the groundwater resource by reducing the water table and exposing reduced inorganic sulfides to oxygen, which may generate acid. The alteration of groundwater chemistry also has the potential to result in indirect impact to the terrestrial GDEs within the quarry.

As highlighted in **Section 14.2.2**, sulfides may be encountered in a portion of the project site between 2.0 m – 2.5 m BGL, and as such the maintenance of water table levels in the project site is an important consideration for the project.

As dredging activities will see most of the water drain back into the dredge pond, there is low risk of oxidation of potentially localised instances of Potential Acid Sulfate Soils (PASS). Returning the water to the dredge pond during the dredging process will prevent lowering of the groundwater table and exposing of PASS to air. Furthermore, recharge is rapid in the dune lithology, further preventing impacts to the groundwater table in and across the project site and beyond. Despite this, the project has low potential to expose PASS, and monitoring of water table and pond levels (as well as management procedures to mitigate any acid production) will be necessary throughout the duration of the project and into closure.

The contaminants of potential concern associated with regional groundwater impacts stem from the Williamtown RAAF base, chiefly PFAS/PFOA, which are known to have impacted the Tomago Sandbeds aquifer.

It can be estimated from water balance calculations that the water table will not be expected to drop significantly as a result of the project. In addition, the regional groundwater discharge zone of Tilligerry Creek and Fourteen Foot Drain means that the movement of groundwater is away from the quarry, to the north and west towards Fullerton Cove, and subsequently north towards Cabbage Tree Road and the Williamtown RAAF base. Additionally, no indication of PFAS compounds has been recorded via monitoring at the quarry to date, and it is therefore considered there will be no risk of the project interacting with PFAS from the RAAF base and associated management zone.

Given the above, the risk of chemical impact to groundwater will be minimal.

8.4.3 Rehabilitation

Physical impacts

The rehabilitation of the project site as a wetland is considered to have a low level of overall risk, as the wetland is expected to facilitate direct water table recharge and return to natural conditions.

Further to the project taking minimal water from the aquifer, combined with the creation of an enhanced groundwater recharge zone in the form of a pond, the water table will not be lowered in the project site post closure, and increased recharge rate will mean movement of groundwater away from the quarry is maintained into the future.

Chemical impacts

The rehabilitation of the project site is considered to have a low level of overall risk, as the wetland will be expected to facilitate direct water table recharge and return to natural conditions, without a deterioration to the chemical composition of the groundwater.

8.4.4 Summary of potential impacts

As detailed above, all consequences associated with potential physical impacts to the aquifer will be minor to negligible. This is primarily because the project site makes such a small contribution to the overall catchment water balance, and that there are no potential receptors to groundwater discharge down-gradient of the project site other than the ecosystems of the Pacific Ocean and Fullerton Cove.

The major risk of chemical impact is likely to be as a result of oxidation of natural *in-situ* sulphides within the existing soil profile. However, potential chemical risks associated with PASS will be minimised during operation of the project, as:

- despite encountering the water bearing zone, the dredging operations are considered unlikely to alter the groundwater level as water extracted during dredging activities is returned to the dredge pond via a closed system; and
- dredging activities include the sieving of sand material, so that fines (materials finer than sand) are separated and immediately returned below the water table.

8.5 Mitigation and management measures

8.5.1 Groundwater monitoring

The following measures will be formalised in an update to the existing *Stockton Sand Quarry Groundwater Management Plan* (GWMP) (Jacobs, 2017) to encompass the project site. The GWMP was prepared in accordance with Schedule 3(12) for Development Consent DA 140-6-2005, and describes the objectives of groundwater management and monitoring along with the proposed types and locations of monitoring. It also describes the monitoring observations which will trigger actions, and the proposed action and/or mitigation should triggers be exceeded.

Monitoring network

The boreholes located outside the project site will form a monitoring network to be periodically sampled. The bores to be included are MW_X1, MW_X2, MW_X5, MW_X6, MW_X7, GW2, GW4 and MW2. Once extraction progresses below the water table, the dredge pond surface will be surveyed so that the relative height of water in the pond over time can be accurately measured.

All bores have been surveyed for relative height to AHD with at least 0.001 m accuracy, so that relative groundwater levels can be compared.

Physical assessment of groundwater and dredge pond levels

Standing groundwater levels (SWL) from all eight bores, and the water level (m AHD) of the dredge pond will be measured monthly during dredging operations. The measurement of SWL from bores will continue during rehabilitation works.

Following rehabilitation, all bores will be incorporated into the existing quarterly groundwater monitoring program for the quarry.

Chemical assessment of groundwater and surface water

All eight bores and the dredge pond will be tested for pH on a monthly basis during dredging operations. The measurement of pH will be performed in the field with a hand-held electronic meter that is 2-point calibrated.

In addition to the above recommended measurement for pH, all bores will be incorporated into the GWMP, which will be updated following approval of the project.

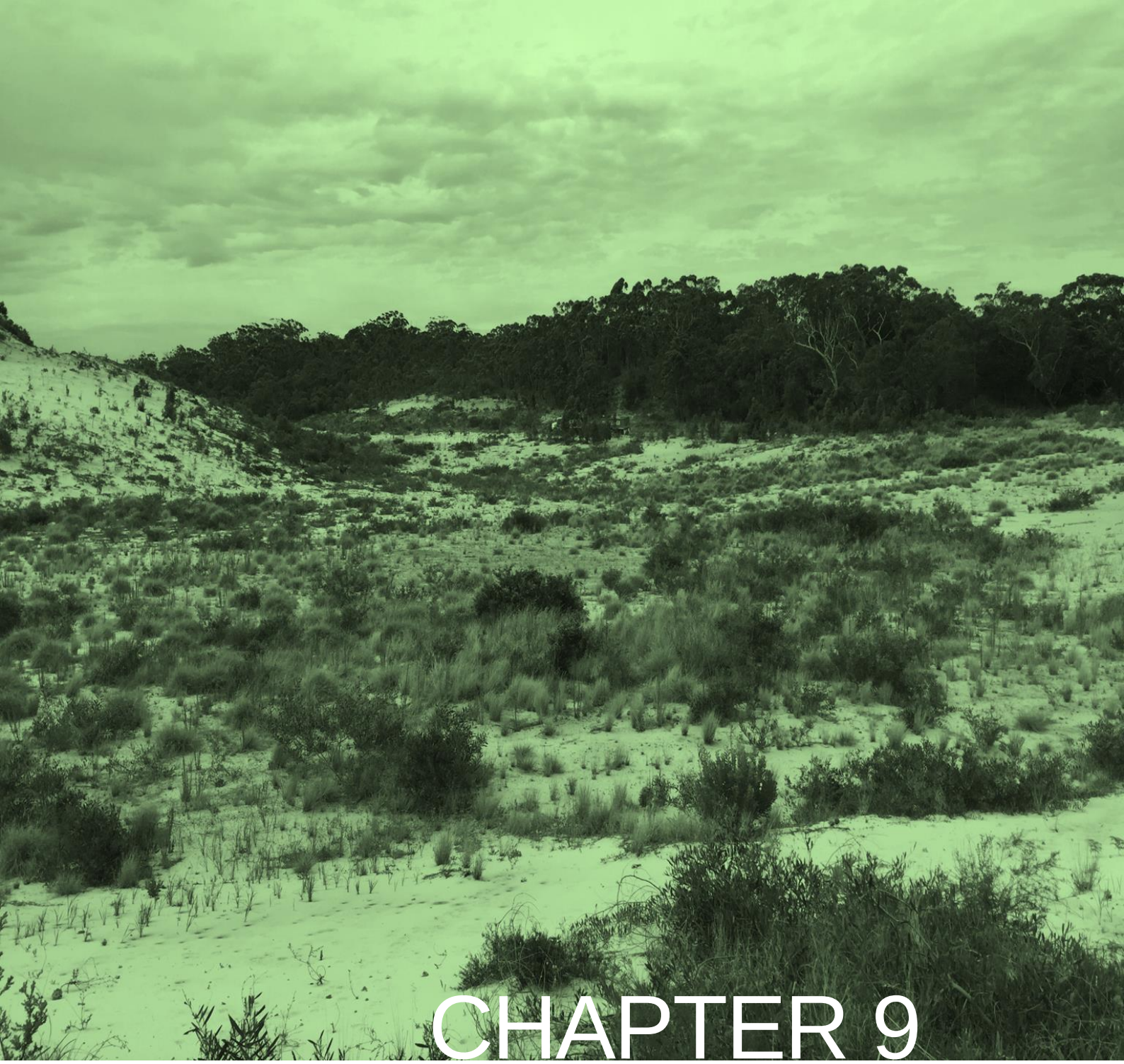
Groundwater bores will be sampled on a monthly basis for SWL and pH, and tested quarterly for the following analytical suite:

Field measurement of:

- pH, EC, ORP, SWL, DO and temperature.

Laboratory analysis for:

- full ionic balance suite pH, TDS, cations (Na, Ca, Mg, K), anions (Cl, SO_4, HCO_3, PO_4, F) and nutrients (NH_4, NO_3, NO_2, Total N); and
- dissolved metals / metalloids including aluminium (Al), arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), manganese (Mn), mercury (Hg), nickel (Ni) and zinc (Zn).



CHAPTER 9

BIODIVERSITY

9 BIODIVERSITY

9.1 Introduction

This section summarises the BDAR, which is in **Appendix E**. It describes the ecological context of the project site, study methods, flora and fauna discovered during surveys, potential impacts and mitigation measures where impacts are unavoidable.

9.1.1 Assessment guidelines and requirements

The SEARs require an assessment of the likely impacts of the project on biodiversity values (**Table 9.1**).

Table 9.1: Biodiversity related SEARs

Requirement	Section and appendix where addressed
Accurate predictions of any vegetation to be cleared on site.	9.3, Appendix E
A detailed assessment of the likely biodiversity impacts of the development, paying particular attention to threatened species, populations and ecological communities and groundwater dependent ecosystems, undertaken in accordance with the Biodiversity Assessment Method and documented in a Biodiversity Development Assessment Report.	9.3, Appendix E
A strategy to offset any residual impacts of the development in accordance with the offset rules under the Biodiversity Offsets Scheme.	9.6, Appendix E

9.1.2 Overview of assessment methods

Biodiversity impacts were assessed in accordance with DPIE's Biodiversity Assessment Method (BAM) using the BAM Calculator, which comprises two stages:

- Stage 1 – biodiversity assessment, involving determination of:
  - habitat value through assessment of landscape features;
  - native vegetation; and
  - threatened species and populations.
- Stage 2 – impact assessment, involving consideration of:
  - how to avoid and minimise impacts on biodiversity values;
  - impact and offset thresholds; and
  - offset requirements.

The following subsections set out how this information was collected and classified for the purposes of informing the assessment set out in **Section 9.3**.

Landscape assessment

Landscape assessment focuses on determining habitat values by comparing the current state of key landscape features with the likely state of the same key landscape features should the project

proceed. The following features were considered, with information sourced from aerial photographs, maps, database searches and site observations:

- native vegetation cover;
- rivers, streams and estuaries;
- areas of geological significance; and
- habitat connectivity.

Native vegetation

Previous records of threatened flora within a 10 km radius of the project site were retrieved from the NSW Bionet Atlas and the EPBC Act PMST.

The PCT mapping in DPIE's Vegetation Information System was used to determine potential biodiversity constraints on the project. The PCTs were validated with fieldwork in September 2017 using the BAM.

The assessment involved observing vegetation attributes in the project site using vegetation quadrats, transects and 'walking meanders' to identify flora species and confirm the PCTs and their condition. High threat and priority weeds were also recorded during the fieldwork.

The validated PCTs were mapped and it was determined if any TEC were present in the project site.

The BAM Calculator was used to predict the presence of threatened flora in the project site, which were targeted during the fieldwork. The list of potential threatened flora was refined after the fieldwork based on previous records within the search radius, observed PCTs, their condition and habitat features. Then a determination was made on the likelihood of threatened flora occurring in the project site.

Threatened species and populations (fauna and habitat)

The NSW Bionet Atlas and EPBC Act PMST were also searched for records of threatened fauna within a 10 km radius of the project site. The results were considered during fieldwork planning and the likelihood of occurrence analysis.

Fauna and habitat fieldwork focussed on threatened species (species credit fauna) and comprised:

- survey of the project site in July 2017, comprising spotlighting, call playback, habitat-based assessment and bird surveys; and
- 'Anabat' bat detection analysis in September 2017.

The habitat assessment recorded:

- slope, aspect and landscape position;
- geology and soil type;
- dominant vegetation communities including their composition, structure and condition;
- form, quality and location of water sources;
- presence, size, number and condition of habitat features such as tree hollows; and
- level of disturbance.

Impacts

Direct, indirect and cumulative impacts to native vegetation and habitat were assessed. Serious and irreversible impacts were assessed in accordance with the BAM, which provides criteria to determine if a project will have serious and irreversible impacts on biodiversity.

Biodiversity which will be seriously and irreversibly impacted by a project requires offsetting, which is determined by using the Biodiversity Credit Calculator to calculate ecosystem and species offset credits. The credits are retired by establishing a biodiversity stewardship site or payment into the Biodiversity Conservation Trust Fund (BCT).

9.2 Results

9.2.1 Native vegetation and flora

Plant community types

The field survey confirmed that the project site consisted predominately of rehabilitation comprising native vegetation, mainly tubestock and some native seeding that had occurred over the past decade.

As detailed in the OEH (2018) Biodiversity Assessment Method Operational Manual, *'Planted native vegetation is treated in the same way as native vegetation if it meets the definition of native vegetation in Section 5A of the Local Land Services Act 2013. Where the vegetation is a mix of local and non-local planted species the assessor should consider the best matching PCT based on the local species present'*.

As such, areas that have been rehabilitated were attributed to two PCTs which likely occurred in the project site prior to clearing, or contain a structure similar to that of the rehabilitated land.

The PCTs validated during fieldwork are summarised in **Table 9.2** and presented in **Figure 9.1**.

The PCTs identified are not listed as a TEC under the BC Act or EPBC Act.

Table 9.2: Summary of PCTs in project site

PCT	TEC	% cleared	Area (ha)
PCT1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland on coastal sands of the Central and Lower North Coast	-	45	31.75
1644 - Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower North Coast	-	96	3.91
Non-native vegetation	-	-	2.48
		Total	**38.14**
		Total native vegetation	**35.66**

High threat weeds

The former Office of Environment and Heritage (OEH), now Environment, Energy and Science (EES), has a list of 'High threat weeds' which were taken into consideration in the BDAR.

High threat weeds recorded in the BDAR as occurring at the site include:

- Farmer's Friend (*Bidens pilosa*);
- Panic Veldtgrass (*Ehrharta erecta*); and
- Africa Lovegrass (*Eragrostis curvula*).

The high threat weed species were distributed across the project site and concentrated near existing disturbance.

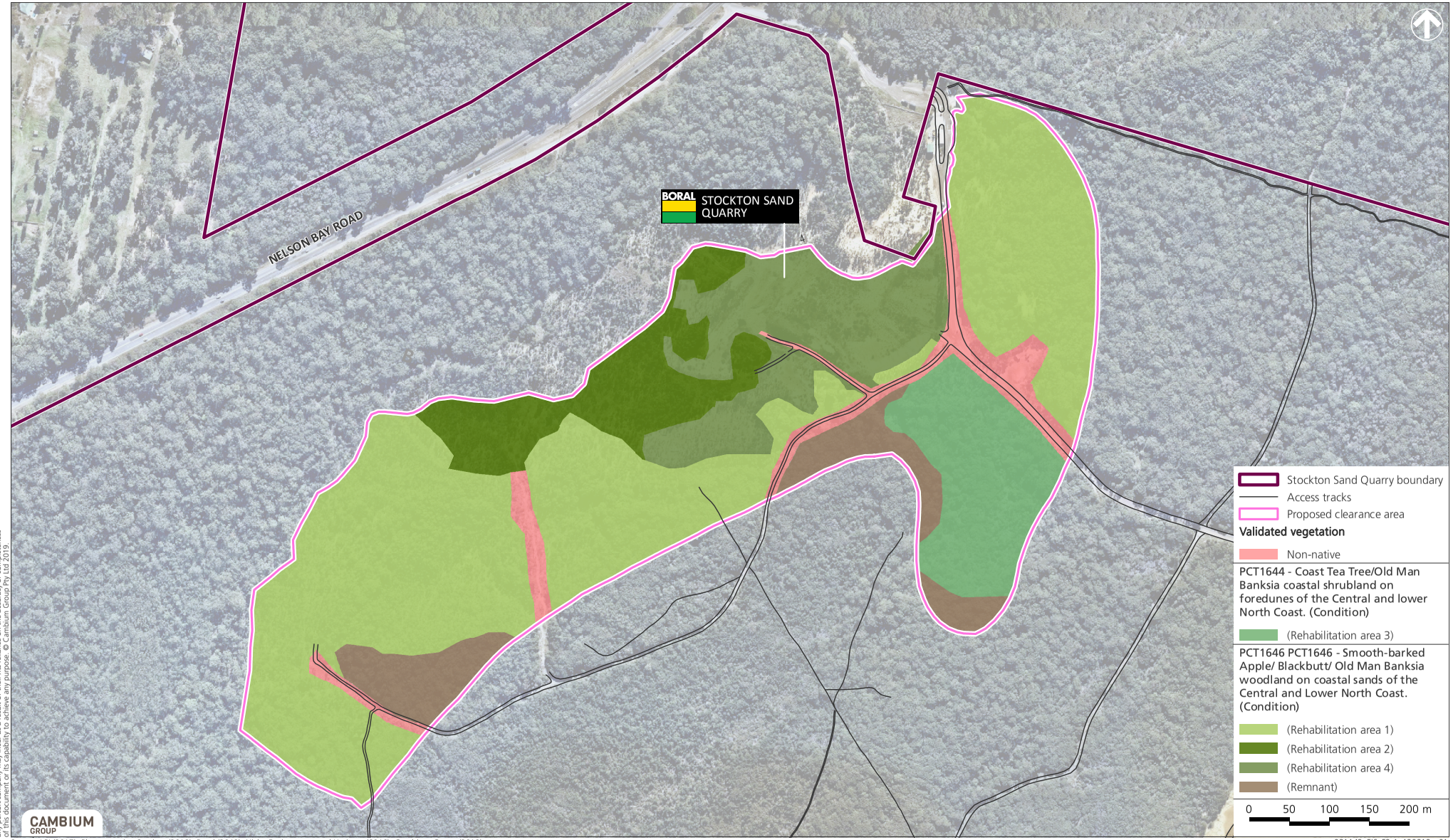
These species, while required to be identified as “high threat”, are not listed as “high risk” species under the NSW *Biosecurity Act 2015.*

Threatened flora

The BAM calculator predicted the 21 threatened flora species in Appendix 1 of **Appendix E** could occur in the project site. This list was refined following initial field survey, with no threatened flora species observed or recorded in the project site.

Figure 9.1
Vegetation communities

STOCKTON SAND QUARRY DREDGING
ENVIRONMENTAL IMPACT STATEMENT



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9.2.2 Fauna and habitat

Fauna habitat

The field survey observed a clear difference in fauna habitat across the project site, attributed to the age of rehabilitation vegetation.

Areas of relatively recent rehabilitation contained scattered logs, generally sparse ground cover and lacked a mid and canopy stratum. Conversely, older rehabilitation areas had a developing canopy and midstorey cover. As such, the remnant and older patches of rehabilitation will offer greater foraging habitat for a variety of fauna, including that of nectivorous birds and the Squirrel Glider.

The survey of rehabilitated areas did not identify trees mature enough to contain hollows, and as such, roosting and breeding habitat for a range of hollow-dependent species, such as microbats, was absent. Limited hollows within adjoining areas of the remnant vegetation occur, none of these had any evidence of owl usage.

Logs have been scattered throughout the rehabilitation areas which provide habitat for reptiles and small ground-dwelling mammals, and foraging resources for birds.

The ground cover of rehabilitated areas is particularly sparse, however the sandy substrate may provide habitat for small to medium-sized mammals to create burrows for shelter.

No habitat in the form of bush rock or rock platforms were identified, nor was there any permanent or ephemeral aquatic habitats on the site.

Habitat connectivity

The project adjoins a large native vegetation corridor which extends along Stockton Bight to Anna Bay in the north, and Stockton in the south. The stretch of the vegetation corridor encompasses Worimi Regional Park and Worimi State Conservation Area.

The west of the site, connectivity of this corridor is fragmented by Nelson Bay Road and the contiguous areas of cleared rural agricultural lands. These existing intrusions form a barrier to fauna movement in the area.

The removal of vegetation (predominantly tubestock plantings within the former inland extraction area) and habitat within the project site will not reduce the amount of important habitat features (e.g. hollow bearing trees) within the corridor to the degree that fauna roosting and foraging habitat will be significantly impacted.

The removal of the vegetation within the project site is unlikely to restrict fauna movement along the corridor extending from Stockton Beach to Anna Bay given the following:

- the area to be disturbed is centred on the former inland extraction area which was historically cleared;
- vegetation would be retained along Nelson Bay Road and towards Stockton Beach allowing continued fauna movement along the corridor; and
- the haul road that is currently in operation for the windblown sand extraction area would not be widened as part of the project and as such no changes to existing fauna movement are likely.

Threatened fauna

The BAM Calculator, based on the identified PCT, predicted the potential for 85 threatened fauna species (refer to Appendix 1 of **Appendix E**) to occur in the 10 km search radius. A total of 21 of

these were identified as ‘candidate’ fauna species (i.e. species credit species). The list of candidate species was then reduced to the Squirrel Glider after validation via fieldwork.

The 28 species listed in Appendix 5 of **Appendix E** were recorded during surveys of the proposed disturbance areas and other areas in and adjacent to the project site. Results comprised three reptile, four mammal and 21 bird species.

The following threatened species were observed, or recorded via Anabat analysis during fieldwork:

- Greater Broad-nosed Bat (*Scoteanax rueppellii*);
- Eastern Bent-wing Bat (*Miniopterus schreibersii*); and
- White-bellied Sea Eagle (*Haliaeetus leucogaster*).

The locations of the threatened species recorded at the project site and areas of potential habitat for the Squirrel Glider are shown on **Figure 9.2**.

The Eastern Bentwing-bat and White-bellied Sea Eagle are ‘species credit’ fauna which require biodiversity offsetting if their habitat is present and/or habitat will be impacted by the project. These species are ‘dual credit’ species with the species credit component only triggered if breeding habitat is present. No breeding habitat was detected for the two species in the project site.

The remainder of the species are ‘ecosystem credit’ species, which are assumed to have habitat in the vegetation types of the project site.

Migratory species

No migratory species listed under the EPBC Act were observed adjacent to or in the project site.

Eight migratory species could occur in or adjacent to the project site. These species could occur due to the presence of opportunistic foraging habitat.

The extensive native vegetation to the north and south of the quarry in Worimi Regional Park and Worimi State Conservation Area contains more habitat for the species.

The dredge pond may provide habitat for some migratory species.

Figure 9.2
Survey type, recorded threatened species and fauna habitat

STOCKTON SAND QUARRY DREDGING
ENVIRONMENTAL IMPACT STATEMENT



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9.3 Impact assessment

9.3.1 Avoidance and minimisation

The following options were considered during design of the project to avoid or minimise impacts:

- Extension of the extraction footprint beyond the previous inland extraction area, and subsequent extraction and dredging of this footprint. It was determined that this option would maximise access to sand resource, however, would increase the clearing of remnant vegetation and habitat compared to the project, and subsequently increase offsetting requirements. Therefore, this option was not investigated further from a biodiversity perspective.
- Extension of the extraction footprint beyond the previous inland extraction area, inclusive of sand extraction to 4 m AHD with no dredging operations. It was determined that this option would reduce the degree of ground disturbance as is experienced with dredging, however, would also increase the area of environmental impact (vegetation clearing, noise, and dust emissions) and fail to maximise use of the sand resource beneath 4 m AHD.

With the above considered, confinement of the project to the previously disturbed inland extraction area was considered to result in the most favourable biodiversity outcomes.

9.3.2 Direct impacts

The project will directly impact biodiversity during site establishment and operation. Most impacts on biodiversity will occur during establishment of the extraction areas, associated with clearing of native vegetation and removal of habitat.

The following direct impacts will result from the project:

- clearing of native vegetation and associated habitat, conservatively estimated to be 35.66 ha, including 32.75 ha of previously rehabilitated areas;
- clearing of approximately 2.48 ha of exotic vegetation; and
- clearing of 26.59 ha of associated species credit fauna habitat for the Squirrel Glider.

Eight species listed under the EPBC Act may be impacted by removal of potential foraging habitat. Therefore, ‘assessments of significance’ were undertaken for these species (refer to Appendix 7 of **Appendix E**). The assessments of significance concluded the project will not significantly impact these species and no referral under the EPBC Act to DoEE is required.

9.3.3 Indirect impacts

Indirect impacts will mostly occur during the establishment of the project and will be short term and largely confined to the project site and immediate surrounds.

The primary indirect impacts may include:

- increased noise and dust from the construction and operation of the project;
- increased edge-effects for surrounding vegetated areas;
- potential alteration to groundwater levels and flows, and possible flow on effects to terrestrial GDEs at the quarry;
- provision of potential sources of ignition leading to a bushfire event (e.g. vehicles driving through dry grassland during warmer months);
- erosion and sedimentation in areas adjoining construction and operational activities; and
- spread of weed propagules, which could lead to invasion of native vegetation by weeds.

9.4 Mitigation and management measures

The following mitigation measures will be implemented to avoid or minimise impacts to biodiversity in and adjacent to the project site.

9.4.1 Fencing and signposting

Fencing and/or the use of highly visible rope or tape boundaries will be used to delineate the boundary of vegetation clearing at the edge of the project site.

Conservation areas will be signposted to restrict entry and reduce incidental interactions with threatened species (e.g. speed limit signage along access roads to reduce potential for fauna vehicle strikes).

9.4.2 Education and training

Employees and contractors will be educated and required to implement the following controls to avoid or minimise potential indirect biodiversity impacts:

- minimise the extent and time that bare sand is exposed and by implementing appropriate dust suppression
- implement procedures for the management of hydrocarbon and/or chemical spills throughout the project site, including the requirements for vehicles to carry spill kits;
- ensure vehicles remain on designated roads and tracks and abide by site speed limits, through use of signposting and driver education during the induction process, and in ongoing project discussions; and
- management and removal of all waste material from the project site.

9.4.3 Vegetation clearing protocols

The vegetation clearing protocol in the *Stockton Transgressive Dune Quarry Rehabilitation and Landscape Management Plan* (ERM, 2010) will continue to be implemented for the project. The following will be implemented:

- Ecologists will survey for ground dwelling fauna prior to clearing of native vegetation and remove any fauna/fauna habitats to adjacent areas not proposed to be disturbed.
- Ecologists will supervise felling of remnant hollow-bearing trees or habitat trees located within Stage 1 of the project area. All hollow-bearing trees that are accessible safely from the ground will be checked and fauna relocated. Hollows higher up and not accessible from the ground will be identified and trees felled gently by an excavator or dozer and left overnight to allow fauna to relocate.
- Fauna displaced during clearing will be captured where possible and relocated to designated areas by trained personnel.
- NSW Wildlife Information, Rescue and Education Service will be contacted to collect injured fauna.

9.4.4 Dust management

The management and mitigation measures listed in **Section 10.3** would be implemented to minimise the potential for dust generation and distribution via winds to adjacent woodland areas.

9.4.5 Groundwater management

As detailed in **Section 8.4**, the project is not anticipated to result in impacts to GDEs at the site.

The management and monitoring measures outlined in **Section 8.5** would be implemented for the project to minimise the potential for adverse impacts to groundwater levels and quality.

9.4.6 Rehabilitation

Disturbed areas will be progressively rehabilitated in accordance with a rehabilitation management strategy (refer to **Chapter 22**) to create a stable landform that does not result in sediment laden runoff or fugitive dust emissions, blends well with the adjacent natural landscapes and re-establishes native bushland.

The *Stockton Transgressive Dune Quarry Rehabilitation and Landscape Management Plan* will be updated to reflect biodiversity management measures to protect and manage biodiversity values. The existing plan contains commitments to threatened species management, pest and weed management, fire management and site hygiene practices, which are to continue for the project.

9.4.7 Pest and weed management

The existing rehabilitation and landscape management plan will be updated to include a section on pest and weed management, including management protocols for the identification of noxious or environmental weeds within areas to be cleared (in order to avoid transporting the weeds to rehabilitation areas or other parts of the quarry).

9.4.8 Fire management

Boral's (2010) *Stockton Transgressive Dune Quarry Environmental Management Strategy* includes a bushfire management plan, which contains fire prevention and suppression measures including maintenance of access roads to prevent potential ignition of grassland by vehicle exhaust. This plan will be updated to reflect the findings of the Bushfire Hazard Assessment for the project (refer to **Chapter 20**).

9.5 Residual impacts

The project will not have 'serious and irreversible impacts' (as defined by the BAM) on any threatened species.

The project will impact PCTs to be cleared as summarised in **Section 9.2.1**. These impacts will require offsetting under the BC Act.

The ecosystem credits required to offset vegetation and habitat impacts are:

- 396 ecosystem credits to offset removal of the Smooth-barked Apple - Blackbutt - Old Man Banksia woodland on coastal s ands of the Central and Lower North Coast PCT; and
- 37 ecosystem credits to offset removal of the Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower North Coast PCT.

521 species credits are required to offset the impacts of the removal of 26.59 ha of foraging habitat for the threatened Squirrel Glider.

9.6 Biodiversity offset strategy

Under the BAM, an offset strategy is not required to be submitted with the BDAR, as the credits are to be formally retired with the establishment of a stewardship site, or payment into the BCT.

However, as noted in the SEARs for the project, a biodiversity offset strategy is required to be included in the BDAR.

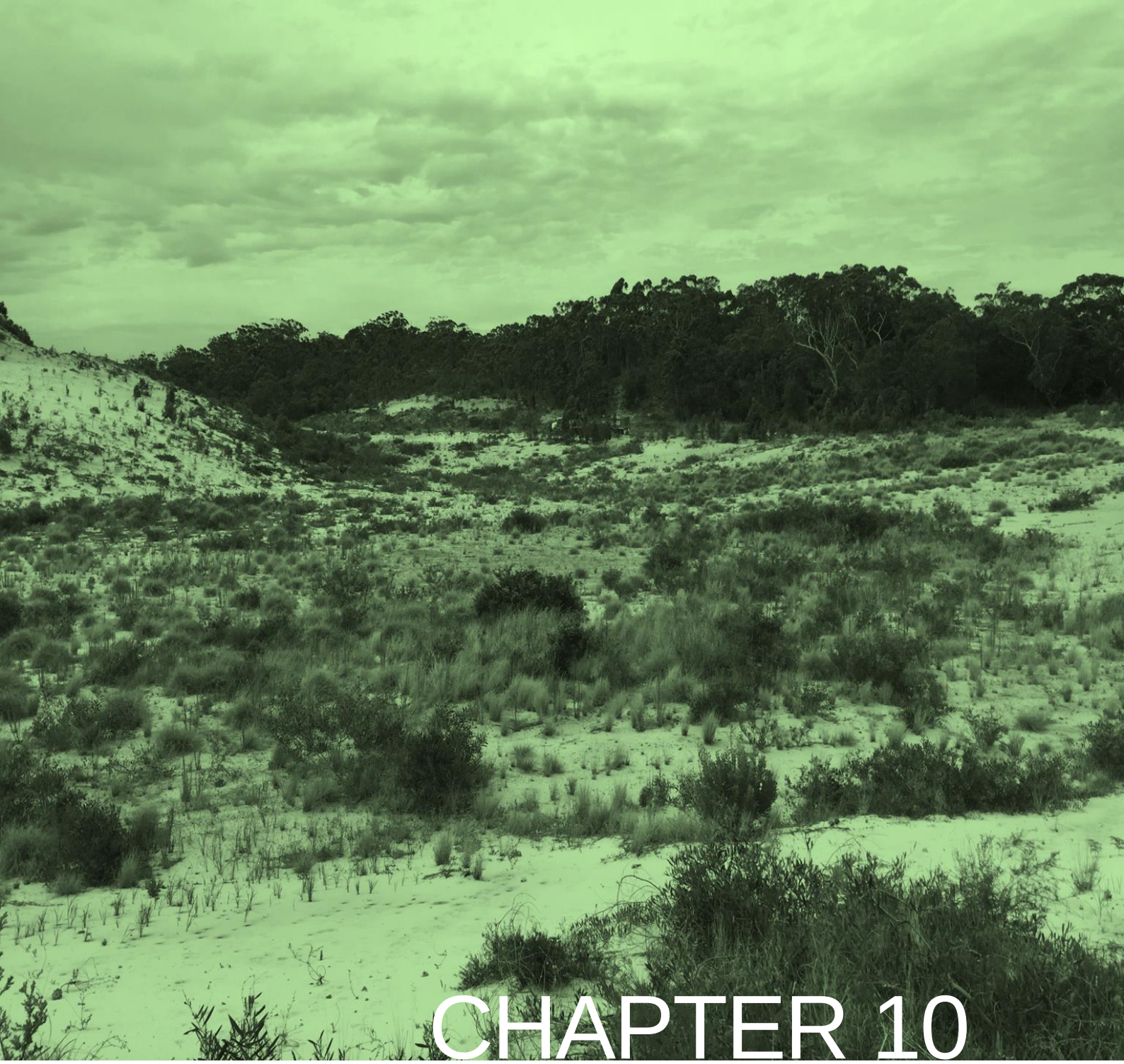
Under the BAM, the biodiversity offsets must provide benefits to biodiversity to compensate for the adverse impacts of an action. Biodiversity offsets assist in achieving long-term conservation outcomes while providing development proponents with the ability to undertake actions that have unavoidable impacts on biodiversity.

Unavoidable impacts to biodiversity are those impacts that are residual (i.e. impacts that remain after impact avoidance, management and mitigation measures are employed to reduce the type or magnitude of biodiversity impacts).

Boral has identified a range of options to offset the project using one or a combination of the following:

1. purchase of offset credits on the market, in which if credits become available Boral may pursue this option;
2. payment into the BCT, in which Boral would pay the equivalent credit costs; and/or
3. use existing Boral landholdings to investigate potential for a biodiversity stewardship site to reduce a portion, or all of the offset credits.

In reference to the above options, given that Boral has the option to pay into the BCF to satisfy the offset requirement, there is minimal risk for Boral not to meet the offsetting liability.



CHAPTER 10

AIR QUALITY

10 AIR QUALITY

10.1 Introduction

This chapter summarises the air quality impact assessment (AQIA) report, which is in **Appendix F**. It describes the air quality assessment criteria which apply to the project, potential air emission sources, modelling method and results, potential impacts and mitigation measures where impacts are unavoidable.

10.1.1 Assessment guidelines and requirements

The SEARs require an assessment of the likely impacts of the project on air quality (**Table 10.1**).

Table 10.1: Air quality SEARs

Requirement	Section and appendix where addressed
A detailed air quality impact assessment (AQIA) of potential construction and operational impacts, in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, and with a particular focus on dust emissions including PM2.5 and PM10, and having regard to the Voluntary Land Acquisition and Mitigation Policy.	10.2, Appendix F

10.1.2 Overview of assessment methods

The objective of the AQIA was to identify and assess the potential for adverse operational air quality impacts which may result from the project.

The following atmospheric pollutants are likely to be generated by the project:

- deposited dust;
- total suspended particulate (TSP) matter, which is nominally taken to be less than 30 micrometres (µm) in diameter and refers to all suspended particles in the air;
- PM_{10}, which is a subset of TSP and have a diameter of 10 micrograms (µm) or less;
- $PM_{2.5}$, which is a subset of TSP and have a diameter of 2.5 µm or less;
- crystalline silica;
- pollutants generated through the combustion of fuel in vehicle engines (oxides of nitrogen and sulfur (NO_2 and SO_2), PM_{10} and $PM_{2.5}$).

Dispersion of air pollutants was modelled using the 'CALPUFF Modelling System', which combines estimated emission rates, neighbouring emission sources, proposed mitigation measures and local meteorology to predict incremental and cumulative air quality impacts.

10.1.3 Assessment criteria

Particulate matter

Dust emissions from the project were estimated by applying emissions factors developed by the United States EPA to the potential dust generating activities. The emissions factors (dust generated by project activities) were used in the dispersion modelling to predict incremental emissions (emissions from the project only) and cumulative emissions (emissions from the project combined with ambient dust levels, which will comprise emissions from other operations in the area) at the receivers.

The project specific air quality criteria in **Table 10.2** were established in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (EPA, 2017).

Table 10.2: Project specific air quality criteria

Particulate matter	Averaging time	Criterion
TSP	Annual	90 micrograms per cubic metre (µg/m³)
PM_{10}	24-hour	50 µg/m³
	Annual	25 µg/m³
$PM_{2.5}$	24-hour	25 µg/m³
	Annual	8 µg/m³
Deposited dust	Annual	Maximum incremental (project only) increase of 2 g/m²/month Maximum total (project and other sources) of 4 g/m²/month

Nitrogen dioxide

The air quality goals for nitrogen dioxide (NO_2) in (NSW EPA, 2017) relevant to the project are summarised in **Table 10.3**.

NO_2 forms when fuel is burned at high temperatures or from blasting and is reddish-brown in colour (at high concentrations) with a characteristic odour and can irritate the lungs and lowers resistance to respiratory infections such as influenza.

SO_2 commonly arises in industrial emissions due to the sulphur content of the fuel and can have impacts upon human health and the habitability of the environment for flora and fauna.

Table 10.3: NSW EPA air quality impact assessment criteria – NO_2

Pollutant	Averaging period	Criterion
NO_2	1 hour	246 µg/m³
	Annual	62 µg/m³

NSW Voluntary Land Acquisition and Mitigation Policy

Voluntary acquisition rights may apply where, even with best practice management, the development contributes to exceed the criteria in **Table 10.4** from the VLAMP (NSW Government, 2018), at any residence, workplace or on more than 25% of any privately owned land where there is an existing dwelling or where a dwelling could be built under existing planning controls (vacant land).

Table 10.4: Particulate matter acquisition criteria

Pollutant	Averaging period	Criterion	Impact type
TSP	Annual	90 µg/m³*	Amenity

Pollutant	Averaging period	Criterion	Impact type
PM_{10}	Annual	20 µg/m^3**	Human health
	24 hour	50 µg/m^3**	
$PM_{2.5}$	Annual	8 µg/m^3*	Human health
	24 hour	25 µg/m^3**	
Deposited dust	Annual	2 g/m^2/month**	Amenity
		4 g/m^2/month*	

* Cumulative impact (increase in the concentration due to the development plus background concentrations due to all other sources).
** Incremental impact (increase in concentrations due to the development alone), with up to five allowable exceedances of the criteria over the life of the development.

Crystalline silica

Silica occurs in nature in a crystalline or amorphous form and may be synthetically produced in amorphous forms. Silica is commonly found in soil and rocks, the most common form is quartz, followed by cristobalite and tridymite. The crystalline form of silica has potential to cause adverse health effects in humans. Occupational exposure to respirable crystalline silica could cause silicosis.

Various jurisdictions have developed criteria for acceptable levels of exposure to crystalline silica. These include the Victorian criterion adopted from Californian reference exposure level values, and occupational standards. There are no criteria in NSW for crystalline silica and as such, **Table 10.5** presents the Victoria Environment Protection Authority impact assessment criteria, which is the most stringent available standards for respirable crystalline silica and thus applied to the project.

Table 10.5: Air quality impact assessment criteria – respirable silica

Pollutant	Averaging period	Criterion
Respirable crystalline silica (as $PM_{2.5}$)	Annual	3 µg/m^3

10.1.4 Summary of background dust levels

Annual average PM_{10} and $PM_{2.5}$ values from the Stockton monitoring station for 2015 were used to represent the background levels for the project as they were the highest recorded at the three monitoring locations.

As noted, the $PM_{2.5}$ and PM_{10} concentrations at the Stockton monitor were elevated due to heavily salt laden air or particulates blowing from the east along the surf break of Stockton Bight. Fresh sea salt aerosol arises from the wave breaking in the ocean and is a natural source of particulate matter. To account for this, background $PM_{2.5}$ and PM_{10} concentrations were adjusted to discount the contribution from salt laden air and annual average $PM_{2.5}$ and PM_{10} concentration were estimated to be 7.3 µg/m³ and 17.0 µg/m³ respectively. These adjusted estimates are comparable with measurements at the Beresfield and Wallsend monitors.

In the absence of available data, estimates of the annual average background TSP and deposited dust concentrations can be determined from a relationship between PM_{10}, TSP and deposited dust concentrations and the measured PM_{10} levels. The annual average TSP concentration and dust deposition levels at the site were conservatively estimated using the relationship and assumed that a PM_{10} concentration of 30 µg/m³ will have an equivalent TSP concentration of 90 µg/m³ and dust deposition level of 4 g/m²/month.

The estimated background air quality levels used in the modelling were:

- annual average TSP concentrations – 61.2 µg/m^3;
- annual average deposited dust levels – 2.7 g/m^2/month;
- 24-hour average $PM_{2.5}$ and PM_{10} concentrations – variable;
- annual average $PM_{2.5}$ concentrations – 7.3 µg/m^3;
- annual average PM_{10} concentrations – 17.0 µg/m^3;
- 1-hour average NO_2 concentrations – 80 µg/m^3; and,
- annual average NO_2 concentrations – 15.0 µg/m^3.

10.1.5 Sensitive receivers

As described in **Section 2.8**, land use surrounding the quarry is a mix of extractive industry, rural, residential, public recreation and environmental conservation areas.

Sensitive receivers considered in the AQIA modelling are identified in **Table 10.6**.

Table 10.6: Sensitive receiver locations

Receiver	Property address	Proximity to the project
R1	101 Norfolk Street, Fern Bay	1,475 m south-west
R2	14 Tuckeroo Circuit, Fern Bay	1,015 m west-south-west
R3	260 Fullerton Cove Road, Fullerton Cove	775 m north-west
R4	12 Coxs Lane, Fullerton Cove	540 m north-west
R5	17A Coxs Lane, Fullerton Cove	520 m north
R6	21 Coxs Lane, Fullerton Cove	490 m north

10.2 Impact assessment

Wind blowing across exposed surfaces and project activities such as loading/unloading of sand and vehicle movements could generate dust emissions.

Project related vehicle movements could generate air emissions from the exhaust and wheel generated dust when travelling on roads.

10.2.1 Particulate matter concentrations

Results from the incremental assessment are in **Table 10.7** and results from the cumulative assessment are in **Table 10.8**.

Dust emissions from the project are predicted to be below criteria.

Table 10.7: 24-hour and annual average particulate dispersion modelling results for sensitive receivers – incremental impact

Receiver ID	$PM_{2.5}$ (µg/m³)		PM_{10} (µg/m³)		TSP (µg/m³)	DD (g/m³/mth)
	24hr average	Annual average	24hr average	Annual average	Annual average	Annual average
	Criteria					
	-	-	-	-	-	2
R1	0.1	<0.1	0.5	<0.1	0.1	<0.1
R2	<0.1	<0.1	0.5	<0.1	0.1	<0.1
R3	0.1	<0.1	0.5	<0.1	0.1	<0.1
R4	0.2	<0.1	1.1	<0.1	0.2	<0.1
R5	0.3	<0.1	1.8	0.2	0.4	<0.1
R6	0.4	<0.1	2.1	0.2	0.5	<0.1

Table 10.8: Annual average particulate dispersion modelling results for sensitive receivers – cumulative impact

Receiver ID	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	TSP (µg/m³)	DD (g/m³/mth)
	Annual average criteria			
	8	25	90	4
R1	7.3	17.1	61.4	2.7
R2	7.3	17.1	61.4	2.7
R3	7.3	17.1	61.4	2.7
R4	7.3	17.3	62.1	2.8
R5	7.4	18.2	65.2	2.9
R6	7.6	19.9	71.5	3.3

The cumulative annual average PM_{10} concentrations generated by the project are illustrated in **Figure 10.1**, and shows that PM_{10} concentrations would be highest within Stage 1 of the project site, before quickly dispersing and resulting in concentrations well below the criterion at the nearest sensitive receivers.

Assessment of cumulative $PM_{2.5}$ and PM_{10} impacts

As indicated in **Section 2.5.2**, maximum 24-hour concentrations of $PM_{2.5}$ and PM_{10} have exceeded or come close to the criteria on occasion at the Stockton monitoring station.

The EPA requires a more thorough assessment when the criteria is likely to be exceeded due to background levels, where the measured background level on a given day is added contemporaneously to the predicted incremental level using the same day's weather. This method has limits in predicting short term impacts, so impacts are described as 'systemic', or over five or more days.

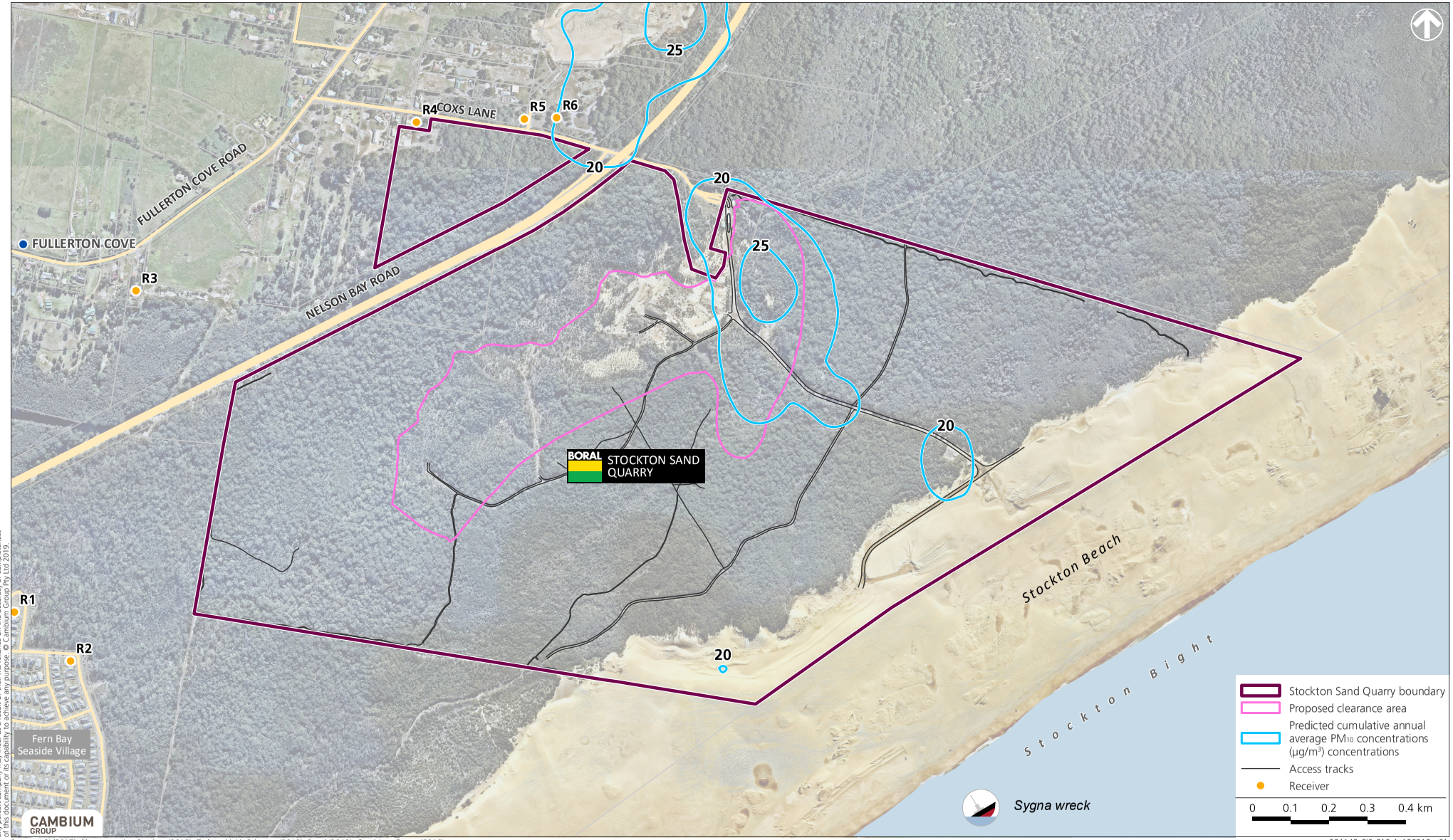
The Level 1 contemporaneous assessment approach of *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (EPA, 2017), which involves adding the maximum background levels to the maximum predicted levels from the project, would show levels above the criterion whether or not the project was operating.

In such situations, a Level 2 contemporaneous assessment approach is applied, where the measured background levels are added to the daily corresponding predicted dust level from the project. The ambient $PM_{2.5}$ and PM_{10} concentrations corresponding with the daily concentrations from the year of modelling (2015) from the Stockton monitoring site were applied to represent the prevailing background levels at receivers around the project.

The results showed that the project will not increase the number of days above the 24-hour average criteria for $PM_{2.5}$ and PM_{10} at any sensitive receiver.

Figure 10.1
Predicted cumulative annual average PM_{10} concentrations ($\mu g/m^3$) concentrations

STOCKTON SAND QUARRY DREDGING
ENVIRONMENTAL IMPACT STATEMENT



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Source: LPI (2017), Photomapping Services (2018), Todoroski Air Sciences (2019), Boral (2019), Cambium Group (2019).

10.2.3 Nitrogen dioxide concentrations

Table 10.9 presents the predicted incremental and cumulative NO_2 dispersion modelling results at each the receivers. NO_2 emissions from the project are predicted to be below criteria.

Table 10.9: NO_2 dispersion modelling results for residential receivers

Receptor ID	Incremental		Cumulative	
	1-hour average	Annual average	1-hour average	Annual average
	Air quality impact criteria			
	-	-	246	62
R1	22.5	<0.1	102.5	15.1
R2	19.5	<0.1	99.5	15.1
R3	26.4	<0.1	106.4	15.1
R4	32.2	0.2	112.2	15.2
R5	49.1	0.3	129.1	15.3
R6	52.1	0.3	132.1	15.3

10.2.4 Respirable crystalline silica

The predicted maximum incremental annual average $PM_{2.5}$ concentration at the nearest receiver will be less than 0.1 µg/m^3. Only a small portion of this dust would contain silica.

As the total level is over thirty times below the adopted criteria of 3 µg/m^3 for respirable crystalline silica, the actual level from the project will be significantly below the criteria and as such the project will not result in an unacceptable level of respirable crystalline silica at receivers.

10.3 Mitigation and management measures

An air quality management plan will be prepared prior to the commencement of operations. The plan will outline the measures to manage dust emissions at the site and include key performance indicators, response mechanisms, compliance reporting and complaints management.

The air quality management measures in **Table 10.10** will be implemented during operation of the project.

Table 10.10: Summary of operational phase air quality management measures

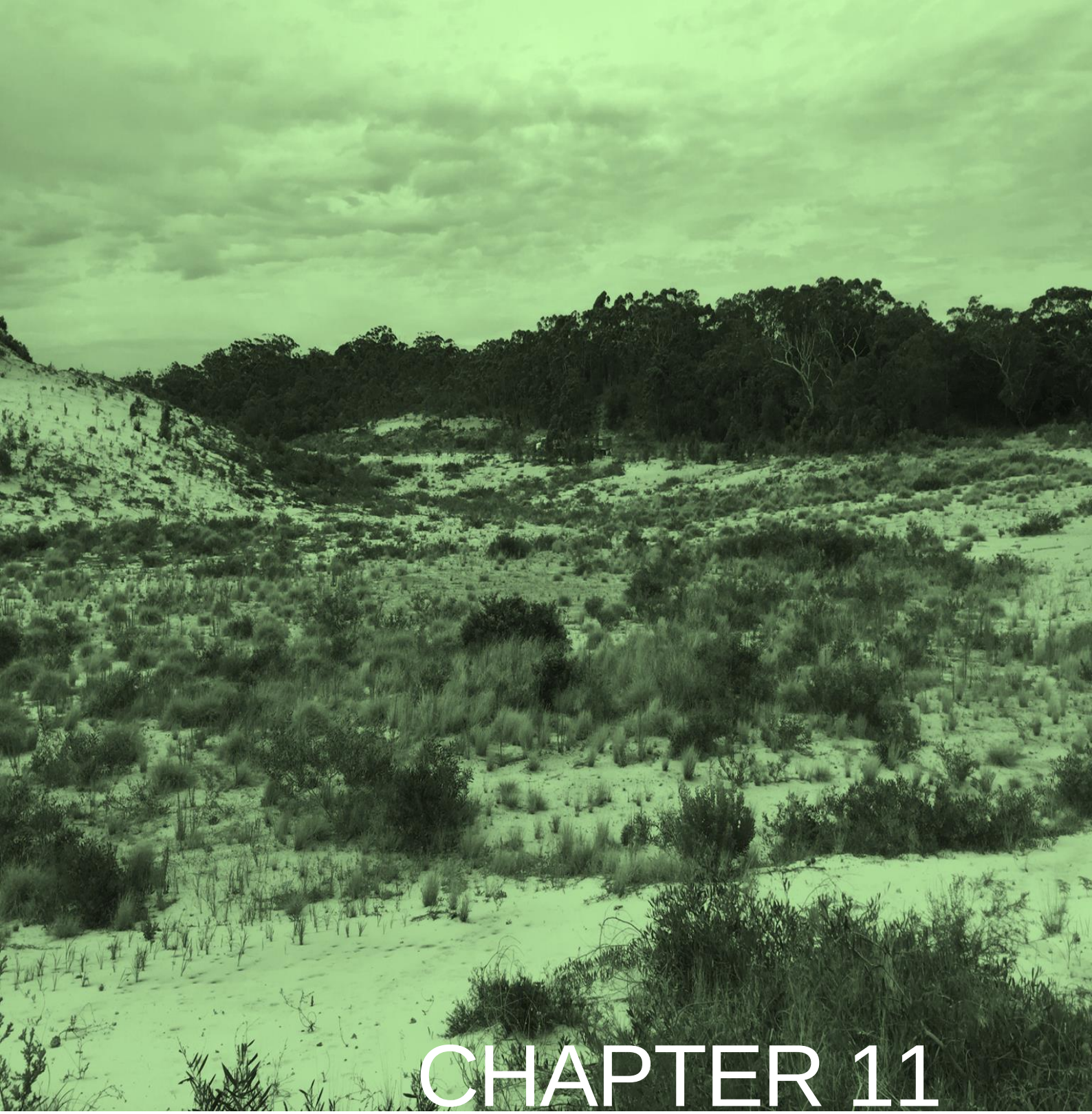
Activity	Control measure
General	▪ Dust generation will be monitored during adverse weather and activities modified as required (e.g. activity will be curtailed or ceased where reasonable levels of visible dust cannot be maintained using the available means). ▪ On-site vehicles and plant will be switched off when not in use. ▪ Vehicles will be maintained and serviced according to manufacturer's specifications.
Exposed areas / stockpiling	▪ The extent of exposed surfaces and stockpiles will be kept to a minimum. ▪ Exposed areas and stockpiles will be covered or dampened with water if dust emissions are visible, or there is potential for dust emissions outside operating hours.

Activity	Control measure
	▪ Dust generation will be minimised by rehabilitating exposed areas when topsoil and subsoil stockpiles are moist and/or wind speed is below 10 m/s.
Material handling	▪ Drop heights from loading and handling equipment will be reduced where practical. ▪ Dampen material when excessively dusty during handling.
Hauling activities	▪ Haul roads will be watered using water cart so the road surface has sufficient moisture to minimise on-road dust generation but not so much as to cause mud/dirt track out. ▪ Regularly inspect haul roads and maintain surfaces to remove potholes or depressions. ▪ Driveways and hardstand areas will be swept/cleaned regularly as required. ▪ Site speed limits will be enforced. ▪ Vehicle loads will be covered when transporting material off-site.
Incidents and complaint management	▪ Complaints and incidents will be logged and investigated via Boral's site incident management system. ▪ Any controls required to manage, mitigate or rectify a complaint or incident will be implemented as soon as practical. Following a complaint or incident, Boral will review all air quality controls and investigate implementation of additional controls if required.

10.4 Residual impacts

The dispersion modelling predictions show the project, with the application of suitable dust mitigation and management measures, will not result in air pollutant levels above criteria at any receiver.

The assessment of cumulative 24-hour average PM_{10} concentrations found that the project, in conjunction with surrounding third party extractive operations, will not result in any additional days above the 24 hour average PM_{10} criterion at receivers.



CHAPTER 11

NOISE

11 NOISE

11.1 Introduction

This section summarises the noise impact assessment (NIA) report, which is in **Appendix G**. It describes the noise assessment criteria which apply to the project, potential noise emission sources, modelling method and results, potential impacts and mitigation measures where impacts are unavoidable.

11.1.1 Assessment guidelines and requirements

The SEARs require an assessment of the likely operational and transportation noise impacts of the project on nearby sensitive receivers (**Table 11.1**).

Table 11.1: Noise related SEARs

Requirement	Section and appendix where addressed
A detailed assessment of the likely construction, operational and off-site transport noise impacts of the development in accordance with the Interim Construction Noise Guideline, NSW Noise Policy for Industry and the NSW Road Noise Policy respectively, and having regard to the Voluntary Land Acquisition and Mitigation Policy;	11.3, Appendix G

11.1.2 Overview of assessment methods

Operational noise emissions from the project were predicted at sensitive receivers using the 'CadnaA' noise prediction software (refer to Section 4.1 of **Appendix G** for detailed operational noise modelling methods). The predictions were compared to the noise criteria in the EPA's (2017) *Noise Policy for Industry* (NPI), DECCW's (2011) *Road Noise Policy* (RNP) and the existing EPL for the quarry. Impacts will occur if the predicted noise levels exceed relevant criteria at any sensitive receivers.

Vibration impacts were not assessed given the separation distance between proposed activities and sensitive receivers.

Meteorology

Certain meteorological conditions may increase noise levels by focusing soundwave propagation paths at a single point. The refraction of sound waves occurs during temperature inversions (where temperature increases with height above ground level) and can vary from hour to hour during the night period. Other adverse meteorological conditions, such as prevailing winds are also required to be considered where relevant for an industrial activity.

The NPI stipulates default parameters to account for noise enhancing weather conditions and these parameters were considered in the NIA. It has been determined that given the project will involve commencement of operations at prior to 7 am (which is the morning shoulder of the night period), the project may be subject to temperature inversions, which occur during the night. Prevailing winds also occur and have been incorporated into noise modelling.

11.1.3 Assessment criteria

The noise modelling results were compared to the project specific noise criteria, which were established using the NPI. The NPI stipulates that intrusiveness and amenity criteria must be determined for daytime (7 am – 6 pm), evening (6 pm – 10 pm) and night time (10 pm – 7 am), as relevant, and apply at the most affected point on or in the receiver property boundary.

The project noise trigger level is the lowest value of the project intrusiveness noise level and project amenity noise level.

Table 11.2 summarises the intrusiveness and amenity criteria for the project, and the project noise trigger levels.

Table 11.2: Project noise trigger levels

Receiver	Time of day[1]	Criteria (dBA)		
		Intrusiveness ($L_{Aeq, 15min}$)	Amenity ($L_{Aeq, period}$)	Project Noise Trigger Level ($L_{Aeq, 15min}$)
All	Morning shoulder (5am-7am)	43	N/A[2]	43
	Day	46	53	46
	Evening	41	43	41
	Night	38	38	38

Sleep disturbance screening levels

Short duration but high intensity activities could cause sleep disturbance at night, without significantly affecting $L_{Aeq, 15min}$ noise levels. The dredge will operate from 6 am and maximum noise level events need to be considered for potential sleep disturbance.

The NPI recommends that, where the night time noise levels at residential receivers exceeds 52 dBA or the RBL plus 15 dBA, whichever is the greater, then a more detailed assessment of potential sleep disturbance impacts is warranted.

As the RBL value plus 15 dBA will be less than 52 dBA for all sensitive receivers, the maximum noise trigger level (sleep disturbance screening level) established by the NIA is set at 52 dBA.

Road traffic noise criteria

The impact assessment criteria for off-site road traffic are specified in the RNP and presented in **Table 11.3**.

Table 11.3: Road traffic noise criteria

Road category	Type of project/land use	Assessment criteria - dBA	
		Day (7am-10pm)	Night (10pm-7am)
Freeway/ arterial/ sub-arterial roads	Existing residences affected by noise from new freeway/arterial/sub-arterial road corridors	$L_{Aeq, 15\text{-hour}}$ 55 (external)	$L_{Aeq, 9\text{-hour}}$ 50 (external)

Road category	Type of project/land use	Assessment criteria - dBA	
		Day (7am-10pm)	Night (10pm-7am)
	Existing residences affected by noise from redevelopment of existing freeway/arterial/sub-arterial roads	$L_{Aeq, 15\text{-hour}}$ 60 (external)	$L_{Aeq, 9\text{-hour}}$ 55 (external)
	Existing residences affected by additional traffic on existing freeway/arterial/sub-arterial roads generated by land use developments		
Local roads	Existing residences affected by noise from new local road corridors	$L_{Aeq, 1\text{-hour}}$ 55 (external)	$L_{Aeq, 1\text{-hour}}$ 50 (external)
	Existing residences affected by noise from redevelopment of existing local roads		
	Existing residences affected by additional traffic on existing local roads generated by land use developments		

The RNP states the relative increase criteria to manage the permissible increase in road traffic noise from a land use development as follows:

'For existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level should be limited to 2 dB above that of the corresponding 'no build option'.

As measured noise levels are above the RNP assessment criteria at the respective monitoring locations, the relative increase criteria was adopted.

Environment protection licence

Section L3 of the EPL stipulates noise limit conditions as described in **Table 11.4**.

Table 11.4: EPL noise criteria

Condition	Description
L3.1	Noise emissions from the premises must not exceed an Leq(15 minute) noise emission criterion of 35 dB(A) at the nearest residential receiver.
L3.2	Noise from the premises is to be measured at the worst affected point or within the residential boundary, or the most affected point within 30 metres of a dwelling (rural situations) where the dwelling is more than 30 metres from the boundary, to determine compliance with the noise limit in this licence.
L3.3	The noise emission limit identified in this licence applies in the following weather conditions: ▪ wind speed up to 3m/s at 10m above ground level; or

Condition	Description
	▪ temperature inversion conditions of up to 30C/100m and wind speed up to 2m/s at 10m above ground level.

11.2 Potential impacts

11.2.1 Operational noise sources

The most significant operation noise sources from the project will be:

- operation of mobile plant and equipment such as excavator, front-end loader, dozer and heavy vehicles during site establishment and sand extraction operations;
- operation of mobile screen equipment;
- operation of the dredge;
- operation of the wash plant and associated pumps and diesel generators;
- heavy vehicles importing fill material during stabilisation works; and
- heavy vehicles transporting sand in the quarry and onto the public road network.

Noise impacts from the project will vary as the nature and location of the works change over the life of the project. The following operational scenarios have been modelled to assess the potential worst-case noise impacts over the life of the project:

- Scenario 1 – where receivers to the north-west of the project in Fullerton Cove will be worst impacted during Stage 1 when a significant portion of plant and work activity is at the northern most area of the project site near the quarry entrance.

  During Stage 1, extraction will still be taking place in Pit 7 (windblown sand extraction area) and, therefore, plant was modelled in this area.

  Heavy vehicles and a water cart moving between pit 7 and the northern end of the project site were included in this scenario.

- Scenario 2 – where plant and extraction operations in Stage 5 will be closest to the Fern Bay receivers to the south-west of the project. A water cart was included moving between the Stage 5 extraction area and the entrance to the quarry in Stage 1.

11.2.2 Assessment of operational noise impacts

The modelled day time operational noise levels at the identified sensitive receivers are presented in **Table 11.5**.

Table 11.5: Predicted day time operational noise impacts

Receiver	Project noise trigger level ($L_{Aeq,15min}$ dBA)	Predicted noise levels – Scenario 1 (dBA)	Predicted noise levels – Scenario 2 (dBA)	Compliance
R1	46	28	28	Yes
R2	46	29	28	Yes
R3	46	29	29	Yes
R4	46	30	29	Yes
R5	46	27	31	Yes

Receiver	Project noise trigger level ($L_{Aeq,15min}$ dBA)	Predicted noise levels – Scenario 1 (dBA)	Predicted noise levels – Scenario 2 (dBA)	Compliance
R6	46	26	30	Yes
R7	46	27	33	Yes
R8	46	26	31	Yes
R9	46	27	31	Yes
R10	46	26	30	Yes
R11	46	24	29	Yes
R12	46	24	30	Yes
R13	46	24	30	Yes
R14	46	15	23	Yes
R15	46	14	23	Yes
R16	46	13	23	Yes
R17	46	12	23	Yes
R18	46	13	22	Yes
R19	46	16	25	Yes
R20	46	15	24	Yes
R21	46	16	24	Yes
R22	46	18	24	Yes
R23	46	18	24	Yes
R24	46	17	24	Yes
R25	46	16	23	Yes
R26	46	17	23	Yes
R27	46	17	22	Yes
R28	46	17	22	Yes
R29	46	17	21	Yes
R30	46	15	21	Yes
R31	46	14	21	Yes
R32	46	13	21	Yes
R33	46	14	21	Yes
R34	46	23	28	Yes
R35	46	23	29	Yes

The predicted operational noise levels will comply with the project noise trigger levels at all sensitive receivers.

The morning shoulder operational noise levels are presented in **Table 11.6**.

Table 11.6: Predicted operational noise levels during the morning shoulder

Receiver	Project noise trigger level ($L_{Aeq,15min}$ dBA)	Predicted noise levels – Scenario 1 (dBA)	Predicted noise levels – Scenario 2 (dBA)	Compliance
R1	43	29	29	Yes
R2	43	30	29	Yes
R3	43	30	29	Yes
R4	43	31	30	Yes
R5	43	28	32	Yes
R6	43	27	31	Yes
R7	43	28	33	Yes
R8	43	27	32	Yes
R9	43	27	32	Yes
R10	43	27	31	Yes
R11	43	25	30	Yes
R12	43	24	31	Yes
R13	43	24	31	Yes
R14	43	15	24	Yes
R15	43	14	24	Yes
R16	43	14	24	Yes
R17	43	12	23	Yes
R18	43	13	22	Yes
R19	43	16	26	Yes
R20	43	15	25	Yes
R21	43	16	25	Yes
R22	43	18	25	Yes
R23	43	19	25	Yes
R24	43	18	24	Yes
R25	43	17	24	Yes
R26	43	17	24	Yes
R27	43	17	23	Yes
R28	43	17	22	Yes
R29	43	17	22	Yes
R30	43	16	22	Yes
R31	43	15	22	Yes
R32	43	14	21	Yes
R33	43	14	21	Yes

Receiver	Project noise trigger level ($L_{Aeq,15min}$ dBA)	Predicted noise levels – Scenario 1 (dBA)	Predicted noise levels – Scenario 2 (dBA)	Compliance
R34	43	23	29	Yes
R35	43	23	30	Yes

The predicted morning shoulder operational noise levels will comply with the project noise trigger levels at all receivers during noise enhancing meteorological conditions.

Sleep disturbance

As detailed in **Table 11.6** the predicted noise levels during the morning shoulder period will be well below the maximum noise trigger level of 52 dBA. Given this, it is considered unlikely that the operations would cause sleep disturbance and no further assessment of maximum noise levels is required.

Road traffic noise

Compliance is predicted on a busy day at all assessment locations, with predicted relative increases of less than 0.2 dB along all routes. Based on compliance during the busy weekday, it is expected that compliance will be comfortably achieved during an average weekday.

Environment protection licence

EPL condition L3.1 states that noise emissions from the premises must not exceed an $L_{eq(15\ minute)}$ noise emission criterion of 35 dB(A) at the nearest residential receiver.

The project will result in a maximum $L_{Aeq,15min}$ noise level at any sensitive receiver of 33 dB(A). and compliance with the EPL conditions would be achieved.

11.2.3 Cumulative noise impacts

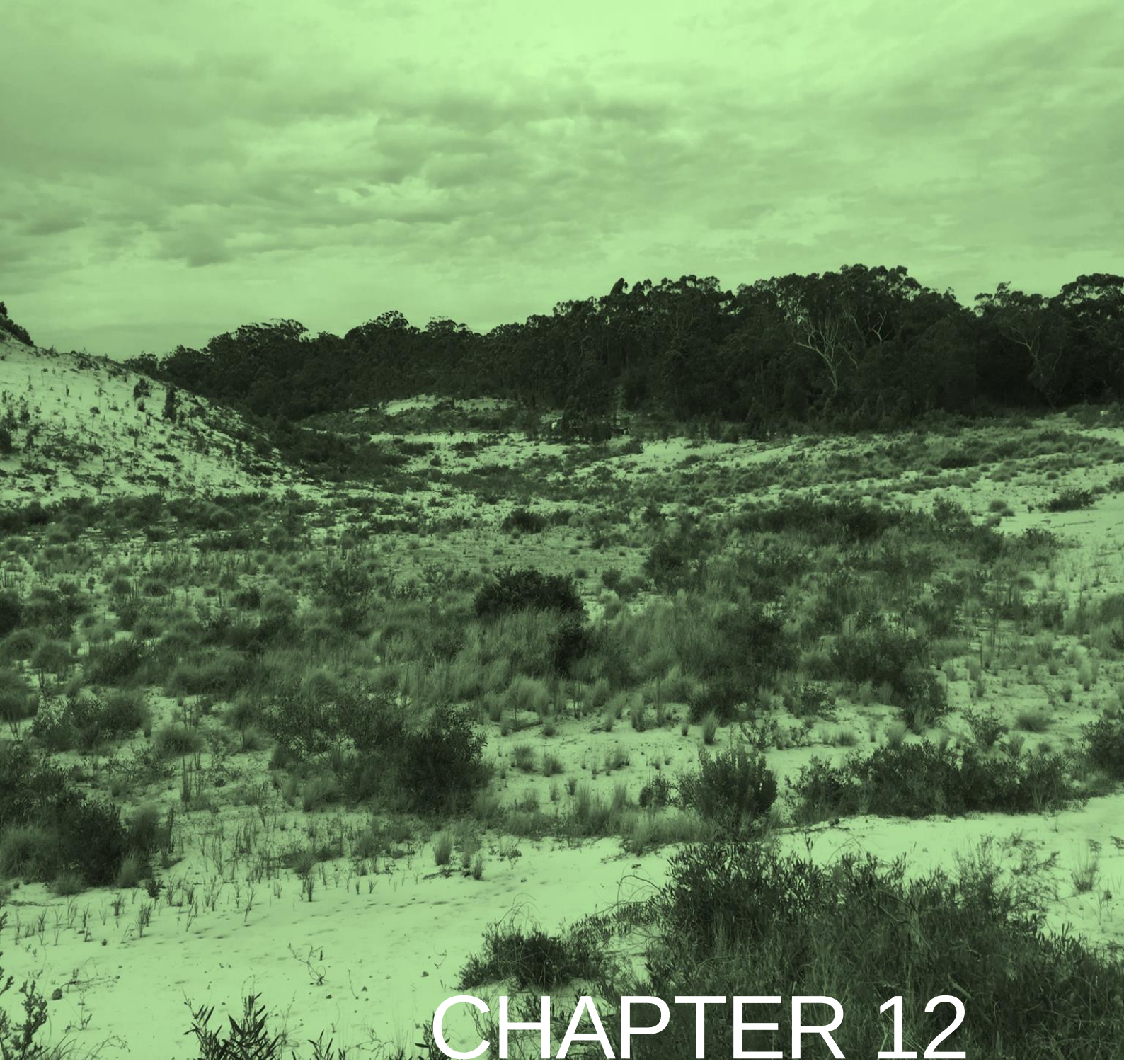
Cumulative noise levels from multiple industrial noise sources are implicit in the amenity criteria.

All predicted $L_{Aeq,15min}$ noise levels are 10 dB or more below the project noise trigger level and it is therefore expected that the project will have a negligible contribution to cumulative noise levels at the receivers.

11.3 Mitigation and management measures

The residual noise impact is the exceedance of the project noise trigger level after all feasible and reasonable mitigation measures have been considered. No residual impacts are predicted at any privately-owned receivers and, therefore, receiver-based treatments or controls are not required.

Notwithstanding, Boral will continue routine operational noise monitoring and community consultation, and will implement measures if an exceedance is detected or a verified/substantiated complaint is received from a member of the community.



CHAPTER 12

TRAFFIC AND TRANSPORT

12 TRAFFIC AND TRANSPORT

12.1 Introduction

This chapter summarises the traffic impact assessment (TIA) report, which is in **Appendix H**. It describes the existing traffic conditions on the nearby road network, describes potential impacts of the project on this network and provides measures to minimise and manage these impacts.

12.1.1 Assessment guidelines and requirements

The SEARs require an assessment of the likely impacts of the project on the road network (**Table 12.1**).

Table 12.1: Traffic related SEARs

Requirement	Section and appendix where addressed
Accurate predictions of the road traffic generated by the construction and operation of the development, including a description of the types of vehicles likely to be used for transportation of quarry products.	12.4, Appendix H
A detailed assessment of potential traffic impacts on the capacity, condition, safety and efficiency of the local and State road network, paying particular attention to the intersections of Nelson Bay Road (MR108) / Coxs Lane (local road) and Nelson Bay Road / Seaside Boulevard (local road) (using SIDRA or a similar traffic model) including a road safety audit.	12.4, Appendix H
A description of the measures that would be implemented to mitigate any impacts.	12.5, Appendix H

12.2 Overview of assessment methods

The objective of the TIA was to examine the impact of additional traffic generated by the project. The Signalised and Unsignalised Intersection Design and Research Aid (SIDRA) traffic modelling program was used to predict impacts on key intersections for the morning (AM) and afternoon (PM) peak hour periods using the existing traffic volumes together with the maximum additional vehicles generated by the project (worst case scenario).

The best criteria for assessing intersection performance is level of service (LoS), degree of saturation (DS), highest movement delay in seconds (HMD) and average vehicle delay (AVD). **Table 12.2** shows the LoS criteria for intersections in the *Guide to Traffic Generating Developments* (RMS, 2002).

The RMS design criteria for intersections is LoS D or better.

Relevant standards/guidelines adopted and used during the TIA were:

- Austroads Guide to Traffic Management;
- Austroads Guide Supplements – Austroads Guide to Traffic Management;
- AS2890.1 (2004) – Parking Facilities. Part 1 Off street car parking; and
- AS2890.2 (2002) – Parking Facilities. Part 2 Off Street Commercial Vehicle facilities.

Table 12.2: LoS criteria for intersections

Level of service	Average delay (seconds per vehicle)	Traffic signals roundabout	Give way & stop signs
A	<14	Good operation	Good operation
B	15 to 28	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	29 to 42	Satisfactory	Satisfactory, but accident study required
D	43 to 56	Operating near capacity	Near capacity and accident study required
E	57 to 70	At capacity; at signals, incidents will cause excessive delays. Roundabouts require other control mode	At capacity, requires other control mode
F	>70	Intersection is oversaturated	Oversaturated, requires other control mode

Source: RMS Guide to Traffic Generating Developments, October 2002

12.3 Existing traffic conditions on road network

The major transportation routes that the Boral fleet use to transport sand product is outlined in **Section 2.4.3**.

Traffic was counted (inclusive of volume and vehicle classification counts) on the road network adjacent to the quarry in December 2018 to examine the traffic conditions on the road network for the peak hours of operation of the quarry. Traffic was counted at several locations on Nelson Bay Road, Coxs Lane (including the on and off ramps to and from Nelson Bay Road) and Cabbage Tree Road.

Vehicles entering and departing the quarry were also counted.

12.3.1 Daily traffic volumes

The daily volumes of traffic on the surrounding road network are outlined in Table 4.1 of **Appendix H**, and **Table 12.3** provides a summary of the average two-way traffic volumes and percentage of heavy vehicles using the road network.

Table 12.3: Daily traffic volumes

Location	Average vehicles per day	Percentage of heavy vehicles (%)
Nelson Bay Road – north of Coxs Lane	22,654	5.2
Nelson Bay Road – south of Seaside Boulevard	26,246	6.7
Coxs Lane – east of Nelson Bay Road	140	82.9
Northbound off ramp from Nelson Bay Road to Coxs Lane	116	57.8

Location	Average vehicles per day	Percentage of heavy vehicles (%)
Southbound on ramp from Coxs Lane to Nelson Bay Road	131	51.9
Cabbage Tree Road – west of Nelson Bay Road	10,857	10.5
Medowie Road – north of Ferodale Road	7,206	6.1

12.3.2 Peak hour traffic volumes

The morning peak hour generally occurs between 7:15 am to 8:15 am, although slightly higher volumes occurred at the Coxs Lane on/off ramp intersections between 6.45 am to 7.45 am.

The principal intersections of Nelson Bay Road, Cabbage Tree Road and Lavis Lane, and Nelson Bay Road, Seaside Boulevard and Fullerton Cove Road had the highest intersection volumes. These are two lane roundabouts.

The afternoon peak hour occurred between 4 and 5 pm at the Nelson Bay Road with Cabbage Tree Road and Lavis Lane, and with Seaside Boulevard and Fullerton Cove Road roundabouts. The afternoon peak occurred between 3 and4 pm at the Coxs Lane intersections with the on and off ramps to and from Nelson Bay Road.

Peak hour traffic volumes recorded at principal intersections are summarised in **Table 12.4**.

Table 12.4: Peak hour traffic volumes

Intersection	Contributing roadway	Morning peak hour traffic volumes (vph)	Afternoon peak hour traffic volumes (vph)
Nelson Bay Road, Cabbage Tree Road and Lavis Lane	Cabbage Tree Road	198	145
	Lavis Lane	279	230
	Nelson Bay Road - northbound	1161	1366
	Nelson Bay Road - southbound	1021	1116
Nelson Bay Road, Seaside Boulevard and Fullerton Cove Road	Seaside Boulevard	330	102
	Fullerton Cove Road	43	37
	Nelson Bay Road – northbound	1205	1293
	Nelson Bay Road - southbound	1032	1254

Traffic volumes on the Coxs Lane off ramp and on ramp intersections, which provide vehicle access to the quarry are very low and number less than 20 vehicles per hour (vph) in the morning and afternoon peak hours.

12.3.3 Assessment of existing traffic conditions

SIDRA modelling of the intersections identified in **Table 12.4** without proposed truck increases during the morning and afternoon peak hours demonstrated they were performing at LoS A, with minimal delays and spare capacity.

12.3.4 Road safety

According to three years of RMS road accident data, there were 21 accidents on Nelson Bay Road between Cabbage Tree Road at Williamtown and Fullerton Street at Fern Bay, comprising:

- 12 of the accidents were casualty crashes, with nine non-casualty crashes;
- 7 of the accidents occurred at or near the Nelson Bay Road, Cabbage Tree Road and Lavis Lane roundabout, three of which were casualty crashes;
- 5 accidents occurred at or near the Nelson Bay Road, Seaside Boulevard and Fullerton Cove Road roundabout, three of which were casualty crashes;
- the remainder were spread along the length of Nelson Bay Road comprising two pedestrian accidents at different locations, rear end and run off road accidents; and
- one of the pedestrian accidents was fatal and involved an elderly pedestrian walking along Nelson Bay Road at night facing traffic, approximately 1.6 km north of Seaside Boulevard. The other pedestrian accident involved a pedestrian crossing Nelson Bay Road approximately 600 m north of Vardon Road (adjacent a bus stop), at night.

This accident history shows no pattern which could be addressed by specific remedial measures.

A safety audit of Nelson Bay Road between Cabbage Tree Road and Fullerton Street identified several minor maintenance issues, which are the responsibility of RMS.

12.3.5 Public transport

Public transport options in the area include local bus routes connecting Port Stephens to Newcastle, and Raymond Terrace to Stockton. Bus routes with services stopping within proximity to the site include 131, 132, 136 and 138 that use Nelson Bay Road.

Routes 136 and 138 are along the section south of Seaside Boulevard and at the section north of Fullerton Cove Road (north intersection) and have a number of bus stops south of Seaside Boulevard.

Routes 130 and 131 have one stop at Bayway Village on Nelson Bay Road, south of Seaside Boulevard.

Traffic flow is not disrupted by buses as there are pull off areas and bus bays on Nelson Bay Road between Fullerton Street and Seaside Boulevard.

12.3.6 Pedestrian and cyclist traffic

There is minimal pedestrian traffic on Nelson Bay Road between Cabbage Tree Road and Seaside Boulevard. To the south of Seaside Boulevard, there is minor residential pedestrian traffic to and from bus stops.

There are no formal pedestrian crossings along Nelson Bay Road between Cabbage Tree Road and Fullerton Street at Fern Bay.

There was minimal pedestrian traffic across Nelson Bay Road at or near the key intersections during the peak hour traffic counts.

There is sufficient room for cyclists on the sealed road shoulders of Nelson Bay Road, however, the bridge over Coxs Lane on Nelson Bay Road is a pinch point for cyclists.

Port Stephens Council is proposing a shared path along Fullerton Cove Road from Seaside Boulevard and joining Nelson Bay Road south of Cabbage Tree Road, which will be an alternative route to the section of Nelson Bay Road adjacent to Coxs Lane.

The weekday peak hour traffic counts indicate that small numbers of cyclists use this section of Nelson Bay Road.

12.4 Potential impacts

12.4.1 Traffic generation

The project will generate additional traffic on the public road network.

There will be a small increase in light, delivery and maintenance vehicles. The largest increase will be in product transport vehicles (heavy vehicles) associated with the additional site wide 250,000 t of sand production to 2028.

The importation of up to 70,000 tpa of VENM will also increase heavy vehicle movements entering and exiting the quarry.

Existing operations

The existing windblown extraction area for the quarry generates:

- 58 one-way heavy vehicle trips on an average weekday; and
- up to 76 one-way heavy vehicle trips on a peak day.

Total two-way heavy vehicle trips (i.e. heavy vehicle movements in and out of the quarry) are 116 on an average weekday, and up to 152 heavy vehicle trips on a peak day.

Currently the highest traffic generation of the quarry occurs on weekdays and this is expected to continue with the project, given that on Saturdays the quarry normally operates for half a day and there is no sand product transportation on some Saturdays.

Project operations

The maximum traffic generation associated with the project will run until 2028, where the existing windblown sand extraction area will run in tandem with the project to reach a site wide maximum output of 750,000 tpa. Following completion of the windblown sand extraction area, the traffic generation of the project will decrease and will comprise vehicles transporting sand and importing VENM.

The project will generate approximately 100 one-way heavy vehicle trips (i.e. 200 two-way heavy vehicle movements) on an average weekday, and up to 142 one-way heavy vehicle trips (i.e. 284 two-way heavy vehicle movements) on a peak day.

Table 12.5 shows the daily two-way traffic volumes generated by the existing quarry operations and those for the project during the peak day to 2028.

Table 12.5: Maximum daily traffic generation for existing and proposed operations until 2028

Activity	Peak day of existing operation	Peak day of project	Additional heavy vehicle movements
Sand product transportation	152	228	76 trucks
VENM importation	-	56	56 trucks
Total	152	284	132 trucks

Up to 284 two-way heavy vehicle trips could occur in the maximum or peak day to 2028. This will be an increase of 132 two-way heavy vehicle trips per day compared to the existing operation.

Table 12.6 shows the daily two-way traffic volumes generated by the existing quarry operations, as well as those for the project during the peak day after 2028.

Table 12.6: Maximum daily traffic generation for existing and proposed operations after 2028

Activity	Peak day of existing operation	Peak day of project	Additional heavy vehicle movements
Sand product transportation	152	152	Nil
VENM importation	-	56	56 trucks
Total	152	208	56 trucks

Up to 56 additional two-way heavy vehicle trips could occur from in the maximum or peak day after 2028 when the windblown sand extraction project ceases operation.

The resulting average weekday heavy vehicle movements on the road network are summarised in **Table 12.7**.

Table 12.7: Additional average weekday vehicle movements on the road network

Location	Additional two-way heavy vehicle movements on average weekday (vpd)	Increase in traffic volumes on road network (%)	Increase in heavy vehicles on road network (%)
Nelson Bay Road – north of Coxs Lane	46	0.47	6.8
Nelson Bay Road – south of Coxs Lane	130	1.35	17.1
Nelson Bay Road – south of Seaside Boulevard	38	0.34	6.2
Cabbage Tree Road – west of Nelson Bay Road	42	0.91	8.1

The additional heavy vehicle traffic will represent a small proportion of total heavy vehicles using the road network on an average weekday.

Heavy vehicle volumes on a maximum day of operation will be higher, with a total of 284 two-way movements. However, maximum days will only occur on approximately 5% of operational days when Boral is supplying major contracts.

12.4.2 Traffic impacts on the road network

During the maximum hour, the project will result in 30 inbound and 30 outbound heavy vehicle trips for product transport and VENM importation (60 two way heavy vehicle trips).

As previously noted in **Section 12.4.1**, the maximum increase associated with the project is an additional 284 two-way heavy vehicles per day.

To assess the impacts of additional traffic associated with the project at the key intersections in the surrounding road network, traffic modelling using the software package SIDRA has been undertaken, as detailed in **Section 12.2**.

SIDRA was used to model the morning peak hour and afternoon peak hours using the maximum proposed hourly traffic volumes (the worst-case scenario).

The results indicate that all intersections identified in **Table 12.4** will continue to operate at LoS A. Therefore, the additional traffic will have satisfactory impacts on these intersections.

12.4.3 Cumulative impacts

Future traffic volumes on Nelson Bay Road and the wider road network will increase due to approved land use changes and developments in the area.

A background traffic growth of 2.4% per year on the intersections was modelled to assess cumulative impacts and demonstrated:

- The Coxs Lane on and off ramps will continue to operate at LoS A, with very low vehicle delays.
- The roundabout intersection of Nelson Bay Road, Cabbage Tree Road and Lavis Lane will retain a good operation with LoS A. The increase in the total average vehicle delay will be 0.2 seconds in the morning peak hour and one second in the afternoon peak hour, which is a very small increase.
- The roundabout intersection of Nelson Bay Road, Seaside Boulevard and Fullerton Cove Road will retain LoS A operation with relatively low total average vehicle delays. The increase in the total average vehicle delay will be 0.3 seconds per vehicle in the morning peak hour and 0.8 seconds per vehicle in the afternoon peak hour.

The intersections to be used by heavy vehicles associated with the project will have sufficient capacity for background traffic growth as well as project related traffic for the next 10 years.

12.4.4 Public transport, pedestrians and cyclists

Given the minimal pedestrian and cyclist use of Nelson Bay Road and other roads to be utilised by the project, the additional heavy vehicles movements will not significantly impact pedestrians, cyclists and buses routes.

12.4.5 Road safety

A safety audit of Nelson Bay Road between Cabbage Tree Road and Fullerton Street identified several minor maintenance issues, which are the responsibility of RMS. The safety audit did not identify any project aspects which would compromise the safety of the road network.

The section of Nelson Bay Road adjacent to the quarry and the other roads to be used by project related vehicles are approved B-double routes.

12.4.6 Parking and internal access

Boral will change the internal operation of the quarry and upgrade the existing infrastructure as described in **Chapter 4**.

New internal roads will be designed and constructed to AS2890.2 requirements for one-way or two-way flow as appropriate to cater for the quarry's heavy vehicles.

The new parking area for the light vehicles will be designed to AS2890.1 requirements. Sufficient parking will be provided for employees and visitors.

12.4.7 Construction traffic

The proposed site infrastructure will be constructed in Stage 1.

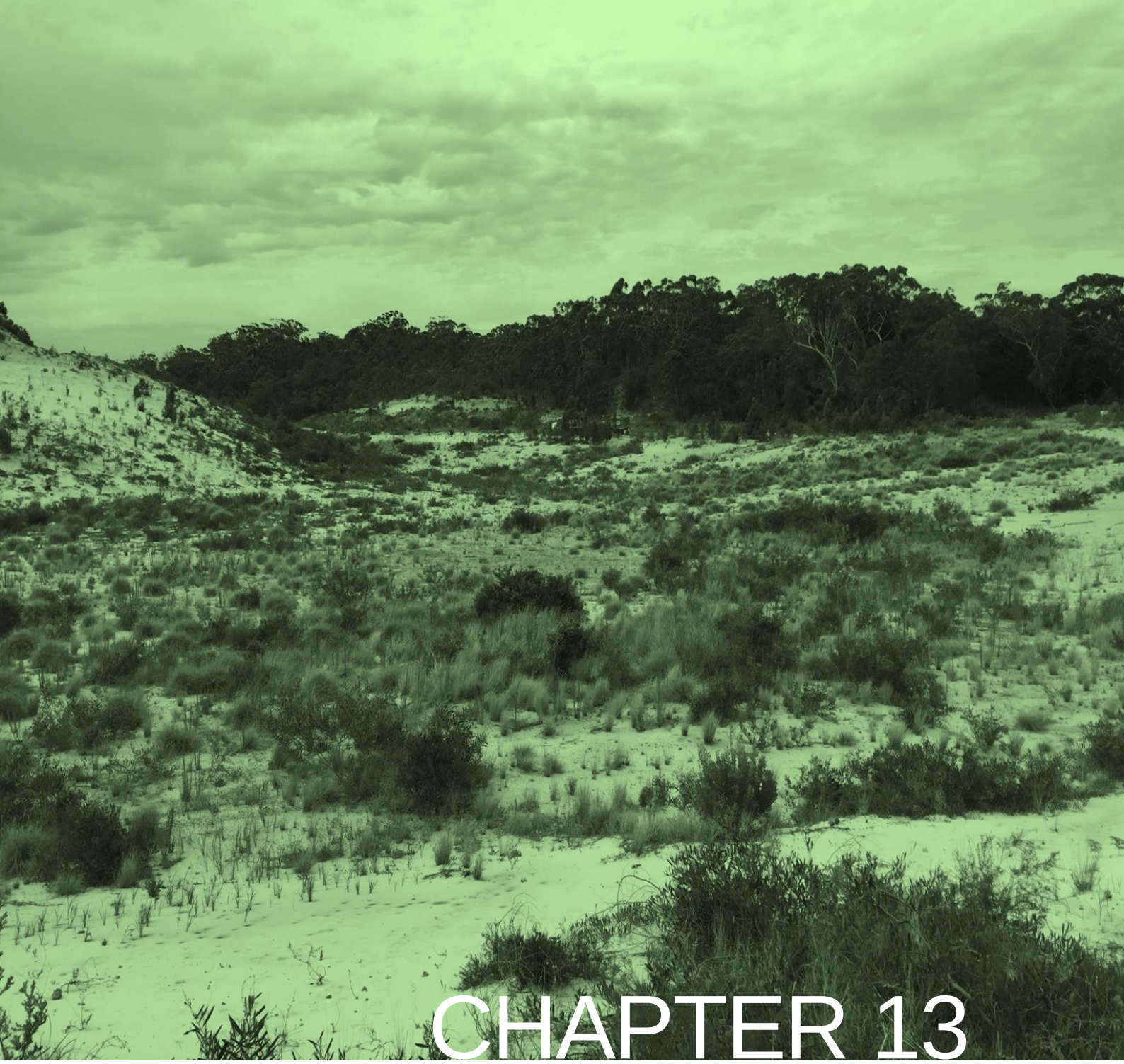
Construction vehicles will comprise low loaders delivering earthwork plant and equipment, semi-trailers, truck and dog trailers delivering road pavement and hardstand materials, concrete agitator trucks and light vehicles associated with the workforce.

There will be up to six light vehicles and between 5 to15 heavy vehicles per day. All construction vehicles will access the site via Coxs Lane and Nelson Bay Road.

The number of construction vehicles accessing the quarry per hour and on a daily basis will be less than the assessed operational vehicle numbers and therefore not anticipated to have significant impact on existing network capacity.

12.5 Mitigation and management measures

Boral will continue to implement the driver awareness training for all truck drivers, with a focus on the correct protocols when entering and exiting the site.



CHAPTER 13

SOCIAL

13 SOCIAL

13.1 Introduction

This chapter summarises the social impact assessment report (SIA), which is in **Appendix I**. It describes the best practice techniques for engaging with the community, and provides a process for assessing, determining and responding to social impacts associated with the project.

13.1.1 Assessment guidelines and requirements

The SEARs require an assessment of the likely social impacts of the project (**Table 13.1**).

Table 13.1: Social impact related SEARs

Requirement	Section and appendix where addressed
A detailed assessment of the potential social impacts of the development that builds on the findings of the Social Impact Assessment Scoping Report, in accordance with the Social impact assessment guideline for State significant mining, petroleum production and extractive industry development, paying particular consideration to:	Appendix I
▪ the full range of categories of potential social impacts identified in Section 1.1 of the SIA guideline;	
▪ how impacts (positive and negative) may be distributed among different groups in the affected communities;	
▪ the principles in Section 1.3 of the SIA guideline;	
▪ ensuring that the person preparing the SIA has appropriate qualification and experience as outlined in the Box 4 of the SIA guideline; and	
▪ the review questions in Appendix D of the SIA guideline.	

The SEARs recommended the use of the *Social impact assessment guideline – For State significant mining, petroleum production and extractive industry development* (NSW Department of Planning and Environment, 2017), which formed the basis of the SIA for the project.

13.1.2 Overview of assessment methods

The SIA involved the following steps:

- scoping the SIA – including consultation to understand issues potentially affecting stakeholders and determining the project's area of social influence;
- establishing the social baseline – which is described in **Section 2.7** of this EIS;
- predicting and analysing social impacts;
- evaluating social impacts;
- developing responses to social impacts; and
- developing a monitoring and management framework.

Scoping

The ‘scoping tool’ defined in (NSW Department of Planning and Environment, 2017) was used for the SIA scoping exercise. The tool is designed to ensure a consistent approach to identifying which of the social impacts associated with a project need to be investigated in the SIA and provides a methodological guide and ready-made SIA template.

The process of applying the scoping tool involved:

1. Using early engagement result as inputs to the scoping tool and considering each ‘matter’ (i.e. amenity, access, built environment, heritage, community and economic) and its subcategories, before determining how likely it is that project activities will cause an impact to it;
2. Considering each ‘matter’ (i.e. amenity, access, built environment, heritage, community and economic) and its subcategories, and determining how likely it is that project activities will impact the matter.
3. For each matter, considering and assessing the material characteristics of any likely impact.
4. For each matter, considering stakeholder/community opinions and sentiment towards the project activities.
5. For each matter, determining whether a social impact will arise from the project activities, and then developing a rationale for the decision.
6. For each matter, determining the level of assessment (and engagement) which is required in the EIS preparation phase, and selecting from the following list the most appropriate SIA type:

    i. desktop;
    ii. standard; or
    iii. comprehensive.

7. Each matter and its associated level of assessment (determined by the scoping tool) was considered in the context of the social impact categories specified in Section 1.1 of the Guideline.

Stakeholders

A stakeholder is a group, individual or organisation that is interested in, affected by, or has the capacity to influence a project. The locally-specific stakeholders are known to Boral courtesy of their long-term presence in the Fullerton Cove area. The stakeholders are generally:

- residents – neighbours and in the community;
- people in host communities – people in communities where construction workers and other people may in-migrate;
- other communities – more distant communities that may be affected;
- project employees;
- Indigenous people – including non-residents who may have connections to the land;
- non-government organisations – local, national or international groups who may have an interest in environmental values of a site; and
- other stakeholders – such as governments, developers, agencies, funding agencies.

Engagement methods

The community was comprehensively engaged during 2018 (scoping engagement) and 2019 (further engagement) for the project. A range of methods were used to engage stakeholders and provide an opportunity to interface with Boral about its operations at the quarry. Engagement methods used and when they were deployed are described in detail in Table 2 and Table 4 of **Appendix I**.

The key stakeholders identified for the project are summarised in **Table 13.2** including the engagement techniques applied to establish and foster a dialogue about the project.

Table 13.2: Stakeholders and engagement methods

Project stakeholder	Letter	Phone call	Email	Interview / Informal briefing / 'door knock'	Site visit / tour	Formal presentation	Community drop-in sessions notification	Community drop-in sessions	Newsletter	Meetings	Social media / online
Host communities and fenceline neighbours											
Coxs Lane neighbours	X			X			X	X	X		X
Fern Bay residential area	X			X			X	X	X		X
Fullerton Cove residential area	X			X			X	X	X		X
Residents in wider region – Stockton/Williamtown							X	X	X		X
Indigenous groups											
Worimi LALC	X	X	X				X	X	X	X	X
Local government (Port Stephens Council)											
Mayor	X		X			X	X	X	X	X	X
General Manager	X		X			X	X	X	X	X	X
Elected councillors	X		X			X	X	X	X	X	X
Planning representatives	X	X	X			X	X	X	X	X	X
State and Federal government											
NSW Member for Port Stephens	X	X	X				X	X	X	X	X

Project stakeholder	Letter	Phone call	Email	Interview / Informal briefing / 'door knock'	Site visit / tour	Formal presentation	Community drop-in sessions notification	Community drop-in sessions	Newsletter	Meetings	Social media / online
NSW Member for Newcastle	X	X	X		X		X	X	X		X
DPIE	X	X	X								X
EPA	X		X								X
RMS	X		X								X
OEH	X		X								X
Worimi Conservation Lands	X		X								X
Media											
Boral corporate media (i.e. Facebook and website)		X	X				X	X	X		X
Interest / activist Groups											
Nil											
Business groups											
Quad bike king	X	X	X	X			X	X			X
Sand dune adventures		X	X				X	X		X	X
Sid Foggs Coaches			X	X					X		

Area of social influence

The term 'locality', or area of social influence (ASI), does not have a prescribed meaning or refer to a fixed, pre-defined geographic boundary. People may not perceive social impacts created by a project to be those felt exclusively in or immediately adjacent to the project boundary, or at a time when operations are conducted on site.

These time and space relationships between the project site and communities, economies, infrastructure, and resources (both human and natural), were explored using a mixed-methods approach. The methods were:

- semi-structured interviews with key Boral project personnel familiar with the existing operations on site and the local communities near the project;
- feedback from residents obtained during the early community engagement methods, in particular the in-person interactive methods; and
- analysis of historical correspondence records.

The development of the ASI considered factors including but not limited to:

- supply chains;
- haulage of sand products;
- transport of goods;
- materials and equipment;
- movement of workers (drive-in-drive-out/fly-in-fly-out working arrangements);
- natural features and recreational values (e.g. coastal sand dunes of Stockton Bight);
- ancillary infrastructure; and
- reputation of other extractive industries in the area.

Social impact assessment

At the completion of the scoping engagement activities, the project team possessed a thorough collection of feedback and questions raised by stakeholders. This collection was obtained from both the scoping engagement and further engagement activities. At this point in time the full collection of results was considered, and a decision was made about the SIA methods. It was evident that the feedback and questions raised during the scoping engagement activities, closely aligned with those raised in the 2019 further engagement.

Table 13.3 summarises the collection of stakeholder feedback and reflects the SIA method decisions.

Table 13.3: The collection of stakeholder feedback and the SIA method selected for the study

Engagement topic and stakeholder feedback	Social impact category (Guideline section 1.1)	Will a specialist study be conducted for the EIS?	Level of assessment for the social impact (scoping tool output)	SIA method(s) to be implemented for the assessment
Amenity (acoustic) Stakeholders did not raise any concerns about acoustic impacts from sources on site or from vehicles utilising the public road network	Health and wellbeing	Yes	No SIA required	Nil
Amenity (visual)	Surroundings	No	Standard SIA	Visual impact assessment

Engagement topic and stakeholder feedback	Social impact category (Guideline section 1.1)	Will a specialist study be conducted for the EIS?	Level of assessment for the social impact (scoping tool output)	SIA method(s) to be implemented for the assessment
Stakeholders did not raise any concerns about visual impacts associated with the project				Semi-structured interview
Access (road and rail network) Residents had minimal concerns with quarry related traffic or the network capacity	Access to and use of infrastructure, services and facilities	Yes	No SIA required	Further engagement and adaptive research approach in relation to the results of the traffic impact assessment
Built environment (public infrastructure) No stakeholder feedback was obtained in relation to the effect of the project on the quality of public infrastructure (i.e. road surfaces)	Access to and use of infrastructure, services and facilities	Yes	Standard SIA	Ethnographic content analysis
Heritage (natural features) There was no evidence to suggest that the sites current operations impact the Stockton Bight dune system or its recreational values	Surroundings	Yes	Standard SIA	Further engagement (consultation with Worimi LALC)
Community (safety) Site records confirm unauthorised site access (attempted and actual)	Health and wellbeing	No	Standard SIA	Participant observation
Economic (natural resource use and livelihood) The PEA established that natural fine sand derived from the quarry will influence supplies for local and regional development projects	Personal and property rights	Yes	Desktop SIA	Desktop research
Economic (livelihood) Boral staff stated that the project will extend the employment of locally-based quarry employees	Personal and property rights	Yes	Desktop SIA	Desktop research

Engagement topic and stakeholder feedback	Social impact category (Guideline section 1.1)	Will a specialist study be conducted for the EIS?	Level of assessment for the social impact (scoping tool output)	SIA method(s) to be implemented for the assessment
and provide additional employment.				

Ethnographic content analysis

Ethnographic content analysis (ECA) is a qualitative media analysis method used to obtain, categorise and analyse different media documents (such as newspapers and magazines) in addition to other forms of media delivered online and via television. It blends the traditional notion of objective content analysis with participant observation to form ethnographic content analysis.

ECA encourages the investigator to be reflexive and interactive, and it enables an element of ongoing discovery as progress is made towards the SIA research goal. It is in this vein that ECA enables documents to be studied to understand culture – or the process and the array of objects, symbols, and meanings that make up social reality shared by members of a society.

The most important element of ECA is the protocol, or a data collection sheet. It is a way to ask questions of a document; a protocol is a list of questions, items, categories or variables that guide data collection from documents.

The following ten steps were applied to articles from the *Port Stephens Examiner*:

1. Pursue a specific problem to be investigated – the scoping tool provided the social matters to be investigated.
2. Become familiar with the process and context of the information source. Explore possible sources of information – the *Port Stephens Examiner* was used as it is the most dominant and popular text media publication.
3. Become familiar with several examples of relevant documents and select a unit of analysis – the string ‘Sand trucks + Stockton’ was searched online and the five highest ranked articles (‘unit of analysis’) were read to recognise article layouts and other sections of the page.
4. List several categories (variables) to guide data collection and draft a protocol (data collection sheet) – categories that emerged from the articles discovered in Step 3 were entered into the protocol. The articles contained the following discourses:

    - excessive quarry trucks using public infrastructure.
    - negative impacts on families and schools.
    - additional truck movements (negative sentiment regarding road quality).
    - quarry operators should share road maintenance burden.

5. Test the protocol by collecting data from several documents – additional articles were collected using the string ‘Sand trucks + Nelson Bay Road’, which provided new discourses and the protocol was expanded accordingly.
6. Revise the protocol and select several additional cases to refine the protocol – the protocol was revised when all articles had been analysed by renaming, splitting, re-defining and merging categories as appropriate.
7. Arrive at a sampling rationale and strategy (e.g. theoretical, purposive, opportunistic, cluster or stratified) – theoretical sampling was used, which involves the selection of material based on emerging understanding of the topic under investigation and was used to identify and refine knowledge of narratives about the quarry over time. An eight-year range of articles was selected to capture cumulative social impacts emerging in the media narratives.
8. Complete data collection for the target social matters – the relevant search strings were applied and the collection of relevant *Port Stephens Examiner* articles continued in a sustained

and rigorous fashion until all articles returned via the online searches had been covered. At the completion of Step 8 the sample had been obtained, each article in the sample had been subject to a manifest content analysis, and the results from these analyses had been recorded in the protocol. The results provided a means to understand the implications of the project for the target social impact matters, via the discourses being circulated amongst the population.

9. Consider the content analysis results shown in the 'discourse' section of the protocol. Write summaries or overviews of the key findings – the individual results were considered, each discourse was summarised, and they were the key findings of the ECA.
10. Integrate the findings including the discourse interpretations and key concepts into the SIA report – refer to impact section.

Participant observation

Participant observation (PO) is a conventional method used in social sciences and provides a researcher with a means to collect data about cultural phenomena and the social settings in which they arise. In practice, this involves the researcher either openly or covertly examining the daily life of people under study.

The PEA identified unauthorised access to the quarry as a potential community safety risk. Despite mitigation measures (e.g. security fencing, high visibility line and signage, closed circuit television (CCTV), equipment and safe batter requirements, trespass procedures, and operating hours) being implemented by Boral, there have been safety incidents associated with members of the public accessing the quarry haul road to gain access to and from the beach. The SIA scoping phase concluded the prominent recreational dune user groups should be further engaged to assess this community safety matter.

It was determined that further engagement with the user groups was not feasible. On the advice of quarry staff, this is due to the fact that members of the public that travel on the public road towards the site and the few that attempt to seek to enter site without authority, are generally unidentified. The few that arrive to the quarry either recognise they are trespassing and leave quickly, or choose an access route that avoids contact with Boral staff. Their visit is fleeting in nature, and establishing a dialogue with them is rarely possible. As such, there is little prospect of engaging them further.

Due to this scenario, PO was selected for the SIA as an alternate method used to explore instances of potential or actual unauthorised access to the existing quarry. As an alternative to direct engagement with the public, it enabled the project team to collect and record data about the behaviour of the members of the public (i.e. the participants) travelling on the public road towards the quarry, including those who actually intended to enter the quarry.

Boral weighbridge staff volunteered their time to make observations about the participants. The weighbridge staff are permanently present at the entry to the quarry during operating hours, and have visibility of the entry either by direct sight or CCTV footage. Accordingly, they were positioned perfectly to make and record observations. The staff were provided with an overview of the method, advice about what observations were required for the SIA, recording instructions, and a template to collect the necessary data.

Visual impact assessment

Visual impacts are relevant to the 'surroundings' social impact category. Visual impacts were assessed (considered during the scoping phase) as Stockton Beach dune users could see the project site.

Observations (including photographs) were made of the dunes from a point higher than surrounding publicly accessible areas.

The significance of visual impacts was assessed by considering:

- Magnitude – the magnitude of visual change in the landscape and its proximity to the viewer. This is influenced by the visibility of the project/components and comprises the combination of scale, extent, distance and duration of views.
- Sensitivity – depends on the nature of the existing environment and on the likely response from people viewing the scene. Someone who is enjoying a recreational experience or someone who is viewing the scene from their living room is more sensitive to a view than someone passing by in a car.

Magnitude and sensitivity are ranked as:

- negligible – very minor loss or alteration to one or more key elements of the baseline visual character and/or introduction of elements that are consistent with the existing visual character;
- low – minor loss/alteration of one or more key elements of the baseline visual character and/or introduction of elements that are consistent with the existing landscape character;
- moderate – partial loss or alteration of one or more key elements of the baseline visual character and/or introduction of elements that may be prominent but not considered to be substantially uncharacteristic of the existing landscape character; or
- high – substantial to total loss of key elements of the baseline visual character and/or introduction of elements considered to be totally uncharacteristic of the existing landscape character.

The rankings can be determined by a combination of the factors in **Table 13.4**.

Table 13.4: Visual impact criteria

Criteria	Definition	Rating
Duration of view		
Long term	>1 hour	High
Moderate term	30 minute to 1 hour	Moderate
Short term	<30 minute	Low
Number of viewers		
High	>1,000	High
Moderate	100-999	Moderate
Low	<100	Low
Viewer sensitivity (type)		
Resident	N/A	High
Pedestrian/cyclist		Moderate
Motorist		Low
View sensitivity		
Pristine landscape	N/A	High
Moderately modified landscape		Moderate
Significantly modified landscape		Low
View distance/proximity		
Short	< 100m	High
Medium	100m-500m	Moderate
Long	>500m	Low

Semi-structured interview

Interviewing was used to explore and assess a number of matters identified in the scoping tool. An interview was conducted under a semi-structured format using a list of predetermined questions. The process involved:

- developing the pre-determined interview questions, designed to explore the social matters identified in the scoping tool;
- sending an interview invitation letter to the participant. The letter explained the purpose of the interview, the intention to record it, and provided some frequently asked questions. It explained that consent was required, and sought to obtain it in a 'free, prior and informed' fashion;
- obtaining participant consent;
- arranging a date and forwarding the participant an advanced copy of the predetermined questions;
- conducting and recording the interview;
- drafting and conducting a qualitative analysis of the interview transcript; and
- extracting transcript content for use in the SIA assessment.

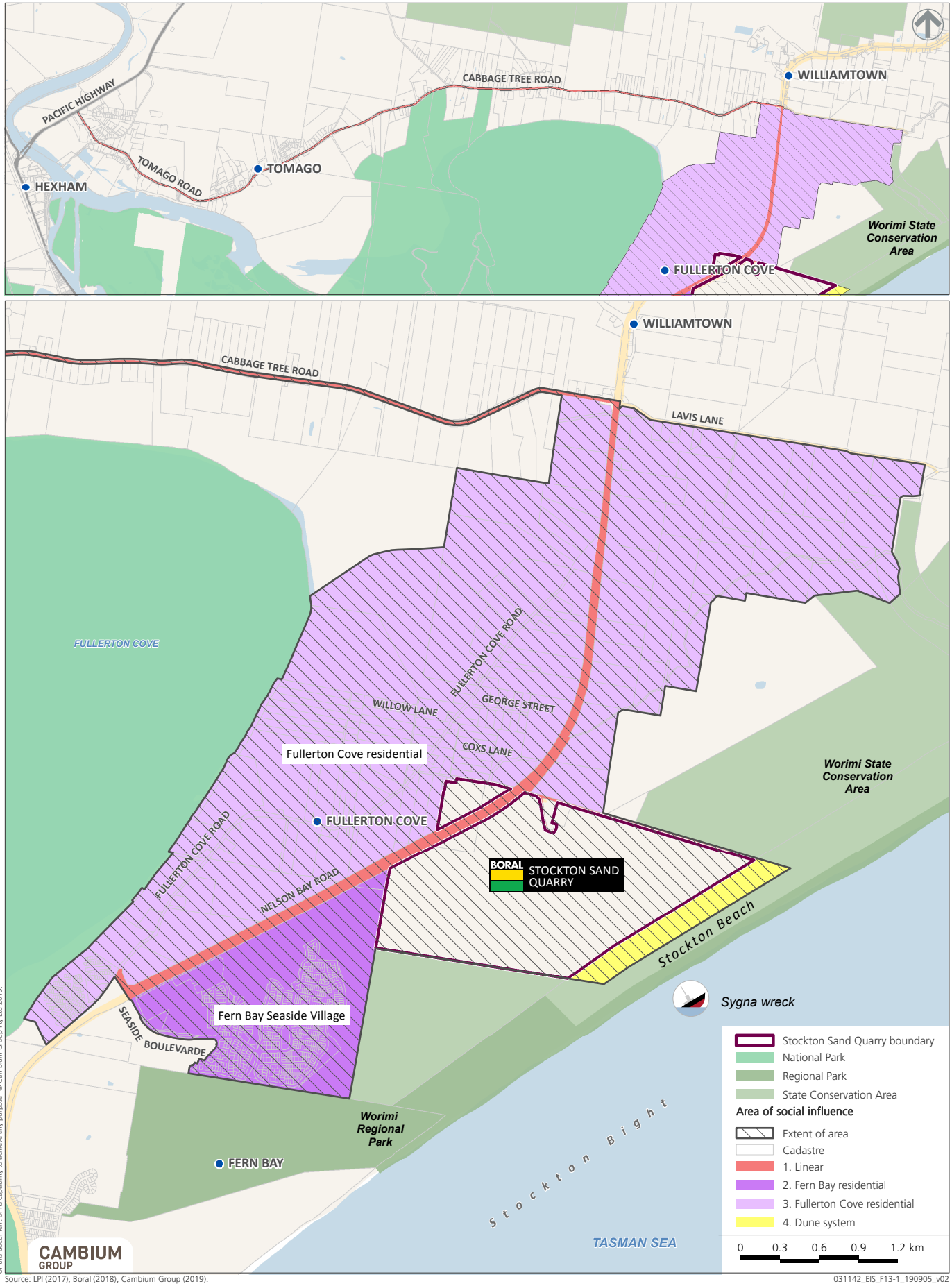
13.2 Results

13.2.1 Area of social influence

The ASI is illustrated in **Figure 13.1** and comprises a polygon containing the project site, the nearest communities including properties in Fern Bay and Fullerton Cove, and a small portion of the sand dune system adjacent to the project site. The polygon is also comprised of linear areas associated with the main transport routes proposed to be used by the project. These linear areas include Coxs Lane, and Nelson Bay Road from its intersection with Seaside Boulevard to its intersection with Cabbage Tree Road. There are no remote locations considered to be indirectly impacted.

Figure 13.1
Area of social influence

STOCKTON SAND QUARRY DREDGING
ENVIRONMENTAL IMPACT STATEMENT



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Source: LPI (2017), Boral (2018), Cambium Group (2019).

13.2.2 Early engagement

Engagement feedback was relevant to the SIA scoping phase and was used to consider what social impacts might warrant investigation.

Letter inviting feedback on Boral's operations

No response was received following the distribution of the letter to households near the project site. The survey contained a link to an online survey which invited all recipients to submit their opinions. No residents completed the survey.

Emails

Email correspondence was sent to councillors from Port Stephens Council to inform them about the consultation program for the project. One reply was received. The reply from a Councillor acknowledged the project and expressed gratitude for the update. It contained no specific feedback.

Interviews

Interviews with 31 residents (via random sample doorknock) living in Fern Bay and Fullerton Cove in March 2018 generated feedback about traffic and road infrastructure, noise, and access to Stockton Beach, as shown in Table 8 of **Appendix I**.

Newsletter

No response or feedback was received from recipients of a newsletter distributed to stakeholders in May 2018. The newsletter was distributed to Fullerton Cove and Fern Bay residents in hard copy, to members of Parliament (MP) offices via email, and online via the project website.

Meeting invitations

Members of the project team met with Kate Washington MP's staffers and briefed them about the project. The discussion was positive and the staffers were familiar with the issues relating to sand quarrying. The staffers raised one question about the project's implications for the water table. The project team responded that groundwater studies to date had not shown the project having a hydrogeological impact.

Council meeting

Members of the project team presented a briefing to Council officers in May 2018 and Councillors in July 2018. The material provided by the project team was welcomed by Council and no specific feedback was received.

Meeting invitations to Worimi LALC

Boral's National Indigenous Affairs Manager received no specific project feedback from Worimi LALC at their meeting in January 2018.

13.2.3 Further engagement

Stakeholders were further engaged during 2019 via the methods summarised in Table 8 of **Appendix I**. The full results of consultation were considered, which resulted in the selected SIA methods summarised in **Table 13.5**.

Table 13.5: Results of further engagement

Engagement activity	Feedback/question received by Project team
Written methods	
Project newsletter and community drop-in sessions notification	No specific feedback from stakeholders was received. It was concluded that it did not prompt a specific interest in the project. However, one community member who received the newsletter did attend the community drop-in session.
Community drop-in sessions notification	70 notifications were distributed via letter-box drop in Fern Bay, and 60 were distributed in Fullerton Cove on 7 February 2019. The residential block nearest to the project site was included in the distribution area. Following its distribution, no specific feedback from stakeholders was received.
Emails	Emails were sent to project stakeholders including the Port Stephens Mayor and councillors regarding the progress of the project. One Councillor replied via email to acknowledge receipt of the project team email. No specific feedback about the project was receive
Phone briefing (informal)	A member of the project team briefed the Port Stephens MP via telephone about the project during early February 2019. The Port Stephens MP confirmed she would like to meet the project team later in the year. The Port Stephens MP did not raise specific concerns about the project.
In person interactive methods	
Meeting – Chief Executive Officer (CEO) Worimi LALC	At the meeting between Boral's Indigenous Affairs Manager and the CEO of Worimi LALC, no concerns about the project were raised by the CEO. The CEO made a request for consultation to occur with five stakeholders whom are either neighbours of the project, part of the Indigenous community, representatives of NSW Government agencies, or a combination of these. The CEO also requested ongoing meetings as a means to receive project updates. Boral's Indigenous Affairs Manager agreed to the requests.
Site tour (Newcastle MP)	Members of the project team escorted the Newcastle MP during the visit. Boral staff provided details about the project and addressed questions raised by the Newcastle MP. No concerns were formally raised with the project team during or following the site tour.
Community drop-in sessions	The community drop-in sessions advertised locally and held on 14 February 2019 attracted only two community members (a husband and wife couple) from Fullerton Cove, who received the project newsletter and community drop-in sessions notification. Consequently, little data was collected from the sessions.
Consultation with resident	A member of the project team had a conversation with Fern Bay resident, following the traffic query he raised with a project consultant conducting field work adjacent to the project site. The project team member explained the proposal for project related traffic, and confirmed the quantity of proposed traffic movements. The resident was satisfied with the responses. Subsequent to the conversation, the project newsletter and community drop-in sessions notification, and the community drop-in sessions notification was provided to the resident via letter-box drop.

Engagement activity	Feedback/question received by Project team
Consultation with neighbours via doorknock	Refer to Appendix D of **Appendix I** for a summary of the consultations.
Media methods	
Website	No project related feedback was received via the website feedback form or via the contact phone number listed on the webpage.
Facebook campaign	The project Facebook post received some reply comments. Within three hours of being uploaded, the post attracted 10 'likes', one 'love', one 'share' and one positive comment from a quarry customer who was satisfied with the service he received from quarry staff. Later, it attracted one ‘angry’ emoji and two comments criticising sand extraction generally.

13.3 Impact assessment

The potential negative social impacts of the project are summarised in this section and are identified on the assumption there is no mitigation. Predicted positive impacts are also assessed.

13.3.1 Access to and use of infrastructure, services and facilities

This social impact category was identified as being relevant to the project and comprises the road and rail network, and public infrastructure. These were assessed in the traffic impact assessment (**Appendix H**), which was supplemented by the ECA methodology for the purpose of the SIA.

Road and rail network

As described in **Chapter 12**, the TIA found that:

- traffic impacts from the additional heavy vehicles associated with the project will not be significant on the adjacent road network;
- future cumulative traffic impacts associated with the project will not be significant;
- construction traffic impacts will not be significant; and
- the project will not negatively impact other road users including pedestrians, cyclists and public transport vehicles (buses), or road safety.

With the above considered, this social impact was assessed to have a low social risk rating during all stages of the project.

Public infrastructure

Public infrastructure (or the condition of local roads) was not identified during the scoping phase as a social matter relevant to the SIA. The condition of local roads was not raised by residents during the early or further engagement activities. However, acknowledging the increased volume of heavy vehicles proposed for the project and the absence of a traffic impact assessment during the scoping phase, a precautionary approach was adopted. This approach involved the implementation of a standard SIA, via the ECA method. The ECA results supplement the traffic impact assessment which has since been completed.

The following discourses emerged from the ECA, each conveying some negative sentiment (excluding item five) towards the social impacts of heavy vehicles using public infrastructure:

1. excessive number of quarry trucks using public infrastructure;
2. trucks have negative impacts on families and schools;

3. the introduction of additional truck movements (negative sentiment regarding road quality);
4. quarry operators should share road maintenance burden;
5. the introduction of additional truck movements (neutral sentiment regarding road quality);
6. negative impacts for community safety; and
7. sand haulage route debate.

Whilst heavy vehicles were a feature of each discourse, neither the project, the project location, or the ASI were their exclusive focus, and the discourses related to truck movements across the Port Stephens LGA, not specifically to heavy vehicles associated with the project. These observations have implications for the assessment of social impacts under the 'access to and use of infrastructure' social impact category. They suggest that the social impacts in question are cumulative, and are a result of the volume of heavy vehicles from across the region, using public infrastructure. That is, the collection of heavy vehicles sourced from multiple projects both in the ASI and beyond, are producing a negative social impact in relation to public infrastructure. Overall, the results of the ECA illustrate a social unease in relation to the collective volume of heavy vehicles, the introduction of additional truck movements, and the road maintenance burden created by heavy vehicles for public infrastructure across an area much broader than the ASI.

This social impact was assessed to have a moderate social risk rating during the operation of the project. This rating was applied on the prediction that the additional heavy vehicle traffic will likely contribute to the cumulative social impact evident in media articles and the ECA results, even if that impact was one perceived by the community.

13.3.2 Culture

Culture, comprising shared beliefs, customs, values and stories, and connections to land, places, and buildings (including Aboriginal culture and connection to country), was considered during the scoping phase and determined to be a social matter not impacted by the project.

13.3.3 Health and wellbeing

The 'health and wellbeing' social impact category is relevant to the SIA in relation to 'acoustic' amenity and 'community safety'.

Acoustic amenity

The scoping exercise determined that no SIA will be required to assess the acoustic amenity impacts of the project in addition to the noise impact assessment conducted for the EIS (refer to **Chapter 11**).

As described in **Chapter 11**, noise generated by the project and project related trucks on public roads will be below relevant noise criteria.

From a social impact perspective, the project is predicted to have a low social risk rating in all stages of the project. The risk is considered to immaterial and not requiring the implementation of a mitigation measure.

Community safety

The scoping exercise determined that a standard SIA will be required in the absence of any specialist study designed to investigate potential implications to public safety. The PO method was applied for this purpose.

During the PO exercise, quarry staff explained that Google maps currently provides directions to Stockton Bight and the Sygna wreck via Cox's Lane. This is likely to draw members of the public to the quarry entrance. Boral have requested that Google correct this and remove the directions

from their mapping software. The request was accepted, yet at the time of writing this EIS there is no change to this situation.

Results of the PO exercise show that 17 participant events were observed by the quarry staff. Of these, two events involved actual instances of unauthorised access to the quarry during the observation period, from early January to late March 2019. For all other instances, members of the public did not enter the quarry and there is every possibility that the participants involved were merely using the public road with no intention of accessing the quarry. They either turned away voluntarily at the quarry entry, some having read the signage on display, or were prompted by quarry staff to turn away.

The data were viewed in the context of the following research questions:

1. *Do the participants seem to be intentionally or unintentionally accessing site?*

PO results indicate that intentional or unintentional site access did occur albeit for a small percentage (12%) of the recorded instances.

2. *What was the known or predicted purpose of those people attempting to access the project site?*

The purpose of the persons who accessed the site without authority is known for only one of the two recorded instances, who was intending to access the beach. The purpose of the second person who accessed site is not known, as quarry staff were not able to have a conversation or determine with certainty what intention that person held.

The travel mode of persons who were potentially interested in site access on five occasions was travel by foot, horse and bicycle. The implied purpose in each case was recreation, however there is no evidence to verify this.

3. *Was the safety of those attempting to access the Project site put at risk?*

In the two instances of unauthorised site access, there was no immediate safety risk to the members of the public. The weighbridge staff were able to alert the members of the public to quarry operations, either by gesture or conversation, and advised them to leave the quarry in a safe manner. Members of the public then departed voluntarily. The cause of risk in these events rests entirely with members of the pubic who choose to undertake their recreational pursuits, whilst ignoring the prominent warning signage and/or communications of quarry staff.

After considering and assessing the PO results, a moderate social risk rating is considered to be adequate for the project.

13.3.4 Surroundings

Visual impacts and heritage (natural features) are relevant to this social impact category.

Impacts of the project on visual amenity were not assessed by a specialist. The scoping exercise determined a standard SIA was required comprising a semi-structured interview and the VIA method were applied

In relation to heritage (natural features), the interface between the Indigenous community and the dune areas adjacent the project formed a focal point of the scoping exercise. It was determined that further engagement with the Worimi LALC was required in relation to the heritage matter. This engagement was required in addition to the Aboriginal cultural heritage assessment (ACHA) process for the project (refer to **Chapter 5** and **15**).

Visual amenity

It was concluded during the VIA that given that recreational dune users are not authorised to breach the boundary rope and access the vantage point assessed, there is no option for them to gain a better vantage point of the quarry and project site, unless they access the site without authorisation. Therefore, the project will have negligible visual impacts.

The owner of a quad bike adventure company stated during the semi-structured interview that there will be negligible visual impacts from the project.

Based on the VIA, semi-structured interview, and engagement results, potential visual impacts will represent a low social risk rating and mitigation measures will not be required.

Heritage (natural features)

No feedback on social impacts from the project was received during further engagement with Worimi LALC. Boral's Indigenous Affairs Manager agreed to the CEO of Worimi LALC's request to include stakeholders in future communication campaigns.

Heritage impacts from the project represent a low social risk rating as the Worimi LALC and other Aboriginal persons were not concerned by the project and management measures will not be required.

13.3.5 Personal and property rights

Economic impacts (use of natural resources and livelihood) were identified under this social impact category.

Economic (natural resource use)

There is a shortage of natural fine sand supply in the local and regional economy, and it is relevant to the SIA that the project will provide a partial remedy to this situation. Natural fine sand is an essential component to construction materials and consequently, to local and regional development projects. The project presents an opportunity to maintain supply at a cost-effective price.

As highlighted by the economics assessment summarised in **Chapter 21**, it is predicted that the project will yield a positive impact from an economic (natural resource use) perspective. This prediction is made on the basis that the level of interest, scale of benefit, equity in the distribution of the benefit, and likelihood of the benefit is forecast to be high.

Economic (livelihood)

An obvious positive impact of the project will be the extension of local employment for the current quarry employees, and the employment of additional staff and subsequent flow on effects.

Interviews with Boral management confirmed the current quarry employees are locally based.

Although the current workforce is not large, it must be recognised that the maintenance of employment for a single staff member will enable an income for the household unit of that employee. In this scenario, the number of people benefitting from the project will be larger than the individuals employed by the project. Employment for the project workforce will ensure income for the associated families (or housemates as the case may be).

Considering the information obtained from the economics assessment for this aspect of the SIA, a positive 'economic (livelihood)' social impact for the local population is predicted. The level of interest, scale of benefit, equity in the distribution of the benefit, and likelihood of the benefit is forecast to be moderate.

13.3.6 Decision making systems

Decision-making systems is the social impact category that relates to the influence that individuals have on decisions that affect their lives, and access to complaint, remedy and grievance mechanisms. Decision making systems were considered during the scoping phase and determined not to be a social impact affected by the project.

13.3.7 Fears and aspirations

Fears and aspirations, comprising fears about the future of the communities surrounding the project, was considered during the scoping phase and determined to be a social impact not affected by the project.

13.3.8 Summary

Positive and negative social impacts are summarised in **Table 13.6**.

Table 13.6: Predicted positive and negative social impacts

Social impact type	Social impact category	Predicted social impact
Positive	Personal and property rights.	Mitigation of a potential shortage of natural fine sand supply in the local and regional economy.
		Employment benefits in the form of income for quarry employees and their households.
Negative	Access to and use of infrastructure, services and facilities.	Community perception of cumulative impacts to road quality caused by heavy vehicles, per the ECA results.
	Health and wellbeing.	Personal safety impact to members of the public that access site without authority.

13.4 Management measures and residual impacts

The below measures and those summarised in **Table 13.7** will be implemented to minimise the predicted negative social impacts of the project.

13.4.1 Access to and use of infrastructure, services and facilities

When the EIS is placed on public exhibition it is recommended that:

- Fullerton Cove residents will be notified in writing about exhibition of the EIS, the increased heavy vehicle volumes derived from the project, where these matters are addressed in the EIS, SIA and technical studies, how/where they can easily view the documentation, and an invitation to contact Boral to discuss any residual or additional concerns they may have; and
- Boral will place a notice on the project webpage (and send the web link to the notice via other media channels typically used throughout the SSD stakeholder engagement process) to notify of the EIS exhibition process as outlined above.

During the above, Boral will outline the:

- increase in heavy vehicle numbers proposed for the road network; and

- high-level results of the road safety audit.

13.4.2 Health and wellbeing

The SIA concluded that potential personal safety risks remain in relation to unauthorised site access. Boral has taken all reasonable and necessary steps to ensure the security of the site and the safety of the public. Staff efforts and quarry features include security fencing and lockable gates, high visibility line and signage, CCTV, equipment and safe batter requirements, trespass procedures, and operating hours, yet a small number of people continue to access site without authority

With other options exhausted, the initial request made to Google will be repeated with the objective of removing the Stockton Bight route (via the quarry) from Google maps. Achieving that objective will potentially dissuade members of the public from attempting to access the quarry without authority.

Table 13.7: Summary of negative impacts and management measures

Social impact category	Impact description			Impact without mitigation		Impact with mitigation		
	Impact	Timing	Affected parties	Impact characteristic	Social risk rating	Mitigation	Social risk rating	Residual risk description
Access to and use of infrastructure, services and facilities	Impact to condition of public road network	Operational	Road users (road network utilised by the project)	Cumulative (perceived or actual) risk of additional heavy vehicle traffic affecting road quality	Moderate	Written notification about the availability of the EIS on exhibition, including the dissemination of EIS information about project heavy vehicles	Low	Low
Health and wellbeing	Impact to personal safety	Operational	Unauthorised community members	Personal safety risk from unauthorised site access	Moderate	The initial request made to Google is repeated with the objective of removing the Stockton Bight route (via the quarry) from Google maps	Low (if Google maps is corrected)	Low and immaterial (if Google maps is corrected)

13.4.3 Management framework

The mitigation measures summarised in **Table 13.7** will be implemented as part of a broader management and monitoring framework for the quarry. A range of management plans will be developed as part of the quarry operations, and those addressing safety issues will assist with the management of the negative project impacts identified in **Table 13.6**. The management plans include the:

- environmental management strategy.
- air quality management plan.
- safety management plan.

Aside from the various management plans, performance measures applicable to the management framework are listed in **Table 13.8**, along with the measure type defined in the DPIE assessment and mitigation framework (NSW Department of Planning and Environment, 2017). Community sentiment derived from stakeholder feedback exists as a performance measure and is additional to those listed in **Table 13.8**.

Table 13.8: Management framework for social impacts

Social impact category	Objectives	Affected parties	Actions	Performance measures	Measure type
Access to and use of infrastructure, services and facilities	Counter cumulative and perceptual risk of increased heavy vehicle volumes	Road users (roads surrounding the project)	Written EIS exhibition notification to Fullerton Cove residents	Distribution of notifications to neighbours during EIS exhibition	Performance-based2F
			Provision of a notification via web link, to disseminate EIS information about Project heavy vehicles	Distribution of social media post and print media	Prescriptive3F
Health and wellbeing	Mitigate personal safety risks for people attempting to access the quarry without authority	Unauthorised community members	Repeat the initial request to Google with the objective of removing the Stockton Bight beach route (via the quarry) from Google maps	Google maps is accurate	Prescriptive

13.4.4 Monitoring

A social impact monitoring framework will apply to the project. Monitoring results will be disclosed via the submission of an AEMR prepared and submitted to DPIE in accordance with conditions of the new SSD approval and will include reporting on all key matters assessed in the EIS.

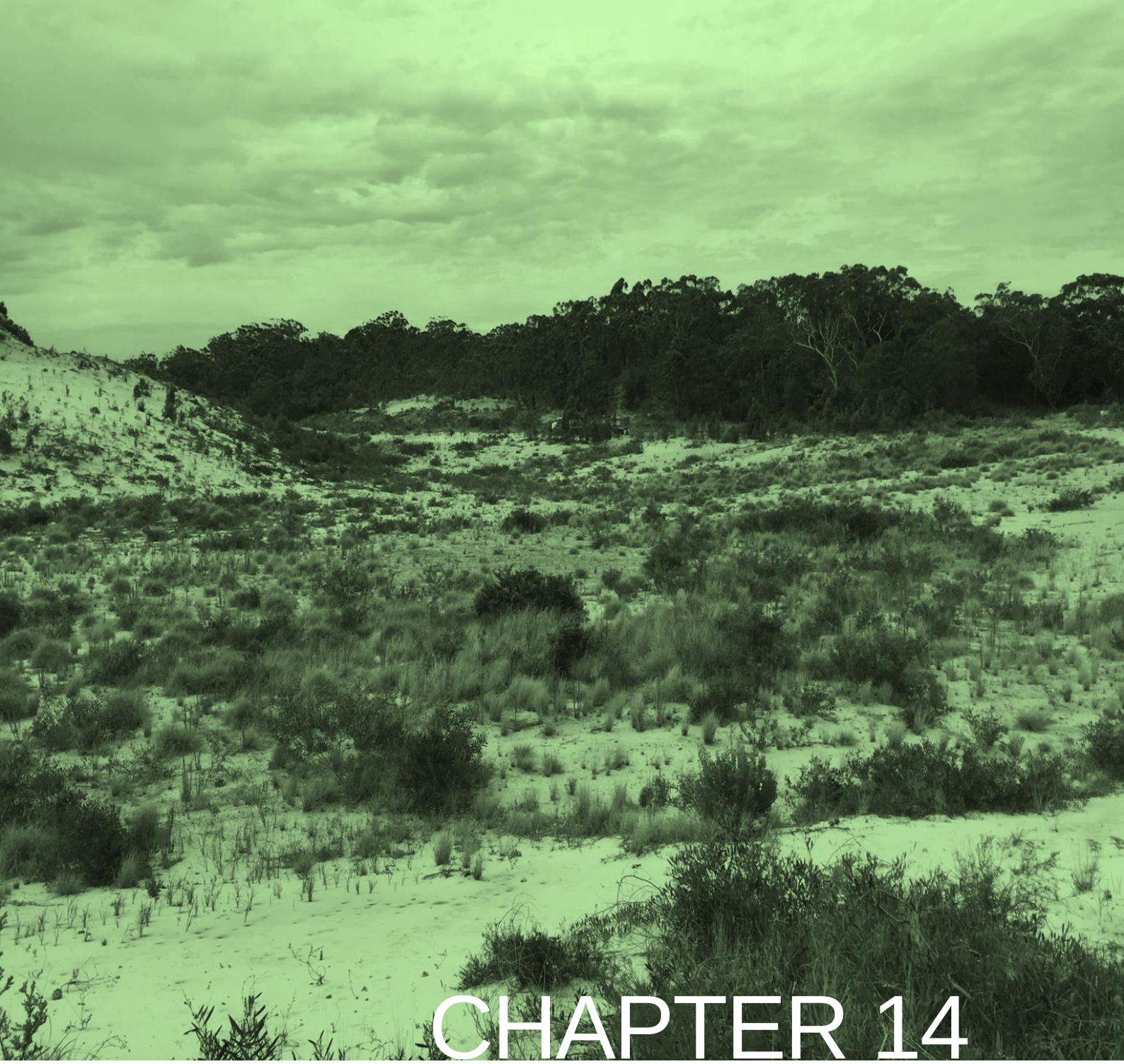
Table 13.9 outlines the social issues which will be monitored to ensure compliance and meet the social objectives. In accordance with the Guideline, the table outlines the:

- key social issues to be monitored;
- how and when monitoring data will be collected; and
- community participation.

Although not included in **Table 13.9**, the project complaints register is an additional data source that applies to each social issue and provides value to the monitoring framework. The register will continue to operate and provide data in relation to each social issue should a complaint be submitted.

Table 13.9: Monitoring framework for social impacts

Social impact category	Social issue	Data source	Data availability / frequency
Access to and use of infrastructure, services and facilities	Road user satisfaction	Council feedback	As available
		Feedback received via Boral corporate communications channels or quarry staff	
Health and wellbeing	Community safety	Quarry staff and CCTV	Constantly during business hours (weighbridge staff) and after hours (CCTV)



CHAPTER 14

SOILS AND LAND RESOURCES

14 SOILS AND LAND RESOURCES

This chapter summarises the potential impacts to soils and land resources at the site and surrounding locality.

14.1 Assessment guidelines and requirements

The SEARs require a consideration of the project to impact soils, landforms and the coastal environment (**Table 14.1**).

Table 14.1: Soils and land resources SEARs

Requirement	Section and appendix where addressed
potential impacts on the broader coastal environment and dune system;	Section 14.2.1, Section 14.3.2
potential impacts on soils and land capability (including potential erosion and land contamination);	Section 14.3.1, Section 14.3.3, Section 14.3.4
potential impacts on landforms (topography), paying particular attention to the long term geotechnical stability of any new landforms;	Section 4.2.5 and Section 14.3.1

14.2 Soil resources

14.2.1 Soil landscape

As outlined in **Section 2.5.5**, most of the project is confined to the Boyces Track soil landscape unit, with the central southern portion of the project site encompassing the Hawks Nest soil landscape unit.

14.2.2 Acid sulfate soils

The ASS maps in the Port Stephens LEP 2013 categorise most of the project site as risk Class 4 (in which ASS is likely to be found beyond two metres depth), while pockets of the southern extent of the proposed extraction area are mapped within risk Class 3 (in which ASS is likely to be found beyond one metre depth).

The project site was also reviewed in the Port Stephens 1:50 000 Acid Sulfate Soils Map (1996) produced by NSW Department of Land and Water Conservation. The project site is in an area of low probability of ASS occurring. The southern boundary of the project site has low probability of ASS between 1-3 m Below Ground Level (BGL) whilst the remainder and majority of the project site has low probability that ASS occurs >3 m BGL.

There is potential for exposed sediments generated by potential lowering of the water table or via bulk sand extraction to form acid upon oxidation. Therefore, the potential for ASS to occur was assessed (**Appendix J**).

Four boreholes were drilled in the project site to depths between 18-24 m BGL. One soil sample was obtained, and field pH and peroxide were tested every change in lithology in the borehole profile.

Of the 44 soil samples collected and analysed from within the project area only one returned a moderate risk of ASS. The risk for ASS was identified in BH2 at a depth between 2.0 m to 2.5 m

BGL. The borehole is located within the northern portion of the project site in a low-lying swale with organics noted in the lithology at the same depth. Soil samples obtained above and below this depth in the borehole did not indicate ASS potential, and as such it was concluded the potential for ASS at the identified depth was a localised occurrence. Other than the one moderate risk of ASS identified, the remainder of the project site is not identified at risk of ASS.

There is low risk of oxidation of possibly localised of potential ASS as most of the water will be returned to the pond during dredging. Returning the water to the dredge pond will prevent lowering of the water table and exposure of potential ASS to air. Furthermore, recharge is rapid in the dune lithology, further preventing impacts to groundwater in and across the project site and beyond.

No fine sediments such as clays, silts, or estuarine muds were observed in the soil profiles. This occurrence further reduces the risk for PASS being oxidised as sulphides typically reside in the finer grained sediments.

The extracted sands will pass through a sluicing device where finer grained materials, if present, will drain back into the dredge pond. This will reduce the risk of any localised finer grained sediments oxidising into potential ASS.

An ASS management plan will be prepared and implemented for the project in accordance with ASSMAC's (1998) *Acid Sulfate Soils Assessment Guidelines*.

14.3 Land resources

14.3.1 Landform and topography

The extraction of sand associated with the project would alter existing landform and topography in the project site. As it would not be possible to reinstate the pre-existing landform and topography of the project site following completion of the project, the final land use of the project site would aim to ensure that all landforms are adequately stabilised. As highlighted in **Section 4.2.5**, geotechnical advice has been obtained pertaining to design of the dredge pond to ensure that landforms are stabilised both above and below the water surface. This coupled with an adequate rehabilitation program (as described in **Chapter 22**) would ensure that the final landform remains stable and is less susceptible to erosion via wind and rainfall into the future.

14.3.2 Coastal dune environment

The project will not impact the beach, foredune, deflation basin and mobile transverse dunes of Stockton Bight as the project site is physically removed from, and downwind of these environments (Coastal Studies, 2019). There is a buffer of at least 300 m of vegetated dunes between the southern boundary of the project site and the mobile (Phase II) dunes, and this is more than sufficient to physically isolate the project from these environments.

Likewise, the project will not impact the existing sand transported along the beach and in the active mobile (Phase II) dunes as the project site is isolated from these environments. The vegetated Phase I and II dunes that surround the project site will be graded, battered and vegetated to ensure their stability as part of the rehabilitation of the project site. Once the vegetation is established, the dunes will remain stable and well vegetated (Coastal Studies, 2019).

In regards to dune morphology, the project site will be surround by 5-20 m high sand dunes covered in remnant native vegetation, with at least a 300 m wide vegetated zone between the project site's southern boundary and the bare mobile (Phase II) dunes, and at least a 1.3 km wide buffer from the Stockton Bight shoreline. These buffers are more than adequate to protect the

project site from windblown sand and shoreline erosion and/or marine inundation (Coastal Studies, 2019).

14.3.3 Land capability

Land capability is the inherent physical capability of land to sustain a range of land uses and management practices in the long term without degradation to soil, land, air and water resources.

Land in the project site was previously assessed and mapped for land and soil capability according to *The Land and Soil Capability Assessment Scheme: Second approximation. A general rural land evaluation system for New South Wales* (OEH, October 2012) (the scheme).

This scheme uses the biophysical features of the land and soil including landform position, slope gradient, drainage, climate, soil type and soil characteristics to class land into one of eight classes (Class 1 to Class 8). Land capability class indicates the level of land management required to sustain a potential land use, without causing degradation to the land and soil. General definition of the eight land capability classes is presented in **Table 14.2**.

Table 14.2: General definitions of land capability classes

Class	General definition
Land capable of a wide variety of land uses (cropping, grazing, horticulture, forestry, nature conservation)	
1	Extremely high capability land: Land has no limitations. No special land management practices required. Land capable of all rural land uses and land management practices.
2	Very high capability land: Land has slight limitations. These can be managed by readily available, easily implemented management practices. Land is capable of most land uses and land management practices, including intensive cropping with cultivation.
3	High capability land: Land has moderate limitations and is capable of sustaining high-impact land uses, such as cropping with cultivation, using more intensive, readily available and widely accepted management practices. However, careful management of limitations is required for cropping and intensive grazing to avoid land and environmental degradation.
Land capable of a variety of land uses (cropping with restricted cultivation, pasture cropping, grazing, some horticulture, forestry, nature conservation)	
4	Moderate capability land: Land has moderate to high limitations for high-impact land uses. Will restrict land management options for regular high-impact land uses such as cropping, high-intensity grazing and horticulture. These limitations can only be managed by specialised management practices with a high level of knowledge, expertise, inputs, investment and technology.
5	Moderate–low capability land: Land has high limitations for high-impact land uses. Will largely restrict land use to grazing, some horticulture (orchards), forestry and nature conservation. The limitations need to be carefully managed to prevent long-term degradation.
Land capable for a limited set of land uses (grazing, forestry and nature conservation, some horticulture)	
6	Low capability land: Land has very high limitations for high-impact land uses. Land use restricted to low-impact land uses such as grazing, forestry and nature conservation. Careful management of limitations is required to prevent severe land and environmental degradation.
Land generally incapable of agricultural land use (selective forestry and nature conservation)	

Class	General definition
7	Very low capability land: Land has severe limitations that restrict most land uses and generally cannot be overcome. On-site and off-site impacts of land management practices can be extremely severe if limitations not managed. There should be minimal disturbance of native vegetation.
8	Extremely low capability land: Limitations are so severe that the land is incapable of sustaining any land use apart from nature conservation. There should be no disturbance of native vegetation.

Broadscale regional land and soil capability mapping by the scheme identified the majority of the project will be in Class 8, meaning that the land has extremely low capability and is incapable of agricultural land use.

The central southern portion of the project is mapped as Class 5, resulting in moderate to low capability and potential for limited agricultural land use such as grazing land.

Given the project will be in a previously disturbed quarry pit, coupled with low land capability classes (5 and 8), the project will have minimal negative impact on the overall land capability, and use of the site for extractive industry will not detract from other agricultural land use.

14.3.4 Land contamination

Historic excavation in the project site associated with the inland extraction area did not involve contaminating activities or incidents, and the secure nature of the site has ensured that there has been no dumping of illegal waste or disposal of hazardous materials in the project site.

There will be low potential to disturb contaminated land given historical land use at the project site, which comprised vegetation clearing and sand extraction at the inland extraction area. Disturbed areas were rehabilitated when sand extraction ceased in 2008. Notwithstanding, there could have been localised spills and leaks from equipment. However, given the project site has replenished with windblown sand, the potential for remnant contaminated material will be low.

The project could contaminate soils by hydraulic oil leaks from equipment. Mobile machinery will be parked overnight at the depot. The concrete floor will ensure no soil or groundwater contamination from oil leaks.

All vehicles will be refuelled off-site or within the bunded fuel storage and distribution facility in depot.

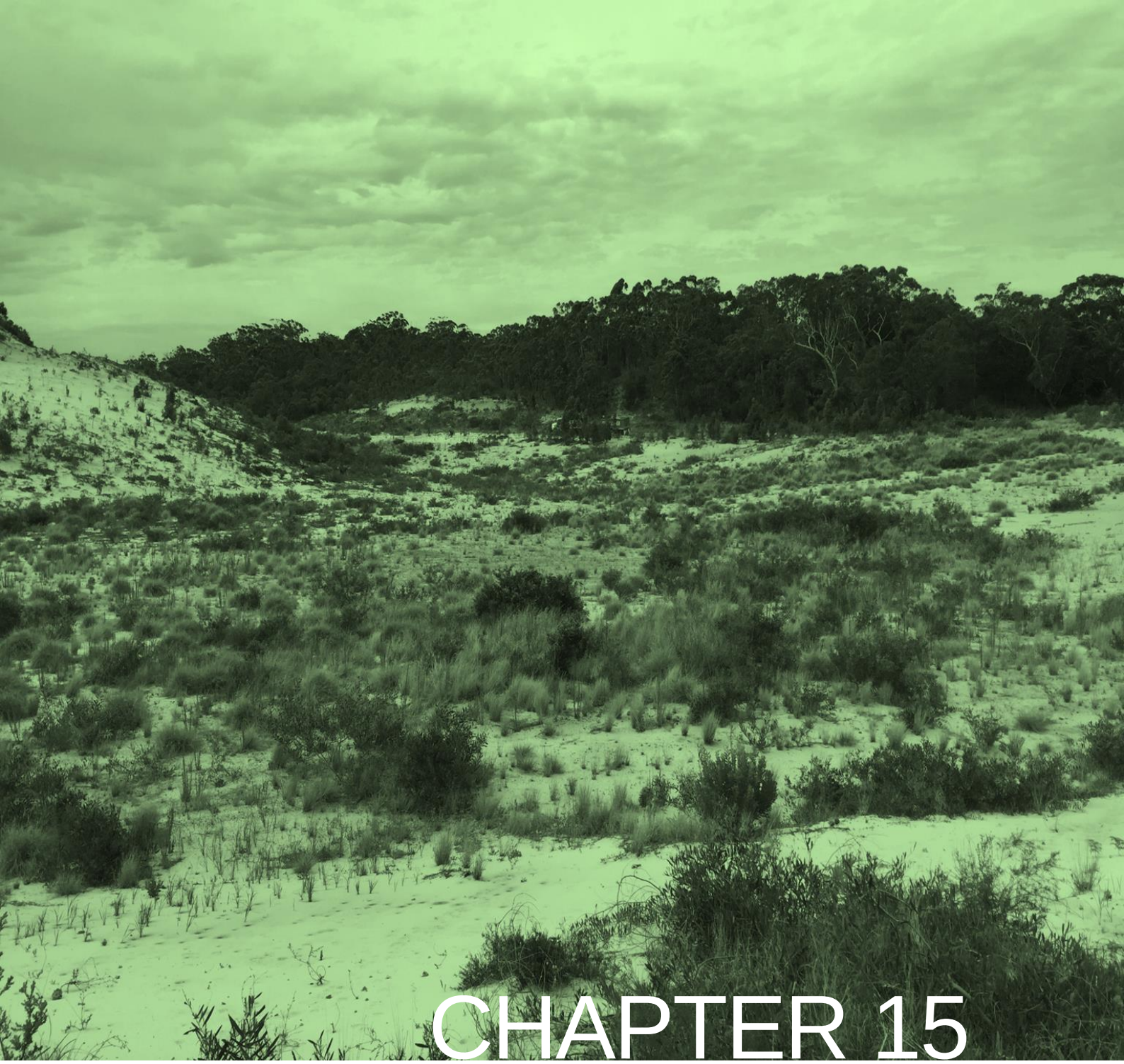
Personnel will regularly check and maintain machinery to minimise the risk of oil leaks.

Given the low risk of contamination, no further assessment of contaminated land or land remediation is required.

Exposure to unexpected contaminated soil and/or materials could pose a health risk to site personnel and impact the wider area if the contaminant migrates. Contamination entering waterways can pose a threat to aquatic ecology, water quality and the wider community. It is an offence under the POEO Act to cause contamination or spread contaminated material.

If previously unidentified contaminated materials are encountered during construction and operation of the project, relevant statutory requirements, including potential soil testing and waste classification, will be complied with, and the material managed and disposed of appropriately.

The mitigation measures in **Section 20.3** will be implemented to contain, remove and remediate contaminated material if there is a leak or spill.



CHAPTER 15

ABORIGINAL HERITAGE

15 ABORIGINAL HERITAGE

15.1 Introduction

This chapter summarises the ACHA report, which is in **Appendix K**. It describes the cultural context of the project site, consultation with the Aboriginal community, study methods, findings of field surveys, potential impacts and mitigation measures to minimise the potential for harm to unidentified Aboriginal objects.

15.1.1 Assessment guidelines and requirements

The SEARs require an assessment of the likely impacts of the project on Aboriginal cultural heritage (**Table 15.1**).

Table 15.1: Aboriginal heritage SEARs

Requirement	Section and appendix where addressed
an assessment of the potential impacts on Aboriginal heritage (cultural and archaeological), including evidence of appropriate consultation with relevant Aboriginal communities/parties and documentation of the views of these stakeholders regarding the likely impact of the development on their cultural heritage	5.4, Appendix K

15.1.2 Overview of assessment methods

The following assessment methods were used during the ACHA.

Desktop study

The AHIMS database was searched (July 2019) to identify any registered Aboriginal sites or places in the project site or surrounds.

Environmental features which could influence historic Aboriginal occupation of the locality were characterised, for example landscape, drainage, geology, soils, vegetation, fauna and climate.

Literature such as previous heritage assessments of the quarry and local area were reviewed to understand historical Aboriginal use of the area and customs.

Information gathered from the desktop study was used to develop a predictive model of what types of Aboriginal sites are likely to occur in the project site and the landforms they may be associated with.

Aboriginal consultation

Aboriginal parties were consulted in accordance with OEH's (2010) *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010*. Sixteen Aboriginal groups or individuals registered their interest (RAPs) in the project and contributed cultural knowledge and archaeological expertise to the Aboriginal heritage assessment process.

Archaeological survey

The project site was surveyed by an archaeologist and the RAPs, which targeted ground exposures. The site inspection aimed to identify Aboriginal objects or sites (if present), assess the archaeological potential and sensitivity of the Project site, and confirm the nature and extent of previous disturbance associated with the former inland extraction area.

Any potential Aboriginal sites were to be photographed, and their locations recorded using global positioning system units.

15.1.3 Results

Desktop study

The search of AHIMS and review of background information revealed there were no known Aboriginal archaeological sites in the project site. The potential for subsurface Aboriginal archaeological material in the project site is considered low and potential has not been indicated by previous archaeological investigations. The project site is generally highly disturbed due to previous disturbance associated with sand extraction.

Archaeological survey

Visual inspection of the project site confirmed the extent and nature of previous disturbance. Previously disturbed areas had little to no archaeological potential given the previous removal of the dune mass to 5 m AHD. Ground surface exposure varied from high to low, with archaeological visibility obscured by vegetation and disturbed sands.

Large sections of the former dunes are absent, with the expansion of the central low-lying basin landform following extraction. The adjoining slopes to the west have also been modified as part of rehabilitation. The reinstated higher elevation slopes and crests to the south and west are heavily vegetated with native regrowth. Aerial imagery from 2004 shows the widespread disturbance prior to the rehabilitated landform.

Topsoil has been reintroduced to a number of areas and surface exposures were infrequent, and where present the visibility was generally low. No shell midden material or Aboriginal objects were observed in these areas. Scattered introduced fill and other rubble was also present on the surface in some of the larger exposures.

Ground disturbance from tracks and the former haul roads was evident in the central basin formed by the previous inland extraction area. Areas of lower disturbance along the southern margin of the project site (where a haul road is proposed) were closely inspected but no archaeological sites or areas of potential were identified.

Other areas of lower disturbance associated with the remnant slope/crest landforms on the edges of the former inland extraction area were closely inspected, but no archaeological material was identified despite frequent exposure and localised disturbance of the ground surface.

In summary, no archaeological sites, Aboriginal objects or areas of Aboriginal archaeological potential (such as shell material) were identified within the project site. The archaeological potential for subsurface archaeological deposits was assessed as very low to nil given the extent of previous disturbance and the findings of previous archaeological assessments.

Therefore, further detailed investigation (test excavation) was not warranted to determine the nature, extent and significance of any archaeological sites and potential archaeological deposits in the project site.

15.2 Significance assessment

15.2.1 Overview

The heritage values held by communities are an important management consideration, with the values collectively called ‘cultural significance’. The ACHA assessed potential impacts of the project as outlined in Section 7.1 of the ACHA.

15.2.2 Statement of significance

The wider area has cultural value for the local Aboriginal community. The identified cultural value is a feeling of attachment and responsibility for the land. RAPs have expressed that traditional knowledge indicates significant areas in the surrounding dune field (outside of the Boral landholding and project site).

To date, no areas of Aboriginal cultural significance have been identified in the project site. Stakeholders concurred with the assessment of severe levels of disturbance in the project site. The project site does not display any identified archaeological, historic or aesthetic significance in relation to Aboriginal heritage values.

15.3 Impact assessment

A review of background information revealed there were no known Aboriginal archaeological sites in the project site. The potential for Aboriginal archaeological material in the project site is low and has not been indicated by previous archaeological investigations.

The potential for subsurface midden sites has consistently been assessed as low and extensive previous investigations across the quarry have not detect any subsurface shell deposits or archaeological material.

Previous extraction for the inland extraction area is likely to have removed any once present archaeological material associated with the earlier Holocene foredune ridge plain at 5-10 m AHD. Given the indications from previous studies that midden material within the Phase I and II dune field occurs within the top 50 cm of the soil profile, the potential for deposit associated with these geomorphological elements has also been removed. The project site is therefore unlikely to contain any buried deposits associated with Aboriginal occupation.

The archaeological survey confirmed the extent and nature of previous disturbance, and no Aboriginal objects, archaeological sites or areas of archaeological potential were identified. Areas of lower apparent disturbance (remnant slope/crest landforms on the edges of the former inland extraction area) were closely inspected but no archaeological material was identified despite frequent exposure and localised disturbance of the ground surface.

The project site does not display any scientific / archaeological significance as does not contain any identified Aboriginal archaeological sites or areas of potential. The wider landscape encompassing the quarry retains Aboriginal cultural value and significance, including nearby traditional areas, movement routes, flora and fauna communities, natural landscape values and the linkages the landscape provides to ancestors and storylines.

The configuration of the project has been developed having regard to the constraints of the land, the desire to mitigate and avoid impacts where possible, whilst balancing the commercial viability of the project and the extent of the known resource. The project seeks to capitalise on sand availability within the area of existing and previous operations, maximising output from existing production facilities. This results in a smaller disturbance footprint and minimises environmental impacts compared to expansion into un-quarried adjacent areas within the wider quarry.

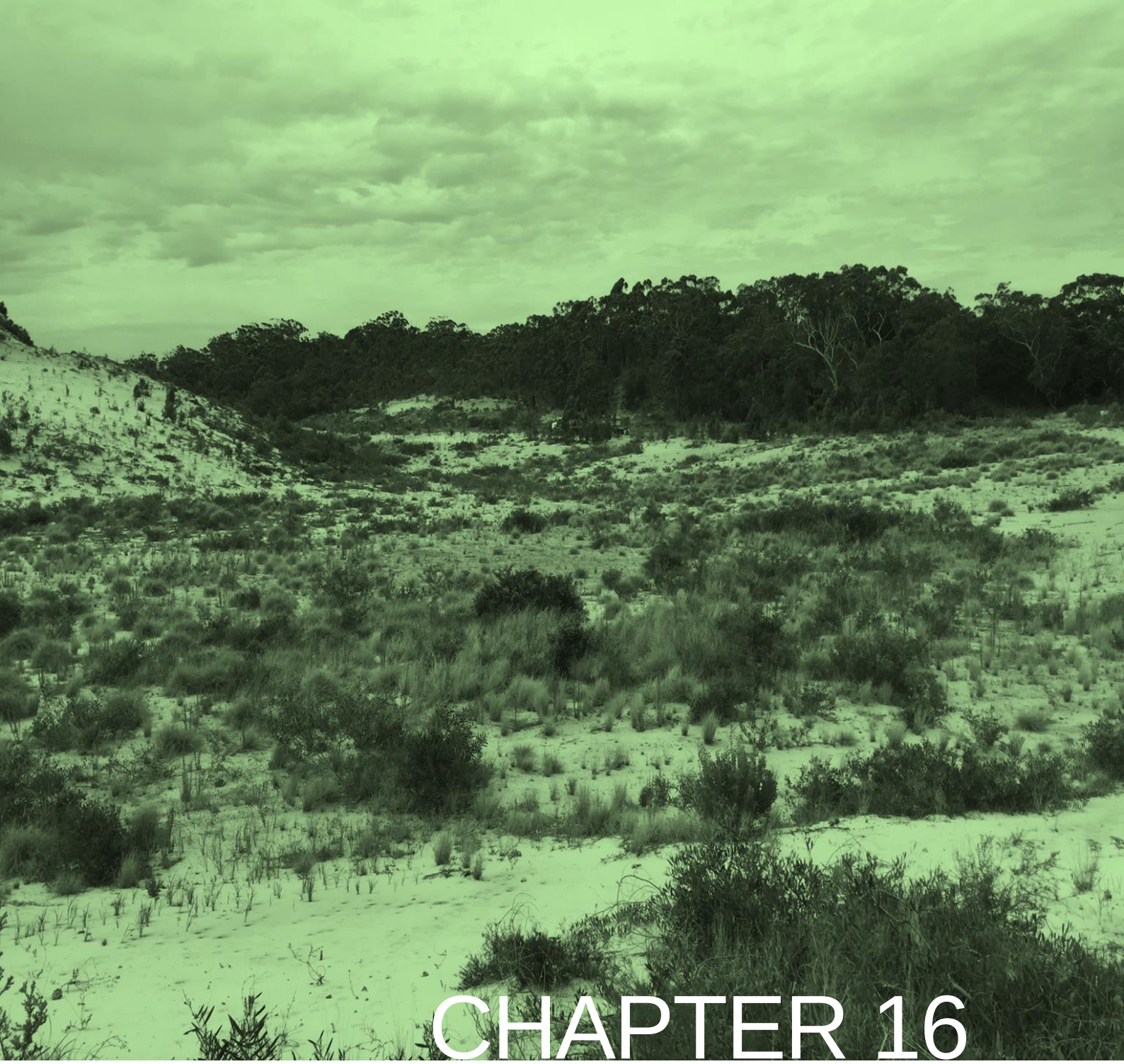
Impact to intrinsic Aboriginal cultural values of the surrounding landscape will also be minimal.

15.4 Management and mitigation measures

Despite no impacts to Aboriginal heritage values resulting from the project, Aboriginal objects are known to occur in adjacent landforms and these must be avoided by all project operations. The boundary of the approved project site will be clearly delineated and Aboriginal heritage considerations will be included in the environmental management strategy.

Documented toolbox talks will also be held to ensure all on-site staff and contractors are aware of obligations and requirements regarding the protection of Aboriginal heritage.

An unexpected finds and human remains procedure will be implemented during the project as summarised in Section 9.3 and 9.4 of the ACHA.



CHAPTER 16

VISUAL

16 VISUAL

16.1 Introduction

This chapter considers the nature, extent and significance of the potential visual impacts of the project with reference to the range of public and private places that could be affected.

16.1.1 Assessment guidelines and requirements

The SEARs require an assessment of the likely risks of the project to the visual amenity of the surrounding locality (**Table 16.1**).

Table 16.1: Visual related SEARs

Requirement	Section and appendix where addressed
an assessment of the potential visual impacts of the development on private landowners in the vicinity of the development and key vantage points in the public domain, paying particular attention to any new landforms.	16.3

16.2 Existing environment

The project site is situated at approximately 5 m AHD which is below the level of the surrounding dune system. The dunes, combined with the established vegetation, work together to prevent a direct line of sight between adjoining private and public land to the project site.

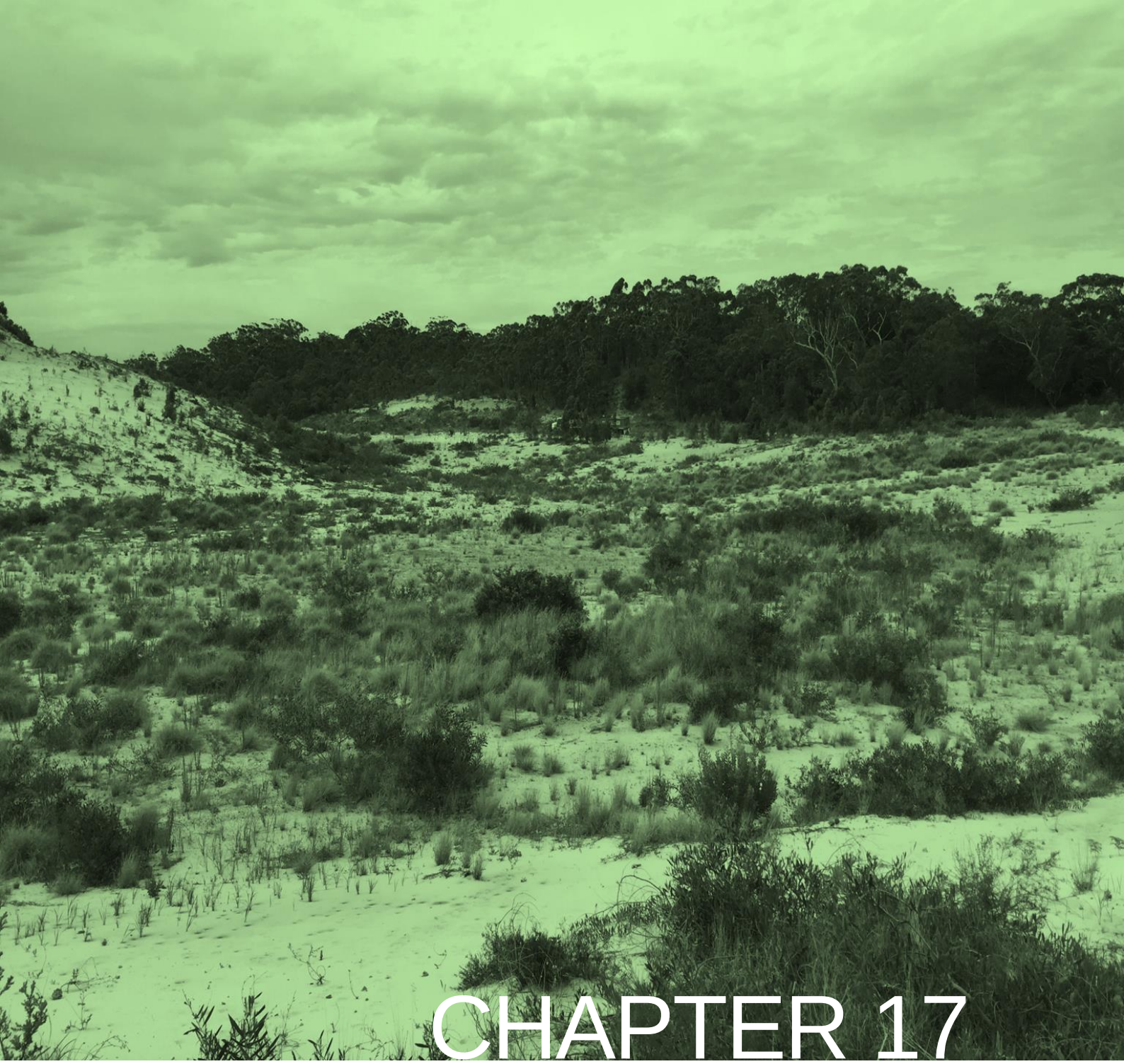
16.3 Potential impacts

The project site will not be visible from Nelson Bay Road or surrounding residential areas.

The project may be partially visible to recreational users accessing the top of the remnant hind dune directly adjacent to Boral's consent boundary. However, the project will only be partially visible from this viewpoint during the initial stages of sand extraction, and following extraction of the existing dune profile, the proposed dredge pond will be formed in a low point shielded by vegetation between the project and hind dunes. As a result, dredging operations will be shielded from potential viewpoints of recreational users of Stockton Bight.

With the above considered, the only likely viewpoint of the project for the public will be along a discrete section of Stockton Bight beach immediately adjacent to the quarry boundary, with temporary views confined to the highest elevation of the project site. As this area is quarried, the remainder of the project will be entirely concealed from public view.

Business operators who utilise this section of Stockton Bight for recreational ventures were consulted during the SIA process and provided feedback that they had grown accustomed to Boral operations associated with the windblown sand extraction area and did not envisage that the project will have any negative implications for their business.



CHAPTER 17

SURFACE WATER

17 SURFACE WATER

17.1 Introduction

This section summarises the surface water assessment report, which is in **Appendix L**. It summarises the potential impacts from the project on surface waters in and near the project site.

The hydrology of the project site and surrounds is summarised in **Section 2.5.8**.

17.1.1 Assessment guidelines and requirements

The SEARs require an assessment of the likely impacts of the project on surface water (**Table 17.1**).

Table 17.1: Surface water related SEARs

Requirement	Section and appendix where addressed
a detailed site water balance, including a description of site water demands and intakes, water disposal methods (inclusive of volume and frequency of any water discharges), water supply infrastructure and, water storage structures	Section 17.4, Appendix L
identification of any licensing requirements or other approvals under the *Water Act 1912* and/or *Water Management Act 2000*	Section 17.5.3, Appendix L
demonstration that water for the construction and operation of the development can be obtained from an appropriately authorised and reliable supply in accordance with the operating rules of any relevant Water Sharing Plan (WSP)	Section 17.5.3, Appendix L
a description of the measures proposed to ensure the development can operate in accordance with the requirements of any relevant WSP or water source embargo	Section 17.6, Appendix L
an assessment of any likely flooding impacts of the development, having regard to the relevant requirements provided by OEH in Attachment 2.	Section 17.2.2, Appendix L
an assessment of the likely impacts on the quality and quantity of existing surface and ground water resources (having regard to the Williamtown RAAF Base Contamination Broader Management Zone), including a detailed assessment of proposed water discharge quantities and quality against receiving water quality and flow objectives	Section 17.3, 17.4 and 17.5, Appendix L
a detailed description of the proposed water management system (including sewage), water monitoring program and other measures to mitigate surface and groundwater impacts	Section 17.3 and 17.5, Appendix L

The following guidelines were used during the assessment:

- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Australian and New Zealand Environment and Conservation Council, 2000); and
- Managing Stormwater: Soils and Construction, Volume 2E – Mines and Quarries (Department of Environment and Climate Change, 2008a); and

The objectives of the surface water assessment were to address the SEARs by:

- describing the existing catchment conditions and flow regime and water quality of water resources in and adjacent to the project site;

- describing the proposed water management system including water supply and demand requirements;
- assessing the potential impacts of changes to potential surface water flow and water quality from the project and identifying measures to prevent or manage these impacts;
- identifying a system to monitor project impacts on surface water and initiate additional management measures if required; and
- identify water licensing and approval requirements for the project.

17.2 Surface water environment

17.2.1 Drainage and interaction with groundwater

The existing project site is a formed basin and has no surface flow connection to adjacent areas. There are no springs or permanent streams within the project site. The lowest existing surface level of the project site is around the south-eastern edge of the project site with an approximate height of 6 m AHD. Local hydrology is characterised by high infiltration rates associated with the porous sands over the quarry and the subsequent interaction with the unconfined aquifer below.

Surface runoff is limited to periods where the aquifer reaches surface levels. This predominantly occurs when rainfall intensity exceeds infiltration rates, resulting in complete saturation of the soil. Ocean conditions, including storm surge, large tides and the wave action also influence groundwater levels. This was highlighted during what is known as the 'Pasha Bulker storm' of June 2007, where the associated storm surge and rainfall resulted in partial inundation of the project site up to approximately 3.5 m AHD.

As summarised in **Section 2.5.7**, a range of previous investigations have been carried out to establish groundwater depths and flow regimes in response to rainfall infiltration.

17.2.2 Flooding

Flooding in the vicinity of the project site is influenced by floodwaters from the Hunter River that overtop the Fullerton Cove levee, and the severity is a function of the magnitude of flooding in the Hunter River, which in turn is influenced by a combination of sea level impacts and catchment runoff.

The project site is beyond Port Stephens Council's mapped flood hazard extents, which also include allowance for climate change impacts. Estimates of the 1% annual exceedance probability (AEP) flood level and probably maximum flood (PMF) level in the vicinity of the quarry are 1.5 m and 5.2 m AHD respectively. Direct surface flood impacts from the Hunter River on the project site for the PMF or more frequent events are not expected, however, floodwaters for the PMF will impact on access to and from the quarry.

As outlined in **Section 17.2.1**, potential ponding of surface water in project site is associated with raised groundwater levels which can be exacerbated by ocean inundation and localised heavy rainfall events. Historically, groundwater levels up to 3.5 m to 4.0 m AHD are experienced at the quarry during wet periods.

17.2.3 Water quality of receiving environment

Rainfall which falls over the project site ultimately infiltrates to the Stockton Groundwater Source, which therefore acts as the receiving environment for the project.

Section 2.5.7 summarises the water quality of the Stockton Groundwater Source beneath the quarry, which has been informed by historical groundwater monitoring at the quarry.

17.2.4 Coastal hazards

Coastal hazards to the project consist of erosion and wave inundation along Stockton Bight. Estimates have been quantified by City of Newcastle Council for coastal erosion and recession to the year 2100. These estimates extend up to the LGA boundary at Fern Bay, approximately 3 km to the south-west of the project site and represent a similar aspect and coastal exposure to that of the quarry.

The likely beach erosion and recession in a large ocean inundation event by 2100 is estimated at 250 m. The project site is well beyond the projected coastal erosion extents and will be completed within 25 years. As such, coastal hazards are not deemed to present a risk for the project.

17.2.5 Existing water demands

The current water demands of the quarry must be understood as these demands will continue once the project is operational.

Dust suppression

Dust is suppressed on the existing unsealed haul roads from the site depot to the active windblown extraction area using a water cart. Water is purchased directly from a water cart contractor, drawing water from the potable water network.

The quantity of water used for dust suppression water use during 2018 was 15.2 ML over an area of approximately 1.82 ha, equating to 8.3 megalitres per hectare (ML/ha) over the year.

Water used in site depot

Apart from potable water, which is supplied in 20 L containers from a contractor, the remainder of water used for the office building and amenities is supplied via a 10,000 L rainwater tank, which collects rainwater from the roof of the office and maintenance shed. Since installation in 2017, the tank has not required supplementary filling from a water contractor, suggesting that captured rainwater is sufficient to service the water consumption of the site depot. The tank may be filled by a water contractor if required.

Wastewater is treated via a septic system and collected in pump out tanks which are regularly emptied by a contractor and disposed off-site. Approximately 5,000 L are collected every seven weeks on average.

17.3 Water management system

17.3.1 Stormwater

Stormwater runoff will generally be confined to roof areas, hardstand areas, and constructed unsealed haul roads. The sandy soils over the remainder of the project site will generate little surface runoff. Exposed slopes within the project site that generate runoff may cause localised sand movement and possible slumping, however these areas will be stabilised to minimise the potential for sediment runoff and possible slumping.

The existing office will continue to drain to the existing rainwater tank. Where possible, any new roofed areas will be plumbed to the tank.

Haul roads will be constructed from imported material to support the necessary traffic loads. Road design, including longitudinal and crossfall grading will divert stormwater runoff from the road surface to the adjoining landscape via sheet runoff or into shallow table drains. Runoff from haul

roads will infiltrate to adjacent areas, or flow to low points in the landscape where it will subsequently infiltrate.

17.3.2 Extraction area

Extracting the sand resource in stages of disturbance will reduce water losses by maintaining surface cover and shading as long as possible and limit sand product losses though wind erosion.

As groundwater is intercepted and the dredge pond is formed, areas previously losing water to the atmosphere via evapotranspiration associated with vegetation over this area will transition to direct evaporation and direct recharge from rainfall. The dredge pond will progressively increase in size up to the completion of Stage 6, after which the pond will be retained as a feature of the rehabilitated site.

17.3.3 Processing

Dry extracted sand will leave the site with a moisture content of approximately 3% based on the results of laboratory testing of extracted material previously undertaken by Boral.

The sand/water pumped from the dredge will pass through a screen and floatation tank for fines removal, prior to being pumped through a cyclone for dewatering and then stockpiled. Dewatered sand leaving the quarry will be estimated to have a moisture content of approximately 5%.

Water and removed fines will be recycled back to the dredge pond away from dredging operations and isolated via a silt boom.

17.3.4 Dust suppression

As highlighted in **Section 4.2.2**, the existing haul road accessing the windblown extraction area will be adjusted to allow for extraction within the Stage 1 area. Alterations will also be made to internal haul roads and a designated exit via the weighbridge. The haul roads will continue to require intermittent dust suppression via a water cart contractor and the frequency will be dependent on climatic conditions and vehicle movements. The haul roads will be progressively constructed to avoid soil/vegetation disturbance and loss of sand to wind erosion.

17.3.5 Wastewater

Wastewater from the site depot will continue to be collected and disposed by a licenced waste management contractor as required during the project. No alterations to the existing septic system are required.

17.4 Water balance

The water balance for the project comprises three components:

- direct water consumption and wastewater generation associated with the site depot;
- water consumption associated with dust suppression as required over the project site; and
- alterations to landscape conditions, primarily comprising removal of vegetation and transformation of dune areas to a dredge pond, as well as losses associated with the moisture content of extracted material leaving the quarry.

17.4.1 Direct demand

Site depot

Water demand at the site depot will not change significantly over the life of the project. Additional potable water will be purchased if required. Currently, rainfall is sufficient for water demands of the site depot.

The project will increase staff numbers to six full time staff and three casual staff. The existing wastewater system can accommodate this additional load and any increase in the generation of wastewater will be managed via an increase in the frequency of servicing of the septic system by a waste management contractor.

Firefighting

A 30,000 L rainwater tank will be installed adjacent to the existing maintenance shed to provide water for firefighting. The tank will be filled with rainwater from the shed roof. The water supply contractor will fill the tank if required.

Dust suppression

The quarry used approximately 15.2 ML in 2018 to suppress dust on approximately 3 ha of unsealed haul roads. This quantity was used to estimate dust suppression water requirements for the life of the project. Dust suppression will peak when the dredge pond is at its full extent, then reduce as the pond area is rehabilitated. Water for dust suppression will continue to be supplied form the contractor.

17.4.2 Landscape changes and sand extraction

The project will interact with the Stockton Groundwater Source.

The site water balance comprises inflow from rainfall and groundwater movement through the extraction area, and outflows in the form of evapotranspiration. The quantity of recharge to groundwater is a function of rainfall depth, evapotranspiration and the condition of the soil moisture store. This system will continue under the project.

Stage 1 of the project will have no interaction with the aquifer, and water extracted during dry extraction activities will be limited to the moisture content of the sand and topsoil.

A ‘window’ to the aquifer will be created when each subsequent stage reaches the aquifer and dredging will generate loss of the groundwater resource associated with the moisture content of the material leaving the site, in addition to losses associated with direct evaporation to the atmosphere via the window to the aquifer. Conversely, the dredge pond will create a direct recharge connection between the aquifer and rainfall over the project site.

A conceptual model of both the existing condition and future condition over the footprint of the project site was conducted to establish how the water balance will change from existing conditions, and then forward over time as the sand extraction process associated with the project expands. The model was used to estimate the likely quantity of water extraction from the Stockton Groundwater Source over the life of the project.

Refer to Section 5.3.2 of **Appendix L** for model assumptions and parameters.

17.4.3 Results

The quantity of water extracted will generally increase over time as the dredge pond surface area expands, peaking at an average close to 100 ML/y in the final years of the project. Monitoring will be required during the project to verify estimated extraction rates and compare with water allocations whilst the aquifer is exposed.

As the dredge pond is created, direct rainfall to the aquifer will increase, as will evaporation and moisture losses associated with the exported sand material.

The model concluded that the net extraction of water is more likely than net import to the aquifer from above average rainfall. Generally, the project will only contribute a net import of water to the Stockton Groundwater Source in years when rainfall is at or above the 90th percentile.

The water balance model of the project shows that there will be significant variability in the quantity of extraction from the Stockton Groundwater Source due to variability in rainfall and the associated changes that direct rainfall will recharge to the aquifer.

17.5 Potential impacts

17.5.1 Water management – site establishment

Given that rainfall infiltrates into the sandy soils quickly, the potential for erosion is negligible. However, access roads and the embankments of the proposed dredge pond will require VENM or other engineering fill that contain clays and other soil types of smaller particle sizes that are more erodible than existing sand material at the project site. Erosion and sediment controls will be required for areas where VENM or other erodible material are imported, in order to limit sediment movement into the established dredge pond (resulting in turbidity and deterioration in water quality in the Stockton Groundwater Source) or into adjoining native vegetation communities at the quarry.

The construction of haul roads and embankment stabilisation will be managed in accordance with an erosion and sediment control plan, which will be prepared in accordance with DECC's (2008) *Managing Urban Stormwater: soils and construction, Volume 1 and Volume 2C: Unsealed roads*, and *Managing Stormwater: Soils and Construction, Volume 2E – Mines and Quarries*.

17.5.2 Water management – operational phase

The haul roads will present a continued source of sediment in periods of high rainfall. The nature of the soil landscape at the quarry means that any eroded material from the haul road surface will be contained within close proximity to the road.

Refueling and storage of hazardous materials will be required and will present a potential for adverse impacts associated with spills, which have the potential to reach surface or groundwater resources, particularly during heavy rainfall events.

Dredge extraction involves a caged impeller which disturbs the sand profile creating a sand/water mix for extraction. Minimal sediment will be suspended during dredging operations as fines are extracted within the mix before being transferred to the wash plant via pipeline. The mix will then pass through a wash plant to remove any fines or other unwanted materials. Given the nature of the sand resource, fines content is expected to be low.

Materials filtered out in the wash plant (predominantly fines) will be pumped back to the dredge pond, away from the dredge operation to encourage settlement, and limit fines movement back though the dredge.

There is no direct connection from the project site to surface floodwaters. However, localised inundation of the project site to 3.5 m to 4.0 m AHD have been experienced at the project site. Despite the potential for occasional localised ponding in the project site, all permanent infrastructure for the quarry (existing and proposed) is located at 4 m AHD and above, and procedures will be implemented to monitor forecast heavy weather events and implement mitigative measures in response.

17.5.3 Water extraction and licensing

Water leaving the project site will include water lost to the atmosphere via evaporation of the dredge pond as well as water exported from the site as moisture content in the outgoing sand product.

Towards the end of the project, when the dredge pond is at its largest extent, total water extraction is estimated at up to 100 ML/y, assuming median rainfall within the catchment.

The project will comprise a minimal impact on the quantity of the Stockton Groundwater Source. The available water within the Stockton Groundwater Source is 14,000 ML/y and after existing landholder rights and allocations are accounted for approximately 12,000 ML/y remains. The estimated annual extraction associated with the project is approximately 1% of the available allocations from the Stockton Groundwater Source.

Boral has previously been issued a WAL for the quarry, however has a zero share allocation for the Stockton Groundwater Source. Boral will therefore be required to obtain sufficient water share allocations from DPIE prior to the commencement of the project to account for the projected quantity of water extraction. These allocations can be obtained either through the trading of existing allocations, or through application for new allocations under Section 65 of the WM Act. Such allocations have been identified as available in the WSP.

17.5.4 Drinking water resources

The Stockton Sandbeds Catchment Area is approximately 150 m to the north-east of the project site at its closest point. Historical groundwater monitoring at the quarry demonstrates that the direction of groundwater flow is away from the catchment area, flowing from the catchment area towards the quarry, and subsequently north-west towards Fullerton Cove or south-east towards the ocean.

As discussed in **Chapter 8**, the potential for adverse impacts on flow regimes and standing levels of the aquifer will be minimal, and the project is unlikely to alter the water quality of the aquifer, thereby maintaining the integrity of available water supply for Hunter Water in the Stockton Sandbeds Catchment Area and Stockton Groundwater Source.

17.6 Mitigation and management measures

The following mitigation and management measures are recommended to ensure surface water is appropriately managed at the project site.

17.6.1 Refuelling and spill management

The mitigation and management measures for hydrocarbon and chemical storage, handling and management as outlined in **Section 20.3** will be implemented.

The existing Environmental Management Strategy for the quarry will be updated to accommodate these changes to operations at the site.

17.6.2 Erosion and sediment control plans

Exposed soils generated through the construction of the haul roads and stabilised dredge pond embankments will be managed through standard erosion and sediment controls implemented in accordance with DECC's (2008) *Managing Urban Stormwater: soils and construction, Volume 1 and Volume 2C: Unsealed roads and 2D: main road construction*, and will be outlined within an erosion and sediment control plan prepared for the establishment of the project.

17.6.3 Flooding and inundation

To predict possible periods of localised inundation, rainfall and ocean level conditions will be monitored through the BoM, including storm warnings for heavy rain and high seas. In conjunction, groundwater levels will continue to be monitored in accordance with the existing groundwater monitoring program, and movement in standing water levels noted. The Quarry Manager will decide on precautionary measures to remove machinery from areas where groundwater levels may increase, and localised ponding may occur.

For the dredge pond, allowances will be made for the dredge to move to a higher level through adjustments in mooring lines and transfer pipes. Management of this risk will include a groundwater inundation management plan that includes monitoring of existing bores, flood and storm warnings as well as specific triggers for the movement of machinery and equipment and temporary storage locations.

17.6.4 Reduction of evaporation

Boral will consider implementing measures to reduce the quantity of water extraction from the Stockton Groundwater Source, particularly via evaporation from the dredge pond surface.

There are a range of technologies available to reduce evaporation through techniques which limit exposure of surface water to atmosphere by providing shade and reducing air flow (wind), and direct barriers.

17.6.5 Fines management

Any fines collected within the wash plant will be returned to the dredge pond. The water and fines return point will be located as far as possible from the dredging operation to limit reprocessing. Should fines settlement become an issue, a silt curtain will be installed to restrict fines movement between the dredge and fines return point. Dredging operations will be monitored to determine whether installation of a silt curtain is required.

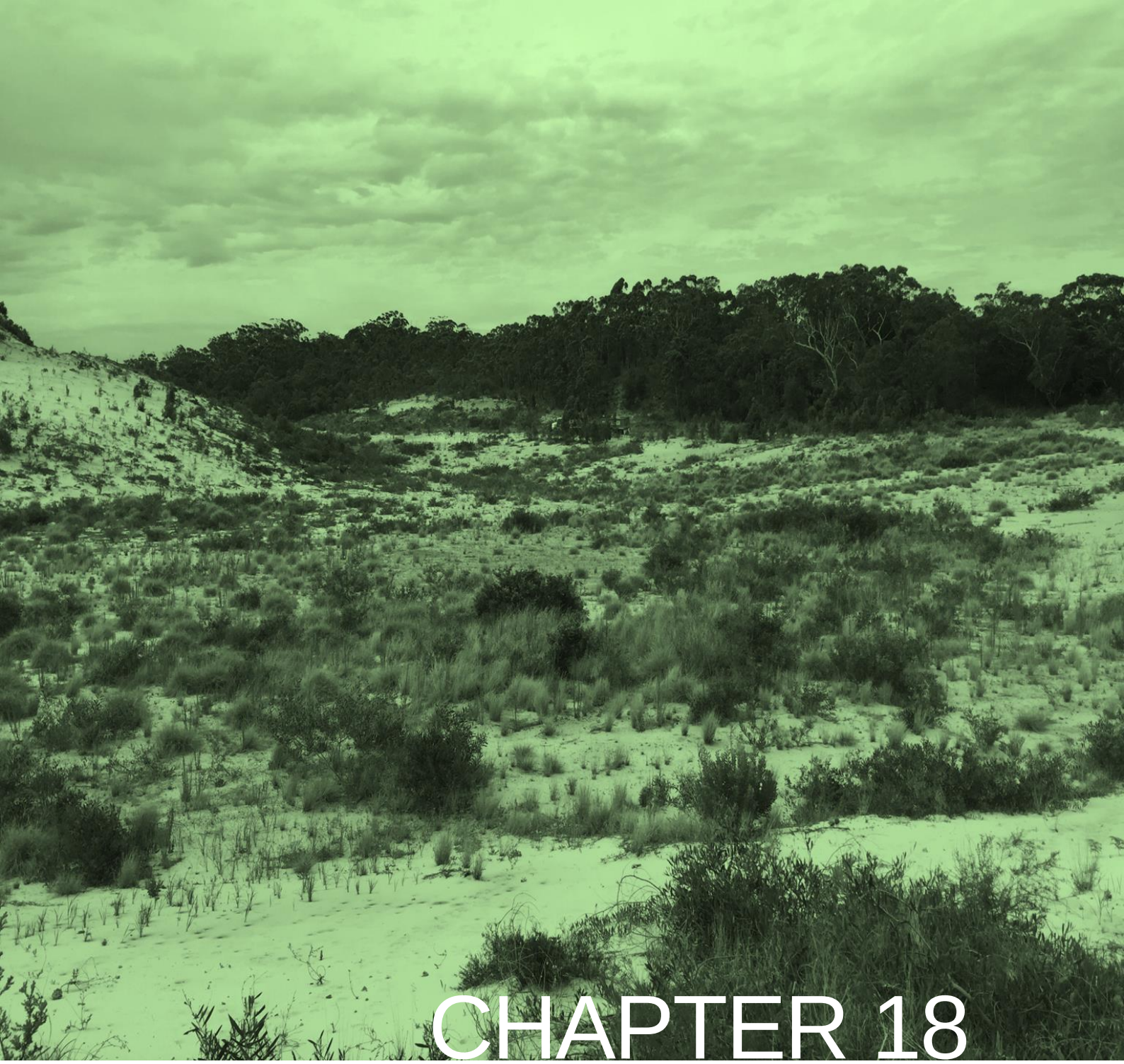
17.6.6 Water quality monitoring

Surface water monitoring within the dredge pond will follow the recommendations outlined in **Section 8.5.1**. After 12 months of regular testing, monthly sampling may be extended to bi-monthly should no exceedances or significant variations occur over time.

17.6.7 Water quantity monitoring

To gather an accurate understanding of extractions from the groundwater source and accurately estimate evaporation losses detailed measurements of the pond area, moisture content of sand material, and sand material export are required. The following monitoring is recommended:

- six monthly measurements of the dredge pond surface area, either through site survey or aerial survey;
- fortnightly measurements of the moisture content of exported sand material through stockpile measurements; and
- records of sand material leaving the project site, including the source of sand material from excavations above the aquifer or from the dredge pond.



CHAPTER 18

HISTORIC HERITAGE

18 HISTORIC HERITAGE

18.1 Introduction

Historical archaeological relics, buildings, structures, archaeological deposits and features are protected under the NSW *Heritage Act 1977*.

This chapter describes the non-Aboriginal cultural context of the project site, significance of identified heritage items and the potential historic heritage impacts.

18.1.1 Assessment guidelines and requirements

The SEARs require an assessment of the likely risks to historic heritage from the project (**Table 18.1**).

Table 18.1: Historic heritage related SEARs

Requirement	Section and appendix where addressed
identification of historic heritage in the vicinity of the development and an assessment of the likelihood and significance of impacts on heritage items.	18.2, 18.3

18.2 Potential impacts

As highlighted in **Section 2.6.2**, the project will not impact a registered heritage item/place protected under the NSW *Heritage Act 1977* or Port Stephens LEP.

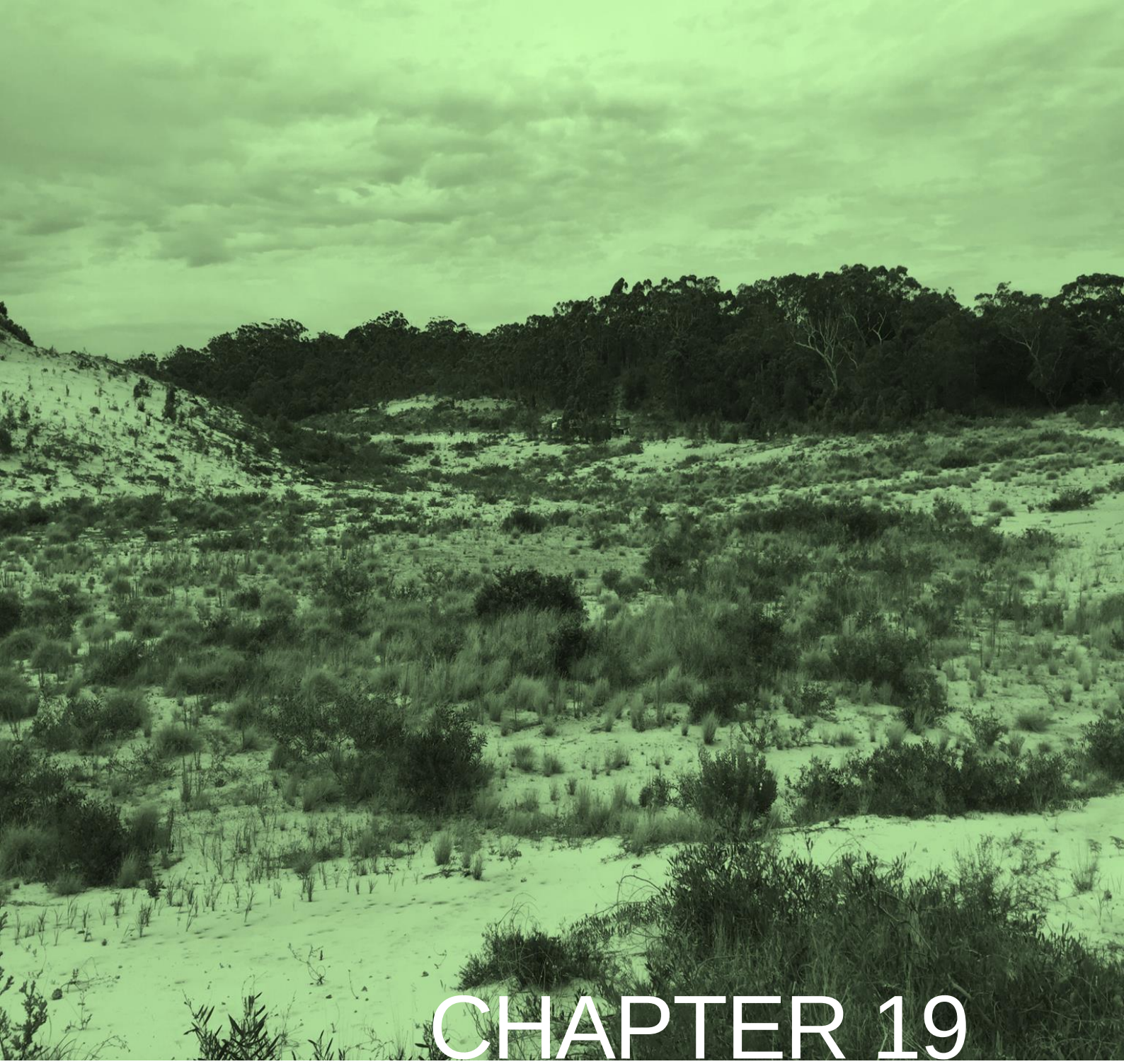
Despite proximity to the Stockton beach dune system, as highlighted in **Section 14.3.2**, the project will not impact the beach, foredune, deflation basin and mobile transverse dunes of Stockton Bight as the project site is physically removed from, and downwind of these environments. As such, the project will not impact upon the natural landscape features comprising the listing.

The project site has been subject to previous surface disturbance and is unlikely to contain any unknown historic heritage items.

18.3 Management and mitigation measures

The following mitigation measure will be implemented:

- should an item of potential Non-Aboriginal heritage be identified during project operations, works will cease, and the Quarry Manager will be contacted immediately. Appropriate measures will be taken to minimise the potential for harm to the object. Further advice will be sought from a qualified archaeologist, and subsequently DPIE Biodiversity and Conservation Division will be notified of the proposed course of action, if required.



CHAPTER 19

WASTE MANAGEMENT

19 WASTE MANAGEMENT

19.1 Introduction

Waste streams will be generated by the project and will require responsible management in accordance with the objectives of the WARR Act, POEO Act and other relevant legislative requirements.

Failure to collect, separate and store waste, or transport and dispose of waste appropriately can result in adverse impacts on the receiving environment.

19.1.1 Assessment guidelines and requirements

The SEARs require an assessment of the likely risks of the project regarding waste management (**Table 19.1**).

Table 19.1: Waste related SEARs

Requirement	Section and appendix where addressed
a waste (overburden, rejects, tailings etc) management strategy;	19.2, 19.3
estimates of the quantity and nature of the waste streams that would be generated or received by the development and any measures that would be implemented to minimise, manage or dispose of these waste streams;	19.3

19.2 Existing operations

The main waste streams generated by the quarry comprise general solid wastes and hazardous and liquid wastes from operations and servicing of equipment.

All waste generated at the quarry is separated, collected in designated waste disposal bins, reused where possible, or disposed of at an appropriately licenced waste facility.

19.2.1 Existing waste management practices

Boral has developed a waste management system for the quarry that ensures all waste generated on site is classified and managed in accordance with EPA's (2014) *Waste Classification Guidelines* and relevant regulatory requirements of the WARR Act and the POEO Act.

In accordance with the WARR Act, Boral adopts the principles of the waste management hierarchy.

These principles will continue to be upheld during the project, and be achieved by:

- purchasing recycled products where appropriate;
- developing and implementing waste management procedures to minimise the generation of waste and where unavoidable, re-use waste on-site;
- recycling as many wastes as practically possible through appropriate handling, separation, storage, and collection; and
- where waste cannot be re-used or recycled, transportation and disposal of waste off-site at an appropriately licenced facility.

19.2.2 General solid waste

The quarry generates building and demolition waste, glass, plastic, rubber, garden waste, wood, paper and cardboard. Additionally, general solid waste (putrescible), such as food waste, is generated by site personnel.

General solid waste streams are segregated where possible, and deposited in large bins, which are covered and collected fortnightly by a licensed waste removal contractor.

19.2.3 Hazardous waste

Contaminated materials generated at the maintenance shed, such as recovered oil and grease, is collected and stored in a 400 L tank for removal by a licensed recycling contractor. Approximately 800 L of oil and grease waste is generated per year.

Used hazardous substance and chemical containers, grease drums, and oil filters, are stored in accordance with standards and regulations, until collected for recycling or disposal by a licensed contractor.

Any spills in the collection areas are contained in bunds and managed in accordance with emergency response procedures.

19.2.4 Liquid waste

The septic system is inspected and pumped out regularly by a licenced disposal contractor.

19.2.5 On-site resource recovery

Cleared vegetation is mulched or stockpiled on-site for later use in rehabilitation. Following clearing of vegetation, topsoil is stripped using a dozer and stored in stockpiles.

When an extraction area is exhausted, topsoil and previously felled vegetation or mulch is re-spread over finished areas and the area is actively rehabilitated and managed. Felled timber is evenly distributed to act as a wind break for emerging seedlings and provide habitat opportunities for small fauna.

19.3 Assessment of impacts

The primary waste streams likely generated by the project will be limited volumes of general solid wastes and hazardous and liquid wastes from operation and servicing of equipment.

All waste will be managed in accordance with the existing quarry waste management system. Waste streams will be classified according to the Waste Classification Guidelines (NSW Environment Protection Authority, 2014) and disposed of accordingly.

19.3.1 Establishment phase impacts

The following waste sources are likely to be generated during establishment of the project:

- removed native and exotic vegetation;
- general solid wastes (non-putrescible), including building and demolition waste;
- excavated material (e.g. spoil) unsuitable and/or not required for backfilling and restoration;
- maintenance waste – waste generated from construction plant and machinery maintenance, such as oil and fuel; and

- general solid wastes (putrescible) and liquid waste from construction personnel.

The nature and volume of waste generated during construction will predominantly be non-hazardous and relatively minor. However, there is potential for adverse impacts on the local environment if waste is not managed appropriately.

Inappropriately managed waste will have potential adverse impacts upon:

- visual amenity and aesthetic quality of the surrounding area;
- health and safety of residents, workers and visitors;
- landfill space, through potentially reusable and/or recyclable materials contributing to landfill waste;
- native fauna through ingestion of fugitive waste materials e.g. plastic bags; and
- hazardous waste, particularly fuels or oils, leaching into local drainage lines and watercourses, leading to subsequent water quality degradation.

Construction wastes will be classified and disposed of in accordance with (NSW Environment Protection Authority, 2014), and in accordance with the resource management hierarchy principles and associated requirements of the WARR Act and NSW Protection of the Environment Operations (Waste) Regulation 2014.

19.3.2 Operational phase impacts

Waste generated during operation of the project will be the same as those currently generated by existing quarry operations **Table 19.2**.

Table 19.2: Operational waste inventory

Waste description	Waste classification	Source	Approximate quantity	Re-used on-site?	Recycled?	Disposed of on-site / off-site
Sewerage	Liquid	Main Office Facilities	5,500 L every 7 weeks	No	Yes	Off-site
Oil and grease	Liquid	Maintenance of mobile equipment	800 L / year	No	No	Off-site
Maintenance / Production waste	Solid	Workshop waste, packaging, waste from quarry processes	6 m³ / month	No	No	Off-site
Office	Solid	General office waste	5 m³ / month	No	No	Off-site
Paper	Solid	Office	540 kg / year	No	Yes	Off-site
Scrap steel	Solid		5 t per year	No	Yes	Off-site
Timber	Solid	Felled vegetation	20 t per year	No	Yes	On-site

These wastes will continue to be managed in accordance with waste management systems and practices, including for topsoils and felled native vegetation.

All wastes generated by operations will be classified and disposed of in accordance with (NSW Environment Protection Authority, 2014), and in accordance with the resource management hierarchy principles and associated requirements of the WARR Act and NSW Protection of the Environment Operations (Waste) Regulation 2014.

19.3.3 Cumulative impacts

General solid wastes, liquid and hazardous wastes will continue to be generated by quarry operations. However, waste quantities will be minimal, and licenced waste contractors will collect and dispose of these wastes to ensure recycling or disposal in a legislatively compliant manner.

Other land uses near the quarry, including other extractive industries, will be subject to waste related consent and EPL conditions. As such, waste at these facilities are likely to be managed in an environmentally responsible manner and in accordance with legislation, thereby minimising the potential for cumulative impacts from the project combined with nearby facilities.

19.4 Management and mitigation measures

Waste will be managed in accordance with the WARR Act by adopting the resource management hierarchy (in order of priority) of avoidance, re-use, recycling / re-processing / treatment and disposal.

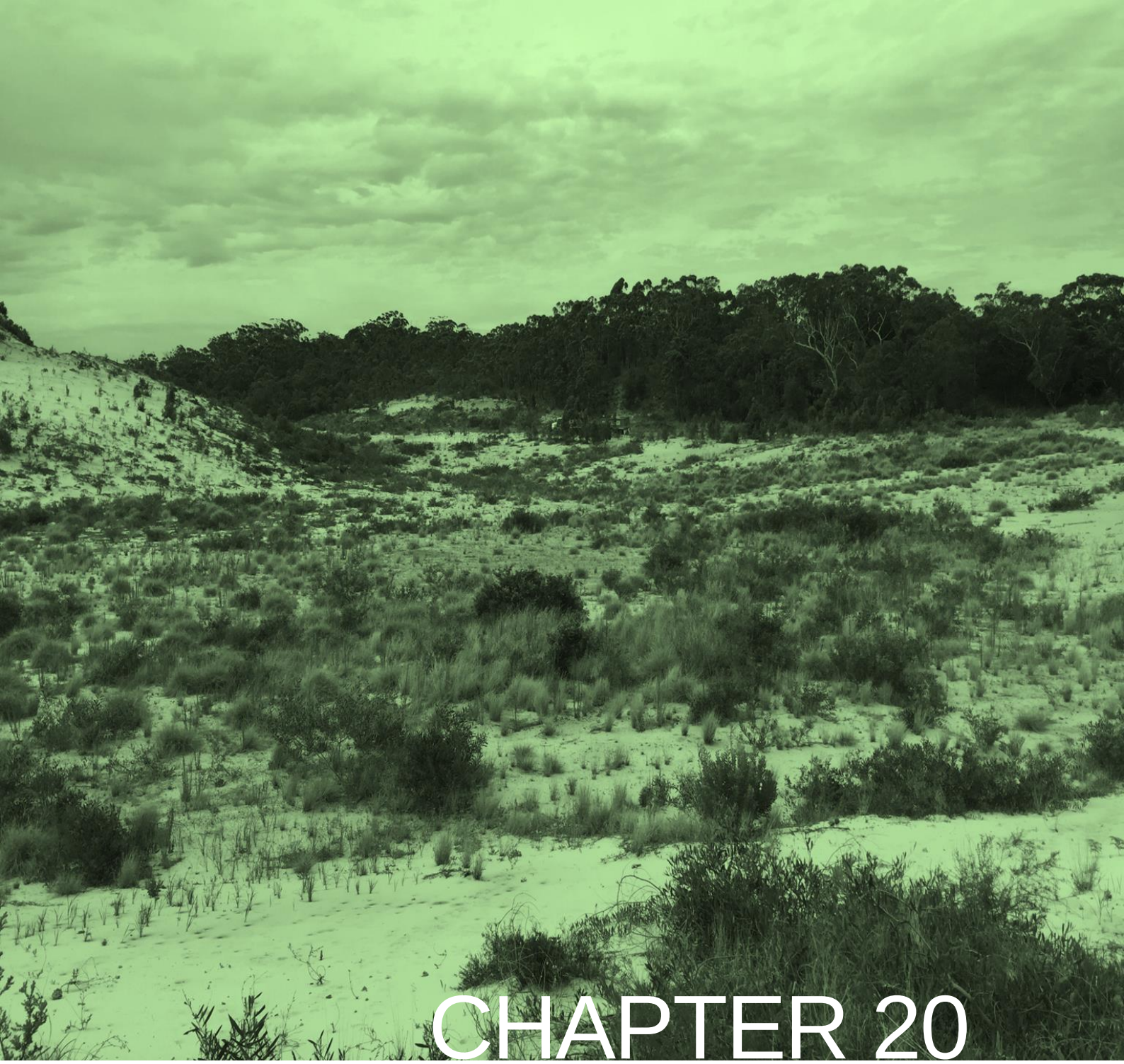
The existing environmental management strategy for the quarry will be updated as follows:

- Wastes will be quantified and classified;
- disposal/reuse strategies for each type of material;
- details of how waste will be stored and treated on site;
- identification of non-recyclable waste;
- identification of measures and initiatives to reduce, reuse and recycle; and
- procedures and disposal arrangements for potentially hazardous material.

The environmental management strategy will include the following:

- Waste will be managed in accordance with (NSW Environment Protection Authority, 2014) and relevant regulatory requirements. This will include (i) its classification prior to leaving the site and (ii) recording (via an appropriate waste tracking system) its legal off site transportation for re-use, recycling or disposal.
- Waste (excluding toilet waste) will be stored in a suitable container with a lid, and transported to an appropriate facility. Enough receptacles for general waste, hazardous waste and recyclable materials will be provided, including sufficient bins to allow separation of wastes for recycling.
- Wastes will only be disposed at a licenced waste disposal depot.
- Wastes will be securely stored so that pollutants are prevented from escaping.
- Fuel, lubricant or hydraulic fluid spillages will be collected using absorbent material and the contaminated material disposed of at a licensed waste facility.
- Hazardous or contaminated wastes (if identified) will be removed and disposed in accordance with the State and national regulations and guidelines and best practice for the removal of these materials. Hazardous materials will only be removed by suitably qualified, licensed and experienced contractors.
- Personnel will be required to notify the Quarry Manager, and follow approved SafeWork NSW procedures for the handling and transport of any asbestos containing material wastes to an EPA approved facility.
- Documents and records of the transport and fates of all materials removed from the project site will be kept as proof of correct disposal and for environmental auditing purposes.

- Waste streams will be sorted to maximise the reuse/recycling potential and minimise disposal costs.
- Waste will be covered, stored and removed in a timely manner so as not to attract native animals or vermin.



CHAPTER 20

HAZARDS AND RISK

20 HAZARDS AND RISK

20.1 Introduction

This chapter provides details on the potential hazards and risks associated with the project, including public safety and bushfire risks, and, where required, management measures to reduce these to acceptable levels.

Additionally, this chapter describes the handling, transport, storage and use of dangerous goods in the project site, and the implications of these dangerous goods with respect to SEPP 33.

20.1.1 Assessment guidelines and requirements

The SEARs require an assessment of the likely risks of the project to public safety (**Table 20.1**).

Table 20.1: Hazards related SEARs

Requirement	Section and appendix where addressed
an assessment of the likely risks to public safety, paying particular attention to potential bushfire risks (including the identification of potential ignition sources during construction and operation) and the transport, handling, storage and use of any chemicals, fuels and, hazardous or dangerous goods; and	20.2
proposed bushfire protection measures including vegetation management, fire suppression capabilities and operational access for firefighting appliances to the site;	20.3

20.2 Potential impacts

20.2.1 Hazardous substance and dangerous goods management

The hazardous substances and dangerous goods required for the project include hydrocarbons, such as fuels (diesel), oils and greases.

Diesel

Diesel is classified as a combustible liquid by Australian Standard (AS) 1940:2004 *The Storage and Handling of Flammable and Combustible Liquids* (AS 1940:2004) (Class C1) for the purpose of storage and handling, but is not classified as a dangerous good by the Australian Dangerous Goods (ADG) Code (National Transport Commission, 2007).

Approximately 105,160 L of diesel was used by the existing operations in 2018, a decrease of approximately 11,840 L from 2017 due to reduced production levels in 2018.

The project will require the continued use of diesel. The quarry has an above ground 4,200 L diesel storage tank in a bunded area of the maintenance shed. Heavy vehicles will be fuelled off-site, with the dredge, front-end loader, generators and excavators to be re-fuelled on-site with a mobile fuel tanker. Diesel will be transported, stored, handled and managed in accordance with regulations and industry standards. The tanker will be parked in a temporary bunded area on an impermeable surface while re-fuelling, and spills in the collection area will be contained and managed in accordance with emergency response procedures. Any incidental contamination will

be classified and disposed of in accordance with waste legislation. A sealed system will transfer fuel from the mobile tanker to the dredge.

The storage and use of diesel is not potentially hazardous under SEPP 33 as the tank will be bunded and stored away from other flammable materials.

Oils and greases

Oil is classified as a combustible liquid (Class C2) by AS 1940:2004.

Boral will need to store small quantities of hydrocarbons, typically oils and greases for maintaining plant and equipment. These will be stored in an existing 400 L bunded tank, installed in accordance with relevant Australian Standards. Recovered oil and grease material is then collected for removal by a licensed recycling contractor.

Oils and greases will not be stored within the same bund as other flammable liquids, and as such would not be subject to the Applying SEPP 33 screening thresholds. As a result, the storage of these materials is not considered potentially hazardous in terms of SEPP 33.

20.2.2 Bushfire management

The site is identified on bushfire planning maps as 'Vegetation Category 1' requiring the preparation of a bushfire management plan.

The existing internal haul roads and site depot were previously assessed for bushfire hazard (Boral Country, 1997), which concluded:

- The sand extraction operations provide no detrimental impact on the ignition or progression of bushfires. The availability of earthmoving equipment and a water cart on-site has a significant positive impact on the firefighting capacity of the area.
- The maintenance of the haul road also contributes to easy access to the area by firefighting crews. The local bushfire brigade has 24-hour access to the site.
- The development of the Boral site has improved overall access to any fires progressing through the vegetated dunes as the haul road provides both a firebreak and access road for firefighting equipment.
- Adequate fire access is provided for the Seaside Village Estate residential development at Fern Bay to the south-west of the quarry, minimising the likelihood of fires encroaching on the site from the south. Fires from the north and east are less common, and existing access in these directions provide for firefighting.
- The water cart will be available at all times for firefighting and employees are trained to be diligent with regard to fire risk and necessary emergency procedures.
- Adequate cleared land occurs around fuel tanks to minimise fire danger.

The bushfire season in the Lower Hunter region predominantly occurs during the hotter months of the year, between October and March. The prevailing weather conditions associated with the bushfire season are north-westerly winds accompanied by high day time temperatures and relative low humidity.

The main sources of bushfire ignition in the region are:

- arson;
- car dumping;
- fugitive embers from legal burn off events;
- fugitive embers from illegal burning; and
- arcs from power lines in high winds.

Most vegetation in the project site consists of stands of replanted woodland, interspersed with grassland and exposed sand.

The land in the project site has a low to moderate risk of bushfire due to limited available fuel source, existing vegetation composition interspersed with disturbed areas, a large former open quarry pit and site infrastructure. Undisturbed vegetated surrounding the project site, including environmental conservation areas to the north-east and south-west represent a high risk of bushfire. These adjoining environmental conservation reserves will experience build-up of high fire fuel sources over time, associated with dense vegetation canopy contributing to leaf litter and tinder on the ground surface.

A combination of relatively low rainfall, dry nature of the landscape, topography, and dense vegetation and high fuel source in the adjacent environmental conservation areas could pose a bushfire risk to the quarry. Bushfires in the reserves will be managed by NSW Rural Fire Service (RFS) and the National Parks & Wildlife Service. Boral will continue to work with the RFS and land authorities to co-ordinate any scheduled burn off events, and monitor and report any fires, suspicious behaviour or hazardous fuel loads within proximity to the quarry boundary.

New development in NSW is assessed for bushfire risks in accordance with RFS (2006) *Planning for Bushfire Protection* (PBP). Extractive development is regarded as 'other' development in PBP and must satisfy the aim and objectives of PBP.

Project infrastructure such as the wash plant, site office and car park are adjacent to Category 1 bushfire prone vegetation and in the surrounding 100 m buffer. The wash plant will be valuable site infrastructure, and the site office will contain personnel during work hours. These assets could be vulnerable to property destruction, and personnel vulnerable to injury or fatality from a fire. The wash plant and car park will be outside the vegetation buffer, however the site office will be inside the buffer.

Bushfire hazards were assessed (**Appendix M**) in relation to the aim and objectives of PBP and is summarised below.

The aim of PBP is:

To use the NSW development assessment system to provide for the protection of human life (including fire fighters) and to minimise impacts on property from the threat of bushfire, while having due regard to development potential, on-site amenity and protection of the environment.

As demonstrated in the consideration of the PBP objectives below, the project will present low bushfire risk and the implementation of bushfire protection measures will not impact the environment.

The objectives of PBP are to:

- *afford occupants of any building adequate protection from exposure to bushfire:*

Occupants of the site depot will have a reduced exposure to bushfire following the establishment of an asset protection zone (APZ). Evacuation planning for the quarry in the event of bushfire will clearly indicate to workers to evacuate early and in a direction away from the fire.

- *provide for a defendable space to be located around buildings:*

A 25 m APZ will be implemented around the buildings in the site depot, and as such defendable space will be available surrounding the buildings from where the fire will be fought. If there is a bushfire, fire fighters and emergency response personnel will have direct access to the surrounding bushland via the internal road network of the quarry.

- *provide appropriate separation between a hazard and buildings which, in combination with other measures, prevent direct flame contact and material ignition:*

PBP provides for APZs, which are a buffer area between the bushfire hazard and buildings. The 25 m APZ for the site depot was determined in accordance with Appendix 2 of PBP.

- *ensure that safe operational access and egress for emergency service personnel and residents is available:*

The existing access to the quarry along Coxs Lane will be an adequate emergency evacuation route in the event of a fire. Similarly, the existing and proposed access roads will provide suitable access for emergency service personnel and the RFS during a fire.

- *provide for ongoing management and maintenance of bush fire protection measures, including fuel loads in the asset protection zone (APZ):*

The APZ will be maintained in accordance with Appendix 5 of PBP and the RFS Standards for Asset Protection Zones.

- *ensure that utility services are adequate to meet the needs of fire fighters (and others assisting in bush firefighting):*

As the quarry is not connected to the potable water network and relies on external water supply, a minimum 20,000 L static water supply will be required for the project and will be equipped with firefighting fittings. There will be a plentiful supply of water in the dredge pond once it is established, which will be available to emergency services for use at the quarry and region.

The assessment of the project against the aim and objectives of PBP concludes that with the implementation of APZs, the site depot and other infrastructure will be sufficiently separated from bushfire hazard vegetation and the risk of bushfire attack will be low.

Notwithstanding the above, activities associated with the project may result in inadvertent bushfire ignition. Such activities may include grass fires sparked by the hot exhaust of vehicles driving or parking in long, dry grassland; fires sparked during hot work activities such as welding; clearing of vegetation; or stockpiling of removed vegetation and timber (prior to reuse in revegetation or rehabilitation) contributing to a fuel source for ignition. This risk can be suitability be managed by continued implementation of the site's emergency management plans and hot works protocols.

Boral will continue to work with the RFS and respective land authorities to co-ordinate any scheduled burn off events, and monitor and report any fires, suspicious behaviour or hazardous fuel loads within proximity to the quarry boundary.

20.2.3 Unexploded explosive ordinance

The project site was historically part of the Stockton Beach Artillery Proof Range from 1942 to 1944 (ERM, 2005). The Artillery Proof Range extended from just south of Boral's property to Lavis Lane. Most of the firing was from Snake Battery Gun Position (to the south of Boral's land holding), with the projectiles impacting on the beach and adjoining sand dunes. Artillery (18 pounder) was also fired from the Ypres observation post (near the depot) towards the beach with the main impact area expected to be at the northern end of Boral's property.

ERM (2005) mapped the project site as having no risk for unexploded explosive ordinance, as it has been previously disturbed by quarrying activities from 1996 to 2008.

20.2.4 Soil and water contamination

Hydrocarbon spills could cause localised contamination of soil and water and impact health and safety.

Uncontrolled releases of hydrocarbons to the environment may damage soils and aquatic ecosystems, and fires can occur if these materials are ignited.

Potentially hazardous materials such as hydrocarbons will be contained in bunded areas in accordance with relevant Australian Standards, codes and regulations.

Refuelling and maintenance activities will be restricted to bunded hardstand areas within the site depot. Therefore, the risk of soil, surface water and groundwater contamination from spills will be low.

20.2.5 Risk to workers

As with any extractive industry operations, daily operations have inherent risk to workers and contractors and have the potential to result in injury or fatality if workers are ill informed of the hazards involved, or risks associated with plant and machinery are not managed. Examples of activities which could result in injury or fatality include crush injuries by moving plant and equipment, motor accidents or crush by heavy vehicles, exposure to hazardous materials, heat exhaustion, working from heights or confined spaces, and exposure to airborne dust and industrial noise.

Boral has a rigorous workplace health and safety regime, as required by the NSW *Work Health and Safety Act 2011* (WHS Act). All workers, contractors and visitors will be inducted on safety protocols and procedures before entering active parts of the site. All personnel working on the site will be required to wear personal protective equipment such as hard hats, high visibility clothing and enclosed footwear. Regular communication of safety requirements and initiatives will also be undertaken on a regular basis.

Provided the implementation of workplace health and safety protocols during construction and operation of the project, as required by the WHS Act and other relevant regulations or standards, the potential for injuries or fatalities to workers, contractors or visitors to the site will be minimised.

20.2.6 Public safety

Risks to public safety may arise where members of the public gain unauthorised access to the site. This is particularly hazardous as it could result in potential fatality for members of the public associated with movement of heavy vehicles and moving plant.

There were nine incidents during 2018, predominantly associated with recreational vehicles and pedestrians entering the quarry either unintentionally or deliberately to access the beachfront.

There is a security gate at the quarry entrance on Coxs Lane. This gate is closed and locked overnight when the site is unoccupied but left open during operation hours to permit the entry and exit of heavy and light vehicles from the site office and weighbridge.

There is a high visibility line and bunting on the fencing along the Stockton Bight windblown extraction area, which demarcates the Boral property boundary, and includes warning signage.

Security fencing and high visibility line and signage are inspected regularly by quarry personnel, with posts for signage and high visibility line made of flexible shatterproof plastic to prevent possible injury during possible collision.

The following management measures are implemented:

- **Operation and maintenance of safe batters –**a working extraction face that does not produce a grade of greater than 1:3 (V:H) is maintained to blend the extraction area with the surrounding dune system to limit risks to recreational vehicles.
- **Equipment requirements –** heavy earthmoving equipment operates with safety equipment including flashing beacons for visibility in all weather conditions, radio communication and rear cameras for reversing movements.

- **Operating hours –** operations are limited on Saturdays, unless there is increased supply demand. Although operations are approved on Saturdays between the hours of 6:15 am and 12 pm (extended to 3 pm during major supply contracts), Boral reduces these hours of operation wherever possible to minimise the potential for contact with recreational users of the beach.
- **Trespassing or emergency assistance procedures –** personnel are trained to inform site management if members of the public are observed on the site in either a trespassing capacity or seeking emergency assistance. In response, the operation of all heavy machinery is ceased until the party is removed from site and it is safe to resume operations.

To address the risks to public safety, Boral will continuously review and improve security at the site, including new fencing, security cameras, gates and signage.

All visitors to the site will be required to report to the site administration office and register prior to gaining entry to the active areas of the site.

With these security initiatives in place, coupled with a regular review and inspection of the integrity and effectiveness of these measures, the potential for members of the public to gain unauthorised access to the quarry will be minimised.

20.2.7 Road safety

Heavy vehicles associated with dispatch of sand product, importation of VENM to the site and deliveries of consumables will frequently travel along Nelson Bay Road and the wider road network. Potential hazards associated with product transportation may occur in the event of a motor vehicle accident, or tip over resulting in the spill of materials across the roadway. Such events could result in injury, fatality, or general inconvenience (e.g. road closures) to the general public who utilise these roadways.

As outlined in **Chapter 12**, the project will not result in negative impacts to other road users and the safety of the public road network and Boral will implement driver awareness training for all staff at the site, with a focus on the correct protocols when entering and exiting the site and driving on public roads.

20.2.8 Cumulative impacts

Despite the project being in proximity to other extractive land uses (including the windblown sand extraction area), there will be no significant cumulative risks as a result of the proximity of the project to these operations. All technical assessments of the potential impacts of the project, have where relevant, considered the cumulative impacts of the development combined with existing activities in the area thereby assessing the cumulative impacts of the project.

Other land uses near the quarry, including other extractive industries, will be subject to hazard related consent and EPL conditions. As such, hazards and risks associated with these facilities are likely to be managed in an environmentally responsible manner and in accordance with legislation, thereby minimising the potential for cumulative impacts from the project combined with nearby facilities.

20.3 Mitigation and management measures

20.3.1 Hazardous substances

The objectives of hazardous substance storage and handling are to avoid contamination of soil and water and to minimize risks to health and safety.

A pollution and incident response management plan (PIRMP) has been prepared to manage potential chemical or hydrocarbon spills. The PIRMP will be updated as follows to incorporate the project:

- All personnel will be trained in hazardous substance management, emergency response and the use of spill kits.
- Appropriately sized and stocked spill response kits will be provided in strategic areas of the quarry and in vehicles used to transport hazardous materials to and from the site.
- Spill response kits will be maintained, clearly identified and readily accessible for use in case of accidental spillages. Key staff will be trained in their use, application and disposal of contaminated material.
- Potential chemical pollutants (e.g. fuels, oils, lubricants, paints, etc.) will be stored in appropriate containers in bunded areas in vehicles or designated storage areas to minimise the risk of spillages and mobilisation of pollutants into the soil or stormwater drains.
- Equipment will not be used if there are signs of fuel, oil or hydraulic leaks. Leaks will be repaired immediately, or the equipment will be removed from site and replaced with a leak-free item.
- Soil contaminated by spills will be excavated, classified in accordance with Waste Classification Guidelines, and disposed of at a licensed waste management facility, or remediated on site in accordance with a contaminated land management action plan to be prepared by a contaminated land specialist.

20.3.2 Bushfire management

The following management measures will continue to be implemented:

- Fire extinguishers will continue to be provided in the depot. The water cart and front-end loader will continue to be available for firefighting.
- The existing haul road to the windblown sand extraction area has been constructed and will continue to be maintained to enable ready access for fire fighting vehicles.
- Internal roads at the quarry will continue to be maintained for operational and firefighting purposes.
- All employees will continue to be trained through the induction process to be vigilant with regard to fire prevention, emergency procedures and reporting of fires to the RFS.

The following additional management measures will be implemented:

- following the approval of the project and for the life of the quarry, the APZ around the depot buildings will be maintained to a distance of 25 m as an inner protection area, as outlined in Appendix 5 of PBP and the NSW Rural Fire Service's document Standards for APZs;
- the existing workshop will have the polycarbonate roofing replaced with metal roof sheeting;
- the new haul roads will comply with Appendix 5 of PBP comprising a minimum 6.5 m in width, with a turning bay with minimum 12 m outer radius at the termination of the road;
- water, electricity and gas utilities will comply with Section 4.1.3 of PBP;
- a 30,000 L static water supply with firefighting fittings will be installed;
- the depot will be landscaped in accordance with Appendix 5 of PBP and managed and maintained; and
- the Quarry Manager will incorporate the new demountable building into the existing emergency evacuation plans, with specific consideration of bushfire evacuation planning.

20.3.3 Soil and water contamination

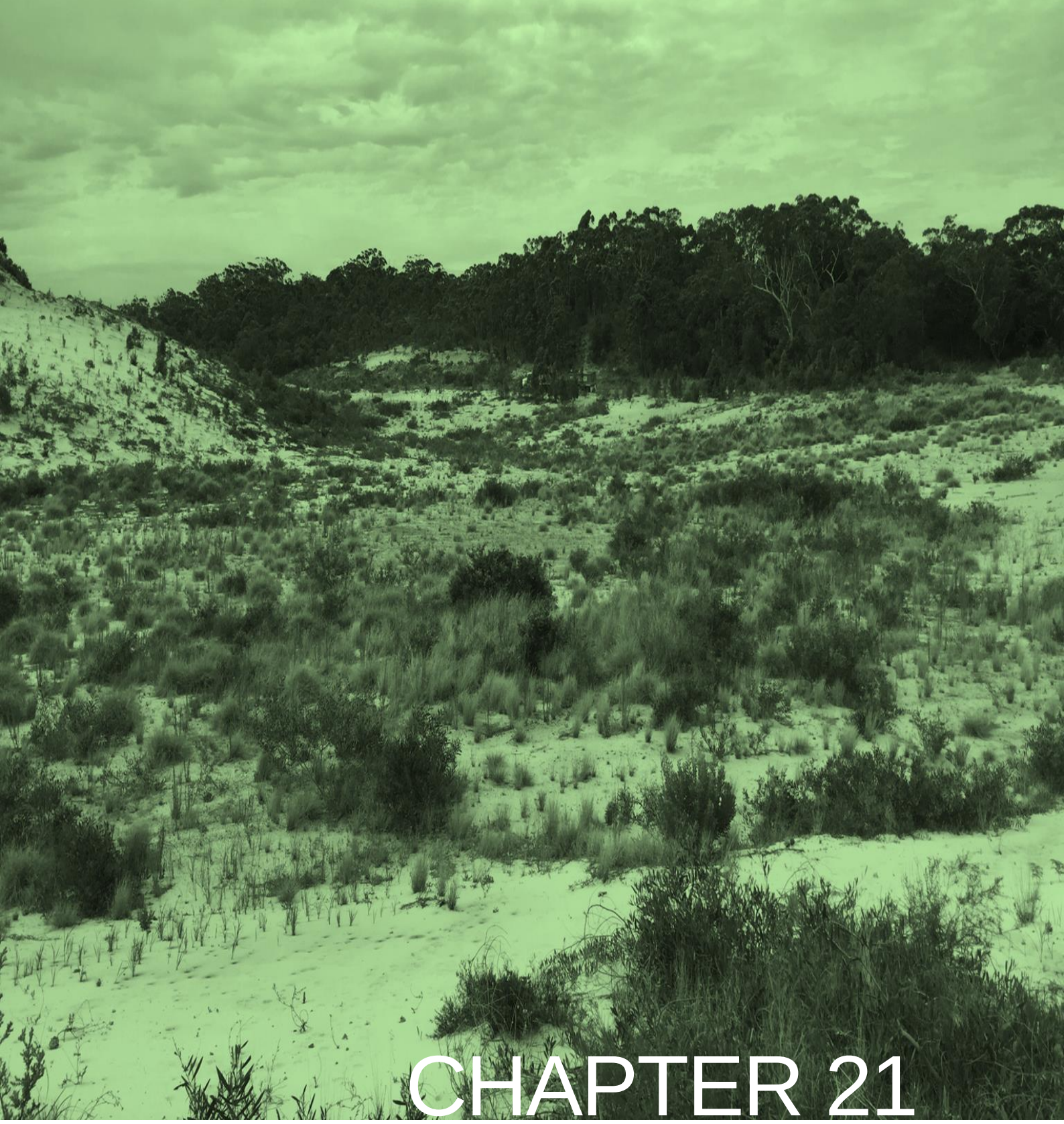
Plant and equipment will be maintained to minimise the potential for leakages, while appropriately sized and stocked spill response kits will be provided in strategic areas of the site, and in vehicles.

A PIRMP has been developed by Boral as part of the approved windblown sand extraction project to manage any potential chemical or hydrocarbon spills. The PIRMP will be updated to incorporate the project.

20.3.4 Risk to workers

Designated first aid and emergency response equipment will be available during construction and operation phases of the project. Appropriately trained personnel will be on site throughout the life of the operations to provide first aid and respond to site emergencies.

Any injuries incurred at the quarry will be reported and investigated in consultation with NSW Resource Regulator and other relevant authorities. Any recommendations or findings of investigation reports will be implemented by Boral where feasible and practical.



CHAPTER 21

ECONOMICS

21 ECONOMICS

21.1 Introduction

This chapter summarises the economic assessment report, which is in **Appendix N**. It describes the Cost Benefit Analysis (CBA), local effects analysis (LEA) and supplementary local effects analysis of the project.

21.1.1 Assessment requirements

The SEARs require an assessment of the likely economic impacts of the project (**Table 21.1**).

Table 21.1: Economics related SEARs

Requirement	Section and appendix where addressed
An assessment of the likely economic impacts of the development, paying particular attention to:	Chapter 21, Appendix N
▪ the significance of the resource;	Section 1.2, Appendix N
▪ the costs and benefits of the project; identifying whether the development as a whole would result in a net benefit to NSW, including consideration of fluctuation in commodity markets and exchange rates;	Section 21.2, Section 21.3, Appendix N
▪ the demand for the provision of local infrastructure and services.	Section 21.2.1, Appendix N
The reasons why the development should be approved having regard to physical, economic and social considerations, including the principles of ecologically sustainable development.	Section 6.3.2

The following guidelines were used for the assessment:

- Guidelines for the economic assessment of mining and coal seam gas proposals (NSW Department of Planning and Environment, 2015); and
- Draft guideline for economic effects and evaluation in environmental impact assessment (Planning NSW, 2002).

21.1.2 Overview of assessment methods

Cost benefit analysis

CBA is the standard technique applied to identify changes in aggregate wealth, from a national perspective, associated with alternative resource use patterns.

CBA compares the present value of aggregate benefits to society as a result of a project with the present value of the aggregate costs. It is the financial and non-financial values held by individuals in society that are relevant. Provided the present value of aggregate benefits to society exceed the present value of aggregate costs (i.e. a net present value of greater than zero), the project is considered to improve the well-being of society and hence is desirable from an economic efficiency perspective.

The key steps in CBA are:

1. **Establish the base case** against which to assess the potential economic, social and environmental impacts of changes due to the project.
2. **Define the project** including all significant inputs required to achieve the project's objectives.
3. **Quantify the changes** from the base case resulting from the project. This will focus on the incremental changes to a range of factors (for example, environmental, economic, social) resulting from the project.
4. **Estimate the monetary value of these changes** and aggregate these values in a consistent manner to assess the outcomes. Where market prices exist, they are a starting point for valuations of both outputs and of inputs used for production. For non-market goods, as for many environmental impacts and some social impacts, the aim is to value them as they will be valued in money terms by the individuals who experience them.
5. **Estimate the net present value (NPV)** of the project's future net benefits, using an appropriate discount rate.
6. **Undertake sensitivity analysis** on the key range of variables, particularly given the uncertainties related to specific benefits and costs.
7. **Assess the distribution of costs and benefits** across different groups.
8. **Report CBA results, including all major unquantified impacts** so the appraisal addresses and incorporates all material relevant to the decision maker.

Local effects analysis

The LEA complements CBA by translating effects at the NSW level to impacts on the communities near the project site (using Statistical Area Level 3 – the LGA). It also provides additional information to describe changes that are anticipated in a locality, such as employment changes. LEA informs the scale of change rather than being representative of costs and benefits to the local community.

The local effects analysed in a LEA are:

- local employment and income effects;
- other local industry effects, for example on suppliers; and
- environmental and social change in the local community.

21.2 Cost benefit analysis

21.2.1 Cost and benefit estimates

CBA is concerned with whether the incremental benefits of the project exceed the incremental costs and, therefore, whether the community will, in aggregate, be better off 'with' the project compared to 'without' it.

The base case (without the project proceeding) for the CBA was continued operation of the windblown sand extraction area with extraction of a remaining sand resource of 1.45 Mt until 2028. On completion of the operation, final rehabilitation of disturbed areas would occur.

In contrast, the project will extract at a rate of up to 0.5 million tonnes per annum (Mtpa). Until such time as the current windblown sand extraction area development consent ceases, the windblown sand extraction area and the project will run in parallel to reach a maximum extraction and processing quantity from the site of up to 0.75 Mtpa.

Relative to the base case, the project may have incremental economic benefits and costs as described in **Table 21.2**.

The main potential economic benefit is the producer surplus (net production benefits) generated from sand extraction, producer surplus generated from ex-quarry transportation to customers,

and any wage benefits to employment. The main potential economic costs relate to any environmental, social and cultural costs of quarrying and product transportation.

The environmental, social and cultural costs are only economic costs to the extent that they affect individual and community well-being through direct use or non-use of the environmental factors. Unless community wellbeing is significantly affected by these, only mitigation, compensation or offsetting costs are included in the CBA.

The analysis period was 25 years and was in real values with 7% discounting. Where available, competitive market prices were used as indicators of economic values.

Production costs

Production costs were applied as follows:

- opportunity cost of land – the land is owned by Boral, with a leased Crown land title. This land could be used for rural production rather than extractive industry and has an estimated value of $2.5 million (M) in 2028.
- capital equipment and infrastructure – there is an opportunity cost of using this equipment for the project that holds some residual market value. For the purposes of the CBA, it was assumed that there is no residual value of capital equipment and infrastructure.
- development cost – capital costs for replacement and upgrades of site infrastructure and purchase of mobile plant and equipment, estimated at $6 M.
- additional one-off costs – $2.5 M was attributed to acquisition of biodiversity offsets and WAL and installation of a water storage tank for firefighting purposes.
- annual operating costs – operating costs of $3 M per year include those associated with project operations progressive rehabilitation and administration (including labour). Operating costs do not include royalties or depreciation.
- rehabilitation and decommissioning costs – the cost to decommission and rehabilitate the project site will be approximately $100,000.

Production benefits

Production benefits were applied as follows:

- avoided rehabilitation and decommissioning costs – by undertaking the project there are no avoided or delayed rehabilitation costs associated with the existing windblown sand development consent. This is because the existing development consent relates to sand extraction in a different location to that proposed for the project. Final rehabilitation under the existing development consent will occur at the end of that consent (i.e. 2028), regardless of the project. The site has minimal infrastructure, comprising a site office with amenities, workshop and weighbridge. Minimal decommissioning costs are assumed.
- value of sand – the main economic benefit of the project will be the market value of the annual sand extracted for external and internal sale.
- residual value at end of evaluation period – it is assumed that rehabilitated land (not including the biodiversity offsets) has a residual value of $2.5 M in accordance with its current land value, and that capital equipment has no residual value.

As product transport externalities are a consideration of the EIS, economic benefits associated with transportation of sand product to customers were considered.

Environmental, social and cultural impacts

Costs or benefits were not attributed to environmental, social or cultural impacts as:

- the opportunity costs of any foregone rural production were incorporated in the CBA by inclusion of the full value of land required for the project (including land already owned by Boral).
- there will be no material noise, air quality, historic heritage or visual impacts.
- the opportunity cost of extracting up to 100 ML/year from the Stockton Groundwater Source was included in the operating costs by applying an assumed market value of water of $5,000/ML.
- no private registered bores will be impacted by the project and hence no material impacts from an aggregate economic efficiency perspective were identified for inclusion in the CBA.
- the capital and operating costs of providing biodiversity offsets and installation of a water storage tank for firefighting purposes were included in the capital and operating costs of the project.

Employment

The project will result in all five existing jobs at the quarry being retained together with an additional two new full-time jobs and two casual jobs at the quarry. In addition, jobs associated with the transportation of quarry material will also be retained and additional transport jobs generated.

The wages associated with employment are considered in the CBA as an economic cost of production, with this cost included in the calculation of net production benefits (producer surplus).

Adjoining land values

All land required for the project is owned by Boral. No benefits to other landholders via land prices in excess of the opportunity cost of the land will occur.

Public infrastructure

No net infrastructure costs to the NSW Government are envisaged as a result of the project. Given that additional employment will likely be sourced from existing residents of NSW, no additional demand for community infrastructure is envisaged.

21.2.2 Consolidated value estimate

The present value of costs and benefits, using a 7% discount rate, are summarised in **Table 21.2**. The project is estimated to have total net production benefits (quarrying and product transportation) of $48 M. Assuming 25% foreign ownership of Boral, $41 M of these net production benefits will accrue to Australia.

For the project to be questionable from an economic efficiency perspective, all incremental residual environmental impacts from the project will need to be valued by the community at greater than $41 M.

However, most of the potential impacts are internalised into the capital and operating costs of Boral via mitigation, offset or compensation, and hence are incorporated into the estimate of net production benefits. Consequently, the project is estimated to have net social benefits to Australia of $41 M and hence is desirable and justified from an economic efficiency perspective.

Table 21.2: Global and national cost benefit analysis results

	Costs		Benefits	
	Description	**Value ($M)**	**Description**	**Value ($M) (present values at 7% discount rate)**
Net production benefits from quarrying	Opportunity cost of land	1	Avoided decommissioning and rehabilitation costs	0
	Opportunity cost of capital	0	Financial sand – internal and external sales	72
	Development costs	7	Residual value of capital	1
	Operating costs	27	Residual value of land	0
	Decommissioning and rehabilitation costs	0		
	Sub-total	***34***	***Sub-total***	***73***
	Net production benefits			**39 (32)**
Net production benefits from ex quarry transport	Transport costs.	72	Transport revenue	81
	Net production benefits			**9 (9)**
	Total net production benefits			**48 (41)**
Environmental, social and cultural impacts	Noise	No property impacted by exceedances	Market values of employment	N/A
	Air quality	No property impacted by exceedances	Economic benefits to existing landholders	N/A
	Surface water and groundwater	Cost of WAL included in capital costs	Economic benefits to suppliers	N/A
	Ecology	Some loss of values but offset. Cost of offset included in capital and operating costs		
	Road transport impacts	No material network, level of service or safety impacts		
	Aboriginal heritage	No material impacts		
	Bushfire hazard	Additional cost of water storage tank and firefighting equipment included in capital costs		
	Historic heritage	No material impacts		

	Costs		Benefits	
	Description	**Value ($M)**	**Description**	**Value ($M) (present values at 7% discount rate)**
	Visual	No material impacts		
	Greenhouse gas	No material impacts		
	Net public infrastructure costs	No material impacts		
	Loss of surplus to other industries	No material impacts		
	Non-market impacts sub-total	**0**		**0**
Net social benefits				**48 (41)**

21.2.3 NSW costs and benefits

The costs and benefits of the project to NSW are summarised in **Table 21.3**. The potential impacts were apportioned to NSW as follows:

- 32% of the company tax (sand extraction and product transport) goes to NSW;
- 32% of the residual net producer surplus (sand extraction and product transport) goes to NSW; and
- 100% of residual net producer surplus of transport provision is apportioned to NSW.

All other potential environmental, social and cultural impacts accrue to NSW households. However, these impacts are largely mitigated, compensated or offset by Boral.

The estimated net social benefits of the project to NSW are estimated at $17 M, present value at 7% discount rate (the latter including employment benefits). Consequently, as well as resulting in net benefits to Australia, the project will also result in net benefits to NSW.

Any unquantified residual impacts of the project after mitigation, offset and compensation will need to be valued at greater than $17 M, present value for the project to be questionable from an NSW economic efficiency perspective.

Table 21.3: NSW cost benefit analysis results

Costs		Benefits	
Description	**Value ($M)**	**Description**	**Value ($M) (present values at 7% discount rate)**
Environmental, social and cultural impacts		**Net production benefits of quarrying**	
Noise	No properties impacted by exceedances	Direct company taxes	4
Air quality	No properties impacted by exceedances	Residual net production benefits	7
Surface water and groundwater	Cost of WAL included in capital costs	***Sub-total***	***11***
Ecology	Some loss of values but offset. Cost of offset included in capital and operating costs	**Net production benefits of product transport**	
Road transport	No capacity or safety issues.	Boral company tax	1
Bushfire hazard	Additional cost of water storage tank and firefighting equipment included in capital costs	Boral residual net production benefits	6
Aboriginal heritage	No material impacts	***Sub-total***	***7***
Historic heritage	No material impacts	**Additional benefits**	
Visual	No material impacts	Market values of employment	N/A
Net public infrastructure costs	No material impacts	Economic benefits to existing landholders	N/A
Loss of surplus to other industries	No material impacts	Economic benefits to existing suppliers	N/A
Total	**0**	***Sub-total***	***0***
Net social benefits to NSW			**17**

Incidence of NSW costs and benefits

The costs and benefits of the project to NSW will potentially be distributed among the stakeholders summarised in **Table 21.4**.

Table 21.4: Incidence of NSW costs and benefits

Benefits and costs	Incidence of costs and benefits	Magnitude of impact ($M)
Net production benefits of quarrying		
Direct company tax	NSW Government and households	4
Residual net production benefits	Boral and its NSW shareholders	7
Net production benefits of product transport		
Boral company tax	NSW Government and households	1
Other transport providers residual net production benefits	Other transport providers and their owners/shareholders	6
Additional benefits		
Wage benefits to employment	Employees of the project who reside in NSW	N/A
Economic benefits to existing land holders	Local landholders who sell land required for project including buffer land	N/A
Economic benefits to suppliers	Regional and State suppliers of inputs to production	N/A
Environmental, social and cultural costs		
Noise	Adjoining landholders.	No properties impacted by exceedances
Air quality	Adjoining landholders	No properties impacted by exceedances
Surface water and groundwater	Local surface water users	0.5 - cost of WAL included in capital costs
Ecology	Local and NSW households	2 - some loss of values but offset. Cost of offsets included in capital and operating costs
Road transport	Local residents	No material network, level of service or safety impacts
Aboriginal heritage	Aboriginal people and other local and NSW households who value Aboriginal heritage	No material impacts
Historic heritage	Local and NSW households who value heritage	No material impacts
Visual	Adjoining landholders and those travelling past the quarry	No material impacts
Greenhouse gas	Local and NSW households	No material impacts
Net public infrastructure costs	NSW Government and NSW households	No material impacts
Loss of surplus to other industries	Local industries adversely impacted by the project	No material impacts

21.3 Local effects analysis

Two different methods were used to assess local effects, with the local effects analysis summarised in this section. The Port Stephens, Newcastle and Maitland LGAs were used as the local area.

The project will have a direct effect by continuing to employ a minimum of five people on-site. Assuming the project did not proceed, these employment opportunities will gradually reduce in line with reduced production and cease following 2028.

The project is estimated to provide continued transport employment for 17 people from the local area, plus employment for an additional nine people from the local area. Based on estimated wages for quarry workers and average wage from the input-output table for the road transport sector, the project is estimated to provide initial incremental net income to the local area of $0.6 M increasing to around $1 M when production levels reduce to 500,000 tpa following 2028. The increased disposable net income in the region may be as high as $1.6 M if current production levels could not be maintained under the base case due to shortages of sand.

The level of benefit to the local area economy, may be reduced if people employed by the project will otherwise have been employed elsewhere in the local area, and the increased demand for labour as a result of the project has no job chain effects (i.e. it is assumed that employment for the quarry and transport will simply substitute for other jobs in the region).

Non-labour expenditure to the local area will be $2.4 M per year, when production associated with the project is at its peak of 750,000 tpa.

The incremental expenditure by employees and non-labour expenditure that is captured by the local area provides flow-on economic activity to the local economy, which can be estimated in terms of economic activity indicators of output, value-added, income and employment.

21.4 Supplementary local effects analysis

The supplementary LEA uses input-output (IO) analysis to identify the gross economic activity associated with the project on the local economy. It involves the development of an IO table representing the buying and selling of goods and services in the economy. These fixed average ratios are used to estimate the direct and indirect impacts of a change in expenditure in a region.

The IO analysis identifies the gross direct and indirect additional (positive) regional economic activity associated with a project in terms of indicators of economic activity – output, income, value-added and employment. Value-added is the difference between the gross value of business turnover and the costs of the inputs of raw materials, components and services bought in to produce the gross regional output.

The project is estimated to make up to the following incremental contribution to the regional economy for 25 years:

- $5 M in annual direct and indirect regional output or business turnover;
- $3 M in annual direct and indirect regional value added;
- $1 M in annual direct and indirect household income; and
- Nine direct and indirect jobs.

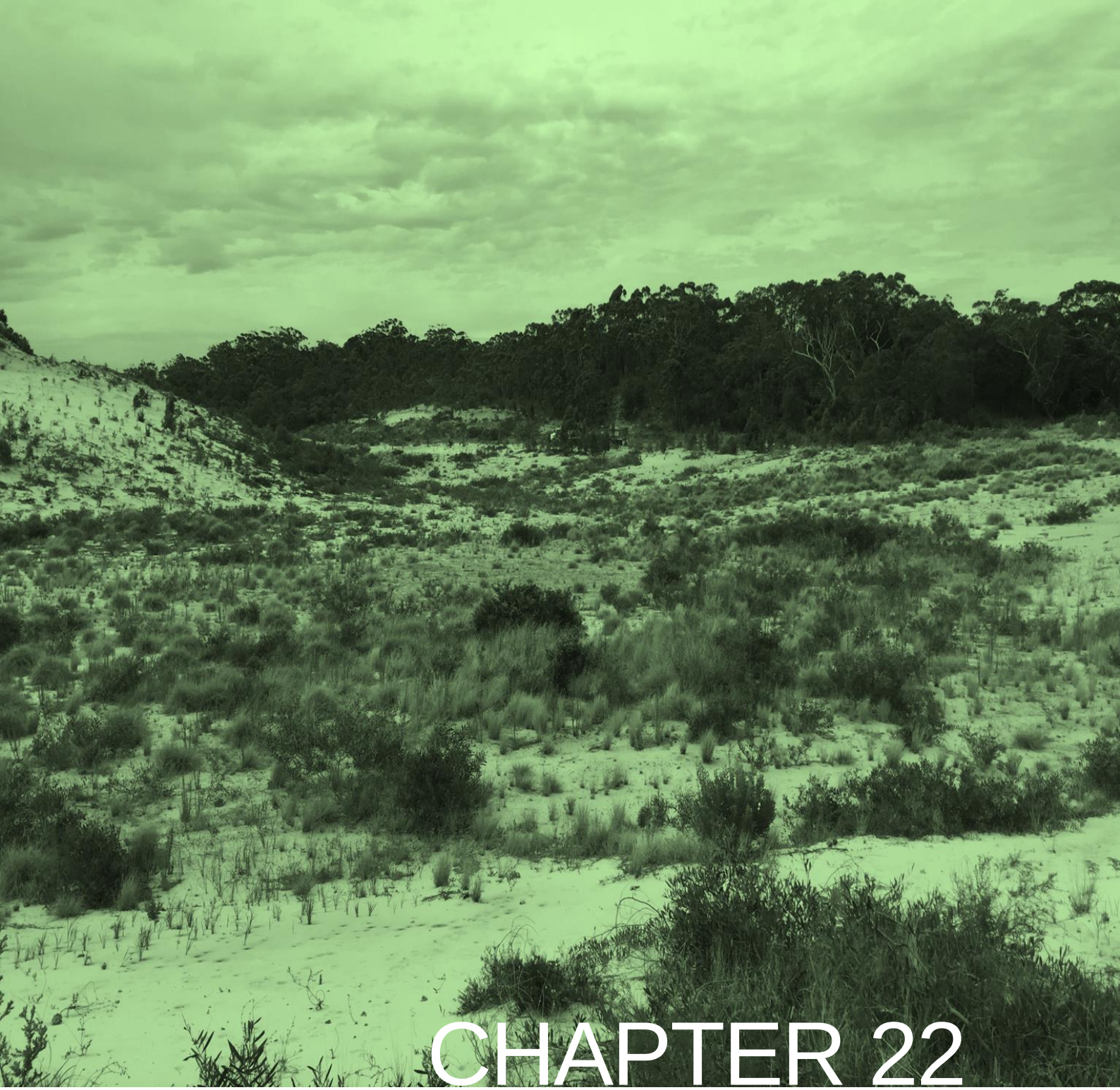
The transportation of sand products generated by the project is estimated to make up to the following incremental contribution to the regional economy for 25 years:

- $4 M in annual direct and indirect regional output or business turnover;
- $2 M in annual direct and indirect regional value added;
- $1 M in annual direct and indirect household income; and

- 16 direct and indirect jobs.

21.5 Residual impacts

A CBA of the project indicated that it will have net social benefits to Australia of $41 M, and net social benefits to NSW of $17 M. Hence the project is desirable and justified from an economic efficiency perspective. Environmental, social and cultural impacts of the project have been minimised through project design and mitigation, offset and compensation measures. The economic value of residual impacts are considered to be immaterial from an aggregated economic efficiency perspective.



CHAPTER 22

REHABILITATION

22 REHABILITATION

This chapter summarises the rehabilitation strategy in **Appendix O**. It describes the rehabilitation objectives, method and management measures.

22.1 Assessment guidelines and requirements

The SEARs require a rehabilitation strategy for the project (**Table 22.1**).

Table 22.1: Rehabilitation strategy SEARs

Requirement	Section and appendix where addressed
the proposed rehabilitation strategy for the site having regard to the key principles in the Strategic Framework for Mine Closure, including:	Appendix O
rehabilitation objectives, methodology, monitoring programs, performance standards and proposed completion criteria;	Section 22.2, 22.3 and 22.5
nominated final land use, having regard to any relevant strategic land use planning or resource management plans or policies; and	Section 22.2
the potential for integrating this strategy with any other rehabilitation and/or offset strategies in the region.	Section 22.4

The SEARs recommend use of the following guidelines, which were used during the assessment:

- *Mine Rehabilitation – Leading Practice Sustainable Development Program for the Mining Industry* (Department of Industry, Tourism and Resources, 2006);
- *Mine Closure and Completion – Leading Practice Sustainable Development Program for the Mining Industry* (Department of Industry, Tourism and Resources, 2006); and
- *Strategic Framework for Mine Closure* (Australian and New Zealand Minerals and Energy Council and Minerals Council of Australia, 2000).

22.1.1 Overview of existing rehabilitation methods

As set out in **Section 4.1**, the project site is generally consistent with the footprint of the previous inland extraction area. This area of historical extraction has and continues to be subject to rehabilitation in accordance with the *Rehabilitation and Landscape Management Plan* (ERM, 2010), that has been updated to include rehabilitation measures for the windblown sand project area.

The rehabilitation and landscape management plan outlines rehabilitation methods comprising species selection, weed and pest management measures, and monitoring and reporting requirements for rehabilitated areas.

The rehabilitation method, where relevant to the inland dunes, is summarised below.

Landscape reshaping

The finished batters along the perimeter of the active extraction area were shaped to merge with the contours of the adjoining land to form a continuous landform free of depressions and steep slopes.

Topsoil replacement

Topsoil stripped ahead of the active working face for immediate placement on reshaped areas or from stockpiles is re-spread over finished areas to a minimum depth of 200 mm. Once placed, the topsoil layer was protected from disruption or compaction by excluding vehicle traffic from the area.

Revegetation procedures

The primary objective is to provide sufficient ground cover to minimise the potential for wind erosion. Initially, a cereal cover crop was sown, which was fertilized to ensure successful establishment. The purpose of the cover crop was to stabilise the soil surface and provide protection for emerging native seedlings from the sun and wind.

Timber felled from disturbance areas is often evenly distributed over the revegetation area to act as brush matting and assist as a wind break for emerging native seedlings.

On steeper slopes, temporary fences, such as woven synthetic cloth, were erected perpendicular to the prevailing wind conditions to protect juvenile plantings from wind damage.

Spinifex (*Spinifex hirsutus*) is often planted to ensure that a stable vegetated surface is maintained in areas subject to severe wind erosion. Generally, the replacement of organic topsoil will ensure the successful re-establishment of native shrubs, trees and ground cover species.

The area was the re-planted with tubestock of indigenous native species to supplement natural regeneration from seed stock.

Revegetation areas are frequently watered after planting.

Weed control

Weed growth is monitored and managed by physical, chemical or biological controls depending on the nature of weed infestation.

The principal weed management strategy is to reduce or eliminate physical disturbance to existing and regenerating vegetation and to closely monitor equipment and vehicles for the spread of weed propagules. Any weeds that establish on revegetated areas are controlled as soon as practicable.

22.1.2 Inspection of rehabilitated areas

The efficiency of rehabilitation to date was assessed, with consideration of time since rehabilitation and any localised site impacts which may have impacted vegetation establishment. The findings of the assessment were used to inform recommendations for rehabilitation of the project site.

Rehabilitation activities have generally been successful at the quarry to date. The degree of vegetation establishment largely depends on the duration since sand extraction activities ceased, with the older rehabilitated areas of the former inland extraction area having well established tree cover, while more recent rehabilitated areas of the inland extraction area have smaller trees and shrubs.

The successful species in rehabilitated areas predominantly comprised:

- Swamp Mahogany (*Eucalyptus robusta*);
- Coastal Wattle (*Acacia sophorae*);
- Beach Fescue (*Austrofestuca littoralis*); and

- Pig Face (*Carpobrotus glaucescens*).

Poor vegetation establishment has occurred in some areas due to:

- exposure to high winds which disturb surface soil, particularly on elevated slopes;
- areas where nutrient deficiency limits plant growth; and
- limited water availability observed on high exposed dunes, and
- soil compaction over former haul roads.

22.1.3 Key rehabilitation learnings

The following successful rehabilitation techniques will continue for the project:

- species selection which has facilitated establishment of a diverse and robust ecological environment which is representative of local native vegetation; and
- weed management which has been successful in removing targeted species and preventing infestation.

The existing rehabilitation process will be improved as follows:

- Areas subject to high winds, such as elevated dunes, require additional stabilisation to allow vegetation establishment. These areas may also require use of more robust species, such as Spinifex to stabilise soil.
- Areas subject to compaction and heavy impact, such as haul roads, may require deep ripping prior to rehabilitation to improve soil water availability and allow root penetration of soil.
- Targeted application of suitable fertilizer, and/or use of nitrogen fixing plant species may improve plant establishment in some areas.

22.2 Rehabilitation objectives

Upon completion, the project site will be left as a freshwater pond and rehabilitation efforts will generally include:

- rehabilitating the pond edge, to provide additional habitat for native fauna;
- plant species planted along the edges of the pond will be selected to maximise the bank stability; and
- stabilising re-profiled areas as soon as possible, minimise potential erosion and degradation of areas of exposed topsoil.

In the initial phases of work, rehabilitation will primarily aim to stabilise the edge of the pond and where necessary continued use of a poly pipe to form a floating boom system at the exposed pond edge to minimise erosion.

Disturbed areas will be progressively rehabilitated to achieve the final landform. The general rehabilitation objectives are:

- rehabilitated land will be geotechnically stable and will not present a greater safety hazard than surrounding land to land-users, the public and native fauna accessing or transiting the post-quarried area;
- land capability will, as far as possible, be returned to a class similar to that existing prior to project commencement (class 5 or 8).
- rehabilitated landforms will be visually compatible with the surrounding natural landscape;
- rehabilitated landforms will be designed to drain surface runoff without causing excessive erosion or increasing downstream sedimentation;

- re-establishment of vegetation community which reflects the endemic ecology of the region and minimises the potential for weed invasion or vegetation community collapse; and
- rehabilitated landforms will not negatively impact visual amenity for nearby residents, thoroughfare motorists of Nelson Bay Road, or recreational users of Stockton Bight.

22.3 Rehabilitation performance criteria

The performance criteria for the rehabilitation of the final post sand extraction landform of the project site are:

- stabilisation of disturbed areas with re-established coverage of endemic species of vegetation; and
- a landscape function analysis (LFA) level of natural regeneration greater than 50% of the previously assessed natural bushland control site in the quarry property.

22.4 Integration of rehabilitation with previous efforts

The post-quarrying landscapes from previous quarry stages have been rehabilitated according to their respective rehabilitation plan (ERM, 2010). While the rehabilitation of these areas has been largely successful, some aspects of the rehabilitation indicate areas where improvements and efficiencies could be made. Where practical, these findings have been incorporated into the development of the rehabilitation strategy for the project. There are no other rehabilitation strategies in the region identified with commonality to the setting of the project site.

The rehabilitation strategy for the project therefore aims to integrate the successful aspects of the rehabilitation efforts at the quarry. This will also provide the benefit of consistency in approach for Boral, consistent use of rehabilitation species and continuity for landscape suppliers.

22.5 Mitigation, monitoring and management measures

Table 22.2 summarises mitigation, rehabilitation, monitoring and maintenance works for rehabilitation of the project site.

Table 22.2: Proposed rehabilitation and management timeline

Site area	Mitigation / rehabilitation measure	Timeframe
Entire project site	Fly over survey of current landform levels to inform rehabilitation, vegetation and monitoring.	Prior to site establishment
Project site periphery	Maintain buffer zone of trees to provide a screen between Project activities and the quarry boundaries	Ongoing
	Monitor buffer zone to ensure the screen remains intact and sufficient for operations.	During sand extraction and ongoing
	Removal of undesirable weed species and vegetation not consistent with the local vegetative succession.	Ongoing maintenance
	Revegetation by way of selective planting with species native to the locality	Ongoing
	Encouragement of natural reafforestation through weed control and reduction.	Ongoing maintenance

Site area	Mitigation / rehabilitation measure	Timeframe
Extraction area / dredge pond	Vegetate dredge pond / excavation area embankments with native low growing shrubs and grasses to provide bank stability and reduce erosion (including water tolerant and salt tolerant species).	During sand extraction and at conclusion of operations in each stage
	Monitor dredge pond / excavation pit embankments to ensure the area remains intact and sufficient for operations.	During sand extraction
	Encouragement of natural reafforestation through weed control and reduction.	Ongoing maintenance
Final landform	Conversion of the dredge pond to a wetland (open pit) / freshwater pond.	At conclusion of Stage 6
	Revegetate dredge pond embankment and other disturbed areas with native water plant species (including water tolerant and salt tolerant species).	At conclusion of site operations in each stage
	Encouragement of natural reafforestation through weed control and reduction.	At conclusion of site operations in each stage

22.5.1 Rehabilitation process

The following steps will be implemented for progressive rehabilitation of the project site.

Development of final landform following completion of dredge activities

Design of the final landform will consider:

- the proposed post quarry land use;
- slope steepness and slope length to facilitate erosion control and establishment of slope stability;
- site drainage;
- requirement for soil preparation (i.e. deep ripping haul road corridors); and
- development to of a ‘natural’ contour profile.

Species selection for landscape position

Species selection will consider landscape position in relation to the dredge pond wetland or beach dune vegetation zones. The beach dune vegetation zones are specifically relevant to high exposed dunes, where wind impacts soil stabilisation.

Suitable revegetation species which may be used in rehabilitation is summarised in **Table 22.3**.

Table 22.3: Revegetation species

Species	Vegetation class	Vegetation zone	Suitability notes
Broad Leaved Paperbark (*Melaleuca quinquenervia*)	Tree	Riparian Zone Emergent Zone Hind Dune	Grows in swampy conditions and can regenerate within weeks of a bushfire. Successful previous use on site.

Species	Vegetation class	Vegetation zone	Suitability notes
Swamp Mahogany (*Eucalyptus robusta*)	Tree	Riparian Zone Hind Dune	Grows in swampy sandy conditions and is tolerant of waterlogging. Successful previous use on site.
Smooth-barked Apple (*Angophora costata*)	Tree	Hind Dune	Large tree, suitable for elevated, but not exposed locations.
Blackbutt (*Eucalyptus pilularis*)	Tree	Riparian Zone Hind Dune	Large tree common in grassy coastal forests.
Red Bloodwood (*Corymbia gummifera*)	Tree	Riparian Zone Hind Dune	Common to coastal flats and low hills. Tolerant of poorer, sandy soils.
Coastal Wattle (*Acacia sophorae*)	Shrub	Riparian Zone Hind Dune Foredune	Has the capacity to capture windblown sands resulting in the formation of hummocks. Beneficial for windblown and exposed areas. Nitrogen fixing species. Successful previous use on site. Wattles may have relatively short lifespan.
Sydney Golden Wattle (*Acacia longifolia*)	Shrub	Riparian Zone Hind Dune Foredune	Has the capacity to capture windblown sands resulting in the formation of hummocks. Beneficial for windblown and exposed areas. Nitrogen fixing species. Subspecies of Coastal wattle. Wattles may have relatively short lifespan.
Sweet Wattle (*Acacia suaveolens*)	Shrub	Riparian Zone Hind Dune Foredune	Has the capacity to capture windblown sands resulting in the formation of hummocks. Beneficial for windblown and exposed areas. Nitrogen fixing species. Wattles may have relatively short lifespan.
Coastal Teatree (*Leptospermum laevigatum*)	Shrub	Hind Dune Foredune	Salt and drought tolerant. Successful previous use on site.
Coastal Banksia (*Banksia integrifolia*)	Shrub	Hind Dune Foredune	Thrives in sandy conditions and suitable for the stabilisation of sand and enables the solubilisation of nutrients. Successful previous use on site.

Species	Vegetation class	Vegetation zone	Suitability notes
Old Man Banksia (*Banksia serrata*)	Shrub	Hind Dune Foredune	Thrives in sandy conditions and suitable for the stabilisation of sand and enables the solubilisation of nutrients.
Tree Broom Heath (*Monotoca elliptica*)	Shrub	Hind Dune Foredune	Long lived and hardy dune species. May be difficult to propagate from seeds – cuttings may perform better.
Common Bush Hop (*Dodonaea triquetra*)	Shrub	Riparian Zone Hind Dune	Forest understory.
Pig Face (*Carpobrotus glaucescens*)	Ground cover	Hind Dune Foredune Exposed dune	Has the capacity to capture windblown sands resulting in the formation of hummocks. Beneficial for windblown and exposed areas. Successful previous use on site.
Beach Fescue (*Austrofestuca littoralis*)	Grass	Hind Dune Foredune Exposed dune	Endemic beach grass species. Successful previous use on site.
Blue Flax Lily (*Dianella caerulea*)	Understory	Riparian Zone Hind Dune Foredune	Hardy and long-lived. Tolerant of a range of moisture conditions.
Kangaroo Grass (*Themeda australis*)	Grass	Foredune, Exposed dune	Widespread native grass, tolerant of a range of conditions.
Bracken Fern (*Pteridium esculentum*)	Understory	Hind Dune Foredune Exposed dune	Quick to colonise disturbed areas. Common in coastal woodlands. May be invasive.
Spiny Headed Mat-Rush (*Lomandra longifolia*)	Rush	Emergent Zone Riparian Zone	Tolerant of wet and drought conditions.
Cogon Grass (*Imperata cylindrica*)	Grass	Foredune Exposed dune	Tolerant grass used for ground cover and erosion control. May be invasive and difficult to control. Highly flammable.
Beach Spinifex (*Spinifex sericeus*)	Grass	Exposed dune	Deep roots to stabilise sand and prevent moisture loss. Recommended for locations where establishment of other vegetation has proven unsuccessful. Successful previous use on site.

Species	Vegetation class	Vegetation zone	Suitability notes
Common Spike Rush (*Eleocharis acuta*)	Rush	Aquatic/emergent zone	Shallow water freshwater wetland rush.

Note:
Information regarding collection of seed and runners, germination and planting, fertilisation and watering are provided in the Stockton Transgressive Dune Quarry Rehabilitation and Landscape Management Plan (ERM, 2010).

Stabilisation and revegetation of disturbed areas

The existing *Rehabilitation and Landscape Management Plan* (ERM, 2010) will be updated to incorporate the project. The updated management plan will address:

- the landscape units within each rehabilitation area;
- species and numbers of plants required for each rehabilitation area;
- site preparation requirements – including earthworks and deep ripping;
- soil stabilisation, erosion control and plant protection requirements for each stabilisation area;
- fertilizer requirements; and
- watering and maintenance requirements until plants are established.

Species selection for each rehabilitation area will also address species diversity and succession over time. While some species, such as wattles, may perform well in the short term, they may result in a monoculture which inhibits establishment of other species.

Pest and weed management

Rehabilitation will be regularly inspected for pests and weeds. Bitou Bush has been a problem at the quarry, however, manual removal has been successful in controlling this species. Targeted spraying or removal may be required during the project.

Animal or insect infestations will be monitored and managed as required.

22.5.2 Rehabilitation inspection schedule

The rehabilitation process will be inspected monthly and annually for progress and problems will be proactively identified.

Monthly monitoring will focus on identification of plant health or establishment issues.

Compliance with the performance criteria, particularly the 50% LFA target, will be inspected annually by a suitably experienced ecologist or environmental restoration consultant.

Long term monitoring

Management and monitoring of rehabilitation may occur for 10 years from the commencement of operations. The success of initial site preparation and vegetation establishment will significantly reduce the management requirements for each area over time.

Short to medium term management and monitoring will occur from 1-5 years where landscape stabilisation, vegetation establishment, erosion control and weed management will be monitored.

Monitoring may be substantially reduced over the long term if the short to medium term rehabilitation is successful. Monitoring over 5-10 years will focus on weed management, and species diversity and succession.

Rehabilitation will be inspected for 10 years post rehabilitation, or until the ecologist or restoration consultant advises inspections are no longer required.

22.5.3 Proposed rehabilitation completion criteria

The completion of the rehabilitation process will be assessed against the performance criteria for the rehabilitation of the final landform.

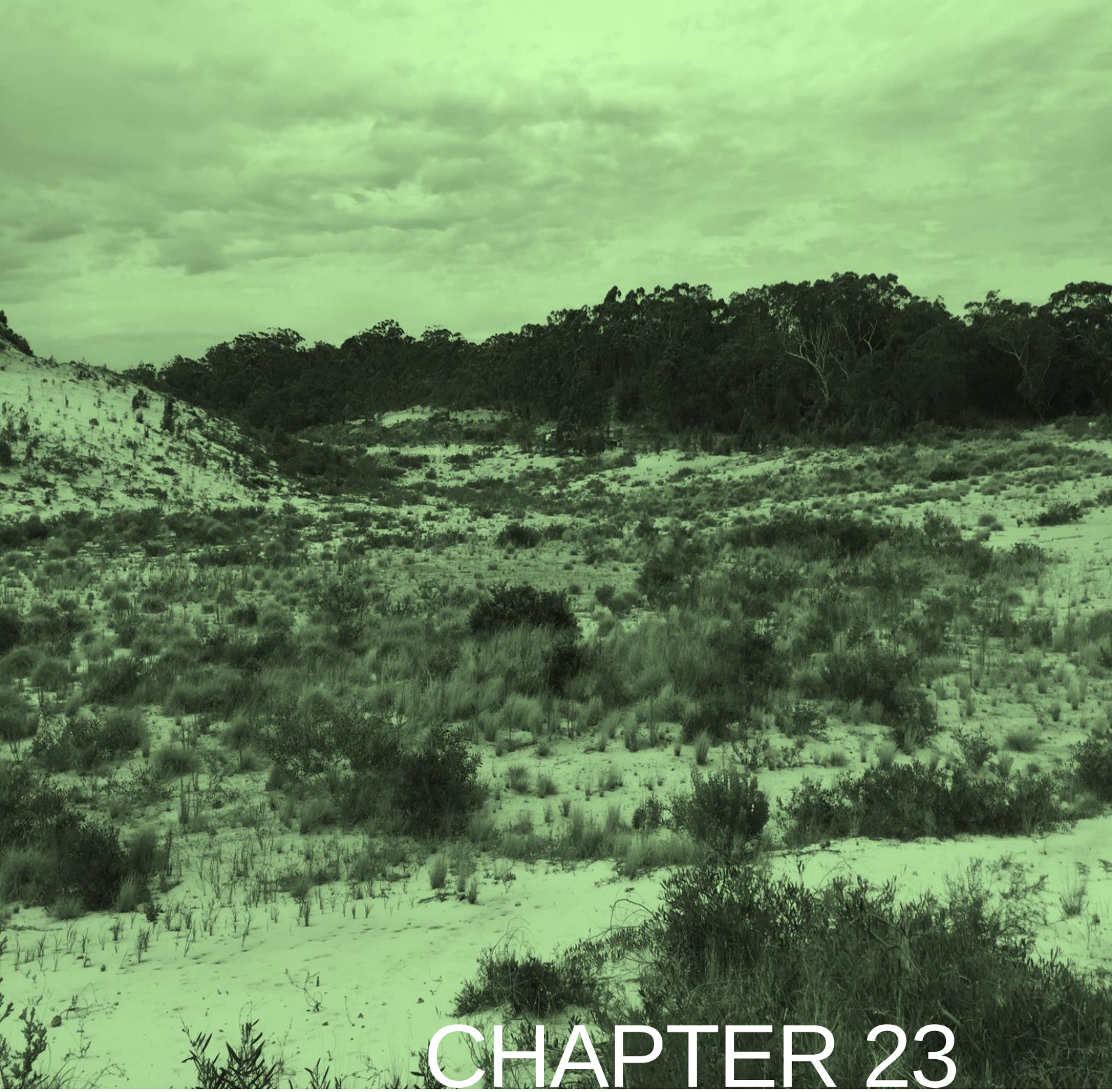
The rehabilitation criteria will be deemed to be complete when the criteria have been met, and vegetation communities are mature and stable. This may occur between 5-10 years post rehabilitation for each rehabilitation area. This will be assessed by the ecologist or environmental restoration consultant who may recommend that ongoing inspections are no longer required.

22.6 Residual impacts

The following risks may be present after implementation of the rehabilitation strategy:

- soils, geology and erosion – poor quality and/or insufficient topsoil; erosion; geotechnical failure such as slumping or subsidence; rehabilitation not meeting targeted land capability classes; and
- biological and environmental – poor vegetation establishment; inadequate weed control; animal predation of juvenile vegetation; disease infestation; poor vegetation development; severe or prolonged drought; bushfire; and major storm damaging vegetation and resulting in erosion.

A trigger action response plan will be prepared to identify trigger events or indicators related to the above threats, and provide appropriate response strategies.



CHAPTER 23

ENVIRONMENTAL MANAGEMENT, MONITORING AND REPORTING

23 ENVIRONMENTAL MANAGEMENT, MONITORING AND REPORTING

23.1 Introduction

This chapter summarises the key mitigation and management measures for addressing the potential environmental impacts of the project as required by the SEARs (**Table 23.1**).

Table 23.1: Environmental management and mitigation SEARs

Requirement	Section and appendix where addressed
Consolidated summary of all the proposed environmental management and monitoring measures, highlighting commitments included in the EIS.	Chapter 23

As outlined in **Chapter 2** and **3**, the quarry is managed in accordance with the conditions of consents, leases and licences, as well as various site environmental management plans.

Boral also maintains a comprehensive groundwater monitoring network at and surrounding the quarry. Data captured from this monitoring is used by quarry management to monitor compliance with their conditions of consent, EPL and other regulatory requirements.

23.2 Environmental management measures

The environmental management measures summarised in **Table 23.2** will be implemented during construction and operation of the project.

Table 23.2: Summary of environmental mitigation and management measures

Mitigation and management measures
Groundwater
The existing *Stockton Sand Quarry Groundwater Management Plan* (GWMP) (Jacobs, 2017) will be updated to encompass the project site.
Biodiversity
Fencing and/or the use of highly visible rope or tape boundaries will be used to delineate the boundary of vegetation clearing at the edge of the project site. Conservation areas will be signposted to restrict entry and reduce incidental interactions with threatened species (e.g. speed limit signage along access roads to reduce potential for fauna vehicle strikes).
Employees and contractors will be educated and required to implement the following controls to avoid or minimise potential indirect biodiversity impacts: ▪ minimise the extent and time that bare sand is exposed and by implementing appropriate dust suppression ▪ implement procedures for the management of hydrocarbon and/or chemical spills throughout the project site, including the requirements for vehicles to carry spill kits; ▪ ensure vehicles remain on designated roads and tracks and abide by site speed limits, through use of signposting and driver education during the induction process, and in ongoing project discussions; and ▪ management and removal of all waste material from the project site.
The vegetation clearing protocol in the *Stockton Transgressive Dune Quarry Rehabilitation and Landscape Management Plan* (ERM, 2010) will continue to be implemented for the project. The following will be implemented: ▪ Ecologists will survey for ground dwelling fauna prior to clearing of native vegetation and remove any fauna/fauna habitats to adjacent areas not proposed to be disturbed. ▪ Ecologists will supervise felling of remnant hollow-bearing trees or habitat trees located within Stage 1 of the project area. All hollow-bearing trees that are accessible safely from the ground will be checked and fauna relocated. Hollows higher up and not accessible from the ground will be

Mitigation and management measures
identified and trees felled gently by an excavator or dozer and left overnight to allow fauna to relocate. ▪ Fauna displaced during clearing will be captured where possible and relocated to designated areas by trained personnel. ▪ NSW Wildlife Information, Rescue and Education Service will be contacted to collect injured fauna.
Disturbed areas will be progressively rehabilitated in accordance with a rehabilitation management strategy to create a stable landform that does not result in sediment laden runoff or fugitive dust emissions, blends well with the adjacent natural landscapes and re-establishes native bushland. The *Stockton Transgressive Dune Quarry Rehabilitation and Landscape Management Plan* will be updated to reflect biodiversity management measures to protect and manage biodiversity values. The existing plan contains commitments to threatened species management, pest and weed management, fire management and site hygiene practices, which are to continue for the project.
The existing rehabilitation and landscape management plan will be updated to include a section on pest and weed management, including management protocols for the identification of noxious or environmental weeds within areas to be cleared (in order to avoid transporting the weeds to rehabilitation areas or other parts of the quarry).
Boral's (2010) *Stockton Transgressive Dune Quarry Environmental Management Strategy* includes a bushfire management plan, which contains fire prevention and suppression measures including maintenance of access roads to prevent potential ignition of grassland by vehicle exhaust. This plan will be updated to reflect the findings of the Bushfire Hazard Assessment for the project.
Air quality
Dust generation will be monitored during adverse weather and activities modified as required (e.g. activity will be curtailed or ceased where reasonable levels of visible dust cannot be maintained using the available means).
On-site vehicles and plant will be switched off when not in use.
Vehicles will be maintained and serviced according to manufacturer's specifications.
The extent of exposed surfaces and stockpiles will be kept to a minimum.
Exposed areas and stockpiles will be covered or dampened with water if dust emissions are visible, or there is potential for dust emissions outside operating hours.
Dust generation will be minimised by rehabilitating exposed areas when topsoil and subsoil stockpiles are moist and/or wind speed is below 10 m/s.
Drop heights from loading and handling equipment will be reduced where practical.
Dampen material when excessively dusty during handling.
Haul roads will be watered using water cart so the road surface has sufficient moisture to minimise on-road dust generation but not so much as to cause mud/dirt track out.
Regularly inspect haul roads and maintain surfaces to remove potholes or depressions.
Driveways and hardstand areas will be swept/cleaned regularly as required.
Site speed limits will be enforced.
Vehicle loads will be covered when transporting material off-site.
Complaints and incidents will be logged and investigated via Boral's site incident management system.
Any controls required to manage, mitigate or rectify a complaint or incident will be implemented as soon as practical. Following a complaint or incident, Boral will review all air quality controls and investigate implementation of additional controls if required.
Traffic
Boral will continue to implement the driver awareness training for all truck drivers, with a focus on the correct protocols when entering and exiting the site.
Social
When the EIS is placed on public exhibition it is recommended that: ▪ Fern Bay and Fullerton Cove residents will be notified in writing about exhibition of the EIS, the increased heavy vehicle volumes derived from the project, where these matters are addressed in the EIS, SIA and technical studies, how/where they can easily view the documentation, and an invitation to contact Boral to discuss any residual or additional concerns they may have; and ▪ Boral will place an article in the *Port Stephens Examiner* as well as on their website (and other media channels typically used throughout the SSD stakeholder engagement process) to notify of the EIS exhibition process as outlined above. During the above, Boral will outline the: ▪ increase in heavy vehicle numbers proposed for the road network; and

Mitigation and management measures
▪ high-level results of the road safety audit.
The initial request made to Google will be repeated with the objective of removing the Stockton Bight route (via the quarry) from Google maps. Achieving that objective will potentially dissuade members of the public from attempting to access the quarry without authority.
Written notification about the availability of the EIS on exhibition, and social media and local print media campaign to disseminate EIS information about project heavy vehicles
Soils and land resources
An ASS management plan will be prepared and implemented for the project in accordance with ASSMAC's (1998) Acid Sulfate Soils Assessment Guidelines.
Rehabilitation
Conduct a fly over survey of current landform levels to inform rehabilitation, vegetation and monitoring.
Maintain buffer zone of trees to provide a screen between project activities and the quarry boundaries.
Monitor buffer zone to ensure the screen remains intact and sufficient for operations.
Remove undesirable weed species and vegetation not consistent with the local vegetative succession.
Promote revegetation by way of selective planting with species native to the locality.
Encourage natural reafforestation through weed control and reduction.
Vegetate dredge pond / excavation area embankments with native low growing shrubs and grasses to provide bank stability and reduce erosion (including water tolerant and salt tolerant species).
Monitor dredge pond / excavation pit embankments to ensure the area remains intact and sufficient for operations.
Revegetate dredge pond embankment and other disturbed areas with native water plant species (including water tolerant and salt tolerant species).
Design of the final landform will consider: ▪ the proposed post quarry land use; ▪ slope steepness and slope length to facilitate erosion control and establishment of slope stability; ▪ site drainage; ▪ requirement for soil preparation (i.e. deep ripping haul road corridors); and ▪ development to of a 'natural' contour profile.
Species selection will consider landscape position in relation to the dredge pond wetland or beach dune vegetation zones. The beach dune vegetation zones are specifically relevant to high exposed dunes, where wind impacts soil stabilisation.
The existing *Rehabilitation and Landscape Management Plan* (ERM, 2010) will be updated to incorporate the project. The updated management plan will address: ▪ the landscape units within each rehabilitation area; ▪ species and numbers of plants required for each rehabilitation area; ▪ site preparation requirements – including earthworks and deep ripping; ▪ soil stabilisation, erosion control and plant protection requirements for each stabilisation area; ▪ fertilizer requirements; and ▪ watering and maintenance requirements until plants are established. Species selection for each rehabilitation area will also address species diversity and succession over time. While some species, such as wattles, may perform well in the short term, they may result in a monoculture which inhibits establishment of other species.
Rehabilitation will be regularly inspected for pests and weeds. Bitou Bush has been a problem at the quarry, however, manual removal has been successful in controlling this species. Targeted spraying or removal may be required during the project. Animal or insect infestations will be monitored and managed as required.
Aboriginal heritage
The boundary of the approved project site will be clearly delineated and Aboriginal heritage considerations will be included in the environmental management strategy.
Documented toolbox talks will be held to ensure all on-site staff and contractors are aware of obligations and requirements regarding the protection of Aboriginal heritage.
An unexpected finds and human remains procedure will be implemented during the project.
Surface water
Exposed soils generated through the construction of the haul roads and stabilised dredge pond embankments will be managed through standard erosion and sediment controls implemented in accordance with DECC's (2008) Managing Urban Stormwater: soils and construction, Volume 1 and

Mitigation and management measures
Volume 2C: Unsealed roads and 2D: main road construction, and will be outlined within an erosion and sediment control plan prepared for the establishment of the project.
Boral will consider implementing measures to reduce the quantity of water extraction from the Stockton Groundwater Source, particularly via evaporation from the dredge pond surface. There are a range of technologies available to reduce evaporation through techniques which limit exposure of surface water to atmosphere by providing shade and reducing air flow (wind), and direct barriers.
Any fines collected within the wash plant will be returned to the dredge pond. The water and fines return point will be located as far as possible from the dredging operation to limit reprocessing. Should fines settlement become an issue, a silt curtain will be installed to restrict fines movement between the dredge and fines return point. Dredging operations will be monitored to determine whether installation of a silt curtain is required.
Historic heritage
Should an item of potential Non-Aboriginal heritage be identified during project operations, works will cease, and the Quarry Manager will be contacted immediately. Appropriate measures will be taken to minimise the potential for harm to the object. Further advice will be sought from a qualified archaeologist, and subsequently DPIE Biodiversity and Conservation Division will be notified of the proposed course of action, if required.
Waste management
Waste will be managed in accordance with the WARR Act by adopting the resource management hierarchy (in order of priority) of avoidance, re-use, recycling / re-processing / treatment and disposal.
The existing environmental management strategy for the quarry will be updated as follows: ▪ wastes will be quantified and classified; ▪ disposal/reuse strategies for each type of material; ▪ details of how waste will be stored and treated on site; ▪ identification of non-recyclable waste; ▪ identification of measures and initiatives to reduce, reuse and recycle; and ▪ procedures and disposal arrangements for potentially hazardous material.
Waste will be managed in accordance with (NSW Environment Protection Authority, 2014) and relevant regulatory requirements. This will include (i) its classification prior to leaving the site and (ii) recording (via an appropriate waste tracking system) its legal off site transportation for re-use, recycling or disposal.
Waste (excluding toilet waste) will be stored in a suitable container with a lid, and transported to an appropriate facility. Enough receptacles for general waste, hazardous waste and recyclable materials will be provided, including sufficient bins to allow separation of wastes for recycling.
Wastes will only be disposed at a licenced waste disposal depot.
Wastes will be securely stored so that pollutants are prevented from escaping.
Fuel, lubricant or hydraulic fluid spillages will be collected using absorbent material and the contaminated material disposed of at a licensed waste facility.
Hazardous or contaminated wastes (if identified) will be removed and disposed in accordance with the State and national regulations and guidelines and best practice for the removal of these materials. Hazardous materials will only be removed by suitably qualified, licensed and experienced contractors.
Personnel will be required to notify the Quarry Manager, and follow approved SafeWork NSW procedures for the handling and transport of any asbestos containing material wastes to an EPA approved facility.
Documents and records of the transport and fates of all materials removed from the project site will be kept as proof of correct disposal and for environmental auditing purposes.
Waste streams will be sorted to maximise the reuse/recycling potential and minimise disposal costs.
Waste will be covered, stored and removed in a timely manner so as not to attract native animals or vermin.
Hazardous substances
A pollution and incident response management plan (PIRMP) has been prepared to manage potential chemical or hydrocarbon spills. The PIRMP will be updated to incorporate the project.
All personnel will be trained in hazardous substance management, emergency response and the use of spill kits.
Appropriately sized and stocked spill response kits will be provided in strategic areas of the quarry and in vehicles used to transport hazardous materials to and from the site.

Mitigation and management measures
Spill response kits will be maintained, clearly identified and readily accessible for use in case of accidental spillages. Key staff will be trained in their use, application and disposal of contaminated material.
Potential chemical pollutants (e.g. fuels, oils, lubricants, paints, etc.) will be stored in appropriate containers in bunded areas in vehicles or designated storage areas to minimise the risk of spillages and mobilisation of pollutants into the soil or stormwater drains.
Equipment will not be used if there are signs of fuel, oil or hydraulic leaks. Leaks will be repaired immediately, or the equipment will be removed from site and replaced with a leak-free item.
Soil contaminated by spills will be excavated, classified in accordance with Waste Classification Guidelines, and disposed of at a licensed waste management facility, or remediated on site in accordance with a contaminated land management action plan to be prepared by a contaminated land specialist.
Bushfire management
The following management measures will continue to be implemented: ▪ Fire extinguishers will continue to be provided in the depot. The water cart and front-end loader will continue to be available for firefighting. ▪ The existing haul road to the windblown sand extraction area has been constructed and will continue to be maintained to enable ready access for fire fighting vehicles. ▪ Internal roads at the quarry will continue to be maintained for operational and firefighting purposes. ▪ All employees will continue to be trained through the induction process to be vigilant with regard to fire prevention, emergency procedures and reporting of fires to the RFS.
Following the approval of the project and for the life of the quarry, the APZ around the depot buildings will be maintained to a distance of 25 m as an inner protection area, as outlined in Appendix 5 of PBP and the NSW Rural Fire Service's document Standards for APZs.
The existing workshop will have the polycarbonate roofing replaced with metal roof sheeting.
The new haul roads will comply with Appendix 5 of PBP comprising a minimum 6.5 m in width, with a turning bay with minimum 12 m outer radius at the termination of the road.
Water, electricity and gas utilities will comply with Section 4.1.3 of PBP.
A minimum 20,000 L static water supply with firefighting fittings will be installed.
The depot will be landscaped in accordance with Appendix 5 of PBP and managed and maintained.
The Quarry Manager will incorporate the new demountable building into the existing emergency evacuation plans, with specific consideration of bushfire evacuation planning.

23.3 Environmental monitoring

Environmental monitoring summarised in **Table 23.3** will be implemented during operation of the project.

Table 23.3 Summary of environmental monitoring

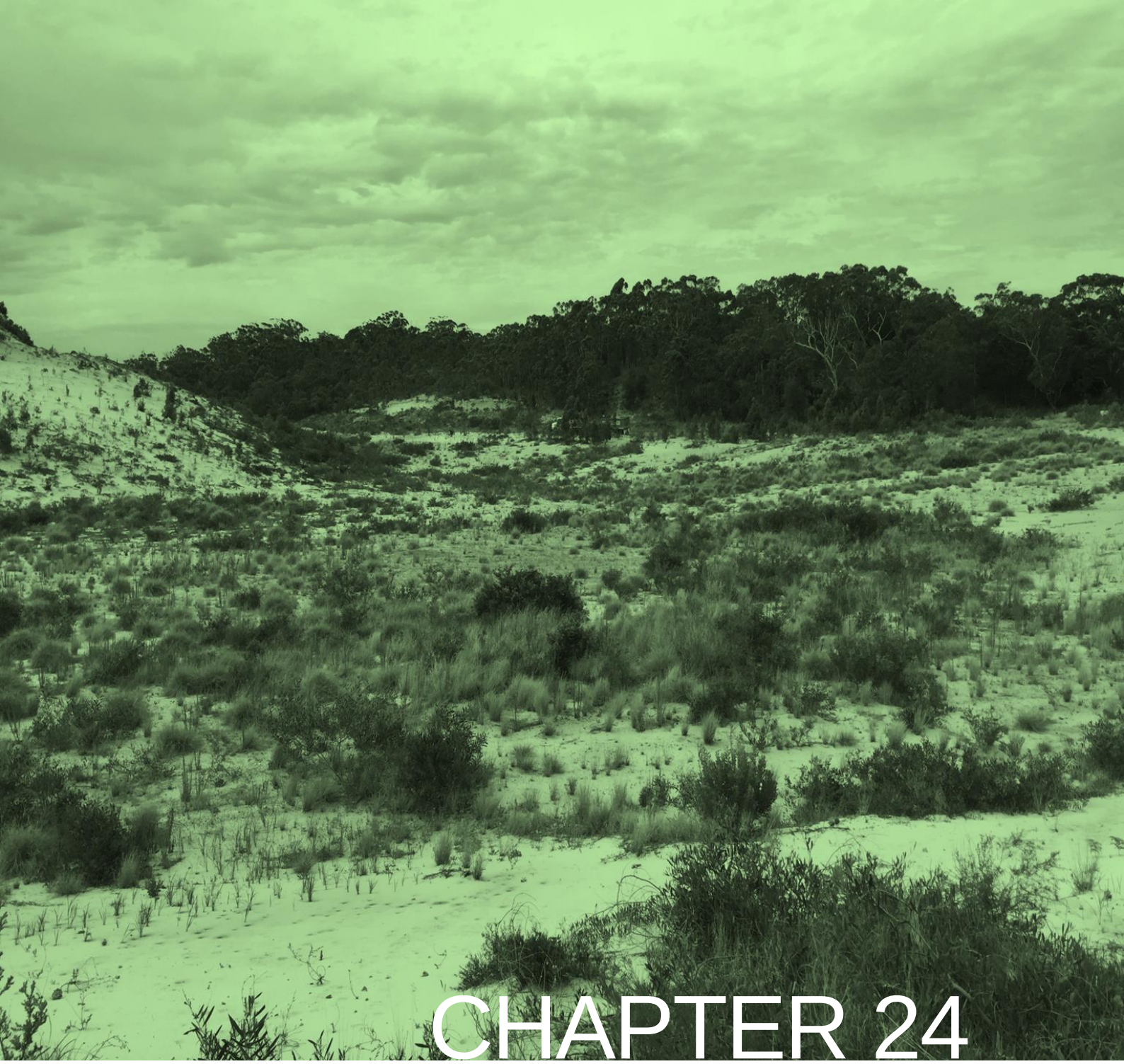
Environmental monitoring
Groundwater
The boreholes located outside the project site will form a monitoring network to be periodically sampled. The bores to be included are MW_X1, MW_X2, MW_X5, MW_X6, MW_X7, GW2, GW4 and MW2. Once extraction progresses below the water table, the dredge pond surface will be surveyed so that the relative height of water in the pond over time can be accurately measured.
Standing groundwater levels (SWL) from all eight bores, and the water level (m AHD) of the dredge pond will be measured monthly during dredging operations. The measurement of SWL from bores will continue during rehabilitation works. Following rehabilitation, all bores will be incorporated into the existing quarterly groundwater monitoring program for the quarry.
All eight bores and the dredge pond will be tested for pH on a monthly basis during dredging operations. The measurement of pH will be performed in the field with a hand-held electronic meter that is 2-point calibrated. In addition to the above recommended measurement for pH, all bores will be incorporated into the GWMP, which will be updated following approval of the project.

Environmental monitoring
Groundwater bores will be sampled on a monthly basis for SWL and pH, and tested quarterly for the following analytical suite: Field measurement of: ▪ pH, EC, ORP, SWL, DO and temperature. Laboratory analysis for: ▪ full ionic balance suite pH, TDS, cations (Na, Ca, Mg, K), anions (Cl, SO_4, HCO_3, PO_4, F) and nutrients (NH_4, NO_3, NO_2, Total N); and ▪ dissolved metals / metalloids including aluminium (Al), arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), manganese (Mn), mercury (Hg), nickel (Ni) and zinc (Zn).
Noise
Boral will continue routine operational noise monitoring and community consultation, and will implement measures if an exceedance is detected or a verified/substantiated complaint is received from a member of the community.
Rehabilitation
The rehabilitation process will be inspected monthly and annually for progress and problems will be proactively identified.
Monthly monitoring will focus on identification of plant health or establishment issues.
Compliance with the performance criteria, particularly the 50% LFA target, will be inspected annually by a suitably experienced ecologist or environmental restoration consultant.
Short to medium term management and monitoring will occur from 1-5 years where landscape stabilisation, vegetation establishment, erosion control and weed management will be monitored.
Monitoring may be substantially reduced over the long term if the short to medium term rehabilitation is successful. Monitoring over 5-10 years will focus on weed management, and species diversity and succession.
Rehabilitation will be inspected for 10 years post rehabilitation, or until the ecologist or restoration consultant advises inspections are no longer required.
The completion of the rehabilitation process will be assessed against the performance criteria for the rehabilitation of the final landform. The rehabilitation criteria will be deemed to be complete when the criteria have been met, and vegetation communities are mature and stable. This may occur between 5-10 years post rehabilitation for each rehabilitation area. This will be assessed by the ecologist or environmental restoration consultant who may recommend that ongoing inspections are no longer required.
Surface water
To predict possible periods of localised inundation, rainfall and ocean level conditions will be monitored through the BoM, including storm warnings for heavy rain and high seas. In conjunction, groundwater levels will continue to be monitored in accordance with the existing groundwater monitoring program, and movement in standing water levels noted. The Quarry Manager will decide on precautionary measures to remove machinery from areas where groundwater levels may increase, and localised ponding may occur. For the dredge pond, allowances will be made for the dredge to move to a higher level through adjustments in mooring lines and transfer pipes. Management of this risk will include a groundwater inundation management plan that includes monitoring of existing bores, flood and storm warnings as well as specific triggers for the movement of machinery and equipment and temporary storage locations.
After 12 months of regular dredge pond monitoring, monthly sampling may be extended to bi-monthly should no exceedances or significant variations occur over time.
To gather an accurate understanding of extractions from the groundwater source and accurately estimate evaporation losses detailed measurements of the pond area, moisture content of sand material, and sand material export are required. The following monitoring is recommended: ▪ six monthly measurements of the dredge pond surface area, either through site survey or aerial survey; ▪ fortnightly measurements of the moisture content of exported sand material through stockpile measurements; and ▪ records of sand material leaving the project site, including the source of sand material from excavations above the aquifer or from the dredge pond.

23.4 Environmental reporting

The principal reporting mechanism for the project with be the submission of an Annual Environmental Management Report, which will be prepared and submitted to DPIE in accordance with conditions of the development consent and will include reporting on all key environmental matters assessed in the EIS.

Other environmental reporting may be required in accordance with the varied/new EPL and/or conditions of approval of the SSD application.



CHAPTER 24

CONCLUSION

24 CONCLUSION

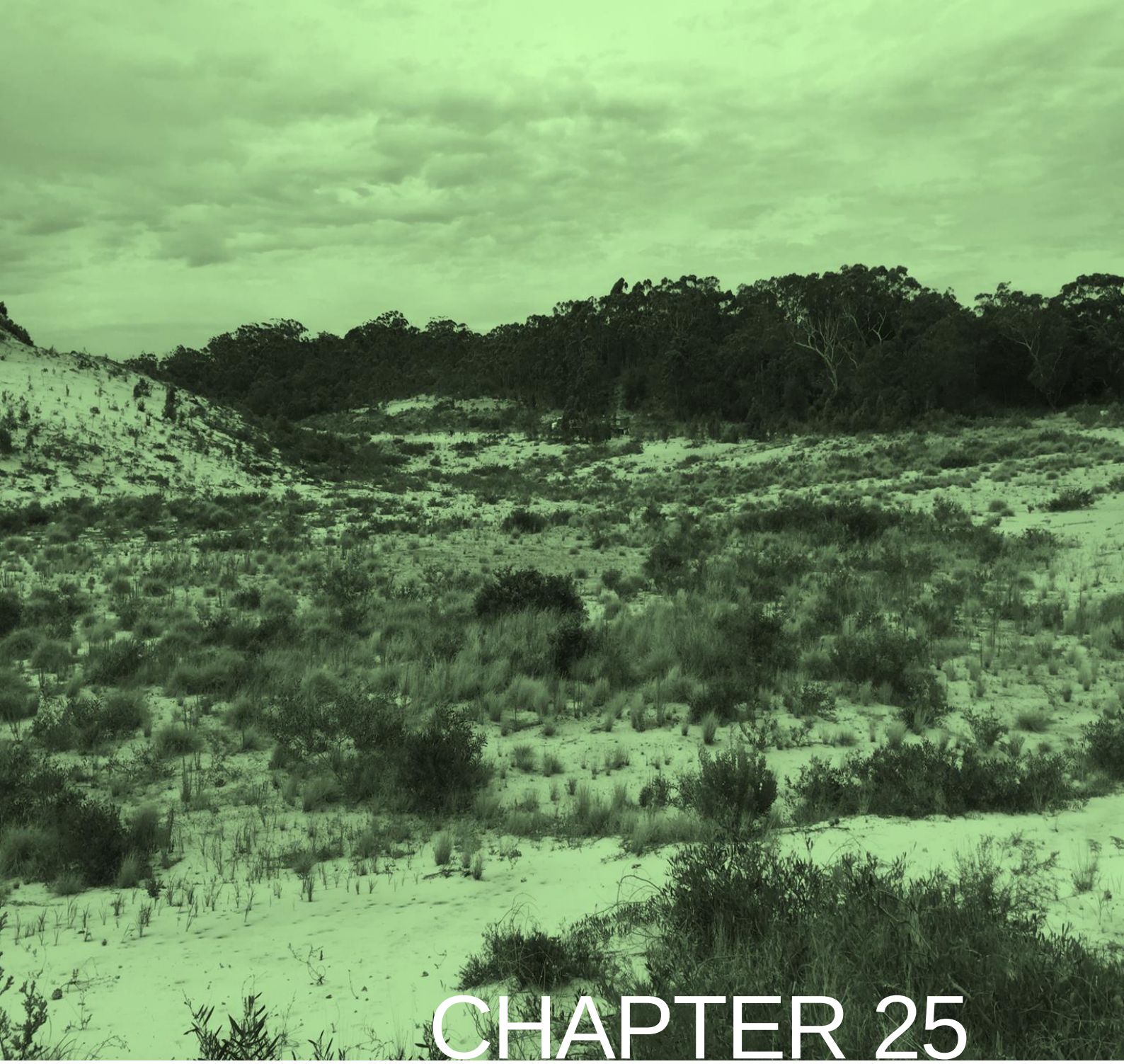
The project is justified on economic, social and environmental grounds, as demonstrated with its consistency with the objects of the EP&A Act and ecologically sustainable development.

The project will enable continued extraction of a resource that is of vital importance to the development of NSW and the associated continued employment of the quarry workforce. It is economically viable and technically feasible to extract a portion of the remaining sand resource for another 25 years.

The project will not result in significant residual impacts on most environmental aspects, including amenity impacts associated with noise, air quality and visual exposure.

The project will have residual impacts on terrestrial biodiversity, which will be offset in accordance with NSW policy. This offsetting will have the benefit of protecting areas of similar native vegetation communities into perpetuity.

The economic analysis of the project demonstrated that it will be socio-economically beneficial to the nation, State and local community. The project will have net social benefits to Australia of $41 M and to NSW of $17 M including employment benefits.



CHAPTER 25

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25 REFERENCES

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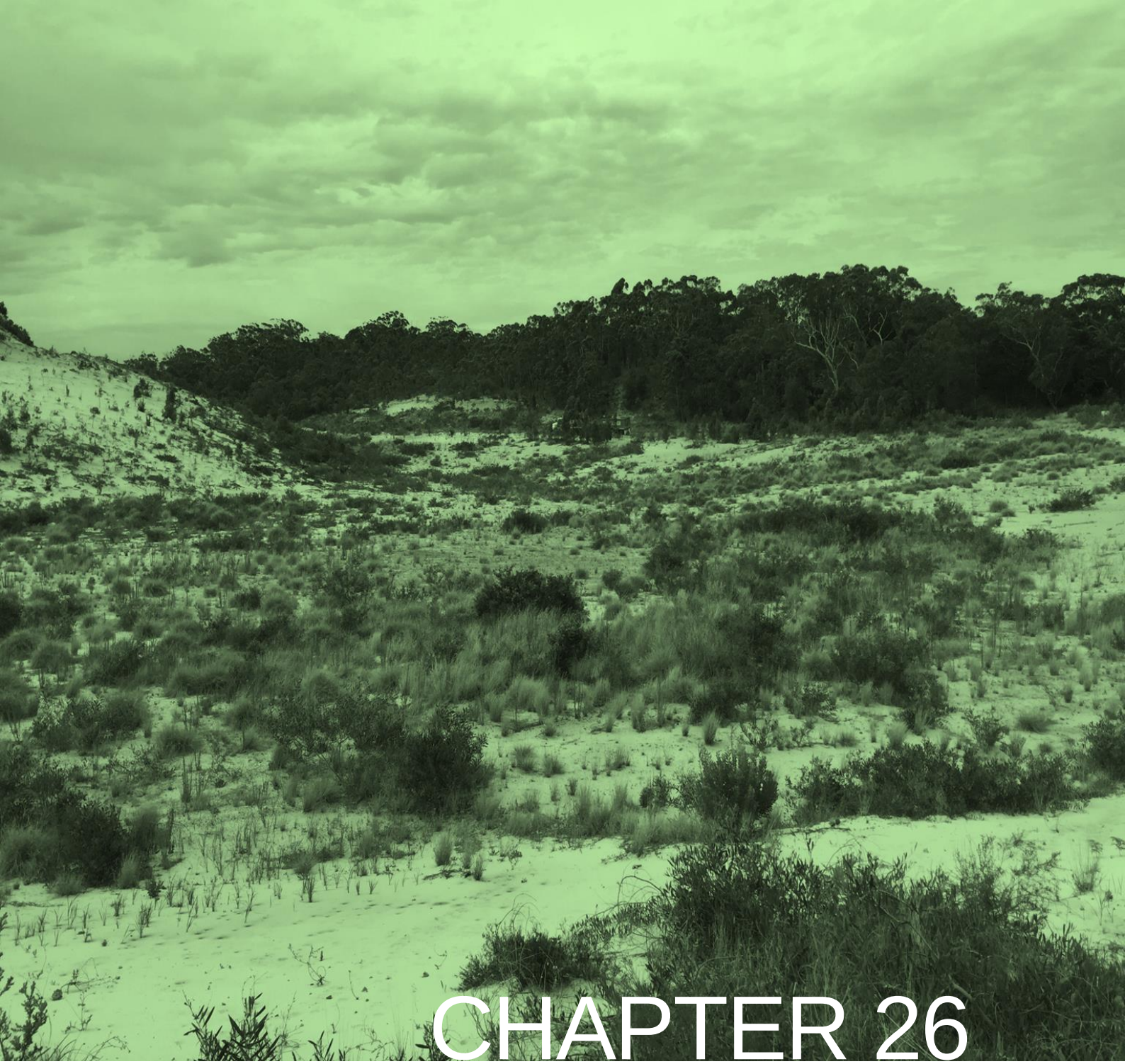


CHAPTER 26

ABBREVIATIONS

26 ABBREVIATIONS

Abbreviation	Definition
ACHA	Aboriginal Cultural Heritage Assessment
AEMR	Annual Environmental Management Report
AHD	Australian Height Datum
AHIMS	Aboriginal Heritage Information Management System
AHIP	Aboriginal Heritage Impact Permit
AIP	NSW Aquifer Interference Policy
ANZECC	Australian and New Zealand Environment and Conservation Council
BC Act	NSW *Biodiversity Conservation Act 2016*
BCT	Biodiversity Conservation Trust
BDAR	Biodiversity Development Assessment Report
BGL	Below ground level
Boral	Boral Resources (NSW) Pty Ltd
BoM	Bureau of Meteorology
BSAL	Biophysical Strategic Agricultural Land
CBA	Cost Benefits Analysis
CLM Act	NSW *Contaminated Land Management Act 1997*
cm	Centimetre
DA	Development Application
DECCW	Department of Environment Climate Change and Water (now DPIE)
DP	Deposited Plan
DoEE	Commonwealth Department of Environment and Energy
DPIE	Department of Planning, Industry and Environment
DRE	Department of Resources and Energy
EEC	Endangered Ecological Community
EIS	Environmental Impact Statement
Element	Element Environment Pty Ltd
EMP	Environmental Management Plan
EMS	Environmental Management Strategy
EPA	NSW Environment Protection Authority
EP&A Act	The *NSW Environmental Planning and Assessment Act 1979*
EP&A Regulation	The NSW Environmental Planning and Assessment Regulation 2000
EPBC Act	Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999*
EPI	Environmental Planning Instrument

Abbreviation	Definition
EPL	Environment Protection Licence
ESD	Ecologically Sustainable Development
GDE	Groundwater Dependent Ecosystems
ha	Hectare
HRP	Hunter Regional Plan 2036
HW Act	NSW *Hunter Water Act 1991*
ICNG	Interim Construction Noise Guideline (DECC 2009)
IPC	Independent Planning Commission
kL	Kilolitre
km	Kilometre
L	Litre
LALC	Local Aboriginal Land Council
LEA	Local Effects Analysis
LFA	Landscape Function Analysis
LEP	Local Environmental Plan
LGA	Local Government Area
m	Metre
mm	Millimetre
ML	Megalitre
MNES	Matters of National Environmental Significance
M	Million
Mt	Million tonnes
NPI	Noise Policy for Industry
NPW Act	NSW *National Parks & Wildlife Act 1974*
NSW	New South Wales
OA	Output Analysis
OEH	Office of Environment and Heritage (now DPIE)
PCT	Plant Community Type
PEA	Preliminary Environmental Assessment
PFAS	Per- and poly-fluoroalkyl substances
PFOA	Perfluorooctanoic acid
$PM_{2.5}$	Particulate matter less than or equal to 2.5 micrometres in aerodynamic diameter
PM_{10}	Particulate matter less than or equal to 10 micrometres in aerodynamic diameter
PMST	Protected Matters Search Tool
POEO Act	*NSW Protection of Environment Operations Act 1997*

Abbreviation	Definition
Quarry	Stockton Sand Quarry
RAAF	Royal Australian Air Force
RAP	Remediation Action Plan
RFS	NSW Rural Fire Service
RMS	NSW Roads and Maritime Services
RNP	NSW Road Noise Policy (EPA 2011)
SEARs	Secretary's Environmental Assessment Requirements
SEPP	State Environmental Planning Policy
SIA	Social Impact Assessment
SRLUP	NSW Strategic Regional Land Use Policy
SSD	State Significant Development
SWL	Sound Power Level
t	Tonne
TEC	Threatened Ecological Community
tpa	Tonnes Per Annum
TSP	Total Suspended Particulate
VLAMP	NSW Voluntary Land Acquisition and Mitigation Policy
WAL	Water Access Licence
WARR Act	NSW *Waste Avoidance and Resource Recovery Act 2001*
Water Act	NSW *Water Act 1912*
WM Act	NSW *Water Management Act 2000*
WSP	Water Sharing Plan



APPENDIX A

SEARS AND GOVERNMENT AGENCY REQUIREMENTS

Stakeholder	Environmental requirement	EIS reference/section
DPIE	Refer to Table 1.2 of the EIS	
EPA Mitchell Bennett Head Strategic Programs Unit – Hunter	Impacts related to the following environmental issues need to be assessed, quantified and reported on: ▪ Air Quality; ▪ Noise and Vibration; ▪ Water Quality and Management; ▪ Waste Management; and ▪ Dangerous Goods, Chemical Storage and Bunding. The Environmental Impact Statement (EIS) should address the specific requirements outlined under each heading below and assess impacts in accordance with the relevant guidelines mentioned.	Chapters 8, 10, 11, 19 and 20
	The currently holds Environmental Protection Licence (EPL 10132) under s48 *Protection of the Environment Operations Act 1997*. Should project approval be granted, the proponent will need to make a separate application to EPA for a variation to the existing Environment Protection Licence No. 10131 or lodge a new application for an Environment Protection Licence. Additional information on licensing is available through EPA's Guide to Licensing document.	Section 6.5.1
	The objectives of the proposal should be clearly stated and refer to: ▪ the size and type of the operation; ▪ the nature of the processes and the products, by-products and wastes produced; ▪ the types and quantities of any chemicals to be used and stored onsite; ▪ proposed operational hours, including any heavy vehicle movements; ▪ proposed maximum and average annual production rates that will occur at the premises; and ▪ proposed staging and timing of the proposal.	Chapters 4, 19 and 20
	The EIS will need to fully identify all the processes and activities intended for the site over the life of the development. This will include details of: ▪ the location of the proposed facility and details of the surrounding environment; ▪ the proposed layout of the site, including a site plan prepared by a registered surveyor clearly showing the boundaries of the proposed premises that will be subject to an Environment Protection Licence (EPL) and the proposed locations of discharge and monitoring points (including groundwater monitoring points); ▪ appropriate land use zoning; ▪ maps/diagrams showing topography, the location of residences and properties likely to be affected and other industrial developments, conservation areas, wetlands, etc. in the locality that may be affected by the facility; ▪ all equipment proposed for use at the site; ▪ all chemicals, including fuel, used on the site and proposed methods for their transportation, storage, use and emergency management; and ▪ methods to mitigate any expected environmental impacts of the development.	Chapters 2, 4, 20 and 23

Stakeholder	Environmental requirement	EIS reference/section
	The EIS must include an air quality impact assessment (AQIA) in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, including, as a minimum the following components: **Assessment Objective** ▪ demonstrate the proposed project will incorporate and apply best management practice emission controls; and ▪ demonstrate that the project will not cause violation of the project adopted air quality impact assessment criteria at any residential dwelling or other sensitive receptor. **Assessment Criteria** ▪ define applicable assessment criteria for the proposed development referencing the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, including appendices and updates ▪ demonstrate the proposal's ability to comply with the relevant regulatory framework, specifically the Protection of the Environment Operations (POEO) Act (1997) and the POEO (Clean Air) Regulation (2010). **Existing Environment** ▪ provide a detailed description of the existing environment within the assessment domain, including: a) geophysical form and land-uses; b) location of all sensitive receptors; c) existing air quality; and d) local and regional prevailing meteorology. ▪ justify all data used in the assessment, specifically including analysis of inter-annual trends (preferably five consecutive years of data), availability of monitoring data, and local topographical features. ▪ meteorological modelling must be verified against monitored data. Verification should involve comparative analysis of wind speed, wind direction and temperature, at a minimum. ▪ a review of all existing, recently approved and planned developments likely to contribute to cumulative air quality impacts must be completed **Emissions Inventory** ▪ provide a detailed description of the project and identify the key stages with regards to the potential for air emissions and impacts on the surrounding environment. ▪ identify all sources of air emissions, including mechanically generated combustion and transport related emissions likely to be associated with the proposed development. ▪ estimate emissions of TSP, PM_{10}, $PM_{2.5}$, NOx, (tonnes per year), at a minimum, for all identified sources during each key development stage. The emissions inventory should: a) utilise USEPA (1995) (and updates) emission estimation techniques, direct measurement or other method approved in writing by EPA; b) calculate uncontrolled emissions (with no particulate matter controls in place); and	Chapter 11, Appendix F

Stakeholder	Environmental requirement	EIS reference/section
	c) calculate controlled emissions (with proposed particulate matter controls in place). ▪ the emissions inventory must be explicitly coupled with the project description. ▪ provide a detailed summary and justification of all parameters adopted within all emission estimation calculations, including site specific measurements, proponent recommended values or published literature. ▪ document, including quantification and justification, all air quality emission control techniques/practices proposed for implementation during the project. As a minimum, consideration must be given to source control techniques, emission control through planning and reactive/predictive management techniques. **Best Practice Determination** ▪ based on the TSP, PM_{10} and $PM_{2.5}$ emissions inventories calculated for the proposed development. ▪ demonstrate that the proposed control techniques/practices are consistent with best management practice. ▪ detail all sources possible sources of air pollution and activities/processes with the potential to cause air pollutants, including odours and fugitive dust emissions; and ▪ describe in detail the measures proposed to mitigate the impacts and quantify the extent to which the mitigation measures are likely to be effective in achieving the relevant environmental outcomes. **Dispersion Modelling and Interpretation of Results** ▪ atmospheric dispersion modelling should be undertaken in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, including appendices and updates. ▪ modelling must implement fit for purpose modelling techniques that: a) have regard for the most up to date and scientifically accepted dispersion modelling techniques; b) contextualise all assumptions based on current scientific understanding and available data; and c) include a thorough validation of adopted methods and model performance. ▪ Use an appropriate atmospheric dispersion model to predict, at a minimum, incremental ground level concentrations/levels of the following: a) 24-hour and annual average PM_{10} concentrations; b) 24-hour and annual average $PM_{2.5}$ concentrations; and c) 1-hour and annual average NO_2 concentrations. NO_2 concentrations should be assessed using a well justified approach for the transformation of NOx to NO_2. ▪ ground level concentrations of pollutants should be presented for surrounding privately-owned properties, quarry-owned properties and other sensitive receptors (as applicable). ▪ undertake a cumulative assessment of predicted impacts. The contribution of all identified existing and recently approved developments should be accounted for in the cumulative assessment. ▪ cumulative 24-hour PM_{10} and $PM_{2.5}$ concentrations must be assessed in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, including appendices and updates, and/or a suitably justified probabilistic methodology.	

Stakeholder	Environmental requirement	EIS reference/section
	▪ cumulative annual average PM_{10}, $PM_{2.5}$, and NO_2 should be assessed using a sufficiently justified background concentration(s); ▪ results of dispersion modelling should be presented as follows: a) isopleth plots showing the geographic extent of maximum pollutant concentrations (incremental and cumulative); b) tables presenting the maximum predicted pollutant concentrations (increment and cumulative) and the frequency of any predicted exceedances at each surrounding privately-owned properties, quarry-owned properties and other sensitive receptors (as applicable); and c) time series and frequency distribution plots of pollutant concentrations at each private receptor location at which an exceedance is predicted to occur. Where no exceedances are predicted, the analysis must be performed for the most impacted off site sensitive receptor. **Air Quality Emission Control Measures** ▪ provide a detailed discussion of all proposed air quality emission control measures, including details of a reactive/predictive management system. The information provided must include: a) explicit linkage of proposed emission controls to the site specific best practice determination assessment timeframe for implementation of all identified emission controls; b) key performance indicators for emission controls; c) monitoring methods (location, frequency, duration); d) response mechanisms; e) responsibilities for demonstrating and reporting achievement of KPIs; f) record keeping and complaints response register; and g) compliance reporting.	
	The following matters should be addressed in relation to noise and vibration impacts associated with the proposal. This includes identification of the hours of operations, assessment of all activities where proposed, and impacts on sensitive receivers associated with the proposed hours of operation. The following matters should be addressed as part of the EIS. **General** ▪ construction noise associated with the proposed development should be assessed using the Interim Construction Noise Guideline (DECC, 2009). ▪ vibration from all activities (including construction and operation) to be undertaken on the premises should be assessed using the guidelines contained in the Assessing Vibration: A Technical Guideline (DEC, 2006). **Industry** ▪ operational noise from all industrial activities (including private haul roads) to be undertaken on the premises should be assessed using the EPA's "A Guide to the Noise Policy for Industry". (EPA October 2017). **Road**	Chapter 10, Appendix G

Stakeholder	Environmental requirement	EIS reference/section
	▪ noise on public roads from increased road traffic generated by land use developments should be assessed using the guidelines contained in the NSW Road Noise Policy (DECCW, 2011). ▪ noise from new or upgraded public roads should be assessed using the NSW Road Noise Policy (DECCW, 2011). **Monitoring** ▪ detail monitoring that will be conducted to assess the impacts of the proposal.	
	Describe Proposal ▪ describe the proposal including position of any intakes and discharges, volumes, water quality and frequency of all water discharges. ▪ demonstrate that all practical options to avoid discharges have been implemented and environmental impact minimised where discharge is necessary. ▪ where relevant include a water balance for the development including water requirements (quantity, quality and source(s)) and proposed storm and wastewater disposal, including type, volumes, proposed treatment and management methods and re-use options. **Background Conditions** ▪ describe existing surface and groundwater quality. An assessment needs to be undertaken for any water resource likely to be affected by the proposal. Issues to be discussed should include but are not limited to: a) a description of any impacts from existing industry or activities on water quality b) a description of the condition of the local catchment e.g. erosion, soils, vegetation cover, etc. c) an outline of baseline groundwater information, including, for example, depth to water table, flow direction and gradient, groundwater quality, reliance on groundwater by surrounding users and by the environment ▪ state the Water Quality Objectives for the receiving waters relevant to the proposal. These refer to the community's agreed environmental values and human uses endorsed by the NSW Government as goals for ambient waters (http://www.environment.nsw.gov.au/ieo/index.htm). ▪ where groundwater may be impacted the assessment should identify appropriate groundwater environmental values. ▪ state the indicators and associated trigger values or criteria for the identified environmental values. This information should be based on the ANZECC (2000) Guidelines for Fresh and Marine Water Quality as a minimum. ▪ state any locally specific objectives, criteria or targets which have been endorsed by the NSW Government. **Impact Assessment** ▪ describe the nature and degree of impact that any proposed discharges will have on the receiving environment, both surface water and groundwater. ▪ detail contractual and other arrangements that will be put in place to prevent pollution from haul roads and unsealed roads, particularly rights of carriageways not owned by the proponent. ▪ assess impacts against the relevant ambient water quality outcomes.	Chapters 8 and 17, Appendix D and L

Stakeholder	Environmental requirement	EIS reference/section
	▪ Demonstrate how the proposal will be designed and operated to: a) protect the Water Quality Objectives for receiving waters where they are currently being achieved; and b) contribute towards achievement of the Water Quality Objectives over time where they are not currently being achieved. ▪ propose water quality limits for any discharge(s), including surface and dredge pond water movement to any groundwater qualifiers. ▪ assess impacts on groundwater and groundwater dependent ecosystems. ▪ describe how stormwater and dredge pond water will be managed during construction, operation and at the end of the sand extraction at the site. **Monitoring** ▪ describe how any potential impacts will be monitored and assessed over time.	
	The EIS should include: ▪ an assessment of potential impacts on soil and land resources should be undertaken, being guided by Soil and Landscape Issues in Environmental Impact Assessment (DLWC 2000). ▪ the nature and extent of any significant impacts should be identified. Particular attention should be given to: a) soil erosion and sediment transport - in accordance with Managing urban stormwater: soils and construction, vol. 1 (Landcom 2004) and vol. 2 (A. Installation of services; B Waste landfills; C. Unsealed roads; D. Main Roads; E. Mines and quarries) (DECC 2008). b) Mass movement (landslides) – in accordance with Landslide risk management guidelines presented in Australian Geomechanics Society (2007). c) Urban and regional salinity – guidance given in the Local Government Salinity Initiative booklets which includes Site Investigations for Urban Salinity (DLWC, 2002). ▪ A description of the mitigation and management options that will be used to prevent, control, abate or minimise identified soil and land resource impacts associated with the project. This should include an assessment of the effectiveness and reliability of the measures and any residual impacts after these measures are implemented.	Chapters 14, 17 and 23
	The EIS should: ▪ include a detailed plan for in-situ classification of waste material, including the sampling locations and sampling regime that will be employed to classify the waste, particularly with regards to the identification of contamination hotspots. ▪ identify, quantify, characterise and classify all waste that currently exists at the site. Identify the intended end use, for example reuse or disposal, and the end use location(s) for the waste. Also, specify the mechanism under which waste will be reused or disposed, such as a Resource Recovery Exemption. Note: All waste must be classified in accordance with EPA's Classification Guidelines.	Chapters 6, 19 and 23

Stakeholder	Environmental requirement	EIS reference/section
	▪ identify, characterise and classify all waste that will be generated onsite, including the proposed quantities of the waste. Note: All waste must be classified in accordance with EPA's Waste Classification Guidelines. ▪ identify, characterise and classify all waste that is proposed to be disposed of to an offsite location, including proposed quantities of the waste and the disposal locations for the waste. This includes waste that is intended for re-use or recycling. ▪ include a commitment to retaining all sampling and classification results for the life of the project to demonstrate compliance with EPA's Waste Classification Guidelines. ▪ provide details of how waste will be handled and managed onsite to minimise pollution, including: a) stockpile location and management i. labelling of stockpiles for identification, ensuring that all waste is clearly identified and stockpiled separately from other types of material (especially the separation of any contaminated and non-contaminated waste). ii. proposed height limits for all waste to reduce the potential for dust and odour. iii. procedures for minimising the movement of waste around the site and double handling. iv. measures to minimise leaching from stockpiles into the surrounding environment, such as sediment fencing, impervious and geofabric liners etc. b) erosion, sediment and leachate control including measures to be implemented to minimise erosion, leachate and sediment mobilisation at the site during works. The EIS should show the location of each measure to be implemented. The Proponent should consider measures such as: i. sediment traps ii. diversion banks iii. sediment fences iv. bunds (earth, hay, mulch) v. geofabric liners vi. other control measures as appropriate The Proponent should also provide details of: a) how leachate from stockpiled waste material will be kept separate from stormwater runoff; b) treatment of leachate through a wastewater treatment plant (if applicable); and c) any proposed transport and disposal of leachate off-site. ▪ provide details of how the waste will be handled and managed during transport to a lawful facility. If the waste possesses hazardous characteristics, the Proponent must provide details of how the waste will be treated or immobilised to render it suitable for transport and disposal.	

Stakeholder	Environmental requirement	EIS reference/section
	▪ include details of all procedures and protocols to be implemented to ensure that any waste leaving the site is transported and disposed of lawfully and does not pose a risk to human health or the environment. ▪ include a statement demonstrating that the Proponent is aware of EPA's requirements with respect to notification and tracking of waste. ▪ include a statement demonstrating that the Proponent is aware of the relevant legislative requirements for disposal of the waste, including any relevant Resource Recovery Exemptions, as gazetted by EPA from time to time. ▪ outline contingency plans for any event that affects operations at the site that may result in environmental harm, including: excessive stockpiling of waste, volume of leachate generated exceeds the storage capacity available on-site etc. ▪ assess Environment Protection Licensing requirements for all potential waste activities associated with the proposal.	
	▪ the EIS must outline all details regarding the transport, handling, storage and use of dangerous goods, chemicals and products, including fuel, both on site and with ancillary activities and describe the measures proposed to minimise the potential for leakage or the migration of pollutants into the soil/waters or from the site. ▪ the EIS should identify any fuel or chemical storage areas proposed for the site. ▪ the EIS should consider compliance with the following legislation, standards and guidelines where relevant: a) Australian Standard AS1692:1989 Tanks for Flammable and combustible liquids; b) The DECC's "Bunding and Spill Management" Technical Guideline (November 1997) c) Australian Standard AS 1940:2004 The Storage and Handling of Flammable and Combustible Liquids d) Australia Standard AS 4452-1997: The Storage and Handling of Toxic Substances; e) Australian/New Zealand Standard AS/NZS 4452:1997: The Storage and Handling of Mixed Classes of Dangerous Goods in Packages and Intermediate Bulk Containers; and f) Road and Rail Transport (Dangerous Goods) Act 1997	Chapter 20
	The EIS should include a detailed assessment of any noise, air quality, weather, water or waste monitoring required during the remediation of the site to ensure that the works achieve a satisfactory level of environmental performance. The evaluation should include a detailed description of the monitoring locations, sample analysis methods and the level of reporting proposed.	Chapter 23
DPIE Biodiversity and Conservation Division (formerly OEH) Nicole Davis	▪ Biodiversity impacts related to the proposed development (SSD 9490) are to be assessed in accordance with the Biodiversity Assessment Method and documented in a Biodiversity Development Assessment Report (BDAR). The BDAR must include information in the form detailed in the Biodiversity Conservation Act 2016 (s6.12), Biodiversity Conservation Regulation 2017 (s6.8) and Biodiversity Assessment Method. ▪ the BDAR must document the application of the avoid, minimise and offset framework including assessing all direct, indirect and prescribed impacts in accordance with the Biodiversity Assessment Method. ▪ the BDAR must include details of the measures proposed to address the offset obligation as follows;	Chapter 9 and Appendix E

Stakeholder	Environmental requirement	EIS reference/section
Acting Senior Team Leader – Planning Hunter Central Coast Branch Conservation & Regional Delivery Division	a) the total number and classes of biodiversity credits required to be retired for the development/project; b) the number and classes of like-for-like biodiversity credits proposed to be retired; c) the number and classes of biodiversity credits proposed to be retired in accordance with the variation rules; d) any proposal to fund a biodiversity conservation action; e) any proposal to conduct ecological rehabilitation (if a mining project); f) any proposal to make a payment to the Biodiversity Conservation Fund. ▪ if seeking approval to use the variation rules, the BDAR must contain details of the reasonable steps that have been taken to obtain requisite like-for-like biodiversity credits. ▪ The BDAR must be prepared by a person accredited in accordance with the Accreditation Scheme for the Application of the Biodiversity Assessment Method Order 2017 under s6.1 O of the *Biodiversity Conservation Act 2016*.	
	▪ the Environmental Impact Assessment (EIS) must identify and describe the Aboriginal cultural heritage values that exist across the whole area that will be affected by the development and document these in the Aboriginal Cultural Heritage Assessment Report (ACHAR). This may include the need for surface survey and test excavation. The identification of cultural heritage values should be guided by the Guide to investigating, assessing and reporting on Aboriginal Cultural Heritage in NSW (DECCW, 2011) and consultation with OEH regional branch officers; ▪ consultation with Aboriginal people must be undertaken and documented in accordance with the Aboriginal cultural heritage consultation requirements for proponents 2010 (DECCW). The significance of cultural heritage values for Aboriginal people who have a cultural association with the land must be documented in the ACHAR; and ▪ impacts on Aboriginal cultural heritage values are to be assessed and documented in the ACHAR. The ACHAR must demonstrate attempts to avoid impact upon cultural heritage values and identify any conservation outcomes. Where impacts are unavoidable, the ACHAR must outline measures proposed to mitigate impacts. Any objects recorded as part of the assessment must be documented and notified to OEH.	Chapter 15 and Appendix K
	▪ the EIS must provide a heritage assessment including but not limited to an assessment of impacts to State and local heritage including conservation areas, natural heritage areas, places of Aboriginal heritage value, buildings, works, relics, gardens, landscapes, views, trees should be assessed. Where impacts to State or locally significant heritage items are identified, the assessment shall: a) outline the proposed mitigation and management measures (including measures to avoid significant impacts and an evaluation of the effectiveness of the mitigation measures) generally consistent with the NSW Heritage Manual (1996), b) be undertaken by a suitably qualified heritage consultant(s) (note: where archaeological excavations are proposed the relevant consultant must meet the NSW Heritage Council's Excavation Director criteria), c) include a statement of heritage impact for all heritage items (including significance assessment), d) consider impacts including, but not limited to, vibration, demolition, archaeological disturbance, altered historical arrangements and access, landscape and vistas, and architectural noise treatment (as relevant), and	Chapter 18

Stakeholder	Environmental requirement	EIS reference/section
	e) where potential archaeological impacts have been identified develop an appropriate archaeological assessment methodology, including research design, to guide physical archaeological test excavations (terrestrial and maritime as relevant) and include the results of these test excavations.	
	▪ the EIS must map the following features relevant to water and soils including: a) Acid sulfate soils (Class 1, 2, 3 or 4 on the Acid Sulfate Soil Planning Map); b) Rivers, streams, wetlands, estuaries (as described in s4.2 of the Biodiversity Assessment Method); c) wetlands as described in s4.2 of the Biodiversity Assessment Method; d) groundwater; e) groundwater dependent ecosystems; and f) proposed intake and discharge locations. ▪ the EIS must describe background conditions for any water resource likely to be affected by the development, including: a) existing surface and groundwater. b) hydrology, including volume, frequency and quality of discharges at proposed intake and discharge locations. c) Water Quality Objectives (as endorsed by the NSW Government http://www.environment.nsw.qov.au/ieo/index.htm) including groundwater as appropriate that represent the community's uses and values for the receiving waters d) indicators and trigger values/criteria for the environmental values identified in accordance with the ANZECC (2000) Guidelines for Fresh and Marine Water Quality and/or local objectives, criteria or targets endorsed by the NSW Government. ▪ the EIS must assess the impacts of the development on water quality, including: a) the nature and degree of impact on receiving waters for both surface and groundwater, demonstrating how the development protects the Water Quality Objectives where they are currently being achieved, and contributes towards achievement of the Water Quality Objectives over time where they are currently not being achieved. This should include an assessment of the mitigating effects of proposed stormwater and wastewater management during and after construction; and b) identification of proposed monitoring of water quality. ▪ the EIS must assess the impact of the development on hydrology, including: a) water balance including quantity, quality .and source; b) effects to downstream rivers, wetlands, estuaries, marine waters and floodplain areas; c) effects to downstream water-dependent fauna and flora including groundwater dependent ecosystems; d) impacts to natural processes and functions within rivers, wetlands, estuaries and floodplains that affect river system and landscape health such as nutrient flow, aquatic connectivity and access to habitat for spawning and refuge (e.g. river benches).	Chapters 8, 14, 17 and 23 Appendix D, J and L

Stakeholder	Environmental requirement	EIS reference/section
	e) changes to environmental water availability, both regulated/licensed and unregulated/rules-based sources of such water. f) mitigating effects of proposed stormwater and wastewater management during and after construction on hydrological attributes such as volumes, flow rates, management methods and re-use options. g) identification of proposed monitoring of hydrological attributes.	
	▪ the EIS must map the following features relevant to flooding as described in the Floodplain Development Manual 2005 (NSW Government 2005) including: a) flood prone land; b) flood planning area, the area below the flood planning level; c) hydraulic categorisation (floodways and flood storage areas). ▪ the EIS must describe flood assessment and modelling undertaken in determining the design flood levels for events, including a minimum of the 1 in 10 year, 1 in 100 year flood levels and the probable maximum flood, or an equivalent extreme event. ▪ the EIS must model the effect of the proposed development (including fill) on the flood behaviour under the following scenarios: a) current flood behaviour for a range of design events as identified in 11 above. This includes the 1 in 200 and 1 in 500 year flood events as proxies for assessing sensitivity to an increase in rainfall intensity of flood producing rainfall events due to climate change. ▪ modelling in the EIS must consider and document: a) the impact on existing flood behaviour for a full range of flood events including up to the probable maximum flood. b) impacts of the development on flood behaviour resulting in detrimental changes in potential flood affection of other developments or land. This may include redirection of flow, flow velocities, flood levels, hazards and hydraulic categories. c) relevant provisions of the NSW Floodplain Development Manual 2005. ▪ the EIS must assess the impacts on the proposed development on flood behaviour, including: a) whether there will be detrimental increases in the potential flood affectation of other properties, assets and infrastructure. b) consistency with Council floodplain risk management plans. c) compatibility with the flood hazard of the land. d) compatibility with the hydraulic functions of flow conveyance in floodways and storage in flood storage areas of the land. e) whether there will be adverse effect to beneficial inundation of the floodplain environment, o·n, adjacent to or downstream of the site. f) whether there will be direct or indirect increase in erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses.	Chapter 17 and Appendix L

Stakeholder	Environmental requirement	EIS reference/section
	g) any impacts the development may have upon existing community emergency management arrangements for flooding. These matters are to be discussed with the SES and Council. h) whether the proposal incorporates specific measures to manage risk to life from flood. These matters are to be discussed with the SES and Council. i) emergency management, evacuation and access, and contingency measures for the development considering the full range or flood risk (based upon the probable maximum flood or an equivalent extreme flood event). These matters are to be discussed with and have the support of Council and the SES. j) any impacts the development may have on the social and economic costs to the community as consequence of flooding.	
NSW Department of Industry Allison Collaros A/Manager – Assessment Advice Wayne Conners, Senior Water Regulation Officer	▪ the identification of an adequate and secure water supply for the life of the project. This includes confirmation that water can be sourced from an appropriately authorised and reliable supply. This is also to include an assessment of the current market depth where water entitlement is required to be purchased. ▪ a detailed and consolidated site water balance. ▪ assessment of impacts on surface and ground water sources (both quality and quantity), related infrastructure, adjacent licensed water users, basic landholder rights, watercourses, riparian land, and groundwater dependent ecosystems, and measures proposed to reduce and mitigate these impacts. ▪ proposed surface and groundwater monitoring activities and methodologies. ▪ consideration of relevant legislation, policies and guidelines, including the NSW Aquifer Interference Policy (2012), the Guidelines for Controlled Activities on Waterfront Land (2018) and the relevant Water Sharing Plans (available at https://www.industry.nsw.gov.au/water).	Chapter 8 and 17, Appendix D and L
	▪ Crown land - including any Crown roads, reserves and tenures - impacted by the proposal must be clearly identified and accurately described in the EIS. ▪ a Crown Land conveyancing search should be undertaken. Information on the department's conveyancing and information search services can be found here: https://www.industry.nsw.gov.au/lands/what-we-do/searches ▪ written consent is required from DoI Crown Lands, as landowner. The EIS should provide evidence of consent, or details on the proposed process to obtain this consent. It is recommended that the proponent contact the department directly to discuss the landowner consent application process. The department's landowner's consent application form can be found here: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0003/144345/Landowners-consentapplication-form.pdf	Table 5.2, Section 6.5.2
DPIE – Division of Resources & Geoscience	The building and construction industries in NSW require the ongoing replacement of supplies as current sources are exhausted. The continued sustainable development of existing and new quarries will facilitate the ongoing supply of construction materials to support affordable housing and infrastructure development for the growth of NSW. The resource in the subject area represents a regionally source of construction sand for the region.	Resource assessment to be provided to DPIE separately to this EIS.

Stakeholder	Environmental requirement	EIS reference/section
Cressida Gilmore Manager – Land Use	It is in the best interests of both the proponent and the community to fully assess the resources which are to be extracted. This means that a thorough geological assessment should be undertaken to determine the nature, quality and extent of the resource. Failure to undertake such an assessment could lead to operational problems and possibly even failure of the proposal. All environmental reports (EIS or similar) accompanying Development Applications for extractive industry lodged under the *Environmental Planning & Assessment Act 1979* should include a resource assessment (as detailed in Attachment A) which: ▪ documents the size and quality of the resource and demonstrates that both have been adequately assessed; and ▪ documents the methods used to assess the resource and its suitability for the intended applications. The above information should be summarised in the EIS, with full documentation appended. If deemed commercial-in-confidence, the resource assessment summary included in the EIS should commit to providing the Division with full resource assessment documentation separately. Applications to modify, expand, extend or intensify an existing consent that has already been adequately reported using the above protocol in publicly available documents, may restrict detailed documentation to the additional resources to be used, if accompanied by a summary of past resource assessments and of past production. The Division collects data on the quantity of construction materials produced annually throughout the State. Forms are sent to all operating quarries at the end of each financial year for this purpose. The statistical data collected is of great value to Government and industry in planning and resource management, particularly as a basis for analysing trends in production and for estimating future demand for particular commodities or in particular regions. Production data may be published in aggregated form, however production data for individual operations is kept strictly confidential. In order to assist in the collection of construction material production data, the proponent should be required to provide annual production data for the subject site to the NSW Division of Resources and Geoscience as a condition of any new or amended development consent. The Division would appreciate the opportunity for early consultation in relation to the proposed location of any biodiversity offset areas (both on and off site) or any supplementary biodiversity measures to ensure there is no consequent reduction in access to prospective land for mineral exploration, or potential for sterilisation of mineral or extractive resources. During the preparation of the EIS, The Division recommends that the proponent consult NSW Department of Planning & Environment's 'EIS Guideline - Extractive Industries – Quarries'.	

Stakeholder	Environmental requirement	EIS reference/section
	The following issues need to be addressed when preparing an environmental assessment (EA) or environmental impact statement (EIS) for a proposed construction materials (extractive materials) quarry: **Resource Assessment** ▪ a summary of the regional and local geology including information on the stratigraphic unit or units within which the resource is located. ▪ the amount of material to be extracted and the method or methods used to determine the size of the resource (e.g. drilling, trenching, geophysical methods). ▪ plans and cross-sections summarising this data, at a standard scale, showing location of drillholes and/or trenches, and the area proposed for extraction, should be included in the EA or EIS. Relevant supporting documentation such as drill logs should be included or appended. Major resource proposals should be subject to extensive drilling programs to identify the nature and extent of the resource. ▪ characteristics of the material or materials to be produced: a) for structural clay/shale extraction proposals, ceramic properties such as plasticity, drying characteristics (e.g. dry green strength, linear drying shrinkage), and firing characteristics (e.g. shrinkage, water absorption, fired colour) should be described. b) for sand extraction proposals, properties such as composition, grainsize, grading, clay content and contaminants should be indicated. The inclusion of indicative grading curves for all anticipated products as well as the overall deposit is recommended. c) for hard rock aggregate proposals, information should be provided on properties such as grainsize and mineralogy, nature and extent of weathering or alteration, and amount and type of deleterious minerals, if any. d) for other proposals, properties relevant to the range of intended uses for the particular material should be indicated. e) Details of tests carried out to determine the characteristics of the material should be included or appended. Such tests should be undertaken by NATA registered testing laboratories. ▪ an assessment of the quality of the material and its suitability for the anticipated range of applications should be given. ▪ the amount of material anticipated to be produced annually should be indicated. ▪ if the proposal includes a staged extraction sequence, details of the staging sequence needs to be provided. The intended life of the operation should be indicated. ▪ if the proposal is an extension to an existing operation, details of history and past production should be provided. ▪ an assessment of alternative sources to the proposal and the availability of these sources. The impact of not proceeding with the proposal should be addressed. ▪ justification for the proposal in terms of the local and, if appropriate, the regional context. ▪ information on the location and size of markets to be supplied from the site.	

Stakeholder	Environmental requirement	EIS reference/section
	▪ route(s) used to transport quarry products to market. ▪ disposal of waste products and the location and size of stockpiles. ▪ assessment of noise, vibration, dust and visual impacts, and proposed measures to minimise these impacts. ▪ proposed rehabilitation procedures during, and after completion of, extraction operations, and proposed final use of site. ▪ assessment of the ecological sustainability of the proposal. **Health & Safety Issues** All mining operations are to comply with the following legislation: ▪ *Work Health and Safety Act 2011* ▪ Work Health and Safety Regulation 2017 ▪ *Work Health and Safety (Mine and Petroleum Sites) Act 2013* ▪ Work Health and Safety (Mine and Petroleum Sites) Regulation 2014 ▪ *Explosives Act 2003* ▪ Explosives Regulation 2013. The mine holder must appoint a mine operator and notify the Department in writing as required by clause 7 of the Work Health and Safety (Mines and Petroleum Sites) Regulation 2014 before commencing any mining operations. Other duties and notification and reporting requirements exist under the WHS laws and duty holders must ensure they understand and comply with these requirements.	
RMS Peter Marler Manager Land Use Assessment Hunter Region	Following a review of the proponent's PEA, Roads and Maritime recommends that the EIS refer to the following guidelines with regard to the traffic and transport impacts of the proposed development: ▪ Road and Related Facilities within the Department of Planning EIS Guidelines; and ▪ Section 2 Traffic Impact Studies of Roads and Maritime's Guide to Traffic Generating Developments 2002. Furthermore, a traffic and transport study shall be prepared in accordance with the Roads and Maritime's Guide to Traffic Generating Developments 2002 and is to include (but not be limited to) the following: ▪ assessment of all relevant vehicular traffic routes and intersections for access to / from the subject properties; ▪ current traffic counts for all of the traffic routes and intersections;	Chapter 12 and Appendix H

Stakeholder	Environmental requirement	EIS reference/section
	▪ the anticipated additional vehicular traffic generated from both the construction and operational stages of the project; ▪ the distribution on the road network of the trips generated by the proposed development. It is requested that the predicted traffic flows are shown diagrammatically to a level of detail sufficient for easy interpretation; ▪ consideration of the traffic impacts on existing and proposed intersections, in particular, the intersections of Nelson Bay Road (MR108) / Coxs Lane (local road) and Nelson Bay Road / Seaside Boulevard (local road), and the capacity of the local and classified road network to safely and efficiently cater for the additional vehicular traffic generated by the proposed development during both the construction and operational stages. The traffic impact shall also include the cumulative traffic impact of other proposed or approved developments in the area; ▪ identify the necessary road network infrastructure upgrades that are required to maintain existing levels of service on both the local and classified road network for the development. In this regard, preliminary concept drawings shall be submitted with the EIS for any identified road infrastructure upgrades. However, it should be noted that any identified road infrastructure upgrades will need to be to the satisfaction of Roads and Maritime and Council. ▪ traffic analysis of any major / relevant intersections impacted, using SIDRA or similar traffic model, including: a) current traffic counts and 10 year traffic growth projections; b) with and without development scenarios; c) 95th percentile back of queue lengths; d) delays and level of service on all legs for the relevant intersections; and e) electronic data for Roads and Maritime review (i.e. SIDRA 8 model). f) any other impacts on the regional and state road network including consideration of pedestrian, cyclist and public transport facilities and provision for service vehicles.	
RFS Paul Creenaune Acting Team Leader – Development Assessment & Planning	The subject land is mapped bush fire prone land by Port Stephens Shire Council. The NSW RFS considers that the EIS for the continued operation of the sand quarry should address the following bush fire criteria: ▪ the aim and objectives of 'Planning for Bush Fire Protection 2006'; ▪ identification of potential ignition sources during construction and operation of the development; ▪ storage of fuels and other hazardous materials (e.g., explosives for blasting); ▪ proposed bush fire protection measures for the development, including vegetation management and fire suppression capabilities; ▪ operational access for fire fighting appliances to the site; and ▪ emergency and evacuation planning.	Chapter 20 and Appendix M
Port Stephens Council	▪ The proponent must prepare a traffic impact assessment, identifying the impacts of any increase in truck movements on the road network as a result of the proposed development and associated mitigation measures; and	Chapter 12 and Appendix H

Stakeholder	Environmental requirement	EIS reference/section
	▪ any production cap needs to be based on maximum annual tonnage extracted, not on a number of truck movements, which was previously the case.	
	The proponent must demonstrate how site rehabilitation, remnant material and surface runoff will be managed within the site after completion of the proposed development.	Chapter 22 and 23
	For the life of the project, the proponent shall pay Council $0.04 per tonne of extractive material transported from the site on a quarterly basis, in accordance with the Port Stephens Council Development Contributions Plan for the maintenance of Coxs Lane, Fullerton Cove. Each payment shall be: ▪ based on weighbridge records of the quantity of extractive material transported from the site quarterly. These records are to be provided to Council within 14 days of the end of the relevant quarter; ▪ paid within 21 days of receipt of the invoice received from Council; and ▪ adjusted in line with the Consumer Price Index calculated from the date of approval and applied annually from the first day of operation.	Section 6.7.3
	The preparation of an updated terrestrial assessment by Boral is supported as it will assist in addressing potential biodiversity issues or offsets.	Chapter 9 and Appendix E
	▪ the preparation of a groundwater assessment is supported, however it is noted that it largely focuses on the impacts during the mining period of the proposed development. Due consideration should be given to the impacts of filling, the resultant depression with VENM and the impacts on groundwater behaviour and quality. ▪ the proposed development and associated excavation is located adjacent to land within the Williamtown RAAF Base Contamination Broader Management Zone. Any potential groundwater impacts must be considered as part of the development, in line with the Environment Protection Authority's recommendations.	Chapter 8 and Appendix D



APPENDIX B

STAKEHOLDER CONSULTATION

Consultation with DPIE – Division of Resources and Geoscience

17 July 2019

Ms Cressida Gilmore
Manager – Land Use
Division of Resources and Geoscience
NSW Department of Planning and Environment
PO Box 344
Hunter Region Mail Centre, NSW 2310
Email: landuse.minerals@geoscience.nsw.gov.au

PO Box 1563
Warriewood
NSW 2012

ABN 45 162 835 083

Dear Cressida

STOCKTON SAND QUARRY – ENVIRONMENTAL IMPACT STATEMENT PREPARATION AND CONSULTATION FOR PROPOSED STATE SIGNIFICANT DEVELOPMENT

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Sand Quarry (hereafter referred to as the 'quarry'), a long standing operation that extracts and transports sand product for use in the building, landscaping and construction markets. The quarry is located at Coxs Lane, Fullerton Cove, in the Port Stephens Local Government Area.

The quarry currently has consent to extract up to 500,000 tonnes of sand per annum from the transgressive (windblown) dunes adjoining Stockton Beach only, until 2028.

In order to meet ongoing sustained demand for a consistent and continuous supply of sand to the Hunter and Sydney regions, Boral is seeking approval for continued operations at the site through a State Significant Development (SSD) application under Part 4 of the Environmental Planning & Assessment Act 1979. Boral propose to extract up to 750,000 tonnes per annum (tpa) of sand product from a former extraction area by front-end loader/excavator and dredging (the Project). The Project would be for a period of up to 25 years, subject to demand of sand resources.

An outline of the Project is available within the Stockton Sand Quarry Dredging: Preliminary Environmental Assessment (Element Environment, September 2018), available on the major projects register at the below link:

http://majorprojects.planning.nsw.gov.au/index.pl?action=view_job&job_id=9490

There would be no alteration to the existing site's hours of operation associated with the addition of the inland area and only a short term increase in total output from the site, rising from 500,000 tonnes per annum to 750,000 tonnes per annum until 2028.

In accordance with the Secretary's Environmental Assessment Requirements (SEARs) issued for the Project from NSW Department of Environment, Industry & Planning (DPIE), which are available at the same major projects website link above, Boral are seeking any further and additional comments of matters for

consideration in the preparation of an Environmental Impact Statement (EIS) for the Project.

Boral has engaged my company (Element Environment Pty Ltd) to prepare a range of technical studies to inform the EIS including traffic, acoustics, air quality, surface water, groundwater, Aboriginal heritage, biodiversity, economics, social impacts and acid sulphate soils. On behalf of Boral and as part of the EIS preparation, we initiate consultation regarding the Project via this letter, and Boral will take into consideration any response that is received.

If you or your colleagues have any questions or would like to discuss the proposal in more detail, please feel free to contact me on **0455 666 006** or luke@elementenvironment.com.au. Alternatively, if your organisation has no comments or concerns and are satisfied to await the exhibition of the EIS (to be further notified when dates are determined), we would appreciate a response to this effect.

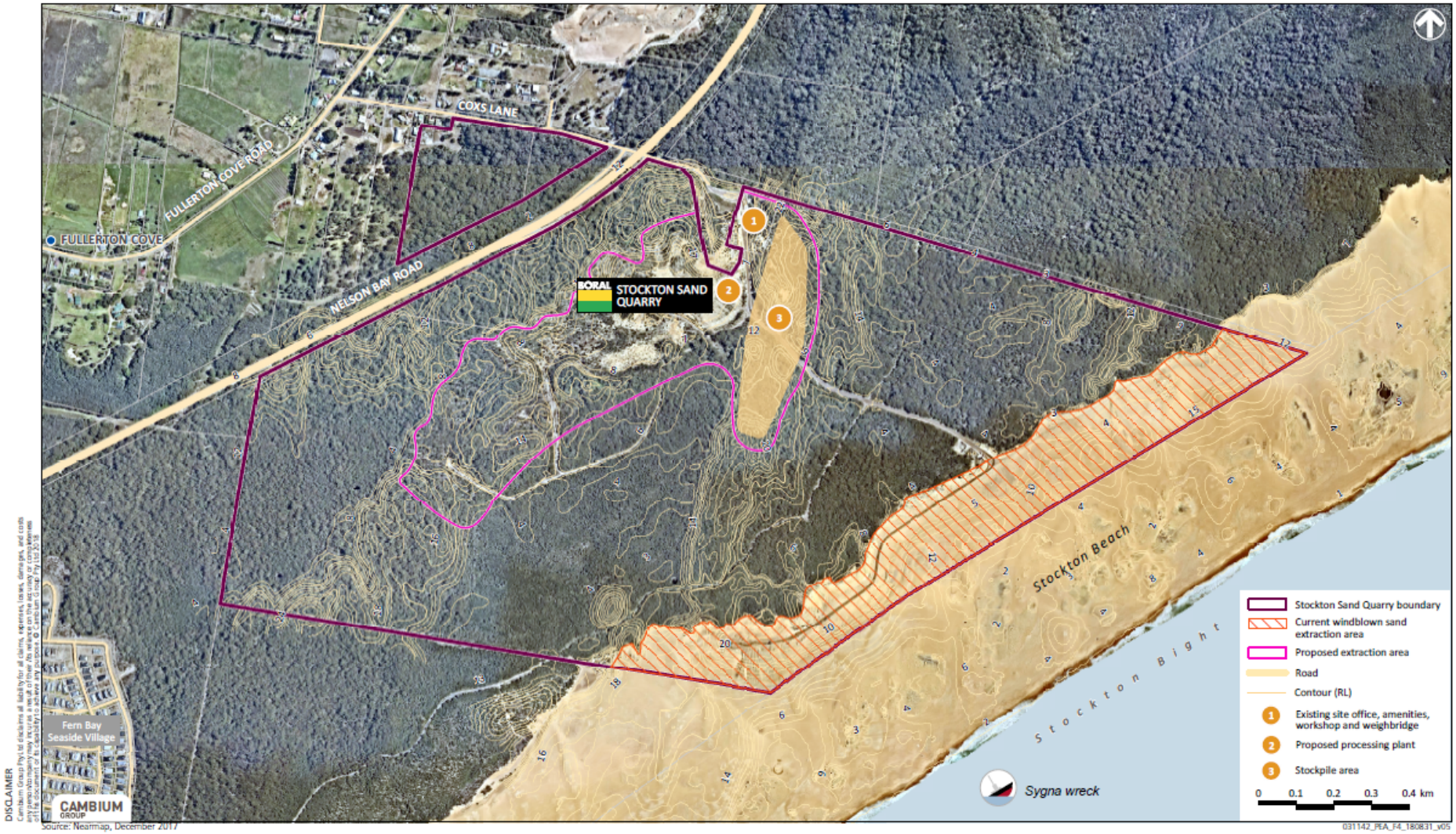
We are hoping to gather all responses to the proposal by **31 July 2019**.

Thank you for your interest in this letter – we look forward to hearing from you soon.

Yours sincerely,



Luke Farrell
Senior Environmental Consultant
Element Environment



Source: Nearmap, December 2017

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16 August 2019

Luke Farrell
Senior Environmental Consultant
Element Environment Pty Ltd
elementenvironment.com.au

Emailed: luke@elementenvironment.com.au

Your Reference: letter dated 17/07/2019
Our Reference: DOC19/633143

Dear Mr Farrell,

Re: Stockton Sand Quarry – Environmental Impact Statement Preparation and Consultation for Proposed State Significant Development.

Thank you for the opportunity to provide additional comments of matters for consideration in the preparation of an Environmental Impact Statement (EIS) for continued operations at Stockton Sand Quarry. This is a response from NSW Department of Planning, Industry & Environment – Division of Resources & Geoscience (the Division).

Sand is not a prescribed mineral under the *Mining Act 1992*. However, the Division is the principal government authority responsible for assessing the State's resources of construction materials and for advising State and local government on their planning and management.

All environmental reports (EIS or similar) accompanying Development Applications for extractive industry lodged under the *Environmental Planning & Assessment Act 1979* should include a resource assessment which:

- Documents the size and quality of the resource and demonstrates that both have been adequately assessed; and

- Documents the methods used to assess the resource and its suitability for the intended applications.

The above information should be summarised in the EIS, with full documentation appended. If deemed commercial-in-confidence, the resource assessment summary included in the EIS should commit to providing the Division with full resource assessment documentation separately. Applications to modify, expand, extend or intensify an existing consent that has already been adequately reported using the above protocol in publicly available documents, may restrict detailed documentation to the additional resources to be used, if accompanied by a summary of past resource assessments and of past production.

The Division collects data on the quantity of construction materials produced annually throughout the State. Forms are sent to all operating quarries at the end of each financial year for this purpose. The statistical data collected is of great value to Government and industry in planning and resource management, particularly as a basis for analysing trends in production and for estimating future demand for particular commodities or in particular regions. Production data may be published in aggregated form, however production data for individual operations is kept strictly confidential.

In order to assist in the collection of construction material production data, the proponent should be required to provide annual production data for the subject site to the NSW Division of Resources and Geoscience as a condition of any new or amended development consent.

During the preparation of the EIS, The Division recommends that the proponent consult NSW Department of Planning & Environment's *'EIS Guideline - Extractive Industries – Quarries'*. This guideline is available from:

http://www.planning.nsw.gov.au/Assess-and-Regulate/Development-Assessment/~/media/4A89C0947A8C4D70A983F8EE1D7B9790.ashx

The Division would appreciate the opportunity for early consultation in relation to the proposed location of any biodiversity offset areas (both on and off site) or any supplementary biodiversity measures to ensure there is no consequent reduction in access to prospective land for mineral exploration, or potential for sterilisation of mineral or extractive resources.

Queries regarding the above information should be directed to the Division of Resources & Geoscience - Land Use team at landuse.minerals@geoscience.nsw.gov.au.

Yours sincerely



Andrew Helman
Senior Geoscientist - Land Use

Consultation with DPIE – Crown Lands Division

17 July 2019

Mrs Melanie Osborne
Group Leader - Property Manager
Crown Lands
NSW Department of Industry
PO Box 2155
Dangar, NSW 2309
Email: maitland.crownlands@crownland.nsw.gov.au

PO Box 1563
Warriewood
NSW 2012

ABN 45 162 835 083

Dear Melanie

STOCKTON SAND QUARRY – ENVIRONMENTAL IMPACT STATEMENT PREPARATION AND CONSULTATION FOR PROPOSED STATE SIGNIFICANT DEVELOPMENT

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There would be no alteration to the existing site's hours of operation associated with the addition of the inland area and only a short term increase in total output from the site, rising from 500,000 tonnes per annum to 750,000 tonnes per annum until 2028.

In accordance with the Secretary's Environmental Assessment Requirements (SEARs) issued for the Project from NSW Department of Environment, Industry & Planning (DPIE), which are available at the same major projects website link above, Boral are seeking any further and additional comments of matters for

consideration in the preparation of an Environmental Impact Statement (EIS) for the Project.

Boral has engaged my company (Element Environment Pty Ltd) to prepare a range of technical studies to inform the EIS including traffic, acoustics, air quality, surface water, groundwater, Aboriginal heritage, biodiversity, economics, social impacts and acid sulphate soils. On behalf of Boral and as part of the EIS preparation, we initiate consultation regarding the Project via this letter, and Boral will take into consideration any response that is received.

If you or your colleagues have any questions or would like to discuss the proposal in more detail, please feel free to contact me on **0455 666 006** or luke@elementenvironment.com.au. Alternatively, if your organisation has no comments or concerns and are satisfied to await the exhibition of the EIS (to be further notified when dates are determined), we would appreciate a response to this effect.

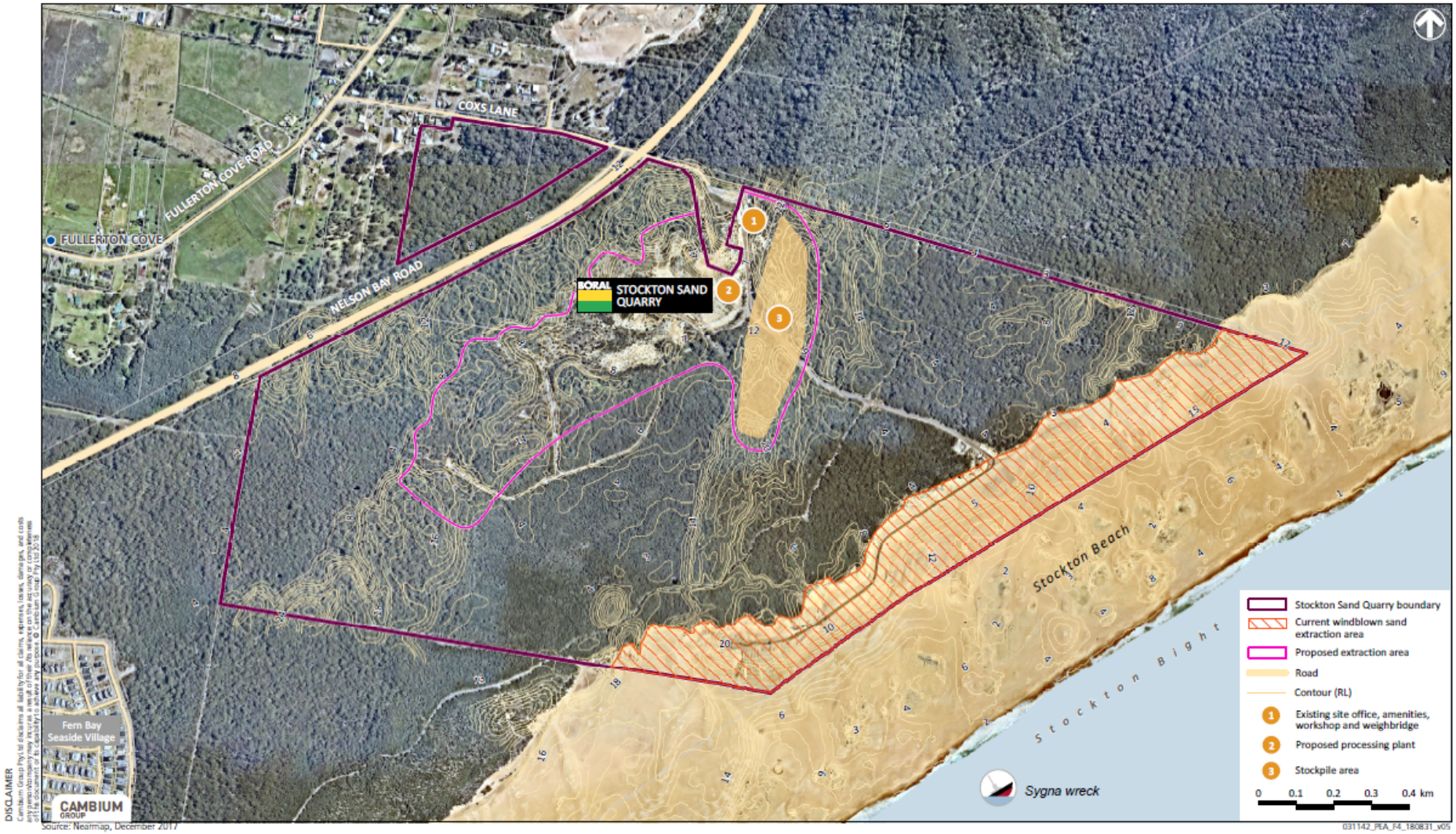
We are hoping to gather all responses to the proposal by **31 July 2019**.

Thank you for your interest in this letter – we look forward to hearing from you soon.

Yours sincerely,



Luke Farrell
Senior Environmental Consultant
Element Environment



Source: Nearmap, December 2017

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Luke Farrell

From: Mark Grace <mark.grace@crownland.nsw.gov.au>
Sent: 26 July 2019 09:48
To: Luke Farrell
Subject: DPIE - Crown Lands comments - Stockton Sand Quarry - SSD-9490 Application - Consultation for Environmental Impact Statement

Hi Luke

Thank you for your email requesting further comments on the Stockton Sand Quarry Project (SSD-9490). The Department of Planning, Industry and Environment – Crown Lands (the Department) provides the following comments for your consideration in the preparation of the EIS:

> The proponent identified in the Preliminary Environmental Assessment (PEA) that Crown land, being Lot 7300 DP 1130730, is required as part of the proposal. Crown land - including any Crown roads, reserves and tenures - impacted by the proposal must be clearly identified and accurately described in the EIS.
> Prior to preparation of the Environmental Impact Statement (EIS) it is recommended that the proponent undertake a Crown Land conveyancing search, available through the department. Information on the department's conveyancing and information search services can be found here:
> https://www.industry.nsw.gov.au/lands/what-we-do/searches
> Development requiring an approval under the *Environmental Planning and Assessment Act 1979* requires the written consent from the Department, as landowner. The EIS should acknowledge that landowner's consent from the Department is required for any affected Crown land and provide details on the actions that the proponent has made, or will make, to obtain this consent. We recommend that the proponent contact the Department directly to discuss the landowner consent application process. The department's landowner's consent application form can be found here:
> https://www.industry.nsw.gov.au/__data/assets/pdf_file/0003/144345/Landowners-consent-application-form.pdf

If you have any questions regarding the above information please contact me.

Regards

Mark
Mark Grace
Natural Resource Management Project Officer
Crown Lands | Department of Planning, Industry and Environment
T 02 4937 9331 | **E** mark.grace@crownland.nsw.gov.au
516 High Street Maitland NSW 2320 | PO Box 2215 Dangar NSW 2309
www.dpie.nsw.gov.au

The Department of Planning, Industry and Environment acknowledges that it stands on Aboriginal land. We acknowledge the traditional custodians of the land and we show our respect for elders past, present and emerging through thoughtful and collaborative approaches to our work, seeking to demonstrate our ongoing commitment to providing places in which Aboriginal people are included socially, culturally and economically.

From: Luke Farrell [mailto:luke@elementenvironment.com.au]
Sent: Wednesday, 17 July 2019 11:13 AM
To: maitland.crownlands@crownland.nsw.gov.au

Cc: PR63
Subject: Stockton Sand Quarry - State Significant Development Application - Consultation for Environmental Impact Statement

ATTN: Melanie Osbourne, Group Leader - Property Manager

Dear Melanie,

Boral Resources (NSW) Pty Ltd (Boral) are seeking approval for continued operations at their Stockton (Fullerton Cove) Sand Quarry through a State Significant Development (SSD) application under Part 4 of the *Environmental Planning & Assessment Act 1979*. Boral propose to extract up to 750,000 tonnes per annum (tpa) of sand product from a former extraction area by front-end loader/excavator and dredging. The project would be for a period of up to 25 years, subject to demand of sand resources.

In accordance with the NSW Department of Environment, Industry & Planning requirements, Boral are seeking from you any further and additional comments of matters for consideration in the preparation of an Environmental Impact Statement (EIS) for the project.

We welcome your feedback about the project as per the attached letter.

Please do not hesitate to get in touch should you have any queries on the project.

Regards,
Luke Farrell

Luke Farrell
Senior Environmental Consultant
0455 666 006

SYDNEY NEWCASTLE CENTRAL COAST TOWNSVILLE
elementenvironment.com.au

This message is intended for the addressee named and may contain confidential information. If you are not the intended recipient, please delete it and notify the sender. Views expressed in this message are those of the individual sender, and are not necessarily the views of their organisation.

Consultation with RMS

17 July 2019

Mr Ken Saxby
Road Safety & Traffic Service Manager
Hunter Road Safety & Traffic
NSW Roads and Maritime Services
Locked Bag 2030
Newcastle, NSW 2300
Email: Development.hunter@rms.nsw.gov.au

PO Box 1563
Warriewood
NSW 2012

ABN 45 162 835 083

Dear Ken

STOCKTON SAND QUARRY – ENVIRONMENTAL IMPACT STATEMENT PREPARATION AND CONSULTATION FOR PROPOSED STATE SIGNIFICANT DEVELOPMENT

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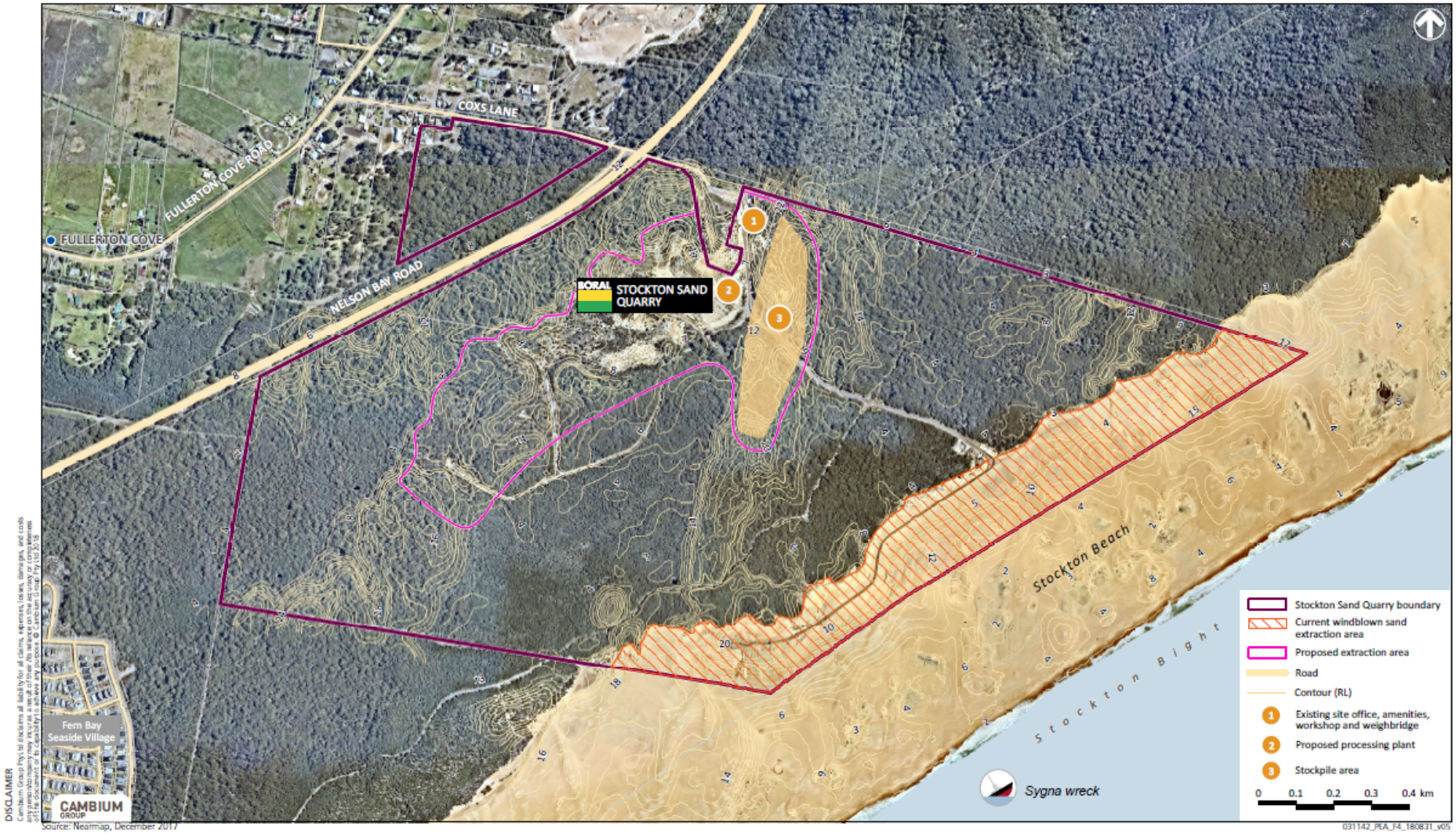
Thank you for your interest in this letter – we look forward to hearing from you soon.

Yours sincerely,



Luke Farrell
Senior Environmental Consultant
Element Environment



Source: Nearmap, December 2017

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Transport
Roads & Maritime
Services

CR2018/004096
SF2018/258570
KAP

19 September 2018

Department of Planning & Environment
Resource Assessments
GPO Box 39
SYDNEY NSW 2001

Attention: Philip Nevill, Environmental Assessment Officer,

PROPOSAL – ESTABLISHMENT OF A SAND QUARRY TO EXTRACT SAND FROM A FORMER EXTRACTION SITE, COXS LANE, FULLERTON COVE (LOTS: 1 & 2 DP: 1006399, LOT: 3 DP: 664552 AND LOT: 7300 DP: 664552), SSD 18_9490

Reference is made to Department of Planning and Environment's email dated 14 September 2018, requesting Roads and Maritime Services' (Roads and Maritime) requirements under Schedule 2 of the *Environmental Planning and Assessment Regulation 2000.*

Transport for NSW and Roads and Maritime's primary interests are in the road network, traffic and broader transport issues. In particular, the efficiency and safety of the classified road network, the security of property assets and the integration of land use and transport.

Roads and Maritime understands the development to be for the increase in extraction of sand at the *Boral* operated Stockton Sand Quarry from 500,000tpa to 750,000tpa and to extend the life of the quarry for a period of 25 years. The Preliminary Environmental Assessment prepared by Element Environment P/L and dated September 2018 explains,

> *"Boral is seeking SSD approval to dredge an estimated 8 million tonnes of sand at a rate of up to 500,000 tonnes per annum from the former extraction area. Until such time that the 2006 windblown sand consent lapses, the two development consents would run in parallel to reach the maximum extraction and processing quantity of up to 750,000 tonnes per annum. Additionally, in order to reduce resultant heavy vehicle movements on local roadways, Boral is proposing to limit the total exportation of sand product via road transportation to 750,000 tonnes per annum until the 2006 windblown sand development consent lapses."*

It is further understood that the proponent will be preparing a traffic and transport impact assessment to determine the potential cumulative impacts on the surrounding road network due to the anticipated increase in truck from 152 movements per day to 228 heavy vehicle movements.

<u>Roads and Maritime response & requirements</u>

Following a review of the proponent's PEA, Roads and Maritime recommends that the EIS refer to the following guidelines with regard to the traffic and transport impacts of the proposed development:

- Road and Related Facilities within the Department of Planning EIS Guidelines, and,

- Section 2 Traffic Impact Studies of Roads and Maritime's *Guide to Traffic Generating Developments 2002*.

Furthermore, a traffic and transport study shall be prepared in accordance with the Roads and Maritime's *Guide to Traffic Generating Developments 2002* and is to include (but not be limited to) the following:

- Assessment of all relevant vehicular traffic routes and intersections for access to / from the subject properties.
- Current traffic counts for all of the traffic routes and intersections.
- The anticipated additional vehicular traffic generated from both the construction and operational stages of the project.
- The distribution on the road network of the trips generated by the proposed development. It is requested that the predicted traffic flows are shown diagrammatically to a level of detail sufficient for easy interpretation.
- Consideration of the traffic impacts on existing and proposed intersections, in particular, the intersections of Nelson Bay Road (MR108) / Coxs Lane (local road) and Nelson Bay Road / Seaside Boulevard (local road), and the capacity of the local and classified road network to safely and efficiently cater for the additional vehicular traffic generated by the proposed development during both the construction and operational stages. The traffic impact shall also include the cumulative traffic impact of other proposed or approved developments in the area.
- Identify the necessary road network infrastructure upgrades that are required to maintain existing levels of service on both the local and classified road network for the development. In this regard, preliminary concept drawings shall be submitted with the EIS for any identified road infrastructure upgrades. However, it should be noted that any identified road infrastructure upgrades will need to be to the satisfaction of Roads and Maritime and Council.
    - Traffic analysis of any major / relevant intersections impacted, using SIDRA or similar traffic model, including:
        - Current traffic counts and 10 year traffic growth projections
        - With and without development scenarios
        - 95th percentile back of queue lengths
        - Delays and level of service on all legs for the relevant intersections
        - Electronic data for Roads and Maritime review (i.e. SIDRA 8 model)
- Any other impacts on the regional and state road network including consideration of pedestrian, cyclist and public transport facilities and provision for service vehicles.

Advice

Roads and Maritime recommends that the following matters should be considered by the DPE in determining this development:

- Roads and Maritime have no proposal that requires any part of the property.
- The property has a common boundary with Nelson Bay Road (MR108) which is classified as a State Road corridor. The property has alternative access via a local road network known as Coxs Lane. Accordingly, direct access to Nelson Bay Road is restricted and access to the property is permitted via Coxs Lane only.

On determination of this matter, please forward a copy of the SEARs to Roads and Maritime for record and / or action purposes. Should you require further information please contact Hunter Land Use on 4924 0688 or by email at development.hunter@rms.nsw.gov.au.

Yours sincerely



Peter Marler
Manager Land Use Assessment
Hunter Region

Consultation with EPA

17 July 2019

Mr Bill George
Senior Operations Officer Hunter Region
Hunter Region
NSW Environment Protection Authority
117 Bull St
Newcastle West, NSW 2302
Email: Hunter.region@epa.nsw.gov.au

PO Box 1563
Warriewood
NSW 2012

ABN 45 162 835 083

Dear Bill

STOCKTON SAND QUARRY – ENVIRONMENTAL IMPACT STATEMENT PREPARATION AND CONSULTATION FOR PROPOSED STATE SIGNIFICANT DEVELOPMENT

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Sand Quarry (hereafter referred to as the 'quarry'), a long standing operation that extracts and transports sand product for use in the building, landscaping and construction markets. The quarry is located at Coxs Lane, Fullerton Cove, in the Port Stephens Local Government Area.

The quarry currently has consent to extract up to 500,000 tonnes of sand per annum from the transgressive (windblown) dunes adjoining Stockton Beach only, until 2028.

In order to meet ongoing sustained demand for a consistent and continuous supply of sand to the Hunter and Sydney regions, Boral is seeking approval for continued operations at the site through a State Significant Development (SSD) application under Part 4 of the Environmental Planning & Assessment Act 1979. Boral propose to extract up to 750,000 tonnes per annum (tpa) of sand product from a former extraction area by front-end loader/excavator and dredging (the Project). The Project would be for a period of up to 25 years, subject to demand of sand resources.

An outline of the Project is available within the Stockton Sand Quarry Dredging: Preliminary Environmental Assessment (Element Environment, September 2018), available on the major projects register at the below link:

http://majorprojects.planning.nsw.gov.au/index.pl?action=view_job&job_id=9490

There would be no alteration to the existing site's hours of operation associated with the addition of the inland area and only a short term increase in total output from the site, rising from 500,000 tonnes per annum to 750,000 tonnes per annum until 2028.

In accordance with the Secretary's Environmental Assessment Requirements (SEARs) issued for the Project from NSW Department of Environment, Industry & Planning (DPIE), which are available at the same major projects website link above, Boral are seeking any further and additional comments of matters for

consideration in the preparation of an Environmental Impact Statement (EIS) for the Project.

Boral has engaged my company (Element Environment Pty Ltd) to prepare a range of technical studies to inform the EIS including traffic, acoustics, air quality, surface water, groundwater, Aboriginal heritage, biodiversity, economics, social impacts and acid sulphate soils. On behalf of Boral and as part of the EIS preparation, we initiate consultation regarding the Project via this letter, and Boral will take into consideration any response that is received.

If you or your colleagues have any questions or would like to discuss the proposal in more detail, please feel free to contact me on **0455 666 006** or luke@elementenvironment.com.au. Alternatively, if your organisation has no comments or concerns and are satisfied to await the exhibition of the EIS (to be further notified when dates are determined), we would appreciate a response to this effect.

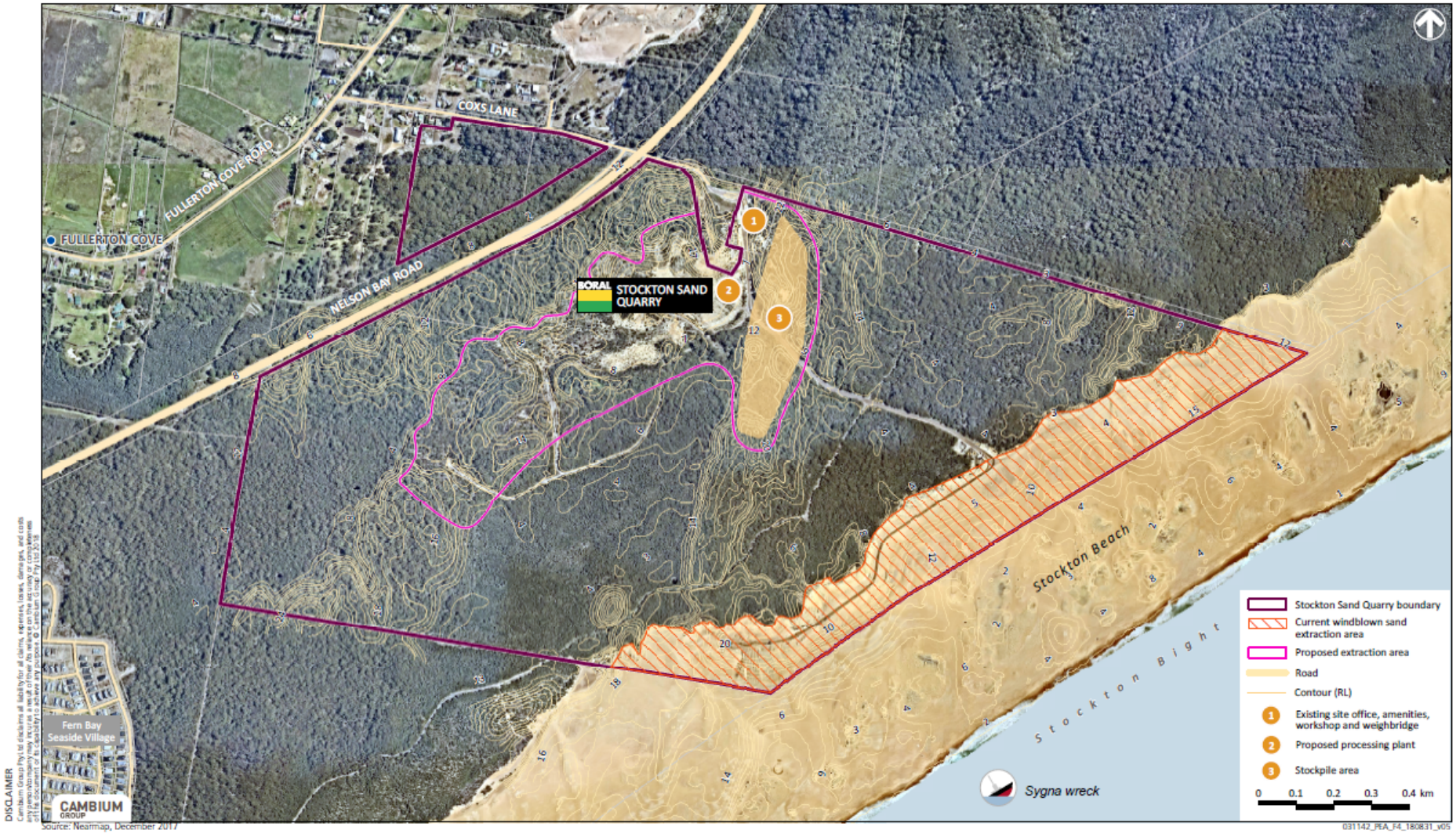
We are hoping to gather all responses to the proposal by **31 July 2019**.

Thank you for your interest in this letter – we look forward to hearing from you soon.

Yours sincerely,



Luke Farrell
Senior Environmental Consultant
Element Environment



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DOC19/611704-1; EF13/3919

Element Environment
PO Box 1563
WARRIEWOOD NSW 2012

Email: elementenvironment.com.au

Attention: Luke Farrell

Dear Mr Farrell

STOCKTON SAND QUARRY – ENVIRONMENTAL IMPACT STATEMENT PREPARATION AND CONSULTATION FOR PROPOSED STATE SIGNIFICANT DEVELOPMENT

Reference is made to your email dated 17 July 2019 to the Environment Protection Authority ("EPA") requesting consultation in relation to the preparation of *Environmental Impact Statement for proposed State Significant Development.*

The EPA has no further comments beyond the previous Environmental Assessment Requirements provided to NSW Department of Planning Industry and Environment.

If you wish to discuss the matter further, please contact me on 02 4908 6826.

Yours sincerely

LISA RICHARDS
Regional Operations Officer - Hunter
Environment Protection Authority

Consultation with DPIE – Environment, Energy and Science Division

17 July 2019

Ms Nicole Davis
Acting Senior Team Leader – Planning
Hunter Central Coast Branch, Conservation and Regional Delivery Division
NSW Office of Environment and Heritage
26 Honeysuckle Drive
Newcastle West, NSW 2300
Email: Nicole.Davis@environment.nsw.gov.au

PO Box 1563
Warriewood
NSW 2012

ABN 45 162 835 083

Dear Nicole

STOCKTON SAND QUARRY – ENVIRONMENTAL IMPACT STATEMENT PREPARATION AND CONSULTATION FOR PROPOSED STATE SIGNIFICANT DEVELOPMENT

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Sand Quarry (hereafter referred to as the 'quarry'), a long standing operation that extracts and transports sand product for use in the building, landscaping and construction markets. The quarry is located at Coxs Lane, Fullerton Cove, in the Port Stephens Local Government Area.

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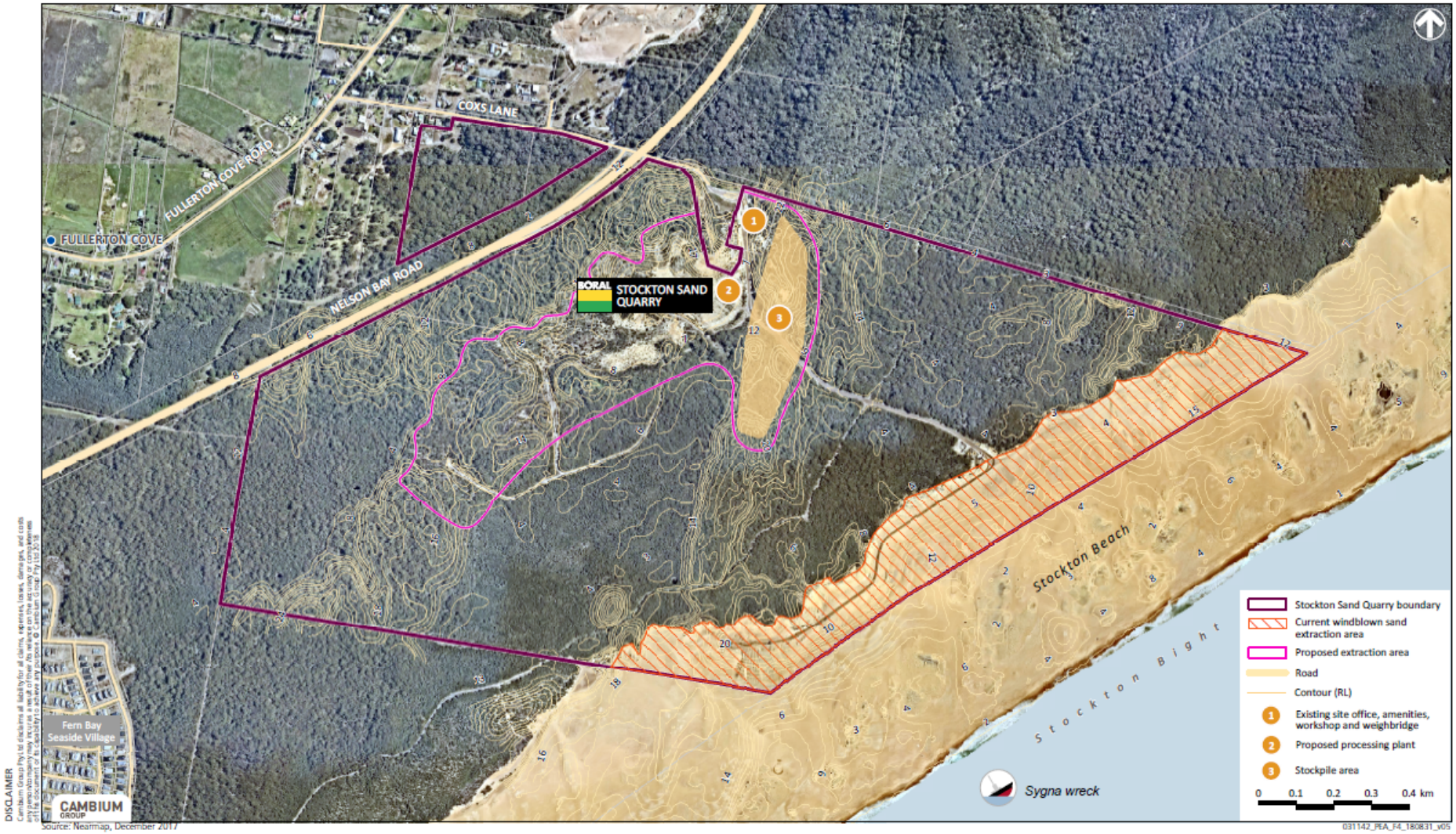
Thank you for your interest in this letter – we look forward to hearing from you soon.

Yours sincerely,



Luke Farrell
Senior Environmental Consultant
Element Environment



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17 July 2019

Mr Timothy Olliver
Acting Senior Customer Strategies Officer
Heritage Division
NSW Office of Environment and Heritage
Locked Bag 5020
Parramatta, NSW 2150
Email: timothy.olliver@environment.nsw.gov.au

PO Box 1563
Warriewood
NSW 2012

ABN 45 162 835 083

Dear Tim

STOCKTON SAND QUARRY – ENVIRONMENTAL IMPACT STATEMENT PREPARATION AND CONSULTATION FOR PROPOSED STATE SIGNIFICANT DEVELOPMENT

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Boral has engaged my company (Element Environment Pty Ltd) to prepare a range of technical studies to inform the EIS including traffic, acoustics, air quality, surface water, groundwater, Aboriginal heritage, biodiversity, economics, social impacts and acid sulphate soils. On behalf of Boral and as part of the EIS preparation, we initiate consultation regarding the Project via this letter, and Boral will take into consideration any response that is received.

If you or your colleagues have any questions or would like to discuss the proposal in more detail, please feel free to contact me on **0455 666 006** or luke@elementenvironment.com.au. Alternatively, if your organisation has no comments or concerns and are satisfied to await the exhibition of the EIS (to be further notified when dates are determined), we would appreciate a response to this effect.

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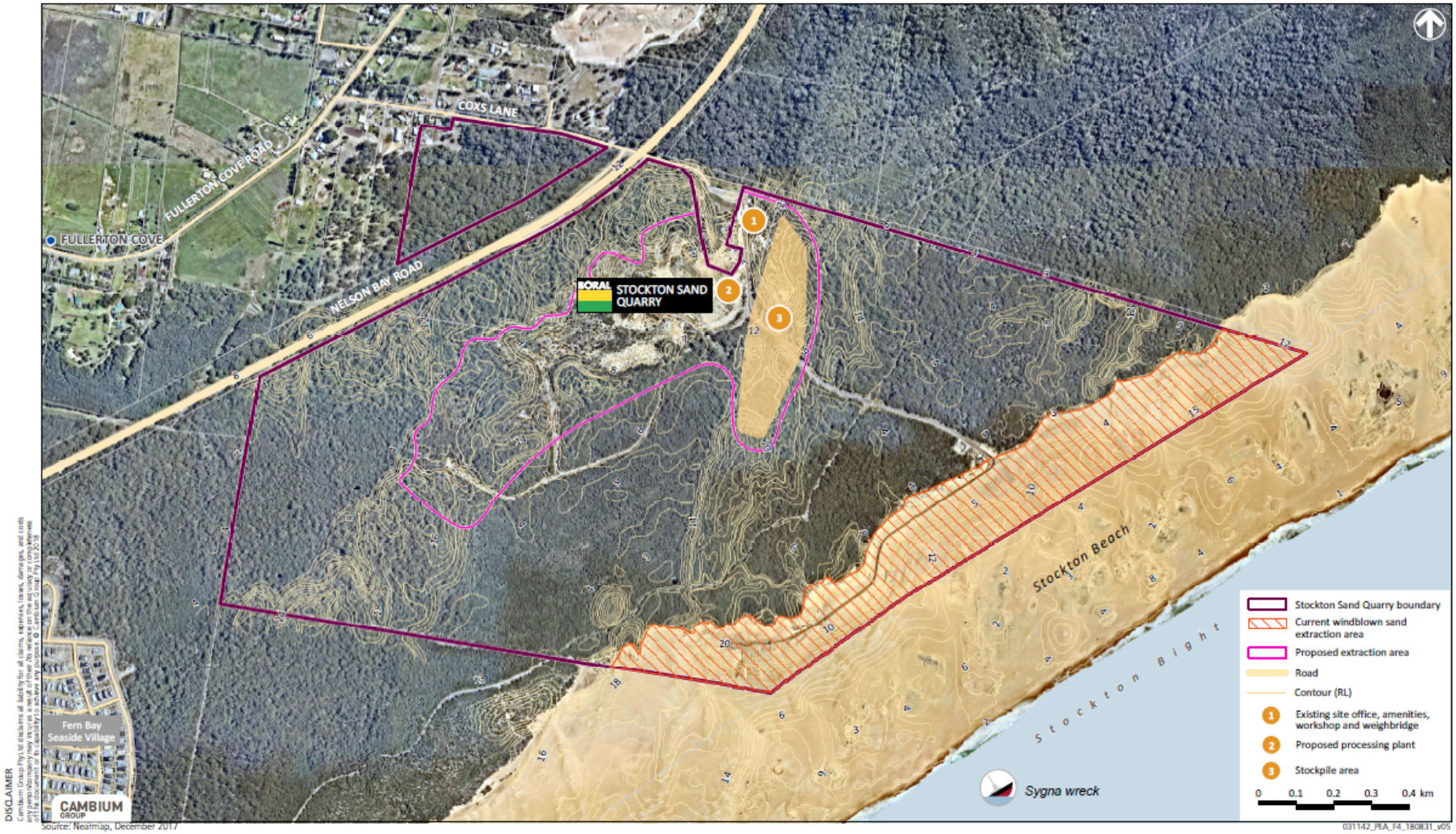
Thank you for your interest in this letter – we look forward to hearing from you soon.

Yours sincerely,



Luke Farrell
Senior Environmental Consultant
Element Environment



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Our ref: DOC19/614255-1
Senders ref:

Mr Luke Farrell

Senior Environmental Consultant
Element Environment
PO Box 1563
Warriewood 2012

Dear Mr Farrell

Biodiversity and Conservation Division comments for the preparation of an Environmental Impact Statement

Thank you for your letter dated 17 July 2019 in which Element Environment requested the Biodiversity and Conservation Division (BCD) of the Department of Planning, Industry and Environment provide comments for the preparation of an Environmental Impact Statement for the proposed Stockton sand quarry at Cox's Lane, Fullerton Cove.

BCD has provided input into Secretary's Environmental Assessment Requirements (SEARs) (our reference DOC18/691590-1) which outline assessment requirements for Aboriginal cultural heritage, threatened biodiversity, impacts to National Parks and Wildlife Estate, soils and water, flooding, floodplain management and coastal erosion. BCD has no further assessment requirements at this stage of the project.

If you require any further information regarding this matter, please contact Vanessa Owen, Senior Regional Biodiversity Conservation Officer, on 4927 3116 or via email at rog.hcc@environment.nsw.gov.au.

Yours sincerely

2 August 2019

STEVEN COX

Senior Team Leader Planning
Hunter Central Coast Branch
Biodiversity and Conservation Division

Consultation with Hunter Local Land Services

17 July 2019

Mr Brett Miners
General Manager
Paterson Office
Hunter Local Land Services
Private Bag 2010
Paterson, NSW 2421
Email: brett.miners@lls.nsw.gov.au

PO Box 1563
Warriewood
NSW 2012

ABN 45 162 835 083

Dear Brett

STOCKTON SAND QUARRY – ENVIRONMENTAL IMPACT STATEMENT PREPARATION AND CONSULTATION FOR PROPOSED STATE SIGNIFICANT DEVELOPMENT

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Sand Quarry (hereafter referred to as the 'quarry'), a long standing operation that extracts and transports sand product for use in the building, landscaping and construction markets. The quarry is located at Coxs Lane, Fullerton Cove, in the Port Stephens Local Government Area.

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If you or your colleagues have any questions or would like to discuss the proposal in more detail, please feel free to contact me on **0455 666 006** or luke@elementenvironment.com.au. Alternatively, if your organisation has no comments or concerns and are satisfied to await the exhibition of the EIS (to be further notified when dates are determined), we would appreciate a response to this effect.

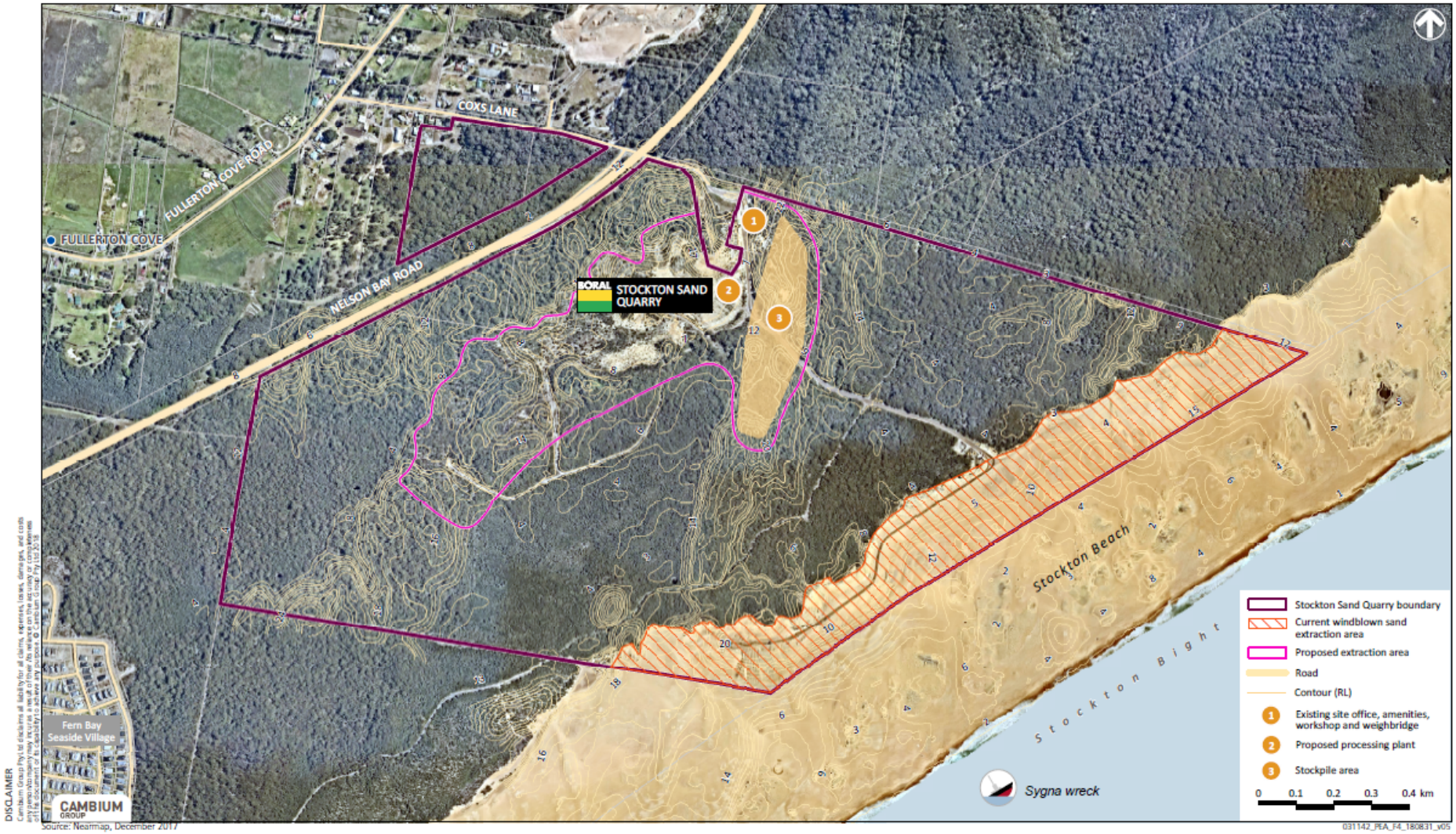
We are hoping to gather all responses to the proposal by **31 July 2019**.

Thank you for your interest in this letter – we look forward to hearing from you soon.

Yours sincerely,



Luke Farrell
Senior Environmental Consultant
Element Environment



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Luke Farrell

From: Brett Miners <brett.miners@lls.nsw.gov.au>
Sent: 17 July 2019 12:25
To: Luke Farrell
Cc: PR63
Subject: Re: Stockton Sand Quarry - State Significant Development Application - Consultation for Environmental Impact Statement

Hello Luke,

Hunter LLS has no statutory role in development consents, so will not be providing feedback on this development proposal.

regards

Brett

Brett Miners | General Manager

Hunter Local Land Services

816 Tocal Road (Private Bag 2010) PATERSON NSW 2421
t: 02 4938 4900 | m: 0427 346 263

e: brett.miners@lls.nsw.gov.au | w: www.lls.nsw.gov.au/hunter



On Wed, 17 Jul 2019 at 11:16, Luke Farrell <luke@elementenvironment.com.au> wrote:

> Dear Brett,
>
> Boral Resources (NSW) Pty Ltd (Boral) are seeking approval for continued operations at their Stockton (Fullerton Cove) Sand Quarry through a State Significant Development (SSD) application under Part 4 of the *Environmental Planning & Assessment Act 1979*. Boral propose to extract up to 750,000 tonnes per annum (tpa) of sand product from a former extraction area by front-end loader/excavator and dredging. The project would be for a period of up to 25 years, subject to demand of sand resources.

In accordance with the NSW Department of Environment, Industry & Planning requirements, Boral are seeking from you any further and additional comments of matters for consideration in the preparation of an Environmental Impact Statement (EIS) for the project.

We welcome your feedback about the project as per the attached letter.

Please do not hesitate to get in touch should you have any queries on the project.

Regards,

Luke Farrell

Luke Farrell

Senior Environmental Consultant

0455 666 006

element.

SYDNEY NEWCASTLE CENTRAL COAST TOWNSVILLE

elementenvironment.com.au

This message is intended for the addressee named and may contain confidential information. If you are not the intended recipient, please delete it and notify the sender. Views expressed in this message are those of the individual sender, and are not necessarily the views of their organisation.

Consultation with Hunter Water

17 July 2019

Mr Malcolm Withers
Accounts Manager
Development
Hunter Water
PO Box 5171
Hunter Region Mail Centre, NSW 2310
Email: enquiries@hunterwater.com.au

PO Box 1563
Warriewood
NSW 2012

ABN 45 162 835 083

Dear Malcolm

STOCKTON SAND QUARRY – ENVIRONMENTAL IMPACT STATEMENT PREPARATION AND CONSULTATION FOR PROPOSED STATE SIGNIFICANT DEVELOPMENT

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Sand Quarry (hereafter referred to as the 'quarry'), a long standing operation that extracts and transports sand product for use in the building, landscaping and construction markets. The quarry is located at Coxs Lane, Fullerton Cove, in the Port Stephens Local Government Area.

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There would be no alteration to the existing site's hours of operation associated with the addition of the inland area and only a short term increase in total output from the site, rising from 500,000 tonnes per annum to 750,000 tonnes per annum until 2028.

The drinking water catchments of Hunter Water Corporation are located within the Port Stephens LGA.

Under Section 51 of the NSW Hunter Water Act 1991 (HW Act), consent authorities including NSW Department of Environment, Industry & Planning (DPIE), are required to refer development applications that may significantly impact on water quality in the drinking water catchments to Hunter Water for comment.

Following the introduction of the Hunter Water Regulation 2015, Hunter Water published the Guidelines for developments in drinking water catchments (Hunter Water, 2017) to provide guidance for development activities within the drinking water catchments and to consent authorities about matters of concern to Hunter Water regarding protection of drinking water quality.

The Project site is not positioned within a drinking water catchment, however it is located to the immediate south of the North Stockton Catchment Area. Additionally, the Tomago and Stockton Sandbed aquifers which lie below the site are listed by Hunter Water as a potential water supply in times of extreme drought.

In accordance with the guidelines, development which warrants referral to Hunter Water under Section 51 of the HW Act include development which has potential to significantly alter groundwater tables, and extractive industries.

Despite not being directly positioned within an existing drinking water catchment, the Project does involve dredging sand below groundwater adjacent to the North Stockton Catchment Area, and within the Tomago and Stockton Sandbeds.

Preliminary hydrogeological investigations have concluded that there would be no significant drawdown of the Tomago and Stockton Sandbeds and the Project would not require dewatering or bulk extraction of groundwater, other than via natural evaporation of the dredge pond and outgoing moisture content of the sand product.

In accordance with the Secretary's Environmental Assessment Requirements (SEARs) issued for the Project from NSW Department of Environment, Industry & Planning (DPIE), which are available at the same major projects website link above, Boral are seeking any further and additional comments of matters for consideration in the preparation of an Environmental Impact Statement (EIS) for the Project.

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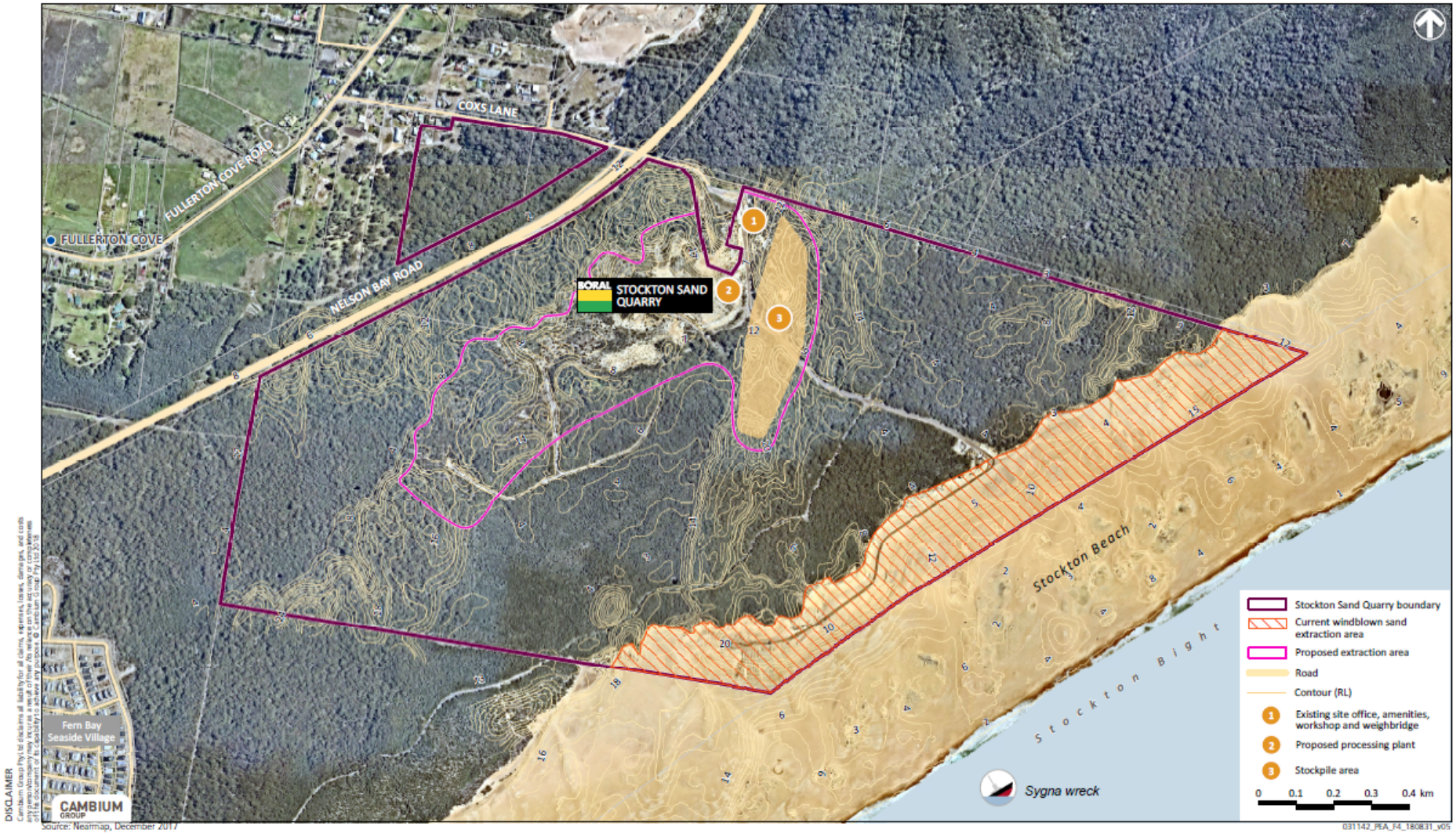
We are hoping to gather all responses to the proposal by **31 July 2019**.

Thank you for your interest in this letter – we look forward to hearing from you soon.

Yours sincerely,



Luke Farrell
Senior Environmental Consultant
Element Environment



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Hunter Water Corporation
ABN 46 228 513 446

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36 Honeysuckle Drive
NEWCASTLE NSW 2300
1300 657 657 (T)
(02) 4979 9468 (F)
enquiries@hunterwater.com.au
hunterwater.com.au

15 August 2019

Our Ref: HW2019-913

Luke Farrell
Senior Environmental Consultant
Element Environmental
via email: luke@elementenvironment.com.au

Dear Luke,

RE: STOCKTON SAND QUARRY – REQUEST FOR COMMENT REGARDING ENVIRONMENTAL IMPACT ASSESSMENT PREPARATION (SSD 18_9490)

Thank you for your email and letter dated 17 July 2019 requesting advice from Hunter Water Corporation (Hunter Water) regarding matters of consideration for the preparation of an Environmental Impact Statement (EIS) to support a State Significant Development Application for the proposed continuation and modification of sand extraction operations at Coxs Lane, Fullerton Cove.

Hunter Water understands the proposed development would include extraction of up to 750,000 tonnes per annum (tpa) of sand product from a former extraction area by front-end loader/excavator and dredging.

The quarry is located adjacent to the North Stockton Catchment Area gazetted under the *Hunter Water Regulation 2015*. While the proposal is located outside of the gazetted catchment area; catchment area boundaries typically follow convenient landscape or cadastral features; thus activities at the site may still affect groundwater in the Catchment Area. While groundwater is not currently extracted from the North Stockton aquifer for potable water supply, Hunter Water maintains an interest in protecting the water source and ensuring it is not adversely impacted by inappropriate development. This includes ensuring that all activities are undertaken in a manner consistent with current best management practice.

The Planning Secretary's Environmental Assessment Requirements (PSEARs) issued on 16 November 2018 include the need to discuss:

- Regional and local geology;
- A description the in-flow and out-flow of materials and discharges to the environment;
- A water management strategy;
- Assessment of the likely impacts of the development on the environment, including assessment of cumulative assessment; and management and mitigation measures. Hunter Water notes that these issues should include a focus on groundwater and potential impacts on the Catchment Area.

It is also noted that the PSEARs require the EIS to describe whether these measures are consistent with industry best practice, and represent the full range of reasonable and feasible mitigation measures that could be implemented. In regards to best management

practice, we note that the proposal to extract sand below the water table is inconsistent with current best practice and the approval of other sand extraction operations in the area, which have limits on the depth of extraction imposed upon them in order to protect groundwater sources. For example, sand extraction at Sibelco's Tanilba Northern Dune operation, Sibelco's Anna Bay operation, the Cabbage Tree Road Quarry (SSD-6125, yet to commence), Salt Ash Sand Quarry (07_0094) and the Fullerton Cove Sand Quarry (07_0145) all have extraction depth limits imposed upon them to safeguard groundwater sources. Measures to protect groundwater sources are related to both pollution risk and the loss of valuable water supplies through drainage and evaporation.

Hunter Water recommends that all extractive operations should be designed and undertaken in a way that ensures protection of water sources and facilitates sustainable future land use. If the Proponent maintains the intention to dredge sand, the EIS must demonstrate why this particular development should be allowed to undertake activities not permitted at other local mines, and how such works would be sustainable and not have any adverse effect on the aquifer. This should include the development of a monitoring and management program to assess and mitigate any effects on groundwater levels or quality.

Further, the EIS should address site operations and management practices, and how these will be undertaken to ensure that site activities do not result in contamination of the sandbeds, including management of wastewater and stormwater. Rehabilitation and future use of the site to protect the sandbeds as a potential source of drinking water in the future should also be addressed.

If you require further advice or clarification of these requirements, please contact me on (02) 4979 9545.

Yours sincerely



Malcolm Withers
Account Manager Major Development

cc Jack Murphy; Department of Planning and Environment;
Jack.Murphy@planning.nsw.gov.au

Consultation with Hunter New England Health

17 July 2019

Mr Michael DiRienzo
CEO
Hunter New England Health
NSW Health
Locked Bag 1
New Lambton, NSW 2305
Email: michael.dirienzo@hnehealth.nsw.gov.au

PO Box 1563
Warriewood
NSW 2012

ABN 45 162 835 083

Dear Michael

STOCKTON SAND QUARRY – ENVIRONMENTAL IMPACT STATEMENT PREPARATION AND CONSULTATION FOR PROPOSED STATE SIGNIFICANT DEVELOPMENT

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If you or your colleagues have any questions or would like to discuss the proposal in more detail, please feel free to contact me on **0455 666 006** or luke@elementenvironment.com.au. Alternatively, if your organisation has no comments or concerns and are satisfied to await the exhibition of the EIS (to be further notified when dates are determined), we would appreciate a response to this effect.

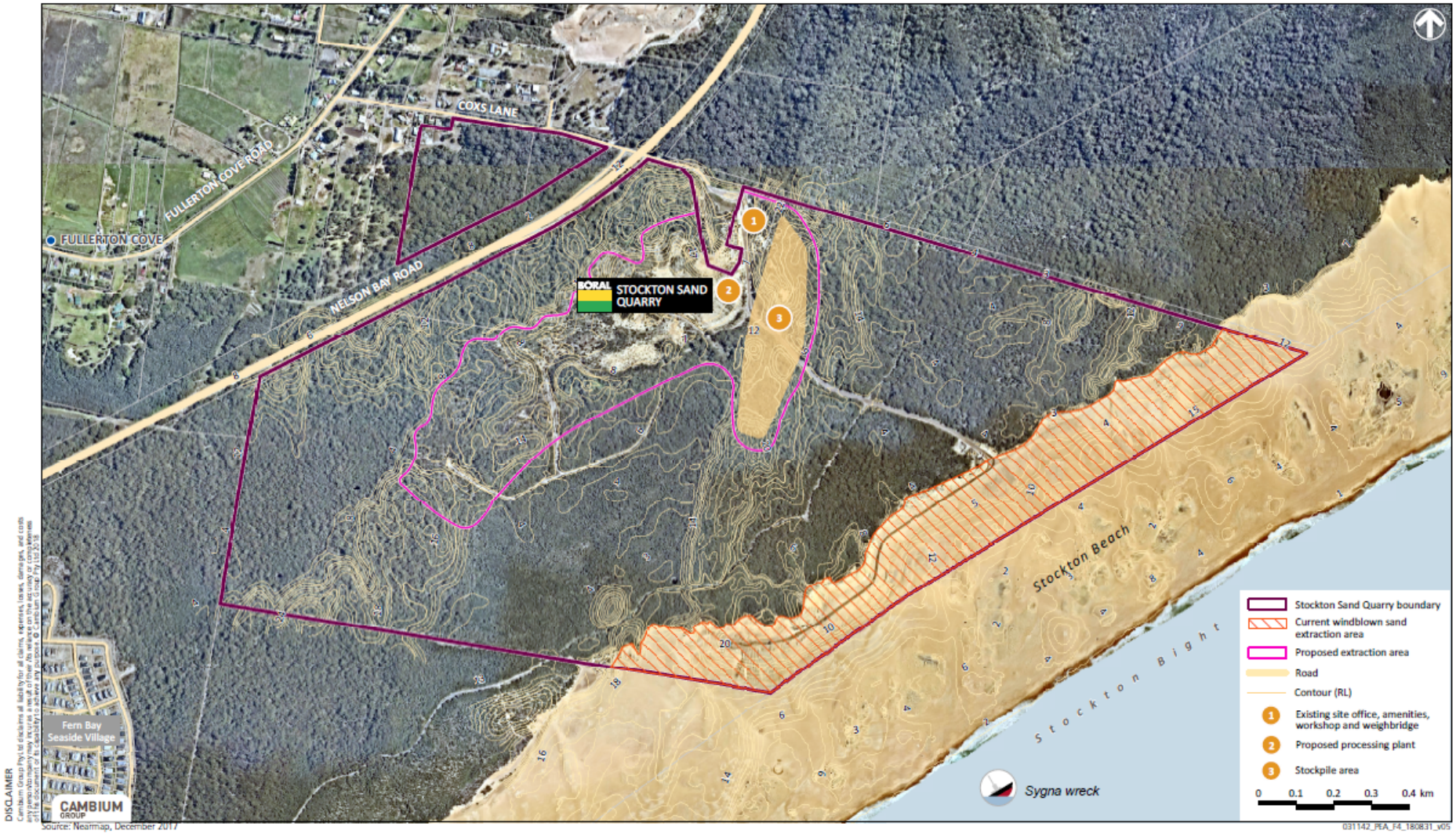
We are hoping to gather all responses to the proposal by **31 July 2019**.

Thank you for your interest in this letter – we look forward to hearing from you soon.

Yours sincerely,



Luke Farrell
Senior Environmental Consultant
Element Environment



Source: Nearmap, December 2017

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Clinical Services, Nursing and Midwifery
Phone: 02 49214916
Facsimile: 02 49214959
Email: Michael.Dirienzo@health.nsw.gov.au

NSW GOVERNMENT Health
Hunter New England
Local Health District

18th July 2019

Luke Farrell
Senior Environmental Consultant
Element Environment

luke@elementenvironment.com.au

Dear Mr Farrell

Re: Boral Resources seeking approval for continued operations Stockton (Fullerton Cove) Sand Quarry

Thank you for your recent correspondence seeking approval for Boral Resources to continue their operations at Stockton (Fullerton Cove) Sand Quarry through a State Significant Development (SSD) application under Part 4 of the *Environmental Planning & Assessment Act 1979*.

Can confirm that our population health team has reviewed the SEARs and are satisfied to await the formal EIS.

We do not feel there is further need for comment at this stage.

Please do not hesitate to contact me if you require any further information.

Yours Sincerely

Michael DiRienzo
Chief Executive
Hunter New England Local Health District

Hunter New England Local Health District
ABN 63 598 010 203

Locked Mail Bag 1
NEW LAMBTON NSW 2305
www.hnehealth.nsw.gov.au

Consultation with DPIE – Water, Lands and Primary Industry Division

17 July 2019

Mr Richard Rienstra
Land Administration Manager
NSW Forestry
NSW Department of Primary Industries
PO Box 168
Wauchope, NSW 2446
Email: Richard.Rienstra@fcnsw.com.au

PO Box 1563
Warriewood
NSW 2012

ABN 45 162 835 083

Dear Richard

STOCKTON SAND QUARRY – ENVIRONMENTAL IMPACT STATEMENT PREPARATION AND CONSULTATION FOR PROPOSED STATE SIGNIFICANT DEVELOPMENT

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Thank you for your interest in this letter – we look forward to hearing from you soon.

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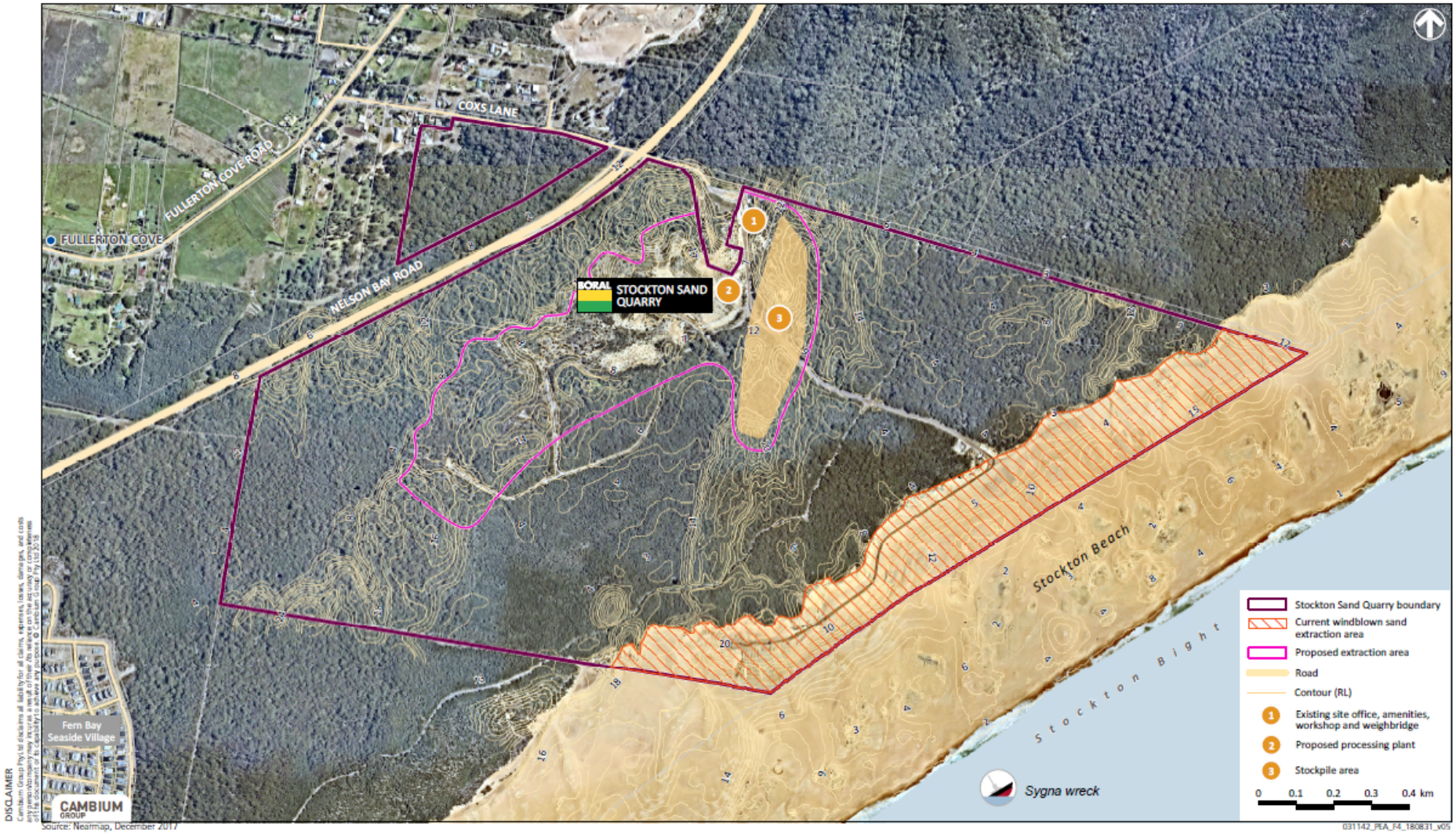
Element Environment



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17 July 2019

Mr Chris Jones
Water Regulation Officer
Water Division
NSW Department of Industry
GPO Box 5477
Sydney, NSW 2001
Email: Christopher.Jones@nrar.nsw.gov.au

PO Box 1563
Warriewood
NSW 2012

ABN 45 162 835 083

Dear Chris

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Yours sincerely,



Luke Farrell
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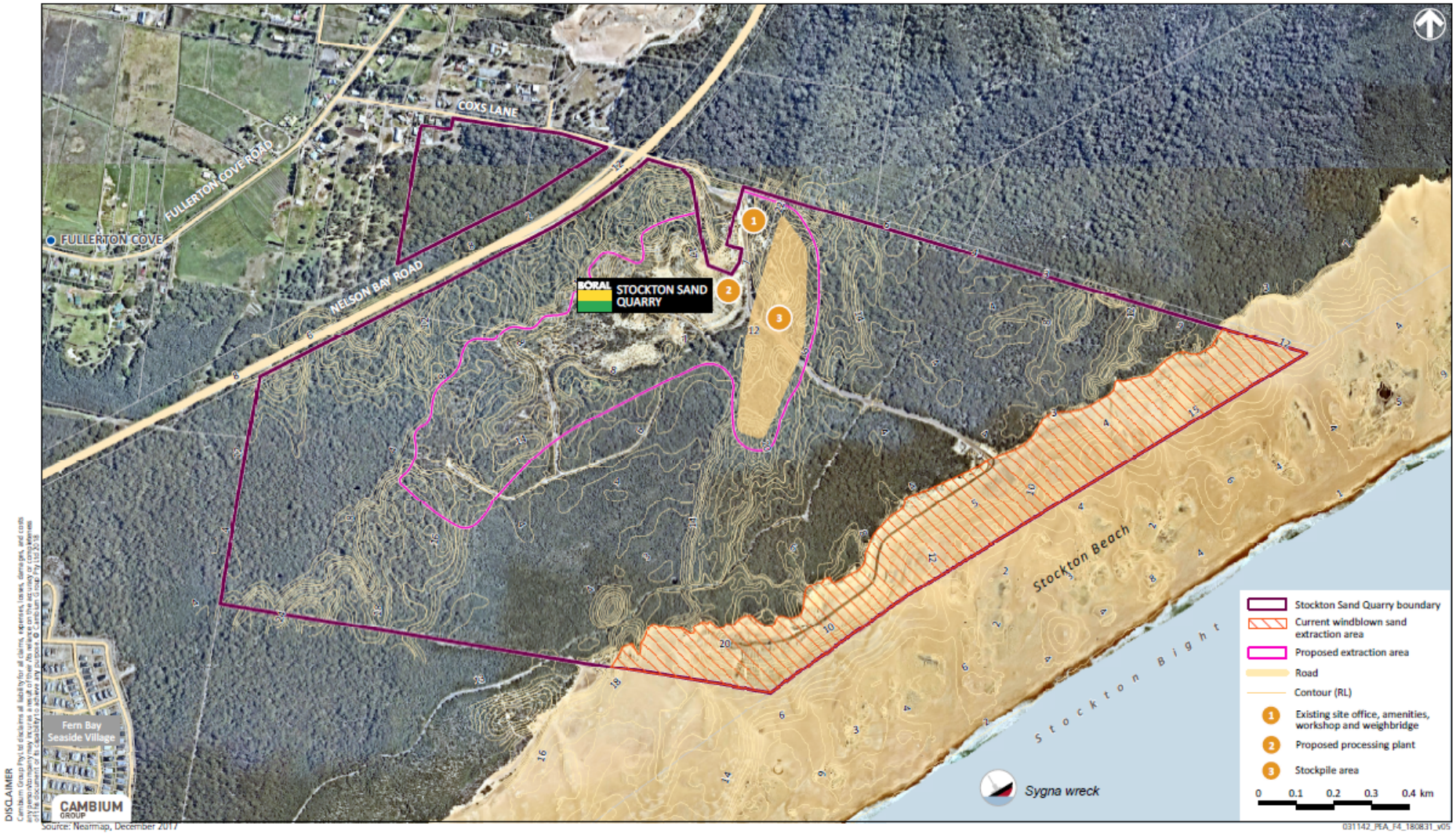

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17 July 2019

Mrs Glenda Briggs
Regional Director
NSW Department of Agriculture
NSW Department of Primary Industries
Locked Bag 21
Orange, NSW 2800
Email: landuse.enquiries@dpi.nsw.gov.au

PO Box 1563
Warriewood
NSW 2012

ABN 45 162 835 083

Dear Glenda

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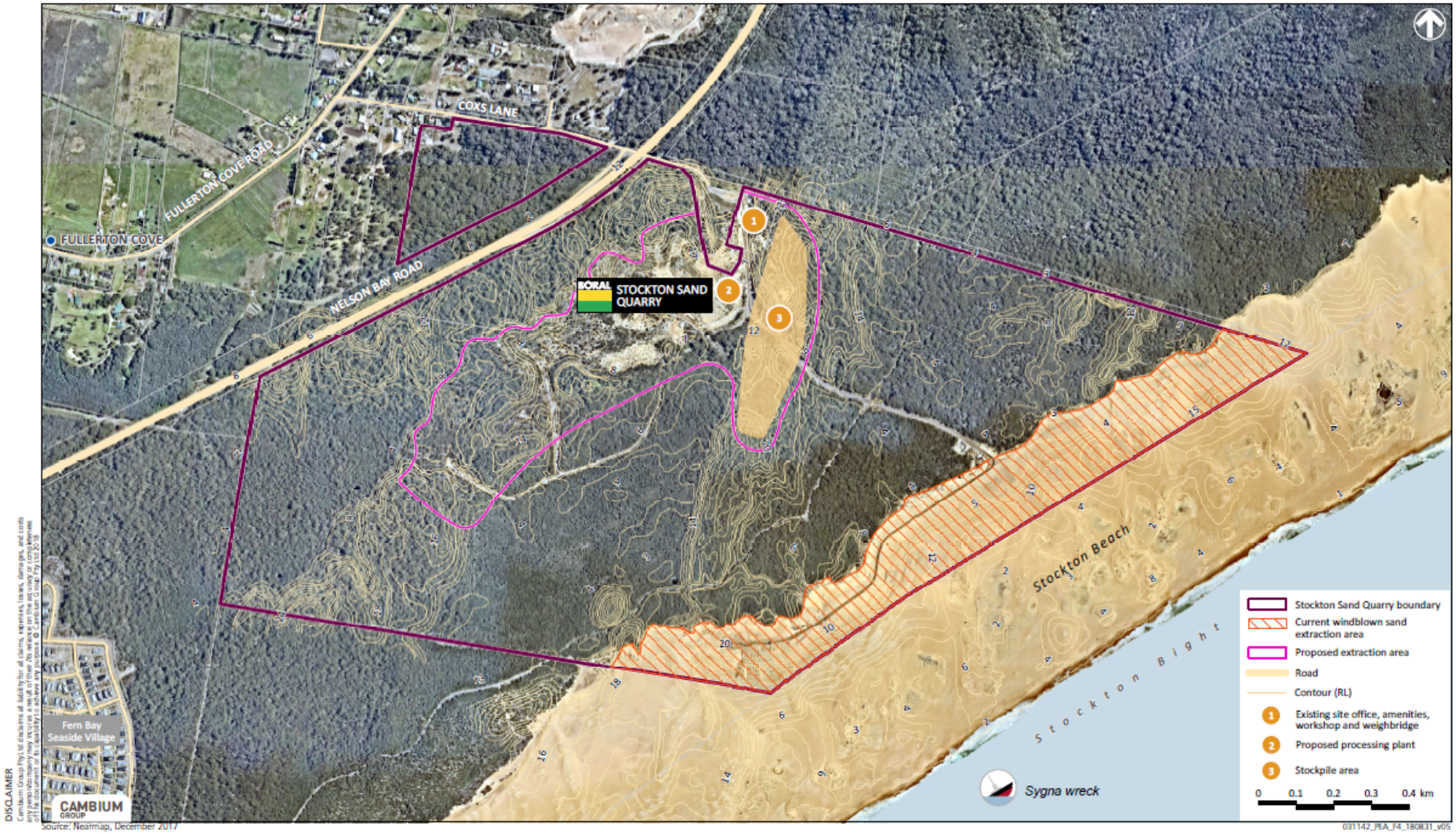
Senior Environmental Consultant
Element Environment



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Luke Farrell

From: tory.lawrence@industry.nsw.gov.au on behalf of Landuse Enquiries <landuse.enquiries@dpi.nsw.gov.au>
Sent: 18 July 2019 09:43
To: Luke Farrell
Subject: Re: Stockton Sand Quarry - State Significant Development Application - Consultation for Environmental Impact Statement

Dear Luke,

Thank you for your letter dated 17 July 2019. The Department of Planning, Industry & Environment (DPIE) - Water, Lands and Primary Industries' assessment requirements are outlined in the SEARs issued by the DPIE - Planning and Assessment group.

DPIE - Water, Lands and Primary Industries have no further comments to add at this stage, but will provide assessment advice at the EIS exhibition stage.

If you have any further inquiries regarding this, please do not hesitate to contact - Simon Francis (Senior project Officer) at:
simon.francis@industry.nsw.gov.au.

Regards
Tory

On Wed, 17 Jul 2019 at 11:10, Luke Farrell <luke@elementenvironment.com.au> wrote:

> **ATTN: Glenda Briggs, Regional Director**
>
> **NSW Department of Agriculture**
>
> Dear Glenda,
>
> Boral Resources (NSW) Pty Ltd (Boral) are seeking approval for continued operations at their Stockton (Fullerton Cove) Sand Quarry through a State Significant Development (SSD) application under Part 4 of the *Environmental Planning & Assessment Act 1979*. Boral propose to extract up to 750,000 tonnes per annum (tpa) of sand product from a former extraction area by front-end loader/excavator and dredging. The project would be for a period of up to 25 years, subject to demand of sand resources.
>
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>
> We welcome your feedback about the project as per the attached letter.

Please do not hesitate to get in touch should you have any queries on the project.

Regards,

Luke Farrell

Luke Farrell

Senior Environmental Consultant

0455 666 006

SYDNEY NEWCASTLE CENTRAL COAST TOWNSVILLE

elementenvironment.com.au

--

Assessments Team

Water | Department of Planning, Industry and Environment

P 0417 626 567 or | **E** landuse.enquiries@dpi.nsw.gov.au

Level 3 | 26 Honeysuckle Drive | Newcastle | NSW 2300
www.dpie.nsw.gov.au

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Consultation with DPI – Fisheries

17 July 2019

Ms Carla Ganassin
Fisheries Manager
NSW Fisheries
NSW Department of Primary Industries
Locked Bag 1
Nelson Bay, NSW 2315
Email: Carla.Ganassin@dpi.nsw.gov.au

PO Box 1563
Warriewood
NSW 2012

ABN 45 162 835 083

Dear Carla

STOCKTON SAND QUARRY – ENVIRONMENTAL IMPACT STATEMENT PREPARATION AND CONSULTATION FOR PROPOSED STATE SIGNIFICANT DEVELOPMENT

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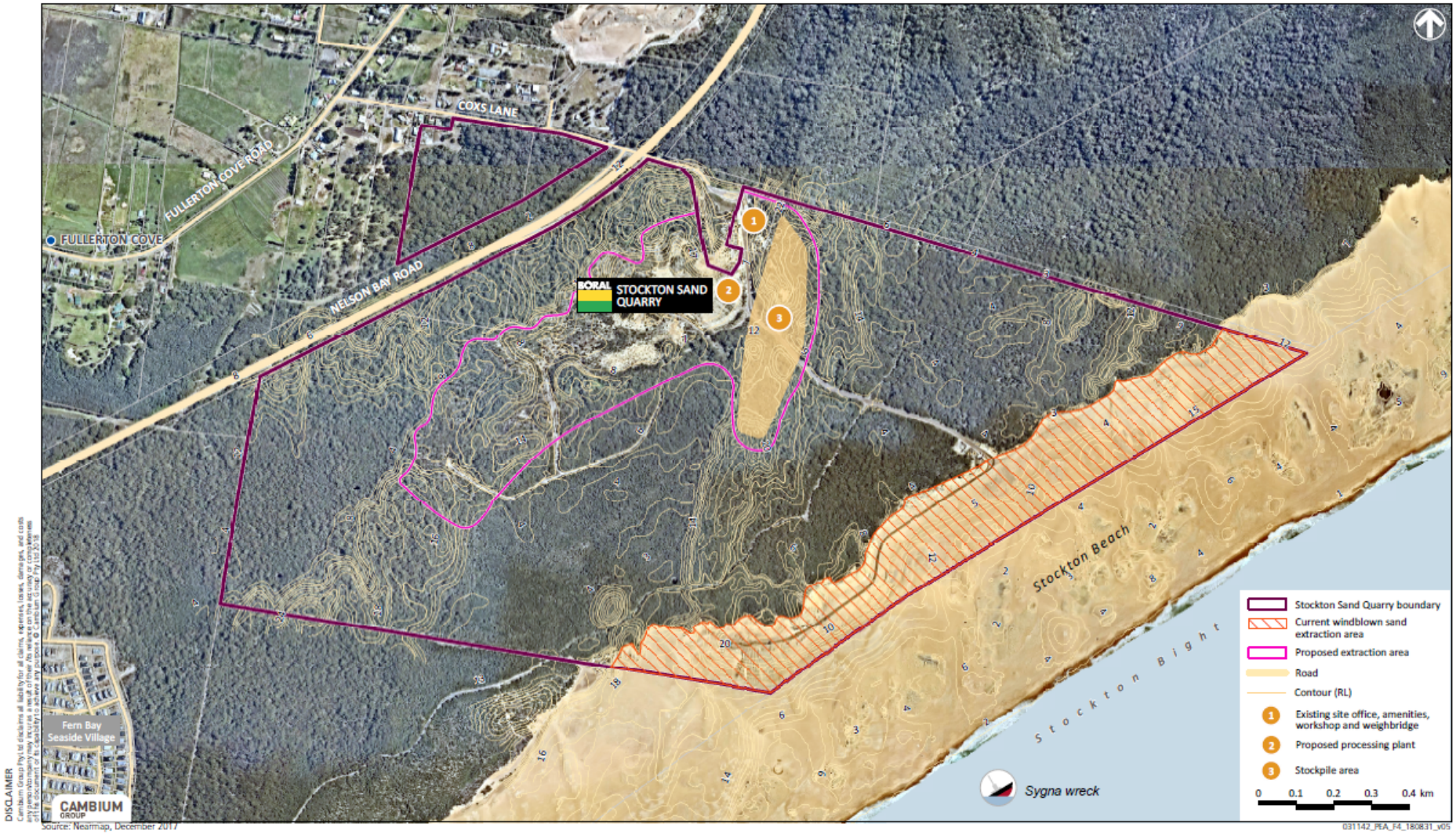

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Luke Farrell

From: Scott Carter <scott.carter@dpi.nsw.gov.au>
Sent: 17 July 2019 12:49
To: Luke Farrell
Subject: Re: Stockton Sand Quarry - State Significant Development Application - Consultation for Environmental Impact Statement

Luke

No Fisheries issues.

Scott Carter | Senior Fisheries Manager
Coastal Systems
NSW Department of Primary Industries | Fisheries
Port Stephens Fisheries Institute| Taylors Beach | NSW 2316
T: +61 2 4916 3931 | E: scott.carter@dpi.nsw.gov.au

FISH HABITAT PROTECTION POLICIES AND PERMIT APPLICATION FORMS AVAILABLE
AT: https://www.dpi.nsw.gov.au/fishing/habitat/help/permit
Email Completed Applications to: **ahp.central@dpi.nsw.gov.au**
Chqs payable to: Department of Trade and Investment
* NB - from date of receipt of application please allow up to 28 days for Land Owners Consent, Permits and Consultations. Please allow up to 40 days for Integrated Development Applications

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On Wed, 17 Jul 2019 at 11:37, Luke Farrell <luke@elementenvironment.com.au> wrote:

> Thanks Carla.
>
> Scott, let me know if any questions. Should be pretty straightforward given no waterways on-site and we are a fair buffer from Fullerton Cove.
>
> Cheers,
>
> Luke.

Luke Farrell

Senior Environmental Consultant

0455 666 006



SYDNEY NEWCASTLE CENTRAL COAST TOWNSVILLE

elementenvironment.com.au

From: Carla Ganassin <carla.ganassin@dpi.nsw.gov.au>
Sent: 17 July 2019 11:32
To: Luke Farrell <luke@elementenvironment.com.au>
Cc: PR63 <pr63@elementenvironment.com.au>; scott.carter <scott.carter@dpi.nsw.gov.au>
Subject: Re: Stockton Sand Quarry - State Significant Development Application - Consultation for Environmental Impact Statement

Hi Luke,

I am passing your email onto Scott Carter who covers the Hunter Region for our team.

Cheers,

Carla Ganassin | Senior Fisheries Manager | Coastal Systems
NSW Department of Primary Industries | Fisheries
Block E, Level 3, 84 Crown Street, Wollongong NSW 2500
SEND MAIL TO: PO Box 97, Huskisson NSW 2540
T: +61 2 4222 8342 | M: 0447 644 357 | E: carla.ganassin@dpi.nsw.gov.au

PERMIT APPLICATION FORMS & FISH HABITAT PROTECTION POLICIES AT:

www.dpi.nsw.gov.au/fisheries/habitat/protecting-habitats/toolkit

EMAIL APPLICATIONS TO: ahp.central@dpi.nsw.gov.au

---------- Forwarded message ---------
From: **Luke Farrell** <luke@elementenvironment.com.au>
Date: Wed, 17 Jul 2019 at 11:12
Subject: Stockton Sand Quarry - State Significant Development Application - Consultation for Environmental Impact Statement
To: Carla Ganassin <carla.ganassin@dpi.nsw.gov.au>
Cc: PR63 <pr63@elementenvironment.com.au>

Dear Carla,

Hope you are well!

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Luke Farrell

Luke Farrell

Senior Environmental Consultant

0455 666 006

SYDNEY NEWCASTLE CENTRAL COAST TOWNSVILLE

elementenvironment.com.au

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Consultation with Port Stephens Council

17 July 2019

Ms Erin Daniel
Senior Development Planner
Planning and Development Services
Port Stephens Council
PO Box 42
Raymond Terrace, NSW 2324
Email: Erin.Daniel@portstephens.nsw.gov.au

PO Box 1563
Warriewood
NSW 2012

ABN 45 162 835 083

Dear Erin

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Boral has engaged my company (Element Environment Pty Ltd) to prepare a range of technical studies to inform the EIS including traffic, acoustics, air quality, surface water, groundwater, Aboriginal heritage, biodiversity, economics, social impacts and acid sulphate soils. On behalf of Boral and as part of the EIS preparation, we initiate consultation regarding the Project via this letter, and Boral will take into consideration any response that is received.

If you or your colleagues have any questions or would like to discuss the proposal in more detail, please feel free to contact me on **0455 666 006** or luke@elementenvironment.com.au. Alternatively, if your organisation has no comments or concerns and are satisfied to await the exhibition of the EIS (to be further notified when dates are determined), we would appreciate a response to this effect.

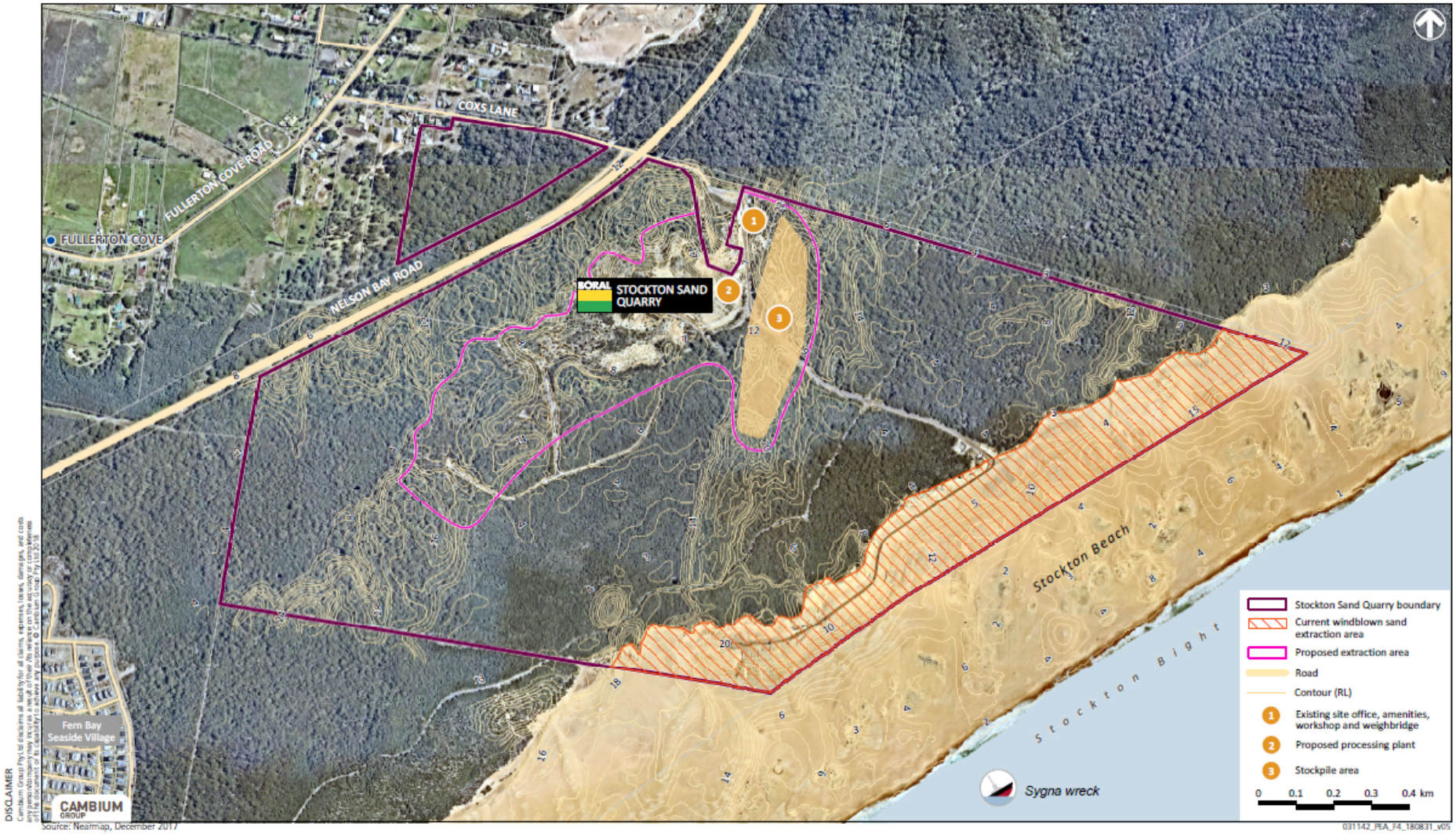
We are hoping to gather all responses to the proposal by **31 July 2019**.

Thank you for your interest in this letter – we look forward to hearing from you soon.

Yours sincerely,



Luke Farrell
Senior Environmental Consultant
Element Environment



Source: Nearmap, December 2017

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Luke Farrell

From: Emmilia Johnstone <Emmilia.Johnstone@portstephens.nsw.gov.au>
Sent: 23 July 2019 10:11
To: Luke Farrell
Cc: PR63
Subject: RE: Stockton Sand Quarry - State Significant Development Application - Consultation for Environmental Impact Statement

Hi Luke,

Thank you for your email.

Council's comments and requirements regarding the Stockton Sand Quarry were sent through to the Department of Planning on the 2nd of October 2018, of which have been incorporated into the SEARs. We have no further comments to provide at this time.

Kind Regards,

PORT STEPHENS COUNCIL

Emmilia Johnstone
Development Planner

w portstephens.nsw.gov.au

From: Luke Farrell [mailto:luke@elementenvironment.com.au]
Sent: Wednesday, 17 July 2019 11:03 AM
To: SwitchPC <switchpc@portstephens.nsw.gov.au>
Cc: PR63 <pr63@elementenvironment.com.au>
Subject: FW: Stockton Sand Quarry - State Significant Development Application - Consultation for Environmental Impact Statement

Good morning,

I forwarded the below email and letter to Erin Daniel who was listed as our Council contact for the below development application.

I was wondering if you would be able to please let me know the contact details for Erin's replacement so that I may contact them to discuss the development?

I appreciate your assistance with the above.

Thanks
Luke Farrell.

Luke Farrell
Senior Environmental Consultant
0455 666 006

SYDNEY NEWCASTLE CENTRAL COAST TOWNSVILLE
elementenvironment.com.au

From: Luke Farrell
Sent: 17 July 2019 11:00
To: Erin.Daniel@portstephens.nsw.gov.au
Cc: PR63 <pr63@elementenvironment.com.au>
Subject: Stockton Sand Quarry - State Significant Development Application - Consultation for Environmental Impact Statement

Dear Erin,

Boral Resources (NSW) Pty Ltd (Boral) are seeking approval for continued operations at their Stockton (Fullerton Cove) Sand Quarry through a State Significant Development (SSD) application under Part 4 of the *Environmental Planning & Assessment Act 1979*. Boral propose to extract up to 750,000 tonnes per annum (tpa) of sand product from a former extraction area by front-end loader/excavator and dredging. The project would be for a period of up to 25 years, subject to demand of sand resources.

In accordance with the NSW Department of Environment, Industry & Planning requirements, Boral are seeking from you any further and additional comments of matters for consideration in the preparation of an Environmental Impact Statement (EIS) for the project.

We welcome your feedback about the project as per the attached letter.

Please do not hesitate to get in touch should you have any queries on the project.

Regards,
Luke Farrell

Luke Farrell
Senior Environmental Consultant
0455 666 006

SYDNEY NEWCASTLE CENTRAL COAST TOWNSVILLE
elementenvironment.com.au

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Consultation with RFS

17 July 2019

Mr Martin Siemsen
Superintendent - Lower Hunter Manager
Lower Hunter
NSW Rural Fire Service
PO Box 2317
Greenhills, NSW 2323
Email: lower.hunter@rfs.nsw.gov.au

PO Box 1563
Warriewood
NSW 2012

ABN 45 162 835 083

Dear Martin

STOCKTON SAND QUARRY – ENVIRONMENTAL IMPACT STATEMENT PREPARATION AND CONSULTATION FOR PROPOSED STATE SIGNIFICANT DEVELOPMENT

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Sand Quarry (hereafter referred to as the 'quarry'), a long standing operation that extracts and transports sand product for use in the building, landscaping and construction markets. The quarry is located at Coxs Lane, Fullerton Cove, in the Port Stephens Local Government Area.

The quarry currently has consent to extract up to 500,000 tonnes of sand per annum from the transgressive (windblown) dunes adjoining Stockton Beach only, until 2028.

In order to meet ongoing sustained demand for a consistent and continuous supply of sand to the Hunter and Sydney regions, Boral is seeking approval for continued operations at the site through a State Significant Development (SSD) application under Part 4 of the Environmental Planning & Assessment Act 1979. Boral propose to extract up to 750,000 tonnes per annum (tpa) of sand product from a former extraction area by front-end loader/excavator and dredging (the Project). The Project would be for a period of up to 25 years, subject to demand of sand resources.

An outline of the Project is available within the Stockton Sand Quarry Dredging: Preliminary Environmental Assessment (Element Environment, September 2018), available on the major projects register at the below link:

http://majorprojects.planning.nsw.gov.au/index.pl?action=view_job&job_id=9490

There would be no alteration to the existing site's hours of operation associated with the addition of the inland area and only a short term increase in total output from the site, rising from 500,000 tonnes per annum to 750,000 tonnes per annum until 2028.

In accordance with the Secretary's Environmental Assessment Requirements (SEARs) issued for the Project from NSW Department of Environment, Industry & Planning (DPIE), which are available at the same major projects website link above, Boral are seeking any further and additional comments of matters for

consideration in the preparation of an Environmental Impact Statement (EIS) for the Project.

Boral has engaged my company (Element Environment Pty Ltd) to prepare a range of technical studies to inform the EIS including traffic, acoustics, air quality, surface water, groundwater, Aboriginal heritage, biodiversity, economics, social impacts and acid sulphate soils. On behalf of Boral and as part of the EIS preparation, we initiate consultation regarding the Project via this letter, and Boral will take into consideration any response that is received.

If you or your colleagues have any questions or would like to discuss the proposal in more detail, please feel free to contact me on **0455 666 006** or luke@elementenvironment.com.au. Alternatively, if your organisation has no comments or concerns and are satisfied to await the exhibition of the EIS (to be further notified when dates are determined), we would appreciate a response to this effect.

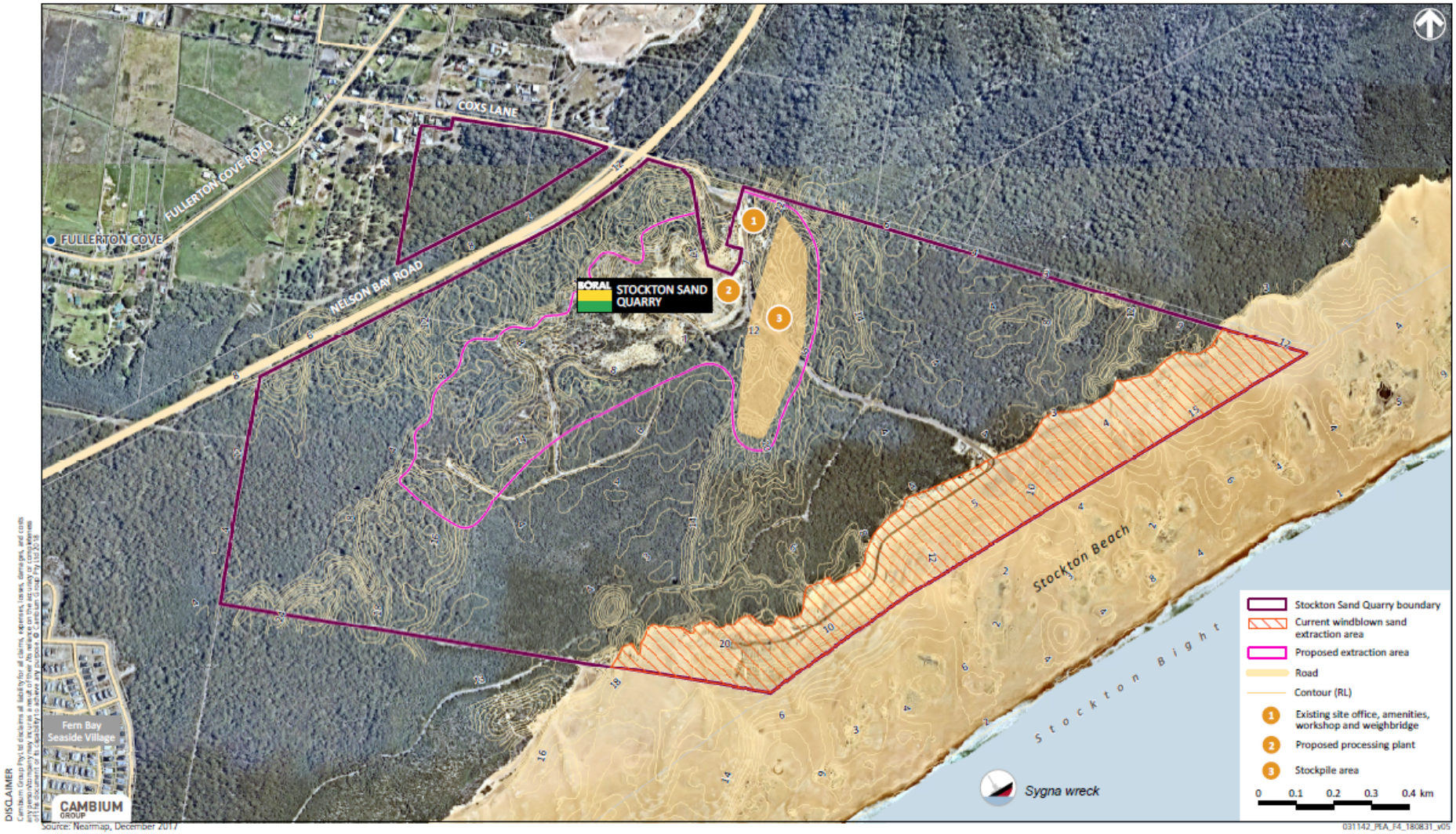
We are hoping to gather all responses to the proposal by **31 July 2019**.

Thank you for your interest in this letter – we look forward to hearing from you soon.

Yours sincerely,



Luke Farrell
Senior Environmental Consultant
Element Environment



Source: Nearmap, December 2017

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Consultation with NRAR

Luke Farrell

From: Lachlan Bain <lachlan@south-east.com.au>
Sent: 26 August 2019 15:47
To: Luke Farrell
Subject: Fwd: Stockton groundwater source and conflict between embargo and WSP
Attachments: New-groundwater-licence.pdf; New-water-access-licence-zero-licence-shares-application-form.pdf

Hi Luke,
See response from NRAR above.

Cheers,

Lachlan Bain (BEng, MEnvMgt)

m +61 403183936 p +61 2 44744439

---------- Forwarded message ---------
From: **Christopher Jones** <christopher.jones@nrar.nsw.gov.au>
Date: Fri, Aug 23, 2019 at 10:09 AM
Subject: Re: Stockton groundwater source and conflict between embargo and WSP
To: Lachlan Bain <lachlan@south-east.com.au>
Cc: Estelle Avery <estelle.avery@nrar.nsw.gov.au>

Hi Lachlan

I discussed this with a Senior Officer and she has advised that two applications will be required for this.

1.The first is the Aquifer Interference application as discussed above (Part 5 Water Act 1912.)
2. The second is a Water Access Licence to account for the water take that is occuring. The most straight-forward approach for this would be apply for a Zero-share Licence which will begin with no allocations and purchase shares from the private market.

I will attach both applications below.

If I can assist with these applications please let me know.

Regards,

Chris Jones | Water Regulation Officer
Natural Resources Access Regulator
Department of Planning, Industry and Environment | Lands & Water
Level 11, 10 Valentine Avenue | Parramatta NSW 2150
Locked Bag 5123 | Parramatta NSW 2124

T: 02 9842 8743
E: Christopher.jones@nrar.nsw.gov.au
W: www.industry.nsw.gov.au

On Wed, Aug 14, 2019 at 10:24 AM Lachlan Bain <lachlan@south-east.com.au> wrote:

Hi Chris,

As discussed, please find a brief summary of the potential conflict that I outlined on the phone.

In summary. Boral are preparing an EIS to undertake a new sand extraction project in existing landholdings behind Stockton beach, over the Stockton groundwater source. The proposal involves extracting sand over a previously mined area down to the groundwater table and then continuing extraction to about -10m AHD via dredge. The operation will require water allocations for both moisture lost within the material removed as well as direct evaporative losses from the groundwater source generated through the creation of a 'window' to the groundwater table over the dredge pond surface - as your previous advice suggested.

As per the Water Sharing Plan for the North Coast Coastal Sands Groundwater Sources 2016, (https://www.industry.nsw.gov.au/__data/assets/pdf_file/0010/166870/northcoast-coastal-sands-groundawter.pdf) the Long term Average Annual Extraction Limit is 14,000 ML/y, of which 1037.5 ML/y are allocated as shares under access licences and 254ML/y as basic landholder rights, leaving about 12500ML/y. Based on the WSP, there would seem to be significant allocations available in the Stockton groundwater source based on the water balance prepared for the WSP and after environmental demands are accounted for.

However, under the Water Act 1912, an embargo on applications for Part 5 licences (aquifer interference under the Water Act) from the Tomago Tomaree Stockton groundwater sources was issued in 2002 (https://www.industry.nsw.gov.au/water/licensing-trade/licences/embargoes), citing that the Tomago, Tomaree and Stockton groundwater zone are: '*unlikely to have more water available than is sufficient to meet requirements of the licensees of bores situated within that zone*.' The gazetted embargo specifically prevents licences for new bores as follows: *…no further applications for licences under Part 5 of the Water Act, for* ***bores*** *accessing water from these formations, may be made…*

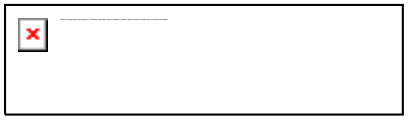
Although a 'bore' is not proposed, a licence for aquifer interference will be required to carry out the project and to obtain allocations for the extraction proposed. As you can see there is a conflict between the embargo and the WSP. Could you please provide some advice as to whether applications for new allocations can be made under the WSP and NSW Water Management Act 2000, or if the embargo overrides this. Further, if the embargo is the control, will there be some kind of resolution between the embargo justification of a lack of water to meet demands and the WSP which clearly states that there is significant water available for the Stockton groundwater source? Could Stockton be removed from the embargo?

Thanks very much for your time.

Regards,

Lachlan Bain (BEng, MEnvMgt)

m +61 403183936 p +61 2 44744439



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APPENDIX C

DESKTOP AND BACKGROUND SEARCHES

Australian Government
Department of the Environment and Energy

EPBC Act Protected Matters Report

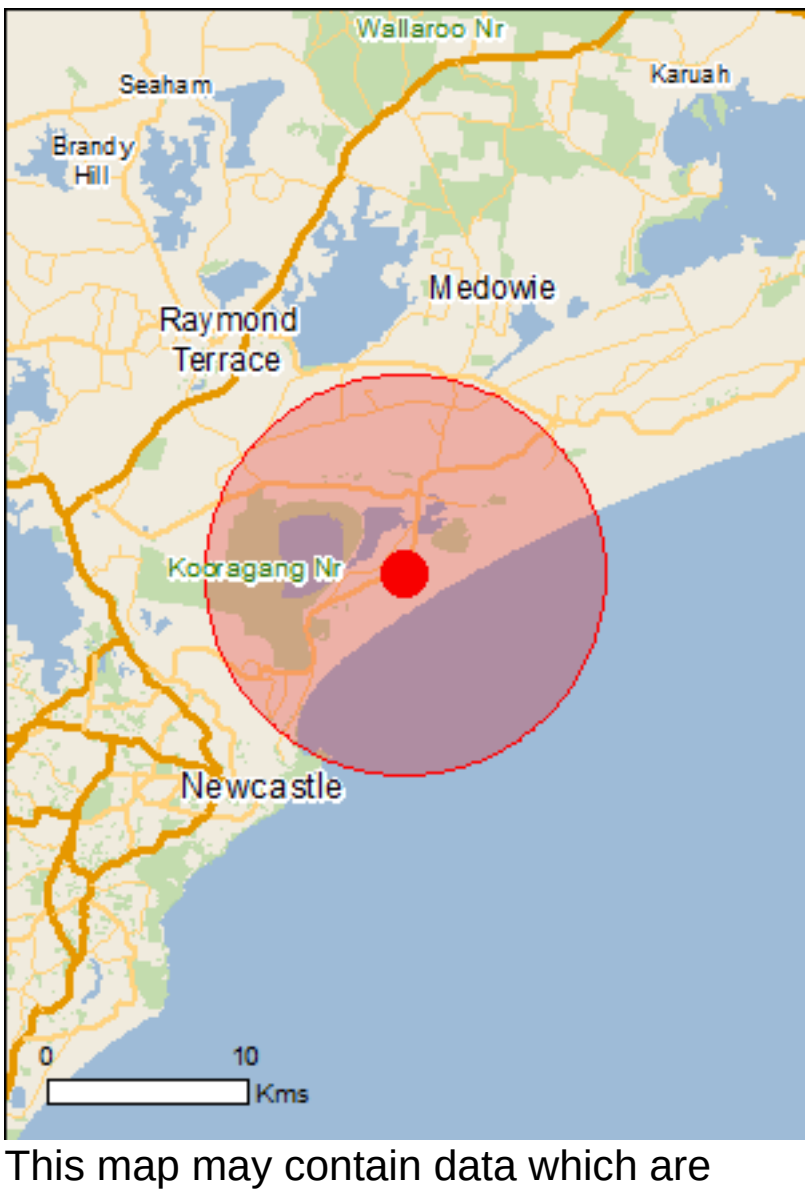
This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 19/03/19 14:22:11

Summary
Details
Matters of NES
Other Matters Protected by the EPBC Act
Extra Information
Caveat
Acknowledgements



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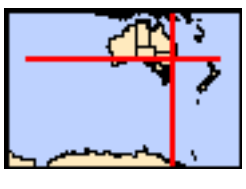
Coordinates
Buffer: 10.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	1
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	4
Listed Threatened Species:	73
Listed Migratory Species:	74

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	7
Commonwealth Heritage Places:	3
Listed Marine Species:	98
Whales and Other Cetaceans:	13
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	5
Regional Forest Agreements:	1
Invasive Species:	44
Nationally Important Wetlands:	1
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Wetlands of International Importance (Ramsar) [Resource Information]

Name	Proximity
Hunter estuary wetlands	Within Ramsar site

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
Temperate East

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Central Hunter Valley eucalypt forest and woodland	Critically Endangered	Community may occur within area
Coastal Swamp Oak (Casuarina glauca) Forest of New South Wales and South East Queensland ecological community	Endangered	Community likely to occur within area
Lowland Rainforest of Subtropical Australia	Critically Endangered	Community may occur within area
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Anthochaera phrygia Regent Honeyeater [82338]	Critically Endangered	Species or species habitat known to occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur

Name	Status	Type of Presence
		within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Dasyornis brachypterus Eastern Bristlebird [533]	Endangered	Species or species habitat likely to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea antipodensis gibsoni Gibson's Albatross [82270]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat likely to occur within area
Fregetta grallaria grallaria White-bellied Storm-Petrel (Tasman Sea), White-bellied Storm-Petrel (Australasian) [64438]	Vulnerable	Species or species habitat likely to occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat may occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat known to occur within area
Limosa lapponica baueri Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat known to occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri) [86432]	Critically Endangered	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species

Name	Status	Type of Presence
		habitat may occur within area
Pterodroma leucoptera leucoptera Gould's Petrel, Australian Gould's Petrel [26033]	Endangered	Species or species habitat may occur within area
Pterodroma neglecta neglecta Kermadec Petrel (western) [64450]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Rostratula australis Australian Painted-snipe, Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche bulleri platei Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta cauta Shy Albatross, Tasmanian Shy Albatross [82345]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche cauta steadi White-capped Albatross [82344]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche eremita Chatham Albatross [64457]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Fish		
Epinephelus daemelii Black Rockcod, Black Cod, Saddled Rockcod [68449]	Vulnerable	Species or species habitat likely to occur within area
Frogs		
Heleioporus australiacus Giant Burrowing Frog [1973]	Vulnerable	Species or species habitat may occur within area
Litoria aurea Green and Golden Bell Frog [1870]	Vulnerable	Species or species habitat known to occur within area
Mixophyes balbus Stuttering Frog, Southern Barred Frog (in Victoria) [1942]	Vulnerable	Species or species habitat likely to occur within area
Mammals		
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Chalinolobus dwyeri Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Dasyurus maculatus maculatus (SE mainland population)		
Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat known to occur within area
Eubalaena australis		
Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Megaptera novaeangliae		
Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Petauroides volans		
Greater Glider [254]	Vulnerable	Species or species habitat may occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)		
Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat known to occur within area
Potorous tridactylus tridactylus		
Long-nosed Potoroo (SE mainland) [66645]	Vulnerable	Species or species habitat known to occur within area
Pseudomys novaehollandiae		
New Holland Mouse, Pookila [96]	Vulnerable	Species or species habitat known to occur within area
Pteropus poliocephalus		
Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Plants		
Angophora inopina		
Charmhaven Apple [64832]	Vulnerable	Species or species habitat known to occur within area
Asperula asthenes		
Trailing Woodruff [14004]	Vulnerable	Species or species habitat may occur within area
Caladenia tessellata		
Thick-lipped Spider-orchid, Daddy Long-legs [2119]	Vulnerable	Species or species habitat likely to occur within area
Commersonia prostrata		
Dwarf Kerrawang [87152]	Endangered	Species or species habitat known to occur within area
Cryptostylis hunteriana		
Leafless Tongue-orchid [19533]	Vulnerable	Species or species habitat likely to occur within area
Cynanchum elegans		
White-flowered Wax Plant [12533]	Endangered	Species or species habitat likely to occur within area
Eucalyptus camfieldii		
Camfield's Stringybark [15460]	Vulnerable	Species or species habitat likely to occur within area
Eucalyptus parramattensis subsp. decadens		
Earp's Gum, Earp's Dirty Gum [56148]	Vulnerable	Species or species habitat known to occur within area
Grevillea parviflora subsp. parviflora		
Small-flower Grevillea [64910]	Vulnerable	Species or species habitat known to occur within area
Grevillea shiressii		
[19186]	Vulnerable	Species or species habitat may occur within area

Name	Status	Type of Presence
[Melaleuca biconvexa](#) Biconvex Paperbark [5583]	Vulnerable	Species or species habitat may occur within area
[Persicaria elatior](#) Knotweed, Tall Knotweed [5831]	Vulnerable	Species or species habitat likely to occur within area
[Phaius australis](#) Lesser Swamp-orchid [5872]	Endangered	Species or species habitat may occur within area
[Prasophyllum sp. Wybong (C.Phelps ORG 5269)](#) a leek-orchid [81964]	Critically Endangered	Species or species habitat may occur within area
[Syzygium paniculatum](#) Magenta Lilly Pilly, Magenta Cherry, Daguba, Scrub Cherry, Creek Lilly Pilly, Brush Cherry [20307]	Vulnerable	Species or species habitat likely to occur within area
[Tetratheca juncea](#) Black-eyed Susan [21407]	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
[Caretta caretta](#) Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
[Chelonia mydas](#) Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
[Dermochelys coriacea](#) Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
[Eretmochelys imbricata](#) Hawksbill Turtle [1766]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
[Natator depressus](#) Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sharks		
[Carcharias taurus (east coast population)](#) Grey Nurse Shark (east coast population) [68751]	Critically Endangered	Species or species habitat likely to occur within area
[Carcharodon carcharias](#) White Shark, Great White Shark [64470]	Vulnerable	Breeding known to occur within area
[Rhincodon typus](#) Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Migratory Marine Birds		
[Anous stolidus](#) Common Noddy [825]		Species or species habitat likely to occur within area
[Apus pacificus](#) Fork-tailed Swift [678]		Species or species habitat likely to occur within area
[Ardenna carneipes](#) Flesh-footed Shearwater, Fleshy-footed		Foraging, feeding or

Name	Threatened	Type of Presence
Shearwater [82404]		related behaviour likely to occur within area
[Calonectris leucomelas](#) Streaked Shearwater [1077]		Species or species habitat known to occur within area
[Diomedea antipodensis](#) Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
[Diomedea epomophora](#) Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
[Diomedea exulans](#) Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
[Diomedea sanfordi](#) Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
[Fregata ariel](#) Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat known to occur within area
[Fregata minor](#) Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat likely to occur within area
[Macronectes giganteus](#) Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
[Macronectes halli](#) Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
[Phoebetria fusca](#) Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
[Sternula albifrons](#) Little Tern [82849]		Breeding may occur within area
[Thalassarche bulleri](#) Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
[Thalassarche cauta](#) Tasmanian Shy Albatross [89224]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
[Thalassarche eremita](#) Chatham Albatross [64457]	Endangered	Foraging, feeding or related behaviour likely to occur within area
[Thalassarche impavida](#) Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
[Thalassarche melanophris](#) Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
[Thalassarche salvini](#) Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
[Thalassarche steadi](#) White-capped Albatross [64462]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area

Name	Threatened	Type of Presence
Migratory Marine Species		
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Species or species habitat likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Breeding known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Dugong dugon Dugong [28]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat may occur within area
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat may occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		

Name	Threatened	Type of Presence
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat known to occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Monarcha trivirgatus Spectacled Monarch [610]		Species or species habitat likely to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat known to occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Roosting known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area

Name	Threatened	Type of Presence
Gallinago stenura		
Pin-tailed Snipe [841]		Roosting likely to occur within area
Limicola falcinellus		
Broad-billed Sandpiper [842]		Roosting known to occur within area
Limosa lapponica		
Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa		
Black-tailed Godwit [845]		Roosting known to occur within area
Numenius madagascariensis		
Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus		
Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Numenius phaeopus		
Whimbrel [849]		Roosting known to occur within area
Pandion haliaetus		
Osprey [952]		Species or species habitat known to occur within area
Philomachus pugnax		
Ruff (Reeve) [850]		Roosting known to occur within area
Pluvialis fulva		
Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola		
Grey Plover [865]		Roosting known to occur within area
Tringa brevipes		
Grey-tailed Tattler [851]		Roosting known to occur within area
Tringa nebularia		
Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis		
Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Xenus cinereus		
Terek Sandpiper [59300]		Roosting known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land -
Commonwealth Land - Australian Postal Commission
Commonwealth Land - Australian Telecommunications Commission
Commonwealth Land - Defence Service Homes Corporation
Defence - RAAF BASE WILLIAMTOWN
Defence - STOCKTON RIFLE RANGE
Defence - TS TOBRUK

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Historic		
Fort Wallace	NSW	Listed place

Name	State	Status
Nobbys Lighthouse	NSW	Listed place
Williamtown RAAF Base Group	NSW	Listed place

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Breeding known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area
Catharacta skua Great Skua [59472]		Species or species habitat may occur within area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Roosting known to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or

Name	Threatened	Type of Presence
		related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea gibsoni Gibson's Albatross [64466]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat likely to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Roosting known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Heteroscelus brevipes Grey-tailed Tattler [59311]		Roosting known to occur within area
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Roosting known to occur within area
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat known to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat known to occur within area
Limicola falcinellus Broad-billed Sandpiper [842]		Roosting known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Roosting known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Monarcha trivirgatus Spectacled Monarch [610]		Species or species habitat likely to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat known to occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Philomachus pugnax Ruff (Reeve) [850]		Roosting known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]		Roosting known to occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Foraging, feeding or related behaviour likely to occur within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Roosting known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area
Sterna albifrons Little Tern [813]		Breeding may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta Tasmanian Shy Albatross [89224]	Vulnerable*	Foraging, feeding or

Name	Threatened	Type of Presence
		related behaviour likely to occur within area
Thalassarche eremita Chatham Albatross [64457]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche sp. nov. Pacific Albatross [66511]	Vulnerable*	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Roosting known to occur within area
Fish		
Acentronura tentaculata Shortpouch Pygmy Pipehorse [66187]		Species or species habitat may occur within area
Festucalex cinctus Girdled Pipefish [66214]		Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippocampus abdominalis Big-belly Seahorse, Eastern Potbelly Seahorse, New Zealand Potbelly Seahorse [66233]		Species or species habitat may occur within area
Hippocampus whitei White's Seahorse, Crowned Seahorse, Sydney Seahorse [66240]		Species or species habitat likely to occur within area
Histiogamphelus briggsii Crested Pipefish, Briggs' Crested Pipefish, Briggs' Pipefish [66242]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Notiocampus ruber Red Pipefish [66265]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Solegnathus spinosissimus Spiny Pipehorse, Australian Spiny Pipehorse [66275]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Solenostomus paradoxus Ornate Ghostpipefish, Harlequin Ghost Pipefish, Ornate Ghost Pipefish [66184]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Mammals		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Arctocephalus pusillus Australian Fur-seal, Australo-African Fur-seal [21]		Species or species habitat may occur within area
Dugong dugon Dugong [28]		Species or species habitat may occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur

Name	Threatened	Type of Presence within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Pelamis platurus Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Delphinus delphis Common Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat likely to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Hunter Wetlands	NSW
Tilligerry	NSW
Worimi	NSW
Worimi	NSW
Worimi	NSW

Regional Forest Agreements [Resource Information]

Note that all areas with completed RFAs have been included.

Name	State
North East NSW RFA	New South Wales

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Acridotheres tristis Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Alauda arvensis Skylark [656]		Species or species habitat likely to occur within area
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis European Goldfinch [403]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Lonchura punctulata Nutmeg Mannikin [399]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Passer montanus Eurasian Tree Sparrow [406]		Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Pycnonotus jocosus Red-whiskered Bulbul [631]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Frogs		
Rhinella marina Cane Toad [83218]		Species or species habitat known to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Lepus capensis Brown Hare [127]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus norvegicus Brown Rat, Norway Rat [83]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Alternanthera philoxeroides Alligator Weed [11620]		Species or species habitat likely to occur within area
Anredera cordifolia Madeira Vine, Jalap, Lamb's-tail, Mignonette Vine, Anredera, Gulf Madeiravine, Heartleaf Madeiravine, Potato Vine [2643]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Asparagus aethiopicus Asparagus Fern, Ground Asparagus, Basket Fern, Sprengi's Fern, Bushy Asparagus, Emerald Asparagus [62425]		Species or species habitat likely to occur within area
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Asparagus plumosus Climbing Asparagus-fern [48993]		Species or species habitat likely to occur within area
Cabomba caroliniana Cabomba, Fanwort, Carolina Watershield, Fish Grass, Washington Grass, Watershield, Carolina Fanwort, Common Cabomba [5171]		Species or species habitat likely to occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Chrysanthemoides monilifera subsp. rotundata Bitou Bush [16332]		Species or species habitat likely to occur within area
Cytisus scoparius Broom, English Broom, Scotch Broom, Common Broom, Scottish Broom, Spanish Broom [5934]		Species or species habitat likely to occur within area
Eichhornia crassipes Water Hyacinth, Water Orchid, Nile Lily [13466]		Species or species habitat likely to occur within area
Genista monspessulana Montpellier Broom, Cape Broom, Canary Broom, Common Broom, French Broom, Soft Broom [20126]		Species or species habitat likely to occur within area
Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat may occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Sagittaria platyphylla Delta Arrowhead, Arrowhead, Slender Arrowhead [68483]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Salvinia molesta Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area
Senecio madagascariensis Fireweed, Madagascar Ragwort, Madagascar Groundsel [2624]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Solanum elaeagnifolium Silver Nightshade, Silver-leaved Nightshade, White Horse Nettle, Silver-leaf Nightshade, Tomato Weed, White Nightshade, Bull-nettle, Prairie-berry, Satansbos, Silver-leaf Bitter-apple, Silverleaf-nettle, Trompillo [12323]		Species or species habitat likely to occur within area

Nationally Important Wetlands

[Resource Information]

Name	State
Kooragang Nature Reserve	NSW

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-32.84705 151.83657

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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APPENDIX D

HYDROGEOLOGICAL IMPACT ASSESSMENT

ENVIRONMENTAL EARTH SCIENCES
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HYDROGEOLOGICAL IMPACT ASSESSMENT, STOCKTON SAND QUARRY DREDGING, COXS LANE, FULLERTON COVE, NSW

BORAL RESOURCES (NSW) PTY LTD

19 FEBRUARY 2020
717041
VERSION 4

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

19 February 2020

Element Environment
PO Box 1563
Warriewood NSW 2120

Attention: **Luke Farrell**
Senior Environmental Consultant

Dear Luke

Hydrogeological Impact Assessment at Stockton Sand Quarry Dredging, Fullerton Cove, NSW

Please find enclosed a copy of our report entitled as above. Thank you for the opportunity to undertake this work.

Should you have any queries, please do not hesitate to contact us on (02) 9922 1777.

For and on behalf of
Environmental Earth Sciences NSW

Project Manager / Author
Elin Griffiths
Associate Environmental Scientist

Project Director / Internal Reviewer
Mark Stuckey
Principal Hydrogeologist and Soil Scientist

717041_v4

EXECUTIVE SUMMARY

Introduction and objectives

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Sand Quarry (hereafter referred to as the 'site' or the 'quarry'), a long standing operation that currently extracts sand from the windblown (transgressive) sand dunes of Stockton Bight and transports up to 500,000 tonnes per annum (tpa) of sand product for use in the building, landscaping and construction markets.

Due to current and future demand for sand in the Hunter and Sydney regions, Boral is seeking approval for continued and expanded operations at the site through a State Significant Development (SSD) application. The proposed development (hereafter referred to as the 'Project') involves the extraction of sand from the inland vegetated dunes by front-end loader/ excavator to a depth of 4 metres (m) Australian Height Datum (AHD) in Stage 1 and subsequent dredging from 4 m AHD to 15 m below sea level (-15 m AHD) in Stages 2-6. The SSD application seeks a sitewide increase on the dispatch limit to 750,000 tpa (i.e. the windblown sand extraction area and the Project operations combined) to 2028 after which the sitewide limit would reduce to a maximum 500,000 tpa. The Project would be for a period of up to 25 years.

The objective of this report is to assess potential groundwater impacts during the establishment, operation and decommissioning of the proposed sand extraction area.

Conceptual site model

The site is situated on the Stockton Sandbeds Aquifer; a shallow aquifer that overlies the eastern extremity of the deeper Tomago Sandbeds Aquifer. There is a groundwater divide which runs in a northeast to southwest direction to the southeast of the windblown sand extraction area. Groundwater is inferred to flow towards the coast to the southeast and to Fullerton Cove to the southwest of the site.

Mean annual rainfall recorded at Stockton exceeds average monthly evaporation rates, suggesting high groundwater recharge rates. High rainfall infiltration will raise the water table, increasing the hydraulic gradient between the recharge and discharge area.

Aquifer testing confirms that the unconfined aquifer beneath the site is very permeable (hydraulic conductivity (K) values between 6 and 55 metres per day and transmissivity values up to between 50 and 4,627 m^2/day), but that due to the low hydraulic gradients (0.002 metres per metre (m/m) or 0.2%), groundwater velocities are relatively low (12.6 – 116 metres per year). Groundwater flux through the area of the proposed extraction area has been estimated at 600 m^3/day (219 megalitres (ML) per annum). This equates to a groundwater flux of approximately 18 ML/month.

Collection of physical information from the site is supported by chemical data. West of the groundwater divide, the shallow Stockton Sands aquifer is predominantly Sodium-Chloride (Na-Cl) dominated, whilst the deeper Tomago Sandbeds Aquifer is Calcium-Bicarbonate

($Ca\text{-}HCO_3$). East of the groundwater divide the groundwater is $Ca\text{-}HCO_3$ and Na-Cl dominated, likely reflective of increasingly marine influence.

The aquifer beneath the site has a generally acidic pH and is fresh, with low concentrations of dissolved salts and metals. It is noted that ambient dissolved metals concentrations (Aluminium, Iron and Zinc in particular) are occasionally outside water quality criteria. However, these elevated levels of dissolved metals were considered as background concentrations due to the previous mineral sands operation and the depositional environment of the aquifer.

No per- or poly-fluoro-alkyl substances (PFAS) were recorded above the laboratory limit of reporting (LOR) for the monitoring period (January – June 2018), which supports the conceptual site model (CSM) for the site that it lies in a separate groundwater (and surface water) catchment to the Williamtown RAAF Base. In addition, concentrations of potentially radioactive elements such as radium, uranium and thorium were not recorded above the LOR or water quality criteria.

Based on the results of the analytical testing, groundwater in the alluvial aquifer is broadly suitable for all uses. Concentrations of dissolved aluminium, iron and zinc are considered either false positives (associated with suspended sediment) or naturally occurring. The dissolved concentration of arsenic exceeded drinking water criteria in bore MWX6 but may also be considered a natural occurrence.

Impact assessment summary

Potential impacts to the environment are likely to arise through the establishment of the project, extraction of sand via dredging operations over approximately a 25 year period.

As groundwater movement accounts for less than 0.5% of catchment drainage even in the driest recorded years, excavation of the aquifer sediments should have no discernible effect on catchment hydrology other than increasing the area available for water storage and direct recharge to the Stockton Sandbeds Aquifer on the site.

Mitigation and monitoring

Soil

An Acid Sulfate Soils Impact Assessment (Environmental Earth Sciences, 2019) concluded a low probability for acid sulfate soils at the site. High alkalinity and acid buffering capacity exists within the boreholes examined. However as one localised occurrent reported a moderate risk for potential acid sulfate soils (ASS), an Acid Sulfate Soil Management Plan is recommended.

Groundwater

Groundwater monitoring and mitigation requirements will be included in an update to the existing Groundwater Monitoring and Management Plan (GMMP) which is prepared in accordance with Condition 3(12) for Development Consent 140-6-2005 (Mod 2). The GMMP describes the objectives of the groundwater management and monitoring and detail the proposed types and locations of monitoring.

ENVIRONMENTAL EARTH SCIENCES
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1 INTRODUCTION

1.1 Background

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Sand Quarry (hereafter referred to as the 'site' or the 'quarry'), a long standing operation that currently extracts sand from the windblown (transgressive) sand dunes of Stockton Bight and transports up to 500,000 tonnes per annum (tpa) of sand product for use in the building, landscaping and construction markets.

Due to current and future demand for sand in the Hunter and Sydney regions, Boral is seeking approval for continued and expanded operations at the site through a State significant development (SSD) application. The proposed development (hereafter referred to as the 'Project') involves the extraction of sand from the inland vegetated dunes by front-end loader/excavator to a depth of 4 metres (m) Australian Height Datum (AHD) in Stage 1 and subsequent dredging from 4 m AHD to 15 m below sea level (-15 m AHD) in Stages 2-6. The SSD application seeks a site wide increase on the dispatch limit to 750,000 tpa (i.e. the windblown sand extraction area and the Project operations combined) to 2028 after which the site wide limit would reduce to a maximum 500,000 tpa. The Project would be for a period of up to 25 years.

Sand extraction has taken place in various locations on the site since 1976 when G. Hawkins and Sons was initially granted consent.

Under Boral's ownership there have been two primary development consents granted, these include:

- DA 2010/94: The 'inland extraction area' (also known as pits 1 – 6) granted by Port Stephens Council in May 1996, and
- DA 140-6-2005: The 'windblown sand extraction area' (also known as the "windblown project" or pit 7) located on the transgressive dunes adjoining Stockton Beach granted by the Department of Planning in 2006.

The inland extraction operation on the vegetated dunes occurred above 5 m AHD and ceased in 2008 and rehabilitation has been ongoing. This former extraction area is generally consistent with the project site and is the focus of this development application.

The windblown sand extraction area started operations in 2008 and in accordance with Condition 5 of the development consent has 20 year life, due to cease in 2028.

The windblown sand extraction area is approximately 375 m south east of the project site and is approved to operate until 2028 and dispatch up to 500,000 tpa (refer to Condition 6 of DA 140-6-2005).

Boral propose to extract sand from a former sandpit in the inland extraction area (which has since replenished with windblown sand) via front-end loader and dredging.

The project would be located within a portion of land within Lot 1 DP1006399 and Lot 3 DP664552 (hereafter referred to as 'the project site'). The extraction area is designated

along the western dune ridge system of the Boral holding and is expected to disturb 37 hectares with a maximum dredge depth of 15 m below sea level (refer to **Figures 1 and 3**).

The project is for extractive industry with a production rate of up to 750,000 tpa and a targeted resource in excess of 9 million tonnes. Accordingly, the project is State Significant Development under the State Environmental Planning Policy (State & Regional Development) 2011.

Environmental Earth Sciences was commissioned by Element Environment, on behalf of Boral Resources NSW Pty Ltd (Boral), to undertake an assessment of hydrogeological conditions and an assessment of the potential impacts of the project.

2 OBJECTIVES

The objectives of this report are to describe the local hydrogeological setting within the areas of potential impact, to assess the potential impacts and recommend controls and mitigation measures.

An Acid Sulfate Soil Impact Assessment (ASS) has been provided by Environmental Earth Sciences (Environmental Earth Sciences, 2018). The results of this report are not duplicated herein. It is recommended that this report be read in conjunction with the ASS report.

3 SCOPE OF WORK

A significant amount of hydrogeological assessment and monitoring, including impact assessment, has been previously performed across the wider Tomago Sandbeds aquifer to the west of the project, including:

- installation of six (6) additional groundwater bores intersecting both aquifers (two deep, two shallow and two paired), which complements an existing network of 11 bores across the Boral site.
- monthly monitoring of existing bores since 2008 and new bores since 2017 within the Boral site, and
- groundwater modelling of the Tomago Sandbeds Aquifer and overlying Stockton Sandbeds Aquifer to the east has been performed at the neighbouring Williamtown RAAF base since 2015 (HydroSimulations, 2016).

3.1 Existing environment

The first component of works (review of existing data for the local aquifer) in the preparation of a Hydrogeological Impact Assessment report, is to be undertaken using an analytical approach to allow development of a water balance for the aquifer, and subsequent

assessment of the potential impacts associated with the proposed works under varying climatic conditions.

This has comprised the following works carried out by Environmental Earth Sciences:

- Review of existing data for the shallow and deep aquifer from:
    - Monthly monitoring data provided by Boral to assess changes in groundwater levels and chemistry over time under varying climactic conditions.
    - Hydrogeological works completed at the nearby Williamtown Royal Australian Air Force (RAAF) defence base, and
    - Collection of site-specific data for the project area (chemical and physical).
- Physical aquifer testing on installed bores to determine aquifer parameters.
- Chemical testing for chemicals of concern known to impact the neighbouring Tomago Sandbeds Aquifer, such as per- and poly-fluoro-alkyl substances (PFAS) including perflurooctaine sulfonate (PFOS) and perflurooctanoic acid (PFOA), and
- Installation of permanent groundwater pressure transducer loggers in select bores to assess groundwater level responses to climactic and tidal conditions.

3.2 Potential impacts

Once the existing environment is characterised, potential impacts as part of the proposed development can be assessed. These are likely to be associated with excavation of the sand resource to expose the aquifer to enhanced recharge and evaporative losses, which could result in changes to baseflow conditions and quality for other potential receptors (such as stock watering, irrigation and recreational water use).

Based on previous investigations, sand extraction activities have not adversely affected water levels. Previous reports carried out at adjacent sites are summarised in **Table 4**.

The characterisation of the existing environment is presented in Section 6. Assessment of potential impacts of the proposed development is presented in Section 9.

4 DESCRIPTION OF THE PROPOSAL

The sand within Boral's landholding comprises a fine to medium grained material suitable for use as a fine aggregate in concrete or as fill sand in construction. The existing windblown sand extraction operation located on the transgressive dunes, east of the project, provides sand principally for Boral's concrete batching plants on the Central Coast, in the lower Hunter Valley, Salamander Way, the Upper Hunter and New England. It is estimated that construction sand from Boral's holding represents approximately 30 %of fine sand produced in Stockton Bight and the Lower Hunter Region.

The project would involve establishment of the sand extraction site, extraction of sand by front-end loader and dredge and pumping it to the processing area for washing, stockpiling and dispatch.

5 LEGISLATIVE CONTEXT

5.1 Relevant legislation

Table 1 summaries the relevant legislation relevant to the project site.

Table 1: Summary of regulatory environment

Key legislation	
Water Management Act 2000	Key instruments of the Water Management Act are the designation of Water Sharing Plans, that ensure that water is provided for the environment and there is more secure access to water users, and the Aquifer Interference Policy, that outlines the approval and licencing process for prescribed aquifer interference activities
Water Sharing Plan (WSP)	**Groundwater:** The site falls within the Stockton Groundwater Source of the WSP for the North Coast Coastal Sands Groundwater Sources. The NSW Office of Water has classified the Stockton Groundwater Source (Coastal Sands) aquifer as a highly productive aquifer. **Surface Water:** The site falls within the Newcastle Water Source of the WSP for the Hunter Unregulated and Alluvial Water Sources. The WSP commenced on 1 August 2009 and continues until July 2020
Aquifer interference policy 2012	The NSW Aquifer Interference policy (2012) provides a framework for the assessment where a proposed activity will take water from an aquifer of connected surface water source and provides objective, measurable thresholds for considering the degree of impact an activity may have on the groundwater levels and quality. The project is likely to require an aquifer interference approval. However, the proposed works are not considered to be impacting on the overall catchment balance, as all groundwater that is abstracted will be recharged back into the aquifer via the dredge ponds.
Contaminated Land Management Act 1997	If activities undertaken at the site during the project works contaminate the land, it is the responsibility of the contaminators to notify NSW EPA in writing, in accordance with the Contaminated Land Management Act 1997.
Guidelines for Groundwater Protection in Australia (ARMCANZ and ANZECC 1995)	This guideline provides a framework for preventing groundwater contamination in Australia.
NSW State Groundwater Policy and Framework Document (NSW Department of Land and Water Conservation 1997)	The Framework document sets out the overall direction of groundwater management in NSW and provides broad objectives and principles to guide groundwater management.

Key legislation	
NSW State Groundwater Quantity Protection Policy (NSW Department of Land and Water Conservation 1998)	Builds on the concepts outlined in the framework document and provides more detail and guidance on how to manage and protect groundwater quantity.
NSW State Groundwater Quality Protection Policy (NSW Department of Land and Water Conservation 1998)	Builds on the concepts outlined in the framework document and provides more detail and guidance on how to manage and protect groundwater quality.
NSW State Groundwater Dependent Ecosystems Policy (NSW Department of Land and Water Conservation 2002)	This policy is specifically designed to protect valuable Groundwater Dependent Ecosystems (GDE's) which rely on groundwater for survival. It aims to maintain or restore the ecological processes and biodiversity of groundwater dependent ecosystems for the benefit of present and future generations.
Guidelines for Fresh and Marine Water Quality (ANZECC / ARMCANZ 2000)	These guidelines would be adopted to assess groundwater quality, potential beneficial use of groundwater at the Site, and to assess potential impacts to groundwater quality from operation of the proposed development.
Approved Methods for the Sampling and Analysis of Water Pollutants in New South Wales (NSW EPA 2003)	These guidelines would be adopted where sampling and analysis of groundwater samples is required as part of this assessment and during groundwater monitoring

5.2 Secretary's environmental assessment requirements (SEARs)

This hydrogeological impact assessment addresses the requirements of the Secretary's Environmental Assessment Requirements (SEARs) for the project. The SEARs in relation to groundwater are listed in **Table 2**.

Table 2: Issued SEARs – water

SEAR	Relevant section within this report
Detailed site water balance, including a description of site water demands and intakes, water disposal methods (inclusive of volume and frequency of any water discharges), water supply infrastructure and, water storage structures;	Section 8 (Conceptual Site Model)
Identification of any licensing requirements or other approvals under the Water Act 1912 and/or Water Management Act 2000;	Section 5.1
Demonstration that water for the construction and operation of the development can be obtained from an appropriately authorised and reliable supply in accordance with the operating rules of any relevant Water Sharing Plan (WSP);	Section 8.6 (Estimated recharge rates and water balance)
A description of the measures proposed to ensure the development can operate in accordance with the requirements of any relevant WSP or water source embargo;	Section 10 (Management and Mitigation)

SEAR	Relevant section within this report
An assessment of the likely impacts on the quality and quantity of existing surface and groundwater resources (including consideration of the Williamtown RAAF Base Contamination Broader Management Zone, any nearby drinking water catchments and other water users);	Section 9 (Impact Assessment)
Detailed description of the proposed water management system (including sewage), water monitoring program and other measures to mitigate potential surface and groundwater impacts.	Section 10 (Management and Mitigation)

6 EXISTING ENVIRONMENT

6.1 Introduction

Existing groundwater information is available around the site from registered bores and previously conducted groundwater investigation (including long-term on-going water quality and level monitoring). Information prior to the field works included a registered groundwater bore search for nearby bores within a 3 km radius of the site and review of previous studies carried out within the area surrounding the site.

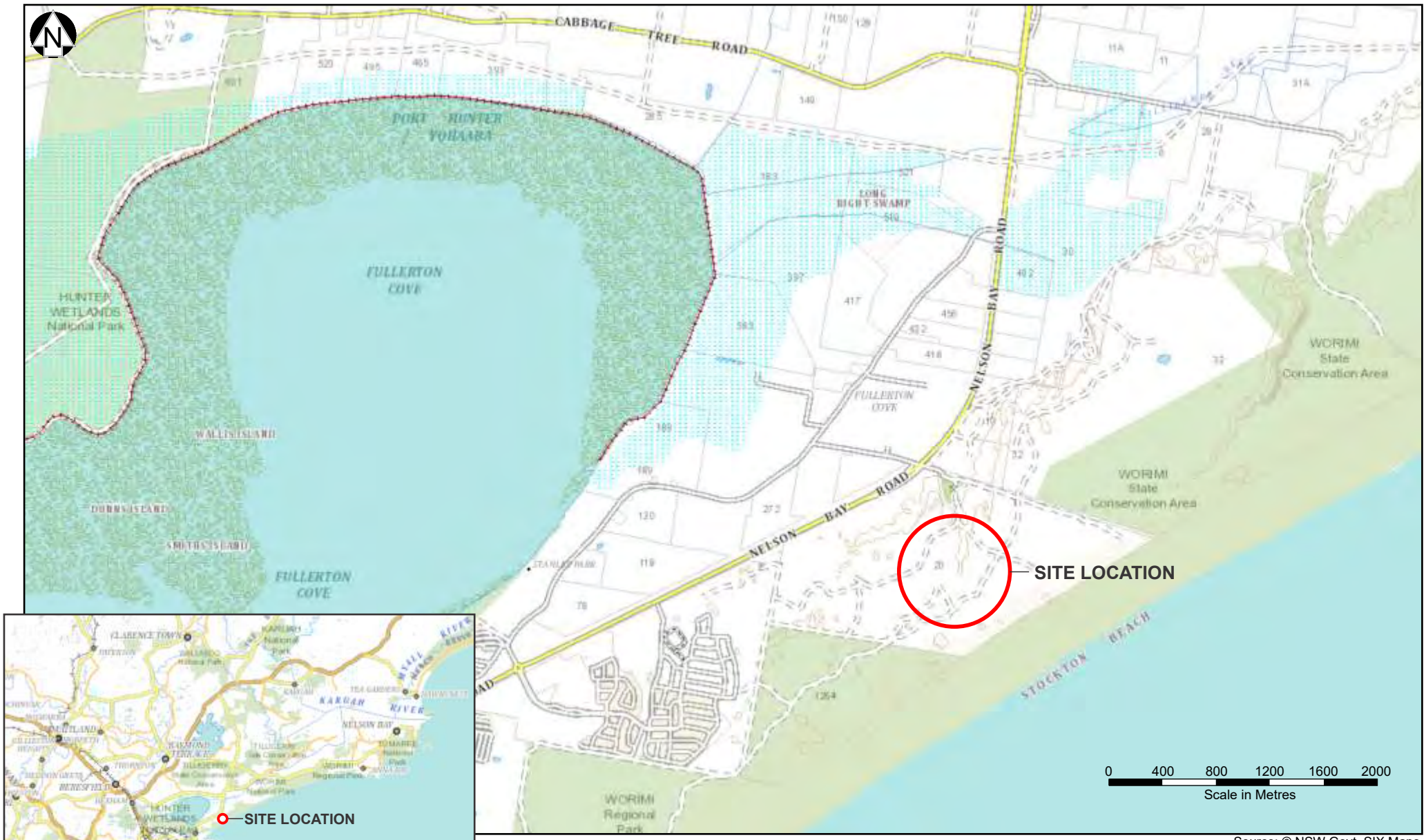
6.2 Site setting

6.2.1 Site locality and land uses

The site is located approximately 10 km north of Newcastle and is currently approved for windblown sand extraction from the Stockton transgressive dunes. **Table 3** below presents key identification features of the site. The site location and proposed extraction staging plan is illustrated in **Figure 1** and **Figure 2**, respectively.

Table 3: Site identification

Item	Details
Site Owner	Boral Resources (NSW) Pty Ltd
Address	Coxs Lane, Fullerton Cove, NSW 2318
Lot & Plan number	Part Lot 1 DP 1006399 Part Lot 3 DP 664552 Part Lot 7300 DP 1130730
Area	Approx. 37 ha
Zoning	RU2 – Rural Landscape; RE1 – Public Recreation (Crown Land)
Proposed land use	Extractive industry
Local Government Authority	Port Stephens Council



Source: © NSW Govt. SIX Maps

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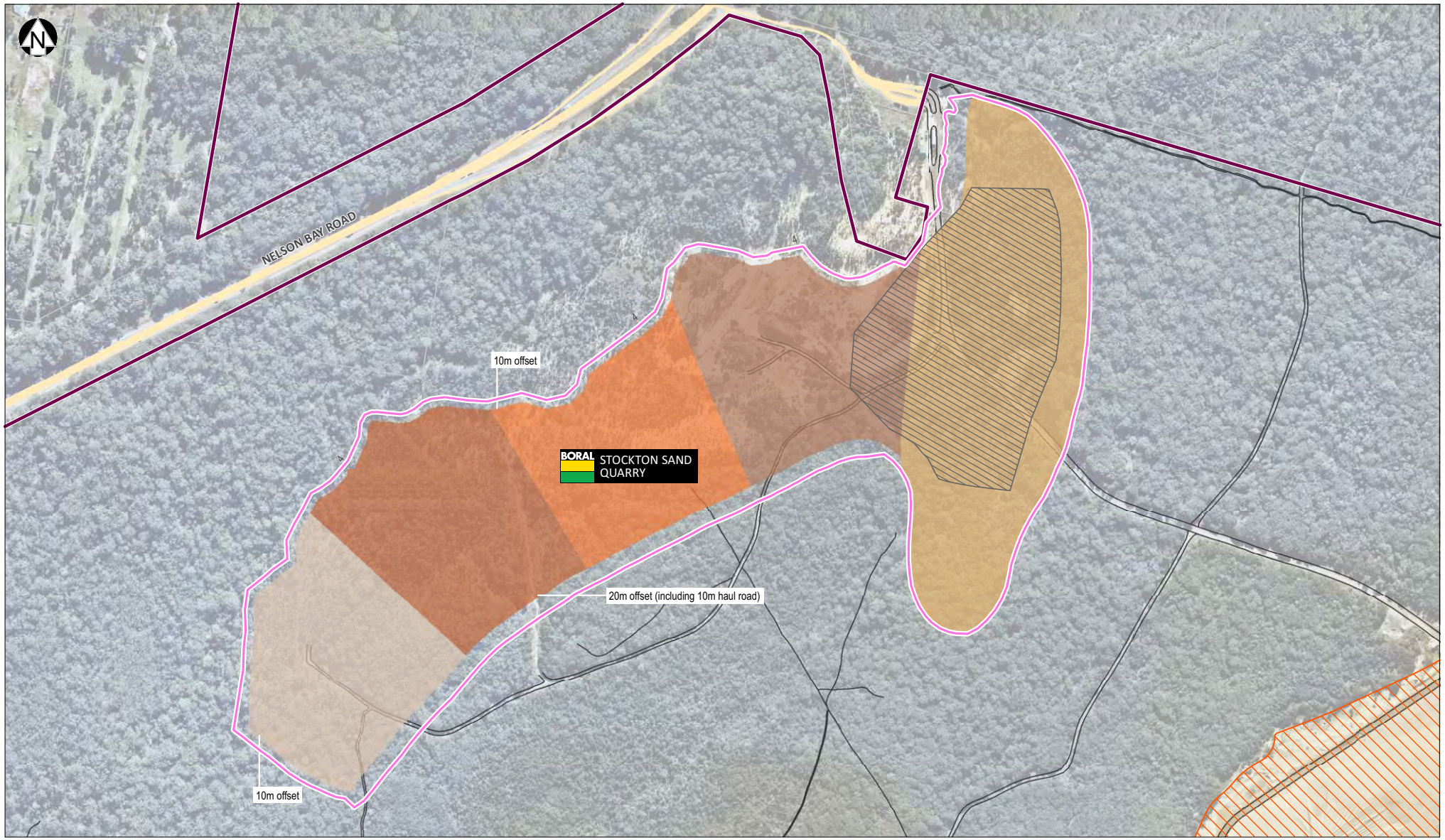
Title:	**Site Location**
Location:	**Nelson Bay Road, Fullerton Cove, NSW**
Client: **Boral Resources (NSW) Pty Ltd**	Job No: **717041**
Project Man: **EG**	Scale: **As shown**
Drawn By: **LB**	Date: **November 2018**
	Figure 1



Source: Element Environment

Stockton Sand Quarry boundary
Current windblown sand extraction area
Proposed clearance area
Access tracks

Extraction staging
Stage 1
Stage 2
Stage 3
Stage 4
Stage 5
Stage 6

0 50 100 150 200 250
Scale in Metres

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Title: **Extraction Staging Plan**

Location: **Nelson Bay Road, Fullerton Cove, NSW**

Client: **Boral Quarries**

Job No: **717041**

Project Man: **LL/AS**

Scale: **As shown**

Drawn By: **LB**

Date: **July 2019**

Figure 2

The Water Sharing Plan for the North Coast coastal sands groundwater sources (NSW DPI, 2016) classifies the Stockton groundwater source as located within the Worimi Conservation Lands which covers the Worimi National Park, Worimi State Conservation Area and Worimi Regional Park, with groundwater predominantly used for domestic purposes with some entitlement for irrigation and commercial purposes.

Land use surrounding the site is a mixture of rural, residential, public recreation and environmental conservation.

To the north west of Nelson Bay Road is the rural area of Fullerton Cove. This area comprises a mixture of small rural holdings and commercial premises. The main access for these properties is via Fullerton Cove Road and Coxs Lane to and from Nelson Bay Road.

These properties are separated from the site by Nelson Bay Road, with the closest approximately 480 metres (m) from the entrance to the quarry. A residential development at Fern Bay (Fern Bay Seaside Village) is approximately 1.5 km to the west south west of the site.

The majority of environmental conservation areas adjacent to the site are Worimi Conservation Land, Regional and National Park that extend along the Stockton Bight beach and dune system. The beach and dune areas of the wider aforementioned conservation areasare used for a variety of recreational purposes including fishing, four-wheel driving, quad bike riding, hiking and horse riding. There are no formal public access points through Boral's holding to Stockton Bight. Formal access to the dunes and beach is via Lavis Lane near Williamtown, and a new access within Seaside Estate at Fern Bay.

To the north-west of the Site is Williamtown RAAF base and associated waste station and waste treatment plant, landfill and sewage treatment plant.

The Worimi are the traditional owners of the Great Lakes and Port Stephens area between the Hunter and Manning Rivers. The area of the Stockton Bight has a special significance because it retains a large amount of cultural history. The Worimi people manage the environmental conservation areas of Stockton Bight adjacent to the site (known as the Worimi Conservation Lands) through a joint agreement with the NSW National Parks and Wildlife Services (NSW DPI 2016).

Boral Resources (NSW) Pty Ltd acknowledge the Traditional owners of the Great Lakes and Port Stephens area, including the Stockton Bight and recognise their continuing connection to land, water and community. Boral Resources (NSW) Pty Ltd pay respect to Elders past, present and emerging.

6.2.2 Site History

Sand extraction has taken place in various locations on the site since 1976 when G. Hawkins and Sons was initially granted consent.

Under Boral’s ownership there have been two primary development consents granted:

- DA 2010/94: The ‘inland extraction area’ (also known as pits 1 – 6) granted by Port Stephens Council in May 1996, and

- DA 140-6-2005: The 'windblown sand extraction area' (also known as the "windblown project" or pit 7) located on the transgressive dunes adjoining Stockton Beach granted by the Department of Planning in 2006.

The inland extraction operation on the vegetated dunes occurred above 5m AHD and ceased in 2008 and rehabilitation has been ongoing. This former extraction area is generally consistent with the project site and is the focus of this development application.

The windblown sand extraction area started in 2008 and is approximately 375 m south east of the proposed project site and is approved to operate until 2028 and dispatch up to 500,000 tpa (refer to Condition 6 of DA 140-6-2005).

6.2.3 Registered groundwater bore search

Registered Groundwater Bore database was searched on 15 May 2018 (BOM,2019). Bores were identified within an approximate 2.5 km radius of the site and were generally within the bounds of the Stockton Sandbeds Aquifer. A summary of the registered bore search is in **Appendix B** and discussed further in Section 8.5.5.

6.2.4 Sensitive groundwater users and groundwater dependent ecosystems (GDEs)

Further assessment of groundwater usage is provided in Section 8.8 of this report. As part of the desktop assessment for the project, investigations into the potential for the presence of GDEs in the vicinity of the site were undertaken. The closest potential GDEs are located to south-east (seaward) and north-west (inland) of the extraction area. Maps illustrating groundwater dependent ecosystems (BOM,2018) are provided in **Appendix C.**

The seaward GDEs comprise small ephemeral and mobile shallow deflation basin lakes vegetated with a variety of grasses, sedges and reeds. These lakes provide an ephemeral habitat for a number of invertebrates and other species (ERM, 2005).

The inland GDEs are primarily the swamp forests in the dune swales and the low-lying heath. These systems are up gradient (inland) of the extraction area. A previous groundwater assessment (ERM, 2005) noted that the risk of impacting these GDEs is very low given the sand extraction depth restrictions and low evaporation in times of high groundwater.

6.2.5 Review of previous reports and information

Environmental Earth Sciences was provided with the following reports pertaining to the site:

- ERM (1994). *Environmental Impact Statement for a Sand Extraction Operation on Boral Resources Freehold Property at Fern Bay, NSW*, ref. 1068/94573. Prepared for Boral Resources (Country) Pty Ltd.

- Umwelt (Australia) Pty Ltd (1995). *Review of Potential Hydraulic Impacts of Proposed Sand Extraction at Stockton Sand Pit, off Cox's Lane, Fern Bay*. Prepared for Boral Resources (Country) Pty Ltd.

- ERM (2005). *Environmental Impact Statement – Stockton Windblown Sand Extraction*, ref. 0027903 Final. Prepared for Boral Resources (Country) Pty Ltd.
- RPS (2016). *Boral Stockton Sand Quarry – Groundwater Gap Analysis*, ref. WS00256/003a. Prepared for Boral Quarries.
- Jacobs (2017). *Stockton Sand Quarry Groundwater Management Plan*, ref. IA147700_001b/B. Prepared for Boral Pty Ltd.

Table 4 provides a summary of pertinent information from previous investigations. Further sources of information are provided in Section 12 of this report.

Based on previous reports, groundwater beneath the wider Stockton area (prior to the current sand extraction plans for the site and those completed in 2008) follows a northeast-southwest orientated ridge line in the dune system with inferred groundwater flow split between the northwest to Fullerton Cove or southeast to the Pacific Ocean (Woolley *et al*. 1995).

No significant physical or chemical impact to groundwater as a result of sand extraction was identified during previous site investigations.

Table 4: Summary of relevant reports

Report	Key findings
ERM (1994)). *Environmental Impact Statement for a Sand Extraction Operation on Boral Resources Freehold Property at Fern Bay, NSW*, ref. 1068/94573. Prepared for Boral Resources (Country) Pty Ltd.	• The Inland Extraction Area consisted of dry sand extraction only, no excavations below the water table; and • Extraction estimated to lower the existing topography to a stabilised and revegetated landscape ~5 – 6 m AHD.
Umwelt (1995) *Review of Potential Hydraulic Impacts of Proposed Sand Extraction at Stockton Sand Pit, off Cox's Lane, Fern Bay*. Prepared for Boral Resources (Country) Pty Ltd.	Assuming that Boral extracts sand above 5 m AHD: • no alteration to the hydraulic conductivity of the aquifer; • no changes to surface or groundwater drainage conditions; • de-vegetation and extraction may increase infiltration rates in localised settings, however infiltration is naturally high; • the surface area of the aquifer to be disturbed at any one time considered miniscule; and, • provided >0.5 m of sand is above the water table, the proposed development will not significantly alter groundwater levels.
ERM (2005) *Environmental Impact Statement – Stockton Windblown Sand Extraction*, ref. 0027903 Final. Prepared for Boral Resources (Country) Pty Ltd.	• Groundwater monitoring of the landward side wells reported groundwater suitable for potable use if treated. • Windblown sand extraction considered to have a nett positive environmental impact.
RPS (2016) *Boral Stockton Sand Quarry – Groundwater Gap Analysis*, ref. WS00256/003a. Prepared for Boral Quarries.	• Conservatively calculates that for every 1 m decline in the water table the saltwater interface will rise by 40 m. • No high-priority groundwater dependant ecosystems identified near the site. • Boral Quarry is a significant distance upgradient of the Red Zone from the Williamtown RAAF Base • Highly unlikely that proposed dredging at site would change groundwater flow conditions or impact contaminant migration relating to the Red Zone. • No significant risk of inducing contaminant migration towards the site from proposed dredging activities. • Anticipates that the proposed dredging will meet the Level 1 Minimal Impact Considerations set by the NSW Aquifer Interference Policy.

Report	Key findings
Jacobs (2017) *Stockton Sand Quarry Groundwater Management Plan*, ref. IA147700_001b/B. Prepared for Boral Pty Ltd.	• Baseline groundwater data has been collected over Boral's monitoring network (2007 – 2017) with some intermittent lapses. • No groundwater impacts due to site operations have been identified to date (as all sand extraction has been above water table). • Groundwater results of monitoring wells (ID: MW1, 2, 5, 6, 7, 8, 9 and 11) considered indicative of natural background levels; • Aluminium (Al), Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu), Mercury (Hg), Nickel (Ni), Zinc (Zn) and nitrate above ANZECC (2000) guidelines for 95% ecosystem protection.

7 FIELD STUDY

7.1 Field investigation

7.1.1 Bore installation

In conjunction with the assessment for acid sulfate soils (ASS) (Environmental Earth Sciences, 2018) four boreholes were drilled across the site to a maximum depth of 24.0m below ground level (bgl) between the dates of 13 and 14 March 2018.

Borehole locations for the ASS assessment (BH1 – BH4) along with existing groundwater monitoring bores are illustrated in **Figure 3**. Full details are provided in bore logs, **Appendix D**.

7.1.2 Ground conditions

The profiles of bores (BH1 – BH4) were typically described as fill comprising sand with chitter gravels of mixed lithology and coal.

This was underlain by natural granular material typically described as loose brown grey medium grained sand, further underlain locally by medium to coarse grained sand, with shell grit which extended beyond the maximum depth of investigation of 24 metres below ground level (m bgl). **Table 5** provides a summary of the stratigraphy encountered at the site.

Table 5: Stratigraphy summary

Strata	From (min/max)	To (min/max)	Min/max thickness	Groundwater (min/max)	Comments
Fill	Ground level	3.5/4.0 m bgl	3.5/4.0 m bgl	1.5/5.5 m bgl	Fill not present in BH2
Natural – Loose brown grey medium grain sand	3.5/4.0 m bgl	10.5/>24 m bgl	6.5/ >24 m bgl		Occasional localised layers of organic material present in BH2
Natural – Loose medium to coarse sand with shell grit	18/21 m bgl	Not encountered	Not applicable		

7.1.3 Groundwater levels

During drilling of BH1 – BH4, groundwater was encountered within all bores at depths between 1.5 and 5.5 m bgl. During these intrusive investigations, the standing water levels of existing surveyed groundwater monitoring bores (ID: MWX1; MWX2; MWX3; MWX4; MWX5 and MWX6) as well as the unsurveyed bore GW1 were recorded on 14 March 2018 within 1.5 hours of each other to reduce tidal variations on the data. **Table 6** provides a summary of observed static water levels (SWLs).

A hydrograph of SWLs from information provided by submersible data loggers, obtained by VGT on a monthly basis for the period of May 2017 to July 2018 is presented in **Chart 1** (**Appendix A).**

Table 6: Groundwater level results, 25 October 2018

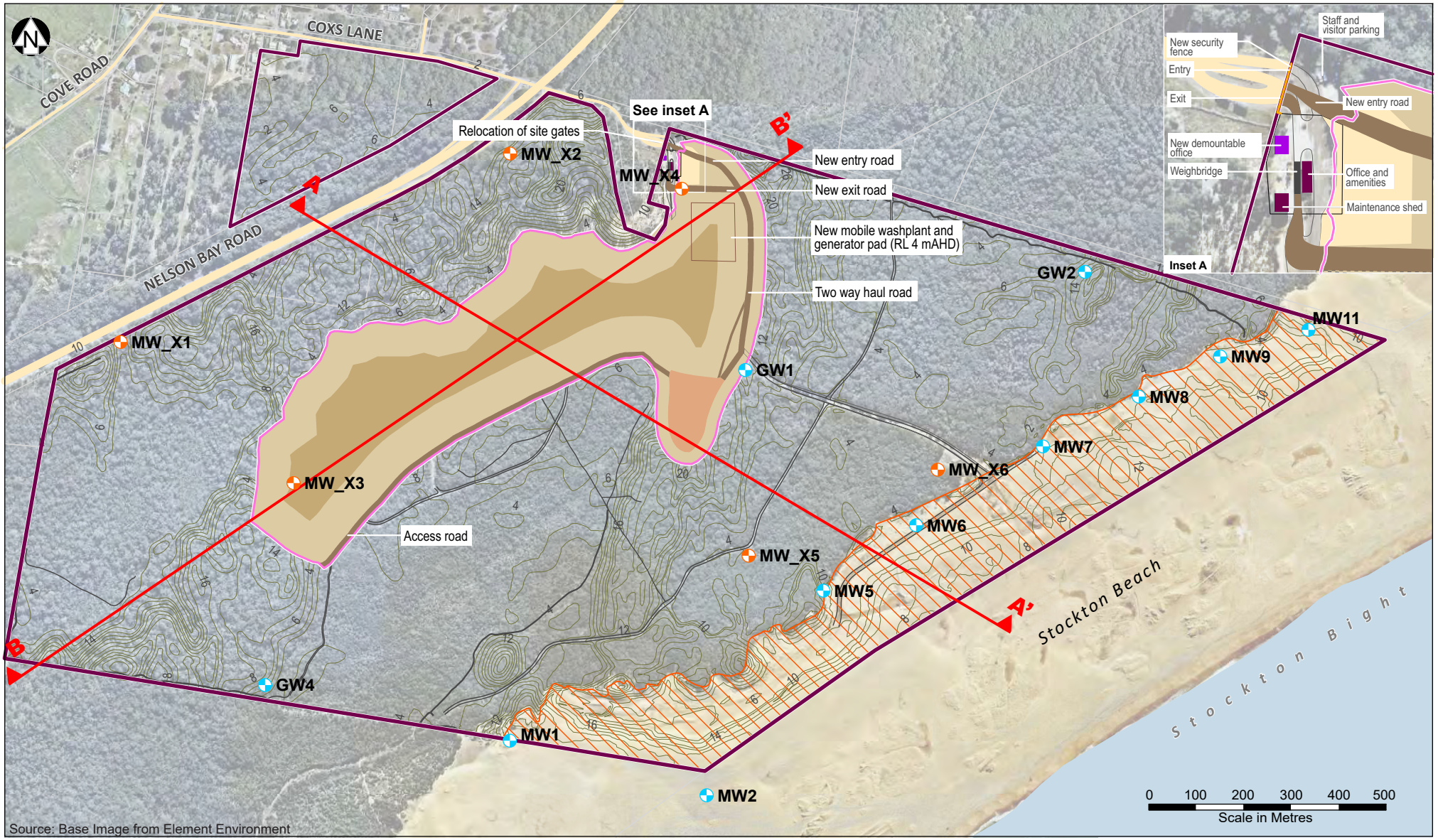
Sample	25 Oct 2018	
	Water Level (m) to Top of Casing (TOC)	Water Level (m AHD)
BH1	3.45	1.00
BH2	2.252	1.248
BH3	0.94	0.59
BH4	2.445	1.005
MWX1	3.813	5.64
MWX2		4.84
MWX3	1.37	5.12
MWX4	1.84	8.95
MWX5	4.295	2.64
MWX6		2.26

7.1.4 Sampling

On 13 March 2018, a water sample was obtained from nested bore MWX3 using a submersible pump.

To ensure that representative samples of groundwater were obtained, the following groundwater geochemical field parameters were collected during purging using a calibrated water quality meter (WQM):

- Oxygen Reduction Potential (ORP) – redox.
- pH.
- Dissolved oxygen (DO).
- Electrical conductivity (EC).
- Temperature.



LEGEND:

- Stockton Sand Quarry boundary
- Current windblown sand extraction area
- Contour (mAHD)
- Access tracks
- Additional groundwater monitoring location - installed April 2017
- Current groundwater monitoring location
- Cross section location (refer Figures 10 and 11)

PROJECT FEATURES:

- Proposed clearance area
- Access road
- Extraction base (RL -15mAHD)
- Batter
- Pad base (RL 4mAHD)

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Title: **Borehole and Groundwater Monitoring Well Locations**

Location: **Nelson Bay Road, Fullerton Cove, NSW**

Client: **Boral Quarries**

Job No: **717041**

Project Man: **EG**

Scale: **As shown**

Drawn By: **LB**

Date: **September 2019**

Figure 3

These field parameters were measured *ex-situ* within in-line flow cells, with the following stabilisation criteria indicating representative groundwater conditions suitable for sample collection:

- ± 10ppm DO when >1 ppm (no criteria for <1 ppm).
- ± 3% EC.
- ± 0.05 pH.
- ± 10mV ORP.

Following purging and stabilisation of field chemical parameters, samples were placed in appropriate containers and stored in ice-filled coolers prior to transportation to the laboratory for analysis. Refer to **Table 7** for a summary of field observations and refer to **Appendix E** for the Groundwater Field Sheets.

Table 7: Summary of SWL and field observations, March 2018.

Bore	Units	MWX3_S	MWX3_D
Date	-	13/03/2018	13/03/2018
Depth to Groundwater	m TOC	5.5	5.9
Depth of Bore	m	11.3	26
DO	ppm	0.13	0.14
EC	µS/cm	257	547
pH	-	6.02	7.01
Redox	mV	13	-104
Temperature	°C	20.1	20.1
Comments	-	Clear, no odour	Clear, no odour

7.1.5 Analytical schedule

Groundwater samples collected from bore MWX3 were sent to Sydney Analytical Laboratories (SAL), a NATA accredited laboratory and analysed for the following determinants:

- full ionic balance suite – pH, EC, total dissolved solids (TDS), cations (Na, Ca, Mg, K), anions (Cl, SO_4, HCO_3, PO_4, F) and nutrients (NH_3, NO_3 and NO_2), and
- dissolved metals / metalloids including aluminium (Al), arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), manganese (Mn), mercury (Hg) and zinc (Zn).

Results that have been used in the current assessment are provided in **Tables 16, 17 and 18** at the back of this report. Full details are attached in laboratory certificates, **Appendix F.**

7.1.6 Procedures for quality control and quality assurance

Quality control is achieved by using NATA registered laboratories using Australian Standards Materials Testing (ASTM) standard methods supported by internal duplicates, the checking of high, abnormal or otherwise anomalous results against background and other chemical results for the sample concerned.

Quality assurance is achieved by confirming that field results, or anticipated results based upon comparison with field observations, are consistent with laboratory results. Also, that sampling methods are uniform, and decontamination is thorough. In addition, the laboratory undertakes additional duplicate analysis as part of their internal quality assurance program on the basis of one duplicate analysis for every 20 samples analysed.

Field observations are compared with laboratory results when they are not as expected. Confirmation, re-sampling and re-analysis of a sample are undertaken if the results are not consistent with field observations and/or measurements. In addition, field duplicate sample results have to be within the acceptable range of reproducibility.

7.1.7 Hydraulic parameter testing

On 13 and 14 March 2018, 'slug-tests' were undertaken on the nested bore at MWX3 (MWX3_Shallow (MWX3S) and MWX3_Deep (MWX3D)). Slug (or falling head) tests require piezometers to have the screens fully submerged beneath the piezometric surface. This method was used to determine the *in*-situ hydraulic conductivity (K).

These tests involved causing an instantaneous change in water level in a section of the piezometer by introducing a known volume (i.e. a 'slug') and then measuring the recovery of the water level over time (after Fetter 2001). Using the data obtained from these tests, values for hydraulic conductivity (K), transmissivity (KD) and groundwater velocity (v) have been determined for the unconfined Quaternary aquifer.

The slug-tests were performed across the Site to determine the change in hydraulic properties of the water bearing sediments beneath the Site. The calculations and results of K determinations across the Site are provided in **Appendix G**, while values derived for K, KD and v have been summarised in **Table 8**. Local hydraulic gradients have been interpreted from **Figures 4 and 5**.

Results were found to be very responsive. As such, only the data from MW_X3S was analysed using the Bouwer-Rice (BR) and Hvorslev methods (after Fetter 2001 and Kruseman and de Ridder 2000). Literature values for hydraulic properties of the Stockton Sands (Hydrosimulations, 2016) record K values ranging between 10 and 20 m/day, specific yield (Sy) of 0.15 and porosity (n) between 0.3 and 0.33.

Data obtained from recent hydraulic testing agrees with literature values and confirms that the unconfined aquifer beneath the Site is very permeable (K values between 6 and 55 m/day and transmissivity values up to between 50 and 4627 m^2/day), but that due to the low hydraulic gradients (i), groundwater velocities are relatively low (12.6 - 116 m/year).

Table 8: Slug test results – March 2018

Bore	Screened interval	Aquifer	Test Date	Q	K	KD	Approximate Hydraulic Gradient (*i*)	Average linear velocity, (v)
	m BGL	-	-	m^3/day	m/day	m^2/day	m/m	m/year
MW_X3 Shallow	8.5 – 11.5	Stockton Sand Member (Holocene)	14/3/2018	600	25	243	0.002	61

Note(s):
1. K hydraulic conductivity; KD transmissivity; Q yield
2. v average linear velocity was calculated assuming effective porosity of 0.35 in medium grained sand (Freeze and Cherry, 1979, Kruseman and de Ridder, 2000)
3. all tests undertaken using the Hvorslev, Bouwer-Rice and Jacob Recovery test analysis methods, after Fetter 2001 and Kruseman and de Ridder, 2000

7.1.8 Long-term monitoring data

In addition to reviewing the data collected by Environmental Earth Sciences in March 2018, Environmental Earth Sciences was provided with groundwater chemical results collected from the MWX bore series on a monthly basis from October 2017 – June 2018. This was collected by VGT and subjected to laboratory analysis for:

- Full ionic balance suite - pH, EC, TDS, cations (Na, Ca, Mg, K), anions (Cl, SO_4, reactive P, F), total alkalinity as $CaCO_3$ and nutrients (NH_3, NO_3 and NO_2);
- dissolved metals / metalloids including aluminium (Al), arsenic (As), boron (B), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), manganese (Mn), mercury (Hg), nickel (Ni) and zinc (Zn); and,
- Perfluorinated compounds including perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) monthly from January – June 2018 at limited locations (ID: MWX1, MWX2, MWX7 and GW4).

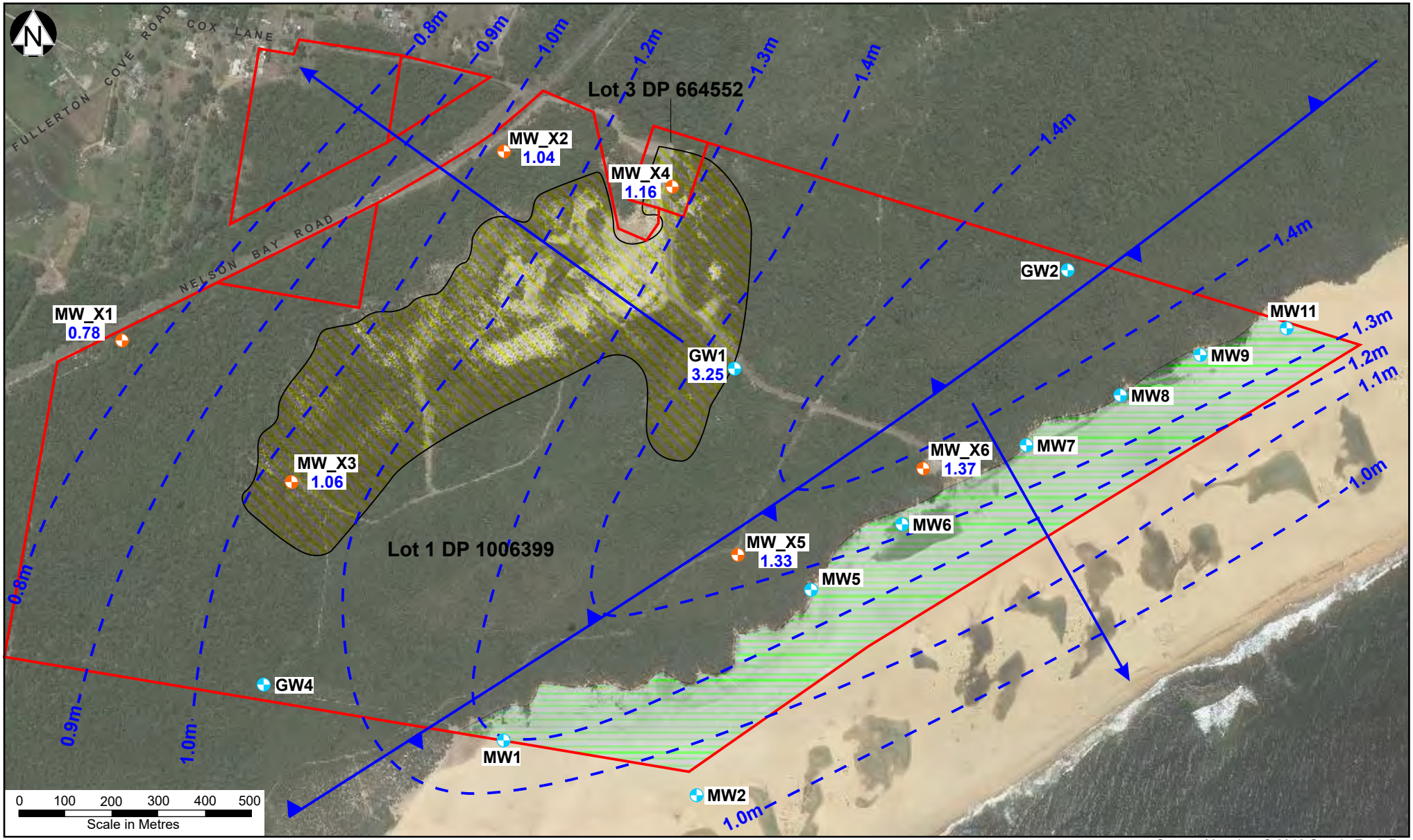
Data from the following borehole locations has been included within this assessment:

- GW1, MWX1; MWX2; MWX3 - nested; MWX4 - nested; MWX5 and MWX6.

7.2 Adequacy of field investigation

Based on the discussion above, it is considered that the information collected to date is appropriate (both physically and chemically) to assess the baseline conditions of the aquifer and provide an analytical assessment of potential impact from the site.

Assessment of water quality and physical groundwater conditions have occurred for a significant period of time (ERM [1994 and 2005], Umwelt [1995], RPS [2016] and Jacobs [2017]), see section 6.2.5, in addition to approximately 12 years' worth of data collected from selected bores. It is considered that whilst the addition of further analysis of groundwater in the lead up to commencement on site is unlikely to have a significant impact on the assessment of baseline conditions, it is recommended that on-going monitoring continue (as detailed in Section 10.2 below) to further enhance the temporal range and increase the robustness of the baseline data.



Source: Map data © 2016 Google Earth Pro

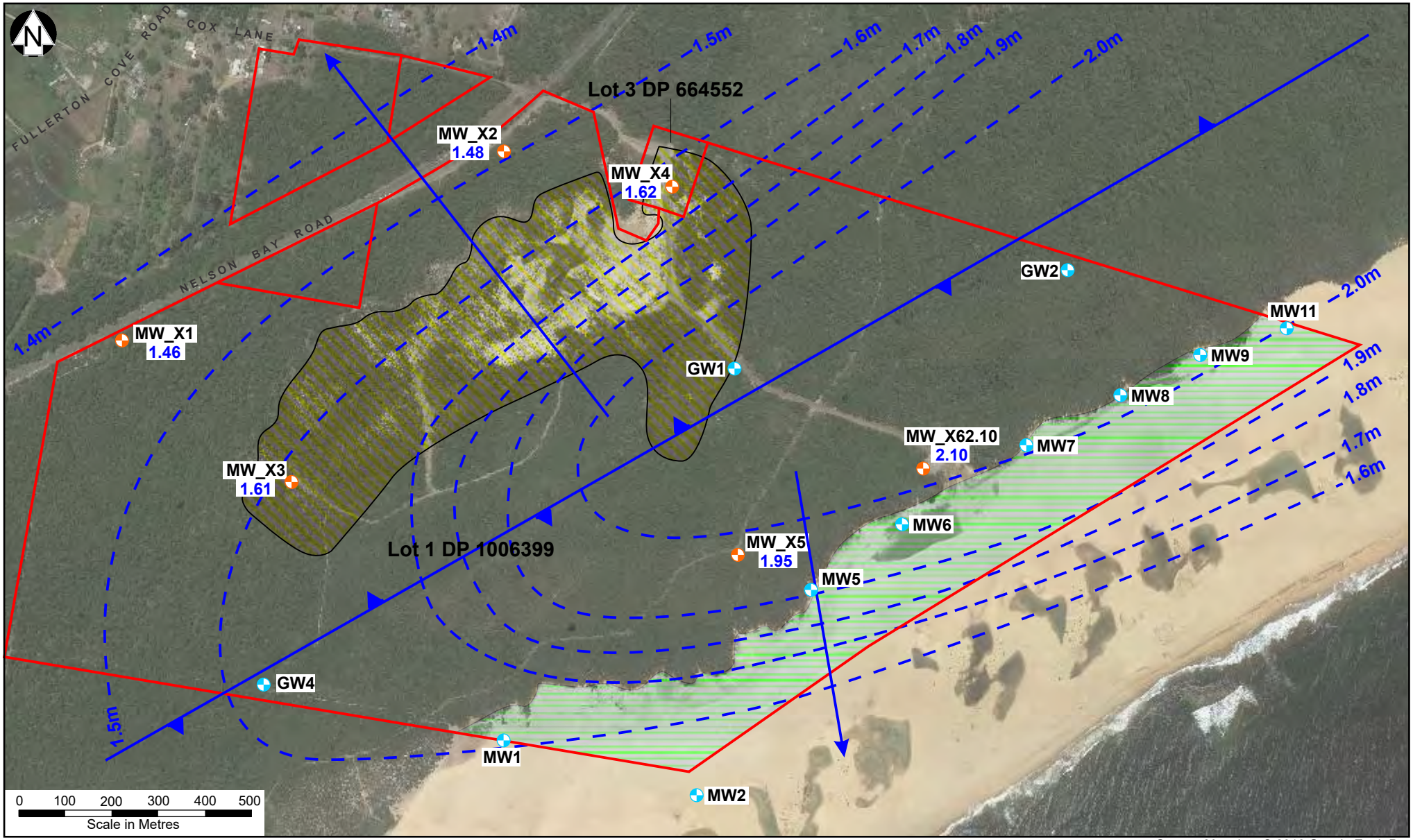
LEGEND:

- Lot area
- Windblown sand extraction area
- Inland extraction area
- Additional groundwater monitoring location - installed April 2017
- Current groundwater monitoring location
- Inferred groundwater level (mAHD)
- Inferred groundwater flow divide
- Inferred groundwater flow direction
- 1.33 Standing water level (mAHD)

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Title:	**Groundwater Levels Low Rainfall (14 March 2018)**
Location:	**Nelson Bay Road, Fullerton Cove, NSW**
Client: **Boral Resources (NSW) Pty Ltd**	Job No: **717041**
Project Man: **EG**	Scale: **As shown**
Drawn By: **LB**	Date: **November 2018**

Figure 4



Source: Map data © 2016 Google Earth Pro

LEGEND:

- Lot area
- Windblown sand extraction area
- Inland extraction area
- Additional groundwater monitoring location - installed April 2017
- Current groundwater monitoring location
- Inferred groundwater level (mAHD)
- Inferred groundwater flow divide
- Inferred groundwater flow direction
- 1.95 Standing water level (mAHD)

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Title:	**Groundwater Levels High Rainfall (20 June 2018)**
Location:	**Nelson Bay Road, Fullerton Cove, NSW**
Client: **Boral Resources (NSW) Pty Ltd**	Job No: **717041**
Project Man: **EG**	Scale: **As shown**
Drawn By: **LB**	Date: **November 2018**

Figure 5

8 CONCEPTUAL HYDROGEOLOGICAL MODEL (CSM)

8.1 Introduction

A CSM is a two- to three-dimensional interpretation of the soil, geology and hydrogeology relationships within a catchment. Information assessed and presented includes inferred soil/ rock weathering processes and groundwater/ surface water flow characteristics. The CSM aims to inform an exposure assessment of any impact (or potential for impact) identified by demarcating sources, pathways and receptors of the groundwater flow system. The CSM is one of the primary planning tools used to support decision making processes, organising available information about a site or issue in a clear structure that facilitates the identification of data and information gaps.

It is often presented using a variety of media, including text, maps, cross sections, two- or three-dimensional graphics, tables and other visual representations (including Piper, Durov, Stiff or Schoeller Plots, for example). This report includes text and tables, along with appended figures including 2D schematic cross sections of the investigation area (**Figures 7, 8 and 9**), data tables, Piper Diagrams and Schoeller Plots.

By gaining a greater understanding of the site, the model can also be used to assess which portions of the project may require further investigation or monitoring. The CSM presented herein is intended to help identify groundwater flow paths and environmental receptors using the available data. The CSM describes the existing hydrogeological environment and constraints.

8.2 Physical setting

8.2.1 Site locality

The site is located within the Stockton dune system of the Newcastle Bight, Aeolian sand dunes that span 32 km from Stockton to Anna Bay. The majority of the site comprises relatively stable and vegetated back dune and inter dune environments, whilst the south eastern property margin encompasses an un-vegetated and mobile foredune environment.

8.2.2 Landform and topography

Environmental Earth Sciences was provided with 3D contours of the site's topography for review. Topography within the project area forms the shape of a basin, reflective of former sand extraction in this area. Topography ranges from approximately 2.0 – 5.5 m AHD in the centre of the Project area and is encircled by higher topography ranging from a maximum of 29 m AHD (north), 8.8 m AHD (south), 27 m AHD (east) and 12 m AHD (west).

The Project area had been subjected to rehabilitation following an earlier sand extraction project ending in approximately 2008. This rehabilitation provides a degree of stability to the underlying sands situated along a crest in the dune fields.

Soil landscape information was sourced from eSPADE v2.0 published by the NSW Office of Environment & Heritage (2018) (espade.environment.nsw.gov.au/, verified 28 March 2018). The majority of the project area is underlain by the Boyces Track soil landscape group that typically exhibits a local relief of 10 – 30 m with slopes >25% and elevation ranging from 10 – 40 m. Refer to **Appendix H** for Soil Landscape Reports.

8.2.3 Climate

Regional meteorological data has been sourced from the Bureau of Meteorology (2018) (www.bom.gov.au, verified 28 March 2018) Williamtown RAAF weather station, approximately 5 km from site, and is summarised in **Figure 6**. Evaporation data is based on monthly averages from 2018.

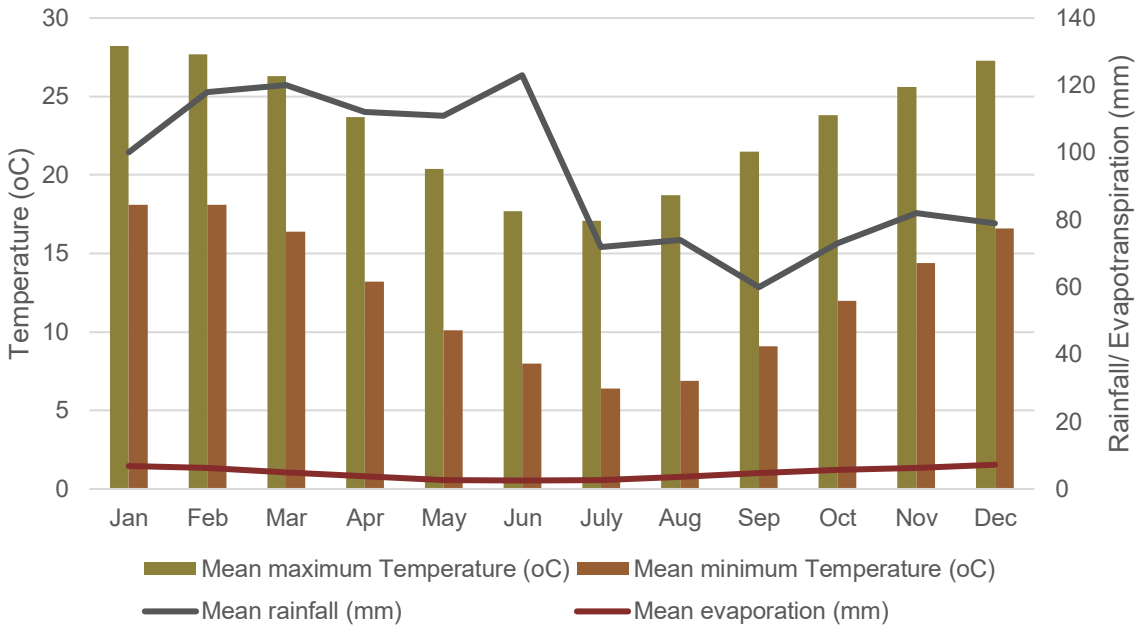


Figure 6: Average monthly climate data

Stockton's climate can be described as warm temperate with mild winters and warm summers. The temperature ranges from a mean daily maximum temperature of 17.1 °C in the coldest month of July, to warm summers with mean daily maximum temperatures of 28.2 °C in January. Minimum winter daily temperatures range from 6.4 – 8 °C and the area is rarely subjected to frosts and temperatures below 0 °C. A graph indicating monthly rainfall in relation to standing water levels (SWL) observed in all onsite wells between 2016 and June 2018 is presented in **Chart 1 (Appendix A)**.

Mean annual rainfall recorded at Stockton is 1,125 mm and the rainfall pattern has a late summer to autumn dominant trend. Monthly total evaporation rates are less than the average monthly rainfall (**Figure 6**), suggesting strong groundwater recharge rates of up to 70 – 80% of total rainfall for this system. Water loss as a result of evaporation is only likely to represent 5% of the total system, whilst transpiration is estimated to represent up to 15% of water loss.

8.3 Soil and geology

8.3.1 Geology

The local geology of the Newcastle Bight has been described as Qa – Quaternary Alluvium consisting of gravel, sand, silt, “Waterloo Rock” (i.e. indurated sand) with marine and freshwater deposits according to the Newcastle 1: 250 000 Geological Series Sheet S1 56-2 (1966).

The site’s geology consists specifically of Quaternary Holocene barrier dune (Qhbd). This is described as unconsolidated aeolian deposits of marine sand estimated to have formed between 9,500 – 6,500 years ago. This deposit ranges from 10 – 30 m thick and it is commonly referred to as the Stockton Sandbeds or the Stockton Sand Member.

The Tomago Sandbeds are Pleistocene-aged (circa 30,000 years) deposits that underlie the Stockton Sandbeds. Finally, the Stockton and Tomago Sandbeds are underlain by the Medowie Clay Member. A geological cross section of the area through the Tomago-Stockton Sandbeds, based on Thom *et al*. (1992) after Woolley *et al*. (1995) is presented in **Figure 7**.

8.3.2 Soil landscape

The dune sands represent a transgressive period of deposition and overly the beach and shore face, shelly sands that represent regressive beach barrier faces. Some localised organic-rich, peaty deposits may be present associated with interdunal swales. Total sediment thicknesses of the Stockton Sandbeds are known to range from between 10 m to 40 m.

The soil observed on the site is described in the Port Stephen Hydrologic Soil Group Map as ‘Group A’ soils (refer to **Appendix I** to view the Port Stephens Hydrologic Soil Group Map). A soil landscape is an area of land that has recognisable and specifiable topographies and soils.

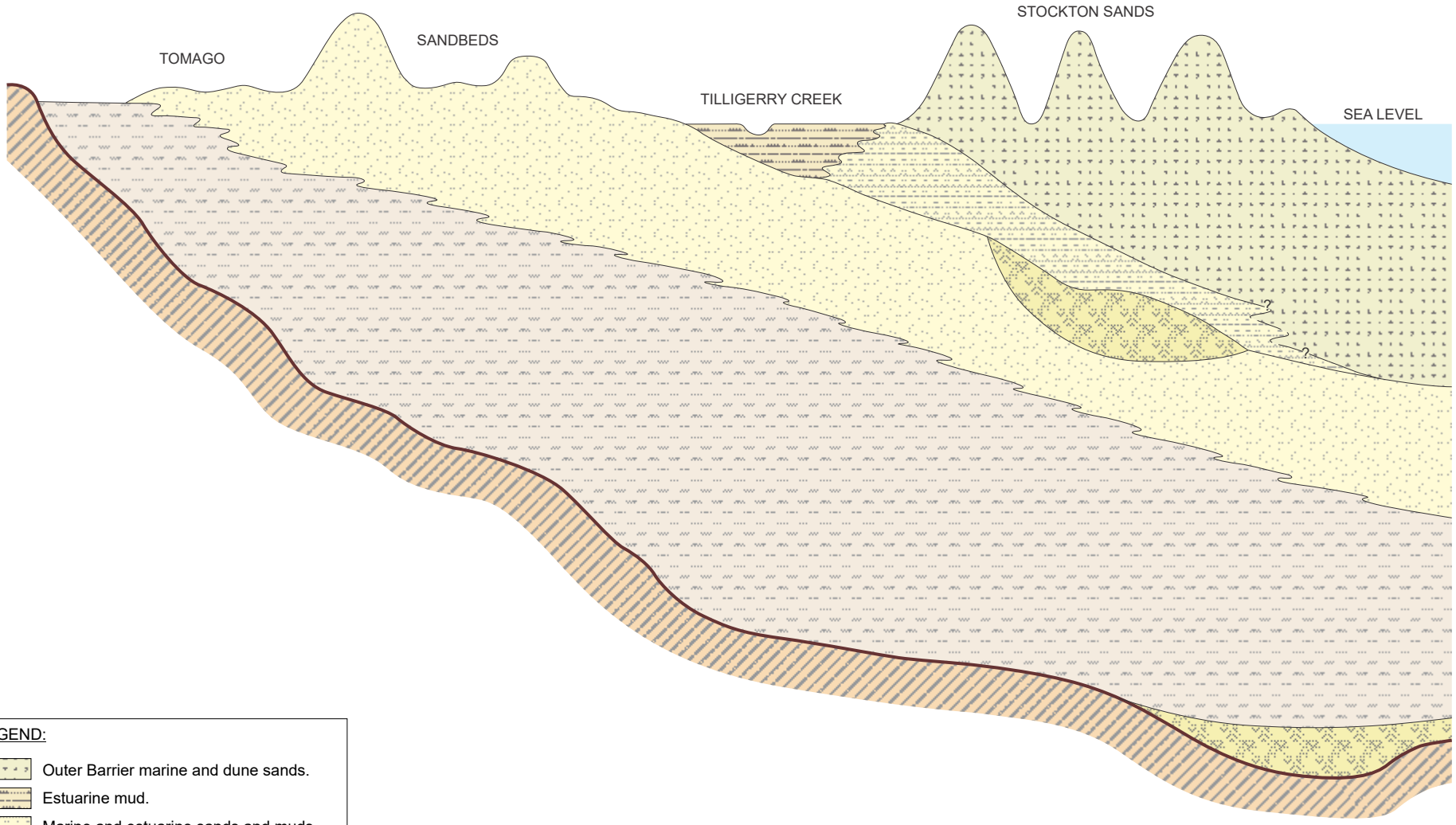
Two soil landscape groups were identified within the Project Area; predominantly Boyces Track with Hawks Nest along the southern Project Area boundary. Boyces Track are Holocene transgressive aeolian dunes with deep (>300 cm), well-draining and weakly developed podzol soils. Typically, these soils are acidic to neutral. Hawks Nest soil landscape are stable low Holocene sand sheets on low transgressive dunes with deep well-draining soils. They generally exhibit high water tables and a potential for acid sulfate soils (ASS) in low lying swampy swales. These soils may be strongly acid. Refer to **Appendix H** for Soil Landscape Reports.

8.3.3 Acid sulfate soils

The site was reviewed in the Port Stephens 1:50 000 Acid Sulfate Soils Map (1996) produced by NSW Department of Land and Water Conservation. The site is considered low probability for ASS in general. The southern boundary of the Project Area is considered low probability between 1 - 3 metres below ground surface (m BGS) whilst the remainder and majority of the Project Area is considered low probability for ASS >3 m BGS.

North West

South East



LEGEND:

- Outer Barrier marine and dune sands.
- Estuarine mud.
- Marine and estuarine sands and muds.
- Fluvial sand and gravel.
- Inner Barrier marine and dune sands.
- Estuarine-lagoonal mud; sand lenses.
- Unconformity.
- Bedrock.

Horizontal 0 1 2 Km

Vertical 0 10 20 30 m

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Title: **General Geological Cross Section**

Location: **Nelson Bay Road, Fullerton Cove, NSW**

Client: **Boral Resources (NSW) Pty Ltd**

Job No: **717041**

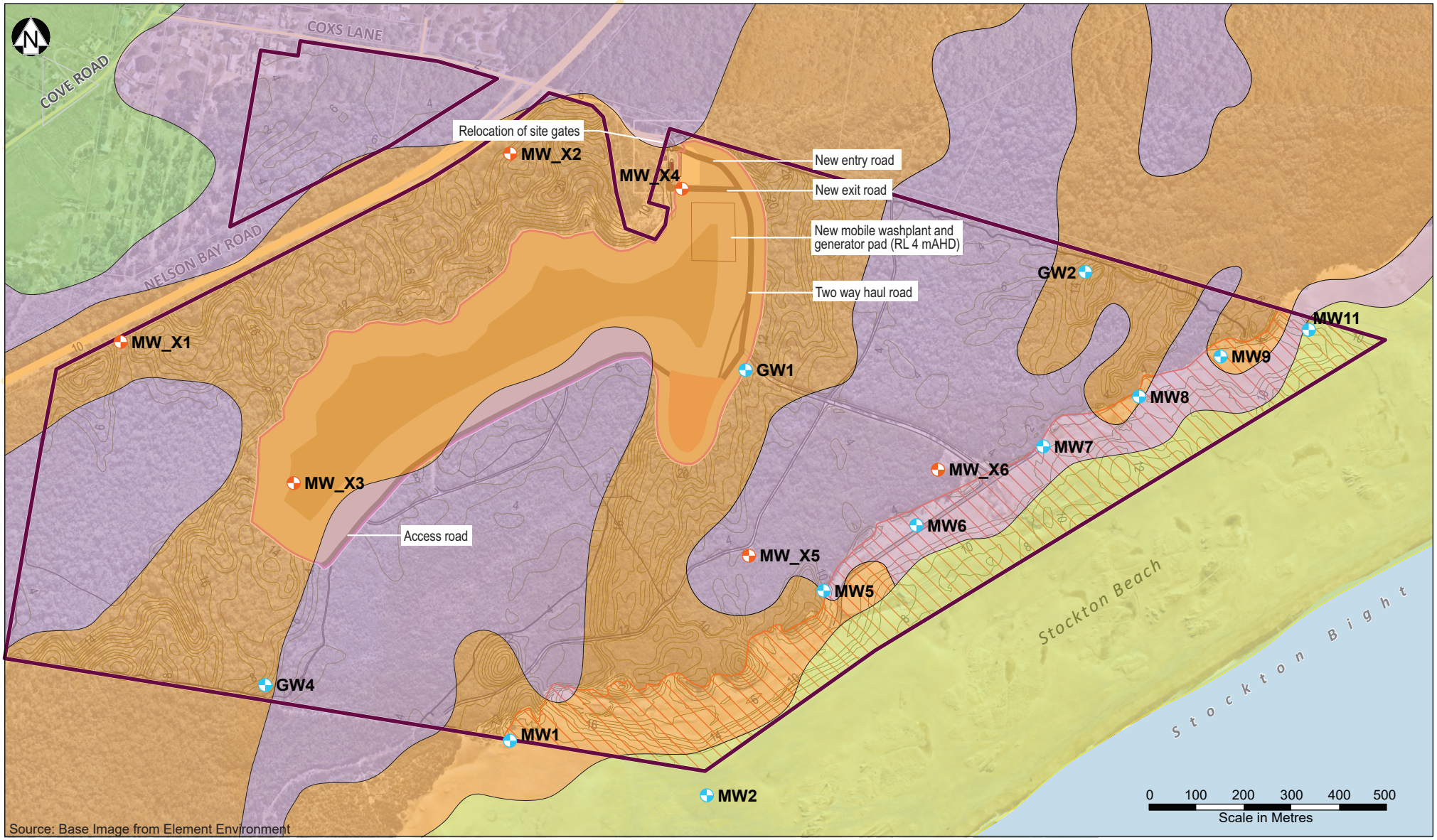
Project Man: **EG**

Scale: **As shown**

Drawn By: **LB**

Date: **November 2018**

Figure 7

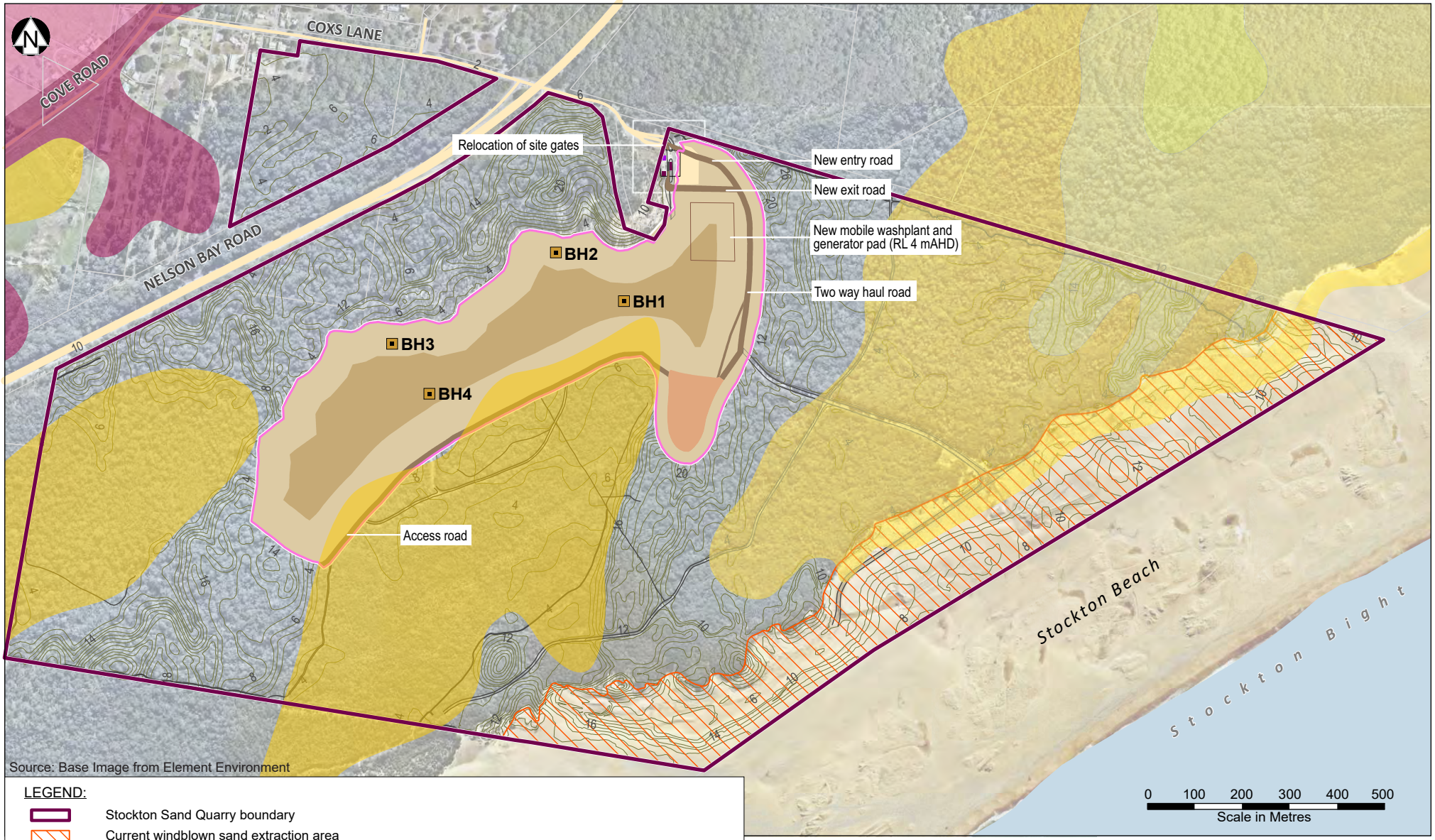


LEGEND:

- Stockton Sand Quarry boundary
- Current windblown sand extraction area
- Contour (mAHD)
- Access tracks
- Additional groundwater monitoring location - installed April 2017
- Current groundwater monitoring location
- Proposed clearance area
- Stockton Beach
- Bobs Farm
- Hawks Nest
- Boyces Track

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Title:	**Local Soil Landscapes**		
Location:	**Nelson Bay Road, Fullerton Cove, NSW**		
Client: **Boral Quarries**		Job No: **717041**	
Project Man: **EG**	Scale: **As shown**	**Figure 8**	
Drawn By: **LB**	Date: **September 2019**		



LEGEND:

- Stockton Sand Quarry boundary
- Current windblown sand extraction area
- Contour (mAHD)
- Access tracks
- Borehole location

PROJECT FEATURES:

- Proposed clearance area
- Access road
- Extraction base (RL -15mAHD)
- Batter
- Pad base (RL 4mAHD)

DEPTH TO ACID SULFATE SOIL MATERIALS:

HIGH PROBABILITY :

- Within 1 metre of the ground surface
- Between 1 and 3 metres below the ground surface

LOW PROBABILITY :

- Between 1 and 3 metres below the ground surface
- Greater than 3 metres below the ground surface

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Title:	**Acid Sulfate Soil Occurrence**
Location:	**Nelson Bay Road, Fullerton Cove, NSW**
Client: **Boral Quarries**	Job No: **717041**
Project Man: **EG**	Scale: **As shown**
Drawn By: **LB**	Date: **September 2019**
	Figure 9

An Acid Sulfate Soils (ASS) Assessment report by Environmental Earth Sciences (2018) corroborated the results of the desktop study, indicating a low probability for ASS at the site with high alkalinity and acid buffering capacity within the boreholes examined. One sample out of 25 tested, reported a moderate risk for potential ASS. Regular monitoring is recommended as part of an ASS Management Plan for a proactive monitoring regime to be employed so that early indications of localised acid generation could trigger appropriate management.

8.4 Hydrology

The site comprises the Stockton sand dunes, with no surface water features present within the Site.

There are no established drainage lines within the site due to the very high rate of infiltration to the sand substrate. Any runoff during high intensity rainfall would typically collect in interdunal swales, where infiltration would be dependent on the antecedent groundwater conditions.

The Pacific Ocean (Tasman Sea) lies directly to the south of the Stockton dunes. Tidally influenced Fullerton Cove and lower Hunter River are situated to the west of the project site and Port Stephens and Tilligerry Creek are tidal water bodies to the north east.

8.5 Hydrogeology

8.5.1 Background

The Stockton Sandbeds and transgressive sand dunes are the main aquifer at the site and comprise the Stockton Groundwater Source of the Water Sharing Plan (WSP) for the North Coast Coastal Sands Groundwater sources. Underlying these are the Tomago Sandbeds of the Tomago Groundwater.

The Stockton Sandbeds Aquifer is a shallow unconfined aquifer which overlies the eastern extremity of the deeper Tomago Sandbeds Aquifer. The sand extraction proposed for the project area is intended to be contained within the Stockton Sandbeds Aquifer.

8.5.2 Groundwater flow system

Groundwater flow is influenced by topography of the Stockton transgressive sand dunes and regional recharge/ discharge zones with water draining either to Fullerton Cove to the northwest of the site or Stockton Beach to the southeast. As a consequence, a northeast-southwest orientated groundwater drainage axis or flow divide exists along the length of the Stockton Sand Member. At the Boral site, the drainage axis is located approximately 1500 m inland from the coast and is centred approximately within the main body of the proposed extraction area.

Regional groundwater flow in the sand units is primarily horizontal with some downward flow due to the relatively high recharge rate. Groundwater is inferred to flow towards the coast to the southeast and to Fullerton Cove to the southwest of the site.

The Tomago Sandbeds Aquifer is situated to the west of the Stockton Sandbeds Aquifer and is separated by Tilligerry Creek and associated drainage network in this low-lying estuarine region. Groundwater from both the Tomago Sandbeds Aquifer and the Stockton Sandbeds Aquifer discharge into this low-lying region, that ultimately directs discharge on to Fullerton Cove (refer to **Figure 1**).

Regional groundwater within the Tomago Sandbeds Aquifer has been historically impacted by PFAS and PFOA associated with the RAAF Base, Williamtown. As a result, a NSW EPA Investigation Area has been nominated in the vicinity of the RAAF Base. The Risk Zone C boundary is drawn along the low-lying drainage area that both the Tomago and Stockton Sandbed Aquifers drain into. The Stockton Sandbeds Aquifer at the site is in a separate groundwater and surface water catchment to RAAF Base Williamtown.

8.5.3 Aquifers and aquitards

The deep marine sands of the Stockton Sandbeds constitute the primary aquifer. Review of borelogs from the site suggest the majority of the site is underlain by medium-grained sand with occasional coarse sands and shell grit. The deepest borelog available for review within the site (MWX6) generally recorded medium grained sand to the end of the bore (27.5 m bgl). The deepest bore investigation within the Project Area (BH2) similarly recorded medium-grained sand to the end of bore (24 m BGL). Refer to **Appendix D** for borelogs.

The sand beds overlie the Medowie Clay Member which is comprised of stiff grey clay or silt and acts as an aquitard for the Stockton and Tomago Sandbeds Aquifers. These clays separate the unconfined sand aquifers above from any fractured bedrock aquifers below.

8.5.4 Saline Interface

Given the coastal nature of the Stockton Sandbeds Aquifer, a saline interface will exist which marks the transition from predominantly fresh groundwater to predominantly saline groundwater.

The position of this interface is often approximated using the Ghyben-Herzberg equation. The equation is based on the density differential between fresh and saline groundwater and makes a number of simplifying assumptions such as the system being in hydraulic equilibrium (no flow), as well as a number of other assumptions, which cannot be met in reality. However, the method provides a useful approximation, and tells us that for every metre of fresh water above mean sea level there will be approximately 40 m of freshwater below it before the interface to saltwater.

In reality, the interface is likely to be a broad zone of dispersion and mixing that will also be dependent on the rate of flow through the aquifer.

In 2013, Geoscience Australia conducted a national review of the vulnerability of different groundwater aquifers to seawater intrusion (Ivkovic et al 2013, after NSW DPI 2016). Coastal sand aquifers were found to be particularly vulnerable to excessive pumping due to the low amounts of groundwater storage relative to rainfall recharge. It was reported that whilst water had migrated southwards to the Tomago, Tomaree and Stockton sand beds from Tilligerry Creek, as a result of an extensive drainage network on the southern banks of the estuary, no increase in salinity was observed at the seaward coastline.

As dewatering will not be performed for the project, the risks of saltwater intrusion are considered to be low (after RPS, 2016).

8.5.5 Results of registered bore search

Full groundwater bore search results are provided in **Appendix B**, whilst a summary of pertinent locations relative to the project site is provided in **Table 9**. Further summary is provided below.

A search of registered groundwater licenses surrounding the site indicates seven boreholes within a 3 km radius of the site that are registered for any purpose other than monitoring. Bores GW079378 and GW079736 are registered for domestic use and are located approximately 1.4 km and 1.5 km to the north and west of the site respectively. Bore GW200423 is located 3 km to the southwest and is registered for use as irrigation. Lithological data indicates a predominantly sand aquifer with minor interbedded clay horizons.

Table 9: Registered groundwater bore details

Bore ID	Distance from Site (km)	Depth (m)	Purpose	Lithology	SWL (m)	Salinity (mg/L)
GW078361	1.8 SSW	34.5	Extractive	Sand	2.0	280.0
GW078360	1.5 SW	35.0	Extractive	Sand 0 – 35	2.0	290.0
GW079736	1.5 W	20.0	Domestic	--	--	--
GW200423	3.0 SW	20.0	Irrigation	Sand 0 – 20 m	--	--
GW079378	1.4 N	--	Domestic	--	--	--
GW062439	1.5 NE	30.0	Extractive	Sand 0 – 30 m Clay 30 – 31 m	2.0	--
GW060459	2.0 NE	34.0	Extractive	Sand 0 – 9 m Clay/Sand 9 – 19 m Sand 19 – 33 m Clay 33 – 34 m	4.0	--

8.5.6 Potentiometric surface

Groundwater levels across the project site are presented in **Figures 4 and 5** which compares groundwater levels following periods of low and high rainfall, respectively.

The hydraulic gradient on the coastal side of the aquifer is estimated to range from approximately 0.2% during dry periods up to 0.36% in wet conditions (Umwelt,1995 after Mackie Martin and Associates, 1992 and Coffey, 1993). Hydraulic gradient for the Fullerton Cove side of the aquifer varies from approximately 0.1% during dry periods to approximately 0.2% during wet conditions (Umwelt, 1995).

Umwelt (1995) identified a secondary drainage pathway from the north eastern corner of the site to the south western corner which has a hydraulic gradient ranging from approximately

0.02 to 0.03%, equating to approximately one tenth of the hydraulic gradient compared to that of the coast in wet and dry conditions. Therefore, predominant groundwater movements at the site is toward either the coastline or Fullerton Cove.

The hydrograph of groundwater levels at the site between 2016 and June 2018 (**Chart 1, Appendix A**) indicates that the aquifer responds rapidly to rainfall. Particularly, that several rainfall events ≥40 mm occurring within a fortnight can raise SWL across all bores by approximately 0.5m.

Conceptual cross sections representing hydrogeological processes across the site are provided in **Figure 10** (north-west to south-east) and **Figure 11** (north-east to south-west). As well as predicted groundwater flow paths, these figures also show the proposed location of the sand extraction area.

Overall, the water-table surface is a subdued form of the topography, which is typical of all local and regional groundwater flow systems. Depths to groundwater are greatest in areas of groundwater recharge and shallowest in areas of groundwater discharge.

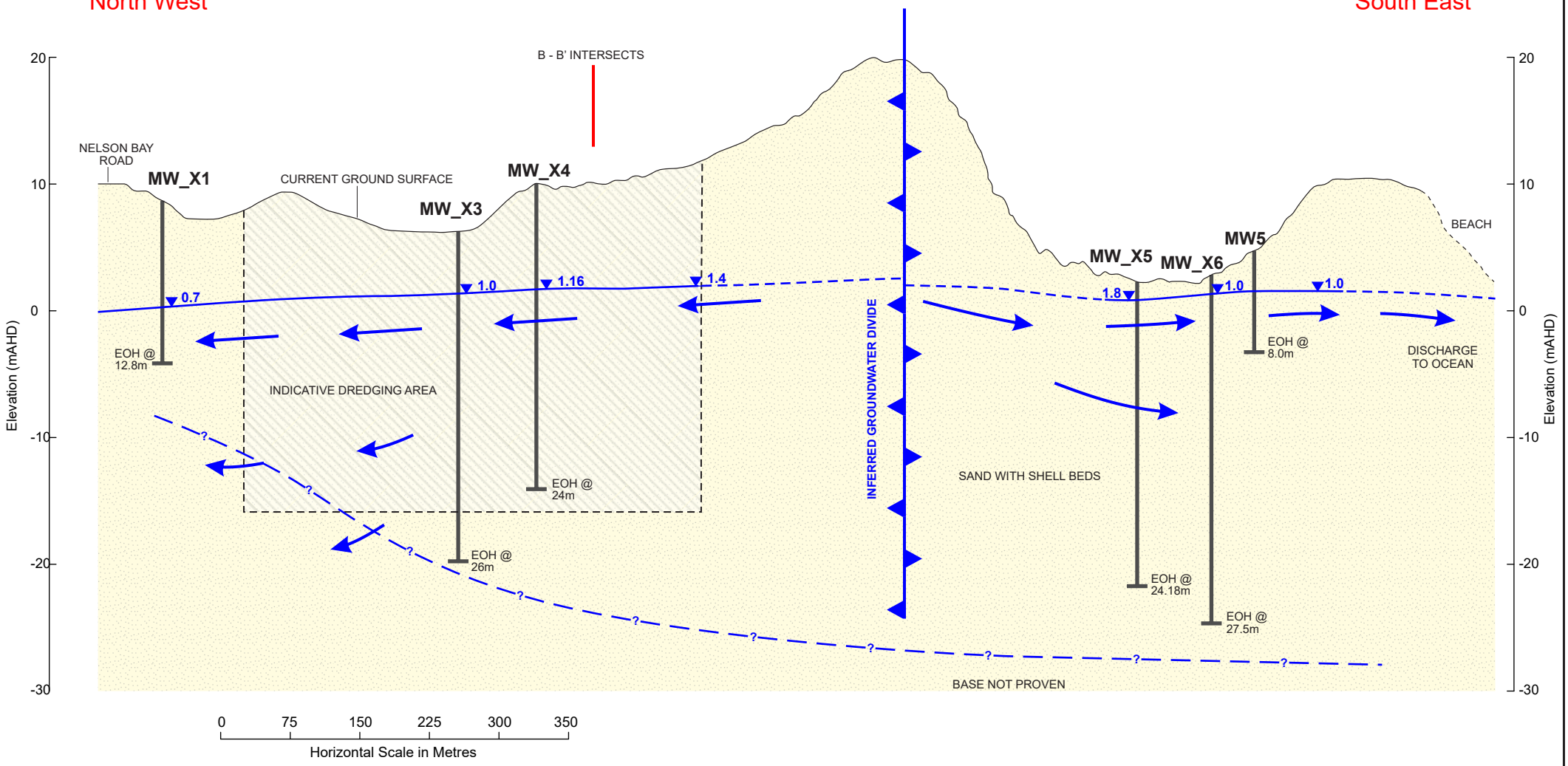
8.6 Estimated recharge rates and water balance

There is a groundwater divide which runs in a northeast to southwest direction to the southeast of the proposed windblown sand extraction area. Groundwater monitoring records identify two primary flow directions for groundwater, either to the north west towards Fullerton Cove, and the Tomago Groundwater Source, or to the south east towards Stockton Beach.

Sand extraction within the project area is conservatively estimated at 750,000 tpa for up to 25 years, with the product expected to contain 3% moisture content. This will result in 15 MLpa of water being 'taken' equating to approximately only 41 m^3/day or 0.5 L/sec. This amount is expected to be less than the natural aquifer recharge onto and discharge off the site towards the Pacific Ocean to the south and Fullerton Cove/ Long Bight Swamp/ Tilligerry Creek to the north (estimated to be around 600 m^3/day).

Crosbie *et al*. (2010b) state that, for the dominant soil type of the catchment (Podosols), recharge would be expected to be in the range of 100-1,000 mm/year, with a line of best fit of 386 mm (337 mm) for an annual rainfall of 1,100 mm on perennial (all) vegetation and Podosol soil types. This equates to 31% of rainfall recharging the aquifer, which is at the lower range of estimates for coastal alluvium provided by Crosbie *et al*. (2010a). The Water Sharing Plan (NSW DPI, 2016) for the area indicates total recharge for the Stockton Groundwater Area as 21,000 ML/yr, with an estimated infiltration rate of 22%.

The dominant recharge to the aquifer is via direct infiltration of rainfall. Recharge from rainfall is estimated at around 30% of total rainfall (taking into account evapotranspiration). However, localised recharge rates in dune environments with predominantly endoheric drainage are likely to be higher.



LEGEND:

- Inferred groundwater flow direction
- SWL March 2018

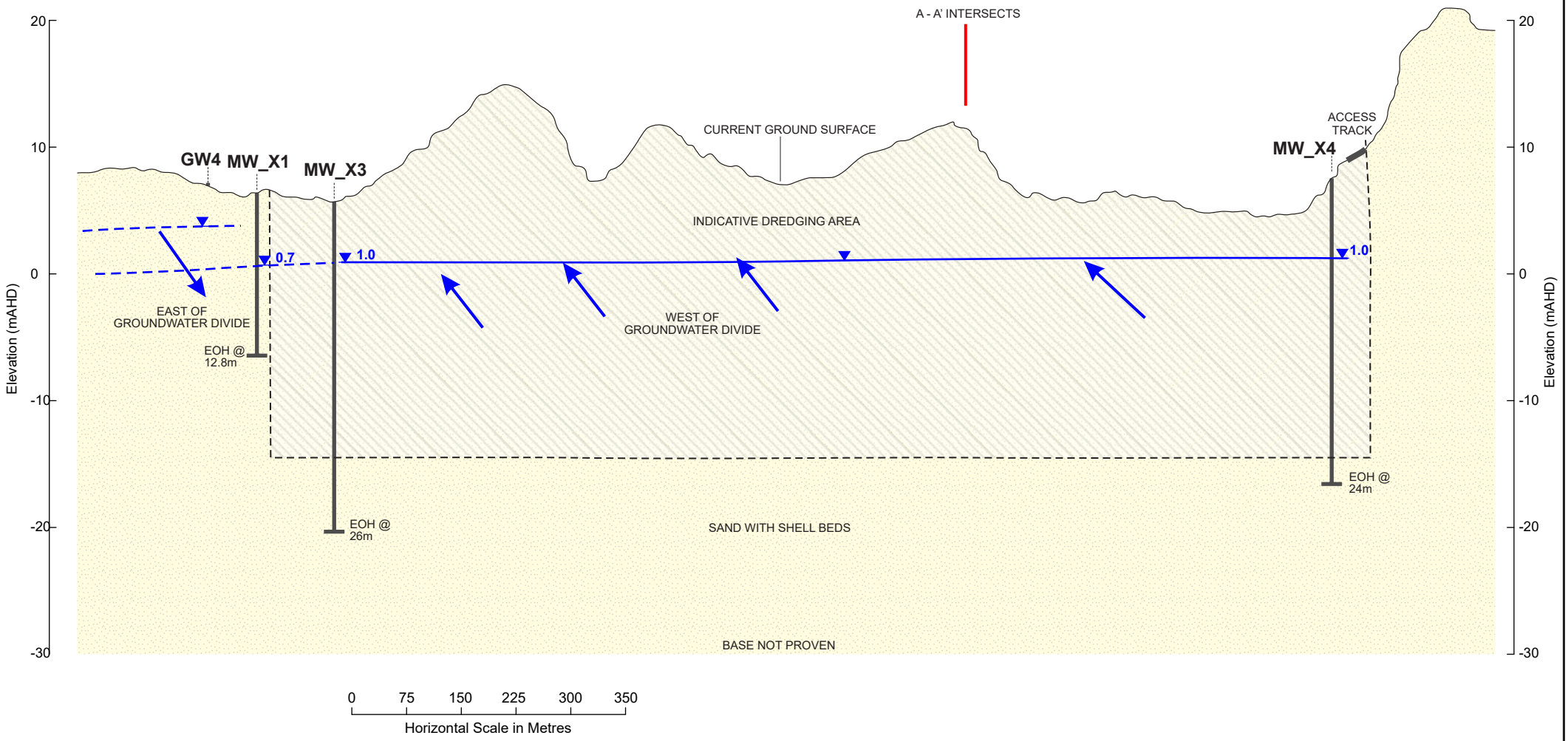
ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Title:	**Conceptual Cross Section A - A'**
Location:	**Nelson Bay Road, Fullerton Cove, NSW**
Client: **Boral Quarries**	Job No: **717041**
Project Man: **EG**	Scale: **Do not scale**
Drawn By: **LB**	Date: **September 2019**

Figure 10

B
South West

B'
North East



LEGEND:
- Inferred groundwater flow direction
- SWL March 2018

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Title:	**Conceptual Cross Section B - B'**
Location:	**Nelson Bay Road, Fullerton Cove, NSW**
Client: **Boral Quarries**	Job No: **717041**
Project Man: **EG**	Scale: **Do not scale**
Drawn By: **LB**	Date: **September 2019**

Figure 11

Total rainfall input to the site is estimated at 1.12 ML/d (407 MLpa). For the project area, recharge for the 37 ha site equates to 0.34 mpa x 370,000 m^2 = 126,170 m^3/y (126 MLpa) or 346 m^3/day or 4.0 L/sec. Evapotranspiration is estimated at 70% of recharge (88 MLpa, 242 m^3/day or 2.8 L/sec).

Under the lake scenario (which is expected to be 23.3 ha), recharge to the 137,000 m^2 non-lake area will be 47 MLpa, 128 m^3/day or 1.5 L/sec, and to the 233,000 m^2 lake will be 256 MLpa, 702 m^3/day or 8.1 L/sec, for a combined lake scenario recharge of 303 MLpa, 830 m^3/day or 9.6 L/sec. Evaporation from the lake is estimated at 1,382 mm, or 322 MLpa (882 m^3/day and 10.2 L/sec), and evapotranspiration from the non-lake area 33 MLpa, 90 m^3/day or 1.1 L/sec.

Discharge will be via through flow to the ocean to the southeast and also inland towards Fullerton Cove (south-west) and its associated drained estuarine flats.

Calculations indicate that the water take with the sand product contributes 4% of total groundwater outflows, which is being 'won' from natural groundwater discharge (outflow) from the site towards either the north or south. As half of this discharge is to the ocean, it is hard to see this as 'take' when it is recharging a marine water body. As the sand extraction proceeds, the above is expected to be altered gradually over time as recharge increases due to direct rainfall onto the dredge pond that is created, off-set by increased direct evaporation from the surface water body. A water balance has been presented in **Table 10**.

Table 10: Site Water Balance

Parameter	**Inflow (Pre-lake)**			**Outflow (Pre-lake)**		
Units	L/sec	m^3/d	ML/a	L/sec	m^3/d	ML/a
Recharge	4.0	346	126			
Groundwater inflow	6.9	600	219			
Evapotranspiration				2.8	242	88
Groundwater outflow				9.7	600	219
TOTAL	10.9	946	345	12.5	842	307
Parameter	**Inflow (Lake)**			**Outflow (Lake)**		
Units	L/sec	m^3/d	ML/a	L/sec	m^3/d	ML/a
Recharge	9.6	830	303			
Groundwater inflow	6.9	600	219			
Evaporation				10.2	882	322
Evapotranspiration				1.1	90	33
Sand Extraction				0.5	41	15
Groundwater outflow				6.9	600	219
TOTAL	16.5	1,430	522	18.7	1,613	589

8.7 Groundwater chemistry

8.7.1 Introduction

As part of this groundwater study, the inorganic chemistry of the unconfined aquifer identified beneath the site was assessed. Ionic balances and dissolved heavy metals including aluminium (Al), nickel (Ni), copper (Cu), lead (Pb), zinc (Zn), cadmium (Cd), chromium (Cr), iron (Fe), arsenic (As), magnesium (Hg) and manganese (Mn) were analysed on collected water samples by Environmental Earth Sciences during the investigation in March 2018 and monthly monitoring of all bores on site by VGT.

Hydrogeochemical characterisation of groundwater to support the development of the CSM, was undertaken using Schoeller plots and Piper diagrams. Schoeller plots express the concentration of ionic constituents in milli-equivalents (meq/L) plotted on logarithmic scale whilst Piper diagrams compare percentages of ionic constituents. Both diagrammatic methods help provide a visual indication of geochemical changes between locations, along flow paths, or to communicate temporal changes in water chemical characteristics.

Results of the field chemical assessment are provided in **Table 7** and **Appendix E** and correlate well with field observations and laboratory results. The chemical laboratory results of this analysis are also illustrated in **Figure 12, 13 and 14**. Full analytical results are in **Appendix F**.

8.7.2 Ionic balance

In brief, the summed total of anions against cations was less than 1% at all locations assessed, with an average difference of 0.2%. It was not possible to calculate the relative percentage difference (RPD) between field and laboratory pH as in most cases, Environmental Earth Sciences were only provided with laboratory data. On average, the relationship between laboratory determined TDS and field measured EC was 0.5 across the site. These results provide confidence in the data set obtained and allow reliance upon the chemical conclusions drawn.

Collection of physical information from the site has been supported by chemical data. Based on the results in **Tables 15 to 18** at the back of this report, the groundwater can be characterised on the basis of beneficial use protection and hydrogeochemical evolution.

Charts 2 – 10 (**Appendix A)** plot the ionic composition of the groundwater for bores GW1 and the MWX series bores on Schoeller diagrams. All bores have a data range of July 2017 – June 2018 for most ions. Data from 2013 – 2015 was also included in the Schoeller diagram for bore GW1 as it was available. These charts show the consistency of groundwater chemistry over time at each sampling location, providing an excellent background water chemistry signature.

From a water quality perspective, the data presented in **Figure 12 to 14** as well as **Table 15** indicate a distinction between the groundwaters within the south-east of the site (east of the groundwater divide) and in the north-west of the site (west of the groundwater divide). This is also evident on **Chart 11**, which shows pH at all bores between July 2017 – June 2018, with a distinction between the more acidic shallow bores to the north-west (bores G1, GW2,

GW4, MWX1, MWX2, MWX3S, MWX4S) and the more alkaline deeper bores and bores to the south-east (bores MWX3D, MWX4D, MWX5, MWX6, MW1, MW2 and MW5-MW11).

A summary of inorganics and metals recorded during the monitoring period July 2017 to June 2018 are illustrated in **Charts 12 to 25** in **Appendix A**.

Figure 12 illustrates the ionic balance in each of the monitoring bores to the west and east of the groundwater divide respectively, based on an average of data from 2017 presented on a Piper Diagram, whilst **Figure 13** illustrates the data recovered in June 2018 presented as a Schoeller Plot.

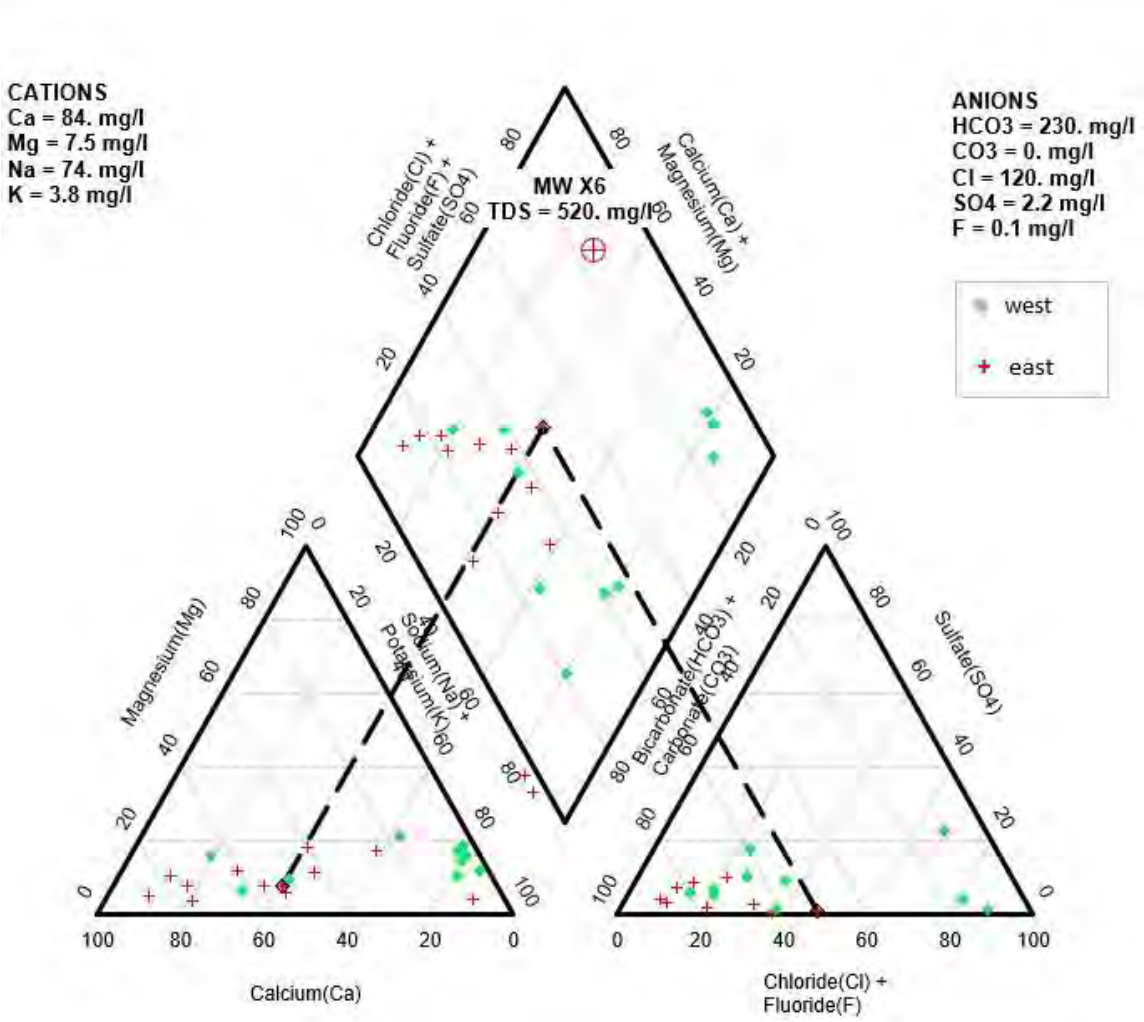


Figure 12: Piper diagram

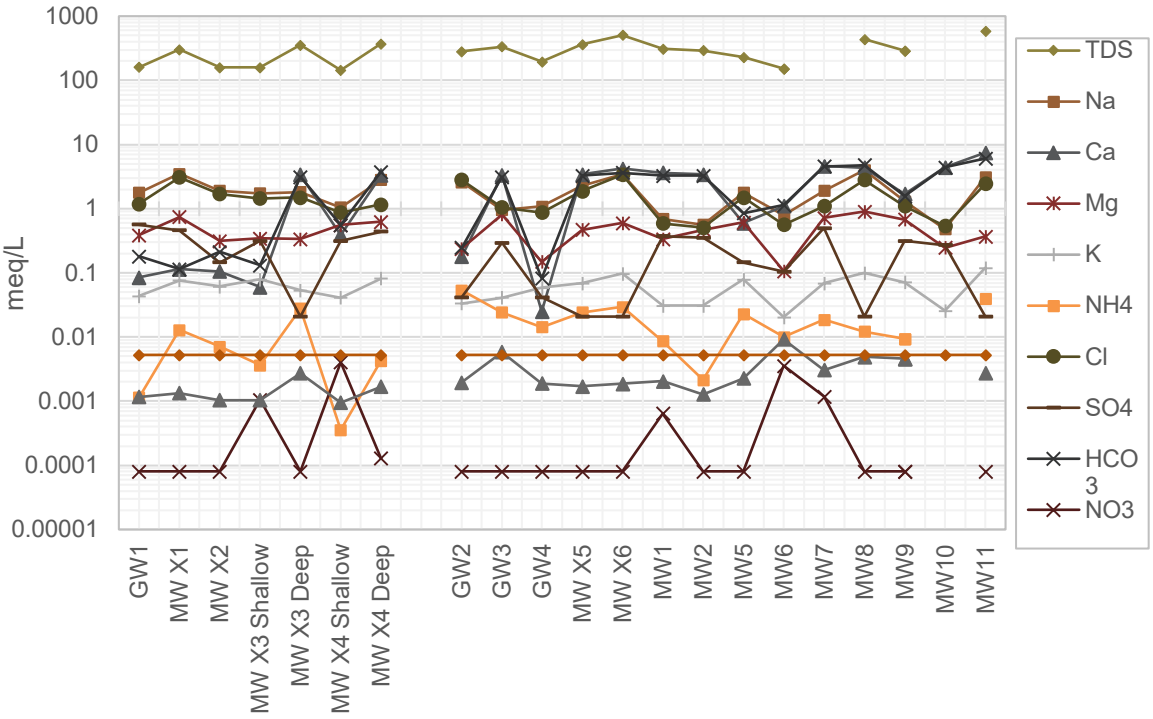


Figure 13: Schoeller Plot – groundwater chemistry, June 2018

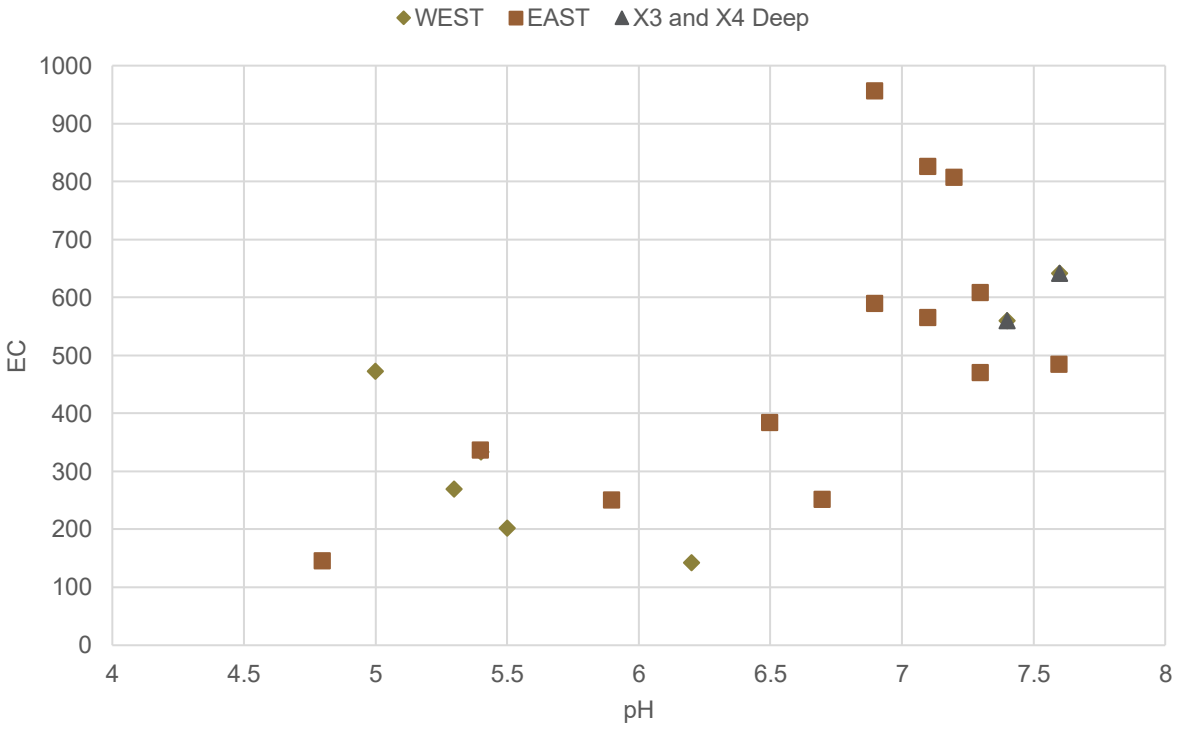


Figure 14: EC-pH summary

West of groundwater divide

To the west of the inferred groundwater flow divide (ID: GW1, GW2, GW4, MWX1, MWX2, MWX3S and MWX4S) the groundwater chemistry is sodium (Na) – chloride (Cl) dominant with the cations magnesium (Mg) and calcium (Ca) and anions sulfate (SO_4) and bicarbonate (HCO_3) sub-dominant. Refer to **Charts 2, 3, 4, 5 and 7** (**Appendix A**) for these individual Schoeller diagrams. These bores are typically more acidic with a pH range between 4.2 and 6.3, ranging between 5.0 and 6.2 during the June 2018 monitoring period. Refer to **Chart 11** for the Groundwater pH (**Appendix A)**.

The deeper of the nested bores (ID: MWX3D and MWX4D) reported groundwater chemistry that was Ca-HCO_3 >Na-Cl dominated. As these bores are screened from 23 – 26 m BGL and 21.5 – 24.5 m BGL respectively, they may potentially be reflective of groundwater chemistry at the deepest level of the Stockton Sandbeds Aquifer, generally assumed to be 20 m thick, or represent a mixing zone with the deeper Tomago Sandbeds Aquifer. Refer to **Charts 6 and 8** in the **Appendix A** for these Schoeller diagrams.

East of groundwater divide

A neutral to slightly alkaline pH range of 6.8 – 7.8 was reported for the deeper bores (MWX3D and MWX4D) and those easts of the groundwater divide. These bores typically reported a more Ca-HCO_3 dominant groundwater chemistry that would influence the pH.

East of the inferred groundwater flow divide (ID: MWX5 and MWX6) the groundwater chemistry was Ca-HCO_3 and Na-Cl dominated, likely reflective of increasingly marine influence. Refer to **Charts 9 and 10** (**Appendix A)** for these Schoeller diagrams.

A relationship exists between pH and salinity (EC) due to the presence of carbonate material (marine shells and other exoskeletons) in the aquifer matrix, resulting in higher pH's to the south-east and deeper in the aquifer, and subsequent higher dissolution rates of bicarbonate ($HCO_{3(aq)}$) rather than venting as $CO_{2(g)}$ in more acidic conditions. The higher HCO_3 results in higher Ca in equilibrium, and slightly higher salinity, as demonstrated on **Figure 13 and 14.**

Summary of hydrochemistry

Based on a review of monthly data, the following observations are surmised:

- Salinity, as EC, typically ranges from 200 to <1,000 µS/cm.
- Salinity between monitoring locations varies significantly, with average salinities ranging from 330 µS/cm at bore MW1 to 805 µS/cm at bore MW11.
- Salinity also varies significantly per location, with bore MW5 showing the greatest range of 796 µS/cm over the past three years (maximum – minimum).
- It is noted that the largest spikes in salinity occur following significant rainfall events and are inferred to be due to recharge flushing relict salt from above the water table.
- pH values are shown to typically range from pH 6.0 to 8.0. A few readings below pH 6 are noted at bores MW5 and MW9, and also bore MW1 in the past. pH values are generally relatively stable. A slight increasing trend over the last three years is noted at bores MW5 and MW9 (moving toward a more neutral pH).

8.7.3 Comparison of data to water quality criteria

In addition to analysis for inorganic chemicals, groundwater collected from the unconfined aquifer in the above-mentioned bores was analysed for a range of 11 heavy metals and PFAS compounds, as summarised in **Tables 17 and 18**. Please refer to **Appendix F** – Laboratory Transcripts for the full results.

The shallow bores to the east of the inferred groundwater flow divide reported acidic pH ranges that exceed the ANZG (2018) guideline values for 95% protection of freshwater aquatic ecosystems. As established in Section 4, acidic soil groups are a feature of the natural environment at the site and the groundwater results reflect this.

All concentrations of TDS across the monitoring network and data range reported TDS below the guidelines.

Arsenic (As) exceeded guidelines for drinking in bore MWX6, however this is considered a natural occurrence and this area is not within a drinking-water zone. Dissolved metals including aluminium, copper, zinc, arsenic and lead exceed guideline values for ecosystem protection (freshwater and marine).

Table 18 shows that all analyses for PFAS compounds at bores MWX1, MWX2, MWX7 and GW4 reported no concentrations above the laboratory LOR from the monitoring period (January – June 2018).

Analysis of two water samples was undertaken on 11 December 2018 by VGT Laboratories Pty Ltd, on behalf of Boral for radium, uranium and thorium. Analysis was undertaken by Envirolab and ALS, both NATA accredited laboratories. Neither sample recorded a positive result above the limit of reporting (LOR).

The groundwater quality results are generally considered to be representative of baseline groundwater quality in the project site and provides a good basis for comparison against results for monitoring throughout the life of the project and into closure.

8.8 Groundwater usage and receptors

8.8.1 Introduction

As the current predominant land use for the site and surrounding down-gradient areas is either industrial or passive recreational use, no extractive use of groundwater is expected. Despite this, the groundwater resource beneath the site is of relatively useful yield and quality (Section 8.5) and is therefore suitable for a number of potential beneficial uses. The search of the BOM registered groundwater bore database discussed in Section 8.5.5 indicates limited stock watering and domestic use in the area (**Appendix B**).

8.8.2 Potential beneficial users

Beneficial reuse of groundwater in NSW is governed by water quality objectives and associated criteria. Potential beneficial uses of an aquifer are directly associated with potential yield (sustainable or otherwise) and quality. All groundwater, regardless of yield or quality, is required to be protective of the natural ecosystem within which it resides and in particular discharges to, including any groundwater dependent ecosystems (GDEs).

In order to determine potential beneficial uses of an aquifer, a water quality and quantity assessment is undertaken, including:

- desk-top assessment of existing users and ecosystems (including GDEs), as well as any information on yield and quality.
- assessment of potential groundwater yields (quantity), including existing information and collection of additional physical data, and
- assessment of groundwater quality based on existing information, collection of field data and chemical analysis of collected groundwater samples.

A summary of each potential beneficial use of the aquifers beneath the site is provided in **Table 11.**

8.8.3 Summary of groundwater usage

Based on **Table 11**, the relevant beneficial users of groundwater (in order of priority and importance) are:

- the freshwater and marine ecosystems of local surface water features and nearby ephemeral creek systems.
- stock watering.
- recreational, direct contact and aesthetic use.
- possible irrigation, and
- project use (dust suppression).

Tables 15 to 18 list the relevant criteria values adopted, which have been derived to ensure water quality is protective of the relevant beneficial uses.

The local groundwater is not considered to have potential beneficial use as drinking water, while use for irrigation is not currently occurring and is considered unlikely.

Table 11: Potential beneficial use assessment

Potential beneficial use	Assessment
Drinking water	• The site is not situated in a catchment that is currently being used as a drinking water aquifer (Hunter Water, 2011). • An assessment of groundwater quality on the basis of TDS and EC, as well as Na, Cl and SO4 in particular has been undertaken, and has confirmed that groundwater is broadly suitable for human consumption, with the exception of arsenic at bore MWx6. However, given the depositional environment, it is considered that this may be a natural occurrence. • Thus, protection of groundwater for drinking supply is not a relevant beneficial use for this project, however as the average TDS is generally <2,000 mg/L drinking water criteria will still be cited in assessment of the data (as required by DEC 2007).
Recreation, direct contact and aesthetics	• Water-based recreational activities undertaken at Fullerton Cove include fishing and potentially water sports. As such, guidelines provided by NHMRC/ NRMMC (2008 and 2011) have been considered. • NHMRC/ NRMMC (2008) state that criteria for recreational/ direct contact quality can be derived from the values presented in NHMRC / NRMMC (2004, which was updated in 2011), by applying a multiplication factor of 10-20 for non-volatile chemicals. The reasoning for this is that the drinking water criteria are calculated based on the assumption that the average person consumes 2 L of water per day, and the rate of assumed incidental ingestion during a daily swimming session is 100-200 mL. • Drinking criteria and the consequent direct contact/ recreational criteria have been included in Tables 15 and 16. Also included in these tables are aesthetic criteria for certain chemicals relevant to the site that have potential odour, discolouration and taste issues (TDS, Na, Cl, NH_3, Mn and Fe).
Irrigation	• For reasons similar to the discussion above for drinking water quality, groundwater in the vicinity of the site is of marginal quality for use as irrigation water. For this reason (in addition to that of the limited area extent of the aquifer), groundwater is not utilised for irrigation in the catchment, based on field observations and discussions, and assessment of water quality data. • Further, iron concentrations in groundwater are also likely to limit potential groundwater use for irrigation (see Table 16). Additionally, analysis of data indicates that the groundwater hardness is on average 150 mg/L as $CaCO_3$. The saturation indices (Langelier and Ryzner) indicates that this water is corrosive.

Potential beneficial use	Assessment
Stock watering	• No groundwater bores within a 2.5 km radius of the site are registered for stock watering purposes (Appendix B). Criteria for stock watering are based on values provided in ANZG (2018), and default to NHMRC/ NRMMC (2011) where specific stock watering criteria are otherwise unavailable.
Discharge to surface water (ecosystem protection)	• The Hunter Wetlands National Park is located in and around Fullerton Cove, ≥2.5 km downgradient of the site. These wetlands support a wide range of aquatic and semi-aquatic flora and fauna in addition to migratory water birds. • Ecosystem protection is a primary beneficial use of the aquifer, as swamps and wetlands down gradient of the project area are receptors for groundwater discharge (see Figures 5 to 7). As such, water quality criteria for protection of 95% of species have been adopted from ANZG (2018).

Groundwater dependent ecosystems (GDE)	• The GDE map provided in Appendix C (after BOM, 2018) shows that the Project Area and vicinity contains a low to moderate potential for terrestrial GDEs, refer to Appendix C.
	• Review of the Stockton Sand Quarry Groundwater Management Plan (Jacobs, 2017) provides the following information pertaining to GDEs at and around the site from their review of previous reports (not sited by Environmental Earth Sciences):
	  • Potential GDEs south east of the Project Area (seaward) include mobile and ephemeral vegetated deflation basins consisting of a variety of reeds, grasses and sedges. This vegetation provides habitat to invertebrates.
	  • Swamp forests, dunes swales and low-lying heath are the primary GDEs north west (inland) of the Project Area. Given the sand extraction depth restrictions and low evaporation in times of high groundwater, the risk of the project operations impacting these GDEs was reported as very low.

Industry	• There are no industrial users of groundwater in the locality. The major reason for this is the relatively isolated location of the site away from the nearest industrial centres. As such, this potential beneficial use requires no further consideration.

9 IMPACT ASSESSMENT

This section presents an assessment of the potential physical and chemical impacts of the project, including consideration of the potential impacts to beneficial uses of the groundwater.

9.1 Assessment methodology

Potential impacts to groundwater beneficial users as a result of the project have been assessed in the context of the local hydrogeological setting, i.e. the CSM, and the relevant legislation and guidelines. The CSM was based on:

- a desktop study of existing information relating to the project and catchment hydrogeology.
- assessment of aquifer physical properties at existing individual locations, and
- assessment of aquifer chemical properties at existing individual locations.

The nature of the groundwater flow system, i.e. a local flow system discharging to the local surface water bodies and creeks, means that all potential impacts of the project are considered to be constrained. The area of potential impacts is constrained to the north and west by Fullerton Cove and associated drainage networks (≤2.5 km). It is constrained to the south and east by the Pacific Ocean (≤1.5 km).

The assessment of impacts is based on the CSM and on knowledge and experience of the authors of flow systems in similar environments and of similar projects. Where appropriate, calculations of groundwater flow velocity, volumetric groundwater flow rate (flux), and travel time are evaluated, based on Darcy's law (Freeze and Cherry, 1979).

Groundwater flow or transport modelling was not justifiable given that dewatering and associated drawdown will not be taking place. Groundwater extraction for use on the project area was not considered as it is understood that this will not be required, in part due to the current practice of sub-contracting dust suppression to an external contractor via water cart, where required.

The different components of the project are described in Section 5.2. The potential impacts associated with the components of the project are described in **Table 12**. Identified potential groundwater impacts are listed in a summary table (**Table 14**) in which the likelihood, consequence and the resulting potential risk associated with each potential impact is considered based on a risk matrix (**Table 13**).

9.2 Description of the proposal

It is understood that the project will encompass the following components:

9.2.1 Site preparation

Prior to commencement of extraction, stage one of the project area would be cleared of vegetation and topsoils stripped and stockpiled for future rehabilitation. All remaining revegetation within the project area would be stripped and stockpiled progressively as the dredge operation progressed.

9.2.2 Site works (excavation)

An estimated total area of 37 ha is expected to be disturbed, with dredging planned to a maximum depth of 15 m below sea level (-15m AHD). It is understood that sand and water pumped from the dredge extraction area will pass over an initial screen processing plant to separate oversize organic matter or debris and into a large wash tank to float out any fines (<75 µm). After washing, the sand will be pumped through a cyclone and stockpiled for further dewatering. Water removed through by the cyclone will be pumped back to the dredge pond. In the event of high turbidity, a silt curtain will be installed to create an in-water fines containment cell. Water pumped from the extraction areas will be returned via the pumping pipeline. Pumped water volumes will be recorded by a flow metre and the same volume of water will be returned to the extraction area to balance water extracted.

9.2.3 Site rehabilitation

Upon completion, it is understood that the area is to be left as a freshwater lake. Rehabilitation will be undertaken in accordance with Stockton Transgressive Dune Quarry Rehabilitation and Landscape Management Plan (Environmental Compliance Services, 2017) and the Environmental Earth Sciences (2019) *Rehabilitation Strategy for Stockton Sand Quarry Dredging, Cox Lane, Fullerton Cove, NSW, Boral Resources (NSW) Pty Ltd* (Ref: 717041_Rehabilitation V1.0, dated 2 September 2019).

There is no dewatering planned during the project operations because the method of sand excavation is via a suction dredge that will operate on the dredge pond that is to be created by the excavation extending below the water-table. Therefore, there is not expected to be any significant drawdown of groundwater levels associated with the project.

Across the site, negligible changes in groundwater levels are expected to occur throughout the life of the project and post-closure. The potential impacts of the project are described separately below in **Table 12** and summarised in **Table 14**.

Table 12: Summary of identified potential impacts

Potential physical impacts to groundwater	
Site preparation	• It is likely that once vegetation is cleared from the project area, recharge of the water table will increase via established high infiltration rates. This will potentially improve the mechanism for water table recharge (i.e. direct infiltration) which, along with reduced evapo-transpiration following vegetation removal, may result in localised water table elevations beneath the project and vicinity. The consequence of such an impact is minor to negligible (Table 12) and may even be beneficial by increasing groundwater flux rates from the project site to Fullerton Cove and low-lying swamps and wetlands north and west of the site.
Excavation	• Whilst the likelihood of any change in water table levels as a result of excavation and consequent alteration of recharge and discharge mechanisms for groundwater at the project area is "possible" (**Table 14**), the consequence is "minor". The actual groundwater inflows and outflows are not expected to alter significantly, primarily as proposed excavation works are not expected to alter the water-table gradient, the K or porosity of the sediments outside the mined area, hence flux will be stable. • Removal of the aquifer matrix by excavation is likely to have very little physical impact on the groundwater resource. This is because the Project area (37 ha to be disturbed) makes up a small proportion (<0.1%) of the overall 39,100-hectare (391 km^2) Stockton Sandbeds catchment. • Total rainfall input to the site is estimated at 1.2 ML/d, with potential evaporative loss estimated at around 50%. For the project area, this equates to approximately 1,125 mmpa which for the 37ha site equates to 0.35mpa x 370,000m^2 = 129,500 m^3/y (129.5 MLpa) or 355 m^3/day or 4.1 L/sec. • Calculations indicate that the water take with the sand product contributes 4% of total groundwater outflows, which is being 'won' from natural groundwater discharge (outflow) from the site towards either the north or south. As half of this discharge is to the ocean, it is hard to see this as 'take' when it is recharging a marine water body. As the sand extraction proceeds, the above is expected to be altered gradually over time as recharge increases due to direct rainfall onto the lake that is created, off-set by increased direct evaporation from the surface water body.
Reinstatement and rehabilitation	• Following completion of sand extraction, the area will remain as a lake. This would be expected to facilitate water table recharge and return to "natural" conditions. There is a "negligible" consequence of physical impact and therefore a "low" risk. • Further to the sand dredging operations taking minimal water from the excavation/ dredge area, combined with the creation of an enhanced groundwater recharge zone in the form of a lake, indicates that the water table will not be lowered in the dredge pond area and that the increased recharge rate will mean movement of groundwater away from the pond (including to the north towards Fullerton Cove, Cabbage Tree Road and the RAAF base).

Potential chemical impact to groundwater	
Site preparation	• Reduced evapo-transpiration following vegetation removal may result in localised water table elevations beneath the Project Area, hence chemical impact as a result of site preparation is expected to be limited to potential increases in fresh water recharge to the aquifer. Any chemical "impact" is therefore likely to be beneficial.
Excavation	• Removal of the aquifer matrix by excavation has the potential to chemically impact on the groundwater resource. The likelihood of any change in water table levels as a result of excavation and consequent alteration of recharge and discharge mechanisms for groundwater at the Project Area is "unlikely" (**Table 12**). As dredging activities will see the majority of the water drain back into the dredge pond, there is low risk from the oxidation of potentially localised instances of PASS (Environmental Earth Sciences, 2018). Returning the water to the dredge pond prevents lowering of the groundwater table. Furthermore, recharge is rapid in the dune lithology, further preventing impacts to the groundwater table in the Project Area and across the site. • The contaminants of potential concern associated with regional groundwater impacts stem from the Williamtown RAAF base, chiefly PFOS/PFOA which are known to have impacted the Tomago Sandbeds aquifer. • As detailed in Section 4.5 above, it can be estimated from water balance calculations that the water table would not be expected to drop significantly. In addition, regional groundwater discharge zone of Tilligerry Creek/ Fourteen Foot Drain means movement of groundwater away from the pond (including to the north towards Fullerton Cove, Cabbage Tree Road and the RAAF base). • Therefore, the risk of chemical impacts to groundwater during excavation/dredging is considered "very unlikely".
Reinstatement and rehabilitation	• The wetland rehabilitation proposed for the area is considered to have a lower level of overall risk as the wetland would be expected to facilitate water table recharge and return to natural conditions. • The creation of an enhanced groundwater recharge zone in the form of a lake, in addition to the regional groundwater discharge zone of Tilligerry Creek/ Fourteen Foot Drain means movement of groundwater away from the pond (including to the north towards Fullerton Cove, Cabbage Tree Road and the RAAF base.

9.3 Comparison of risks

A summary of the primary potential groundwater impacts of the different components of the project, based on the above discussion, has been provided in **Table 12**. The individual impacts are considered separately in terms of their likelihood and consequence; scores are attributed to both likelihood and consequence on a scale from 1 to 5 in each case. The risk is, in turn, scored as the sum of the likelihood and consequence scores. The risk matrix is illustrated in **Table 13.**

Table 13: Risk matrix

		Likelihood				
Consequence		Very unlikely (5)	Unlikely (4)	Possible (3)	Likely (2)	Very Likely (1)
	Negligible (5)	10	9	8	7	6
	Minor (4)	9	8	7	6	5
	Moderate (3)	8	7	6	5	4
	Major (2)	7	6	5	4	3
	Critical (1)	6	5	4	3	2

Note(s):

Likelihood scale has five categories with scores from 5 to 1, i.e. Very Unlikely (5), Unlikely (4), Possible (3), Likely (2), Very Likely (1)

Consequence scale has five categories with scores from 5 to 1, i.e. Negligible (5), Minor (4), Moderate (3), Major (2), Critical (1)

Overall risk value = Consequence value + Likelihood value; consequence and likelihood are considered separately

Red denotes Extreme Risk (scores of 2-3), Orange denotes High Risk (scores of 4-5), Yellow denotes Moderate risk (scores of 6-7), Green denotes low risk (8-10)

9.4 Summary of impacts

As detailed in **Table 14**, all consequences associated with potential physical and chemical impacts are “minor” to “negligible”. This is primarily because the project site makes such a small contribution to the overall catchment water balance, and that there are no sensitive receptors to groundwater discharge down-gradient of the site.

The risk assessment as illustrated in **Table 14** concludes all potential physical and chemical impacts to groundwater are considered Low.

One category was classified initially as moderate as one location was identified with a moderate risk for potential ASS. However, this was a localised occurrence and was considered “no risk-nonreactive” (Environmental Earth Sciences, 2018). ASS issues on the project site will be managed by an acid sulfate soil management plan (ASSMP).

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Table 14: Qualitative impact assessment

Project Component	Aspect of Project Component	Potential Impacts to Groundwater	Likelihood of Impact	Consequence of Impact	Risk rating	Comments
Site Preparation	Vegetation Clearing	Physical Impact to Groundwater	Unlikely (4)	Minor (4)	**Low (8)**	Impacts: increased recharge, run-on, run-off and erosion
		Chemical Impact to Groundwater	Very Unlikely (5)	Moderate (3)	**Low (8)**	No mechanism for impact
		Ensuing Physical Impact to Ecosystems or Groundwater Users	Very Unlikely (5)	Negligible (5)	**Low (10)**	Ecosystem **not** heavily reliant on groundwater
		Ensuing Chemical Impact to Ecosystems or Groundwater Users	Very Unlikely (5)	Moderate (3)	**Low (8)**	No mechanism for impact
Excavation/dredging	Removal of Aquifer matrix	Physical Impact to Groundwater	Unlikely (4)	Minor (4)	**Low (8)**	Lowering of water table
		Chemical Impact to Groundwater	Very Unlikely (5)	Moderate (3)	**Low (8)**	PASS not considered a risk beneath site
		Ensuing Physical Impact to Ecosystems or Groundwater Users	Unlikely (4)	Minor (4)	**Low (8)**	Ecosystem **not** heavily reliant on groundwater
		Ensuing Chemical Impact to Ecosystems or Groundwater Users	Unlikely (4)	Minor (4)	**Low (8)**	No mechanism for impact
		Drawdown of water increasing plume of PFAS from RAAF base	Very Unlikely (5)	Moderate (3)	**Low (8)**	Site is in a separate groundwater and surface water catchment to the identified sources of PFAS in groundwater.

Project Component	Aspect of Project Component	Potential Impacts to Groundwater	Likelihood of Impact	Consequence of Impact	Risk rating	Comments
Rehabilitation (wetland and lake)	Wetland and lake formation	Physical Impact to Groundwater	Very Unlikely (5)	Negligible (5)	**Low (10)**	Risk decreasing over time
		Chemical Impact to Groundwater	Unlikely (4)	Minor (4)	**Low (6)**	Risk decreasing over time
		Ensuing Physical Impact to Ecosystems or Groundwater Users	Unlikely (4)	Negligible (5)	**Low (9)**	Ecosystem **not** heavily reliant on groundwater surface expression
		Ensuing Chemical Impact to Ecosystems or Groundwater Users	Unlikely (4)	Minor (4)	**Low (8)**	Regional groundwater flow to north-west and south-east

10 MANAGEMENT AND MITIGATION

10.1 Summary of soil mitigation and monitoring recommendations

The physical risk to groundwater from the project is very low.

Limited potential chemical risks were identified in an ASS assessment by Environmental Earth Sciences (2018) which reported a moderate risk for PASS in one location. However, high alkalinity and a high buffering capacity was reported throughout the borehole investigations within the Project Area.

Potential chemical risk during the operation of the project are considered to be mitigated by:

- excavation activities within the Project Area, while encountering the water bearing zone on site, are considered unlikely to change the groundwater level as water will be drained back into the dredge pond.
- proposed dredging activities include the sieving of material, so that fines (materials finer than sand) are separated on site and immediately returned below the water table.

Regular monitoring is therefore recommended as part of an ASS Management Plan for a proactive monitoring regime to be employed so that early indications of localised acid generation could trigger appropriate management.

10.2 Summary of groundwater monitoring recommendations

The following recommendations will be formalised in an update to the existing Groundwater Monitoring and Management Plan (GMMP) (Jacobs, 2017) to encompass the proposed extraction area. The GMMP forms a sub-plan to the Water Management Plan (WMP) prepared in accordance with DA 140-6-2005, Condition 3(12).

The GMMP describes the objectives of the groundwater management and monitoring and details the proposed types and locations of monitoring. It also describes the monitoring observations which would trigger actions, and the proposed action and/or mitigation should triggers be exceeded (Jacobs, 2017). The recommended monitoring program is intended to facilitate closure-focussed interpretation of the data.

10.2.1 Monitoring network

It is recommended that those boreholes outside the proposed extraction areas (7 total) form a monitoring network to be periodically sampled. They include bores MWX1, MWX2, MWX5, MWX6, MWX7, GW2, GW4 and MW2. Once extraction progresses below the water table, the dredge pond surface will need to be surveyed so that the relative height of water in the pond over time can be accurately measured.

All bores will need to be surveyed for relative height to Australian Height Datum (AHD) with at least 0.001 m accuracy, so that relative groundwater levels can be compared.

10.2.2 Physical assessment of groundwater and pond levels

Static groundwater levels (SWL) and pond water level will need to be measured monthly during dredging operations, and during rehabilitation works (bores only). Following rehabilitation, all bores will be incorporated into the quarterly groundwater monitoring program for the wider quarrying area.

10.2.3 Chemical assessment of groundwater and surface water

During excavation/dredging works, in additional to SWL and pond water level measurement, all seven bores and the pond will need to be tested for pH, on a monthly basis. It is recommended that pH measurement be performed in the field with a handheld electronic metre that is 2-point calibrated (calibration certificates to be provided).

In addition to the above recommended measurement for pH, all bores will be incorporated into the pre-existing groundwater management plan, which will be updated as a result of the determination.

Groundwater bores will be sampled on a monthly basis for static water levels (SWL) and pH, and tested quarterly for the following analytical suite:

- Field measurement of:
    - pH, electrolytic conductivity (EC), oxidation-reduction potential (ORP), static water levels (SWL), dissolved oxygen (DO) and temperature.
- Laboratory analysis for:
    - full ionic balance suite – pH, TDS, cations (Na, Ca, Mg, K), anions (Cl, SO_4, HCO_3, PO_4, F) and nutrients (NH_3, NO_3 and NO_2), and
    - dissolved metals / metalloids including aluminium (Al), arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), manganese (Mn), mercury (Hg), nickel (Ni) and zinc (Zn).

11 LIMITATIONS

This report has been prepared by Environmental Earth Sciences NSW ABN 109 404 006 in response to and subject to the following limitations:

1. The specific instructions received from client Element Environment;
2. The specific scope of works set out in PO717059 issued by Environmental Earth Sciences for and on behalf of Element Environment;
3. This report and all material contained within it is subject to Australian copyright law and is the property of Boral Limited. Other than in accordance with the *Copyright Act 1968* or the report, no material from the report may, in any form or by any means, be reproduced, distributed, stored in a retrieval system or transmitted, other than with the written consent of Boral Limited or its subsidiaries;

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5. This report comprises the formal report, documentation sections, tables, figures and appendices as referred to in the index to this report and must not be released to any third party or copied in part without all the material included in this report for any reason;

6. The report only relates to the site referred to in the scope of works being located at Stockton Sand Quarry, Fullerton Cove, NSW ("the site");

7. The report relates to the site as at the date of the report as conditions may change thereafter due to natural processes and/or site activities;

8. No warranty or guarantee is made in regard to any other use than as specified in the scope of works and only applies to the depth tested and reported in this report;

9. Fill, soil, groundwater and rock to the depth tested on the site may be fit for the use specified in this report. Unless it is expressly stated in this report, the fill, soil and/or rock may not be suitable for classification as clean fill if deposited off site; and

10. Our General Limitations set out at the back of the body of this report.

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13 GLOSSARY OF TERMS

The following descriptions are of terms used in the text of this report.

Acid Sulfate Soil (ASS). A soil containing iron sulfides deposited during either the Pleistocene or Holocene geological epochs (Quaternary aged) as sea levels rose and fell.

Alluvial. Describes material deposited by, or in transit in, flowing water.

Anaerobic. Reducing or without oxygen.

Aquifer. A rock or sediment in a formation, group of formations, or part of a formation which is saturated and sufficiently permeable to transmit economic quantities of water to wells and springs.

Aquifer, confined. An aquifer that is overlain by a confining bed with significantly lower hydraulic conductivity than the aquifer.

Aquifer, perched. A region in the unsaturated zone where the soil is locally saturated because it overlies soil or rock of low permeability.

Background. The natural level of a property.

Baseline. An initial value of a measure.

Biodegradation. A biochemical process of microbial oxidation of complex organic compounds, to simpler chemical products. Micro-organisms derive the energy and cell carbon for growth from oxidation of organic compounds.

Bore. A hydraulic structure that facilitates the monitoring of groundwater level, collection of groundwater samples, or the extraction (or injection) of groundwater. Also known as a well, monitoring well or piezometer, although piezometers are typically of small diameter and only used for measuring the groundwater elevation or potentiometric surface.

Borehole. An uncased well drill hole.

Cation Exchange Capacity (CEC). The maximum positive charge required to balance the negative charge on colloids (clays and other charged particles). The units are milli-equivalents per 100 grams of material or centimoles of charge per kilogram of exchanger.

Clay. A soil material composed of particles finer than 0.002 mm. When used as a soil texture group such soils contain at least 35% clay.

Colluvial. Unconsolidated soil and rock material moved down-slope by gravity.

Confined Aquifer. An aquifer that is confined between two low-permeability aquitards. The groundwater in these aquifers is usually under hydraulic pressure, i.e. its hydraulic head is above the top of the aquifer.

Confining layer. A layer with low vertical hydraulic conductivity that is stratigraphically adjacent to one or more aquifers. A confining layer is an aquitard. It may lie above or below the aquifer.

Contaminant. Generally, any chemical species introduced into the soil or water. More particularly relates to those species that render soil or water unfit for beneficial use.

Contamination. Is considered to have occurred when the concentration of a specific element or compound is established as being greater than the normally expected (or actually quantified) background concentration.

Diffusion. A process by which species in solution move, driven by concentration gradients (from high to low).

Dilution. The mixing of a small volume of contaminated leachate with a large volume of uncontaminated water. The concentration of contaminants is reduced by the volume of the lower concentrated water. However the physical process of dilution often causes chemical disequilibria resulting in the destruction of ligand bonds, the alteration of solubility products

and the alteration of water pH. This usually causes precipitation by different chemical means of various species.

Discrete sample. Samples collected from different locations and depths that will not be composited but analysed individually.

Dispersion. A process by which species in solution mix with a second solution, thus reducing in concentration. In particular, relates to the reduction in concentration resulting from the movement of flowing groundwater.

Dissolved Oxygen (DO). Oxygen in the gaseous phase dissolved in water. Measured either as a concentration in mg/L or as a percentage of the theoretical saturation point, which is inversely related to temperature. At 19, 20 and 21 degrees Celsius, the oxygen concentrations in mg/L corresponding to 100% saturation are 9.4, 9.2 and 9.0 respectively.

Electrical Conductivity (EC). The EC of water is a measure of its ability to conduct an electric current. This property is related to the ionic content of the sample, which is in turn a function of the total dissolved (ionisable) solids (TDS) concentration. An estimate of TDS in fresh water can be obtained by multiplying EC by 0.65.

Flow path. The direction in which groundwater is moving.

Fluvial. A material deposited by, or in transit, in streams or watercourses.

Fracture. A break in the geological formation, e.g. a shear or a fault.

Gradational. The lower boundary between soil layers (horizons) has a gradual transition to the next layer. The solum (soil horizon) becomes gradually more clayey with depth.

Gradient. The rate of inclination of a slope. The degree of deviation from the horizontal; also refers to pressure.

Groundwater. The water held in the pores in the ground below the water table.

Groundwater Elevation. The elevation of the groundwater surface measured relative to a specified datum such as the Australian Height Datum (mAHD) or an arbitrary survey datum onsite, or “reduced level” (mRL).

Head space. The air space at the top of a soil or water sample.

Heavy Metals. All metallic elements whose atomic mass exceeds that of calcium (20) and includes lead (Pb), copper (Cu), Zinc (Zn), cadmium (Cd), and tin (Sn).

Heterogeneous. A condition of having different characteristics in proximate locations. Non-uniform. (Opposite of homogeneous).

Horizon. An individual soil layer, based on texture and colour, which differs from those above and below.

Hydraulic Conductivity (K). A coefficient describing the rate at which water can move through a permeable medium. It has units of length per time. The units for hydraulic conductivity are typically m3/day/m2 or m/day.

Hydraulic Gradient (i). The rate of change in total head per unit of distance of flow in a given direction – the direction is that which yields a maximum rate of decrease in head. Hydraulic Gradient is unit less.

Hydraulic Head (h). The sum of the elevation head and the pressure head at a point in an aquifer. This is typically reported as an elevation above a fixed datum, such as sea level.

Hydrocarbon. A molecule consisting of carbon and hydrogen atoms only, such as found in petroleum.

Hydrocarbon, volatile. A hydrocarbon with a low boiling point (high vapour pressure). Normally taken to mean those with ten (or less) carbon atoms per molecule.

Infiltration. The passage of water, under the influence of gravity, from the land surface into the subsurface.

Ionic Exchange. Adsorption occurs when a particle with a charge imbalance, neutralises this charge by the attraction (and subsequent adherence of) ions of opposite charge from solution. There are two types of such a charge: pH dependent; and pH independent or crystalline charge. Metal hydroxides and oxy-hydroxides represent examples of the former type, whilst clay minerals are representative of the latter and are normally associated with cation exchange.

Ions. An ion is a charged element or compound as a result of an excess or deficit of electrons. Positively charged ions are called cations, whilst negatively charged ions are called anions. Cations are written with superscript +, whilst anions use - as the superscript. The major aqueous ions are those that dominate total dissolved solids (TDS). These ions include: Cl-, SO42-, HCO3-, Na+, Ca2+, Mg2+, K+, NH4+, NO3-, NO2-, F-, PO43- and the heavy metals.

Lithic. Containing large amounts of fragments derived from previously formed rocks.

Mottled. Masses, blobs or blotches of sub-dominant, varying colours in the soil matrix.

Nodulation. Are hard, usually small, accumulation of precipitated iron and/or manganese in the soil profile, usually a result of past alternating periods of oxidation/reduction.

Nodule. A small, concretionary (hard) deposit, usually of iron and/or manganese.

Organics. Chemical compounds comprising atoms of carbon, hydrogen and others (commonly oxygen, nitrogen, phosphorous, sulfur). Opposite is inorganic, referring to chemical species not containing carbon.

Oxidation. Was originally referred only to the addition of oxygen to elements. However oxidation now encompasses the broader concept of the loss of electrons by electron transfer to other ions.

Perched Groundwater. Unconfined groundwater separated from an underlying main body of groundwater by an unsaturated zone. Perched groundwater typically occurs in discontinuous, often ephemeral, lenses, with unsaturated conditions both above and below.

Permeability (k). Property of porous medium relating to its ability to transmit or conduct liquid (usually water) under the influence of a driving force. Where water is the fluid, this is effectively the hydraulic conductivity. A function of the connectivity of pore spaces.

Piezometric or Potentiometric Surface. A surface that represents the level to which water will rise in cased bores. The water table is the potentiometric surface in an unconfined aquifer.

pH. A logarithmic index for the concentration of hydrogen ions in an aqueous solution, which is used as a measure of acidity.

Polycyclic aromatic Hydrocarbons (PAHs). Complex organic molecules which originate typically in the combustion of organic compounds.

Potential Acid Sulfate Soil (PASS). A soil that has the potential to become acidic if it is exposed to the atmosphere.

Porosity (n). The ratio of the volume of void spaces in a rock or sediment to the total volume of the rock or sediment. Typically given as a percentage.

Porosity, effective (ne). The volume of the void spaces through which water or other fluids can travel in a rock or sediment divided by the total volume of the rock or sediment.

Precipitation (chemical). There are two types of precipitation, pH dependent precipitation and solubility controlled precipitation. As the pH is raised beyond a threshold level the precipitation of metal cations such as oxy-hydroxides and hydroxides occur. As the pH is raised further precipitation continues until there are very few metal cations remaining in solution. This reaction is entirely reversible. Solubility controlled precipitation occurs between two ions when, at a given temperature and pressure, the concentration of one of the ions exceeds a certain level.

Profile. The solum. This includes the soil A and B horizons and is basically the depth of soil to weathered rock.

Purge (wells). The pumping out of well water to remove drilling debris or impurities; also conducted to bring fresh groundwater into the casing for sample collection. The later ensures that a more representative sample of an aquifer is taken.

QA/QC. Quality Assurance / Quality Control.

Recharge Area. Location of the replenishment of an aquifer by a natural process such as addition of water at the ground surface, or by an artificial system such as addition through a well

Recovery. The rate at which a water level in a well rises after pumping ceases.

Redox. REDuction-OXidation state of a chemical or solution.

Redox potential (Eh). The oxidation/reduction potential of the soil or water measured as milli-volt.

Reducing Conditions. Can be simply expressed as the absence of oxygen, though chemically the meaning is more complex. For more details refer to OXIDATION.

Remediation. The restoration of land or groundwater contaminated by pollutants, to a state suitable for other, beneficial uses.

Representative Sample. Assumed not to be significantly different than the population of samples available. In many investigations samples are often collected to represent the worst case situation.

Saturated Zone. A zone in which the rock or soil pores are filled (saturated) with water.

Shale. Fine-grained sedimentary rock formed by the compaction of silt, clay, or sand that accumulates in deltas and on lake and ocean bottoms. It is the most abundant of all sedimentary rocks.

Standing Water Level (SWL). The depth to the groundwater surface in a well or bore measured below a specific reference point – usually recorded as metres below the top of the well casing or below the ground surface.

Stratigraphy. A vertical sequence of geological units.

Subsoil. Subsurface material comprising the B and C horizons of soils with distinct profiles. They often have brighter colours and higher clay content than topsoils.

Texture. The size of particles in the soil. Texture is divided into six groups, depending on the amount of coarse sand, fine sand, silt and clay in the soil.

Topsoil. Part of the soil profile, typically the A1 horizon, containing material which is usually darker, more fertile and better structured than the underlying layers.

Total Dissolved Salts (TDS). The total dissolved salts comprise dissociated compounds and undissociated compounds, but not suspended material, colloids or dissolved gases.

Unsaturated Zone. The zone between the land surface and the water table, in which the rock or soil pores contain both air and water (water in the unsaturated zone is present at less than atmospheric pressure). It includes the root zone, intermediate zone and capillary fringe. Saturated bodies such as perched groundwater may exist in the unsaturated zone. Also referred to as the Vadose Zone.

Volatile. Having a low boiling or subliming pressure (a high vapour pressure).

Water table. Interface between the saturated zone and unsaturated zones. The surface in an aquifer at which pore water pressure is equal to atmospheric pressure.

Well. A hydraulic structure that facilitates the monitoring of groundwater level, collection of groundwater samples, or the extraction (or injection) of groundwater. Also known as a Bore.

ENVIRONMENTAL EARTH SCIENCES
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ENVIRONMENTAL EARTH SCIENCES GENERAL LIMITATIONS

Scope of services
The work presented in this report is Environmental Earth Sciences response to the specific scope of works requested by, planned with and approved by the client. It cannot be relied on by any other third party for any purpose except with our prior written consent. Client may distribute this report to other parties and in doing so warrants that the report is suitable for the purpose it was intended for. However, any party wishing to rely on this report should contact us to determine the suitability of this report for their specific purpose.

Data should not be separated from the report
A report is provided inclusive of all documentation sections, limitations, tables, figures and appendices and should not be provided or copied in part without all supporting documentation for any reason, because misinterpretation may occur.

Subsurface conditions change
Understanding an environmental study will reduce exposure to the risk of the presence of contaminated soil and or groundwater. However, contaminants may be present in areas that were not investigated, or may migrate to other areas. Analysis cannot cover every type of contaminant that could possibly be present. When combined with field observations, field measurements and professional judgement, this approach increases the probability of identifying contaminated soil and or groundwater. Under no circumstances can it be considered that these findings represent the actual condition of the site at all points.

Environmental studies identify actual sub-surface conditions only at those points where samples are taken, when they are taken. Actual conditions between sampling locations differ from those inferred because no professional, no matter how qualified, and no sub-surface exploration program, no matter how comprehensive, can reveal what is hidden below the ground surface. The actual interface between materials may be far more gradual or abrupt than an assessment indicates. Actual conditions in areas not sampled may differ from that predicted. Nothing can be done to prevent the unanticipated. However, steps can be taken to help minimize the impact. For this reason, site owners should retain our services.

Problems with interpretation by others
Advice and interpretation is provided on the basis that subsequent work will be undertaken by Environmental Earth Sciences NSW. This will identify variances, maintain consistency in how data is interpreted, conduct additional tests that may be necessary and recommend solutions to problems encountered on site. Other parties may misinterpret our work and we cannot be responsible for how the information in this report is used. If further data is collected or comes to light we reserve the right to alter their conclusions.

Obtain regulatory approval
The investigation and remediation of contaminated sites is a field in which legislation and interpretation of legislation is changing rapidly. Our interpretation of the investigation findings should not be taken to be that of any other party. When approval from a statutory authority is required for a project, that approval should be directly sought by the client.

Limit of liability
This study has been carried out to a particular scope of works at a specified site and should not be used for any other purpose. This report is provided on the condition that Environmental Earth Sciences NSW disclaims all liability to any person or entity other than the client in respect of anything done or omitted to be done and of the consequence of anything done or omitted to be done by any such person in reliance, whether in whole or in part, on the contents of this report. Furthermore, Environmental Earth Sciences NSW disclaims all liability in respect of anything done or omitted to be done and of the consequence of anything done or omitted to be done by the client, or any such person in reliance, whether in whole or any part of the contents of this report of all matters not stated in the brief outlined in Environmental Earth Sciences NSW's proposal number and according to Environmental Earth Sciences general terms and conditions and special terms and conditions for contaminated sites.

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TABLES

ENVIRONMENTAL EARTH SCIENCES
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Table 15: Summary of Hydrogeochemistry, June 2018

		Ratios				Inorganics												Metals		
		Cl/SO4	Na/Ca	Na/Cl	Cl/HCO3	pH (Lab)	TDS	Sulfate as SO4 - Turbidimetric (Filtered)	Alkalinity (Bicarbonate as CaCO3) (mg/L)	Alkalinity (Carbonate as CaCO3) (mg/L)	Alkalinity (ResAlk) (mg/L)	Anions Total (meq/L)	Cation Total (meq/L)	Chloride (mg/L)	Fluoride (mg/L)	Ionic Balance (%)	Sodium (Filtered) (mg/L)	Calcium (Filtered) (mg/L)	Magnesium (Filtered) (mg/L)	Potassium (Filtered) (mg/L)
LOR						0.01	10	1	1	1	1	0.01	0.01	1	0.1	0.01	1	1	1	1
Location	**Date**																			
WEST																				
GW1	23/04/2018	1.4	30.9	0.9	3.4	5.5	129.0	26.0	11.0	2.8	23.6	3.7	8.6	0.2	0.1	71.0	34.0	1.1	3.5	1.4
MW-X1	24/04/2018	4.6	33.3	0.6	21.7	5.0	297.0	28.0	6.0	6.0	42.8	5.4	9.6	0.1	0.1	63.7	80.0	2.4	9.6	2.9
MW-X2	24/04/2018	8.1	19.6	0.6	8.1	5.4	212.0	11.0	11.0	6.8	20.9	4.2	7.7	0.2	0.1	127.7	53.0	2.7	5.1	2.8
MW-X3 shallow	24/04/2018	3.6	43.0	0.7	9.1	5.3	169.0	18.0	7.0	2.5	20.3	3.9	8.2	0.1	0.1	78.6	43.0	1.0	4.7	3.3
MW-X4 shallow	24/04/2018	2.4	2.3	0.6	1.1	6.2	88.0	10.0	21.0	15.3	47.4	1.5	7.4	0.6	0.1	60.9	14.0	6.1	3.3	1.2
MWX7	28/03/2018	0.67	12.77	2.61	0.27	7.1	1.11	68	170.66	24	205	5.532	6.0	46	0.2	0.041	120	9.4	2.8	2.8
Deep																				
MW-X3 deep	24/04/2018	65.0	0.6	0.6	0.3	7.4	333.0	1.0	190.0	175.0	186.5	1.3	9.7	3.1	0.1	161.4	42.0	70.0	4.1	2.1
MW-X4 deep	24/04/2018	1.8	1.0	1.3	0.2	7.6	377.0	28.0	240.0	167.5	195.9	2.0	12.0	3.8	0.1	193.3	67.0	67.0	8.5	3.3
EAST																				

ENVIRONMENTAL EARTH SCIENCES
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		Ratios				Inorganics												Metals		
GW2	24/04/2018	46.5	15.6	0.6	18.6	5.4	283.0	2.0	5.0	8.5	20.9	5.7	0.0	0.2	0.1	120.1	53.0	3.4	3.9	1.0
GW4	24/04/2018	9.0	50.0	0.7	7.2	4.8	181.0	4.0	5.0	1.3	8.7	3.7	14.0	0.1	0.1	35.5	25.0	0.5	2.0	2.5
MW X5	24/04/2018	8.5	0.8	0.8	0.3	7.3	365.0	8.0	220.0	177.5	195.6	1.6	9.3	3.3	0.1	168.1	55.0	71.0	6.0	2.6
MW X6	24/04/2018	12.0	0.9	0.7	0.5	7.2	491.0	10.0	230.0	212.5	239.6	2.2	8.7	3.6	0.1	190.0	78.0	85.0	7.4	3.6
MW1	23/04/2018	0.8	0.2	0.9	0.1	7.3	293.0	23.0	180.0	192.5	199.0	0.5	5.2	3.3	0.2	188.9	17.0	77.0	4.1	1.6
MW2	23/04/2018	1.0	0.2	0.5	0.1	7.6	263.0	27.0	200.0	195.0	195.6	0.4	4.2	3.3	0.1	169.8	13.0	78.0	6.4	1.3
MW5	23/04/2018	7.5	3.1	0.7	1.1	5.9	175.0	6.0	41.0	25.0	60.4	2.3	10.6	0.9	0.1	118.4	31.0	10.0	5.6	2.4
MW6	23/04/2018	2.4	1.0	0.8	0.5	6.7	179.0	13.0	61.0	62.5	60.2	1.0	5.2	1.1	0.1	80.4	24.0	25.0	1.4	0.9
MW7	23/04/2018	0.6	0.4	1.2	0.1	6.9	385.0	50.0	230.0	212.5	265.3	1.2	8.2	4.6	0.1	264.5	38.0	85.0	11.0	2.6
MW8	23/04/2018	17.1	1.2	0.8	0.5	7.1	538.0	7.0	230.0	202.5	262.3	2.5	10.3	4.8	0.1	274.0	99.0	81.0	7.0	3.6
MW9	23/04/2018	1.9	0.4	0.5	0.3	6.5	261.0	20.0	120.0	127.5	118.6	1.2	11.3	1.6	0.1	129.6	18.0	51.0	6.7	2.1
MW11	6/11/2017	87.0	0.5	0.8	0.2	6.9	587.0	1.0	370.0	375.0	231.9	0.3	0.7	4.4	0.1	10.4	72.0	150.0	4.5	4.7

Notes:
- Not analysed / Not calculated
LOR = Limit of Reporting
Sample Type: Normal = Primary, Field_D = Intra-laboratory Duplicate, Interlab_D = Inter-laboratory Duplicate
ug/l = Micrograms per litre (ppb)
meq/L = miliequivalents per litre
mg/L = miligrams per litre

Table 16 DATA SUMMARY TABLE - INORGANIC CHEMISTRY

Criteria														
			Na	Ca	Mg	K	NH_4	Cl	SO_4	HCO_3	NO_3	PO_4	F	pH	TDS[2]
Drinking water - Health[3]			180*	-	-	-	0.5*	250*	500	-	50	-	1.5	-	600*
Recreation[4]			-	-	-	-	-	-	5000	-	500	-	15	6.5 -8.5	-
Ecological (fresh)[5]			-	-	-	-	0.9[A]	-	-	-	10.6^	-	-	-	-
Ecological (marine)[5]			-	-	-	-	0.91[A]	-	-	-		-	-	-	-
Livestock[4]			-	600	600	-	-	-	1000	-	400	-	2	-	4000
Irrigation[4]			115-460	-	-	-	5	175-700	-	-	20	-	1	6.0 -8.5	1500
		Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	-	mg/L
Sample	Date	Lab ID													
GW1	13/10/2017	4911/1	52	3.00	6.00	2.00	0.049	76	14.0	13.409	0.010	0.0306	<1	5.6	-
GW1	6/11/2017	4999/1	37	2.20	4.10	2.60	0.110	59	14.0	15.847	0.010	0.0153	<1	5.2	165
GW1	6/12/2017	5112/1	30	2.10	4.00	1.30	<0.005	45	16.0	11.000	0.005	0.0050	<1	5.7	125
GW1	29/01/2018	5321/1	39	2.90	5.30	2.00	0.047	51	23.0	8.000	0.010	0.0660	<1	5.3	162
GW1	28/02/2018	5424/1	29	1.70	3.80	1.90	0.042	44	26.0	10.000	<0.005	0.0670	<1	5.4	171
GW1	28/03/2018	5560/1	42	2.00	5.00	1.70	0.031	45	29.0	23.000	0.030	0.0430	<1	5.4	176
GW1	23/04/2018	5711/1	41	1.70	4.70	1.70	0.016	42	27.0	11.000	<0.005	0.0380	<1	5.5	161
GW1	21/05/2018	5858/1	35	1.70	3.80	1.90	0.042	44	26.0	11.000	<0.005	0.0370	<1	5.5	154
GW1	20/06/2018	6009/1	34	1.10	3.50	1.40	0.038	37	26.0	11.000	<0.005	0.0580	<1	5.5	129
MW X1	17/07/2017	4569/1	65	2.00	8.00	4.00	-	-	-	-	-	-	-	-	232
MW X1	11/10/2017	4910/4	76	2.00	10.00	4.00	0.270	120	21.0	7.320	<0.005	0.1530	<1	-	-
MW X1	7/11/2017	7998/4	73	2.10	9.40	3.90	0.270	130	26.0	6.100	<0.005	0.0153	<1	5.2	339
MW X1	7/12/2017	5113/4	90	2.80	15.00	4.50	0.260	160	25.0	6.000	<0.005	0.0050	<1	4.9	391
MW X1	30/01/2018	5322/4	89	2.80	12.00	3.70	0.190	130	25.0	5.000	<0.005	0.0850	<1	4.8	315
MW X1	1/03/2018	5425/4	62	2.90	9.80	3.90	0.270	120	25.0	10.000	<0.005	0.0540	<1	5.1	297
MW X1	29/03/2018	5561/4	75	2.40	9.00	3.50	0.270	110	22.0	19.000	<0.005	0.0450	<1	5.1	297
MW X1	24/04/2018	5715/4	81	2.30	9.00	3.00	0.180	110	22.0	7.000	<0.005	0.0440	<1	4.8	303
MW X1	22/05/2018	5859/4	82	2.20	8.80	2.80	0.150	120	24.0	6.000	<0.005	0.0410	<1	4.9	309
MW X1	21/06/2018	6010/4	80	2.40	9.60	2.90	0.170	130	28.0	6.000	<0.005	0.0550	<1	5	297
MW X2	17/07/2017	4569/2	53	5.00	5.00	3.00	-	-	-	-	-	-	-	-	178
MW X2	11/10/2017	4910/5	52	4.00	6.00	3.00	0.110	92	4.0	14.640	<0.005	0.0306	<1	-	-
MW X2	7/11/2017	4998/5	53	3.40	5.10	2.80	0.110	93	7.0	13.420	<0.005	0.0153	<1	5.3	351
MW X2	7/12/2017	5113/5	54	3.30	5.50	3.00	0.100	91	7.0	12.000	0.009	0.0050	<1	5.4	225
MW X2	30/01/2018	5322/5	54	3.00	5.40	3.10	0.110	85	6.0	11.000	<0.005	0.0630	<1	5.3	171
MW X2	1/03/2018	5425/5	39	2.70	4.40	2.80	0.110	73	7.0	16.000	<0.005	0.0420	<1	5.5	158
MW X2	29/03/2018	5561/5	46	2.30	4.10	2.40	0.110	66	7.0	25.000	<0.005	0.0430	<1	5.4	166
MW X2	24/04/2018	5715/5	44	2.10	3.80	2.40	0.099	60	7.0	13.000	<0.005	0.0340	<1	5.3	158
MW X2	22/05/2018	5859/5	46	2.00	3.80	2.40	0.100	64	9.0	13.000	<0.005	0.0330	<1	5.4	184
MW X2	21/06/2018	6010/5	53	2.70	5.10	2.80	0.110	89	11.0	11.000	<0.005	0.0440	<1	5.4	212
MW X3 Shallow	17/07/2017	4569/3	39	1.00	3.00	3.00	-	-	-	-	-	-	-	-	114
MW X3 Shallow	11/10/2017	4910/6	36	2.00	3.00	2.00	0.034	45	18.0	19.520	0.062	0.1836	<1	-	-
MW X3 Shallow	7/11/2017	4998/6	34	1.10	4.00	2.70	0.035	51	17.0	12.200	0.020	0.0153	<1	5.3	152
MW X3 Shallow	7/12/2017	5113/6	34	2.20	4.70	2.90	0.015	47	19.0	14.000	0.075	0.0050	<1	5.6	147
MW X3 Shallow	30/01/2018	5322/6	38	1.30	4.70	3.10	0.038	52	18.0	7.000	0.010	0.0590	<1	5.2	134
MW X3 Shallow	1/03/2018	5425/6	31	1.30	4.40	3.10	0.073	54	15.0	12.000	0.005	0.0390	<1	5.3	182
MW X3 Shallow	13/03/18	-	38	3.00	4.50	4.40	<0.1	58	19.0	9.000	<0.1	<0.1	<1	5.6	135
MW X3 Shallow	29/03/2018	5561/6	41	1.70	4.40	2.90	0.053	52	17.0	21.000	0.040	0.0370	<1	5.3	148
MW X3 Shallow	24/04/2018	5715/6	40	1.20	4.20	3.10	0.051	51	15.0	8.000	0.065	0.0340	<1	5.3	158
MW X3 Shallow	22/05/2018	5859/6	44	1.20	4.10	3.20	0.050	55	20.0	8.000	0.130	0.0270	<1	5.4	139
MW X3 Shallow	21/06/2018	6010/6	43	1.00	4.70	3.30	0.080	64	18.0	7.000	0.040	0.0420	<1	5.3	169
MW X3 Deep	17/07/2017	4569/4	41	70.00	4.00	2.00	-	-	-	-	-	-	-	-	350
MW X3 Deep	11/10/2017	4910/7	39	74.00	5.00	2.00	0.400	61	<1	231.800	<0.005	0.1530	<1	-	-
MW X3 Deep	7/11/2017	4998/7	38	66.00	3.90	2.10	0.130	40	14.0	183.000	0.120	0.0580	<1	7.1	306
MW X3 Deep	7/12/2017	5113/7	38	72.00	4.40	2.20	0.340	57	1.0	190.000	<0.005	0.0500	<1	7.7	341
MW X3 Deep	30/01/2018	5322/7	41	74.00	4.60	2.40	0.370	59	<1	200.000	<0.005	0.1700	<1	7.4	323
MW X3 Deep	1/03/2018	5425/7	33	73.00	4.30	2.30	0.330	55	5.0	190.000	0.030	0.0820	<1	7.3	341
MW X3 Deep	13/03/18	-	26	75.00	4.70	3.70	0.400	60	2.0	215.000	<0.1	<0.1	<1	6.9	285
MW X3 Deep	29/03/2018	5561/7	41	68.00	4.10	2.10	0.380	54	2.0	200.000	<0.005	0.0850	<1	7.5	331
MW X3 Deep	24/04/2018	5715/7	42	68.00	4.10	2.10	0.390	53	1.0	190.000	<0.005	0.0890	<1	7.6	355
MW X3 Deep	22/05/2018	5859/7	42	64.00	3.90	2.10	0.370	57	<1	180.000	<0.005	0.0890	<1	7.6	344
MW X3 Deep	21/06/2018	6010/7	42	70.00	4.10	2.10	0.380	65	<1	190.000	<0.005	0.0960	<1	7.4	333
MW X4 Shallow	17/07/2017	4569/5	19	3.00	3.00	2.00	-	-	-	-	-	-	-	-	93
MW X4 Shallow	11/10/2017	4910/8	17	3.00	2.00	2.00	0.083	24	13.0	61.000	<0.005	0.3366	<1	-	-
MW X4 Shallow	7/11/2017	4998/8	14	3.10	2.00	1.20	<0.005	28	7.0	13.420	0.057	0.0306	<1	5.4	87
MW X4 Shallow	7/12/2017	5113/8	18	6.40	3.50	1.60	<0.005	28	10.0	21.000	0.110	0.0090	<1	6.2	113
MW X4 Shallow	30/01/2018	5322/8	19	2.10	3.10	1.70	0.005	33	8.0	7.000	0.075	0.0560	<1	5.7	84
MW X4 Shallow	1/03/2018	5425/8	17	1.80	3.00	1.50	<0.005	30	8.0	11.000	0.059	0.0320	<1	5.6	73
MW X4 Shallow	29/03/2018	5561/8	14	1.40	2.60	1.20	0.008	22	6.0	21.000	0.099	0.0350	<1	5.8	66
MW X4 Shallow	24/04/2018	5715/8	24	7.80	6.80	1.60	0.005	31	15.0	34.000	0.250	0.0310	<1	6.3	144
MW X4 Shallow	22/05/2018	5859/8	23	9.80	4.90	1.80	<0.005	30	15.0	37.000	0.230	0.0290	<1	6.3	141
MW X4 Shallow	21/06/2018	6010/8	14	6.10	3.30	1.20	0.025	24	10.0	21.000	0.200	0.0400	<1	6.2	88
MW X4 Deep	17/07/2017	4569/6	66	67.00	8.00	3.00	-	-	-	-	-	-	-	-	388
MW X4 Deep	11/10/2017	4910/9	61	72.00	8.00	3.00	0.049	45	28.0	292.800	<0.005	0.0612	<1	-	-

Criteria														
			Na	Ca	Mg	K	NH_4	Cl	SO_4	HCO_3	NO_3	PO_4	F	pH	TDS[2]
Drinking water - Health[3]			180*	-	-	-	0.5*	250*	500	-	50	-	1.5	-	600*
Recreation[4]			-	-	-	-	-	-	5000	-	500	-	15	6.5 -8.5	-
Ecological (fresh)[5]			-	-	-	-	0.9[A]	-	-	-	10.6^	-	-	-	-
Ecological (marine)[5]			-	-	-	-	0.91[A]	-	-	-		-	-	-	-
Livestock[4]			-	600	600	-	-	-	1000	-	400	-	2	-	4000
Irrigation[4]			115-460	-	-	-	5	175-700	-	-	20	-	1	6.0 -8.5	1500
		Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	-	mg/L
Sample	Date	Lab ID													
MW X4 Deep	7/11/2017	4998/9	64	68.00	7.30	3.30	0.063	46	28.0	293.000	<0.005	0.0796	<1	7	356
MW X4 Deep	7/12/2017	5113/9	62	72.00	8.00	3.40	0.055	44	26.0	250.000	<0.005	0.0220	<1	7.7	391
MW X4 Deep	30/01/2018	5322/9	68	74.00	8.50	3.60	0.059	45	26.0	250.000	<0.005	0.0980	<1	7.6	364
MW X4 Deep	1/03/2018	5425/9	52	70.00	8.10	3.30	0.063	45	24.0	250.000	<0.005	0.0780	<1	7.7	375
MW X4 Deep	29/03/2018	5561/9	65	65.00	8.10	3.30	0.087	43	22.0	250.000	<0.005	0.0670	<1	7.8	375
MW X4 Deep	24/04/2018	5715/9	65	66.00	7.60	3.20	0.060	41	21.0	230.000	0.008	0.0550	<1	7.7	370
MW X4 Deep	22/05/2018	5859/9	67	63.00	7.50	3.20	0.069	45	23.0	240.000	<0.005	0.0500	<1	7.7	392
MW X4 Deep	21/06/2018	6010/9	67	67.00	8.50	3.30	0.096	51	28.0	240.000	<0.005	0.0570	<1	7.6	377
MW X5	17/07/2017	4569/7	52	69.00	6.00	3.00	-	-	-	-	-	-	-	-	341
MW X5	11/10/2017	4910/10	47	72.00	6.00	3.00	0.340	79	<1	231.800	<0.005	0.1224	<1	-	-
MW X5	7/11/2017	4998/10	49	69.00	5.30	2.70	0.360	78	<1	231.800	<0.005	0.0029	<1	7.4	351
MW X5	7/12/2017	5113/10	48	71.00	5.80	2.70	0.320	72	<1	200.000	<0.005	0.0080	<1	7.7	348
MW X5	30/01/2018	5322/10	52	73.00	6.10	3.00	0.320	76	<1	200.000	<0.005	0.0780	<1	7.5	362
MW X5	1/03/2018	5425/10	40	71.00	5.80	2.70	0.330	75	<1	200.000	<0.005	0.0620	<1	7.7	373
MW X5	29/03/2018	5561/10	51	68.00	5.60	2.50	0.330	70	<1	210.000	<0.005	0.0820	<1	7.7	375
MW X5	24/04/2018	5715/10	52	69.00	5.70	2.70	0.340	67	<1	200.000	<0.005	0.0560	<1	7.7	364
MW X5	22/05/2018	5859/10	52	64.00	5.50	2.70	0.310	71	<1	200.000	<0.005	0.0750	<1	7.6	368
MW X5	21/06/2018	6010/10	55	71.00	6.00	2.60	0.300	68	8.0	220.000	<0.005	0.0480	<1	7.3	365
MW X6	17/07/2017	4569/8	77	84.00	7.00	4.00	-	-	-	-	-	-	-	-	467
MW X6	11/10/2017	4910/11	69	89.00	8.00	4.00	0.420	130	<1	244.000	<0.005	0.1224	<1	-	-
MW X6	7/11/2017	4998/11	71	80.00	6.90	3.50	0.420	130	<1	266.200	0.005	0.0796	<1	7.1	483
MW X6	7/12/2017	5113/11	74	85.00	8.00	4.00	0.440	120	<1	210.000	<0.005	0.0050	<1	7.5	490
MW X6	30/01/2018	5322/11	82	90.00	8.30	4.30	0.410	130	<1	220.000	<0.005	0.0800	<1	7.5	497
MW X6	1/03/2018	5425/11	58	85.00	7.40	3.70	0.390	120	<1	220.000	<0.005	0.0680	<1	7.5	463
MW X6	29/03/2018	5561/11	77	84.00	7.50	3.70	0.410	120	<1	230.000	<0.005	0.0600	<1	7.5	524
MW X6	24/04/2018	5715/11	79	84.00	7.30	3.80	0.410	120	<1	220.000	<0.005	0.0610	<1	7.5	505
MW X6	22/05/2018	5859/11	78	78.00	7.20	3.70	0.390	120	3.0	210.000	<0.005	0.0510	<1	7.5	496
MW X6	21/06/2018	6010/11	78	85.00	7.40	3.60	0.370	120	10.0	230.000	<0.005	0.0650	<1	7.2	491

Note(s): 1. all table entries in mg/L other than pH (field measurement)

2. TDS total dissolved salts; Na sodium; Ca calcium; Mg magnesium; K potassium; NH_4 ammonium; Cl chloride; SO_4 sulfate; HCO_3 bicarbonate (alkalinity); NO_3 nitrate; PO_4 phosphate; F , fluoride.

3. Health – Australian Drinking Water Guidelines (ADWG, 2011)

4. Recreational and primary industries water quality - ANZECC (2000)

5. 95% species protection – ANZECC / ARMCANZ (2000)

Table 17 DATA SUMMARY TABLE - DISSOLVED METALS IN GROUNDWATER

Criteria			Al	As	B	Cd	Cr	Cu	Fe	Mn	Ni	Pb	Se	Zn	Hg
Drinking water - Health[2]			-	0.01	4	0.002	0.05	2	-	0.5	0.02	0.01	0.01	-	3
Recreation[3]			0.2	0.05	1	0.005		1	0.3	0.1	0.1	0.05		5	0.001
Ecological (fresh)[4]			0.055	0.024	0.37	0.0002	0.001	0.0055	-	1.9	0.011	0.0034	0.011	0.031	0.0006
Ecological (marine)[4]			-	-	-	0.0055	0.0044	0.0013	-	-	0.07	0.0044	-	0.015	0.0004
Livestock[3]			5	0.5	5	0.01	1	0.4	-	-	1	0.1	0.02	20	0.002
Irrigation[3]				0.1	0.5		0.1	0.2	0.2	0.2	0.2	2		2	
		Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Sample	Date	Lab ID													
GW1	13/10/2017	4911/1	0.07	0.003	0.1	<0.001	<0.001	<0.001	0.34	0.001	<0.001	<0.001	<0.001	0.021	<0.00005
GW1	21/11/2017	4999/1	0.07	0.002	0.07	<0.001	<0.001	<0.001	0.03	0.005	<0.001	<0.001	<0.001	0.019	<0.00005
GW1	6/12/2017	5112/1	0.1	0.003	0.03	<0.001	<0.001	<0.001	0.37	0.005	<0.001	<0.001	<0.001	0.005	<0.00005
GW1	29/01/2018	5321/1	0.11	0.005	0.1	<0.001	<0.001	<0.001	0.51	0.005	0.001	<0.001	<0.001	0.035	<0.00005
GW1	28/02/2018	5424/1	0.16	0.006	0.09	<0.001	<0.001	<0.001	0.41	0.005	<0.001	0.002	<0.001	0.029	<0.00005
GW1	28/03/2018	5560/1	0.12	0.005	0.2	<0.001	<0.001	<0.001	0.53	0.008	<0.001	<0.001	<0.001	0.047	<0.00005
GW1	23/04/2018	5711/1	0.1	0.005	0.1	<0.001	<0.001	<0.001	0.45	0.005	0.001	<0.001	<0.001	0.025	<0.00005
GW1	21/05/2018	5858/1	0.12	0.004	0.1	<0.001	<0.001	<0.001	0.4	0.005	0.001	<0.001	<0.001	0.035	<0.00005
GW1	20/06/2018	6009/1	0.23	0.006	0.1	<0.001	<0.001	<0.001	0.29	0.005	<0.001	<0.001	<0.001	0.036	<0.00005
MW_X1	17/07/2017	4569/1	0.71	<0.001	0.03	<0.001	<0.001	<0.001	0.18	-	<0.001	<0.001	<0.001	0.005	<0.00005
MW_X1	13/10/2017	4910/4	0.73	<0.001	0.03	<0.001	<0.001	<0.001	1.1	0.018	0.003	<0.001	<0.001	0.006	<0.00005
MW_X1	7/11/2017	7998/4	0.67	<0.001	0.06	<0.001	<0.001	<0.001	1.2	0.021	<0.001	<0.001	<0.001	0.013	<0.00005
MW X1	7/12/2017	5113/4	0.86	<0.001	0.04	<0.001	<0.001	<0.001	1.7	0.022	<0.001	<0.001	<0.001	0.012	<0.00005
MW X1	30/01/2018	5322/4	0.84	<0.001	0.04	<0.001	<0.001	<0.001	1.2	0.016	<0.001	<0.001	<0.001	0.021	<0.00005
MW X1	1/03/2018	5425/4	0.72	<0.001	0.07	<0.001	<0.001	0.002	1.2	0.034	<0.001	<0.001	<0.001	0.025	<0.00005
MW X1	29/03/2018	5561/4	0.7	<0.001	0.1	<0.001	<0.001	<0.001	1.3	0.029	<0.001	<0.001	<0.001	0.021	<0.00005
MW X1	24/04/2018	5715/4	0.76	<0.001	0.09	<0.001	<0.001	<0.001	1.1	0.017	<0.001	<0.001	<0.001	0.01	<0.00005
MW X1	22/05/2018	5859/4	0.71	<0.001	0.08	<0.001	<0.001	<0.001	0.91	0.012	<0.001	<0.001	<0.001	0.016	<0.00005
MW X1	21/06/2018	6010/4	0.6	<0.001	0.09	<0.001	<0.001	<0.001	1	0.02	<0.001	<0.001	<0.001	0.017	<0.00005
MW_X2	17/07/2017	4569/2	0.07	0.006	0.03	<0.001	<0.001	<0.001	0.57	-	<0.001	<0.001	<0.001	0.006	<0.00005
MW_X2	13/10/2017	4910/5	0.09	<0.001	0.03	<0.001	<0.001	<0.001	0.44	0.02	<0.001	<0.001	<0.001	0.004	<0.00005
MW_X2	7/11/2017	4998/5	0.08	<0.001	0.06	<0.001	<0.001	<0.001	0.47	0.021	0.002	<0.001	<0.001	0.018	<0.00005
MW X2	7/12/2017	5113/5	0.09	<0.001	0.03	<0.001	<0.001	<0.001	0.51	0.017	0.002	<0.001	<0.001	0.008	<0.00005
MW X2	30/01/2018	5322/5	0.08	<0.001	0.03	<0.001	<0.001	0.001	0.43	0.014	<0.001	<0.001	<0.001	0.017	<0.00005
MW X2	1/03/2018	5425/5	0.08	<0.001	0.08	<0.001	<0.001	<0.001	0.52	0.019	<0.001	<0.001	<0.001	0.037	<0.00005
MW X2	29/03/2018	5561/5	0.08	<0.001	0.07	<0.001	<0.001	<0.001	<0.01	0.016	<0.001	<0.001	<0.001	0.029	<0.00005
MW X2	24/04/2018	5715/5	0.08	<0.001	0.09	<0.001	<0.001	<0.001	0.41	0.013	<0.001	<0.001	<0.001	0.024	<0.00005
MW X2	22/05/2018	5859/5	0.08	<0.001	0.08	<0.001	<0.001	<0.001	0.4	0.012	<0.001	<0.001	<0.001	0.023	<0.00005
MW X2	21/06/2018	6010/5	0.06	<0.001	0.07	<0.001	<0.001	<0.001	0.46	0.014	<0.001	<0.001	<0.001	0.022	<0.00005
MW_X3 Deep	17/07/2017	4569/3	0.02	0.001	0.02	<0.001	<0.001	<0.001	3.5		<0.001	<0.001	<0.001	0.005	<0.00005
MW_X3 Deep	13/10/2017	4910/6	0.01	<0.001	<0.00	<0.001	<0.001	<0.001	3.8	0.034	<0.001	<0.001	<0.001	0.002	<0.00005
MW_X3 Deep	7/11/2017	4998/6	0.02	<0.001	0.09	<0.001	<0.001	0.011	3.3	0.03	0.004	<0.001	<0.001	0.044	<0.00005
MW X3 Deep	7/12/2017	5113/6	0.01	<0.001	<0.001	<0.001	<0.001	0.003	4.2	0.036	<0.001	<0.001	<0.001	0.005	<0.00005
MW X3 Deep	30/01/2018	5322/6	0.01	<0.001	0.02	<0.001	<0.001	<0.001	4	0.033	<0.001	<0.001	<0.001	0.006	<0.00005
MW X3 Deep	1/03/2018	5425/6	0.02	<0.001	0.06	<0.001	<0.001	<0.001	4.1	0.038	<0.001	<0.001	<0.001	0.022	<0.00005
MW X3 Deep	13/03/18	-	<0.1	<0.01	-	<0.0002	<0.01	<0.001	3.4	0.04	-	<0.001	<0.001	0.002	<0.00005
MW X3 Deep	29/03/2018	5561/6	0.02	<0.001	0.07	<0.001	<0.001	<0.001	3.5	0.033	<0.001	<0.001	<0.001	0.032	<0.00005
MW X3 Deep	24/04/2018	5715/6	0.01	<0.001	0.07	<0.001	<0.001	<0.001	3.8	0.035	<0.001	<0.001	<0.001	0.022	<0.00005
MW X3 Deep	22/05/2018	5859/6	0.02	<0.001	0.05	<0.001	<0.001	<0.001	3.8	0.034	<0.001	<0.001	<0.001	0.03	<0.00005
MW X3 Deep	21/06/2018	6010/6	0.02	<0.001	0.05	<0.001	<0.001	<0.001	3.4	0.033	<0.001	<0.001	<0.001	0.015	<0.00005
MW_X3 Shallow	17/07/2017	4569/4	0.27	0.002	0.03	<0.001	<0.001	<0.001	0.41		<0.001	<0.001	<0.001	0.006	<0.00005
MW_X3 Shallow	13/10/2017	4910/7	0.35	0.002	0.02	<0.001	<0.001	0.005	0.33	0.014	<0.001	<0.001	<0.001	0.004	<0.00005
MW_X3 Shallow	7/11/2017	4998/7	0.2	0.001	0.08	<0.001	<0.001	<0.001	0.31	0.016	<0.001	<0.001	<0.001	0.031	<0.00005
MW X3 Shallow	7/12/2017	5113/7	0.22	0.001	0.02	<0.001	<0.001	0.003	0.26	0.016	<0.001	<0.001	<0.001	0.015	<0.00005
MW X3 Shallow	30/01/2018	5322/7	0.24	0.002	0.03	<0.001	<0.001	0.002	0.42	0.011	<0.001	<0.001	<0.001	0.024	<0.00005
MW X3 Shallow	1/03/2018	5425/7	0.28	0.003	0.08	<0.001	<0.001	<0.001	0.6	0.015	<0.001	<0.001	<0.001	0.031	<0.00005
MW X3 Shallow	13/03/18	-	<0.1	<0.01	-	<0.0002	<0.01	<0.001	0.48	0.01	-	<0.001	<0.001	0.004	<0.00005
MW X3 Shallow	29/03/2018	5561/7	0.25	0.001	0.1	<0.001	<0.001	<0.001	0.24	0.013	<0.001	<0.001	<0.001	0.045	<0.00005
MW X3 Shallow	24/04/2018	5715/7	0.22	0.001	0.07	<0.001	<0.001	<0.001	0.26	0.01	<0.001	<0.001	<0.001	0.017	<0.00005
MW X3 Shallow	22/05/2018	5859/7	0.19	0.001	0.07	<0.001	<0.001	<0.001	0.22	0.012	<0.001	<0.001	<0.001	0.038	<0.00005
MW X3 Shallow	21/06/2018	6010/7	0.19	0.001	0.07	<0.001	<0.001	<0.001	0.3	0.012	<0.001	<0.001	<0.001	0.051	<0.00005
MW_X4 Deep	17/07/2017	4569/5	0.02	0.004	0.06	<0.001	<0.001	<0.001	0.17	-	<0.001	<0.001	<0.001	0.003	<0.00005
MW_X4 Deep	13/10/2017	4910/8	0.02	0.003	0.05	<0.001	<0.001	<0.001	0.21	0.017	<0.001	<0.001	<0.001	0.001	<0.00005
MW_X4 Deep	7/11/2017	4998/8	0.01	0.003	0.08	<0.001	<0.001	<0.001	0.22	0.018	<0.001	<0.001	<0.001	0.01	<0.00005
MW X4 Deep	7/12/2017	5113/8	0.02	0.003	0.06	<0.001	<0.001	<0.001	0.24	0.016	<0.001	<0.001	<0.001	0.001	<0.00005
MW X4 Deep	30/01/2018	5322/8	0.02	0.003	0.06	<0.001	<0.001	<0.001	0.24	0.015	<0.001	<0.001	<0.001	0.003	<0.00005
MW X4 Deep	1/03/2018	5425/8	0.02	0.004	0.09	<0.001	<0.001	<0.001	0.3	0.019	<0.001	<0.001	<0.001	0.019	<0.00005
MW X4 Deep	29/03/2018	5561/8	0.01	0.004	0.1	<0.001	<0.001	<0.001	0.33	0.022	<0.001	<0.001	<0.001	0.018	<0.00005
MW X4 Deep	24/04/2018	5715/8	0.01	0.004	0.1	<0.001	<0.001	<0.001	0.43	0.022	0.003	<0.001	<0.001	0.019	<0.00005
MW X4 Deep	22/05/2018	5859/8	0.01	0.004	0.08	<0.001	<0.001	<0.001	0.5	0.024	<0.001	<0.001	<0.001	0.019	<0.00005
MW X4 Deep	21/06/2018	6010/8	0.01	0.004	0.09	<0.001	<0.001	<0.001	0.53	0.033	<0.001	<0.001	<0.001	0.024	<0.00005
MW_X4 Shallow	17/07/2017	4569/6	0.02	<0.001	<0.02	<0.001	<0.001	<0.001	0.03	-	<0.001	<0.001	<0.001	0.008	<0.00005
MW_X4 Shallow	13/10/2017	4910/9	0.02	<0.001	<0.00	<0.001	<0.001	0.003	0.06	0.001	<0.001	<0.001	<0.001	0.004	<0.00005

Criteria														
			Al	As	B	Cd	Cr	Cu	Fe	Mn	Ni	Pb	Se	Zn	Hg
Drinking water - Health[2]			-	0.01	4	0.002	0.05	2	-	0.5	0.02	0.01	0.01	-	3
Recreation[3]			0.2	0.05	1	0.005		1	0.3	0.1	0.1	0.05		5	0.001
Ecological (fresh)[4]			0.055	0.024	0.37	0.0002	0.001	0.0014	-	1.9	0.011	0.026	0.011	0.008	0.0006
Ecological (marine)[4]			-	-	-	0.0055	0.0044	0.0013	-	-	0.07	0.0044	-	0.015	0.0004
Livestock[3]			5	0.5	5	0.01	1	0.4	-	-	1	0.1	0.02	20	0.002
Irrigation[3]				0.1	0.5		0.1	0.2	0.2	0.2	0.2	2		2	
		Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Sample	Date	Lab ID													
MW_X4 Shallow	7/11/2017	4998/9	0.01	<0.001	0.06	<0.001	<0.001	0.004	0.02	0.005	<0.001	<0.001	<0.001	0.025	<0.00005
MW X4 Shallow	7/12/2017	5113/9	0.02	<0.001	<0.001	<0.001	<0.001	0.001	0.05	0.005	<0.001	<0.001	<0.001	0.005	<0.00005
MW X4 Shallow	30/01/2018	5322/9	0.02	<0.001	<0.02	<0.001	<0.001	0.002	0.03	0.005	<0.001	<0.001	<0.001	0.01	<0.00005
MW X4 Shallow	1/03/2018	5425/9	0.02	<0.001	0.06	<0.001	<0.001	0.004	0.03	0.005	<0.001	<0.001	<0.001	0.036	<0.00005
MW X4 Shallow	29/03/2018	5561/9	0.02	<0.001	0.09	<0.001	<0.001	0.002	0.03	0.005	<0.001	<0.001	<0.001	0.031	<0.00005
MW X4 Shallow	24/04/2018	5715/9	0.01	<0.001	0.08	<0.001	<0.001	0.006	0.01	0.005	<0.001	<0.001	<0.001	0.023	<0.00005
MW X4 Shallow	22/05/2018	5859/9	0.02	<0.001	0.06	<0.001	<0.001	0.007	0.01	0.005	<0.001	<0.001	<0.001	0.024	<0.00005
MW X4 Shallow	21/06/2018	6010/9	0.02	<0.001	0.06	<0.001	<0.001	0.004	0.02	0.005	<0.001	<0.001	<0.001	0.024	<0.00005
MW_X5	17/07/2017	4569/7	0.02	0.004	0.03	<0.001	<0.001	<0.001	0.72	-	<0.001	<0.001	<0.001	0.003	<0.00005
MW_X5	13/10/2017	4910/10	0.02	0.004	0.02	<0.001	<0.001	0.036	0.71	0.05	0.002	0.004	<0.001	0.026	<0.00005
MW_X5	7/11/2017	4998/10	0.02	0.004	0.09	<0.001	<0.001	<0.001	1.1	0.048	<0.001	0.001	<0.001	0.037	<0.00005
MW X5	7/12/2017	5113/10	0.01	0.004	0.03	<0.001	<0.001	<0.001	1.3	0.048	<0.001	<0.001	<0.001	0.002	<0.00005
MW X5	30/01/2018	5322/10	0.02	0.004	0.03	<0.001	<0.001	<0.001	1.2	0.051	<0.001	<0.001	<0.001	0.004	<0.00005
MW X5	1/03/2018	5425/10	0.02	0.004	0.07	<0.001	<0.001	<0.001	1.3	0.059	<0.001	<0.001	<0.001	0.024	<0.00005
MW X5	29/03/2018	5561/10	0.01	0.004	0.05	<0.001	<0.001	<0.001	1.1	0.044	<0.001	<0.001	<0.001	0.018	<0.00005
MW X5	24/04/2018	5715/10	0.01	0.004	0.07	<0.001	<0.001	<0.001	1.1	0.046	<0.001	<0.001	<0.001	0.018	<0.00005
MW X5	22/05/2018	5859/10	0.01	0.003	0.06	<0.001	<0.001	<0.001	1	0.045	<0.001	<0.001	<0.001	0.022	<0.00005
MW X5	21/06/2018	6010/10	0.02	0.003	0.1	<0.001	<0.001	<0.001	0.98	0.041	<0.001	<0.001	<0.001	0.027	<0.00005
MW_X6	17/07/2017	4569/8	<0.01	0.022	0.03	<0.001	<0.001	<0.001	3.1	-	<0.001	<0.001	<0.001	0.002	<0.00005
MW_X6	13/10/2017	4910/11	<0.01	0.022	0.02	<0.001	<0.001	<0.001	2.7	0.34	<0.001	<0.001	<0.001	0.002	<0.00005
MW_X6	7/11/2017	4998/11	<0.01	0.022	0.06	<0.001	<0.001	<0.001	2.9	0.35	<0.001	<0.001	<0.001	0.017	<0.00005
MW X6	7/12/2017	5113/11	<0.01	0.022	0.03	<0.001	<0.001	<0.001	3.8	0.39	<0.001	<0.001	<0.001	0.003	<0.00005
MW X6	30/01/2018	5322/11	0.01	0.02	0.03	<0.001	<0.001	<0.001	3.9	0.39	<0.001	<0.001	<0.001	0.006	<0.00005
MW X6	1/03/2018	5425/11	<0.01	0.023	0.02	<0.001	<0.001	<0.001	3.4	0.43	<0.001	<0.001	<0.001	0.004	<0.00005
MW X6	29/03/2018	5561/11	<0.01	0.026	0.06	<0.001	<0.001	<0.001	3	0.38	<0.001	<0.001	<0.001	0.022	<0.00005
MW X6	24/04/2018	5715/11	<0.01	0.026	0.06	<0.001	<0.001	<0.001	3	0.37	<0.001	<0.001	<0.001	0.017	<0.00005
MW X6	22/05/2018	5859/11	<0.01	0.024	0.07	<0.001	<0.001	<0.001	2.8	0.34	<0.001	<0.001	<0.001	0.023	<0.00005
MW X6	21/06/2018	6010/11	<0.01	0.023	0.07	<0.001	<0.001	<0.001	2.7	0.37	<0.001	<0.001	<0.001	0.02	<0.00005

Note(s):
1. all table entries in mg/L other than pH (field measurement)
2. Health – Australian Drinking Water Guidelines (ADWG, 2011)
3. Recreational and primary industries water quality - ANZECC (2000)
4. 95% species protection – ANZECC / ARMCANZ (2000)

Table 18 DATA SUMMARY TABLE - PFAS IN GROUNDWATER

Criteria						
		PFHxS	PFOS	PFOA	6:2 Fluorotelomer sulfonate	8:2 Fluorotelomer sulfonate
Tolerable Daily Intake (TDI)[2] [ug/kg_{bw}/d]		0.02	0.02	0.16	-	-
Drinking water - Health[2]		0.07	0.07	0.56	-	-
Recreational water[2]		0.7	0.7	5.6	-	-
Freshwater[3]		-	0.13	220	-	-
Interim marine[3]		-	0.13	220	-	-
	Units	ug/L	mg/L	mg/L	mg/L	mg/L
Sample	Date					
GW2	1/10/2015	-	<0.02	<0.02	<0.1	<0.1
GW4	1/03/2018	<0.01	<0.01	<0.01	<0.01	<0.01
GW4	1/03/2018	<0.01	<0.01	<0.01	<0.01	<0.01
GW4	29/03/2018	<0.01	<0.01	<0.01	<0.01	<0.01
GW4	24/04/2018	<0.01	<0.01	<0.01	<0.01	<0.01
GW4	22/05/2018	<0.01	<0.01	<0.01	<0.01	<0.01
GW4	21/06/2018	<0.01	<0.01	<0.01	<0.01	<0.01
MW X1	1/03/2018	<0.01	<0.01	<0.01	<0.01	<0.01
MW X1	1/03/2018	<0.01	<0.01	<0.01	<0.01	<0.01
MW X1	29/03/2018	<0.01	<0.01	<0.01	<0.01	<0.01
MW X1	24/04/2018	<0.01	<0.01	<0.01	<0.01	<0.01
MW X1	22/05/2018	<0.01	<0.01	<0.01	<0.01	<0.01
MW X1	21/06/2018	<0.01	<0.01	<0.01	<0.01	<0.01
MW X2	1/03/2018	<0.01	<0.01	<0.01	<0.01	<0.01
MW X2	1/03/2018	<0.01	<0.01	<0.01	<0.01	<0.01
MW X2	29/03/2018	<0.01	<0.01	<0.01	<0.01	<0.01
MW X2	24/04/2018	<0.01	<0.01	<0.01	<0.01	<0.01
MW X2	22/05/2018	<0.01	<0.01	<0.01	<0.01	<0.01
MW X2	21/06/2018	<0.01	<0.01	<0.01	<0.01	<0.01
MW X7	29/03/2018	<0.01	<0.01	<0.01	<0.01	<0.01
MW X7	24/04/2018	<0.01	<0.01	<0.01	<0.01	<0.01
MW X7	22/05/2018	<0.01	<0.01	<0.01	<0.01	<0.01
MW X7	21/06/2018	<0.01	<0.01	<0.01	<0.01	<0.01

Note(s): 1. all table entries in ug/L

2. Health based guidance values – Table 1 NEMP (2018)

3. 95% species protection (slightly to moderately disturbed systems)– Table 5 NEMP (2018)

APPENDIX A: CHARTS

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Chart 2 - Schoeller Diagram GW1

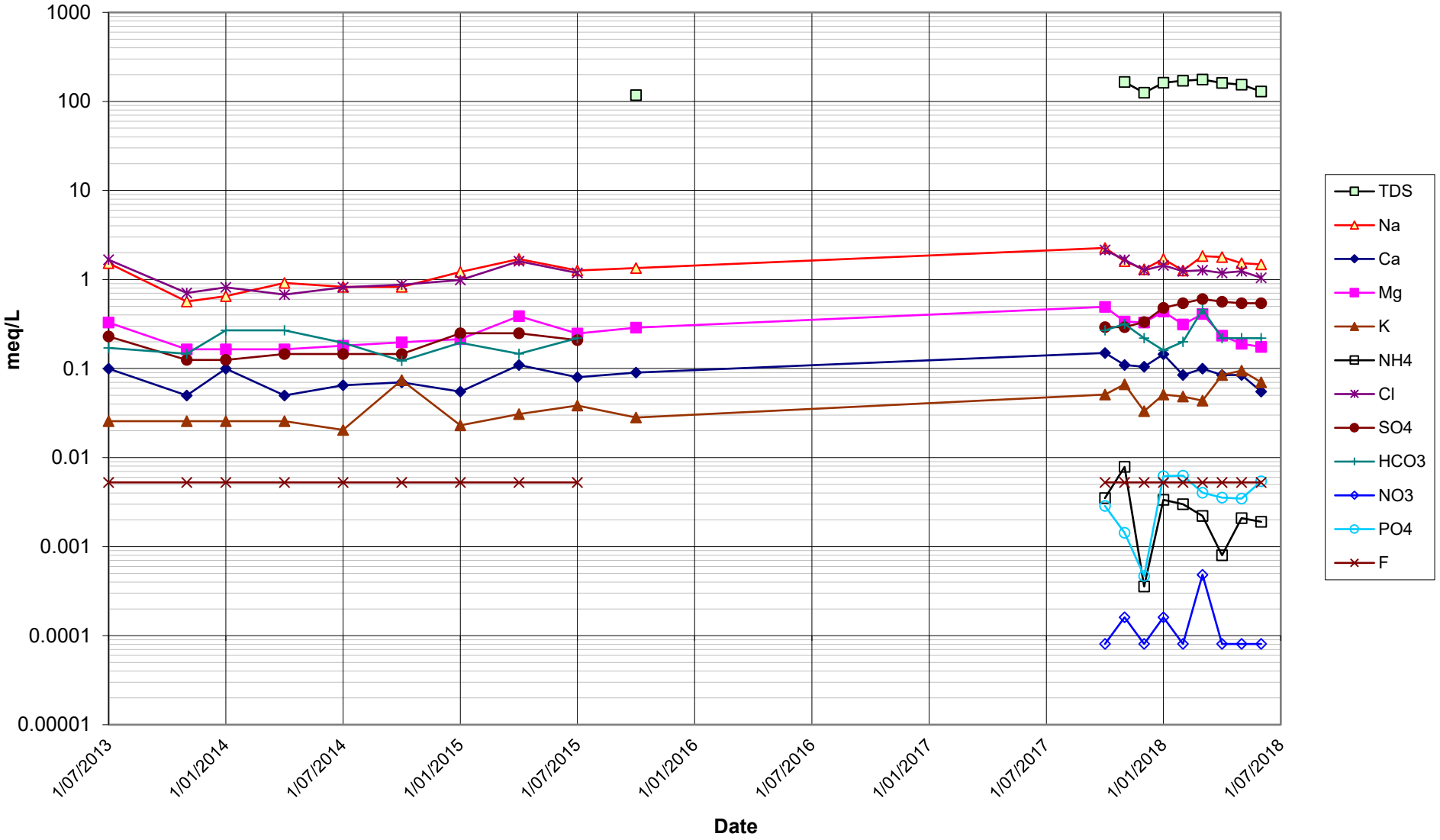


Chart 2

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Chart 3 - Schoeller Diagram MWx1

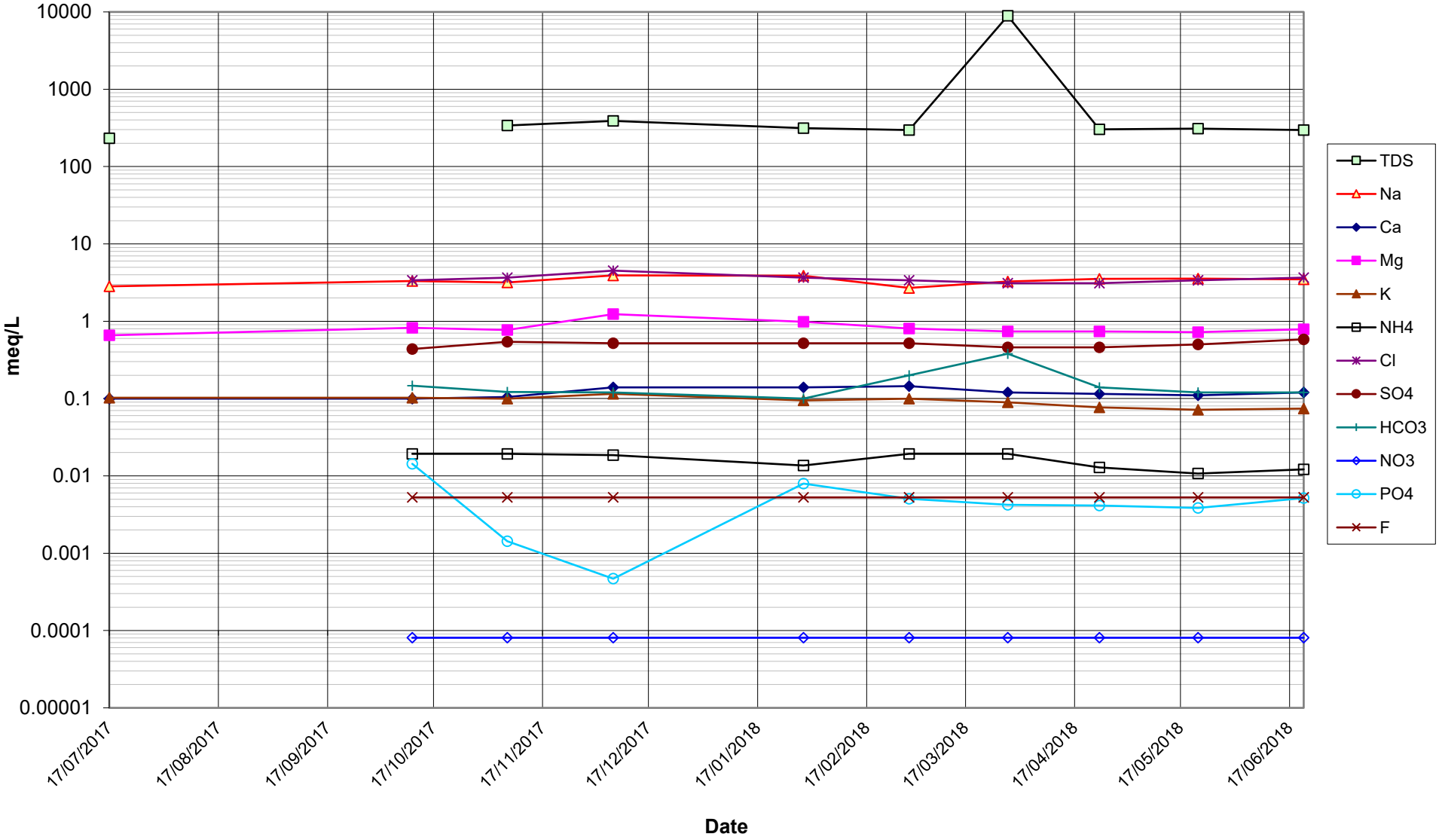


Chart 3

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Chart 4 - Schoeller Diagram MWx2

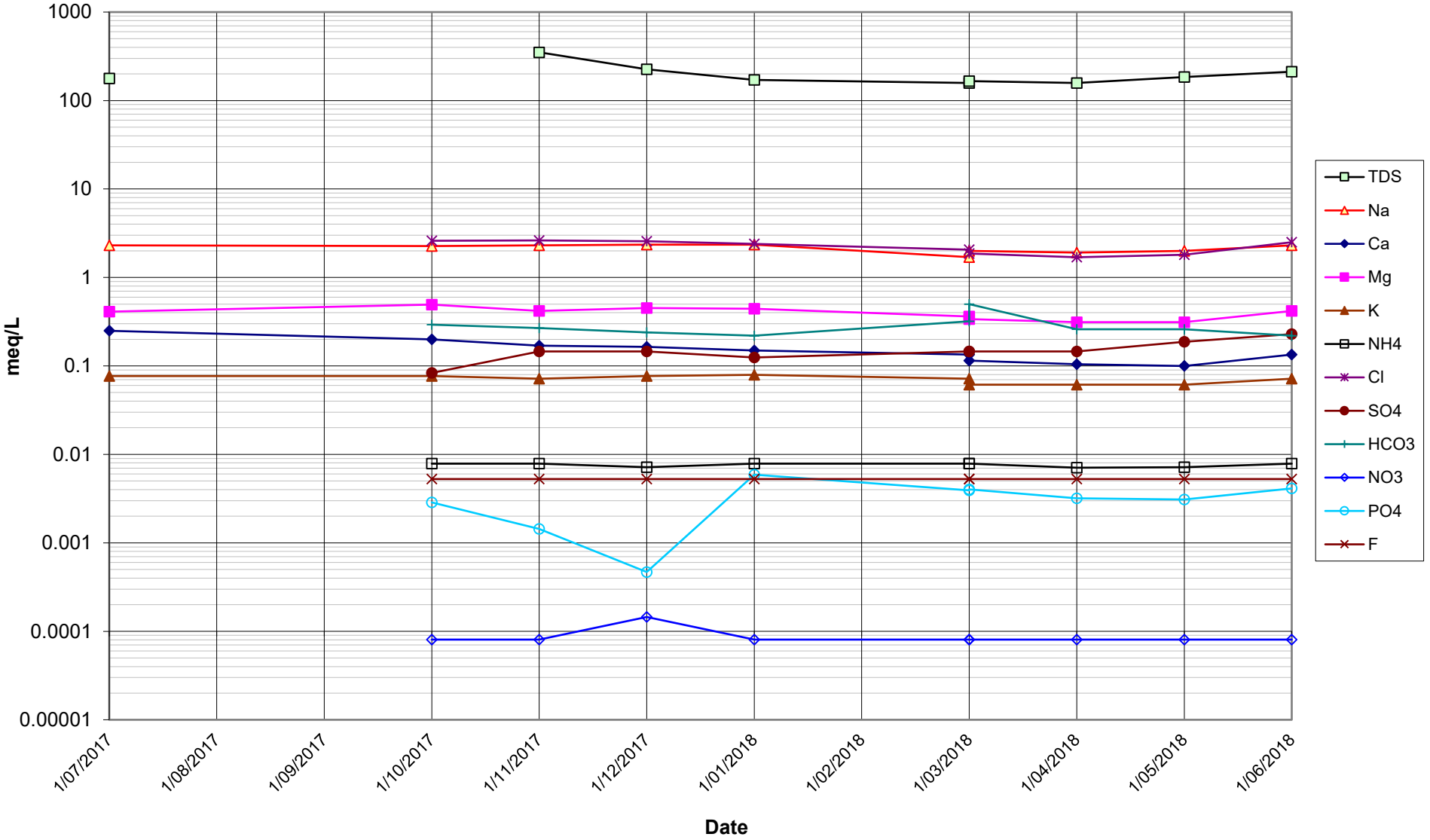


Chart 4

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Chart 5 - Schoeller Diagram MWx3_Shallow

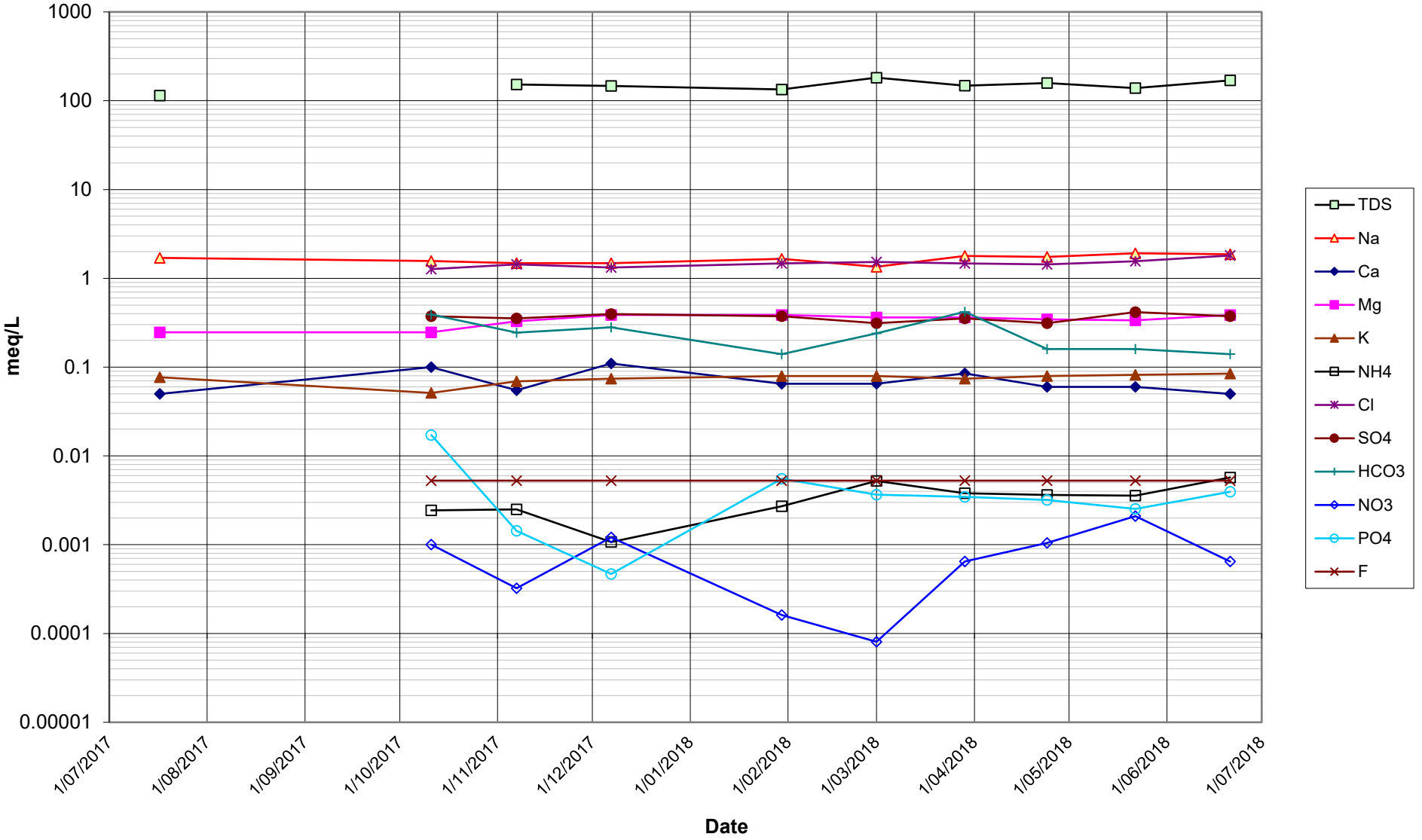


Chart 5

Chart 6 - Schoeller Diagram MWx3_Deep

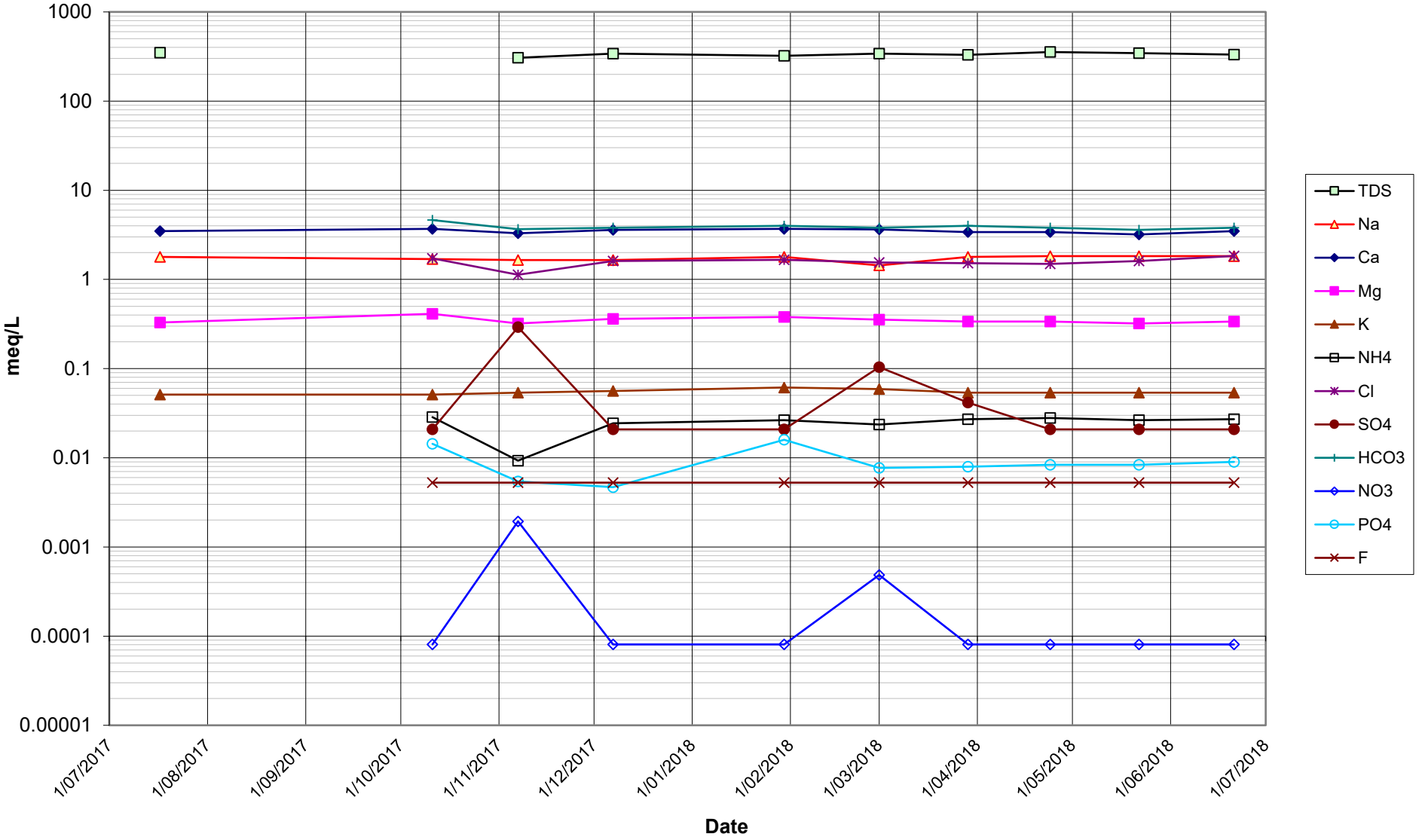
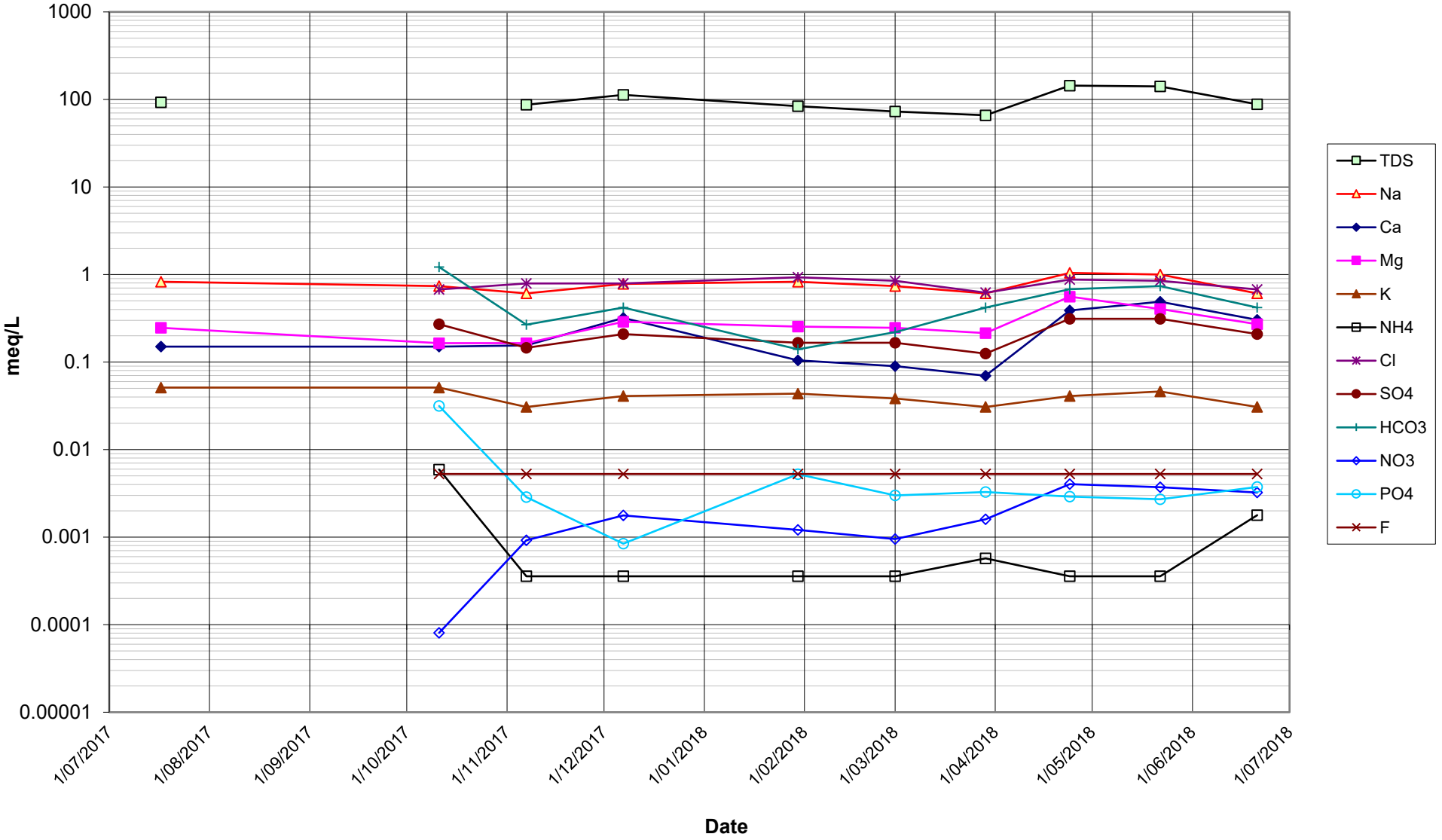
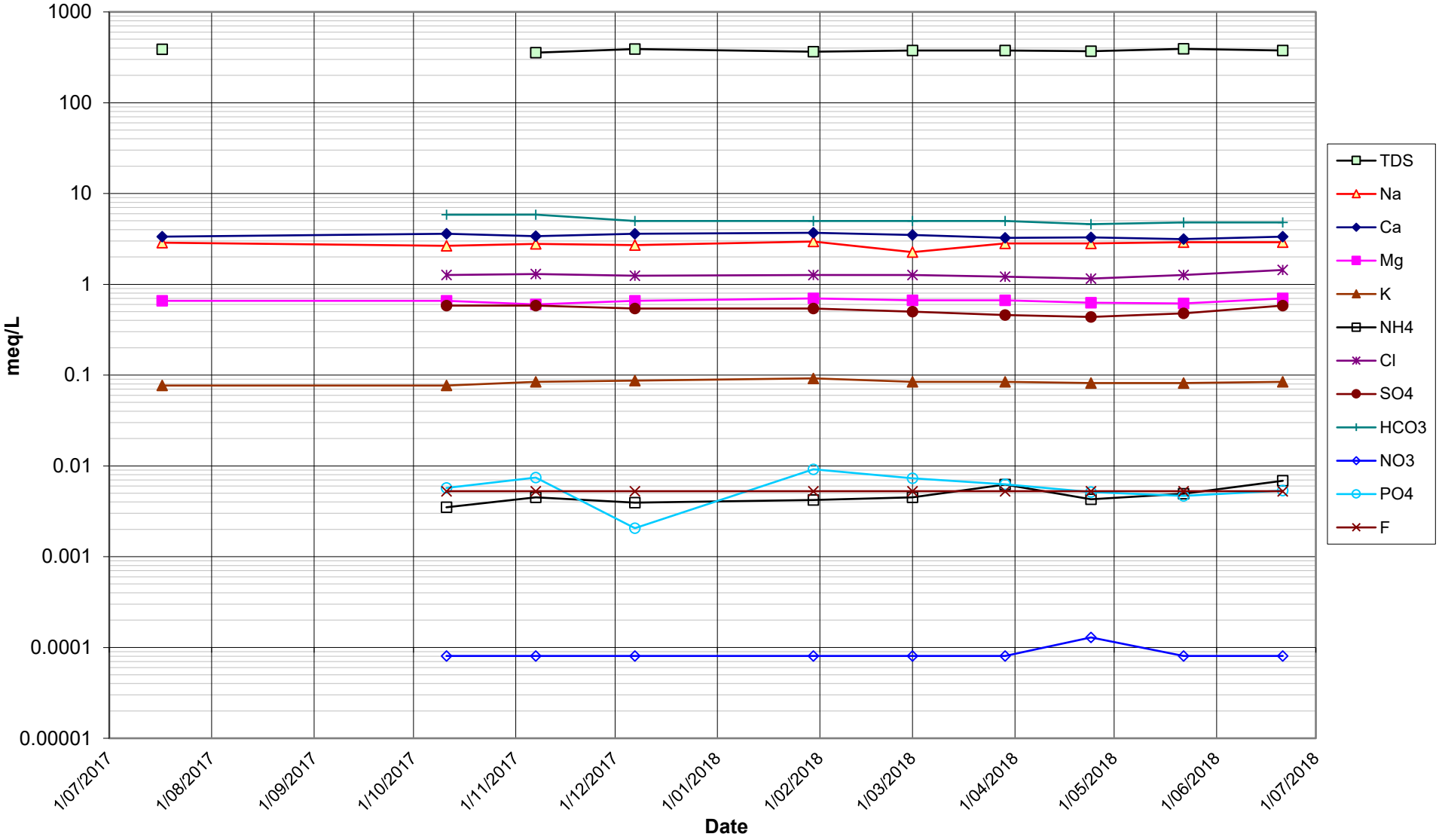


Chart 7 - Schoeller Diagram MWx4_Shallow



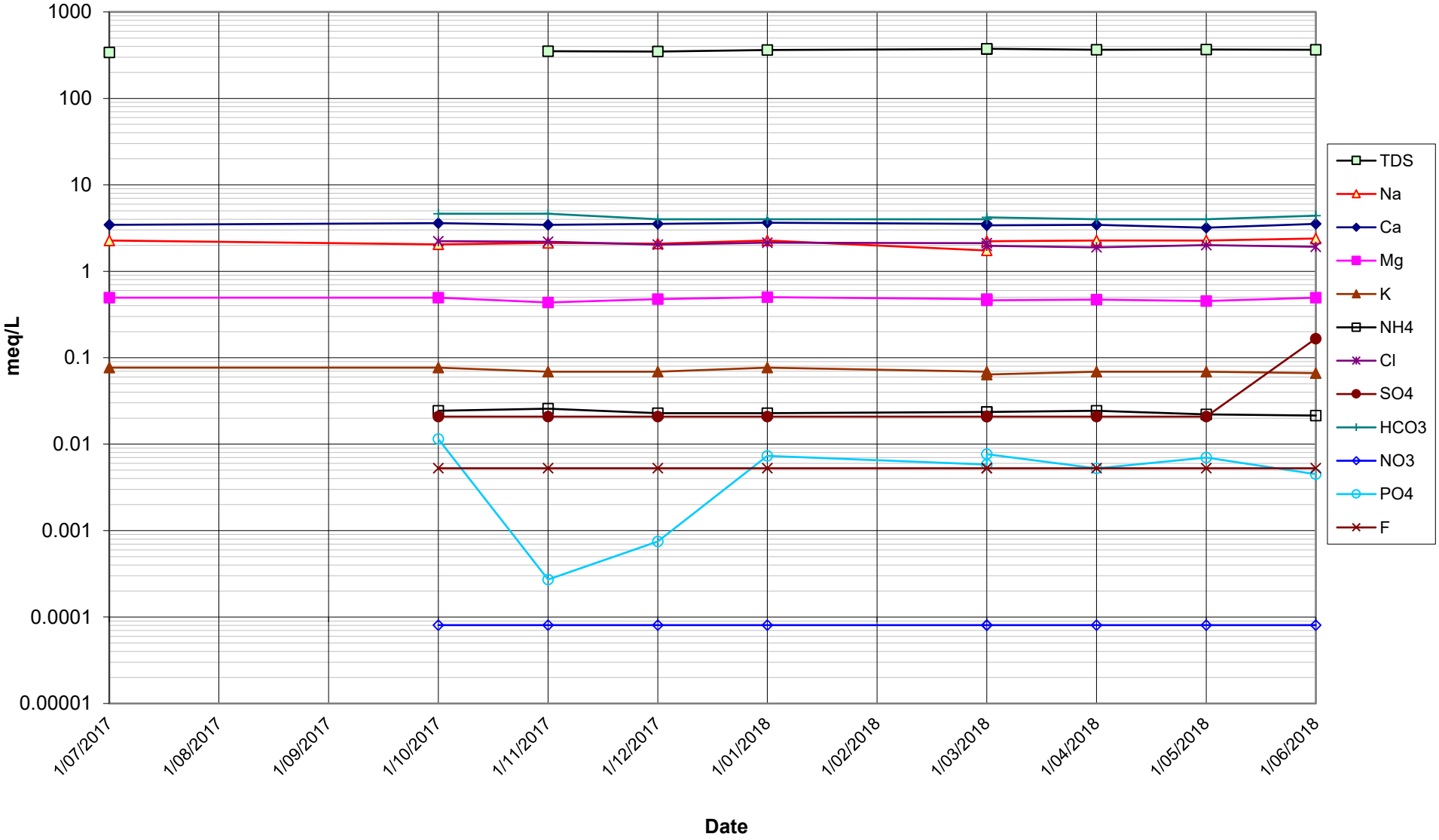
ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Chart 8 - Schoeller Diagram MWx4_Deep



ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Chart 9 - Schoeller Diagram MWx5



ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Chart 10 - Schoeller Diagram MWx6

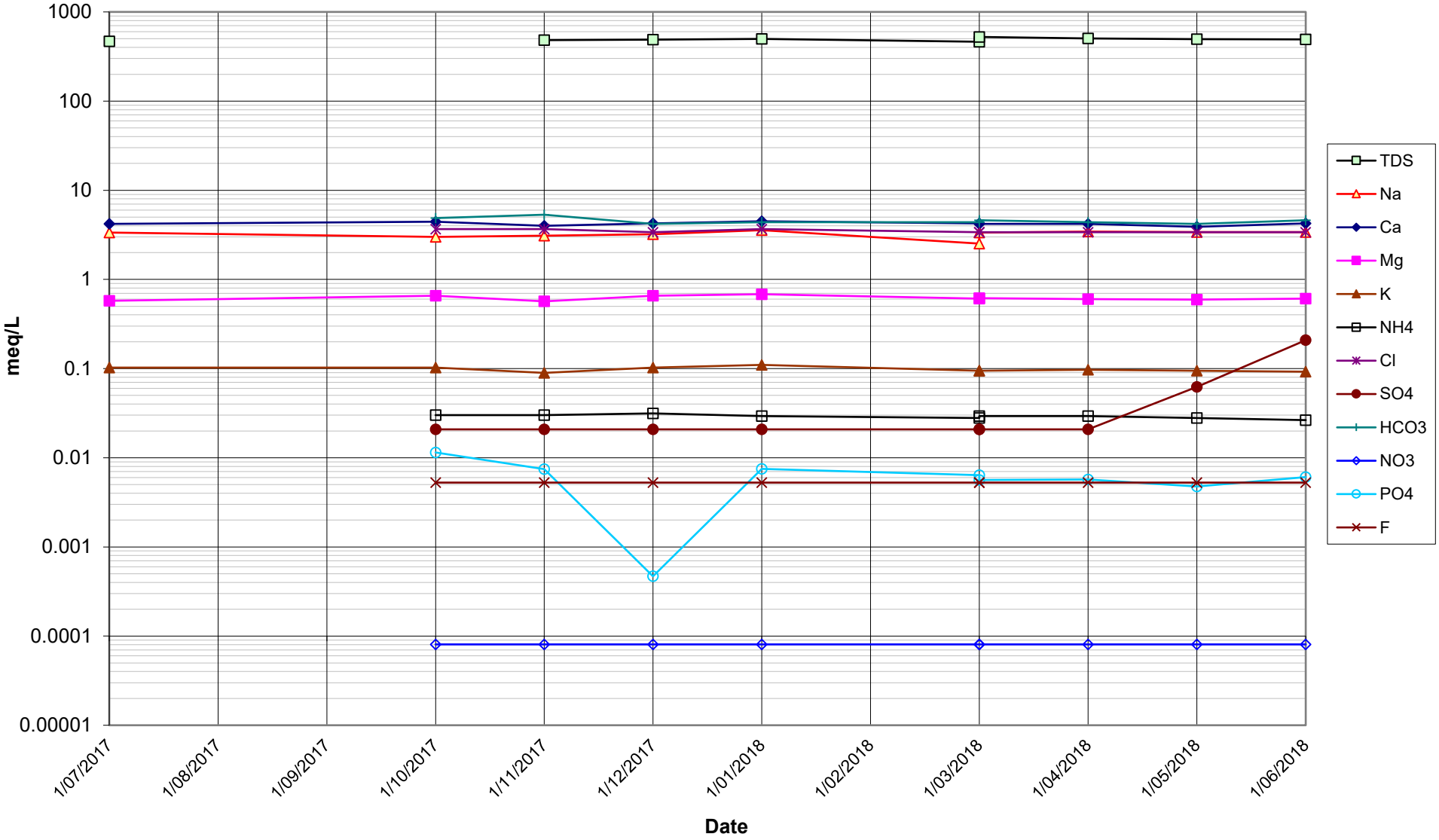


Chart 10

Chart 11 - Groundwater pH

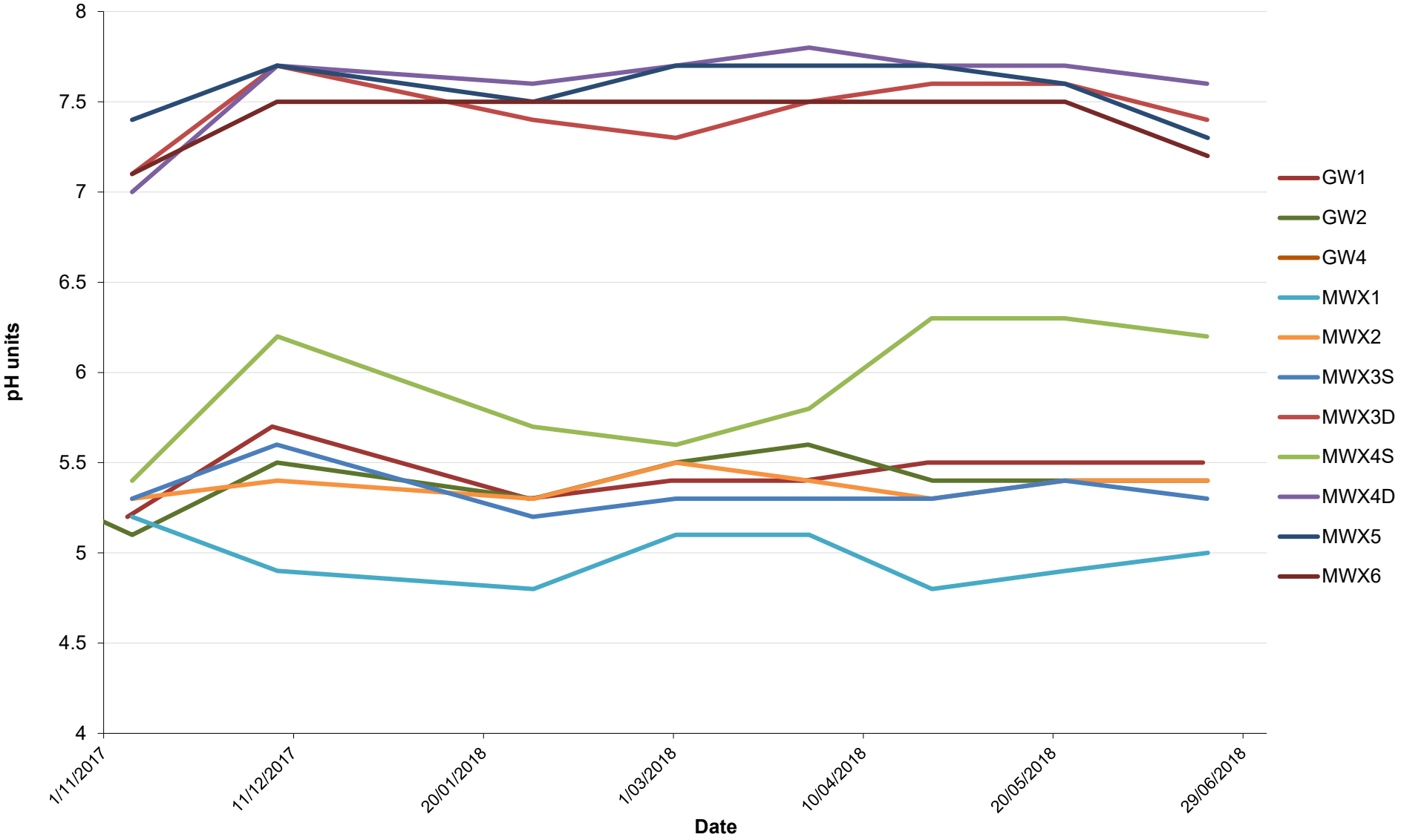


Chart 11

Chart 12 - Aluminium concentrations in groundwater

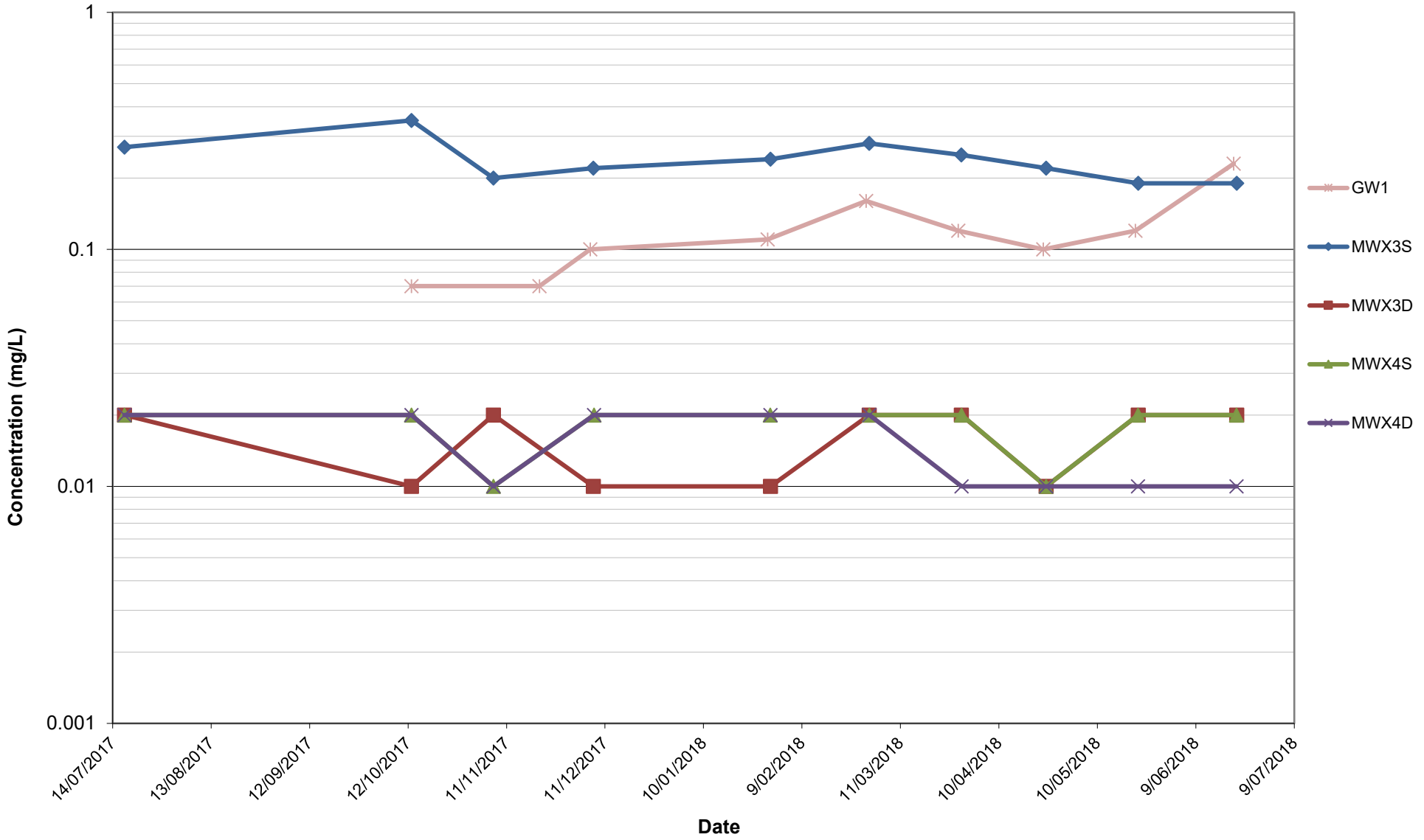


Chart 13 - Calcium concentrations in groundwater

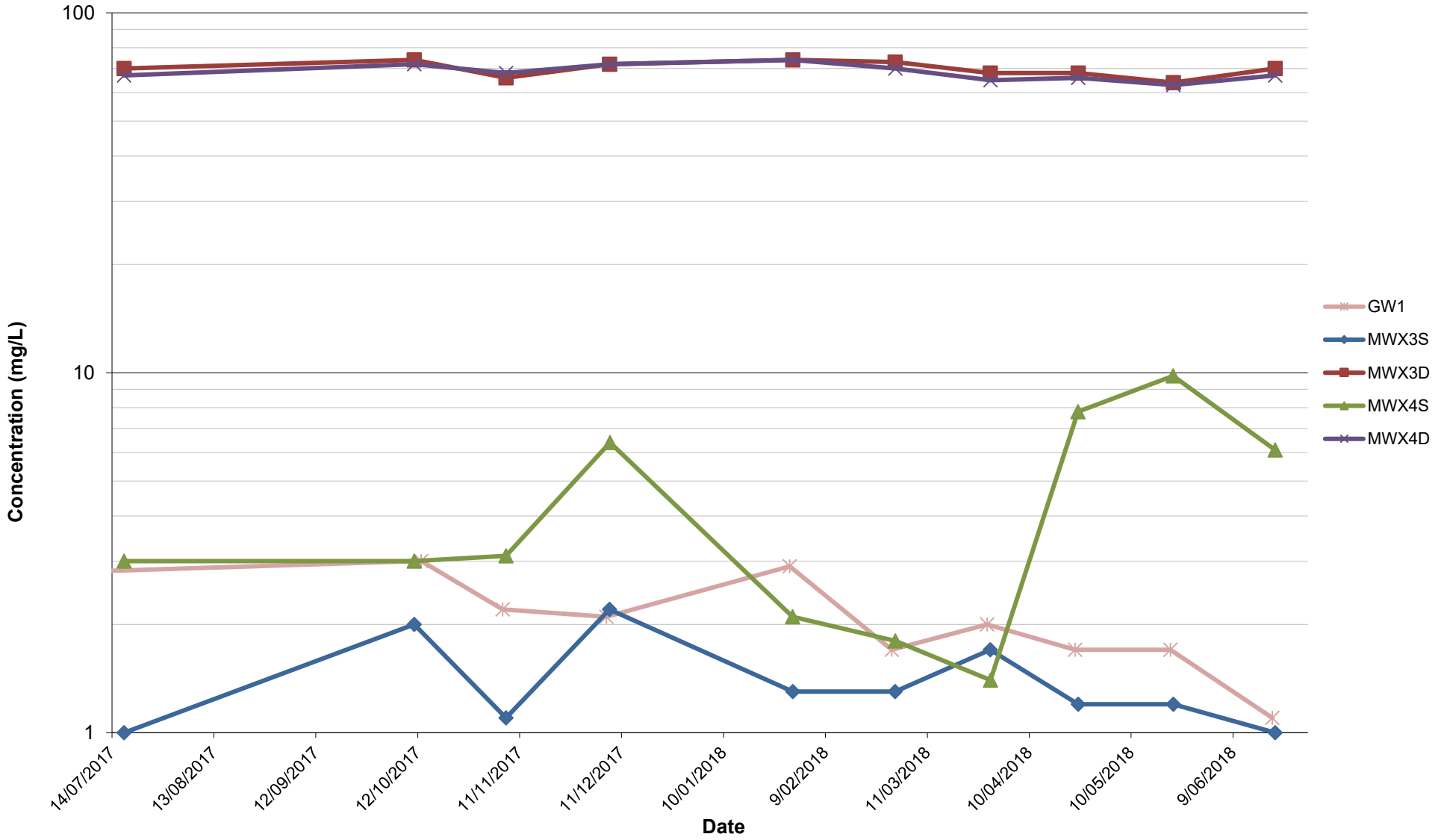


Chart 13

Chart 14 - Copper concentrations in groundwater

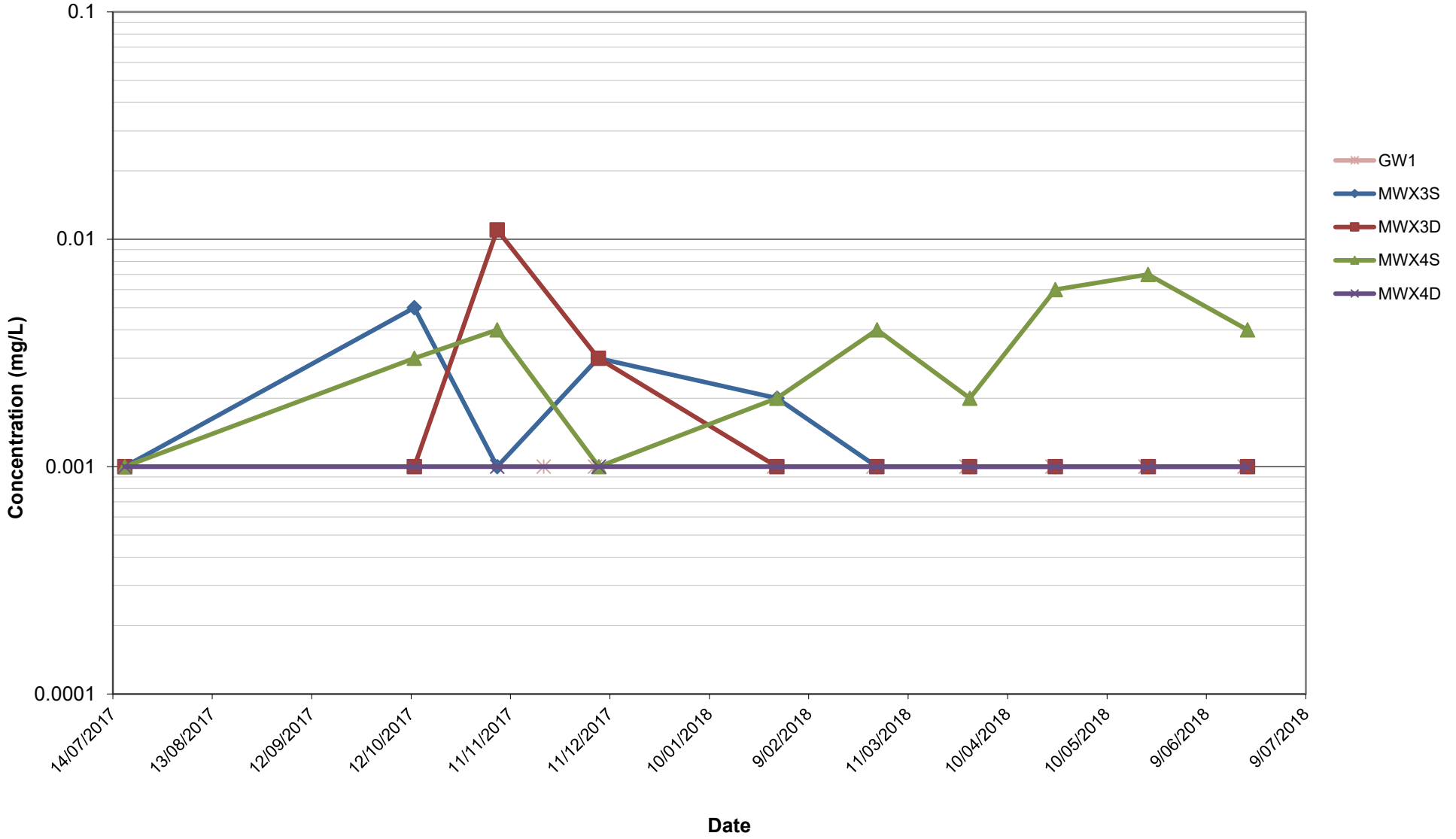


Chart 14

Chart 15 - Iron concentrations in groundwater

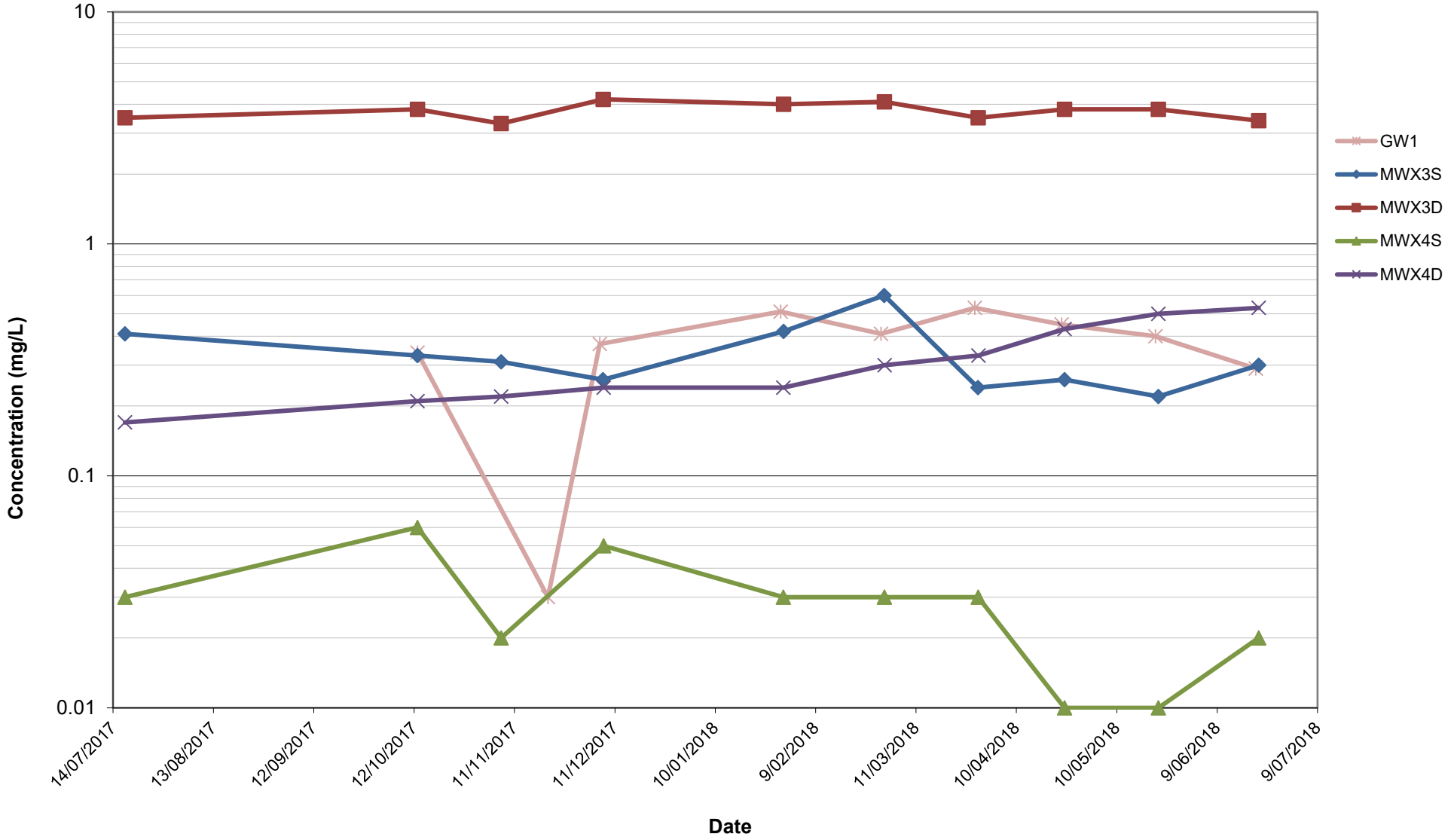


Chart 15

Chart 16 - Lead concentrations in groundwater

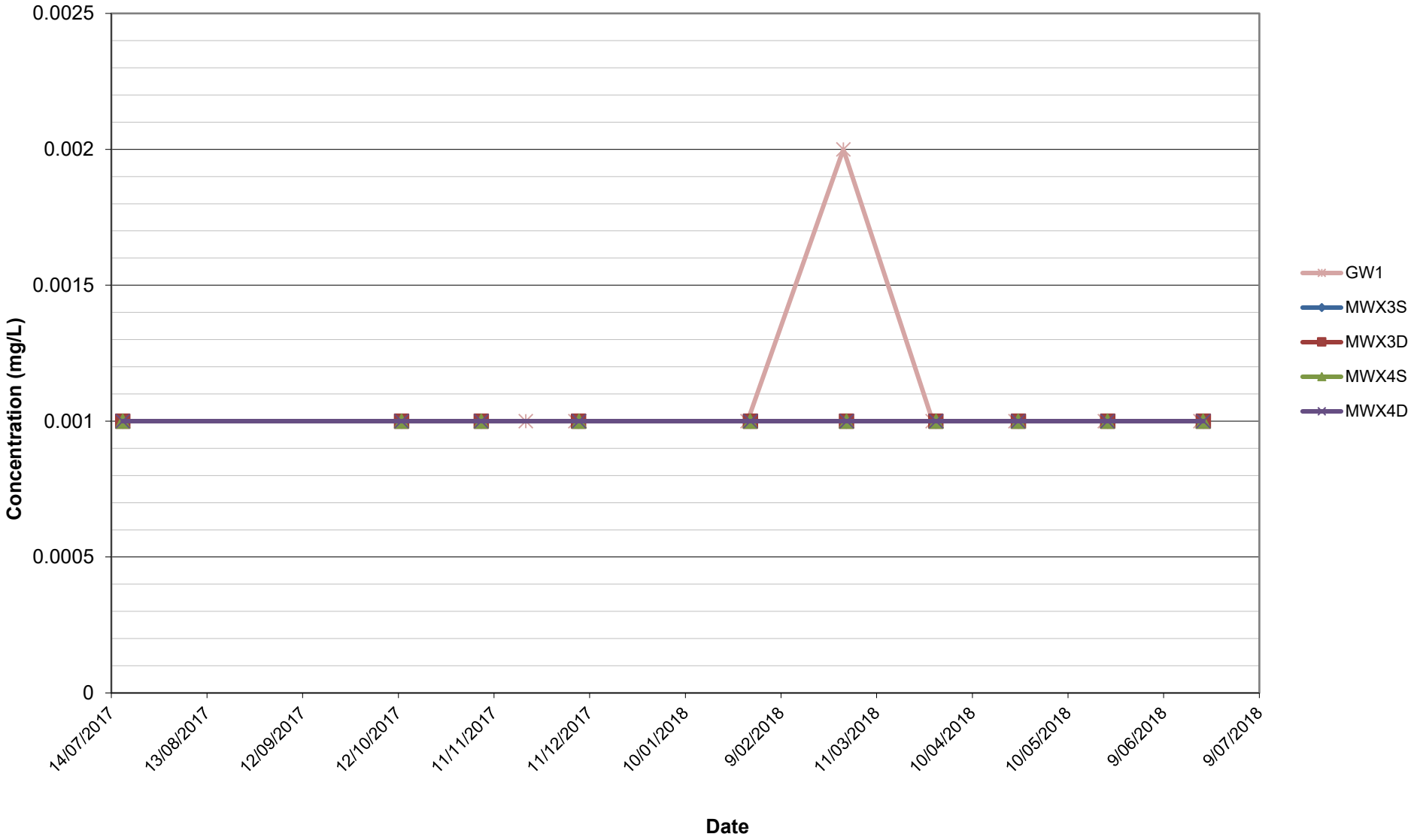


Chart 17 - Magnesium concentrations in groundwater

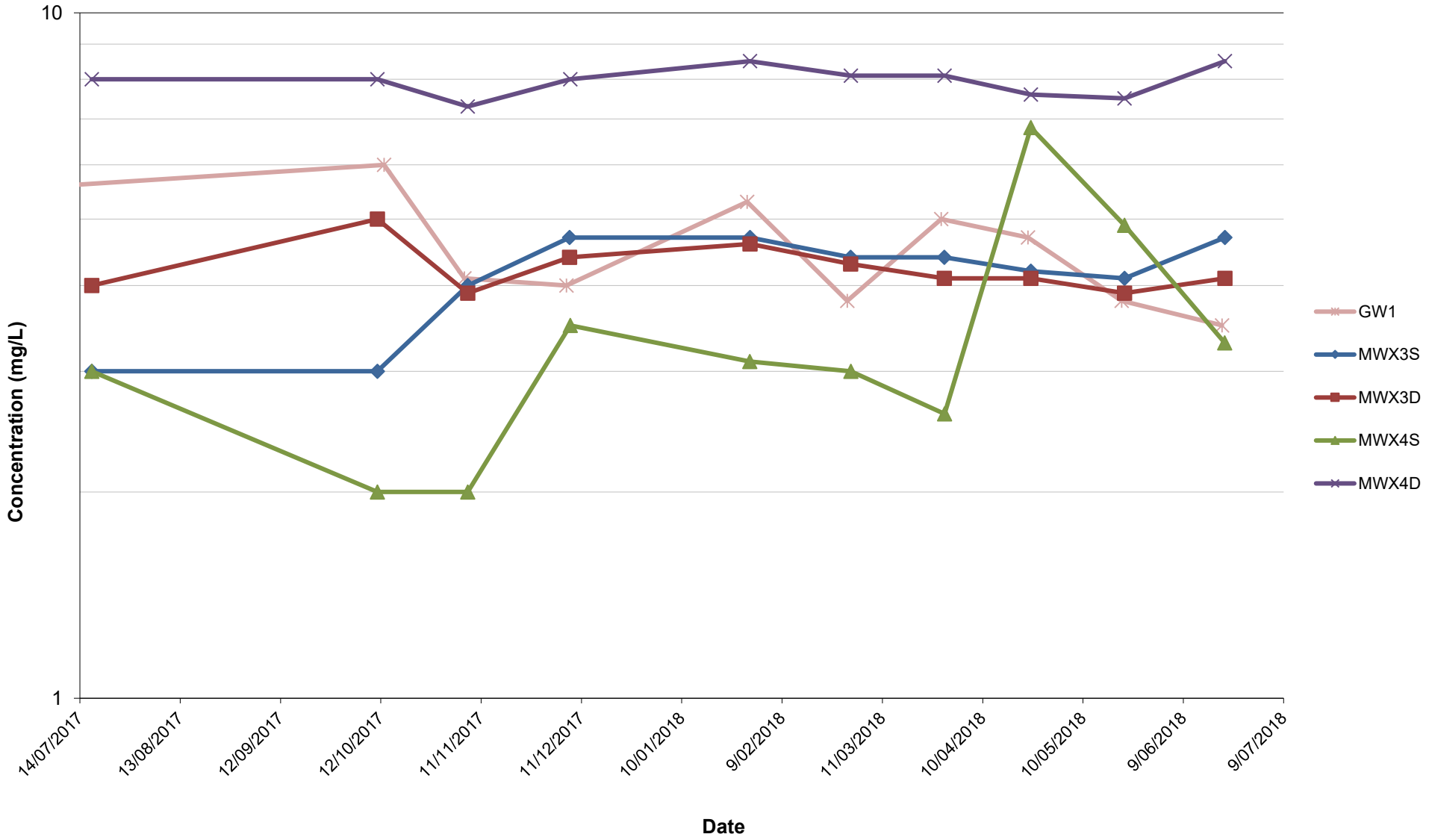


Chart 17

Chart 18 - Potassium concentrations in groundwater

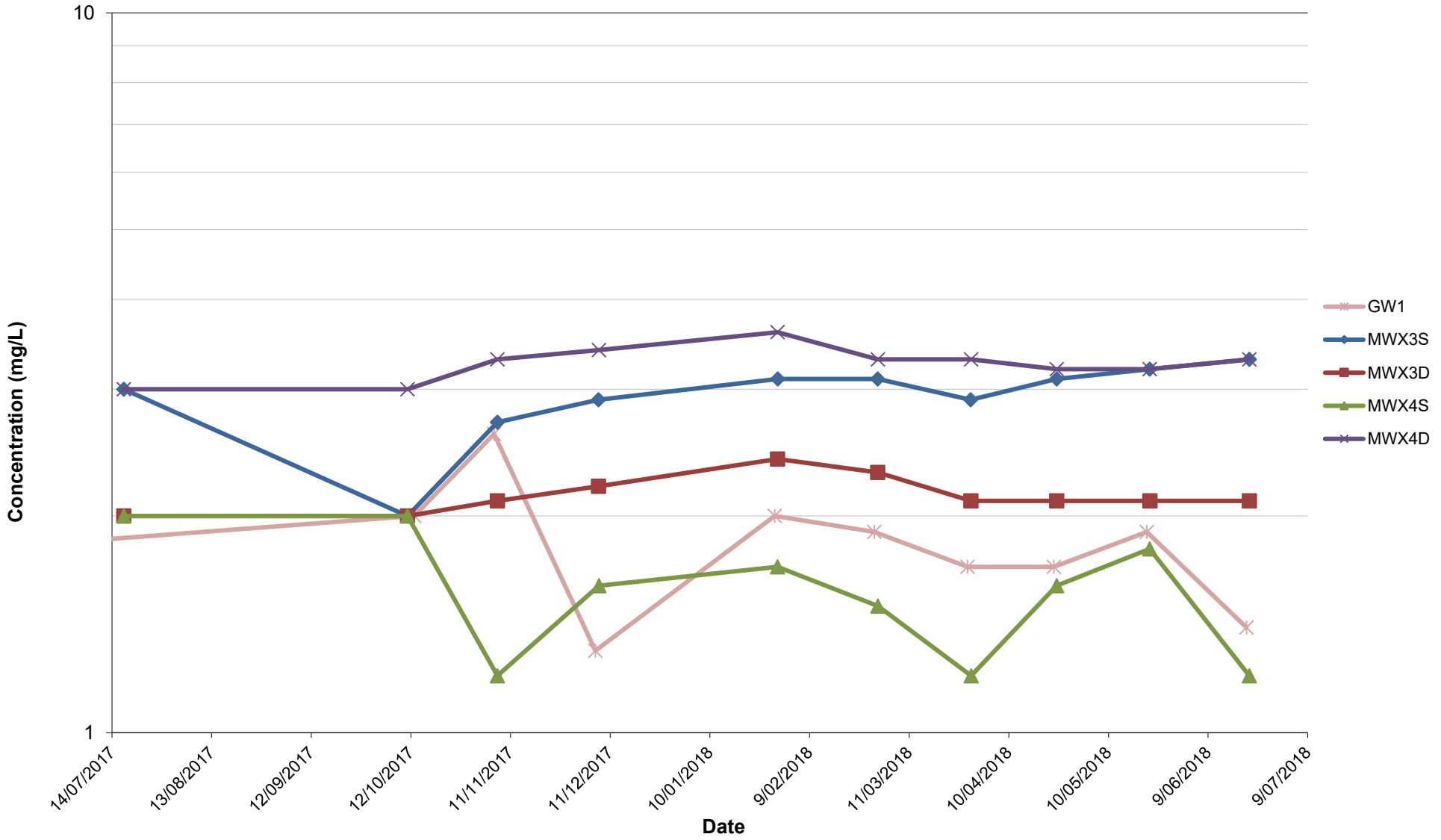


Chart 19 - Chloride concentrations in groundwater

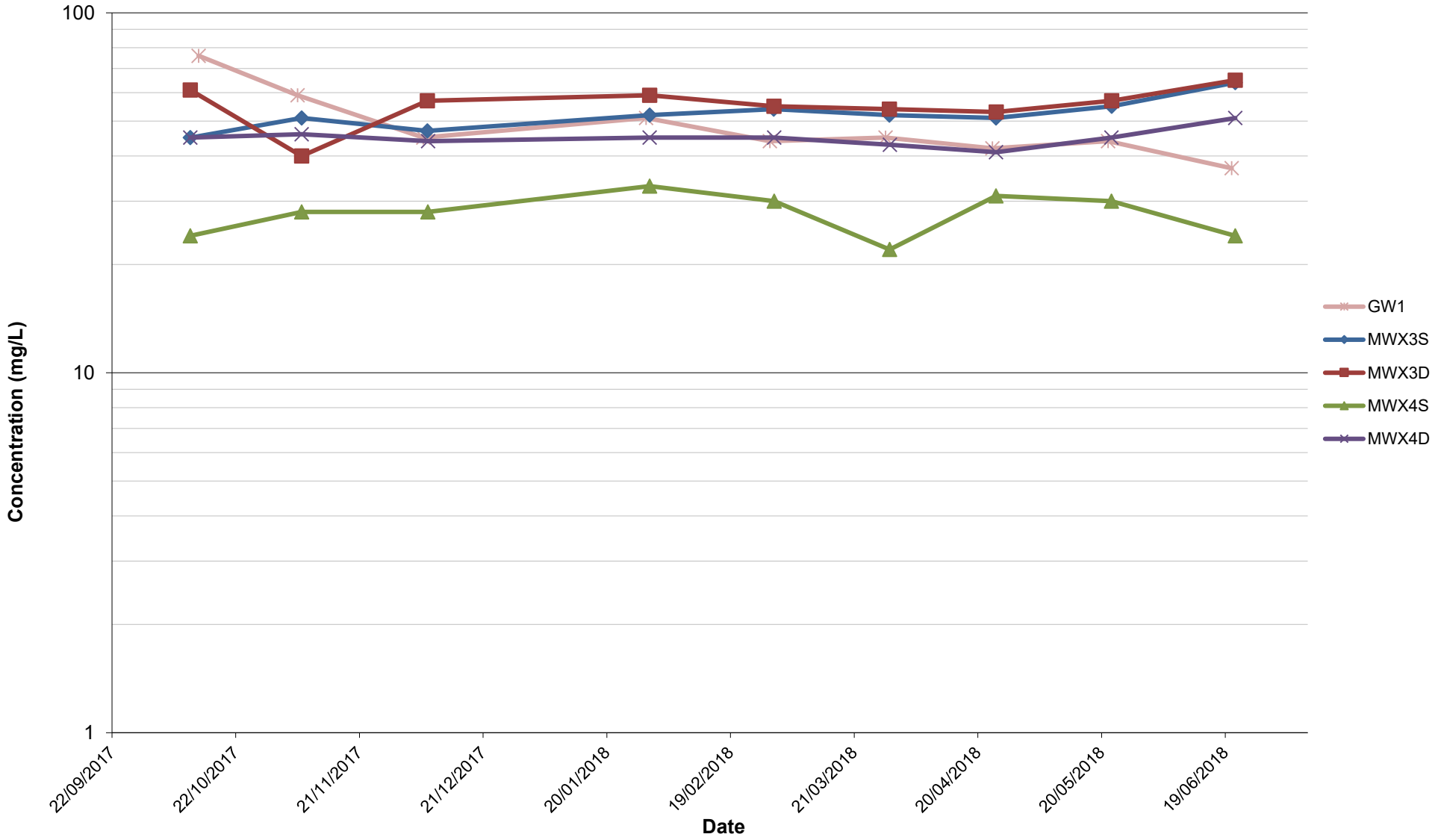


Chart 19

Chart 20 - Nitrate concentrations in groundwater

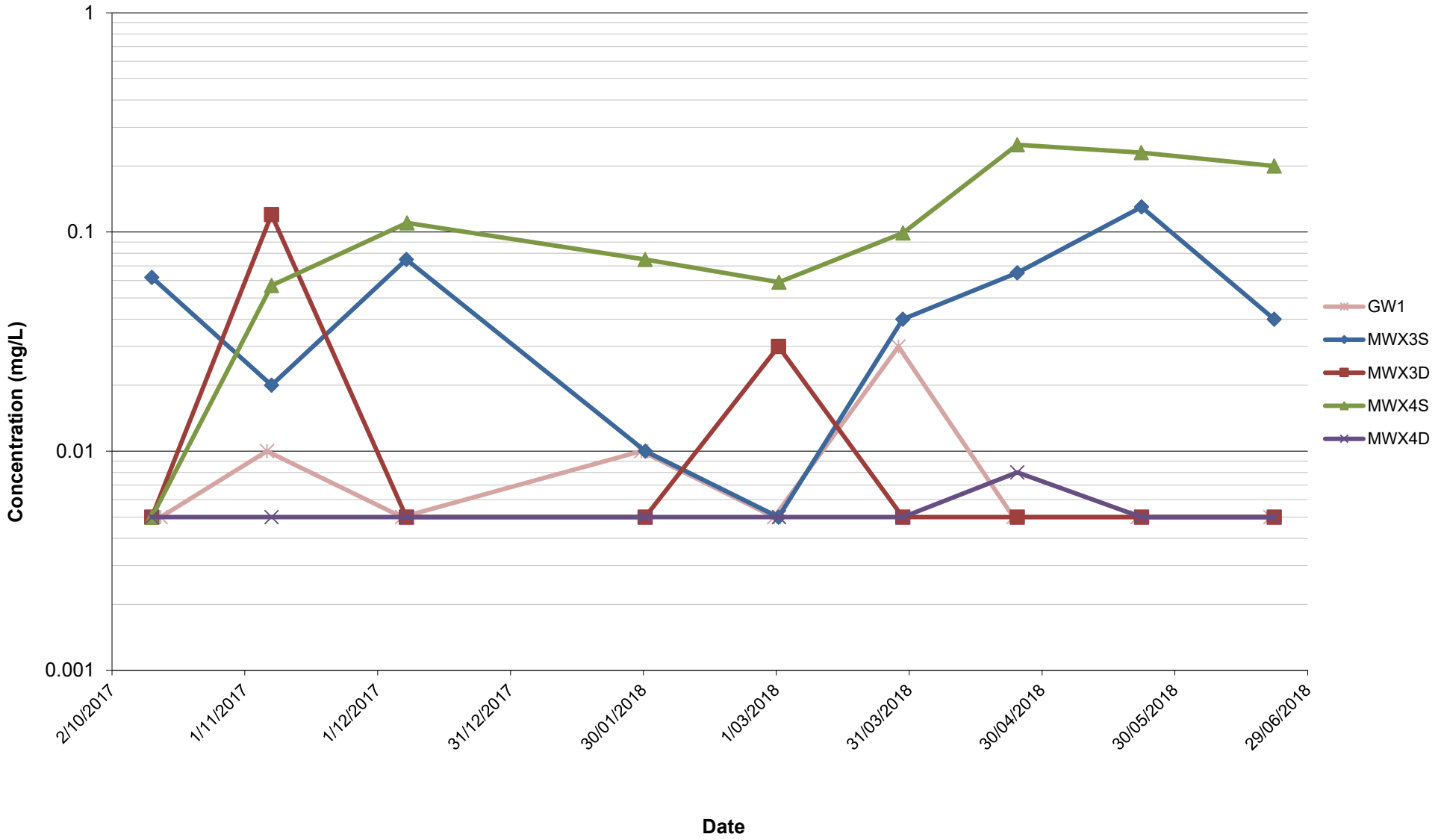


Chart 21 - Phosphate concentrations in groundwater

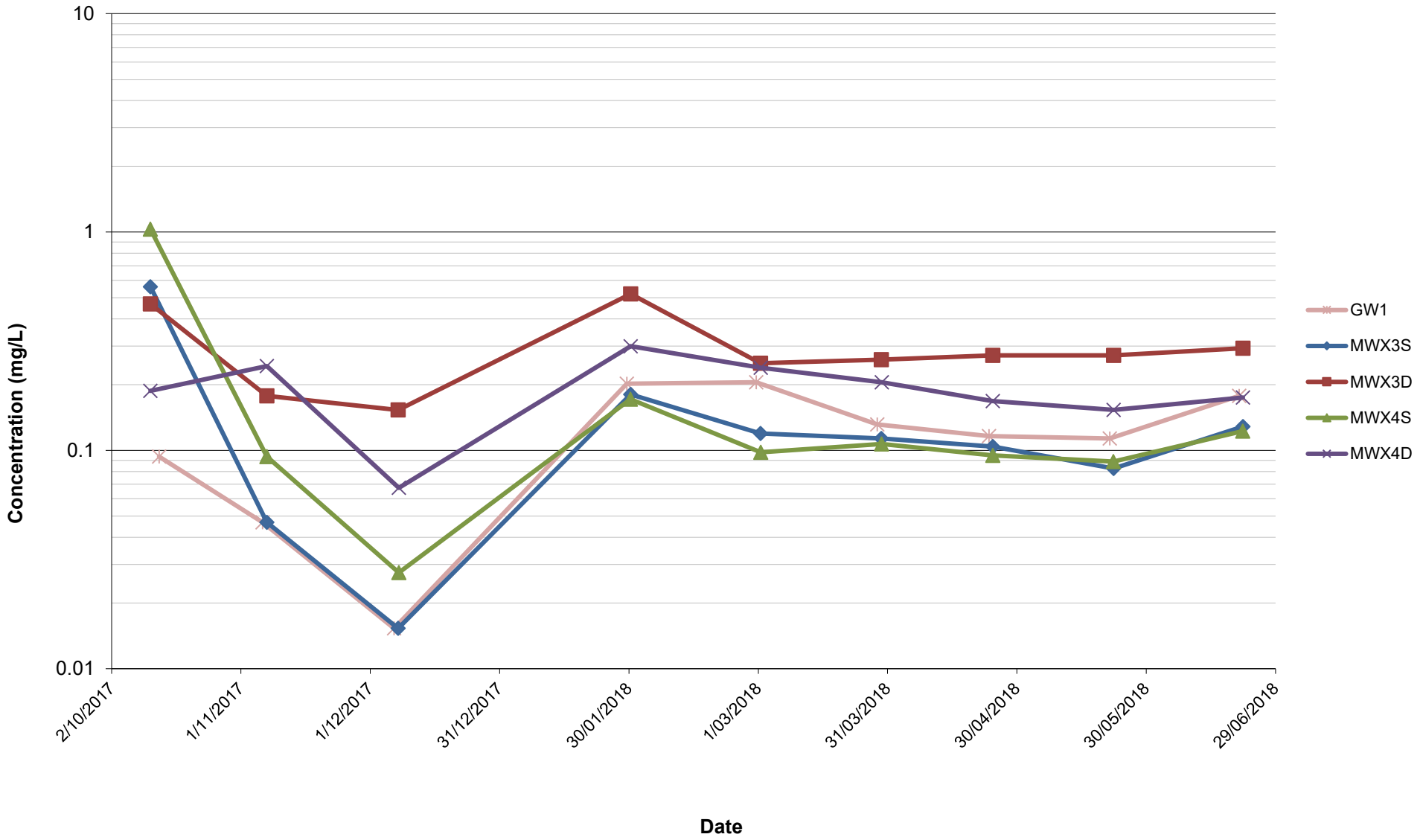


Chart 21

Chart 22 - Sulfate concentrations in groundwater

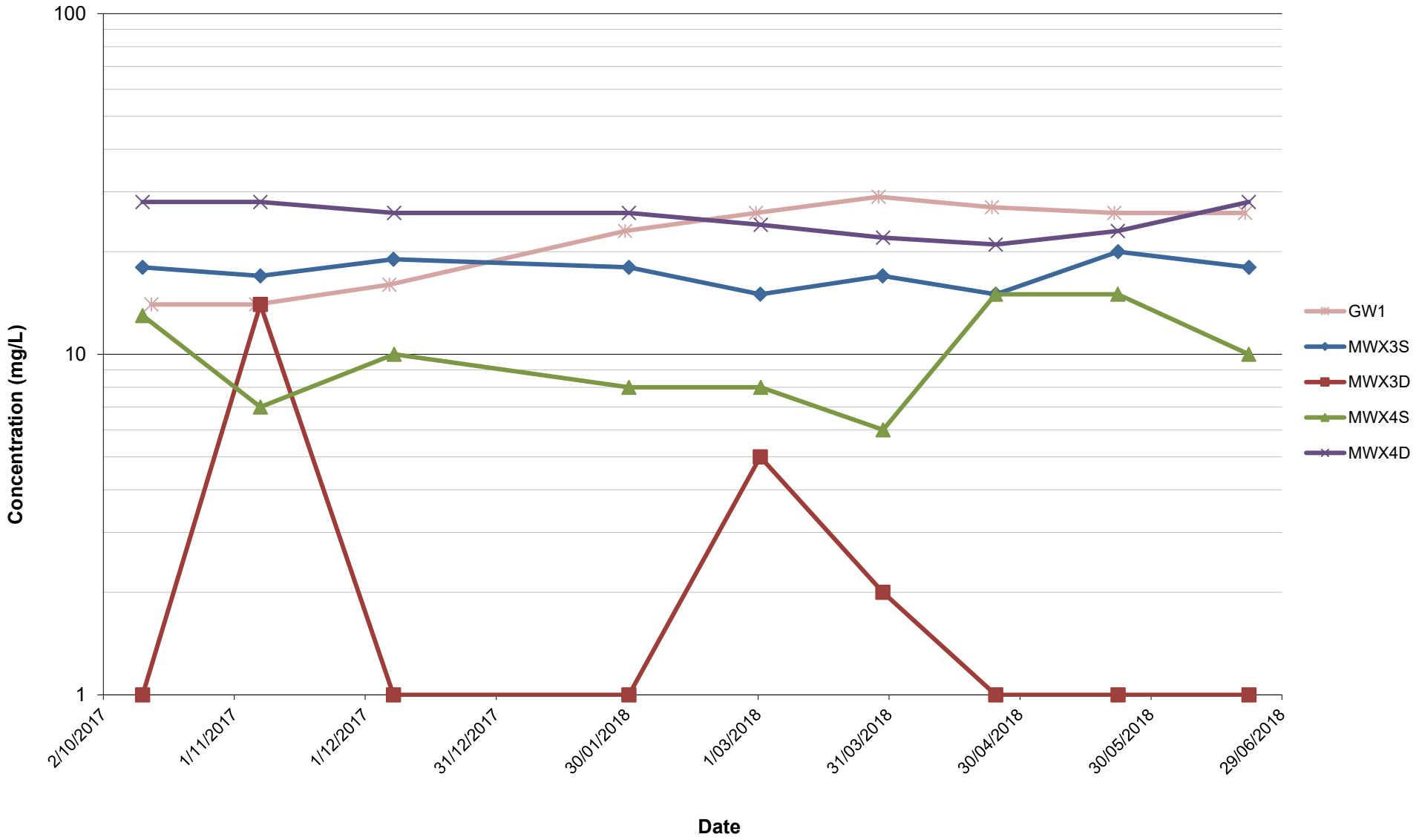


Chart 21

Chart 23 - Bicarbonate concentrations in groundwater

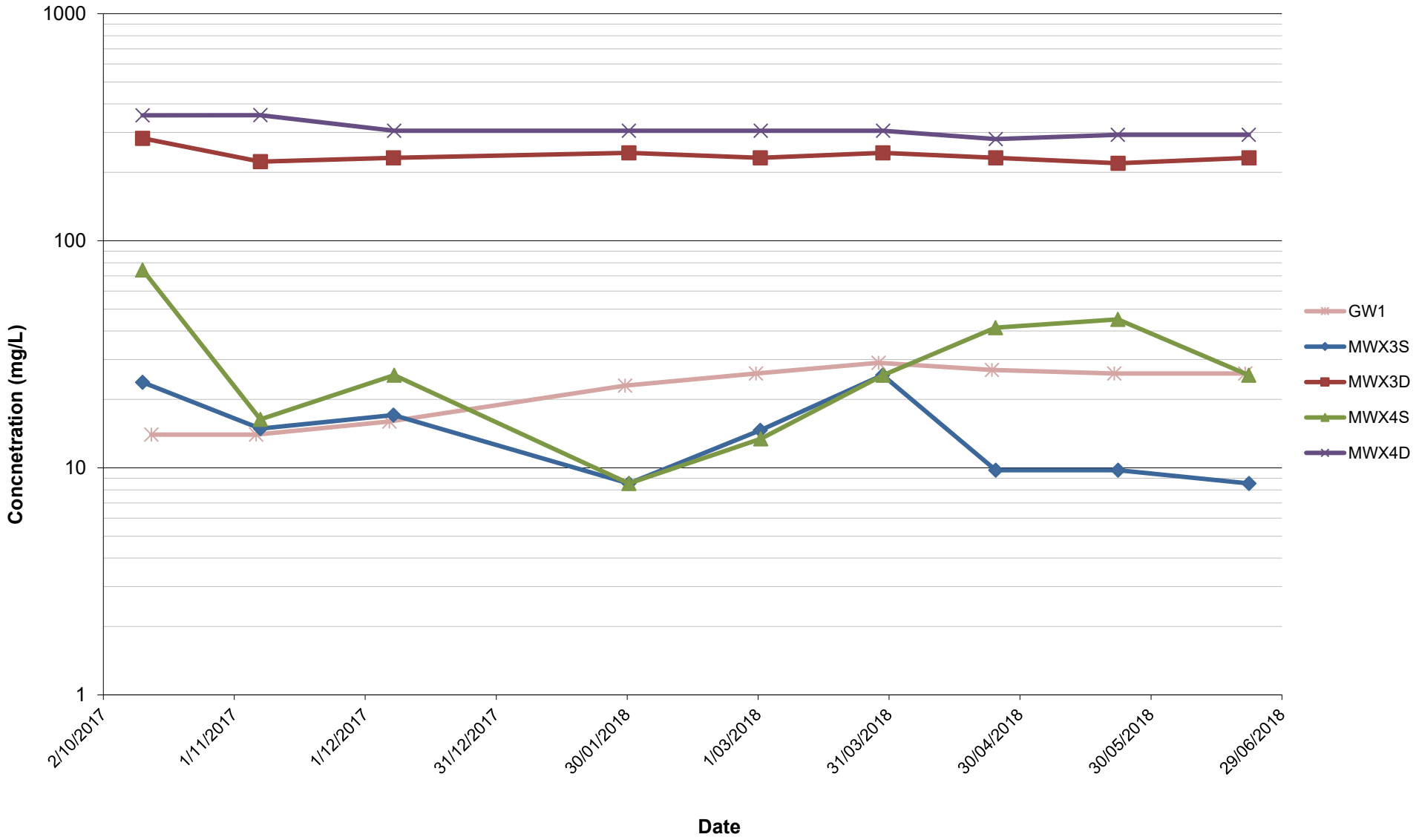


Chart 24 - Ammonia concentrations in groundwater

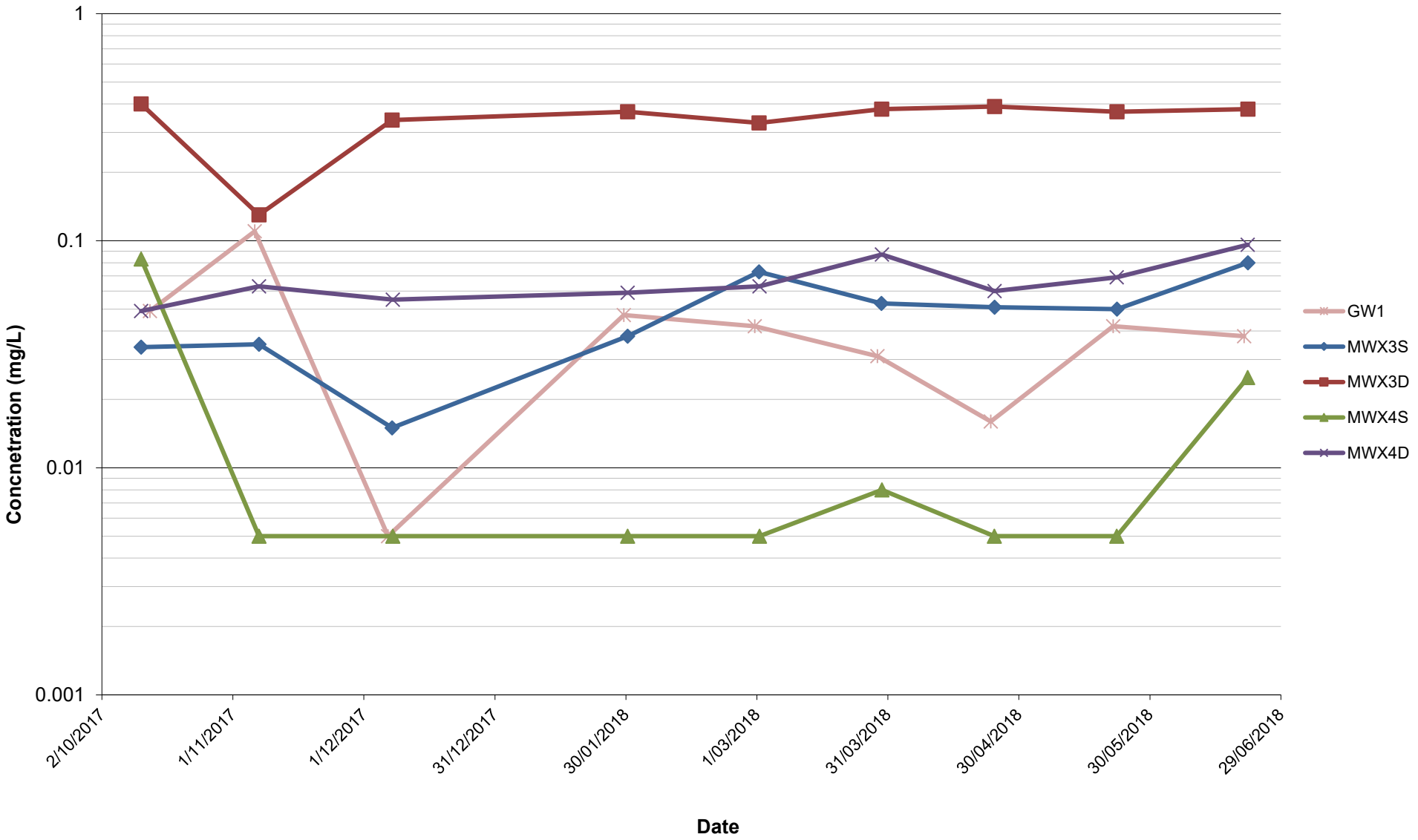
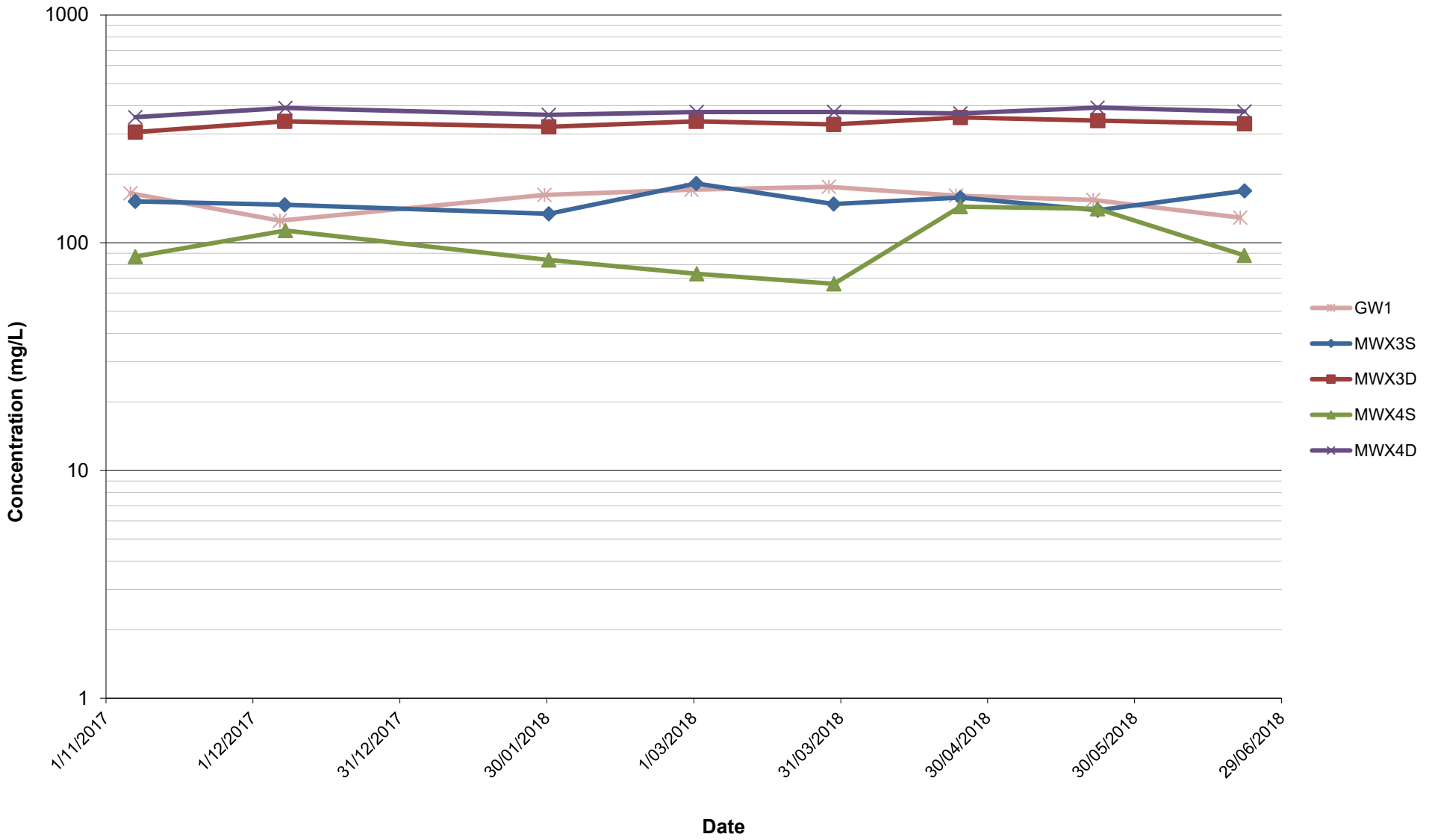


Chart 25 - Total Dissolved Solids concentrations in groundwater



APPENDIX B: GROUNDWATER BORE SEARCH RESULTS

NSW Office of W ater
Work Summary

GW060459

Licence: 20BL134880
Licence Status: LAPSED

Authorised Purpose(s): MINING
Intended Purpose(s): MINING

Work Type: Bore
Work Status:
Construct.Method: Rotary Mud
Owner Type: Private

Commenced Date:
Completion Date: 01/11/1986
Final Depth: 30.00 m
Drilled Depth: 34.00 m

Contractor Name:
Driller: Garry Stanley Strudwick
Assistant Driller:

Property: N/A NSW
GWMA: -
GW Zone: -
Standing W ater Level (m):
Salinity Description:
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	GLOUC	GLOUC.040	173
Licensed:	GLOUCESTER	STOWELL	Whole Lot //

Region: 20 - Hunter
River Basin: 210 - HUNTER RIVER
Area/District:
CMA Map: 9232-2N
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: (Unknown)
Northing: 6366133.0
Easting: 392401.0
Latitude: 32°50'15.3"S
Longitude: 151°51'01.1"E

GS Map: -
MGA Zone: 0
Coordinate Source: GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Annulus	(Unknown)	10.00	34.00	400			Graded
1		Backfill	Backfill	31.00	34.00				
1	1	Casing	Welded Steel	-0.50	20.00	220			Seated on Bottom
1	1	Opening	Screen	20.00	29.00	220		1	Stainless Steel, A: 0.75mm
1	1	Casing	Welded Steel	29.00	31.00	220			

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
20.00	29.00	9.00	Unconsolidated	4.00		43.00			

Geologists Log

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	1.00	1.00	Sand Yellow	Sand	
1.00	2.00	1.00	Sand White	Sand	

2.00	4.00	2.00	Sand Light Brown	Sand	
4.00	6.00	2.00	Sand Grey Fine	Sand	
6.00	9.00	3.00	Sand Grey Coarse	Sand	
9.00	19.00	10.00	Sand Grey Coarse Some Clay	Sand	
19.00	23.00	4.00	Sand Light Brown Coarse Shell Water Supply	Sand	
23.00	30.00	7.00	Sand Grey Coarse Some Small Gravel Water Supply	Sand	
30.00	32.00	2.00	Sand Light Yellow Coarse Some Small Gravel	Sand	
32.00	33.00	1.00	Sand Yellow	Sand	
33.00	34.00	1.00	Clay Grey	Clay	

Remarks

18/08/1988: BACKFILL IS GRAVEL

*** End of GW060459 ***

Warning T o Clients: This raw data has been supplied to the NSW Office of W ater by drillers, licensees and other sources. The NOW does not verify the accuracy of this data. The data is presented for use by you at your own risk. You should consider verifying this data before relying on it. Professional hydrogeological advice should be sought in interpreting and using this data.

NSW Office of W ater
Work Summary

GW062439

Licence: 20BL136178
Licence Status: CONVERTED

Authorised Purpose(s): MINING
Intended Purpose(s): MINING

Work Type: Bore
Work Status:
Construct.Method: Rotary Mud
Owner Type: Private

Commenced Date:
Completion Date: 01/04/1989
Final Depth: 30.00 m
Drilled Depth: 31.00 m

Contractor Name:
Driller: Garry Stanley Strudwick
Assistant Driller:

Property: NOT KNOWN 28 LAVIS LANE WILLIAMTOWN 2318 NSW
GWMA: 025 - TOMAGO TOMAREE STOCKTON
GW Zone: 003 - STOCKTON
Standing W ater Level (m):
Salinity Description:
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	GLOUC	GLOUC.040	173
Licensed:	GLOUCESTER	STOWELL	Whole Lot 911//1008362

Region: 20 - Hunter
River Basin: 210 - HUNTER RIVER
Area/District:
CMA Map: 9232-2N
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: (Unknown)
Northing: 6366008.0
Easting: 392246.0
Latitude: 32°50'19.3"S
Longitude: 151°50'55.1"E

GS Map: -
MGA Zone: 0
Coordinate Source: GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Annulus	(Unknown)	1.00	31.00	400			Graded
1	1	Casing	Steel	-1.00	20.00	220			Seated on Bottom
1	1	Opening	Screen	20.00	29.00	220		1	Stainless Steel, A: 0.75mm
1	1	Casing	Steel	29.00	30.00	220			Seated on Bottom

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
2.00	30.00	28.00	Unconsolidated	2.00		15.00			

Geologists Log

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	3.00	3.00	Sand Yellow Water Supply	Sand	

3.00	5.00	2.00	Sand Light Brown Water Supply	Sand	
5.00	10.00	5.00	Clay Grey Veined Water Supply	Clay	
10.00	12.00	2.00	Sand Grey Silty Water Supply	Sand	
12.00	20.00	8.00	Sand Light Grey Medium Water Supply	Sand	
20.00	27.00	7.00	Sand Light Grey Coarse Water Supply	Sand	
27.00	29.00	2.00	Sand Dark Grey Coarse Water Supply	Sand	
29.00	30.00	1.00	Sand Grey Silty Water Supply	Sand	
30.00	31.00	1.00	Clay Grey	Clay	

Remarks

*** End of GW062439 ***

Warning T o Clients: This raw data has been supplied to the NSW Office of W ater by drillers, licensees and other sources. The NOW does not verify the accuracy of this data. The data is presented for use by you at your own risk. You should consider verifying this data before relying on it. Professional hydrogeological advice should be sought in interpreting and using this data.

NSW Office of W ater
Work Summary

GW078360

Licence: 20WA202361
Licence Status: CANCELLED
Authorised Purpose(s): MINING
Intended Purpose(s):
Work Type: Bore
Work Status:
Construct.Method: Rotary Mud
Owner Type:
Commenced Date:
Completion Date: 08/04/1997
Final Depth: 35.00 m
Drilled Depth: 35.00 m
Contractor Name: INTERTEC DRILLING SERVICES
Driller: Colin Leslie Barden
Assistant Driller:
Property: FULLERTON COVE - MLA 7 OFF LAVIS LANE WILLIAMTOWN 2301
GWMA: 025 - TOMAGO TOMAREE STOCKTON
GW Zone: 003 - STOCKTON
Standing W ater Level (m):
Salinity Description:
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	GLOUC	GLOUC.040	LOT 20 DP 828848
Licensed:	GLOUCESTER	STOWELL	Whole Lot 20//828848

Region: 20 - Hunter
River Basin: - Unknown
Area/District:
CMA Map:
Grid Zone:
Scale:
Elevation: 0.00 m (A.H.D.)
Elevation Source: Unknown
Northing: 6363612.0
Easting: 390011.0
Latitude: 32°51'36.3"S
Longitude: 151°49'28.1"E
GS Map: -
MGA Zone: 0
Coordinate Source: Unknown

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	35.00	350			Rotary Mud
1		Annulus	Crushed Aggregate	0.00	9.00				Graded, Q:0.600m3
1		Annulus	Crushed Aggregate	9.00	27.60				Graded, Q:1.200m3
1	1	Casing	Steel	0.70	27.60	219			Suspended in Clamps, Welded
1	1	Opening	Screen	17.00	26.40	219		1	Stainless Steel, Welded, A: 0.90mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
3.00	35.00	32.00	Unknown	2.00		20.00	16.50	01:00:00	290.00

Geologists Log

Drillers Log

From	To	Thickness	Drillers Description	Geological Material	Comments

(m)	(m)	(m)			
0.00	2.10	2.10	dark grey coarse grain sand	Sand	
2.10	12.30	10.20	sand	Sand	
12.30	17.70	5.40	crushed shell/sand red	Sand	
17.70	26.30	8.60	brown coarse grain sand	Sand	
26.30	33.40	7.10	crushed shell/sand red	Sand	
33.40	35.00	1.60	light brown coarse grain sand	Sand	

Remarks

*** End of GW078360 ***

Warning T o Clients: This raw data has been supplied to the NSW Office of W ater by drillers, licensees and other sources. The NOW does not verify the accuracy of this data. The data is presented for use by you at your own risk. You should consider verifying this data before relying on it. Professional hydrogeological advice should be sought in interpreting and using this data.

NSW Office of W ater
Work Summary

GW078361

Licence: 20WA202361
Licence Status: CANCELLED

Authorised Purpose(s): MINING
Intended Purpose(s):

Work Type: Bore
Work Status:
Construct.Method: Rotary Mud
Owner Type:

Commenced Date:
Completion Date: 05/04/1997
Final Depth: 34.50 m
Drilled Depth: 34.50 m

Contractor Name: INTERTEC DRILLING SERVICES
Driller: Colin Leslie Barden
Assistant Driller:

Property: FULLERTON COVE - MLA 7 OFF LAVIS LANE WILLIAMTOWN 2301
GWMA: 025 - TOMAGO TOMAREE STOCKTON
GW Zone: 003 - STOCKTON
Standing W ater Level (m):
Salinity Description:
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	GLOUC	GLOUC.040	LOT 20 DP 828848
Licensed:	GLOUCESTER	STOWELL	Whole Lot 20//828848

Region: 20 - Hunter
River Basin: - Unknown
Area/District:
CMA Map:
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: Unknown
Northing: 6363736.0
Easting: 390139.0
Latitude: 32°51'32.3"S
Longitude: 151°49'33.1"E

GS Map: -
MGA Zone: 0
Coordinate Source: Unknown

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	34.50	350			Rotary Mud
1		Annulus	Waterworn/Rounded	0.00	14.00				Graded, Q:0.840m3
1		Annulus	Waterworn/Rounded	14.00	30.00				Graded, Q:1.200m3
1	1	Casing	Steel	0.70	30.00	219			Suspended in Clamps, Welded
1	1	Opening	Screen	19.50	28.90	219		1	Stainless Steel, Welded, A: 0.90mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
3.00	34.50	31.50	Unknown	2.00		20.00	19.00	01:00:00	280.00

Geologists Log

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	1.30	1.30	grey coarse grain sand	Sand	

1.30	2.40	1.10	dark grey coarse grain sand	Sand	
2.40	9.00	6.60	indurated sand	Sand	
9.00	13.70	4.70	shell/sand layer	Sand	
13.70	21.00	7.30	brown coarse grey sand	Sand	
21.00	29.30	8.30	crushed shell/sand bed	Sand	
29.30	34.50	5.20	light brown coarse grain sand	Sand	

Remarks

*** End of GW078361 ***

Warning T o Clients: This raw data has been supplied to the NSW Office of W ater by drillers, licensees and other sources. The NOW does not verify the accuracy of this data. The data is presented for use by you at your own risk. You should consider verifying this data before relying on it. Professional hydrogeological advice should be sought in interpreting and using this data.

NSW Office of W ater
Work Summary

GW079736

Licence: 20BL167158
Licence Status: CONVERTED

Authorised Purpose(s): DOMESTIC
Intended Purpose(s): DOMESTIC

Work Type: Bore
Work Status:
Construct.Method:
Owner Type:

Commenced Date:
Completion Date:
Final Depth:
Drilled Depth:

Contractor Name:
Driller:
Assistant Driller:

Property: N/A 220 FULLERTON COVE ROAD FULLERTON COVE 2318
GWMA: 025 - TOMAGO TOMAREE STOCKTON
GW Zone: 003 - STOCKTON
Standing W ater Level (m):
Salinity Description:
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	GLOUC	GLOUC.039	PORTION 19)
Licensed:	GLOUCESTER	STOCKTON	Whole Lot 343//719242

Region: 20 - Hunter
River Basin: - Unknown
Area/District:
CMA Map:
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: Unknown
Northing: 6365083.0
Easting: 389396.0
Latitude: 32°50'48.3"S
Longitude: 151°49'05.1"E

GS Map: -
MGA Zone: 0
Coordinate Source: Unknown

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

Geologists Log
Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments

Remarks

30/11/2009: Reviewed data - nothing to update.

*** End of GW079736 ***

Warning T o Clients: This raw data has been supplied to the NSW Office of W ater by drillers, licensees and other sources. The NOW does not verify the accuracy of this data. The data is presented for use by you at your own risk. You should consider verifying this data before relying on it. Professional hydrogeological advice should be sought in interpreting and using this data.

NSW Office of W ater
Work Summary

GW079778

Licence: | Licence Status:

Authorised Purpose(s):
Intended Purpose(s):

Work Type: Bore
Work Status:
Construct.Method:
Owner Type:

Commenced Date: | Final Depth:
Completion Date: | Drilled Depth:

Contractor Name:
Driller:
Assistant Driller:

Property: | Standing W ater Level (m):
GWMA: | Salinity Description:
GW Zone: | Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	GLOUC	GLOUC.040	LTPT3 DP753192
Licensed:			

Region: 20 - Hunter | CMA Map:
River Basin: - Unknown | Grid Zone: | Scale:
Area/District:

Elevation: 0.00 m (A.H.D.) | Northing: 6364173.0 | Latitude: 32°51'18.3"S
Elevation Source: (Unknown) | Easting: 390628.0 | Longitude: 151°49'52.1"E

GS Map: - | MGA Zone: 0 | Coordinate Source: Unknown

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

Geologists Log
Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments

Remarks

10/12/1999: Form A Remarks:
Boral Country Fullerton Cove Monitoring Bores, stockton beach Newcastle
Bore No GW4
30/11/2009: Reviewed data - nothing to update.

*** End of GW079778 ***

Warning T o Clients: This raw data has been supplied to the NSW Office of W ater by drillers, licensees and other sources. The NOW does not verify the accuracy of this data. The data is presented for use by you at your own risk. You should consider verifying this data before relying on it. Professional hydrogeological advice should be sought in interpreting and using this data.

NSW Office of W ater
Work Summary

GW200423

Licence: 20CA203259
Licence Status: CURRENT

Authorised Purpose(s): IRRIGATION
Intended Purpose(s): STOCK, DOMESTIC

Work Type: Bore
Work Status: New Bore
Construct.Method: Auger - Hollow Flight
Owner Type: Private

Commenced Date:
Completion Date: 24/08/2005
Final Depth: 20.00 m
Drilled Depth: 20.00 m

Contractor Name: KF & BL GIGGINS PTY. LTD.
Driller: Kenneth Frank Giggins
Assistant Driller:

Property: N/A 85 NELSON BAY ROAD FERN BAY NSW
GWMA: 025 - TOMAGO TOMAREE STOCKTON
GW Zone: 003 - STOCKTON
Standing W ater Level: 3.000
Salinity:
Yield:

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	GLOUC	GLOUC.39	16//258848
Licensed:	GLOUCESTER	STOCKTON	Whole Lot 1//270466

Region: 20 - Hunter
River Basin: - Unknown
Area/District:
CMA Map:
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: Unknown
Northing: 6363887.0
Easting: 388749.0
Latitude: 32°51'26.9"S
Longitude: 151°48'39.7"E

GS Map: -
MGA Zone: 0
Coordinate Source: GPS - Global Positioning System

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	20.00	250			Auger - Hollow Flight
1		Annulus	Waterworn/Rounded	10.00	18.00				Graded, Q:172.000m3, PL:Poured/Shovelled
1	1	Casing	Pvc Class 9	-0.50	18.00	162	150		Seated on Bottom, Glued
1	1	Opening	Slots - Horizontal	12.00	18.00	162		1	Casing - Machine Slotted, PVC Class 9, Glued, SL: 32.0mm, A: 0.25mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
6.00	18.00	12.00	Unknown	3.00				01:00:00	

Geologists Log

Drillers Log

From	To	Thickness	Drillers Description	Geological Material	Comments

(m)	(m)	(m)			
0.00	1.00	1.00	Top sand fill	Topsoil	
1.00	6.00	5.00	Dark clayey sand	Clayey Sand	
6.00	18.00	12.00	Light grey sand med to coarse	Sand	
18.00	20.00	2.00	Light grey fine sand	Sand	

Remarks

08/06/2011: Karla Abbs, 8-Jun-2011: Corrected Rock Types in Drillers Log

*** End of GW200423 ***

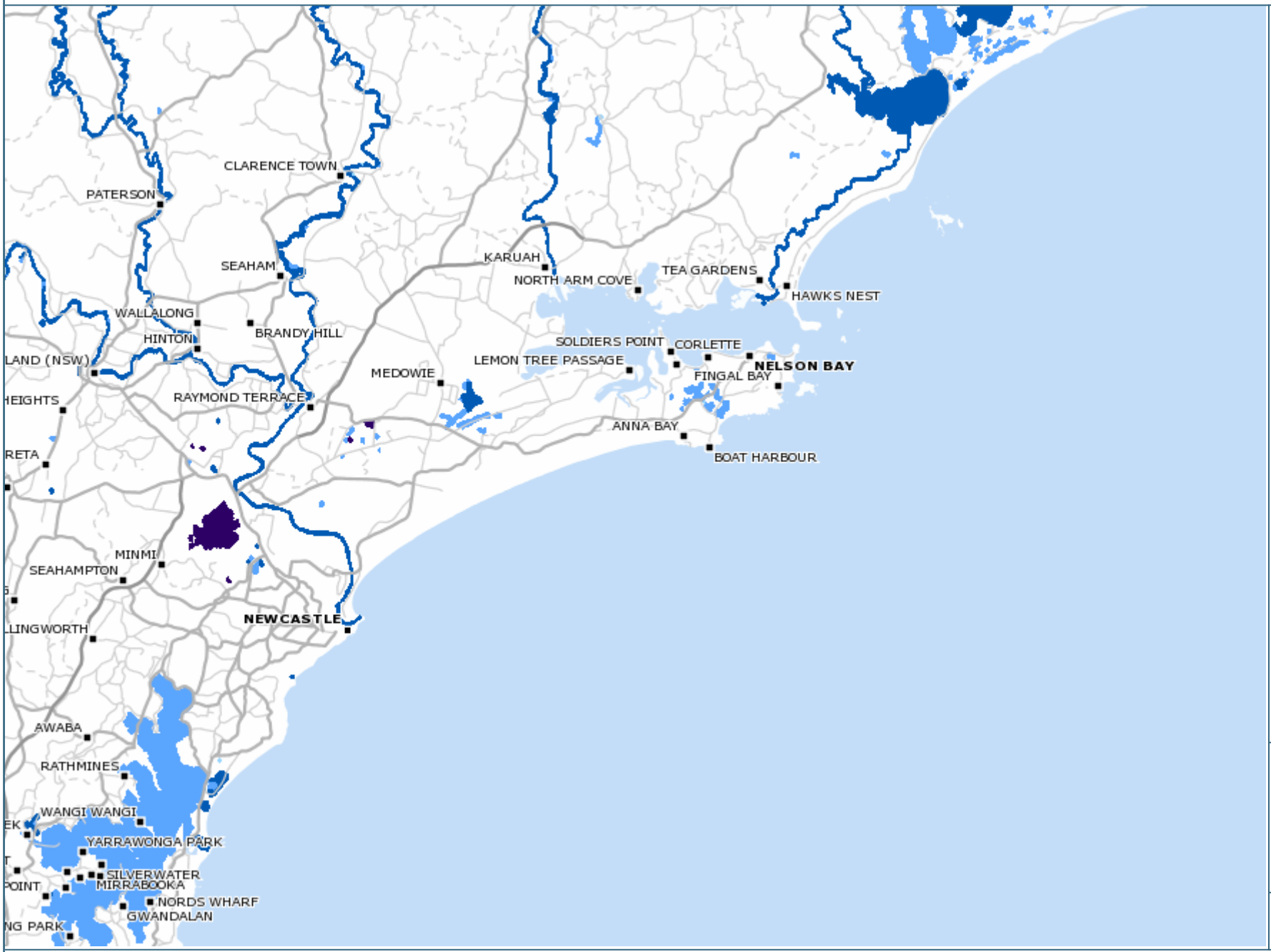
Warning T o Clients: This raw data has been supplied to the NSW Office of W ater by drillers, licensees and other sources. The NOW does not verify the accuracy of this data. The data is presented for use by you at your own risk. You should consider verifying this data before relying on it. Professional hydrogeological advice should be sought in interpreting and using this data.

APPENDIX C: GROUNDWATER DEPENDENT ECOSYSTEMS MAP REPORTS

Australian Government
Bureau of Meteorology

Groundwater Dependent Ecosystems Atlas

717041 Aquatic GDEs



Aquatic Inflow Dependent Ecosystem (IDE), reliant on water in addition to rainfall

- Highly likely to be an IDE
- Likely to be an IDE

Aquatic GDE

- Known GDE - from regional s
- High potential GDE - from r
- Moderate potential GDE - fr
- Low potential GDE - from re
- Unclassified potential GDE
- High potential GDE - from n
- Moderate potential GDE - fr
- Low potential GDE - from na
- Unclassified potential GDE

Aquatic Inflow Dependent Ecosystem (IDE), reliant on water in addition to rainfall

- Highly likely to be an IDE
- Likely to be an IDE

Aquatic Inflow Dependent

N

1:539,698

Kilometres 10 20

Data Source: Bureau of Meteorology, Geoscience Australia and State/Territory lead water agencies. Refer to metadata for further information: Click here

Australian Albers GDA94

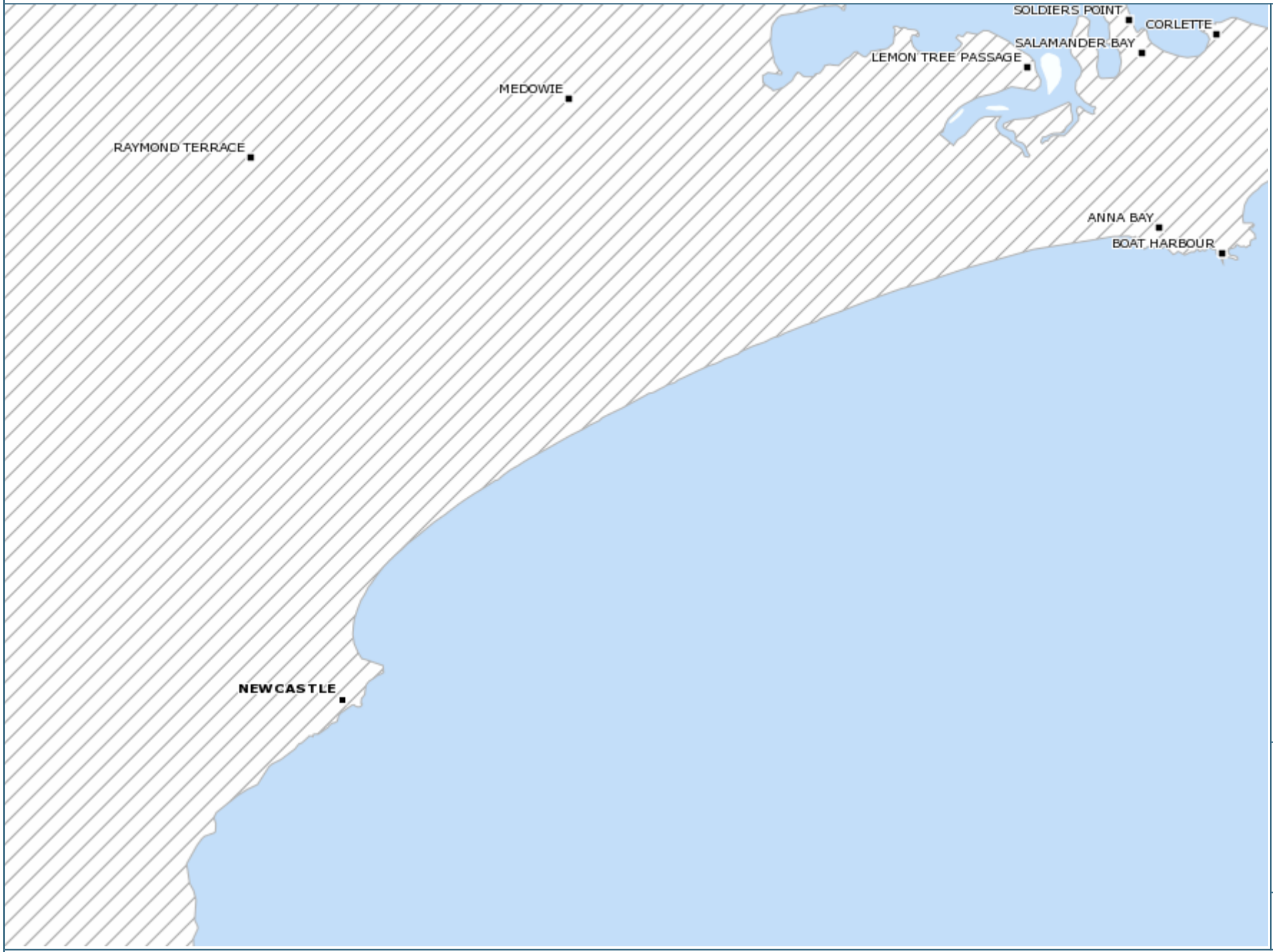
CC BY

Date: 4 February, 2018

Australian Government
Bureau of Meteorology

Groundwater Dependent Ecosystems Atlas

717041 Subterranean GDEs



Subterranean GDE (no data)

No ecosystems analysed

Subterranean GDE

Known GDE - from regional s
High potential GDE - from r
Moderate potential GDE - fr
Low potential GDE - from re
Unclassified potential GDE

N

1:222,406

Kilometres 5

Data Source: Bureau of Meteorology, Geoscience Australia and State/Territory lead water agencies. Refer to metadata for further information: Click here

Australian Albers GDA94

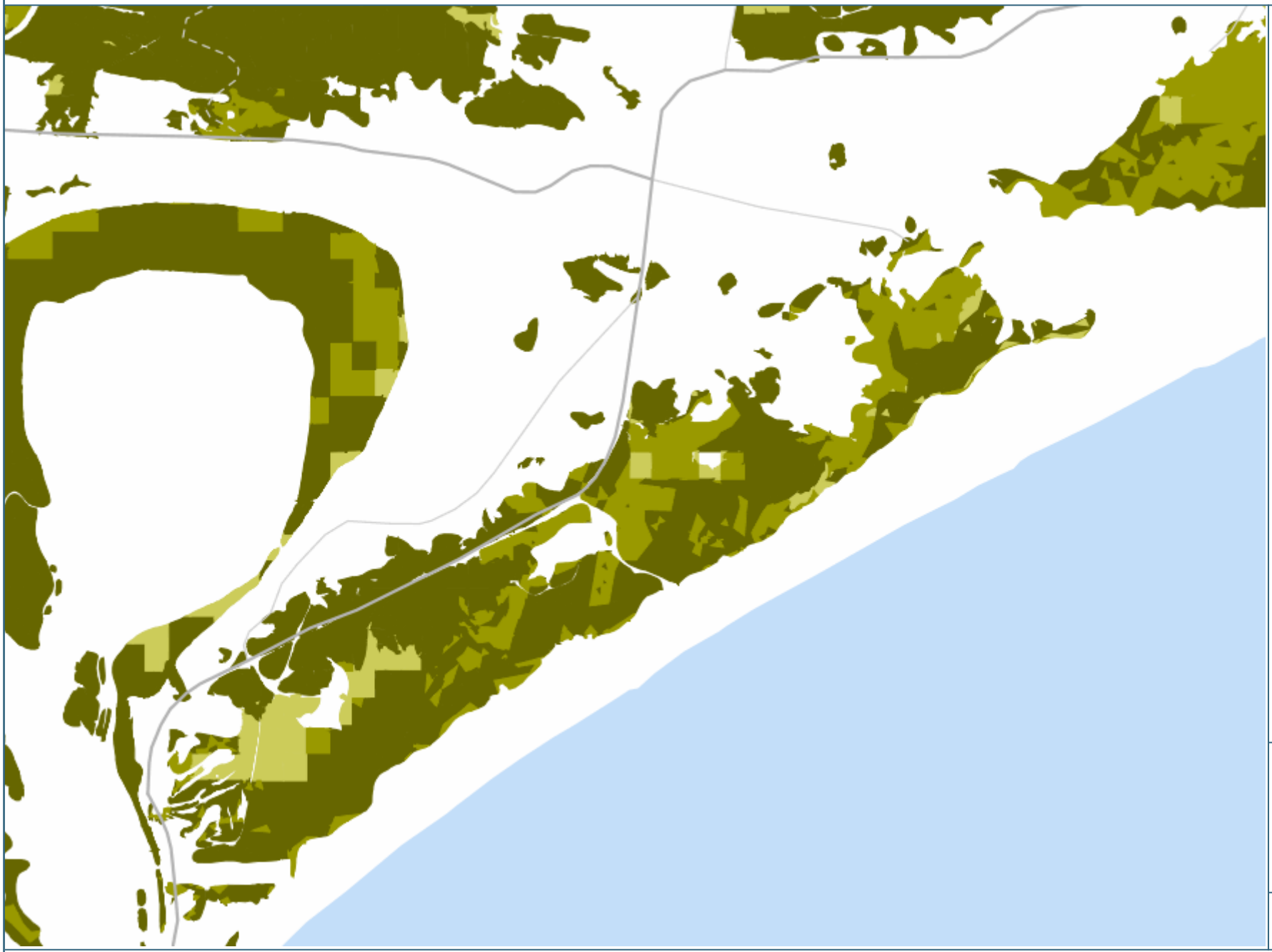
CC BY

Date: 4 February, 2018

Australian Government
Bureau of Meteorology

Groundwater Dependent Ecosystems Atlas

717041 Terrestrial GDEs



Data Source: Bureau of Meteorology, Geoscience Australia and State/Territory lead water agencies. Refer to metadata for further information: Click here

Australian Albers GDA94

CC BY

Date: 4 February, 2018

APPENDIX D: BORELOGS

LOCATION:	Fullerton Cove	JOB No.	717041	TRENCH NUMBER:	BH1	LOGGED BY:
EASTING:		DRILL TYPE:	Sonic Drill			LV
NORTHING:		DATE STARTED:	12/03/18	CLIENT:	Element Environment	APPROVED:
ELEVATION:		DATE FINISHED:	12/03/18			LV

Water Level
▼ Water level
▽ Potential water level range
Moisture
D=Dry M=Moist MS=Moist Saturated S=Saturated

PAGE #: 1 / 1

Depth (metres).	STRATIGRAPHY	GRAPHIC LOG	SAMPLES: Sample Interval	Moisture	pH Field	pH FOX	Water Level	COMMENTS
0	FILL: Loose grey-brown SAND with chitter gravels of mixed lithology and coal.			D	6.9	5.7		
1				M	7.2	6.1		
	FILL: Loose, faun SAND of homogeneous medium grain size.			MS	6.8	3.7	▼	
2	FILL: Loose, dark brown SAND of homogeneous medium grain size.			MS	6.5	4.9		
3	FILL: Loose, faun SAND of medium - coarse grain size.			MS	6.5	3.6		
4	FILL: Loose brown SAND of medium - coarse grain size with chitter.			MS	6.2	3.7		
5	NATURAL: Loose, faun - brown SAND of medium grain size.							
6								
7	NATURAL: Loose, light brown - grey SAND of medium grain size.			MS	5.4	3.2		
8								
9								
10								
11	NATURAL: Loose, light grey SAND with medium - coarse grain size, shell grit present.			MS	6.3	6.1		
12	NATURAL: Loose, grey SAND of medium grain size, minor shell grit present.			MS	7.8	6.1		
13								
14								
15								
16	NATURAL: Loose, grey SAND of medium - coarse grain size, shell grit present.			MS	8.3	6.1		
17								
18								
19	End of core @ 18.0m (> 16m below the water table).							

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

LOCATION:	Fullerton Cove	JOB No.	717041	TRENCH NUMBER:	BH2	LOGGED BY:
EASTING:		DRILL TYPE:	Sonic Drill			LV
NORTHING:		DATE STARTED:	13/03/18	CLIENT:	Element Environment	APPROVED:
ELEVATION:		DATE FINISHED:	13/03/18			LV

Water Level
▼ Water level
▽ Potential water level range
Moisture
D=Dry M=Moist MS=Moist Saturated S=Saturated

PAGE #: 1 / 1

Depth (metres)	STRATIGRAPHY	GRAPHIC LOG	SAMPLES: Sample Interval	Moisture	pH Field	pH FOX	Water Level	COMMENTS
0	NATURAL: Loose, light brown SAND.			D	8.7	6.6		
1	NATURAL: Loose, cream - light brown SAND of medium grain size. Both chitter gravels and brick present.							
2				M	5.0	1.3	▽	
3	NATURAL: Loose, dark brown - black SAND of medium grain size. Organic layer present.			M	6.5	2.8		
4	NATURAL: Loose, light brown - grey SAND of medium coarse grain size.			M	6.4	5.2		
5	NATURAL: Loose cream - light brown SAND of medium - coarse grain size.							
6	Minor presence of organics.			MS	6.2	5.6	▽	
7								
8								
9	NATURAL: Loose, light brown - brown SAND of medium grain size.			MS	6.4	3.1		
10								
11								
12	NATURAL: Loose, cream SAND of medium grain size.			MS	6.9	5.8		
13								
14								
15								
16	NATURAL: Loose, light grey SAND of medium grain size.			MS	6.5	5.5		
17								
18								
19								
20	Grading to grey mottle.			MS	6.0	6.4		
21								
22								
23								
24				MS	6.6	6.1		
25	End of core @ 24.0m (> 16m below the water table).							

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

LOCATION:	Fullerton Cove	JOB No.	717041	TRENCH NUMBER:	BH3	LOGGED BY:
EASTING:		DRILL TYPE:	Sonic Drill			LV
NORTHING:		DATE STARTED:	13/03/18	CLIENT:	Element Environment	APPROVED:
ELEVATION:		DATE FINISHED:	13/03/18			LV

Water Level
▼ Water level
▽ Potential water level range
Moisture
D=Dry M=Moist MS=Moist Saturated S=Saturated

PAGE #: 1 / 1

Depth (metres)	STRATIGRAPHY	GRAPHIC LOG	SAMPLES: Sample Interval	Moisture	pH Field	pH FOX	Water Level	COMMENTS
0	FILL: Loose, grey SAND of medium grain size.			D	7.2	6.9		
3	FILL: Loose, dark brown, loamy SAND of fine - medium grain size. Both chitter gravels and organics present.			DM	7.4	6.5		
				DM	7.7	5.9		
4				DM	7.4	5.7		
	NATURAL: Loose, cream SAND of medium grain size with brown mottle.							
5	NATURAL: Loose, cream SAND of medium grain size.						▽	
6				MS	7.0	5.8	▽	
8	Becoming medium - coarse grain size.			MS	7.1	5.7		
9	NATURAL: Loose, grey- brown SAND of medium grain size.			MS	6.9	2.6		
12	NATURAL: Loose, light grey SAND of medium grain size. Shell grit and fine gravels present.			MS	7.4	6.3		
15	Grading to dark grey mottle.			MS	8.2	6.2		
16	NATURAL: Loose, grey SAND with minor shell grit present.							
18	NATURAL: Loose, yellow - grey SAND of medium grain size.			MS	6.8	5.9		
21	End of core @ 21.0m (> 16m below the water table).							
22								

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

LOCATION: Stockton	JOB No. 717041	TRENCH NUMBER: BH4	LOGGED BY:
EASTING:	DRILL TYPE: Sonic Drill		LV
NORTHING:	DATE STARTED: 14/03/18	CLIENT: Element Environment	APPROVED:
ELEVATION:	DATE FINISHED: 14/03/18		LV

Water Level
▼ Water level
▽ Potential water level range
Moisture
D=Dry M=Moist MS=Moist Saturated S=Saturated

PAGE #: 1 / 1

Depth (metres)	STRATIGRAPHY	GRAPHIC LOG	SAMPLES: Sample Interval	Moisture	pH Field	pH FOX	Water Level	COMMENTS
0	FILL: Loose, grey SAND of medium grain size. Gravels and organics present.			D	7.2	5.5		
1								
2	FILL: Loose, grey SAND with chitter and gravels present.			DM	7.3	5.1		
3								
4	NATURAL: Loose, coffee SAND of medium grain size.			MS	7.5	4.8	▽ ▽	
5	NATURAL: Loose, milk - coffee SAND of medium grain size.			MS	7.4	5.0		
6	NATURAL: Loose, light brown SAND of medium grain size.			MS	7.3	3.0		
7								
8								
9				MS	7.0	2.6		
10								
11								
12	NATURAL: Loose, grey SAND of medium grain size.			MS	7.4	4.6		
13								
14								
15	NATURAL: Loose, brown SAND of medium grain size.			MS	7.2	3.9		
16	NATURAL: Loose, light grey SAND of medium grain size.			MS	7.2	2.6		
				MS	7.5	6.1		
17	NATURAL: Loose, dark grey SAND of medium - coarse grain size. Shell grit present.			MS	8.7	5.6		
18	NATURAL: Loose, light brown - grey SAND of medium grain size.							
19								
20								
21	NATURAL: Loose, white- light grey SAND of fine - medium grain size.			MS	8.8	6.1		
22	End of core @ 21.0m (> 16m below the water table).							

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Department of Primary Industries Water

Form A Particulars of completed work

Driller's Licence No:	1772	1
Class of Licence:	4	
Driller's Name:	Peter Stewart	
Assistant Driller:	BLAKE Stewart	
Contractor:	Port Stephens Drilling	
New bore		Replacement bore
Deepened		Enlarged
Reconditioned		Other (specify)
Final Depth	12.18 m	Monitoring Well 12.18

Work Licence No:	MW x 1	2
Name of Licensee:	Coal Resources PTY LTD	
Intended Use:	Monitoring Wells	
Completion Date:	5-5-17	

DRILLING DETAILS 3

From (m)	To (m)	Hole Diameter (mm)	Drilling Method See Code 3
0	12.18	101	1

WATER BEARING ZONES 4

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method See Code 4		D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)
5.46	12.18	6.72	5.46									

CASING / LINER DETAILS 5

Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code 5
8	60.33	5.02		12.18	5

Casing support method — See Code 5: 2

Type of casing bottom — See Code 5: 2

Centralisers installed (Yes/No): NO (indicate on sketch)

Sump installed (Yes/No): NO From m To m

Pressure cemented (Yes/No): NO From m To m

Casing Protector cemented in place

WATER ENTRY DESIGN 6

General Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Opening type See Code 6	Fixing See Code 5	Screen Aperture (mm)	Slot Details Length (mm)	Width (mm)	Alignment See Code 6
8	60.33	5.02	12.18	9.18	5	5	0.5	3000	60.33	H

GRAVEL PACK 7

Type		Grade		Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity m^3
Rounded		Graded	/	8	16	12.18	3.18	180	
Crushed		Ungraded				3.18	2.18		
Bentonite/Grout seal (Yes/No)	Yes								
Method of placement of Gravel Pack		See Code 7	2						

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Department of Primary Industries Water

Form A Particulars of completed work

Work Licence No: MW-X1

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud (Yes/No) NO Name: Base Resources PTY LTD

Method	Bailing/Surging	Jetting	Airlifting	Backwashing	Pumping	Other:
Duration	hrs	hrs	hrs	hrs	hrs	hrs

DISINFECTION ON COMPLETION 9

Chemical(s) used	Quantity applied (Litres)	Method of application
Decon 90	5 LTRS	Sprayed on

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (mins)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level m Test Method See Code 4

WORK PARTLY BACKFILLED OR ABANDONED 11

Original depth of work: m Is work partly backfilled: (Yes/No)

Is work abandoned: (Yes/No) Method of abandonment: Backfilled Plugged Capped

Has any casing been left in the work (Yes/No) From m To m

Sealing / fill type (See Code 11)	From depth (m)	To depth (m)	Sealing / fill type (See Code 11)	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist Geologist Driller Diviner Client Other 12

13

Lot No 1 DP No 1006399

Work Location Co ordinates Easting Northing Zone 54

GPS: (Yes/No) >> AMG/AGD or MGA/GDA (See explanation)

Longitude Latitude

Please mark the work site with "X" on the CLID provided map.

Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

Signatures:

Driller: Date: 5-5-17

Licensee: Date: 5-5-17

Department of Primary Industries Water

Form A Particulars of completed work

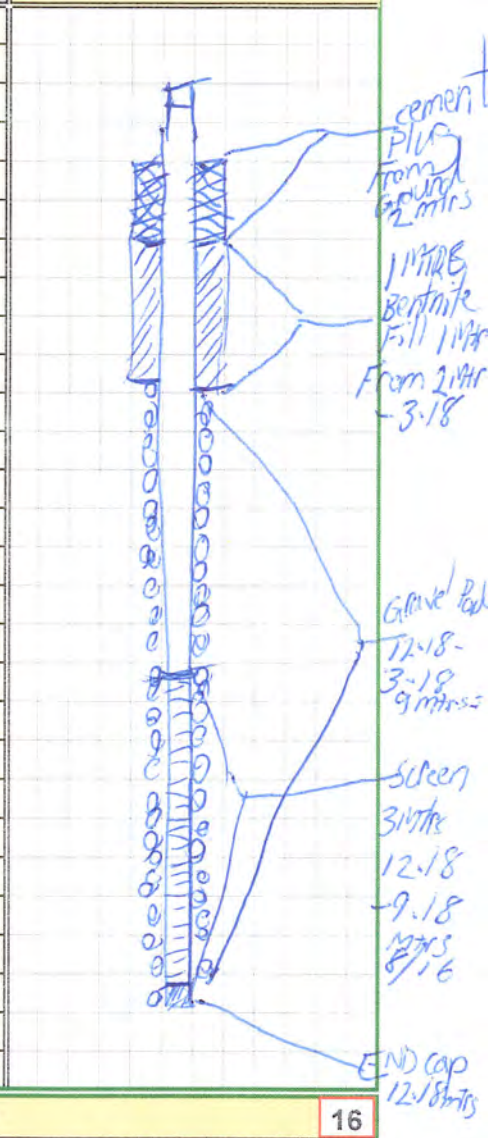
Work Licence No:

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY)

15

Depth From (m)	Depth To (m)	Description (See Code 15)
0		
0	.5	Black - Amber Sand
.5	5.5	Amber sand Medium grain
5.5	12.18	Amber sand Course to Medium Grain

WORK CONSTRUCTION SKETCH



WORK NOT CONSTRUCTED BY DRILLING RIG

16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m)

Please attach copies of the following if available

17

Geologist log	(Yes/No) ☐	Laboratory analysis of water Sample	(Yes/No) ☐	Pumping test(s)	(Yes/No) ☐
Geophysical log	(Yes/No) ☐	Sieve analysis of aquifer material	(Yes/No) ☐	Installed Pump details	(Yes/No) ☐

Department of Primary Industries Water — Form A Particulars of completed work

1

Driller's Licence No: 1772
Class of Licence: 4
Driller's Name: Peter Stewart
Assistant Driller: Blake Stewart
Contractor: Port Stephens Drilling

New bore		Replacement bore	
Deepened		Enlarged	
Reconditioned		Other (specify)	/

Final Depth: 26.04 m — Monitoring well 26.04

2

Work Licence No: MW3
Name of Licensee: Boral Resources PTY LTD
Intended Use: Monitoring well
Completion Date: 6-5-19

DRILLING DETAILS — 3

From (m)	To (m)	Hole Diameter (mm)	Drilling Method See Code 3
0	26.04	101	1

WATER BEARING ZONES — 4

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method See Code 4	D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)
5.31	26.04	20.73	5.31	/	/	/	/	/	/	/	/

CASING / LINER DETAILS — 5

Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code 5
8	60.53	5.02		26.04	5

Casing support method — See Code 5: 2
Type of casing bottom — See Code 5: 2
Centralisers installed (Yes/No): NO (indicate on sketch)
Sump installed (Yes/No): NO — From m To m
Pressure cemented (~~Yes~~/No): N/A — From m To m
Casing Protector cemented in place

WATER ENTRY DESIGN — 6

General: Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Opening type See Code 6	Fixing See Code 5	Screen Aperture (mm)	Slot Details: Length (mm)	Width (mm)	Alignment See Code 6
8	60.53	5.02	5.31	26.04	5	5	0.5	3000	60.53	H

GRAVEL PACK — 7

Type		Grade		Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity m^3
Rounded		Graded	/	8/16		3.4	26.4	920	
Crushed		Ungraded							
Bentonite/Grout seal (Yes/No): YES						2.4	~~2.4~~ 3.4	~~2.4~~ 23	~~20~~
Method of placement of Gravel Pack — See Code 7: 2									

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Department of Primary Industries Water

Form A Particulars of completed work

Work Licence No: MW-X3

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud (Yes/No) NO Name: Bore Resources PTY LTD

Method	Bailing/Surging	Jetting	Airlifting	Backwashing	Pumping	Other:
Duration	hrs	hrs	hrs	hrs	hrs	hrs

DISINFECTION ON COMPLETION 9

Chemical(s) used	Quantity applied (Litres)	Method of application
Decon 90	5 LTRS	SPRAYED ON

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (mins)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level m Test Method See Code 4

WORK PARTLY BACKFILLED OR ABANDONED 11

Original depth of work: m Is work partly backfilled: (Yes/No)

Is work abandoned: (Yes/No) Method of abandonment: Backfilled Plugged Capped

Has any casing been left in the work (Yes/No) From m To m

Sealing / fill type (See Code 11)	From depth (m)	To depth (m)	Sealing / fill type (See Code 11)	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist Geologist Driller Diviner Client / Other 12

13

Lot No 1 DP No 1006399

Work Location Co ordinates Easting Northing Zone 54

GPS: (Yes/No) >> AMG/AGD or MGA/GDA (See explanation)

Longitude Latitude

Please mark the work site with "X" on the CLID provided map.

Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

Signatures:

Driller: Peter Stewart

Date: 5-5-17

Licensee:

Date: 5-5-17

Department of Primary Industries Water

Form A Particulars of completed work

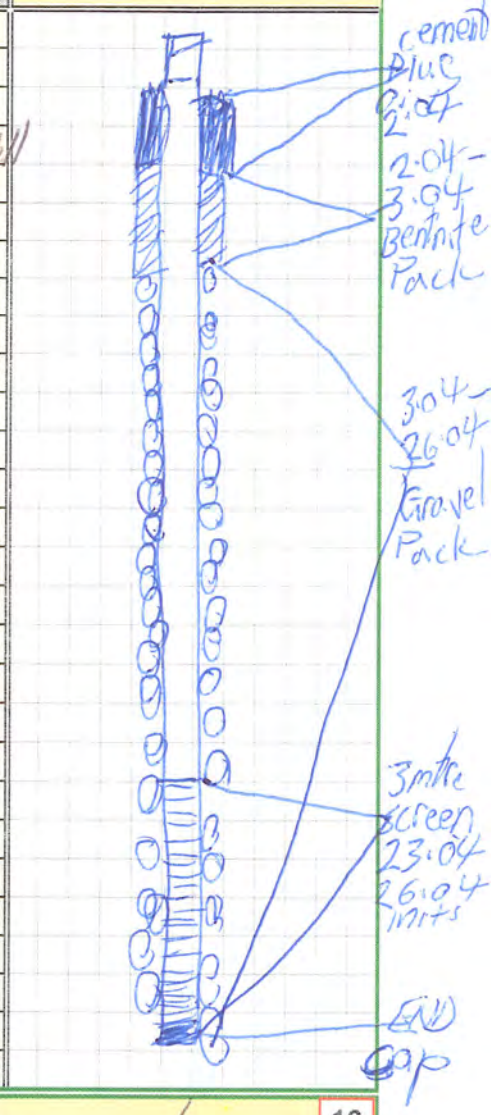
Work Licence No: MW-X3

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY)

15

Depth From (m)	Depth To (m)	Description (See Code 15)
0	3	Amber Sand Medium Grain
3	12.9	Amber Sand Medium to Coarse Grain
12.9	14.9	Grey Sand with Shell Fragments
14.9	24	Grey Sand with Fine Gravel Stone
24	26.9	Grey Sand Medium Sand

WORK CONSTRUCTION SKETCH



WORK NOT CONSTRUCTED BY DRILLING RIG

16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other ☐

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m)

Please attach copies of the following if available

17

Geologist log	(Yes/No) ☐	Laboratory analysis of water Sample	(Yes/No) ☐	Pumping test(s)	(Yes/No) ☐
Geophysical log	(Yes/No) ☐	Sieve analysis of aquifer material	(Yes/No) ☐	Installed Pump details	(Yes/No) ☐

NSW GOVERNMENT | Department of Primary Industries Water

Form A Particulars of completed work

1

Driller's Licence No: 1772
Class of Licence: 4
Driller's Name: Peter Stewart
Assistant Driller: Blake Stewart
Contractor:

New bore		Replacement bore	
Deepened		Enlarged	
Reconditioned		Other (specify)	

Final Depth: 11.44 m — Monitoring well

2

Work Licence No: MW-X3
Name of Licensee: Boca Resources PTY LTD
Intended Use: Monitoring Well
Completion Date: 6-5-17

DRILLING DETAILS **3**

From (m)	To (m)	Hole Diameter (mm)	Drilling Method See Code 3
0	11.44	101	1

WATER BEARING ZONES **4**

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method See Code 4		D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)
4.92	11.44	6.52	4.92									

CASING / LINER DETAILS **5**

Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code 5
8	60.53	5.02	0	11.44	5

Casing support method — See Code 5: 2
Type of casing bottom — See Code 5: 2
Centralisers installed {Yes/No}: NO (indicate on sketch)
Sump installed {Yes/No}: NO From m To m
Pressure cemented {Yes/No}: NO From m To m
Casing Protector cemented in place

WATER ENTRY DESIGN **6**

General: Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Opening type See Code 6	Fixing See Code 5	Screen Aperture (mm)	Slot Details: Length (mm)	Width (mm)	Alignment See Code 6
8	60.53	5.02	8.44	11.44	5	5	0.5	3000	60.53	H

GRAVEL PACK **7**

Type		Grade		Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity m^3
Rounded		Graded	✓	8	16	2.44	11.44	180	
Crushed		Ungraded							

Bentonite/Grout seal (Yes/No): YES
Method of placement of Gravel Pack — See Code 7: 2

For Departmental use only: GW

Department of Primary Industries Water

Form A Particulars of completed work

Work Licence No:

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud (Yes/No)		Name:									
Method	Bailing/Surging		Jetting		Airlifting		Backwashing		Pumping		Other
Duration		hrs		hrs		hrs		hrs		hrs	hrs

DISINFECTION ON COMPLETION 9

Chemical(s) used	Quantity applied (Litres)	Method of application

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (mins)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level ____ m Test Method ____ See Code 4

WORK PARTLY BACKFILLED OR ABANDONED 11

Original depth of work: ____ m Is work partly backfilled: (Yes/No) ____

Is work abandoned: (Yes/No) ____ Method of abandonment: Backfilled ____ Plugged ____ Capped ____

Has any casing been left in the work (Yes/No) ____ From ____ m To ____ m

Sealing / fill type (See Code 11)	From depth (m)	To depth (m)	Sealing / fill type (See Code 11)	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist ____ Geologist ____ Driller ____ Diviner ____ Client ✓ Other ____ 12

13

Lot No 1 DP No 1006399

Work Location Co ordinates Easting ____ Northing ____ Zone 54

GPS: (Yes/No) ____ >> AMG/AGD ____ or MGA/GDA ____ (See explanation)

Longitude ____ Latitude ____

Please mark the work site with "X" on the CLID provided map.

Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

Signatures:

Driller: Peter Stewart **Licensee:** [signature]

Date: 6-5-17 **Date:** 6-5-17

Please submit forms to water.gds@dpi.nsw.gov.au or to the local NSW Office of Water agency

Department of Primary Industries Water

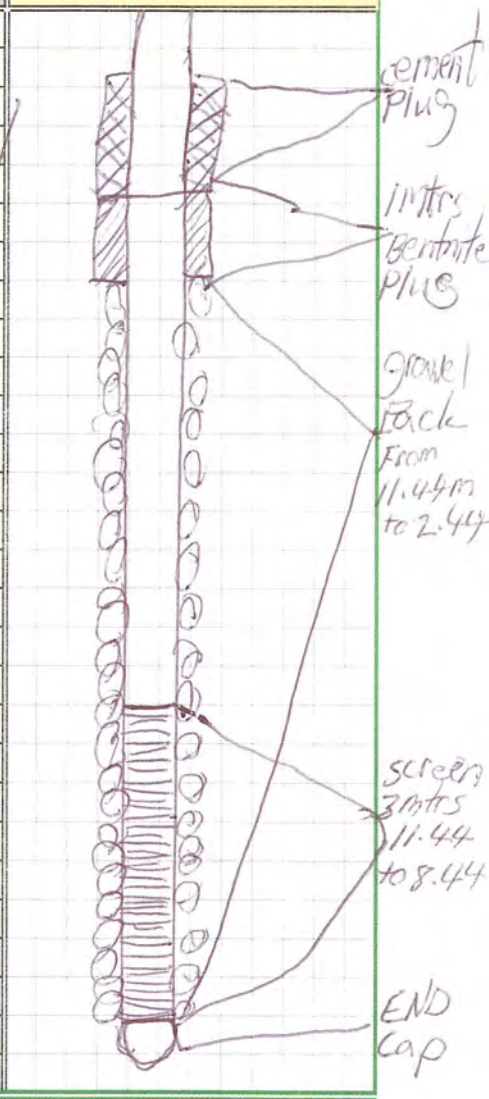
Form A Particulars of completed work

Work Licence No:

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY)

Depth From (m)	Depth To (m)	Description (See Code 15)
0	5	MG Amber Sand
5	8	MG/CG Amber Sand
8	10	CG/F Fine Gravel Grey Colour
10	11.44	Amber CG sand with fine Gravel

15 WORK CONSTRUCTION SKETCH



WORK NOT CONSTRUCTED BY DRILLING RIG — 16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m)

Please attach copies of the following if available — 17

Geologist log	(Yes/No) ☐	Laboratory analysis of water Sample	(Yes/No) ☐	Pumping test(s)	(Yes/No) ☐
Geophysical log	(Yes/No) ☐	Sieve analysis of aquifer material	(Yes/No) ☐	Installed Pump details	(Yes/No) ☐

Department of Primary Industries
Water

Form A Particulars of completed work

1

Driller's Licence No: 1772
Class of Licence: 4
Driller's Name: Peter Stewart
Assistant Driller: Blake Stewart
Contractor: Port Stephens Drilling

New bore		Replacement bore	
Deepened		Enlarged	
Reconditioned		Other (specify)	Monitoring well

Final Depth: 12.10 m

2

Work Licence No: MW-X14
Name of Licensee: Boral Resources PTY LTD
Intended Use: Monitoring well
Completion Date: 19-5-17

DRILLING DETAILS **3**

From (m)	To (m)	Hole Diameter (mm)	Drilling Method See Code 3
0	12.10		1

WATER BEARING ZONES **4**

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method See Code 4	D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)
8.90	12.10	3.2	8.90								

CASING / LINER DETAILS **5**

Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code 5
8	60.33	5.02		12.10	

Casing support method: See Code 5: 2
Type of casing bottom: See Code 5: 2
Centralisers installed {Yes/No}: NO (indicate on sketch)
Sump installed {Yes/No}: NO From m To m
Pressure cemented {Yes/No}: NO From m To m
Casing Protector cemented in place

WATER ENTRY DESIGN **6**

General Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Opening type See Code 6	Fixing See Code 5	Screen Aperture (mm)	Slot Details Length (mm)	Width (mm)	Alignment See Code 6
8	60.33	5.02	8.90	12.10	5	5	0.5	3000	60.33	H

GRAVEL PACK **7**

Type	Grade	Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity m^3
Rounded	Graded	8	16	2	12.10	180	
Crushed	Ungraded						
Bentonite/Grout seal (Yes/No): YES				2	3	30	
Method of placement of Gravel Pack: See Code 7: 1							

For Departmental use only: G W

Department of Primary Industries Water

Form A Particulars of completed work

Work Licence No: MW-[illegible]

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud (Yes/No) No Name: Boral Resources PTY LTD

Method	Bailing/Surging	Jetting	Airlifting	Backwashing	Pumping	Other:
Duration	hrs	hrs	hrs	hrs	hrs	hrs

DISINFECTION ON COMPLETION 9

Chemical(s) used	Quantity applied (Litres)	Method of application

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (mins)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level m Test Method See Code 4

WORK PARTLY BACKFILLED OR ABANDONED 11

Original depth of work: m Is work partly backfilled: (Yes/No)

Is work abandoned: (Yes/No) Method of abandonment: Backfilled Plugged Capped

Has any casing been left in the work (Yes/No) From m To m

Sealing / fill type (See Code 11)	From depth (m)	To depth (m)	Sealing / fill type (See Code 11)	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist Geologist Driller Diviner Client Other 12

13

Lot No 1 DP No 1006399

Work Location Co ordinates Easting Northing Zone 54

GPS: (Yes/No) >> AMG/AGD or MGA/GDA (See explanation)

Longitude Latitude

Please mark the work site with "X" on the CLID provided map.

Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

Signatures:

Driller: [signature] Licensee: ----------

Date: 19-5-17 Date: ----------

Department of Primary Industries Water

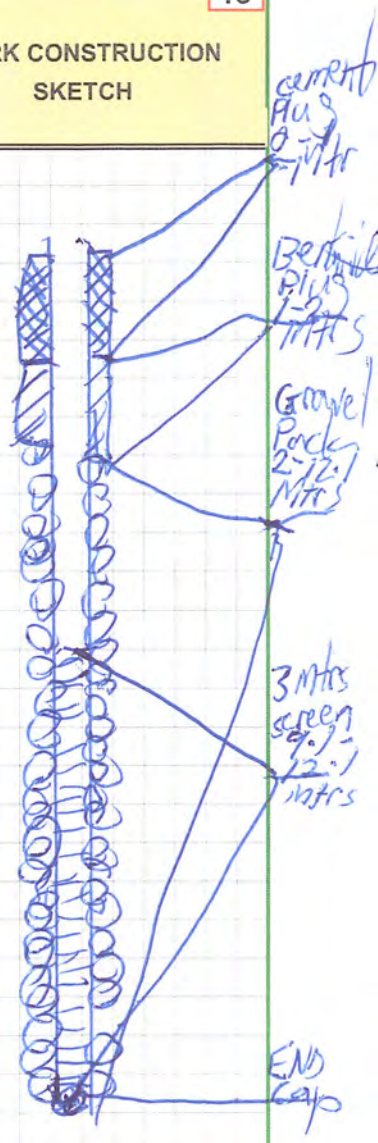
Form A Particulars of completed work

Work Licence No: MW-24

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY) — 15

Depth From (m)	Depth To (m)	Description (See Code 15)
0	4	Amber sand MG
4	7	Amber Sand MG with FG
7	10	Amber sand CG with Traces of Shell
10	12.1	Amber Sand CG

WORK CONSTRUCTION SKETCH



WORK NOT CONSTRUCTED BY DRILLING RIG — 16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other ☐

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m)

Please attach copies of the following if available — 17

Geologist log	(Yes/No) ☐	Laboratory analysis of water Sample	(Yes/No) ☐	Pumping test(s)	(Yes/No) ☐
Geophysical log	(Yes/No) ☐	Sieve analysis of aquifer material	(Yes/No) ☐	Installed Pump details	(Yes/No) ☐

Department of Primary Industries Water

Form A Particulars of completed work

1

Driller's Licence No: 1772
Class of Licence: 4
Driller's Name: Peter Stewart
Assistant Driller: Blake Stewart
Contractor: Port Stephens Drilling

New bore		Replacement bore	
Deepened		Enlarged	
Reconditioned		Other (specify)	Monitoring well

Final Depth 24.48 m

2

Work Licence No: MW-X4
Name of Licensee: Boral Resources PTY LTD
Intended Use: Monitoring well
Completion Date: 18-5-17

DRILLING DETAILS **3**

From (m)	To (m)	Hole Diameter (mm)	Drilling Method See Code 3
0	24.48	101	1

WATER BEARING ZONES **4**

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method See Code 4	D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)
8.74	24.48	15.74	8.74								

CASING / LINER DETAILS **5**

Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code 5
8	60.53	5.07		24.48	5

Casing support method See Code 5: 2
Type of casing bottom See Code 5: 2
Centralisers installed {Yes/No}: NO (indicate on sketch)
Sump installed {Yes/No}: NO From m To m
Pressure cemented {Yes/No}: NO From m To m
Casing Protector cemented in place

WATER ENTRY DESIGN **6**

General Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Opening type See Code 6	Fixing See Code 5	Screen Aperture (mm)	Slot Details Length (mm)	Width (mm)	Alignment See Code 6
8	60.53	5.07	8.74	24.48	5	5	0.5	3000	60.53	A

GRAVEL PACK **7**

Type		Grade		Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity m^3
Rounded		Graded	✓	8	16	3	24.48	360	
Crushed		Ungraded							

Bentonite/Grout seal (Yes/No)
Method of placement of Gravel Pack See Code 7

For Departmental use only: G W

Department of Primary Industries Water

Form A Particulars of completed work

Work Licence No: MW-X64

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud (Yes/No) No Name: Bore Resources PTY LTD

Method	Bailing/Surging	Jetting	Airlifting	Backwashing	Pumping	Other:
Duration	hrs	hrs	hrs	hrs	hrs	hrs

DISINFECTION ON COMPLETION 9

Chemical(s) used	Quantity applied (Litres)	Method of application

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (mins)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level m Test Method See Code 4

WORK PARTLY BACKFILLED OR ABANDONED 11

Original depth of work: m Is work partly backfilled: (Yes/No)

Is work abandoned: (Yes/No) Method of abandonment: Backfilled Plugged Capped

Has any casing been left in the work (Yes/No) From m To m

Sealing / fill type (See Code 11)	From depth (m)	To depth (m)	Sealing / fill type (See Code 11)	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist Geologist Driller Diviner Client Other 12

13

Lot No 1 DP No 1006399

Work Location Co ordinates Easting Northing Zone 54

GPS: (Yes/No) >> AMG/AGD or MGA/GDA (See explanation)

Longitude Latitude

Please mark the work site with "X" on the CLID provided map.

Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

Signatures:

Driller: Peter Stewart Licensee:

Date: 18-5-17 Date:

Department of Primary Industries Water

Form A Particulars of completed work

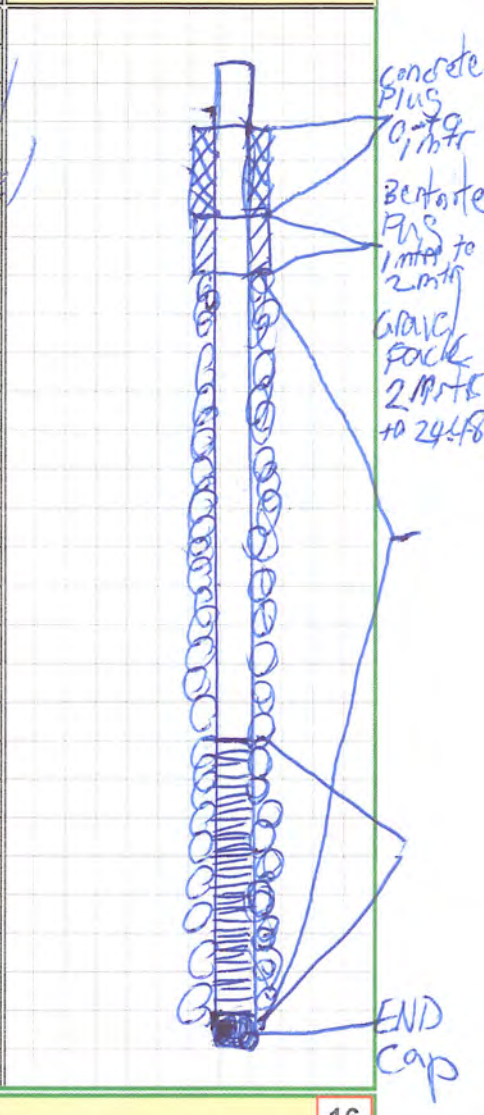
Work Licence No: MW- X4

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY)

15

Depth From (m)	Depth To (m)	Description (See Code 15)
0	4	Amber Sand ~~Fine~~ MG
4	12	Amber CG
12	15	Amber sand CG with Fine Gravel
15	17	Gray Sand MG with Shell
17	24	Gray sand CG with Fine Gravel

WORK CONSTRUCTION SKETCH



WORK NOT CONSTRUCTED BY DRILLING RIG

16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other ☐

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m)

Please attach copies of the following if available

17

Geologist log	(Yes/No) ☐	Laboratory analysis of water Sample	(Yes/No) ☐	Pumping test(s)	(Yes/No) ☐
Geophysical log	(Yes/No) ☐	Sieve analysis of aquifer material	(Yes/No) ☐	Installed Pump details	(Yes/No) ☐

Department of Primary Industries Water

Form A Particulars of completed work

1

Driller's Licence No: 1772
Class of Licence: 4
Driller's Name: Peter Stewart
Assistant Driller: Blake Stewart
Contractor: Bot Stephens Drilling

New bore		Replacement bore	
Deepened		Enlarged	
Reconditioned		Other (specify)	-

Final Depth 24.18 m Monitoring well

2

Work Licence No: MW25
Name of Licensee: Boral Resources Pty LTD
Intended Use: Monitoring well
Completion Date: 6-5-17

DRILLING DETAILS **3**

From (m)	To (m)	Hole Diameter (mm)	Drilling Method See Code 3
0	24.18		1

WATER BEARING ZONES **4**

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method See Code 4	D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)
2.45	24.18	21.73	2.45								

CASING / LINER DETAILS **5**

Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code 5
8	60.53	5.02	~~21.18~~ 2.45	24.18	8

Casing support method See Code 5: 2
Type of casing bottom See Code 5: 2
Centralisers installed {Yes/No}: No (indicate on sketch)
Sump installed {Yes/No}: No From m To m
Pressure cemented {Yes/No}: No From m To m
Casing Protector cemented in place

WATER ENTRY DESIGN **6**

General Material Code 5	General OD (mm)	General Wall Thickness (mm)	General From (m)	General To (m)	General Opening type See Code 6	General Fixing See Code 5	Screen Aperture (mm)	Slot Details Length (mm)	Slot Details Width (mm)	Slot Details Alignment See Code 6
~~8~~	~~60.53~~	5.02	~~21.18~~ 2.45	24.18	5	5	.05	2000	60.53	H

GRAVEL PACK **7**

Type		Grade		Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity m^3
Rounded		Graded	1	8/16		3.18	24.18	375	
Crushed		Ungraded							

Bentonite/Grout seal (Yes/No): Yes
Method of placement of Gravel Pack: See Code 7: 1

For Departmental use only: G W

Department of Primary Industries Water

Form A Particulars of completed work

Work Licence No: MW-X5

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud (Yes/No) [ ] Name: Bore Resources PTY LTD

Method	Bailing/Surging	Jetting	Airlifting	Backwashing	Pumping	Other:
Duration	hrs	hrs	hrs	hrs	hrs	hrs

DISINFECTION ON COMPLETION 9

Chemical(s) used	Quantity applied (Litres)	Method of application

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (mins)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level [ ] m Test Method [ ] See Code 4

WORK PARTLY BACKFILLED OR ABANDONED 11

Original depth of work: [ ] m Is work partly backfilled: (Yes/No) [ ]

Is work abandoned: (Yes/No) [ ] Method of abandonment: Backfilled [ ] Plugged [ ] Capped [ ]

Has any casing been left in the work (Yes/No) [ ] From [ ] m To [ ] m

Sealing / fill type (See Code 11)	From depth (m)	To depth (m)	Sealing / fill type (See Code 11)	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist [ ] Geologist [ ] Driller [ ] Diviner [ ] Client [ ] Other [ ] 12

13

Lot No 1 DP No 1006399

Work Location Co ordinates Easting [ ] Northing [ ] Zone 54

GPS: (Yes/No) [ ] >> AMG/AGD [ ] or MGA/GDA [ ] (See explanation)

Longitude [ ] Latitude [ ]

Please mark the work site with "X" on the CLID provided map.

Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

Signatures:

Driller: [signature] Licensee: ----------

Date: 6-5-17 Date: ----------

Please submit forms to water.gds@dpi.nsw.gov.au or to the local NSW Office of Water agency

Department of Primary Industries Water

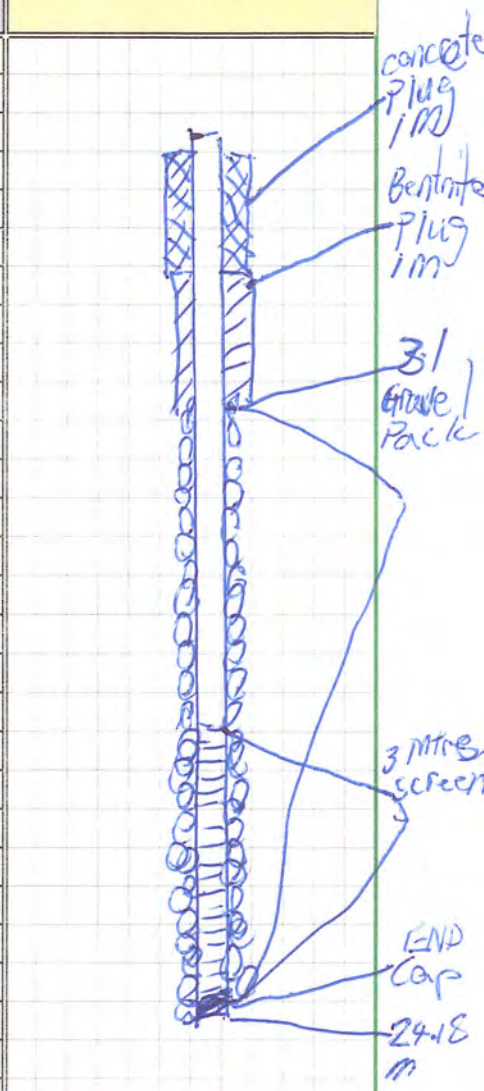
Form A Particulars of completed work

Work Licence No:

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY) — 15

Depth From (m)	Depth To (m)	Description (See Code 15)
0		
0	8	Amber sand MG
8	15	Amber sand MG with FG
15	19	Grey Sand with Shell
19	24.18	Grey Sand MG

WORK CONSTRUCTION SKETCH



WORK NOT CONSTRUCTED BY DRILLING RIG — 16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other ☐

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m)

Please attach copies of the following if available — 17

Geologist log	(Yes/No) ☐	Laboratory analysis of water Sample	(Yes/No) ☐	Pumping test(s)	(Yes/No) ☐
Geophysical log	(Yes/No) ☐	Sieve analysis of aquifer material	(Yes/No) ☐	Installed Pump details	(Yes/No) ☐

CODE TABLES

DRILLING METHOD 3

1	Auger - Hollow Flight	9	Rotary - Percussion - (Down Hole Hammer)
2	Auger - Solid Flight	10	Rotary - Percussion - Foam injection
3	Cable Tool - Drill and Drive Casing	11	Rotary - Reverse circulation - Air
4	Cable Tool - Mud stabilised	12	Rotary - Reverse circulation - Mud
5	Rotary Air	13	Rotary - Coring
6	Rotary - Air/foam	14	Jetted - Air
7	Rotary - Mud	15	Jetted - Water
8	Rotary - Water	16	Other - See page 2, N0 11

WATER BEARING ZONE 4

TEST METHOD

1	Airlift	6	Pump - Helical Roto
2	Bailer	7	Pump - Jet
3	Pump - Centrifugal	8	Pump - Turbine
4	Pump - Cylinder	9	Freeflow
5	Pump - Electric submersib		

FLOW MEASURING DEVICE

A	Container of known volum	F	Weir - Rectangular
B	Flow meter	G	Weir - V Notch - 60°
C	Flume	H	Weir - V Notch - 90°
D	Orifice, plate & manomete	I	Other
E	Ultra sonic meter		

CASING / LINER DETAILS 5

MATERIAL

1	A.B.S.	6	PVC - Class 12	11	Steel - Stainless
2	Aluminium	7	PVC - Class 15	12	Steel - Stainless 304
3	Concrete cylinder	8	PVC - Class 18	13	Steel - Stainless 316
4	Fibre glass (FRP)	9	Steel - ERW	14	Other
5	PVC - Class 9	10	Steel - Galvanised		

METHOD OF FIXING

1	Glued	6	Welded - Butt
2	Kwik-lock	7	Welded - Colla
3	Packer	8	Other
4	Riveted		
5	Screwed		

CASING SUPPORT METHOD

1	Driven into small hole	5	Held in clamp
2	Seated on bottom	6	Other
3	Seated on backfill		
4	Cemented		

TYPE OF CASING BOTTOM

1	Open end	5	Casing shoe
2	End cap	6	Wash down shoe
3	Plug - concrete	7	Cementing shoe
4	Plug - wood	8	Other

WATER ENTRY DESIGN 6

OPENING TYPE

1	Casing - Bridge slot	7	Casing - Plasma-cut slot
2	Casing - Drilled holes	8	Casing - Perforated in hole
3	Casing - Hand sawn slot	9	Screen - gauze / mesh
4	Casing - Louvre slot	10	Screen - round wire
5	Casing - Machine slotted	11	Screen - wedge wire
6	Casing - Oxy cut slot		

SLOT ALIGNMENT

D	Diagonal
H	Horizontal
V	Vertical

For MATERIAL and FIXING Codes Please refer to CASING DETAILS code table

GRAVEL PACK - METHOD OF PLACEMENT 7

1	Poured or shovelled into annulu	2	Placed through tremie pipe	3	Reverse circulated

WORK PARTLY BACKFILLED OR ABANDONED - SEALING MATERIAL 11

1	Cement grout	3	Bentonite	5	Clay	7	Gravel
2	Concrete	4	Drilled cuttings	6	Sand	8	Coarse stone

DRILLER'S ROCK STRATA DESCRIPTION 15

Reporting sequence	1 Rock type	2 Colour	3 Grain size	4 Texture
Example	Sandstone	Dk Grey	mg	Fractured

To save confusion, write the *full name of colour and abbreviate th following:* light = lt, dark = dk, fine grained = fg, medium grained = mg, coarse grained = cg. *Texture can relate t* weathered, fractured, broken, hard, soft etc.

Department of Primary Industries Water — Form A Particulars of completed work

1

Driller's Licence No: 1772
Class of Licence: 4
Driller's Name: Peter Stewart
Assistant Driller: Blake Stewart
Contractor: Port Stephens Drilling

New bore		Replacement bore	
Deepened		Enlarged	
Reconditioned		Other (specify)	✓

Final Depth: 27.58 m — monitoring well

2

Work Licence No: MW36
Name of Licensee: Boral Resources PTY LTD
Intended Use: Monitoring well
Completion Date: 5-5-17

DRILLING DETAILS — 3

From (m)	To (m)	Hole Diameter (mm)	Drilling Method See Code 3
0	27.58		1

WATER BEARING ZONES — 4

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method See Code 4		D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)
2.45	27.58	25.13	2.45									

CASING / LINER DETAILS — 5

Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code 5
8	60.53	5.02	0	27.58	5

Casing support method — See Code 5: 2
Type of casing bottom — See Code 5: 2
Centralisers installed {Yes/No}: No (indicate on sketch)
Sump installed {Yes/No}: No — From m To m
Pressure cemented {Yes/No}: No — From m To m
Casing Protector cemented in place

WATER ENTRY DESIGN — 6

General Material Code 5	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Opening type See Code 6	Fixing See Code 5	Screen Aperture (mm)	Slot Details Length (mm)	Width (mm)	Alignment See Code 6
8	60.53	5.02	14.58	27.58	5	5	.05	3000	60.53	H

GRAVEL PACK — 7

Type		Grade		Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity m^3
Rounded		Graded	✓	8/16		3	27.	450	
Crushed		Ungraded							
Bentonite/Grout seal (Yes/No)									
Method of placement of Gravel Pack		See Code 7	1						

For Departmental use only: G W

Department of Primary Industries Water

Form A Particulars of completed work

Work Licence No: MW-X6

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud (Yes/No) | Name: Boral Resources PTY LTD

Method	Bailing/Surging	Jetting	Airlifting	Backwashing	Pumping	Other:
Duration	hrs	hrs	hrs	hrs	hrs	hrs

DISINFECTION ON COMPLETION 9

Chemical(s) used	Quantity applied (Litres)	Method of application

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (mins)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level ____ m | Test Method ____ | See Code 4

WORK PARTLY BACKFILLED OR ABANDONED 11

Original depth of work: ____ m | Is work partly backfilled: (Yes/No) ____

Is work abandoned: (Yes/No) ____ | Method of abandonment: Backfilled ____ Plugged ____ Capped ____

Has any casing been left in the work (Yes/No) ____ | From ____ m To ____ m

Sealing / fill type (See Code 11)	From depth (m)	To depth (m)	Sealing / fill type (See Code 11)	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist ____ Geologist ____ Driller ____ Diviner ____ Client ____ Other ____ 12

13

Lot No 1 | DP No 100 6399

Work Location Co ordinates Easting ____ Northing ____ Zone 54

GPS: (Yes/No) ____ >> AMG/AGD ____ or MGA/GDA ____ (See explanation)

Longitude ____ Latitude ____

Please mark the work site with "X" on the CLID provided map.

Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

Signatures:

Driller: ____ **Licensee:** ____

Date: 5-5-17 **Date:** ____

Please submit forms to water.gds@dpi.nsw.gov.au or to the local NSW Office of Water agency

Department of Primary Industries Water

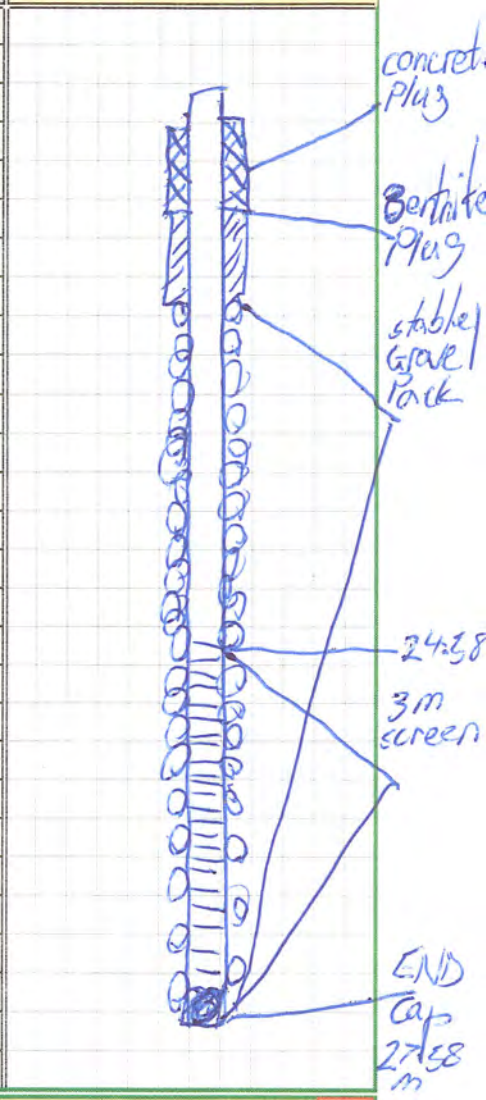
Form A Particulars of completed work

Work Licence No: MW-X6

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY) — 15

Depth From (m)	Depth To (m)	Description (See Code 15)
0	10	Amber Sand MG
10	15	Amber Sand MG with Fine Gravel
15	20	Amber Sand CG with Organics
20	27.58	Gray sand MG with shell fragments

WORK CONSTRUCTION SKETCH



WORK NOT CONSTRUCTED BY DRILLING RIG — 16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other ☐

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m)

Please attach copies of the following if available — 17

Geologist log	(Yes/No) ☐	Laboratory analysis of water Sample	(Yes/No) ☐	Pumping test(s)	(Yes/No) ☐
Geophysical log	(Yes/No) ☐	Sieve analysis of aquifer material	(Yes/No) ☐	Installed Pump details	(Yes/No) ☐

CODE TABLES

DRILLING METHOD 3

1	Auger - Hollow Flight	9	Rotary - Percussion - (Down Hole Hammer)
2	Auger - Solid Flight	10	Rotary - Percussion - Foam injection
3	Cable Tool - Drill and Drive Casing	11	Rotary - Reverse circulation - Air
4	Cable Tool - Mud stabilised	12	Rotary - Reverse circulation - Mud
5	Rotary Air	13	Rotary - Coring
6	Rotary - Air/foam	14	Jetted - Air
7	Rotary - Mud	15	Jetted - Water
8	Rotary - Water	16	Other - See page 2, N0 11

WATER BEARING ZONE 4

TEST METHOD				FLOW MEASURING DEVICE			
1	Airlift	6	Pump - Helical Rotc	A	Container of known volum	F	Weir - Rectangular
2	Bailer	7	Pump - Jet	B	Flow meter	G	Weir - V Notch - 60°
3	Pump - Centrifugal	8	Pump - Turbine	C	Flume	H	Weir - V Notch - 90°
4	Pump - Cylinder	9	Freeflow	D	Orifice, plate & manomete	I	Other
5	Pump - Electric submersib			E	Ultra sonic meter		

CASING / LINER DETAILS 5

MATERIAL						METHOD OF FIXING			
1	A.B.S.	6	PVC - Class 12	11	Steel - Stainless	1	Glued	6	Welded - Butt
2	Aluminium	7	PVC - Class 15	12	Steel - Stainless 304	2	Kwik-lock	7	Welded - Colla
3	Concrete cylinder	8	PVC - Class 18	13	Steel - Stainless 316	3	Packer	8	Other
4	Fibre glass (FRP)	9	Steel - ERW	14	Other	4	Riveted		
5	PVC - Class 9	10	Steel - Galvanised			5	Screwed		

CASING SUPPORT METHOD				TYPE OF CASING BOTTOM			
1	Driven into small hole	5	Held in clamp	1	Open end	5	Casing shoe
2	Seated on bottom	6	Other	2	End cap	6	Wash down shoe
3	Seated on backfill			3	Plug - concrete	7	Cementing shoe
4	Cemented			4	Plug - wood	8	Other

WATER ENTRY DESIGN 6

OPENING TYPE				SLOT ALIGNMENT	
1	Casing - Bridge slot	7	Casing - Plasma-cut slot	D	Diagonal
2	Casing - Drilled holes	8	Casing - Perforated in hole	H	Horizontal
3	Casing - Hand sawn slot	9	Screen - gauze / mesh	V	Vertical
4	Casing - Louvre slot	10	Screen - round wire		
5	Casing - Machine slotted	11	Screen - wedge wire		
6	Casing - Oxy cut slot				

For MATERIAL and FIXING Codes Please refer to CASING DETAILS code table

GRAVEL PACK - METHOD OF PLACEMENT 7

1	Poured or shovelled into annul	2	Placed through tremie pipe	3	Reverse circulated

WORK PARTLY BACKFILLED OR ABANDONED - SEALING MATERIAL 11

1	Cement grout	3	Bentonite	5	Clay	7	Gravel
2	Concrete	4	Drilled cuttings	6	Sand	8	Coarse stone

DRILLER'S ROCK STRATA DESCRIPTION 15

Reporting sequence	1 Rock type	2 Colour	3 Grain size	4 Texture
Example	Sandstone	Dk Grey	mg	Fractured

To save confusion, write the *full name of colour and abbreviate th following:* light = lt, dark = dk, fine grained = fg, medium grained = mg, coarse grained = cg. *Texture can relate t* weathered, fractured, broken, hard, soft etc.

NSW DEPARTMENT OF WATER & ENERGY

Natural Resource Products

FORM A 28/2/2013
PARTICULARS OF COMPLETED WORK

Work Licence No: B L

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud No [x] Yes [ ] Name:

Method	Bailing/Surging [ ]	Jetting	Airlifting [ ]	Backwashing [ ]	Pumping [ ]	Other:
Duration	hrs	hrs	hrs	hrs	hrs	hrs

DISINFECTION ON COMPLETION 9

Chemical/s used	Quantity applied (litres)	Method of application

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery		
								Water level (m)	Time taken (hrs)	(mins)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level ____ m Test Method Code [ ] See Code Table 4

WORK PARTLY BACKFILLED OR ABANDONED 11

Original depth of work: ____ metres Is work partly backfilled: No [x] Yes [ ]

Is work abandoned: No [x] Yes [ ] Method of abandonment: Backfilled [ ] Plugged [ ] Capped [ ]

Has any casing been left in the work No [x] Yes [ ] From m To m

Sealing / fill type Code	From depth (m)	To depth (m)	Sealing / fill type Code	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist [ ] Geologist [ ] Driller [ ] Diviner [ ] Client [x] Other ____ 12

13

Lot No DP No

Work Location Co ordinates Easting 392604.05 Northing 6364756.47 Zone ____

GPS: No [ ] Yes [ ] >> AMG/AGD [ ] or MGA/GDA [ ] (See explanation)

Please mark the work site with "X" on the DWE CLID map
indicate also the distances in metres from two (2) adjacent boundaries and attach the map to this Form A package

Signatures:

Driller: _____ **Licensee:** _____

Date: 24/04/2013 **Date:** _____

NSW DEPARTMENT OF WATER & ENERGY

Natural Resource Products

FORM A .....
PARTICULARS OF COMPLETED WORK

Work Licence No: ..... B L .....

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY)

15

Depth From (m)	Depth To (m)	Description	WORK CONSTRUCTION SKETCH
0	15	Sand medium to course - Dry	
15	21	Sand Medium to course - wet - saturated	

WORK NOT CONSTRUCTED BY DRILLING RIG

16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other .....

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m

Please attach copies of the following if available

17

Geologist log No [x] Yes ☐ Laboratory analysis of water Sample No ☐ Yes ☐ Pumping test(s) No ☐ Yes ☐

Geophysical log No [x] Yes ☐ Sieve analysis of aquifer material No [x] Yes ☐ Installed Pump details No [x] Yes ☐

NSW DEPARTMENT OF WATER & ENERGY

Natural Resource Products

FORM A
PARTICULARS OF COMPLETED WORK

1

Driller's Licence No: DL2013
Class of Licence: Class 2
Driller's Name: Tim Tucker
Assistant Driller: Toby Osbourne
Contractor: Boral

New bore [ ] Replacement bore [X]
Deepened [ ] Enlarged [ ]
Reconditioned [ ] Other (specify)
Final Depth 18m m MW02

2

Work Licence No: B L
Name of Licensee: Boral Stockton
Intended Use: Water monitoring
Completion Date: 29/03/2013

3 DRILLING DETAILS

From (m)	To (m)	Hole Diameter (mm)	Drilling Method Code
0	18	200	1

4 WATER BEARING ZONES

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method Code	D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond. (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)

5 CASING / LINER DETAILS

Material Code	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code
6	60	5	0	12	5

Casing support method Code 2
Type of casing bottom Code 2
Centralisers installed No [X] Yes [ ] (indicate on sketch)
Sump installed No [X] Yes [ ] From m To m
Pressure cemented No [X] Yes [ ] From m To m
Casing Protector cemented in place No [X] Yes [ ]

6 WATER ENTRY DESIGN

General: Material Code	General: OD (mm)	General: Wall Thickness (mm)	General: From (m)	General: To (m)	General: Opening type Code	General: Fixing Code	Screen: Aperture (mm)	Slot Details: Length (mm)	Slot Details: Width (mm)	Slot Details: Alignment Code
6	60	5	12	18	5	5	0.04	45	50	H

7 GRAVEL PACK

Type	Grade	Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres or m³
Rounded [ ]	Graded [X]	1	2	12	18	
Crushed [ ]	Ungraded [ ]					

Bentonite/Grout seal No [ ] Yes [X]
Method of placement of Gravel Pack Code 1

For D W E use only: G W

NSW DEPARTMENT OF WATER & ENERGY

Natural Resource Products

FORM A 29/2/2013
PARTICULARS OF COMPLETED WORK

Work Licence No: B L

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud No [x] Yes [ ] Name:

Method	Bailing/Surging [ ]	Jetting	Airlifting [ ]	Backwashing [ ]	Pumping [ ]	Other:
Duration	hrs	hrs	hrs	hrs	hrs	hrs

DISINFECTION ON COMPLETION 9

Chemical/s used	Quantity applied (litres)	Method of application

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (mins)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level ____ m Test Method Code [ ] See Code Table 4

WORK PARTLY BACKFILLED OR ABANDONED 11

Original depth of work: ____ metres Is work partly backfilled: No [x] Yes [ ]

Is work abandoned: No [x] Yes [ ] Method of abandonment: Backfilled [ ] Plugged [ ] Capped [ ]

Has any casing been left in the work No [x] Yes [ ] From m To m

Sealing / fill type Code	From depth (m)	To depth (m)	Sealing / fill type Code	From depth (m)	To depth (m)

12

Site chosen by: Hydrogeologist [ ] Geologist [ ] Driller [ ] Diviner [ ] Client [x] Other ____

13

Lot No DP No

Work Location Co ordinates Easting 392599.55 Northing 6364951.41 Zone ____

GPS: No [ ] Yes [ ] >> AMG/AGD [ ] or MGA/GDA [ ] (See explanation)

Please mark the work site with "X" on the DWE CLID map.
Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

Signatures:

Driller: ____ **Licensee:** ____

Date: 24/04/2013 **Date:** ____

NSW DEPARTMENT OF WATER & ENERGY

Natural Resource Products

FORM A
PARTICULARS OF COMPLETED WORK

Work Licence No: B L

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY) — 15

Depth From (m)	Depth To (m)	Description	WORK CONSTRUCTION SKETCH
0	12	Sand medium to course - Dry	
12	18	Sand Medium to course - wet - saturated	

WORK NOT CONSTRUCTED BY DRILLING RIG — 16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other .....

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m)

Please attach copies of the following if available — 17

Geologist log	No [x]	Yes ☐	Laboratory analysis of water Sample	No ☐	Yes ☐	Pumping test(s)	No ☐ Yes ☐
Geophysical log	No [x]	Yes ☐	Sieve analysis of aquifer material	No [x]	Yes ☐	Installed Pump details	No [x] Yes ☐

NSW DEPARTMENT OF WATER & ENERGY

Natural Resource Products

FORM A
PARTICULARS OF COMPLETED WORK

1

Driller's Licence No: DL2013
Class of Licence: Class 2
Driller's Name: Tim Tucker
Assistant Driller: Toby Osbourne
Contractor: Boral

New bore [ ] Replacement bore [X]
Deepened [ ] Enlarged [ ]
Reconditioned [ ] Other (specify)

Final Depth 8m m MW3

2

Work Licence No: B L
Name of Licensee: Boral Stockton
Intended Use: Water monitoring
Completion Date: 1/03/2013

3 DRILLING DETAILS

From (m)	To (m)	Hole Diameter (mm)	Drilling Method Code
0	8	200	1

4 WATER BEARING ZONES

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method Code	D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond. (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)

5 CASING / LINER DETAILS

Material Code	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code
6	60	5	0	2	5

Casing support method Code 2
Type of casing bottom Code 2
Centralisers installed No [x] Yes [ ] (indicate on sketch)
Sump installed No [x] Yes [ ] From m To m
Pressure cemented No [x] Yes [ ] From m To m
Casing Protector cemented in place No [ ] Yes [ ]

6 WATER ENTRY DESIGN

General: Material Code	General: OD (mm)	General: Wall Thickness (mm)	General: From (m)	General: To (m)	General: Opening type Code	General: Fixing Code	Screen: Aperture (mm)	Slot Details: Length (mm)	Slot Details: Width (mm)	Slot Details: Alignment Code
6	60	5	2	8	5	5	0.04	45	50	H

7 GRAVEL PACK

Type	Grade	Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres	Quantity or m^3
Rounded [ ]	Graded [X]	1	2	2	8		
Crushed [ ]	Ungraded [ ]						

Bentonite/Grout seal No [ ] Yes [x]
Method of placement of Gravel Pack Code 1

For D W E use only: G W [ ][ ][ ][ ][ ][ ][ ]

NSW DEPARTMENT OF WATER & ENERGY

Natural Resource Products

FORM A 28/2/2013
PARTICULARS OF COMPLETED WORK

Work Licence No: B L

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud No ☐ Yes ☐ Name:

Method	Bailing/Surging ☐	Jetting	Airlifting ☐	Backwashing ☐	Pumping ☐	Other:
Duration	hrs	hrs	hrs	hrs	hrs	hrs

DISINFECTION ON COMPLETION 9

Chemical/s used	Quantity applied (litres)	Method of application

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (mins)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level ..... m Test Method Code ☐ See Code Table 4

WORK PARTLY BACKFILLED OR ABANDONED 11

Original depth of work: ..... metres Is work partly backfilled: No ☐ Yes ☐

Is work abandoned: No ☐ Yes ☐ Method of abandonment: Backfilled ☐ Plugged ☐ Capped ☐

Has any casing been left in the work No ☐ Yes ☐ From m To m

Sealing / fill type Code	From depth (m)	To depth (m)	Sealing / fill type Code	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist ☐ Geologist ☐ Driller ☐ Diviner [x] Client ☐ Other 12

Lot No DP No 13

Work Location Co ordinates Easting 390480.16 Northing 6364597.62 Zone .....

GPS: No ☐ Yes ☐ >> AMG/AGD ☐ or MGA/GDA ☐ (See explanation)

Please mark the work site with "X" on the DWE CLID map.
Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

Signatures:

Driller: .....

Date: 24/04/2013

Licensee: .....

Date: .....

NSW DEPARTMENT OF WATER & ENERGY

Natural Resource Products

FORM A
PARTICULARS OF COMPLETED WORK

Work Licence No: ..... B L .....

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY)

15

Depth From (m)	Depth To (m)	Description
0	2	Sand medium to course - Dry
2	8	Sand Medium to course - wet - saturated

WORK CONSTRUCTION SKETCH

WORK NOT CONSTRUCTED BY DRILLING RIG

16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other .....

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (n

Please attach copies of the following if available

17

Geologist log No ☐ Yes ☐ Laboratory analysis of water Sample No ☐ Yes ☐ Pumping test(s) No ☐ Yes ☐

Geophysical log No ☐ Yes ☐ Sieve analysis of aquifer material No ☐ Yes ☐ Installed Pump details No ☐ Yes ☐

NSW DEPARTMENT OF WATER & ENERGY

Natural Resource Products

FORM A
PARTICULARS OF COMPLETED WORK

1

Driller's Licence No: DL2013
Class of Licence: Class 2
Driller's Name: Tim Tucker
Assistant Driller: Toby Osbourne
Contractor: Boral

New bore [ ] Replacement bore [X]
Deepened [ ] Enlarged [ ]
Reconditioned [ ] Other (specify)
Final Depth m 8m MW4

2

Work Licence No: B L
Name of Licensee: Boral Stockton
Intended Use: Water monitoring
Completion Date: 28/03/2013

DRILLING DETAILS

3

From (m)	To (m)	Hole Diameter (mm)	Drilling Method Code
0	8	200	1

WATER BEARING ZONES

4

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method Code	D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond. (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)

CASING / LINER DETAILS

5

Material Code	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code
6	60	5	0	2	5

Casing support method Code 2
Type of casing bottom Code 2
Centralisers installed No [x] Yes [ ] (indicate on sketch)
Sump installed No [x] Yes [ ] From m To m
Pressure cemented No [x] Yes [ ] From m To m
Casing Protector cemented in place No [ ] Yes [ ]

WATER ENTRY DESIGN

6

General Material Code	General OD (mm)	General Wall Thickness (mm)	General From (m)	General To (m)	General Opening type Code	General Fixing Code	Screen Aperture (mm)	Slot Details Length (mm)	Slot Details Width (mm)	Slot Details Alignment Code
6	60	5	2	8	5	5	0.04	45	50	H

GRAVEL PACK

7

Type	Grade	Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres or m^3
Rounded [ ]	Graded [X]	1	2	2	8	
Crushed [ ]	Ungraded [ ]					
Bentonite/Grout seal No [ ] Yes [x]						
Method of placement of Gravel Pack Code 1						

For D W E use only: G W

NSW DEPARTMENT OF WATER & ENERGY

Natural Resource Products

FORM A 28/2/2013
PARTICULARS OF COMPLETED WORK

Work Licence No: B L

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud No ☐ Yes ☐ Name:

Method	Bailing/Surging ☐	Jetting	Airlifting ☐	Backwashing ☐	Pumping ☐	Other:
Duration	hrs	hrs	hrs	hrs	hrs	hrs

DISINFECTION ON COMPLETION 9

Chemical/s used	Quantity applied (litres)	Method of application

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (mins)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level ..... m Test Method Code ☐ See Code Table 4

WORK PARTLY BACKFILLED OR ABANDONED 11

Original depth of work: ..... metres Is work partly backfilled: No ☐ Yes ☐

Is work abandoned: No ☐ Yes ☐ Method of abandonment: Backfilled ☐ Plugged ☐ Capped ☐

Has any casing been left in the work No ☐ Yes ☐ From m To m

Sealing / fill type Code	From depth (m)	To depth (m)	Sealing / fill type Code	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist ☐ Geologist ☐ Driller ☐ Diviner x Client ☐ Other 12

13

Lot No DP No

Work Location Co ordinates Easting 392242.69 Northing 6364807.51 Zone .....

GPS: No ☐ Yes ☐ >> AMG/AGD ☐ or MGA/GDA ☐ (See explanation)

Please mark the work site with "X" on the DWE CLID map,
indicate also the distances in metres from two (2) adjacent boundaries and attach the map to this Form A package

Signatures:

Driller: .....

Date: 24/04/2013

Licensee: .....

Date: .....

NSW DEPARTMENT OF WATER & ENERGY

Natural Resource Products

FORM A .....
PARTICULARS OF COMPLETED WORK

Work Licence No: ..... B L .....

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY)

15

Depth From (m)	Depth To (m)	Description
0	2	Sand medium to course - Dry
2	8	Sand Medium to course - wet - saturated

WORK CONSTRUCTION SKETCH

WORK NOT CONSTRUCTED BY DRILLING RIG

16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other .....

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m)

Please attach copies of the following if available

17

Geologist log No ☐ Yes ☐ Laboratory analysis of water Sample No ☐ Yes ☐ Pumping test(s) No ☐ Yes ☐

Geophysical log No ☐ Yes ☐ Sieve analysis of aquifer material No ☐ Yes ☐ Installed Pump details No ☐ Yes ☐

NSW DEPARTMENT OF WATER & ENERGY

Natural Resource Products

FORM A
PARTICULARS OF COMPLETED WORK

1

Driller's Licence No: DL2013
Class of Licence: Class 2
Driller's Name: Tim Tucker
Assistant Driller: Toby Osbourne
Contractor: Boral

New bore [ ] Replacement bore [X]
Deepened [ ] Enlarged [ ]
Reconditioned [ ] Other (specify)

Final Depth 8m m MW5

2

Work Licence No: B L
Name of Licensee: Boral Stockton
Intended Use: Water monitoring
Completion Date: 28/03/2013

DRILLING DETAILS 3

From (m)	To (m)	Hole Diameter (mm)	Drilling Method Code
0	8	200	1

WATER BEARING ZONES 4

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method Code	D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond. (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)

CASING / LINER DETAILS 5

Material Code	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code
6	60	5	0	2	5

Casing support method Code 2
Type of casing bottom Code 2
Centralisers installed No [X] Yes [ ] (indicate on sketch)
Sump installed No [X] Yes [ ] From m To m
Pressure cemented No [X] Yes [ ] From m To m
Casing Protector cemented in place No [ ] Yes [ ]

WATER ENTRY DESIGN 6

General: Material Code	General: OD (mm)	General: Wall Thickness (mm)	General: From (m)	General: To (m)	General: Opening type Code	General: Fixing Code	Screen: Aperture (mm)	Slot Details: Length (mm)	Slot Details: Width (mm)	Slot Details: Alignment Code
6	60	5	2	8	5	5	0.04	45	50	H

GRAVEL PACK 7

Type	Grade	Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres or m³
Rounded [ ]	Graded [X]	1	2	2	8	
Crushed [ ]	Ungraded [ ]					

Bentonite/Grout seal No [ ] Yes [X]
Method of placement of Gravel Pack Code 1

For D W E use only: G W [ ][ ][ ][ ][ ][ ]

NSW DEPARTMENT OF WATER & ENERGY

Natural Resource Products

FORM A 28/2/2013
PARTICULARS OF COMPLETED WORK

Work Licence No: B L

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud No ☐ Yes ☐ Name:

Method	Bailing/Surging ☐	Jetting	Airlifting ☐	Backwashing ☐	Pumping ☐	Other:
Duration	hrs	hrs	hrs	hrs	hrs	hrs

DISINFECTION ON COMPLETION 9

Chemical/s used	Quantity applied (litres)	Method of application

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (mins)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level ____ m Test Method Code ☐ See Code Table 4

WORK PARTLY BACKFILLED OR ABANDONED 11

Original depth of work: ____ metres Is work partly backfilled: No ☐ Yes ☐

Is work abandoned: No ☐ Yes ☐ Method of abandonment: Backfilled ☐ Plugged ☐ Capped ☐

Has any casing been left in the work No ☐ Yes ☐ From m To m

Sealing / fill type Code	From depth (m)	To depth (m)	Sealing / fill type Code	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist ☐ Geologist ☐ Driller ☐ Diviner x Client ☐ Other ____ 12

13

Lot No DP No

Work Location Co ordinates Easting 392042.12 Northing 6364700.48 Zone

GPS: No ☐ Yes ☐ >> AMG/AGD ☐ or MGA/GDA ☐ (See explanation)

Please mark the work site with "X" on the DWE CLID map.
Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

Signatures:

Driller: _____ **Licensee:** _____

Date: 24/04/2013 **Date:** _____

NSW DEPARTMENT OF WATER & ENERGY

Natural Resource Products

FORM A
PARTICULARS OF COMPLETED WORK

Work Licence No: B L

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY)

15

Depth From (m)	Depth To (m)	Description
0	2	Sand medium to course - Dry
2	8	Sand Medium to course - wet - saturated

WORK CONSTRUCTION SKETCH

WORK NOT CONSTRUCTED BY DRILLING RIG

16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other .....

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m

Please attach copies of the following if available

17

Geologist log No ☐ Yes ☐ Laboratory analysis of water Sample No ☐ Yes ☐ Pumping test(s) No ☐ Yes ☐

Geophysical log No ☐ Yes ☐ Sieve analysis of aquifer material No ☐ Yes ☐ Installed Pump details No ☐ Yes ☐

NSW DEPARTMENT OF WATER & ENERGY

Natural Resource Products

FORM A
PARTICULARS OF COMPLETED WORK

1

Driller's Licence No: DL2013
Class of Licence: Class 2
Driller's Name: Tim Tucker
Assistant Driller: Toby Osbourne
Contractor: Boral

New bore [ ] Replacement bore [X]
Deepened [ ] Enlarged [ ]
Reconditioned [ ] Other (specify)
Final Depth 8m m MW6

2

Work Licence No: B L
Name of Licensee: Boral Stockton
Intended Use: Water monitoring
Completion Date: 28/03/2013

DRILLING DETAILS

3

From (m)	To (m)	Hole Diameter (mm)	Drilling Method Code
0	8	200	1

WATER BEARING ZONES

4

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method Code	D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond. (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)

CASING / LINER DETAILS

5

Material Code	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code
6	60	5	0	2	5

Casing support method Code 2
Type of casing bottom Code 2
Centralisers installed No [X] Yes [ ] (indicate on sketch)
Sump installed No [X] Yes [ ] From m To m
Pressure cemented No [X] Yes [ ] From m To m
Casing Protector cemented in place No [ ] Yes [ ]

WATER ENTRY DESIGN

6

General: Material Code	General: OD (mm)	General: Wall Thickness (mm)	General: From (m)	General: To (m)	General: Opening type Code	General: Fixing Code	Screen: Aperture (mm)	Slot Details: Length (mm)	Slot Details: Width (mm)	Slot Details: Alignment Code
6	60	5	2	8	5	5	0.04	45	50	H

GRAVEL PACK

7

Type	Grade	Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres or m³
Rounded [ ]	Graded [X]	1	2	2	8	
Crushed [ ]	Ungraded [ ]					

Bentonite/Grout seal No [ ] Yes [x]
Method of placement of Gravel Pack Code 1

For D W E use only: G W [ ][ ][ ][ ][ ][ ]

NSW DEPARTMENT OF WATER & ENERGY

Natural Resource Products

FORM A ..... 28/2/2013 .....
PARTICULARS OF COMPLETED WORK

Work Licence No: ..... B L .....

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud No ☐ Yes ☐ Name:

Method	Bailing/Surging ☐	Jetting	Airlifting ☐	Backwashing ☐	Pumping ☐	Other:
Duration	hrs	hrs	hrs	hrs	hrs	hrs

DISINFECTION ON COMPLETION 9

Chemical/s used	Quantity applied (litres)	Method of application

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (mins)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level ..... m Test Method Code ☐ See Code Table 4

WORK PARTLY BACKFILLED OR ABANDONED 11

Original depth of work: ..... metres Is work partly backfilled: No ☐ Yes ☐

Is work abandoned: No ☐ Yes ☐ Method of abandonment: Backfilled ☐ Plugged ☐ Capped ☐

Has any casing been left in the work No ☐ Yes ☐ From m To m

Sealing / fill type Code	From depth (m)	To depth (m)	Sealing / fill type Code	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist ☐ Geologist ☐ Driller ☐ Diviner [x] Client ☐ Other 12

Lot No DP No 13

Work Location Co ordinates Easting 391780.84 Northing 6364527.43 Zone .....

GPS: No ☐ Yes ☐ >> AMG/AGD ☐ or MGA/GDA ☐ (See explanation)

Please mark the work site with "X" on the DWE CUD map.
Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package

Signatures:

Driller: ..... **Licensee:** .....

Date: 24/04/2013 **Date:** .....

NSW DEPARTMENT OF WATER & ENERGY

Natural Resource Products

FORM A .....
PARTICULARS OF COMPLETED WORK

Work Licence No: B L .....

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY)

15

Depth From (m)	Depth To (m)	Description
0	2	Sand medium to course - Dry
2	8	Sand Medium to course - wet - saturated

WORK CONSTRUCTION SKETCH

WORK NOT CONSTRUCTED BY DRILLING RIG

16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other .....

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m

Please attach copies of the following if available

17

Geologist log No ☐ Yes ☐ Laboratory analysis of water Sample No ☐ Yes ☐ Pumping test(s) No ☐ Yes ☐

Geophysical log No ☐ Yes ☐ Sieve analysis of aquifer material No ☐ Yes ☐ Installed Pump details No ☐ Yes ☐

NSW DEPARTMENT OF WATER & ENERGY

Natural Resource Products

FORM A
PARTICULARS OF COMPLETED WORK

1

Driller's Licence No: DL2013
Class of Licence: Class 2
Driller's Name: Tim Tucker
Assistant Driller: Toby Osbourne
Contractor: Boral

New bore [ ] Replacement bore [X]
Deepened [ ] Enlarged [ ]
Reconditioned [ ] Other (specify)

Final Depth 8m m MW7

2

Work Licence No: B L
Name of Licensee: Boral Stockton
Intended Use: Water monitoring
Completion Date: 28/03/2013

DRILLING DETAILS **3**

From (m)	To (m)	Hole Diameter (mm)	Drilling Method Code
0	8	200	1

WATER BEARING ZONES **4**

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method Code	D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond. (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)

CASING / LINER DETAILS **5**

Material Code	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code
6	60	5	0	2	5

Casing support method Code 2
Type of casing bottom Code 2
Centralisers installed No [X] Yes [ ] (indicate on sketch)
Sump installed No [X] Yes [ ] From m To m
Pressure cemented No [X] Yes [ ] From m To m
Casing Protector cemented in place No [ ] Yes [ ]

WATER ENTRY DESIGN **6**

General: Material Code	General: OD (mm)	General: Wall Thickness (mm)	General: From (m)	General: To (m)	General: Opening type Code	General: Fixing Code	Screen: Aperture (mm)	Slot Details: Length (mm)	Slot Details: Width (mm)	Slot Details: Alignment Code
6	60	5	2	8	5	5	0.04	45	50	H

GRAVEL PACK **7**

Type	Grade	Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres or m³
Rounded [ ]	Graded [X]	1	2	2	8	
Crushed [ ]	Ungraded [ ]					
Bentonite/Grout seal No [ ] Yes [X]						

Method of placement of Gravel Pack Code 1

For D W E use only: G W

NSW DEPARTMENT OF WATER & ENERGY

Natural Resource Products

FORM A 28/2/2013
PARTICULARS OF COMPLETED WORK

Work Licence No: B L

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud No ☐ Yes ☐ Name:

Method	Bailing/Surging ☐	Jetting	Airlifting ☐	Backwashing ☐	Pumping ☐	Other:
Duration	hrs	hrs	hrs	hrs	hrs	hrs

DISINFECTION ON COMPLETION 9

Chemical/s used	Quantity applied (litres)	Method of application

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (mins)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level ..... m Test Method Code ☐ See Code Table 4

WORK PARTLY BACKFILLED OR ABANDONED 11

Original depth of work: ..... metres Is work partly backfilled: No ☐ Yes ☐

Is work abandoned: No ☐ Yes ☐ Method of abandonment: Backfilled ☐ Plugged ☐ Capped ☐

Has any casing been left in the work No ☐ Yes ☐ From m To m

Sealing / fill type Code	From depth (m)	To depth (m)	Sealing / fill type Code	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist ☐ Geologist ☐ Driller ☐ Diviner x Client ☐ Other 12

Lot No DP No 13

Work Location Co ordinates Easting 391588.88 Northing 6364388.16 Zone .....

GPS: No ☐ Yes ☐ >> AMG/AGD ☐ or MGA/GDA ☐ (See explanation)

Please mark the work site with "X" on the DWE CLID map.
Indicate also the distances in metres from two (2) adjacent boundaries and attach the map to this Form A package

Signatures:

Driller: .....

Date: 24/04/2013

Licensee: .....

Date: .....

NSW DEPARTMENT OF WATER & ENERGY

Natural Resource Products

FORM A
PARTICULARS OF COMPLETED WORK

Work Licence No: B L

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY) — 15

Depth From (m)	Depth To (m)	Description
0	2	Sand medium to course - Dry
2	8	Sand Medium to course - wet - saturated

WORK CONSTRUCTION SKETCH

WORK NOT CONSTRUCTED BY DRILLING RIG — 16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other .....

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (n

Please attach copies of the following if available — 17

Geologist log No ☐ Yes ☐ Laboratory analysis of water Sample No ☐ Yes ☐ Pumping test(s) No ☐ Yes ☐

Geophysical log No ☐ Yes ☐ Sieve analysis of aquifer material No ☐ Yes ☐ Installed Pump details No ☐ Yes ☐

NSW DEPARTMENT OF WATER & ENERGY

Natural Resource Products

FORM A
PARTICULARS OF COMPLETED WORK

1

Driller's Licence No: DL2013
Class of Licence: Class 2
Driller's Name: Tim Tucker
Assistant Driller: Toby Osbourne
Contractor: Boral

New bore [ ] Replacement bore [X]
Deepened [ ] Enlarged [ ]
Reconditioned [ ] Other (specify)

Final Depth 25m m
MW8

2

Work Licence No: B L
Name of Licensee: Boral Stockton
Intended Use: Water monitoring
Completion Date: 28/03/2013

DRILLING DETAILS

3

From (m)	To (m)	Hole Diameter (mm)	Drilling Method Code
0	25	200	1

WATER BEARING ZONES

4

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method Code	D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond. (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)

CASING / LINER DETAILS

5

Material Code	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code
6	60	5	0	19	5

Casing support method Code 2
Type of casing bottom Code 2
Centralisers installed No [X] Yes [ ] (indicate on sketch)
Sump installed No [X] Yes [ ] From m To m
Pressure cemented No [X] Yes [ ] From m To m
Casing Protector cemented in place No [ ] Yes [ ]

WATER ENTRY DESIGN

6

General: Material Code	General: OD (mm)	General: Wall Thickness (mm)	General: From (m)	General: To (m)	General: Opening type Code	General: Fixing Code	Screen: Aperture (mm)	Slot Details: Length (mm)	Slot Details: Width (mm)	Slot Details: Alignment Code
6	60	5	19	25	5	5	0.04	45	50	H

GRAVEL PACK

7

Type	Grade	Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres or m^3
Rounded [ ]	Graded [X]	1	2	19	25	
Crushed [ ]	Ungraded [ ]					
Bentonite/Grout seal No [ ] Yes [X]						
Method of placement of Gravel Pack Code 1						

For D W E use only: G W

NSW DEPARTMENT OF WATER & ENERGY

Natural Resource Products

FORM A 28/2/2013
PARTICULARS OF COMPLETED WORK

Work Licence No: B L

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud No [x] Yes [ ] Name:

Method	Bailing/Surging [ ]	Jetting	Airlifting [ ]	Backwashing [ ]	Pumping [ ]	Other:
Duration	hrs	hrs	hrs	hrs	hrs	hrs

DISINFECTION ON COMPLETION 9

Chemical/s used	Quantity applied (litres)	Method of application

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (mins)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level ..... m Test Method Code [ ] See Code Table 4

WORK PARTLY BACKFILLED OR ABANDONED 11

Original depth of work: ..... metres Is work partly backfilled: No [ ] Yes [ ]

Is work abandoned: No [ ] Yes [ ] Method of abandonment: Backfilled [ ] Plugged [ ] Capped [ ]

Has any casing been left in the work No [ ] Yes [ ] From m To m

Sealing / fill type Code	From depth (m)	To depth (m)	Sealing / fill type Code	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist [ ] Geologist [ ] Driller [ ] Diviner [x] Client [ ] Other 12

Lot No DP No 13

Work Location Co ordinates Easting 391428.28 Northing 6364224.74 Zone .....

GPS: No [ ] Yes [ ] >> AMG/AGD [ ] or MGA/GDA [ ] (See explanation)

Please mark the work site with "X" on the DWE CLID map.
Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

Signatures:

Driller: .....

Date: 24/04/2013

Licensee: .....

Date: .....

NSW DEPARTMENT OF WATER & ENERGY

Natural Resource Products

FORM A
PARTICULARS OF COMPLETED WORK

Work Licence No: 5BL

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY)

15

Depth From (m)	Depth To (m)	Description
0	2	Sand medium to course - Dry
2	8	Sand Medium to course - wet - saturated

WORK CONSTRUCTION SKETCH

WORK NOT CONSTRUCTED BY DRILLING RIG

16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other .....

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m)

Please attach copies of the following if available

17

Geologist log No ☐ Yes ☐ Laboratory analysis of water Sample No ☐ Yes ☐ Pumping test(s) No ☐ Yes ☐

Geophysical log No ☐ Yes ☐ Sieve analysis of aquifer material No ☐ Yes ☐ Installed Pump details No ☐ Yes ☐

NSW DEPARTMENT OF WATER & ENERGY

Natural Resource Products

FORM A
PARTICULARS OF COMPLETED WORK

1

Driller's Licence No: DL2013
Class of Licence: Class 2
Driller's Name: Tim Tucker
Assistant Driller: Toby Osbourne
Contractor: Boral

New bore [ ] Replacement bore [X]
Deepened [ ] Enlarged [ ]
Reconditioned [ ] Other (specify)
Final Depth m 25m MW9

2

Work Licence No: B L
Name of Licensee: Boral Stockton
Intended Use: Water monitoring
Completion Date: 28/03/2013

DRILLING DETAILS

3

From (m)	To (m)	Hole Diameter (mm)	Drilling Method Code
0	25	200	1

WATER BEARING ZONES

4

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method Code	D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond. (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)

CASING / LINER DETAILS

5

Material Code	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code
6	60	5	0	19	5

Casing support method Code 2
Type of casing bottom Code 2
Centralisers installed No [X] Yes [ ] (indicate on sketch)
Sump installed No [X] Yes [ ] From m To m
Pressure cemented No [X] Yes [ ] From m To m
Casing Protector cemented in place No [ ] Yes [ ]

WATER ENTRY DESIGN

6

General Material Code	General OD (mm)	General Wall Thickness (mm)	General From (m)	General To (m)	General Opening type Code	General Fixing Code	Screen Aperture (mm)	Slot Details Length (mm)	Slot Details Width (mm)	Slot Details Alignment Code
6	60	5	19	25	5	5	0.04	45	50	H

GRAVEL PACK

7

Type	Grade	Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres or m^3
Rounded [ ]	Graded [X]	1	2	19	25	
Crushed [ ]	Ungraded [ ]					

Bentonite/Grout seal No [ ] Yes [X]
Method of placement of Gravel Pack Code 1

For D W E use only: G W [ ][ ][ ][ ][ ][ ]

NSW DEPARTMENT OF WATER & ENERGY

Natural Resource Products

FORM A .....28/2/2013.....
PARTICULARS OF COMPLETED WORK

Work Licence No: ..... B L .....

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud No [x] Yes [ ] Name:

Method	Bailing/Surging [ ]	Jetting	Airlifting [ ]	Backwashing [ ]	Pumping [ ]	Other:
Duration	hrs	hrs	hrs	hrs	hrs	hrs

DISINFECTION ON COMPLETION 9

Chemical/s used	Quantity applied (litres)	Method of application

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery: Water level (m)	Recovery: Time taken (hrs)	Recovery: Time taken (mins)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level ..... m Test Method Code [ ] See Code Table 4

WORK PARTLY BACKFILLED OR ABANDONED 11

Original depth of work: ..... metres Is work partly backfilled: No [ ] Yes [ ]

Is work abandoned: No [ ] Yes [ ] Method of abandonment: Backfilled [ ] Plugged [ ] Capped [ ]

Has any casing been left in the work No [ ] Yes [ ] From m To m

Sealing / fill type Code	From depth (m)	To depth (m)	Sealing / fill type Code	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist [ ] Geologist [ ] Driller [ ] Diviner [x] Client [ ] Other 12

Lot No DP No 13

Work Location Co ordinates Easting 390939.54 Northing 6364058.75 Zone .....

GPS: No [ ] Yes [ ] >> AMG/AGD [ ] or MGA/GDA [ ] (See explanation)

Please mark the work site with "X" on the DWE CLID map.
Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

Signatures:

Driller: ..... **Licensee:** .....

Date: 24/04/2013 **Date:** .....

NSW DEPARTMENT OF WATER & ENERGY

Natural Resource Products

FORM A
PARTICULARS OF COMPLETED WORK

Work Licence No: B L

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY)

Depth From (m)	Depth To (m)	Description
0	21	Sand medium to course - Dry
21	25	Sand Medium to course - wet - saturated

15 WORK CONSTRUCTION SKETCH

WORK NOT CONSTRUCTED BY DRILLING RIG

16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other .....

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m)

Please attach copies of the following if available

17

Geologist log No ☐ Yes ☐ Laboratory analysis of water Sample No ☐ Yes ☐ Pumping test(s) No ☐ Yes ☐

Geophysical log No ☐ Yes ☐ Sieve analysis of aquifer material No ☐ Yes ☐ Installed Pump details No ☐ Yes ☐

NSW DEPARTMENT OF WATER & ENERGY

Natural Resource Products

FORM A
PARTICULARS OF COMPLETED WORK

1

Driller's Licence No: DL2013
Class of Licence: Class 2
Driller's Name: Tim Tucker
Assistant Driller: Toby Osbourne
Contractor: Boral

New bore [ ] Replacement bore [X]
Deepened [ ] Enlarged [ ]
Reconditioned [ ] Other (specify)

Final Depth 25m m MW10

2

Work Licence No: B L
Name of Licensee: Boral Stockton
Intended Use: Water monitoring
Completion Date: 28/03/2013

DRILLING DETAILS

3

From (m)	To (m)	Hole Diameter (mm)	Drilling Method Code
0	25	200	1

WATER BEARING ZONES

4

From (m)	To (m)	Thickness (m)	S W L (m)	Estimated Yield (L/s) Individual Aquifer	Estimated Yield (L/s) Cumulative	Test method Code	D D L at end of test (m)	Duration Hrs	Duration min	Salinity (Conductivity or TDS) Cond. (µS/cm)	Salinity (Conductivity or TDS) TDS (mg/L)

CASING / LINER DETAILS

5

Material Code	OD (mm)	Wall Thickness (mm)	From (m)	To (m)	Method Fixing Code
6	60	5	0	19	5

Casing support method Code 2

Type of casing bottom Code 2

Centralisers installed No [X] Yes [ ] (indicate on sketch)

Sump installed No [X] Yes [ ] From m To m

Pressure cemented No [X] Yes [ ] From m To m

Casing Protector cemented in place No [ ] Yes [ ]

WATER ENTRY DESIGN

6

General Material Code	General OD (mm)	General Wall Thickness (mm)	General From (m)	General To (m)	General Opening type Code	General Fixing Code	Screen Aperture (mm)	Slot Details Length (mm)	Slot Details Width (mm)	Slot Details Alignment Code
6	60	5	19	25	5	5	0.04	45	50	H

GRAVEL PACK

7

Type	Grade	Grain size (mm) From	Grain size (mm) To	Depth (m) From	Depth (m) To	Quantity Litres or m^3
Rounded [ ]	Graded [X]	1	2	19	25	
Crushed [ ]	Ungraded [ ]					

Bentonite/Grout seal No [ ] Yes [X]

Method of placement of Gravel Pack Code 1

For D W E use only: G W

NSW DEPARTMENT OF WATER & ENERGY

Natural Resource Products

FORM A 28/2/2013
PARTICULARS OF COMPLETED WORK

Work Licence No: B L

BORE DEVELOPMENT 8

Chemical used for breaking down drilling mud No [x] Yes [ ] Name:

Method	Bailing/Surging	Jetting	Airlifting	Backwashing	Pumping	Other:
	[ ]	[ ]	[ ]	[ ]	[ ]	
Duration	hrs	hrs	hrs	hrs	hrs	hrs

DISINFECTION ON COMPLETION 9

Chemical/s used	Quantity applied (litres)	Method of application

PUMPING TESTS ON COMPLETION 10

Test type		Date	Pump intake depth (m)	Initial Water Level (SWL) (m)	Pumping rate (L/s)	Water Level at end of pumping (DDL) (m)	Duration of Test (hrs)	Recovery		
								Water level (m)	Time taken (hrs)	(mins)
Multi stage (stepped drawdown)	Stage 1									
	Stage 2									
	Stage 3									
	Stage 4									
Single stage (constant rate)										

Height of measuring point above ground level ..... m Test Method Code [ ] See Code Table 4

WORK PARTLY BACKFILLED OR ABANDONED 11

Original depth of work: ..... metres Is work partly backfilled: No [x] Yes [ ]

Is work abandoned: No [x] Yes [ ] Method of abandonment: Backfilled [ ] Plugged [ ] Capped [ ]

Has any casing been left in the work No [x] Yes [ ] From m To m

Sealing / fill type Code	From depth (m)	To depth (m)	Sealing / fill type Code	From depth (m)	To depth (m)

Site chosen by: Hydrogeologist [ ] Geologist [ ] Driller [ ] Diviner [ ] Client [x] Other 12

Lot No DP No 13

Work Location Co ordinates Easting 391351.67 Northing 6363950.75 Zone .....

GPS: No [ ] Yes [ ] >> AMG/AGD [ ] or MGA/GDA [ ] (See explanation)

Please mark the work site with "X" on the DWE CLID map.
Indicate also the distances in metres from two (2) adjacent boundaries, and attach the map to this Form A package.

Signatures:

Driller: ..... **Licensee:** .....

Date: 24/04/2013 **Date:** .....

NSW DEPARTMENT OF WATER & ENERGY

Natural Resource Products

FORM A
PARTICULARS OF COMPLETED WORK

Work Licence No: B L

DRILLER'S ROCK/STRATA DESCRIPTION (LITHOLOGY)

Depth From (m)	Depth To (m)	Description
0	21	Sand medium to course - Dry
21	25	Sand Medium to course - wet - saturated

15 WORK CONSTRUCTION SKETCH

WORK NOT CONSTRUCTED BY DRILLING RIG

16

Method of excavation: Hand dug ☐ Back hoe ☐ Dragline ☐ Dozer ☐ Other .....

Depth (m)	Length (m)	Width (m)	Diameter (m)	Lining material	Dimentions of liner (m)	From Depth (m)	To Depth (m)

Please attach copies of the following if available

17

Geologist log No [X] Yes ☐ Laboratory analysis of water Sample No ☐ Yes ☐ Pumping test(s) No ☐ Yes ☐

Geophysical log No [X] Yes ☐ Sieve analysis of aquifer material No [X] Yes ☐ Installed Pump details No [X] Yes ☐

APPENDIX E: GROUNDWATER FIELD SHEETS

ENVIRONMENTAL EARTH SCIENCES
THE KNOW AND THE HOW

Groundwater - Well Sampling Data Form

JOB INFORMATION

Date:	13/3/18	Time:	12:00
Project Name:	Boral Stockton	Project Number:	717041
Site Location:	stockton	Sample:	MWx3 - shallow
Well ID:	MWx3 shallow	Weather:	sunny

EQUIPMENT

Water Quality Equipment: TPS90FL PH/TEM/CON/SAL/DO/TUR

Interface Probe Number: Solinist Water Level Meter 101

Purging Equipment:

(please circle)

Bailer type: Plastic Teflon Waterra

Pump type: Peristaltic Submersable Micro-purge Waterra

WELL GAUGING & PURGE VOLUME CALCULANTIONS

Casing Diameter	25mm	50mm	100mm	125mm	150mm	200mm
Conversion Factor (L/m)	0.98	1.96	7.85	31.4	49.1	70.7

Total Well Depth	(-)	Water Level	(=)	Water Column
11.3 (m)	(-)	5.5 (m)		5.8 (m)

Water Column	(x)	Conversion Factor	(=)	Well Volume (L)
5.8 (m)	(x)	_____	(=)	11.3 L

Volume of water in well
= Pr x r x h

P=3.14159
r = radius of well in cm
h = height of well in cm
V = volume in litres

Depth to Product	Product Thickness	Verified with bailer:
n/a (m)	n/a (m)	n/a (Y/N)

WATER QUALITY PARAMETERS

Beginning purge time: 12:24

Ending purge time: 3 x Well volume

Parameters

Litres	Time	pH	Temp (°C)	Cond	DO	DO	Redox	Comments
		6.83	20.4	260	0.29		-41.8	clear, no odor
		6.46	20.3	257.9	0.17		5.6	
		6.31	20.3	257.4	0.14		9.8	
		6.11	20.2	257.3	0.13		13.7	
		6.02	20.1	257.1	0.13		12.9	

pH, temp, EC readings not necessary if well is purged dry

Total Well Volume

Flow Rate (ml/minute)

Sample time: _____

Containers used: _____

Field parameters stabilise: (Y / N)

Well purge dry: _____ (Y / N)

FIELD QC CHECKS (circle)

Was clean sampling equipment used for sample collection?	Y	N	
Was clean sample equipment properly protected from contaminant?	Y	N	
Were air bubbles present in vials at the time of collection?	Y	N	N/A
Were metals field filtered prior to preservation?	Y	N	N/A
Duplicate sample collected? (if YES write Sample ID here)	Y	N	N/A
Rinsate blank collected?	Y	N	

ENVIRONMENTAL EARTH SCIENCES
"HE KNOW AND "HE HOW

Groundwater - Well Sampling Data Form

JOB INFORMATION

Date:	13/3/18	Time:	
Project Name:	717041	Project Number:	717041
Site Location:	Boral	Sample:	MW x3 - deep
Well ID:	MW x3 - Deep	Weather:	Sunny

EQUIPMENT

Water Quality Equipment: TPS90FL PH/TEM/CON/SAL/DO/TUR

Interface Probe Number: Solinist Water Level Meter 101

Purging Equipment:

(please circle)

Bailer type: Plastic Teflon Waterra

Pump type: Peristaltic Submersable Micro-purge Waterra

WELL GAUGING & PURGE VOLUME CALCULANTIONS

Casing Diameter	25mm	50mm	100mm	125mm	150mm	200mm
Conversion Factor (L/m)	0.98	1.96	7.85	31.4	49.1	70.7

Total Well Depth	(-)	Water Level	(=)	Water Column
26 (m)	(-)	5.9 (m)		20.1 (m)

Volume of water in well
= Pr x r x h

P =3.14159
r = radius of well in cm
h = height of well in cm
V = volume in litres

Water Column	(x)	Conversion Factor	(=)	Well Volume (L)
20.1 (m)	(x)	1.96	(=)	39.3 L

Depth to Product	Product Thickness	Verified with bailer:
n/a (m)	n/a (m)	n/a (Y/N)

WATER QUALITY PARAMETERS

Beginning purge time: 12:07 — Ending purge time: 3x well volume

Parameters: SPC µS

Litres	Time	pH	Temp (°C)	Cond	DO	DO	Redox	Comments
		7.23	20.1	518.1	0.82		+122.2	clear / Lbr.
		7.04	20.1	546.7	0.77		-106.1	no odour
		7.03	20.0	546.6	0.27		-106.9	
		7.02	20.0	546.4	0.18		-104.0	
		7.01	20.1	546.5	0.14		-103.6	

pH, temp, EC readings not necessary if well is purged dry

Total Well Volume

Flow Rate (ml/minute)

Sample time: _____

Containers used: _____

Field parameters stabilise: (Y) N

Well purge dry: _____ (Y / N)

FIELD QC CHECKS (circle)

Was clean sampling equipment used for sample collection?	(Y)	N	
Was clean sample equipment properly protected from contaminant?	(Y)	N	
Were air bubbles present in vials at the time of collection?	Y	(N)	N/A
Were metals field filtered prior to preservation?	Y	(N)	N/A
Duplicate sample collected? (if YES write Sample ID here)	Y	(N)	N/A
Rinsate blank collected?	Y	(N)	

Slug Test

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Job no: 717041 Date: 14/3/18 Tester name: LV

Well number: MWx3 shallow Site: Stockton Rising/Falling Test (circle): Both

Well Depth 11.317 (m) Depth to water (TOC): 5.525 (m) Stickup: 0.2 (m)

Casing and screen diameter (inner diameter): 50 (mm)

Construction comments (length of screen, position of screen etc): _____

Data logger type/brand/serial no: Van ESSEN

Method of communication with logger (direct read/pre-programmed) pre-programmed

Construction details (notes of construction, depth to seal etc):

Slug details (if known) (note a slug of 1L is 900m long by 37.5mm dia)

Length: 1.8 m Diameter: ~~900m~~ 37.5 Volume: ~~37.5mm~~ 2L

Test

Test time start: _____ Test time finish: _____

Test ID on computer: MWx3-shallow_V4 and _V5

Length of transducer cable to be used: ~~7.4~~ 8 (m)

- Measure length of rope/cable + Slug such that the base of slug is just above the water (depth to water minus the length of the slug): (7.4 (m))
- Measure length of rope/cable + slug such that slug will be fully submerged but not hitting transducer. (mark or tie off)

Other notes/comments

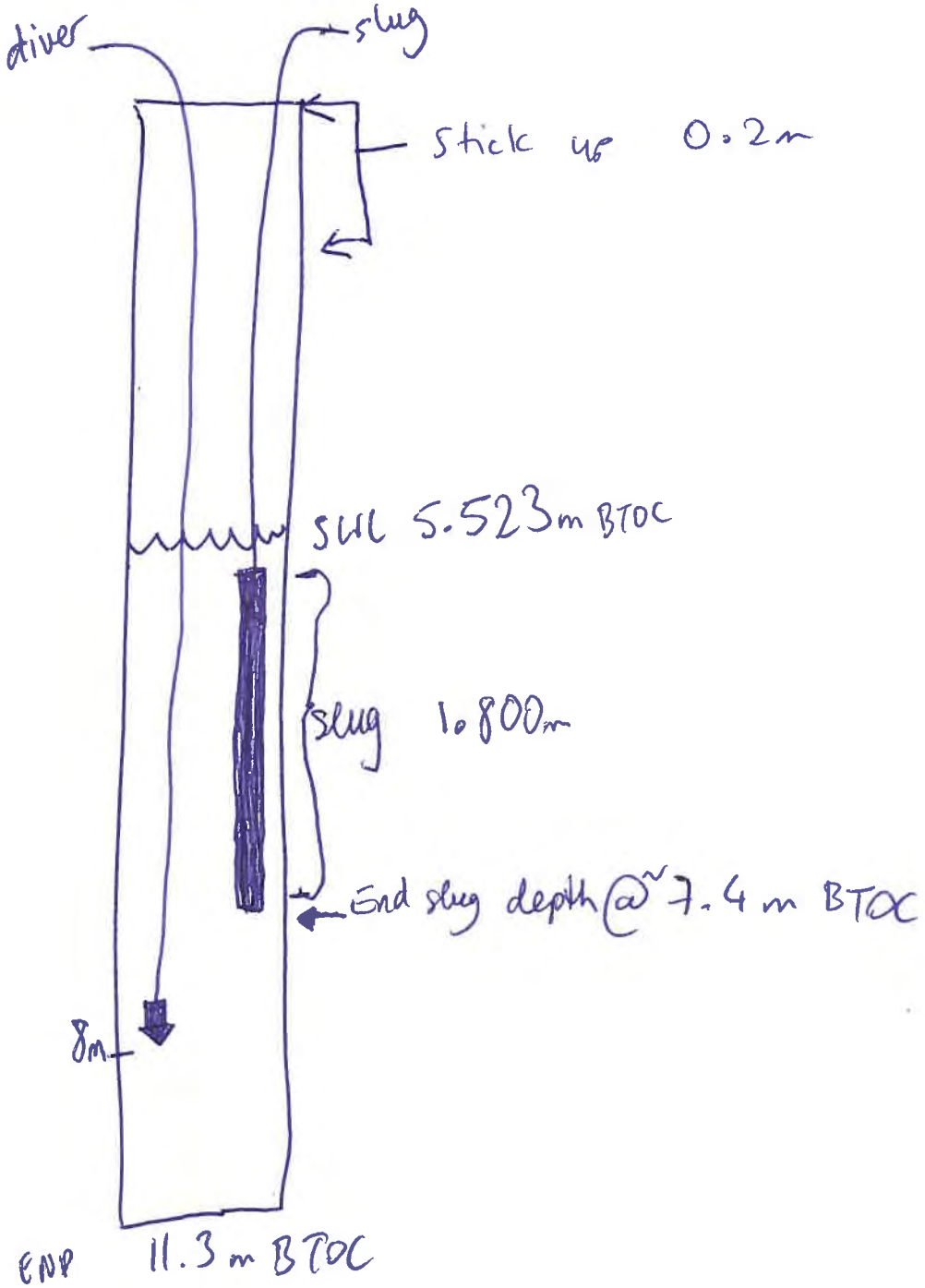
Diver in well for ~10 mins to equilibrate before inserting slug in V4, approx 5mins equilibrate for V5

SWL pre-start: 5.525 m ~~BTOC~~

SWL post-slug: 5.525

MW x 3 - shallow

SWL from ground surface
= 5.323m BGS



Well construction
total depth: 11.45m
Screen length: 3m
SWL : 4.92 m

Slug Test

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Job no: 717041 Date: 14/3/18 Tester name: CV

Well number: MWx3 deep Site: Stockton Rising/Falling Test (circle): Both

Well Depth 26 (m) Depth to water (TOC): 5.910 (m) Stickup: 0.51 (m)

Casing and screen diameter (inner diameter): 50 (mm)

Construction comments (length of screen, position of screen etc): _____

Data logger type/brand/serial no: Van Essen

Method of communication with logger (direct read/pre-programmed) pre programmed

Construction details (notes of construction, depth to seal etc):

Slug details (if known) (note a slug of 1L is 900m long by 37.5mm dia)

Length: 1.8 Diameter: 37.5 Volume: 2L

Test

Test time start: V4: 10mins Test time finish: _____

Test ID on computer: V2 + V3

Length of transducer cable to be used: 8 (m)

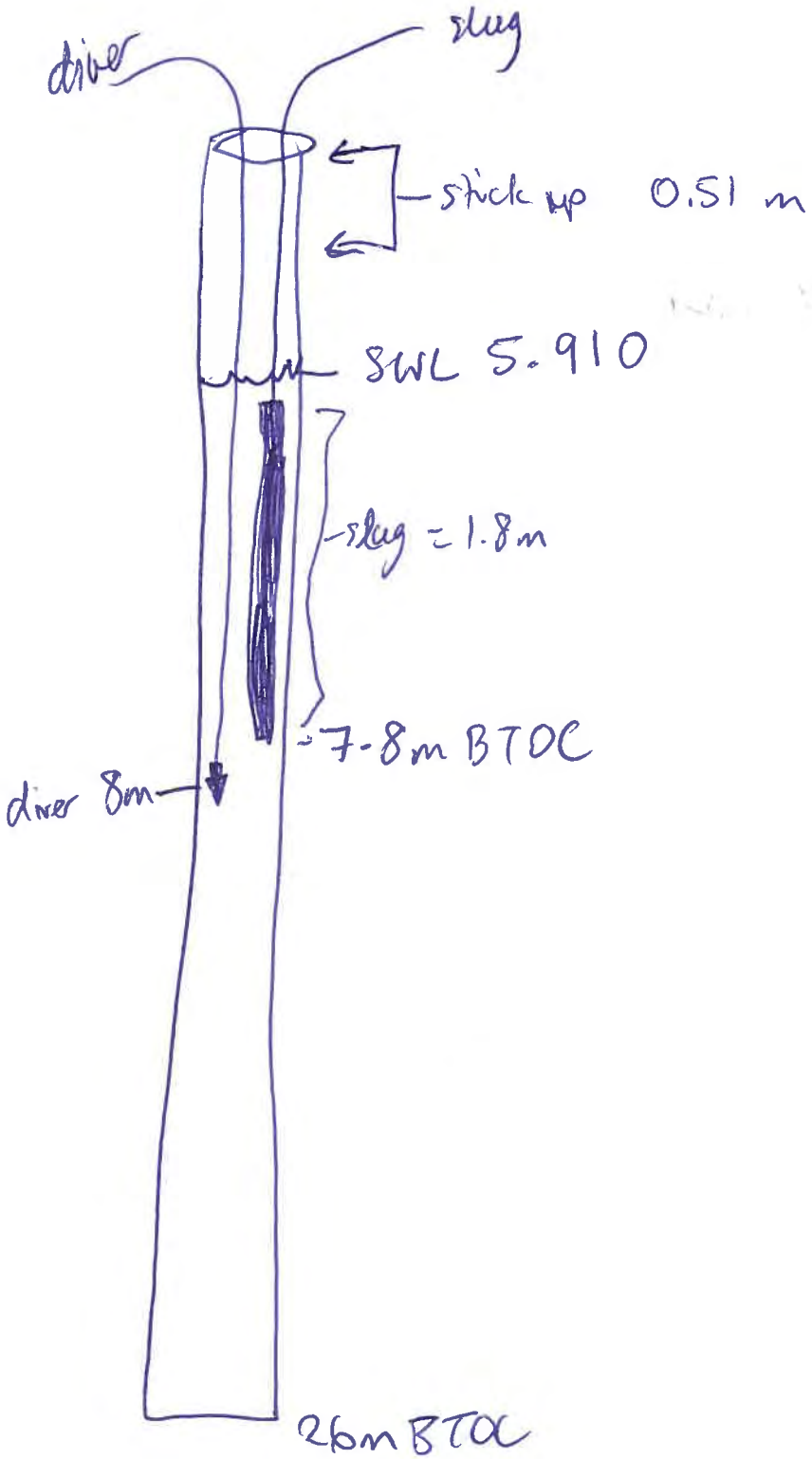
- Measure length of rope/cable + Slug such that the base of slug is just above the water (depth to water minus the length of the slug): (7.8 (m))
- Measure length of rope/cable + slug such that slug will be fully submerged but not hitting transducer. (mark or tie off)

Other notes/comments

SWL pre - slug : 5.910
SWL post - slug : 5.910
~5 mins equilibration time in well prior to slug test

MW x 3 - deep

SWL from ground surface
= 5.400m BGS



Well construction:
total depth: 26m BGL
screen length: 3m
SWL: 5.31

Rising
267 - 274

Falling
328 - 331

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

APPENDIX F: LABORATORY TRANSCRIPTS

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1807813**	Page	: 1 of 2
Client	: **ENVIRONMENTAL EARTH SCIENCES**	Laboratory	: Environmental Division Brisbane
Contact	: LORETTA VISINTIN	Contact	: Peter Ravlic
Address	:	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 02 99221777	Telephone	: +61-7-3243 7222
Project	: 717041	Date Samples Received	: 27-Mar-2018 10:19
Order number	:	Date Analysis Commenced	: 29-Mar-2018
C-O-C number	: ----	Issue Date	: 29-Mar-2018 10:54
Sampler	: LORETTA VISINTIN		
Site	: Boral Stockton		
Quote number	: EN/010/17		
No. of samples received	: 3		
No. of samples analysed	: 3		

ilac-MRA NATA
Accreditation No. 825
Accredited for compliance with ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- **The samples in this work order have been re-batched from ES1807945.**
- ASS: EA033 (CRS Suite): Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime (CaCO3) and using a safety factor of 1.5 to allow for non-homogeneous mixing and poor reactivity of lime. For conversion of Liming Rate from 'kg/t dry weight' to 'kg/m3 in-situ soil', multiply 'reported results' x 'wet bulk density of soil in t/m3'.

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			Client sample ID	**BH2_2.0 ES1807945-013**	**BH4_6.0 ES1807945-037**	**BH4_9.0 ES1807945-038**	**----**	**----**
			Client sampling date / time	13-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB1807813-001**	**EB1807813-002**	**EB1807813-003**	**--------**	**--------**
				Result	Result	Result	----	----
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	**0.11**	**0.15**	**0.02**	**----**	**----**
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	**22**	**30**	<10	**----**	**----**
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	**0.03**	**0.05**	<0.01	**----**	**----**

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **EB1807813**	Page	: 1 of 3
Client	: **ENVIRONMENTAL EARTH SCIENCES**	Laboratory	: Environmental Division Brisbane
Contact	: LORETTA VISINTIN	Contact	: Peter Ravlic
Address	:	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 02 99221777	Telephone	: +61-7-3243 7222
Project	: 717041	Date Samples Received	: 27-Mar-2018
Order number	:	Date Analysis Commenced	: 29-Mar-2018
C-O-C number	: ----	Issue Date	: 29-Mar-2018
Sampler	: LORETTA VISINTIN		
Site	: Boral Stockton		
Quote number	: EN/010/17		
No. of samples received	: 3		
No. of samples analysed	: 3		

ilac-MRA NATA
Accreditation No. 825
Accredited for compliance with ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA033-C: Acid Neutralising Capacity (QC Lot: 1532412)									
EB1807813-001	BH2_2.0 ES1807945-013	EA033: Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	0.11	0.15	35.3	0% - 50%
		EA033: sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	0.03	0.05	35.3	No Limit
		EA033: acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	22	31	35.3	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA033-C: Acid Neutralising Capacity (QCLot: 1532412)								
EA033: Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	<0.01	10 % CaCO3	99.0	70	130
EA033: acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	<10	----	----	----	----
EA033: sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	<0.01	----	----	----	----

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

- **No Matrix Spike (MS) or Matrix Spike Duplicate (MSD) Results are required to be reported.**

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EB1807813**	Page	: 1 of 4
Client	: **ENVIRONMENTAL EARTH SCIENCES**	Laboratory	: Environmental Division Brisbane
Contact	: LORETTA VISINTIN	Telephone	: +61-7-3243 7222
Project	: 717041	Date Samples Received	: 27-Mar-2018
Site	: Boral Stockton	Issue Date	: 29-Mar-2018
Sampler	: LORETTA VISINTIN	No. of samples received	: 3
Order number	:	No. of samples analysed	: 3

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **NO Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

- **NO Quality Control Sample Frequency Outliers exist.**

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA033-C: Acid Neutralising Capacity							
80* dried soil (EA033)							
BH2_2.0 - ES1807945-013	**13-Mar-2018**	**29-Mar-2018**	13-Mar-2019	✓	**29-Mar-2018**	27-Jun-2018	✓
80* dried soil (EA033)							
BH4_6.0 - ES1807945-037, BH4_9.0 - ES1807945-038	**14-Mar-2018**	**29-Mar-2018**	14-Mar-2019	✓	**29-Mar-2018**	27-Jun-2018	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **SOIL**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Chromium Suite for Acid Sulphate Soils	EA033	1	3	**33.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Chromium Suite for Acid Sulphate Soils	EA033	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Chromium Suite for Acid Sulphate Soils	EA033	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Chromium Suite for Acid Sulphate Soils	EA033	SOIL	In house: Referenced to Ahern et al 2004. This method covers the determination of Chromium Reducible Sulfur (SCR); pHKCl; titratable actual acidity (TAA); acid neutralising capacity by back titration (ANC); and net acid soluble sulfur (SNAS) which incorporates peroxide sulfur. It applies to soils and sediments (including sands) derived from coastal regions. Liming Rate is based on results for samples as submitted and incorporates a minimum safety factor of 1.5.

Preparation Methods	Method	Matrix	Method Descriptions
Drying at 85 degrees, bagging and labelling (ASS)	EN020PR	SOIL	In house

SAMPLE RECEIPT NOTIFICATION (SRN)

Work Order : **EB1807813**

Client	: **ENVIRONMENTAL EARTH SCIENCES**	Laboratory	: Environmental Division Brisbane
Contact	: LORETTA VISINTIN	Contact	: Peter Ravlic
Address	:	Address	: 2 Byth Street Stafford QLD Australia 4053
E-mail	: lvisintin@environmentalearthsciences.com	E-mail	: peter.ravlic@alsglobal.com
Telephone	: +61 02 99221777	Telephone	: +61-7-3243 7222
Facsimile	: +61 02 99221010	Facsimile	: +61-7-3243 7218
Project	: 717041	Page	: 1 of 2
Order number	:	Quote number	: ES2015ENVEAR0001 (EN/010/17)
C-O-C number	: ----	QC Level	: NEPM 2013 B3 & ALS QC Standard
Site	: Boral Stockton		
Sampler	: LORETTA VISINTIN		

Dates

Date Samples Received	: 27-Mar-2018 10:19	Issue Date	: 27-Mar-2018
Client Requested Due Date	: 04-Apr-2018	Scheduled Reporting Date	: **04-Apr-2018**

Delivery Details

Mode of Delivery	: Samples On Hand	Security Seal	: Not Available
No. of coolers/boxes	: ----	Temperature	: ----
Receipt Detail	: REBATCH	No. of samples received / analysed	: 3 / 3

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- **The samples in this work order have been re-batched from ES1807945.**
- Discounted Package Prices apply only when specific ALS Group Codes ('W', 'S', 'NT' suites) are referenced on COCs.
- Please direct any turn around / technical queries to the laboratory contact designated above.
- Sample Disposal - Aqueous (3 weeks), Solid (2 months) from receipt of samples.
- Analysis will be conducted by ALS Environmental, Brisbane, NATA accreditation no. 825, Site No. 818 (Micro site no. 18958).
- **Breaches in recommended extraction / analysis holding times (if any) are displayed overleaf in the Proactive Holding Time Report table.**

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exists.**

Any sample identifications that cannot be displayed entirely in the analysis summary table will be listed below.

EB1807813-001 : [13-Mar-2018] : BH2_2.0 - ES1807945-013
EB1807813-002 : [14-Mar-2018] : BH4_6.0 - ES1807945-037
EB1807813-003 : [14-Mar-2018] : BH4_9.0 - ES1807945-038

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process necessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.
If no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component

Matrix: **SOIL**

Laboratory sample ID	*Client sampling date / time*	*Client sample ID*	SOIL - EA033-C ANC ANC only from Chromium Suite Method
EB1807813-001	13-Mar-2018 00:00	BH2_2.0 ES1807945-0...	✓
EB1807813-002	14-Mar-2018 00:00	BH4_6.0 ES1807945-0...	✓
EB1807813-003	14-Mar-2018 00:00	BH4_9.0 ES1807945-0...	✓

Proactive Holding Time Report

Sample(s) have been received within the recommended holding times for the requested analysis.

Requested Deliverables

ALL INVOICES MELB ADDRESS

- A4 - AU Tax Invoice (INV)	Email	accounts@eesigroup.com

LORETTA VISINTIN

- *AU Certificate of Analysis - NATA (COA)	Email	lvisintin@environmentalearthsciences.com
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	lvisintin@environmentalearthsciences.com
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	lvisintin@environmentalearthsciences.com
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	lvisintin@environmentalearthsciences.com
- Chain of Custody (CoC) (COC)	Email	lvisintin@environmentalearthsciences.com
- EDI Format - ENMRG (ENMRG)	Email	lvisintin@environmentalearthsciences.com
- EDI Format - ESDAT (ESDAT)	Email	lvisintin@environmentalearthsciences.com

MARK STUCKEY

- *AU Certificate of Analysis - NATA (COA)	Email	mstuckey@eesigroup.com
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	mstuckey@eesigroup.com
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	mstuckey@eesigroup.com
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	mstuckey@eesigroup.com
- Chain of Custody (CoC) (COC)	Email	mstuckey@eesigroup.com
- EDI Format - ENMRG (ENMRG)	Email	mstuckey@eesigroup.com
- EDI Format - ESDAT (ESDAT)	Email	mstuckey@eesigroup.com

From: Loretta Visintin [mailto:lvisintin@eesigroup.com]
Sent: Tuesday, 27 March 2018 10:19 AM
To: ALSEnviro Sydney <ALSEnviro.Sydney@ALSGlobal.com>
Cc: Mark Stuckey <mstuckey@eesigroup.com>
Subject: RE: RESULTS & EDD for ALS Workorder : ES1807945 | Your Reference: 717041

Hello,

We have an additional analysis request; we would like to schedule ANC titration (EA033-C) analysis on the following samples:

1 • BH2_2.0
2 • BH4_6.0
3 • BH4_9.0

Standard turnaround will suffice, thanks.

Kind regards, Loretta

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

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Environmental Division
Brisbane
Work Order Reference
EB1807813

Telephone : +61-7-3243 7222

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1807945**	Page	: 1 of 8
Client	: **ENVIRONMENTAL EARTH SCIENCES**	Laboratory	: Environmental Division Sydney
Contact	: LORETTA VISINTIN	Contact	: Peter Ravlic
Address	:	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: +61 02 99221777	Telephone	: +61-2-8784 8555
Project	: 717041	Date Samples Received	: 15-Mar-2018 17:30
Order number	:	Date Analysis Commenced	: 24-Mar-2018
C-O-C number	: ----	Issue Date	: 26-Mar-2018 12:44
Sampler	: LV		
Site	: Boral Stockton		
Quote number	: EN/010/17		
No. of samples received	: 48		
No. of samples analysed	: 29		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ASS: EA033 (CRS Suite):Retained Acidity not required because pH KCl greater than or equal to 4.5
- ASS: EA033 (CRS Suite): Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime (CaCO3) and using a safety factor of 1.5 to allow for non-homogeneous mixing and poor reactivity of lime. For conversion of Liming Rate from 'kg/t dry weight' to 'kg/m3 in-situ soil', multiply 'reported results' x 'wet bulk density of soil in t/m3'.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH1_1.5	BH1_3.0	BH1_4.0	BH1_7.0	BH1_15.5
			Client sampling date / time	12-Mar-2018 00:00	12-Mar-2018 00:00	12-Mar-2018 00:00	12-Mar-2018 00:00	12-Mar-2018 00:00
Compound	CAS Number	LOR	Unit	ES1807945-003	ES1807945-005	ES1807945-006	ES1807945-007	ES1807945-010
				Result	Result	Result	Result	Result
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	5.6	6.0	5.5	6.1	9.5
Titratable Actual Acidity (23F)	----	2	mole H+ / t	2	<2	2	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	0.026	0.016	0.024	0.018	0.016
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	16	10	15	11	<10
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	----	----	----	----	1.21
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	----	----	----	----	241
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	----	----	----	----	0.39
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	0.03	<0.02	0.03	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	18	10	17	11	<10
Liming Rate	----	1	kg CaCO3/t	1	<1	1	<1	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	0.03	<0.02	0.03	<0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	18	10	17	11	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t	1	<1	1	<1	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH2_0.5	BH2_2.0	BH2_2.5	BH2_3.0	BH2_9.0
			Client sampling date / time	13-Mar-2018 00:00	13-Mar-2018 00:00	13-Mar-2018 00:00	13-Mar-2018 00:00	13-Mar-2018 00:00
Compound	CAS Number	LOR	Unit	ES1807945-012	ES1807945-013	ES1807945-014	ES1807945-015	ES1807945-017
				Result	Result	Result	Result	Result
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**10.0**	**5.1**	**6.0**	**6.2**	**5.8**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	**42**	<2	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	**0.07**	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	**0.010**	**0.099**	**0.026**	**0.009**	**0.020**
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	**62**	**16**	<10	**12**
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	**3.28**	----	----	----	----
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	**656**	----	----	----	----
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	**1.05**	----	----	----	----
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	<0.02	**0.17**	**0.03**	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	**104**	**17**	<10	**12**
Liming Rate	----	1	kg CaCO3/t	<1	**8**	**1**	<1	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	**0.17**	**0.03**	<0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	**104**	**17**	<10	**12**
Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	**8**	**1**	<1	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH3_3.5	BH3_4.0	BH3_9.0	BH3_15.0	BH3_16.0
			Client sampling date / time	13-Mar-2018 00:00	13-Mar-2018 00:00	13-Mar-2018 00:00	13-Mar-2018 00:00	13-Mar-2018 00:00
Compound	CAS Number	LOR	Unit	ES1807945-024	ES1807945-025	ES1807945-028	ES1807945-030	ES1807945-031
				Result	Result	Result	Result	Result
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**6.1**	**6.0**	**5.7**	**9.6**	**9.5**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	**0.007**	**0.008**	**0.018**	**0.017**	**0.012**
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	**11**	**10**	<10
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	**----**	**----**	**----**	**4.84**	**0.65**
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	**----**	**----**	**----**	**967**	**130**
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	**----**	**----**	**----**	**1.55**	**0.21**
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	**12**	<10	<10
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	<1	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	**12**	**10**	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	<1	<1	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH4_2.0	BH4_3.5	BH4_5.0	BH4_6.0	BH4_9.0
			Client sampling date / time	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00
Compound	CAS Number	LOR	Unit	ES1807945-034	ES1807945-035	ES1807945-036	ES1807945-037	ES1807945-038
				Result	Result	Result	Result	Result
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**10.2**	**6.6**	**6.2**	**5.3**	**5.4**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	**4**	**6**
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	**0.050**	**0.007**	**0.007**	**0.027**	**0.030**
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	**31**	<10	<10	**17**	**18**
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	**8.26**	**0.27**	----	----	----
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	**1650**	**54**	----	----	----
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	**2.65**	**0.09**	----	----	----
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	**0.03**	**0.04**
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	**21**	**24**
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	**2**	**2**
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	**0.05**	<0.02	<0.02	**0.03**	**0.04**
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	**31**	<10	<10	**21**	**24**
Liming Rate excluding ANC	----	1	kg CaCO3/t	**2**	<1	<1	**2**	**2**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH4_12.0	BH4_15.0	BH4_16.0	BH4_17.0	BH4_20.5
			Client sampling date / time	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00
Compound	CAS Number	LOR	Unit	ES1807945-039	ES1807945-040	ES1807945-041	ES1807945-043	ES1807945-044
				Result	Result	Result	Result	Result
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**6.0**	**8.0**	**5.5**	**5.9**	**9.2**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	**0.029**	**0.018**	**0.017**	**0.018**	**0.012**
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	**18**	**11**	**11**	**11**	<10
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	**----**	**0.20**	**----**	**----**	**0.62**
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	**----**	**39**	**----**	**----**	**125**
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	**----**	**0.06**	**----**	**----**	**0.20**
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	**0.03**	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	**18**	<10	**12**	**11**	<10
Liming Rate	----	1	kg CaCO3/t	**1**	<1	<1	<1	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	**0.03**	<0.02	<0.02	<0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	**18**	**11**	**12**	**11**	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t	**1**	<1	<1	<1	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	FD1	FD2	FD3	FD4	----
			Client sampling date / time	13-Mar-2018 00:00	12-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	----
Compound	CAS Number	LOR	Unit	ES1807945-045	ES1807945-046	ES1807945-047	ES1807945-048	--------
				Result	Result	Result	Result	----
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**8.6**	**9.3**	**6.3**	**5.6**	----
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	----
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	**0.014**	**0.016**	<0.005	**0.025**	----
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	**16**	----
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	**0.21**	**1.18**	----	----	----
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	**41**	**235**	----	----	----
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	**0.07**	**0.38**	----	----	----
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	----
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	**0.03**	----
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	**17**	----
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	**1**	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	**0.03**	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	<10	**17**	----
Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	<1	**1**	----

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **ES1807945**	Page	: 1 of 3
Client	: **ENVIRONMENTAL EARTH SCIENCES**	Laboratory	: Environmental Division Sydney
Contact	: LORETTA VISINTIN	Contact	: Peter Ravlic
Address	:	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: +61 02 99221777	Telephone	: +61-2-8784 8555
Project	: 717041	Date Samples Received	: 15-Mar-2018
Order number	:	Date Analysis Commenced	: 24-Mar-2018
C-O-C number	: ----	Issue Date	: 26-Mar-2018
Sampler	: LV		
Site	: Boral Stockton		
Quote number	: EN/010/17		
No. of samples received	: 48		
No. of samples analysed	: 29		

ilac-MRA NATA
Accreditation No. 825
Accredited for compliance with ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA033-A: Actual Acidity (QC Lot: 1516717)									
ES1807945-003	BH1_1.5	EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	0.00	No Limit
		EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	2	2	0.00	No Limit
		EA033: pH KCl (23A)	----	0.1	pH Unit	5.6	5.7	1.77	0% - 20%
ES1807945-024	BH3_3.5	EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	0.00	No Limit
		EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	0.00	No Limit
		EA033: pH KCl (23A)	----	0.1	pH Unit	6.1	6.3	3.22	0% - 20%
EA033-A: Actual Acidity (QC Lot: 1516718)									
ES1807945-039	BH4_12.0	EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	0.00	No Limit
		EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	0.00	No Limit
		EA033: pH KCl (23A)	----	0.1	pH Unit	6.0	6.1	1.65	0% - 20%
EA033-B: Potential Acidity (QC Lot: 1516717)									
ES1807945-003	BH1_1.5	EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	0.026	0.024	6.25	No Limit
		EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	16	15	0.00	No Limit
ES1807945-024	BH3_3.5	EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	0.007	0.009	28.6	No Limit
		EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	0.00	No Limit
EA033-B: Potential Acidity (QC Lot: 1516718)									
ES1807945-039	BH4_12.0	EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	0.029	0.026	9.93	No Limit
		EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	18	16	9.93	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA033-A: Actual Acidity (QCLot: 1516717)								
EA033: pH KCl (23A)	----	----	pH Unit	----	4.6 pH Unit	100	70	130
EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	17.7 mole H+ / t	96.6	70	130
EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA033-A: Actual Acidity (QCLot: 1516718)								
EA033: pH KCl (23A)	----	----	pH Unit	----	4.6 pH Unit	100	70	130
EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	17.7 mole H+ / t	108	70	130
EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA033-B: Potential Acidity (QCLot: 1516717)								
EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	<0.005	0.25483 % S	84.0	70	130
EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	----	----	----	----
EA033-B: Potential Acidity (QCLot: 1516718)								
EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	<0.005	0.25483 % S	81.8	70	130
EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	----	----	----	----
EA033-C: Acid Neutralising Capacity (QCLot: 1516717)								
EA033: Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	<0.01	10 % CaCO3	100	70	130
EA033: acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	<10	----	----	----	----
EA033: sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	<0.01	----	----	----	----
EA033-C: Acid Neutralising Capacity (QCLot: 1516718)								
EA033: Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	<0.01	10 % CaCO3	100	70	130
EA033: acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	<10	----	----	----	----
EA033: sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	<0.01	----	----	----	----

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

- **No Matrix Spike (MS) or Matrix Spike Duplicate (MSD) Results are required to be reported.**

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **ES1807945**	Page	: 1 of 6
Client	: **ENVIRONMENTAL EARTH SCIENCES**	Laboratory	: Environmental Division Sydney
Contact	: LORETTA VISINTIN	Telephone	: +61-2-8784 8555
Project	: 717041	Date Samples Received	: 15-Mar-2018
Site	: Boral Stockton	Issue Date	: 26-Mar-2018
Sampler	: LV	No. of samples received	: 48
Order number	:	No. of samples analysed	: 29

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **NO Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

- **NO Quality Control Sample Frequency Outliers exist.**

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA033-A: Actual Acidity							
Snap Lock Bag - frozen (EA033)							
BH1_1.5, BH1_3.0, BH1_4.0, BH1_7.0, BH1_15.5, FD2	**12-Mar-2018**	**24-Mar-2018**	12-Mar-2019	✓	**24-Mar-2018**	22-Jun-2018	✓
Snap Lock Bag - frozen (EA033)							
BH2_0.5, BH2_2.0, BH2_2.5, BH2_3.0, BH2_9.0, BH3_3.5, BH3_4.0, BH3_9.0, BH3_15.0, BH3_16.0, FD1	**13-Mar-2018**	**24-Mar-2018**	13-Mar-2019	✓	**24-Mar-2018**	22-Jun-2018	✓
Snap Lock Bag - frozen (EA033)							
BH4_2.0, BH4_3.5, BH4_5.0, BH4_6.0, BH4_9.0, BH4_12.0, BH4_15.0, BH4_16.0, BH4_17.0, BH4_20.5, FD3, FD4	**14-Mar-2018**	**24-Mar-2018**	14-Mar-2019	✓	**24-Mar-2018**	22-Jun-2018	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA033-B: Potential Acidity							
Snap Lock Bag - frozen (EA033) BH1_1.5, BH1_3.0, BH1_4.0, BH1_7.0, BH1_15.5, FD2	**12-Mar-2018**	**24-Mar-2018**	12-Mar-2019	✓	**24-Mar-2018**	22-Jun-2018	✓
Snap Lock Bag - frozen (EA033) BH2_0.5, BH2_2.0, BH2_2.5, BH2_3.0, BH2_9.0, BH3_3.5, BH3_4.0, BH3_9.0, BH3_15.0, BH3_16.0, FD1	**13-Mar-2018**	**24-Mar-2018**	13-Mar-2019	✓	**24-Mar-2018**	22-Jun-2018	✓
Snap Lock Bag - frozen (EA033) BH4_2.0, BH4_3.5, BH4_5.0, BH4_6.0, BH4_9.0, BH4_12.0, BH4_15.0, BH4_16.0, BH4_17.0, BH4_20.5, FD3, FD4	**14-Mar-2018**	**24-Mar-2018**	14-Mar-2019	✓	**24-Mar-2018**	22-Jun-2018	✓
EA033-C: Acid Neutralising Capacity							
Snap Lock Bag - frozen (EA033) BH1_1.5, BH1_3.0, BH1_4.0, BH1_7.0, BH1_15.5, FD2	**12-Mar-2018**	**24-Mar-2018**	12-Mar-2019	✓	**24-Mar-2018**	22-Jun-2018	✓
Snap Lock Bag - frozen (EA033) BH2_0.5, BH2_2.0, BH2_2.5, BH2_3.0, BH2_9.0, BH3_3.5, BH3_4.0, BH3_9.0, BH3_15.0, BH3_16.0, FD1	**13-Mar-2018**	**24-Mar-2018**	13-Mar-2019	✓	**24-Mar-2018**	22-Jun-2018	✓
Snap Lock Bag - frozen (EA033) BH4_2.0, BH4_3.5, BH4_5.0, BH4_6.0, BH4_9.0, BH4_12.0, BH4_15.0, BH4_16.0, BH4_17.0, BH4_20.5, FD3, FD4	**14-Mar-2018**	**24-Mar-2018**	14-Mar-2019	✓	**24-Mar-2018**	22-Jun-2018	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA033-D: Retained Acidity							
Snap Lock Bag - frozen (EA033) BH1_1.5, BH1_3.0, BH1_4.0, BH1_7.0, BH1_15.5, FD2	**12-Mar-2018**	**24-Mar-2018**	12-Mar-2019	✓	**24-Mar-2018**	22-Jun-2018	✓
Snap Lock Bag - frozen (EA033) BH2_0.5, BH2_2.0, BH2_2.5, BH2_3.0, BH2_9.0, BH3_3.5, BH3_4.0, BH3_9.0, BH3_15.0, BH3_16.0, FD1	**13-Mar-2018**	**24-Mar-2018**	13-Mar-2019	✓	**24-Mar-2018**	22-Jun-2018	✓
Snap Lock Bag - frozen (EA033) BH4_2.0, BH4_3.5, BH4_5.0, BH4_6.0, BH4_9.0, BH4_12.0, BH4_15.0, BH4_16.0, BH4_17.0, BH4_20.5, FD3, FD4	**14-Mar-2018**	**24-Mar-2018**	14-Mar-2019	✓	**24-Mar-2018**	22-Jun-2018	✓
EA033-E: Acid Base Accounting							
Snap Lock Bag - frozen (EA033) BH1_1.5, BH1_3.0, BH1_4.0, BH1_7.0, BH1_15.5, FD2	**12-Mar-2018**	**24-Mar-2018**	12-Mar-2019	✓	**24-Mar-2018**	22-Jun-2018	✓
Snap Lock Bag - frozen (EA033) BH2_0.5, BH2_2.0, BH2_2.5, BH2_3.0, BH2_9.0, BH3_3.5, BH3_4.0, BH3_9.0, BH3_15.0, BH3_16.0, FD1	**13-Mar-2018**	**24-Mar-2018**	13-Mar-2019	✓	**24-Mar-2018**	22-Jun-2018	✓
Snap Lock Bag - frozen (EA033) BH4_2.0, BH4_3.5, BH4_5.0, BH4_6.0, BH4_9.0, BH4_12.0, BH4_15.0, BH4_16.0, BH4_17.0, BH4_20.5, FD3, FD4	**14-Mar-2018**	**24-Mar-2018**	14-Mar-2019	✓	**24-Mar-2018**	22-Jun-2018	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **SOIL**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Chromium Suite for Acid Sulphate Soils	EA033	3	29	**10.34**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Chromium Suite for Acid Sulphate Soils	EA033	2	29	**6.90**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Chromium Suite for Acid Sulphate Soils	EA033	2	29	**6.90**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Chromium Suite for Acid Sulphate Soils	EA033	SOIL	In house: Referenced to Ahern et al 2004. This method covers the determination of Chromium Reducible Sulfur (SCR); pHKCl; titratable actual acidity (TAA); acid neutralising capacity by back titration (ANC); and net acid soluble sulfur (SNAS) which incorporates peroxide sulfur. It applies to soils and sediments (including sands) derived from coastal regions. Liming Rate is based on results for samples as submitted and incorporates a minimum safety factor of 1.5.

Preparation Methods	Method	Matrix	Method Descriptions
Drying at 85 degrees, bagging and labelling (ASS)	EN020PR	SOIL	In house

CHAIN OF CUSTODY - ANALYSIS REQUEST FORM

Project Manager: Loretta Visintin Sampler: LV Job No: 717041 Site Location: Boral Stockton Laboratory: ALS Sheet: 1 of 1

No. of samples	Sample ID/ Depth	Field pH water	Date sampled	Field Test: Difference pHFOX	Sample Matrix: Soil	Water	Sediment	Analysis Required: EA033 (Cr suite complete)	HOLD												Sample-specific instructions/ notes
1	BH1_0.3	6.9	12/03/2018	1.2	X				x												
2	BH1_1.0	7.2	12/03/2018	1.1	X				x												
3	BH1_1.5	6.8	12/03/2018	3.1	X			x													
4	BH1_2.0	6.2	12/03/2018	1.6	X				x												
5	BH1_3.0	6.5	12/03/2018	2.9	X			x													
6	BH1_4.0	6.2	12/03/2018	2.5	X			x													
7	BH1_7.0	5.4	12/03/2018	2.2	X			x													
8	BH1_10.5	6.3	12/03/2018	0.2	X				x												
9	BH1_12.0	7.8	12/03/2018	1.7	X				x												
10	BH1_15.5	8.3	12/03/2018	2.2	X			x													
11	BH2_0.25	6.8	13/03/2018	0.8	X				x												
12	BH2_0.5	8.7	13/03/2018	2.1	X			x													
13	BH2_2.0	5	13/03/2018	3.7	X			x													
14	BH2_2.5	6.5	13/03/2018	3.7	X			x													
15	BH2_3.0	6.4	13/03/2018	1.2	X			x													
16	BH2_6.0	6.2	13/03/2018	0.6	X				x												
17	BH2_9.0	6.4	13/03/2018	3.3	x			x													
	TOTAL																				

Turn Around *(circle)*: NORMAL / 3 DAYS / 48 HRS / 24 HRS *(confirm with lab in advance if quick turn-around is required)*

Comments/ Instructions:

Lab Quotation No. *(if applicable)*:

Send report to *(email address)*: lvisintin@environmentalearthsciences.com

Cc: report to *(email address)*: mstuckey@eesigroup.com

Cc: invoice to *(email address)*: accounts@eesigroup.com

	Name	Signature	Date	Time
Sent off Site/Office by:	Loretta Visintin	[signature]	15-Mar-18	
Receiving Lab:	Sacy Stephens	Aes	15/3/18	1730 OK
Receiving Lab:				

Phone: (02) 9922 1777
Fax: (02) 9922 1010
PO Box 380 North Sydney NSW 2059
Email: eesnsw@environmentalearthsciences.com

ENVIRONMENTAL EARTH SCIENCES
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Subcon / Forward Lab / Split WO
Lab / Analysis: Brisbane / Cr Suite EA033
Organised By / Date: ----------
Relinquished By / Date: ----------
Connote / Courier: ----------
WO No: ----------
Attach By PO / Internal Sheet: ------

Environmental Division
Sydney
Work Order Reference
ES1807945

Telephone : + 61-2-8784 8555

CHAIN OF CUSTODY - ANALYSIS REQUEST FORM

Project Manager: Loretta Visintin | Sampler: LV | Job No: 717041 | Site Location: Boral Stockton | Laboratory: ALS | Sheet: 1 of 1

No. of samples	Sample ID/ Depth	Field pH water	Date sampled	Field Test: Difference pHFOX	Sample Matrix			Analysis Required												Sample-specific instructions/ notes
					Soil	Water	Sediment	EA033 (Cr suite complete)	HOLD											
18	BH2_12.0	6.9	13/03/2018	1.1	X				x											
19	BH2_16.0	6.5	13/03/2018	1	X				x											
20	BH2_19.5	6	13/03/2018	0.4	X				x											
21	BH2_24.0	6.6	13/03/2018	0.5	X				x											
22	BH3_0.5	7.2	13/03/2018	0.3	X				x											
23	BH3_2.75	7.4	13/03/2018	0.9	X				x											
24	BH3_3.5	7.7	13/03/2018	1.8	X			x												
25	BH3_4.0	7.4	13/03/2018	1.7	X			x												
26	BH3_6.0	7	13/03/2018	1.2	X				x											
27	BH3_8.0	7.1	13/03/2018	1.4	X				x											
28	BH3_9.0	6.9	13/03/2018	4.3	X			x												
29	BH3_12.0	7.4	13/03/2018	1.1	X				x											
30	BH3_15.0	8.2	13/03/2018	2	X			x												
31	BH3_16.0	8.6	13/03/2018	2.5	X			x												
32	BH3_18.0	6.8	13/03/2018	0.9	X				x											
33	BH4_0.5	7.2	14/03/2018	1.7	X				x											
34	BH4_2.0	7.3	14/03/2018	2.2	X			x												
	TOTAL																			

Turn Around *(circle)*: **NORMAL** / **3 DAYS** / **48 HRS** / **24 HRS** *(confirm with lab in advance if quick turn-around is required)*

Comments/ Instructions:

Lab Quotation No. *(if applicable)*:

Send report to *(email address)*: lvisintin@environmentalearthsciences.com

Cc: report to *(email address)*: mstuckey@eesigroup.com

Cc: Invoice to *(email address)*: accounts@eesigroup.com

	Name	Signature	Date	Time
Sent off Site/Office by:	Loretta Visintin		15-Mar-18	
Receiving Lab:	[illegible]		15/3/18	1730 OK
Receiving Lab:				

Phone: (02) 9922 1777
Fax: (02) 9922 1010
PO Box 380 North Sydney NSW 2059
Email: eesnsw@environmentalearthsciences.com

ENVIRONMENTAL EARTH SCIENCES
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CHAIN OF CUSTODY - ANALYSIS REQUEST FORM

Job No: 717041 Laboratory: ALS

Project Manager: Loretta Visintin Sampler: LV Site Location: Boral Stockton Sheet: 1 of 1

No. of samples	Sample ID/ Depth	Field pH water	Date sampled	Field Test: Difference pHFOX	Sample Matrix: Soil	Sample Matrix: Water	Sample Matrix: Sediment	Analysis Required: EA033 (Cr suite complete)	Analysis Required: HOLD												Sample-specific instructions/ notes
35	BH4_3.5	7.5	14/03/2018	2.7	X			x													
36	BH4_5.0	7.4	14/03/2018	2.4	X			x													
37	BH4_6.0	7.3	14/03/2018	4.3	X			x													
38	BH4_9.0	7	14/03/2018	4.4	X			x													
39	BH4_12.0	7.4	14/03/2018	2.8	X			x													
40	BH4_15.0	7.2	14/03/2018	3.3	X			x													
41	BH4_16.0	7.2	14/03/2018	4.6	X			x													
42	BH4_16.5	7.5	14/03/2018	1.4	X				x												
43	BH4_17.0	8.7	14/03/2018	3.1	X			x													
44	BH4_20.5	8.8	14/03/2018	2.7	X			x													
45	FD1		13/03/2018		X			x													
46	FD2		12/03/2018		X			x													
47	FD3		14/03/2018		X			x													
48	FD4		14/03/2018		x			x													
	TOTAL		48					29	19												

Turn Around *(circle)*: ***NORMAL*** **/ 3 DAYS / 48 HRS / 24 HRS** *(confirm with lab in advance if quick turn-around is required)*

Comments/ Instructions:

Lab Quotation No. *(if applicable)*:

Send report to *(email address)*: lvisintin@environmentalearthsciences.com

Cc: report to *(email address)*: mstuckey@eesigroup.com

Cc: invoice to *(email address)*: accounts@eesigroup.com

	Name	Signature	Date	Time
Sent off Site/Office by:	Loretta Visintin	[signature]	15-Mar-18	
Receiving Lab:	Sony Stephen	ALS	15/3/18	1730 O-K
Receiving Lab:				

Phone: (02) 9922 1777
Fax: (02) 9922 1010
PO Box 380 North Sydney NSW 2059
Email: eesnsw@environmentalearthsciences.com

ENVIRONMENTAL EARTH SCIENCES
THE KNOW AND THE HOW

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

INTERIM REPORT 207744

Client Details

Client	VGT Laboratories Pty Ltd
Attention	Administration Email
Address	PO Box 2335, Greenhills, NSW, 2323

Sample Details

Your Reference	**6740**
Number of Samples	2 water
Date samples received	11/12/2018
Date completed instructions received	11/12/2018

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	18/12/2018
Interim Report Date	18/12/2018

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Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Radioactivity Analysis report			
Our Reference		207744-1	207744-2
Your Reference	UNITS	6740/2	6740/4
Date Sampled		06/12/2018	06/12/2018
Type of sample		water	water
Date prepared	-		
Date analysed	-		
Radium-226	Bq/L		
Radium-228	Bq/L		

HM in water - total			
Our Reference		207744-1	207744-2
Your Reference	UNITS	6740/2	6740/4
Date Sampled		06/12/2018	06/12/2018
Type of sample		water	water
Date prepared	-	12/12/2018	12/12/2018
Date analysed	-	12/12/2018	12/12/2018
Uranium-Total	µg/L	<0.5	<0.5
Thorium-Total	µg/L	<0.5	<0.5

Method ID	Methodology Summary
Ext-041	Analysed by Australian Government - Australian Radiation Protection and Nuclear Safety Agnency. VIC. Radium 226 is determined by liquid scintiallation counting. Radium 228 is measured by high resolution gamma-ray spectrometry.
Metals-022	Determination of various metals by ICP-MS.

QUALITY CONTROL: HM in water - total						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
Date prepared	-			12/12/2018	[NT]	[NT]	[NT]	[NT]	12/12/2018	[NT]
Date analysed	-			12/12/2018	[NT]	[NT]	[NT]	[NT]	12/12/2018	[NT]
Uranium-Total	µg/L	0.5	Metals-022	<0.5	[NT]	[NT]	[NT]	[NT]	105	[NT]
Thorium-Total	µg/L	0.5	Metals-022	<0.5	[NT]	[NT]	[NT]	[NT]	110	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

CHAIN OF CUSTODY - Client

ENVIROLAB GROUP - National phone number 1300 42 43 44

Sydney Lab - Envirolab Services
12 Ashley St, Chatswood, NSW 2067
Ph 02 9910 6200 / sydney@envirolab.com.au

Perth Lab - MPL Laboratories
16-18 Hayden Crt Myaree, WA 6154
Ph 08 9317 2505 / lab@mpl.com.au

Melbourne Lab - Envirolab Services
1A Dalmore Drive Scoresby VIC 3179
Ph 03 9763 2500 / melbourne@envirolab.com.au

Brisbane Office - Envirolab Services
20a, 10-20 Depot St, Banyo, QLD 4014
Ph 07 3266 9532 / brisbane@envirolab.com.au

Adelaide Office - Envirolab Services
7a The Parade, Norwood, SA 5067
Ph 0406 350 706 / adelaide@envirolab.com.au

Client: VGT Pty Ltd

Contact Person: Lisa Thomson / Anthony Crane

Project Mgr:

Sampler:

Address:
Delivery: 4/30 Glenwood Dr, Thornton NSW 2322
Postal: PO Box 2335, Greenhills, NSW 2323

Phone: 4028 6412 **Mob:** 0427 334471

Email: Results: lab@vgt.com.au Invoice: mail@vgt.com.au

Client Project Name / Number / Site etc (ie report title): 6740

PO No.:

Envirolab Quote No. : 2016_C3 (No $25 Admin Fee, No Min $100)

Date results required:

Or choose: standard

Note: Inform lab in advance if urgent turnaround is required - surcharges apply

Report format: esdat / equis /

Lab Comments:

Sample information					Tests Required														Comments
Envirolab Sample ID	Client Sample ID or information	second Desc	Date sampled	Type of sample	Gross Alpha and Beta	Uranium/Thorium													Provide as much information about the sample as you can
1	6740/2		6/12/18	GW	X	X													
2	6740/4		6/12/18	GW	X	X													

ENVIROLAB
Envirolab Services
12 Ashley St
Chatswood NSW 2067
Ph: (02) 9910 6200

Job No: 207744

Date Received: 11/12

Time Received: 10:42

Received By: AZ

Temp: Cool/Ambient

Cooling: Ice/Icepack

Security: Intact/Broken/None

Relinquished by (Company): VGT Pty Ltd

Print Name: Athony Crane

Date & Time: 10/12/2018

Signature: AJC

Received by (Company): ELS

Print Name: Andy Zhang

Date & Time: 11/12 10:42

Signature: AZ

Lab use only:

Samples Received: Cool or Ambient (circle one)

Temperature Received at: **(if applicable)**

Transported by: Hand delivered / courier

White - Lab copy / Blue - Client copy / Pink - Retain in Book

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 207744

Client Details

Client	VGT Laboratories Pty Ltd
Attention	Administration Email
Address	PO Box 2335, Greenhills, NSW, 2323

Sample Details

Your Reference	**6740**
Number of Samples	2 water
Date samples received	11/12/2018
Date completed instructions received	11/12/2018

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	18/12/2018
Date of Issue	16/01/2019
Reissue Details	This report replaces R00 created on 16/01/2019 due to: Sample ID Amended (Client Request)

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Results Approved By
Jaimie Loa-Kum-Cheung, Senior Chemist
Nancy Zhang, Assistant Lab Manager

Authorised By



Jacinta Hurst, Laboratory Manager

Radioactivity Analysis report			
Our Reference		207744-1	207744-2
Your Reference	UNITS	MW2	MW7
Date Sampled		06/12/2018	06/12/2018
Type of sample		water	water
Radium-226	Bq/L	#	#
Radium-228	Bq/L	#	#

HM in water - total			
Our Reference		207744-1	207744-2
Your Reference	UNITS	MW2	MW7
Date Sampled		06/12/2018	06/12/2018
Type of sample		water	water
Date prepared	-	12/12/2018	12/12/2018
Date analysed	-	12/12/2018	12/12/2018
Uranium-Total	µg/L	<0.5	<0.5
Thorium-Total	µg/L	<0.5	<0.5

Method ID	Methodology Summary
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Metals-022	Determination of various metals by ICP-MS.

QUALITY CONTROL: HM in water - total						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
Date prepared	-			12/12/2018	[NT]	[NT]	[NT]	[NT]	12/12/2018	[NT]
Date analysed	-			12/12/2018	[NT]	[NT]	[NT]	[NT]	12/12/2018	[NT]
Uranium-Total	µg/L	0.5	Metals-022	<0.5	[NT]	[NT]	[NT]	[NT]	105	[NT]
Thorium-Total	µg/L	0.5	Metals-022	<0.5	[NT]	[NT]	[NT]	[NT]	110	[NT]

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NA	Test not required
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NEPM	National Environmental Protection Measure
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Quality Control Definitions

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Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
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LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
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Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

Laboratory Acceptance Criteria

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Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

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When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Report Comments

Gross Alpha and Beta analysed by ALS, report no CA1807626.
see report atatched.

ALS Water

CERTIFICATE OF ANALYSIS

Work Order	: **CA1807626**	Page	: 1 of 2
Amendment	: **1**		
Client	: **Envirolab Services**	Laboratory	: ALS Water Resources Group
Contact	: Results Envirolab	Contact	: Client Services
Address	: 12 Ashley Street Chatswood NSW 2067	Address	: 16B Lithgow Street Fyshwick ACT Australia 2609
Telephone	: 0299106200	Telephone	: +61 2 6202 5404
Project	: —	Date Samples Received	: 13-Dec-2018 11:20
Order number	:	Date Analysis Commenced	: 18-Dec-2018
C-O-C number	: —	Issue Date	: 16-Jan-2019 13:48
Sampler	: —		
Site	: —		
Quote number	: —		
No. of samples received	: 2		
No. of samples analysed	: 2		

Accreditation No. 992
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Titus Vimalasiri	Metals Teamleader	Radionuclides, Fyshwick, ACT

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- **For samples collected by ALS WRG, sampling was carried out in accordance with Procedure EN67**

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Client sample ID*	— **MW2**	— **MW7**	—	—	—
			Client sampling date / time	12-Dec-2018 00:00	12-Dec-2018 00:00	---	---	---
Compound	*CAS Number*	*LOR*	*Unit*	**CA1807626-001**	**CA1807626-002**	———	——-	———
				Result	Result	---	---	---
EA250CA: Gross Alpha and Beta Activity								
Gross alpha	––	0.05	Bq/L	<0.05	<0.05	––	—	—
Gross beta	––	0.10	Bq/L	<0.10	<0.10	––	—	—
Gross beta activity - 40K	––	0.10	Bq/L	<0.10	<0.10	––	—	—

APPENDIX G: SLUG TEST RESULTS

stockton *717041*

slug test 13/14 March 208

MW06

Parameters		Jacob Approximation		Hvorslev			Bouwer & Rice					
							Lw=h		***h>Lw***			
Test 1		***T = 2.3Q/4*pi*delta s***		***To=(ln(0,37/E)/F***								
Depth (m)	11.4	slope	0.135	E	0.8012		Le/R	60.0	A	3		
Static (m)	5.5			F	-1.168		C	2	B	0.6		
Hydraulic gradient (m/m)	0.002						Ho	0.169	ln (Re/R)	3.1451		
Aquifer thickness (b,m)	6.0	**delta S**	0.3108		checked by hand		Ht	0.018				
Le (m)	3	**S**	3.00E-05	To	0.661		t	1.5				
Lw (m)	5.9	**KD (m2/d)**	353.281	**KD (m2/d)**	334.243							
R (m)	0.05	**K (m/d)**	**58.8801**	**K (m/d)**	**55.7071**	**6.91**	**KD (m2/d)**	305.496	**KD (m2/d)**	253.5700		
Porosity	0.35	**v (m/d)**	0.336458	**v (m/d)**	0.318326		**K (m/d)**	**50.9160**	**K (m/d)**	**42.2617**		
		v (m/year)	122.807	**v (m/year)**	116.189		**v (m/d)**	0.290949	**v (m/d)**	0.24150		
Q (m3/d)	**600.000**						**v (m/year)**	106.196	**v (m/year)**	88.1458		
Water (m)	5.9											

	Average	SD	CV
KD	311.65	43.42	0.14
K	49.63	4.01	0.08
v	0.297	0.04	0.14
	108.33	15.09	0.14

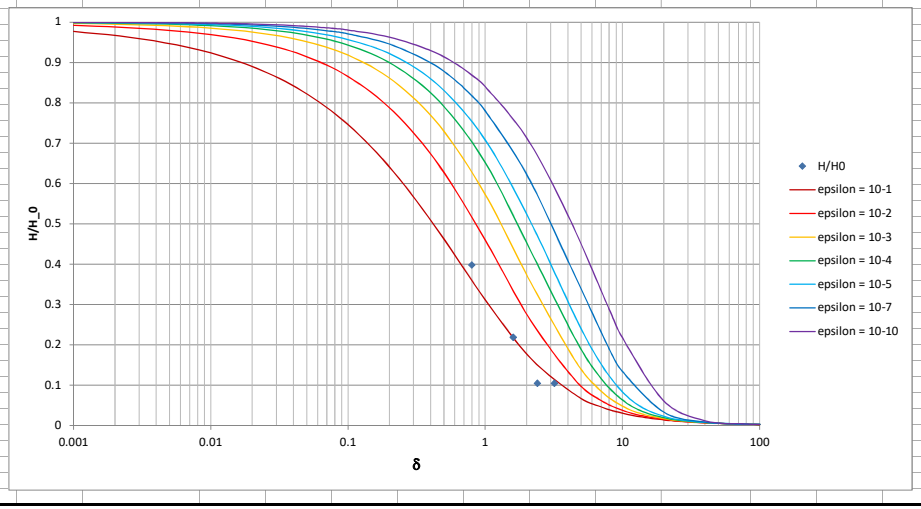
Cooper, Bredehoft, and Papadopulos (1967) slug test analysis for well screens below the water table and dominated by horizontal flow. Insert your observed t vs. H/H_0 data, then enter model data in the yellow row and adjust K_r to achieve a match to one of the curves. Then enter the best-fit alpha (blue cell) to get an estimated Ss. All data must be in one consistent set of time and length units (e.g. day, meter). The parameters are defined as follows: H=deviation of head from static, H_0 = initial H, at t=0, t=time, r_s=effective radius of the screen, r_c=effective radius of the casing, B=length of the well screen or formation thickness for fully-penetrating well, K=horizontal hydraulic conductivity, S_s=specific storage, ε (epsilon)= S_s b(r_s/r_c)^2, δ=Kbt/(r_c)^2.

Cooper, H. H., J. D. Bredehoeft, and I. S. Papadopulos. 1967. Response of a finite diameter well to an instantaneous charge of water. *Water Resources Research*, 3, 263--269.

Papadapulos, I. S., Bredehoeft, J. D., and H. H. Cooper. 1973. On the analysis of "slug test" data. *Water Resources*

r_s [L]	r_c [L]	b [L]	K [L/T]		Best fit epsilon [ ]		S
0.05	0.05	10	4.0E-04	m/s	1.0E-01		1.0E-01
			3.5E+01	m/d	S_s [1/L] computed from best fit epsilon		
MW1			3.5E+02	m2/d	1.0E-02		

t	H/H0	δ
0	1	0
0.5	0.397929	0.8
1	0.218935	1.6
1.5	0.10503	2.4
2	0.10503	3.2
		0
		0
		0
		0
		0
		0
		0



APPENDIX H: SOIL LANDSCAPE REPORTS

bt BOYCES TRACK



Landscape—steep Quaternary Holocene sand dunes on the Tomago Coastal Plain. Local relief 10–30 m, slopes >25%, elevation 10–40 m. Uncleared tall open-forest.

Soils—deep (>300 cm), well-drained weakly developed Podzols (Uc2.2).

Qualities and Limitations—wind erosion hazard, steep slopes, mass movement hazard (if disturbed), ground water pollution hazard, non-cohesive acid soils of low fertility.

LOCATION

Steep stable Holocene dunes on the Tomago Coastal Plain between North Stockton and Bobs Farm. Type location is along Boyces Track (Area reference 4**01****E, 63 **70****N).

LANDSCAPE

Geology and Regolith

Holocene transgressive aeolian dunes.

Topography

Steep stable Holocene transgressive dunes. Two long walled ridges, parallel to the shoreline, form the major part of this landscape (Thom *et al*. 1992). These ridges are separated by a low relief sand plain (see Hawks Nest **(hn)** soil landscape). Local relief 10–20 m, slope gradients often >30 %, elevation 10–40 m. Windward slopes are generally longer and more gently inclined than leeward slopes which are shorter and steeper, often having formed at the angle of repose of the sand.

Vegetation

Predominantly uncleared tall open-forest containing *Eucalyptus pilularis* (blackbutt), *Angophora costata* (smooth-barked apple), *Banksia serrata* (old man banksia), *Acacia longifolia* (sydney golden wattle) with an understorey of *Persoonia* spp. (geebung), *Pteridium esculentum* (bracken) and *Imperata cylindrica* (blady grass).

Land Use

Predominantly bushland. Some areas are being sand mined.

Existing Land Degradation

This landscape is often being buried on the seaward side by large encroaching unstable transgressive dunes.

SOILS

Dominant Soil Materials

bt1—Speckled loose loamy sand (topsoil—A_1 horizon)

Colour	commonly brownish grey (10YR 4/1)
Texture	coarse loamy sand
Structure	loose
Fabric	sandy
Field pH	moderately to slightly acid (pH 5.0–6.0)
Coarse fragments	few charcoal fragments
Roots	common fine, few coarse
Exposed condition	loose
Permeability	high
Type location	Boyces Track on top of dune 500 m south of Nelson Bay Road (Grid Ref. 4 **01**10*E, 63 **70**40*N). *Soil Landscapes of the Port Stephens 1:100 000 Sheet* Soil Data System card 25, 0–40 cm

bt2—Bleached loose sand (topsoil—A_2 horizon)

Colour	greyish yellow brown (10YR 5/2) to light grey (10YR 7/1, 10YR 8/1). Dry colours usually bleached light grey (10YR 7/1, 10YR8/1)
Texture	sand
Structure	loose

Fabric	sandy
Field pH	slightly acid to neutral (pH 6.0–7.0)
Coarse fragments	few charcoal fragments
Roots	few fine, few coarse
Exposed condition	loose
Permeability	high
Type location	Boyces Track on top of dune 500 m south of Nelson Bay Road (Grid Ref. 4 **01**10*E, 63 **70**40*N). *Soil Landscapes of the Port Stephens 1:100 000 Sheet* Soil Data System card 25, 40–140 cm

bt3—Faintly mottled sand (topsoil—weak Bhs horizon)

Colour	mixture of dark brown (10YR 4/3) or brown (10YR 4/4) mottles in a background colour of dull yellow orange (10YR 6/4)
Texture	sand
Structure	loose
Fabric	sandy
Field pH	slightly acid to neutral (pH 6.0–7.0)
Coarse fragments	absent
Roots	few fine, few coarse
Exposed condition	loose
Permeability	high
Type location	Boyces Track on top of dune 500 m south of Nelson Bay Road (Grid Ref. 4 **01**10*E, 63 **70**40*N). *Soil Landscapes of the Port Stephens 1:100 000 Sheet* Soil Data System card 25, 140–180 cm

bt4—Loose dull yellow orange sand (parent material—C horizon)

Colour	dull yellow orange (10YR 6/4)
Texture	sand
Structure	loose
Fabric	sandy
Field pH	slightly acid to neutral (pH 6.0–7.0)
Coarse fragments	absent
Roots	absent
Exposed condition	loose
Permeability	high
Type location	Boyces Track on top of dune 500 m south of Nelson Bay Road (Grid Ref. 4 **01**10*E, 63 **70**40*N). *Soil Landscapes of the Port Stephens 1:100 000 Sheet* Soil Data System card 25, >180 cm

Occurrence and Relationships

Generally. Up to 40 cm of speckled loose loamy sand **(bt1)** overlies up to 100 cm of bleached loose light grey sand **(bt2)**, which overlies up to a 50 cm of faintly mottled sand **(bt3)** and >500 cm of loose dull yellow orange sand **(bt4)** [well-drained weakly developed Podzols (Uc2.2)]. Boundaries are clear except for **bt3/bt4** which is diffuse. Total soil depth >300 cm.

QUALITIES AND LIMITATIONS

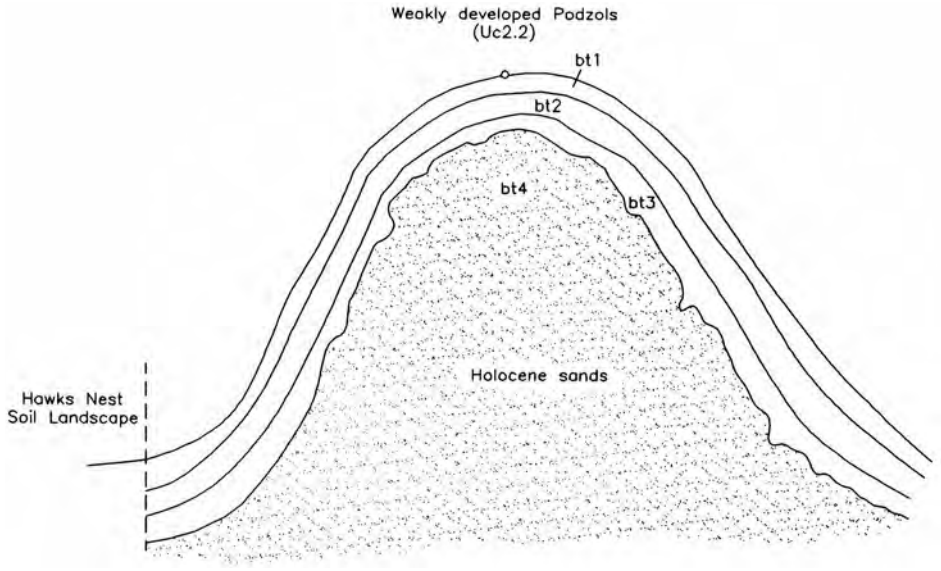
Landscape Limitations

High wind erosion hazard
Mass movement hazard (if disturbed)
Steep slopes (localised)
Non-cohesive soils
Foundation hazard
Ground water pollution hazard

Soil Limitations

bt1
High erodibility
High permeability
Very strong acidity
Low fertility
Low available water-holding capacity

bt2
High erodibility
High permeability
Strong acidity
Very low fertility
Very low available water-holding capacity



■ ***Schematic cross-section of Boyces Track soil landscape illustrating the occurrence and relationship of the dominant soil materials.***

bt3 High erodibility
High permeability
Strong acidity
Very low fertility
Very low available water-holding capacity

bt4 High erodibility
High permeability
Very low fertility
Very low available water-holding capacity

Fertility

Soil Materials as Plant Growth Media. Soil material suitability as growth media is generally low, due to strongly acid soils, high permeability, low fertility and very low available water-holding capacity.

Soil Profile Fertility. Soil profile suitability is generally low to moderate for deep, well-drained Podzols.

Erodibility

	K factor	Non-concentrated flows	Concentrated flows	Wind
bt1	0.000	very low	high	moderate
bt2	0.000	very low	very high	high
bt3	0.000	very low	high	high
bt4	0.000	very low	high	high

Erosion Hazard

	Non-concentrated flows	Concentrated flows	Wind
grazing	slight	high	V high
cultivation	slight	high	extreme
urban	slight	very high	V high

Foundation Hazard

High foundation hazard due to steep slopes and localised mass movement hazard.

Urban Capability

Generally high to severe limitations for urban development.

Rural Capability

Generally severe limitations for cultivation and high limitations for grazing. This landscape is best left undisturbed and retained under native vegetation.

Sustainable Land Management Recommendations

To prevent wind erosion it is important to maintain sufficient ground cover. Fertilisers may be necessary to establish good cover. Protective fences around critical vegetated areas and weed control may also be necessary.

Soil Conservation Earthworks

Not suitable, due to highly pervious soil materials.

hn HAWKS NEST



Landscape—low Holocene sandsheets and low transgressive dunes on the Tomago Coastal Plain. Local relief <3 m, slope gradients <10%, elevation 3–12 m. Dry scrubland, woodland and tall open-forest.

Soils—deep (>300 cm), well-drained Podzols (Uc2.3) and Siliceous Sands/Podzols (Uc2.21) on dunes, deep (>200 cm), poorly drained Humus Podzols (Uc5.1) on sandsheets.

Qualities and Limitations—wind erosion hazard, high watertables (localised), seasonal waterlogging (localised), permanent waterlogging (localised), non-cohesive, potential acid sulphate soils, ground water pollution hazard.

LOCATION

Stable low Holocene sandsheets and low transgressive dunes on the Tomago Coastal Plain from North Stockton to Bobs Farm (Area reference Salt Ash 4 **00**5**E, 63 **70**6**N).

LANDSCAPE

Geology and Regolith

Holocene quartz sandsheets and beach ridges.

Topography

Stable, gently undulating, Holocene, sandsheets and low transgressive dunes. Local relief <3 m, slope gradients <10%, elevation 3–12 m ASL. Low sandy dunes and swales are the dominant landform elements. The area is generally well drained apart from isolated, small, shallow swamps which occur in low lying, poorly drained swales and depressions.

Vegetation

Predominantly uncleared woodland and tall open-forest. Common species include *Angophora costata* (smooth-barked apple), *Eucalyptus pilularis* (blackbutt), *Eucalyptus gummifera* (red bloodwood), *Banksia serrata* (old man banksia), with an understorey of *Pteridium esculentum* (bracken), *Imperata cylindrica* (blady grass), *Actinotus helianthi* (flannel flower), *Persoonia* spp. (geebung), *Acacia longifolia* (sydney golden wattle).

Land Use

The main land use is bushland.

Existing Land Degradation

None identified.

SOILS

Dominant Soil Materials

hn1—Loose speckled grey brown loamy sand (topsoil—A_1 horizon)

Colour	brownish grey (10YR 4/1), occasionally brownish black in moist areas
Texture	loamy sand
Structure	single-grained
Fabric	sandy
Field pH	moderately acid (pH 5.5)
Coarse fragments	few charcoal fragments
Roots	fine common, few to common coarse
Exposed condition	loose
Permeability	very high
Type location	Boyces Track 300 m south of Nelson Bay Road (Grid Ref. 4 **00**850*E, 63 **70**80*N). *Soil Landscapes of the Port Stephens 1: 100 000 Sheet* Soil Data System card 246, 0–45 cm

hn2—Loose bleached sand (subsoil—A_2 horizon)

Colour	dull yellow orange (10YR 7/2), bleached
Texture	sand **Structure** single-grained
Fabric	sandy
Field pH	moderately acid (pH 5.5)

Coarse fragments	absent
Roots	few
Exposed condition	loose
Permeability	very high
Type location	Boyces Track 300 m south of Nelson Bay Road (Grid Ref. 4 **00**850*E, 63 **70**80*N). *Soil Landscapes of the Port Stephens 1:100 000 Sheet* Soil Data System card 246, 45–150 cm

hn3—Coloured mottled sand (subsoil—Bhs horizon)

Colour	organic staining; dark brown (10YR 3/4), brown (10YR 4/4) , organic/iron staining dull yellow orange (10YR 6/4) to dull yellow brown (10YR 5/4) with pale brown mottles
Texture	sand
Structure	single-grained
Fabric	sandy
Field pH	moderately to slightly acid (pH 5.5–6.0)
Coarse fragments	absent
Roots	fine common, few to common coarse
Exposed condition	loose to slightly hardsetting
Permeability	high
Type location	Boyces Track 300 m south of Nelson Bay Road (Grid Ref. 4 **00**850*E, 63 **70**80*N). *Soil Landscapes of the Port Stephens 1:100 000 Sheet* Soil Data System card 246, 150–270 cm

hn4—Greyish yellow brown sand (C horizon)

Colour	commonly greyish yellow brown (10YR 6/2)
Texture	sand
Structure	single-grained
Fabric	sandy
Field pH	moderately acid to neutral (pH 5.5–7.0)
Coarse fragments	absent
Roots	absent
Exposed condition	loose
Permeability	very high
Type location	Boyces Track 300 m south of Nelson Bay Road (Grid Ref. 4 **00**850*E, 63 **70**80*N). *Soil Landscapes of the Port Stephens 1:100 000 Sheet* Soil Data System card 246, 270–>300 cm

Occurrence and Relationships

Soil type is dependent on the age of the sand body. Along the coastal fringe lie the youngest aged dunes, and soil development is very poor apart from some organic matter build-up on the surface and minor development of a Bhs horizon. Further inland the dunes become progressively older and consequently the soils become more strongly developed with increasing age. It must be noted that the poorly developed soils of the seaward dunes very slowly become more developed as one travels landward.

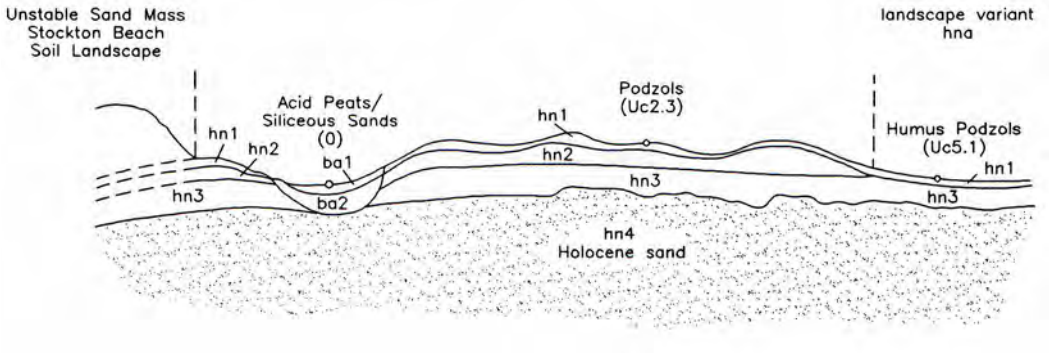
Dunes. Up to 40 cm of **hn1** overlies 10–150 cm of bleached loose sand **(hn2)**. **hn2** overlies 30–>100 cm of coloured mottled sand **(hn3)** and over 300 cm of greyish yellow brown sand **(hn4)** [well-drained Siliceous Sand/Podzol intergrades (Uc2.21) on the seaward fringe, Podzols (Uc2.3) occur landward]. Total soil depth is >300 cm and the boundaries between the soil materials are clear except for the boundary between **hn3** and **hn4** which is often diffuse.

Swampy swales. Small areas Acid Peats (O) occur in low lying, poorly drained swales with up to 10 cm **ba1** overlying >100 cm **ba2** [very poorly drained Acid Peat/Siliceous Sand intergrades]. (See Blind Harrys Swamp **(ba)** soil landscape.)

QUALITIES AND LIMITATIONS

Landscape Limitations

Wind erosion hazard
Non-cohesive soil
High watertables (localised, swales)
Seasonal waterlogging (localised, swales)
Permanent waterlogging (localised, swamps)
Ground water pollution hazard



■ ***Schematic cross-section of Hawks Nest soil landscape illustrating the occurrence and relationship of the dominant soil materials.***

Soil Limitations

hn1 High permeability
Strong acidity
Low fertility
Low available water-holding capacity

hn2 High erodibility
High permeability
Very low fertility
Very low available water-holding capacity

hn3 High erodibility
High permeability
Very low fertility
Very low available water-holding capacity

hn4 High erodibility
High permeability
Strong acidity
Very low fertility
Very low available water-holding capacity
Potential acid sulphate soil (localised)

Fertility

Soil Materials as Plant Growth Media. Soil material suitability is generally low due to very low nutrient and moisture retention capacities, low exchangeable cations and high permeability.

Soil Profile Fertility. Generally low suitability for deep, poorly drained Humus Podzols and deep, well-drained Podzols and Siliceous Sands/Podzols.

Erodibility

	K factor	Non-concentrated flows	Concentrated flows	Wind
hn1	0.000	very low	high	high
hn2	0.000	very low	high	high
hn3	0.000	very low	high	high
hn4	0.000	very low	high	high

Erosion Hazard

	Non-concentrated flows	Concentrated flows	Wind
grazing	slight	high	high
cultivation	slight	high	V high
urban	slight	very high	high

Foundation Hazard

Generally low, except for swampy swales which have a high foundation hazard due to high watertables.

Urban Capability

Exposed areas, swamps, and poorly drained sand flats have high limitations for urban development. Sheltered areas have moderate limitations for urban development.

Rural Capability

Due to the highly sensitive nature of the dunes which are easily predisposed to wind erosion, there is generally a high limitation for both cultivation and grazing. The area is best retained under native timber.

Sustainable Land Management Recommendations

To prevent wind erosion, it is important to maintain sufficient ground cover. Fertilisers may be necessary to establish good cover. Protective fences around critical vegetated areas and weed control may be necessary.

Soil Conservation Earthworks

Not suitable, due to highly pervious soil materials.

APPENDIX I: HYDROLOGICAL SOIL GROUP MAPPING

Port Stephens Hydrologic Soil Group Mapping

PORT STEPHENS COUNCIL

Hydrologic Soil Group Map - Sheet HSG_004

Hydrologic Soil Group

- A
- B
- C
- D
- Not Assessed
- Water

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NOTES

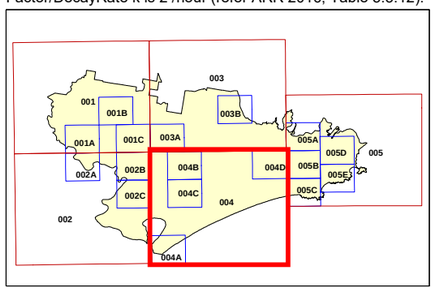
This map provides an estimation of Hydrologic Groups of Soils in NSW according to the four class system. The map was released by the NSW Government 11 October 2016. The map uses the best available soils mapping coverage and was derived by linking a Hydrologic Group class to a particular Great Soil Group.

Group A— soils having high infiltration rates, even when thoroughly wetted and consisting chiefly of deep, well to excessively-drained sands or gravels.These soils have a high rate of water transmission. For design purposes, it is assumed that the Antecedent Moisture Condition is "Rather wet" (refer to Australian Rainfall and Runoff (ARR) 2016, Table 5.3.11) and the Horton Maximum (Initial) Infiltration Rate is 83.6 mm/hr, the Minimum (Final) Infiltration Rate is 25 mm/hr and the Shape Factor/Decay Rate k is 2 /hour (refer ARR 2016, Table 5.3.12).

Group B— soils having moderate infiltration rates when thoroughly wetted and consisting chiefly of moderately deep to deep, moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission. For design purposes it is assumed that the Antecedent Moisture Condition is "Rather wet" (refer to ARR 2016, Table 5.3.11) and the Horton Maximum (Initial) Infiltration Rate is 66.3 mm/hr, the Minimum (Final) Infiltration Rate is 13 mm/hr and the Shape Factor/Decay Rate k is 2 /hour (refer ARR 2016, Table 5.3.12).

Group C— soils having slow infiltration rates when thoroughly wetted and consisting chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine texture. These soils have a slow rate of transmission. For design purposes, it is assumed that the Antecedent Moisture Condition is "Rather wet" (refer to ARR 2016, Table 5.3.11) and the Horton Maximum (Initial) Infiltration Rate is 33.7 mm/hr, the Minimum (Final) Infiltration Rate is 6 mm/hr and the Shape Factor/Decay Rate k is 2 /hour (refer ARR 2016, Table 5.3.12).

Group D— soils having very slow infiltration rates when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a high water table, soils with a clay layer, and shallow soils over nearly impervious material. These soils have a very slow rate of transmission. For stormwater design purposes, it is assumed that the Antecedent Moisture Condition is "Rather wet" (refer to ARR 2016, Table 5.3.11) and the Horton Maximum (Initial) Infiltration Rate is 7.4 mm/hr, the Minimum (Final) Infiltration Rate is 3 mm/hr and the Shape Factor/DecayRate k is 2 /hour (refer ARR 2016, Table 5.3.12).



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GDA 1994
MGA Zone 56

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Map identification number :
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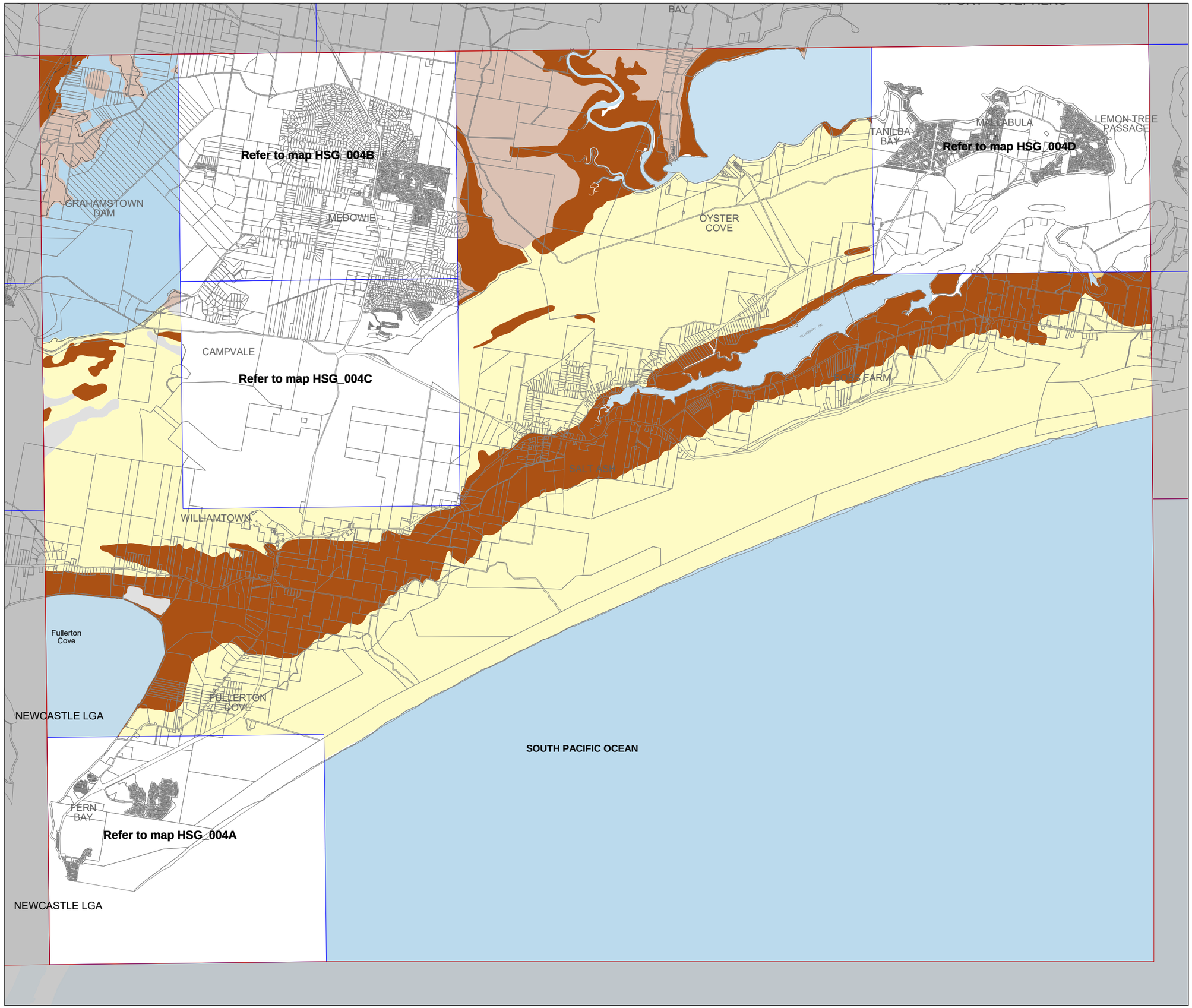

Port Stephens Hydrologic Soil Group Mapping

Hydrologic Soil Group Map - Sheet HSG_004A

Hydrologic Soil Group

- A
- B
- C
- D
- Not Assessed
- Water

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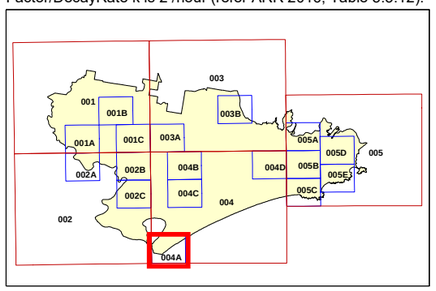
Group A— soils having high infiltration rates, even when thoroughly wetted and consisting chiefly of deep, well to excessively-drained sands or gravels.These soils have a high rate of water transmission. For design purposes, it is assumed that the Antecedent Moisture Condition is "Rather wet" (refer to Australian Rainfall and Runoff (ARR) 2016, Table 5.3.11) and the Horton Maximum (Initial) Infiltration Rate is 83.6 mm/hr, the Minimum (Final) Infiltration Rate is 25 mm/hr and the Shape Factor/Decay Rate k is 2 /hour (refer ARR 2016, Table 5.3.12).

Group B— soils having moderate infiltration rates when thoroughly wetted and consisting chiefly of moderately deep to deep, moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission. For design purposes, it is assumed that the Antecedent Moisture Condition is "Rather wet" (refer to ARR 2016, Table 5.3.11) and the Horton Maximum (Initial) Infiltration Rate is 66.3 mm/hr, the Minimum (Final) Infiltration Rate is 13 mm/hr and the Shape Factor/Decay Rate k is 2 /hour (refer ARR 2016, Table 5.3.12).

Group C— soils having slow infiltration rates when thoroughly wetted and consisting chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine texture. These soils have a slow rate of transmission. For design purposes, it is assumed that the Antecedent Moisture Condition is "Rather wet" (refer to ARR 2016, Table 5.3.11) and the Horton Maximum (Initial) Infiltration Rate is 33.7 mm/hr, the Minimum (Final) Infiltration Rate is 6 mm/hr and the Shape Factor/Decay Rate k is 2 /hour (refer ARR 2016, Table 5.3.12).

Group D— soils having very slow infiltration rates when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a high water table, soils with a clay layer, and shallow soils over nearly impervious material. These soils have a very slow rate of transmission. For stormwater design purposes, it is assumed that the Antecedent Moisture Condition is "Rather wet" (refer to ARR 2016, Table 5.3.11) and the Horton Maximum (Initial) Infiltration Rate is 7.4 mm/hr, the Minimum (Final) Infiltration Rate is 3 mm/hr and the Shape Factor/DecayRate k is 2 /hour (refer ARR 2016, Table 5.3.12).



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MGA Zone 56

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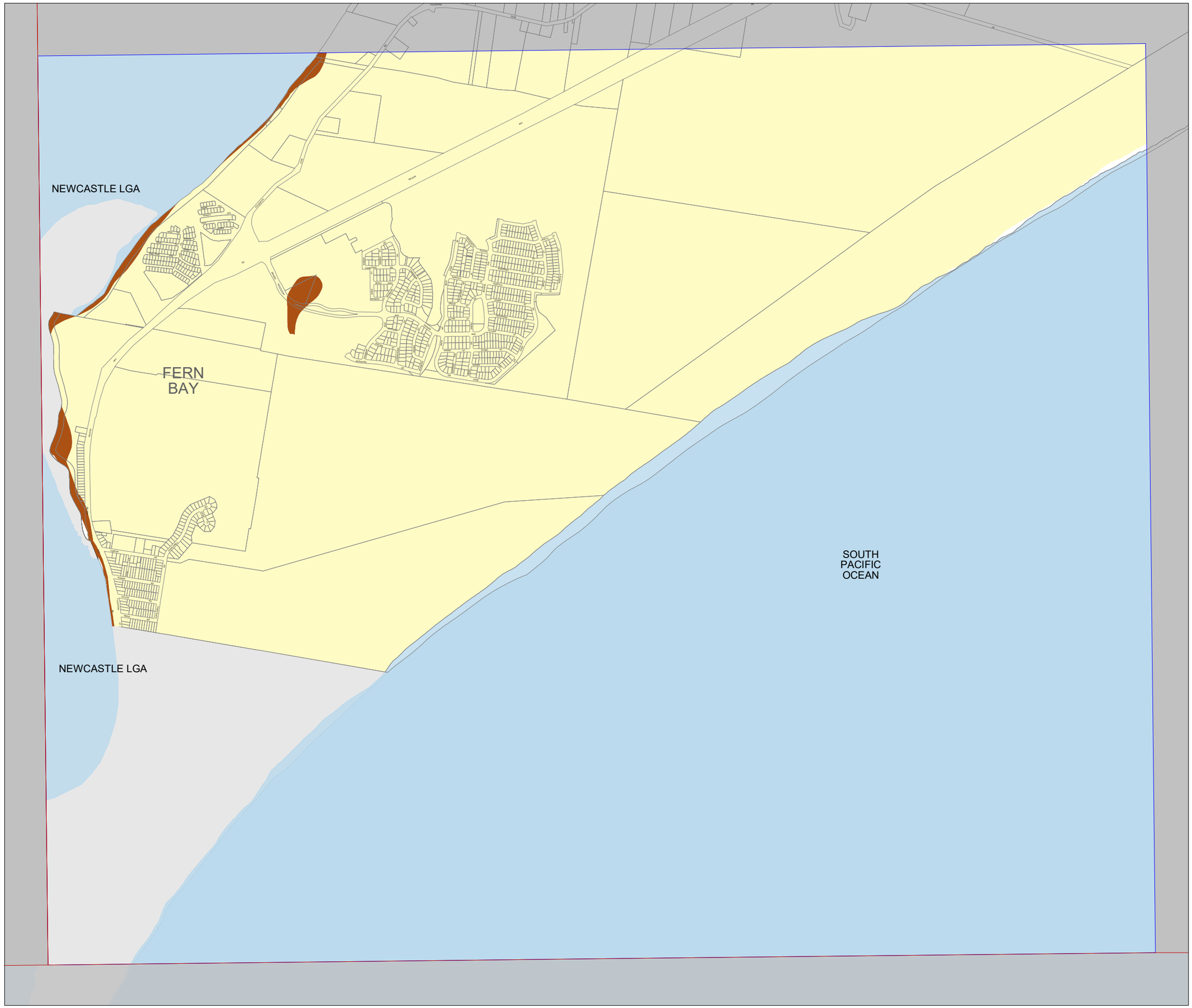

Port Stephens Hydrologic Soil Group Mapping

Hydrologic Soil Group Map - Sheet HSG_004B

Hydrologic Soil Group

- A
- B
- C
- D
- Not Assessed
- Water

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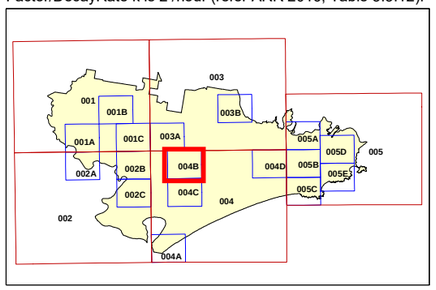
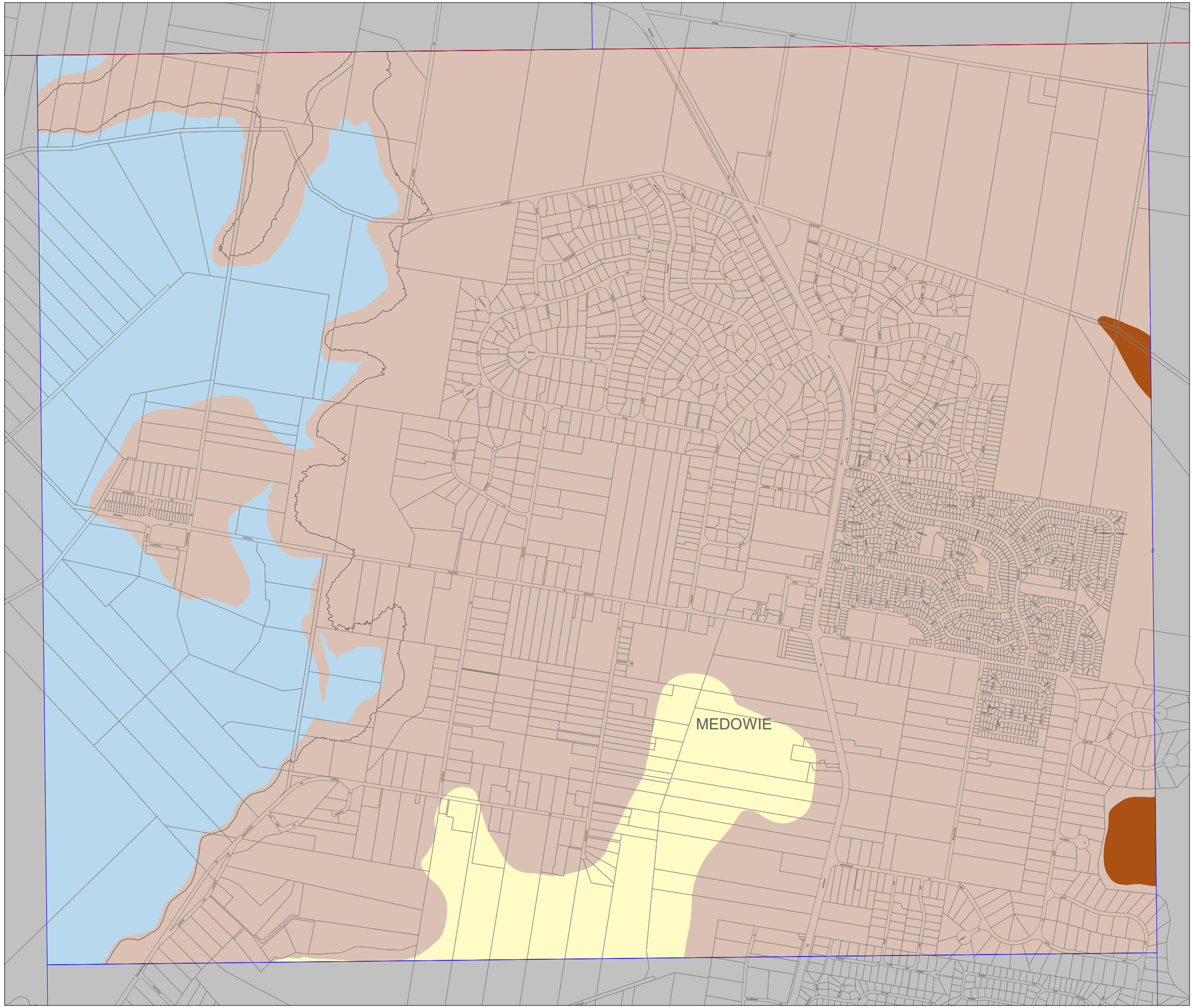
Group A— soils having high infiltration rates, even when thoroughly wetted and consisting chiefly of deep, well to excessively-drained sands or gravels.These soils have a high rate of water transmission. For design purposes, it is assumed that the Antecedent Moisture Condition is "Rather wet" (refer to Australian Rainfall and Runoff (ARR) 2016, Table 5.3.11) and the Horton Maximum (Initial) Infiltration Rate is 83.6 mm/hr, the Minimum (Final) Infiltration Rate is 25 mm/hr and the Shape Factor/Decay Rate k is 2 /hour (refer ARR 2016, Table 5.3.12).

Group B— soils having moderate infiltration rates when thoroughly wetted and consisting chiefly of moderately deep to deep, moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission. For design purposes, it is assumed that the Antecedent Moisture Condition is "Rather wet" (refer to ARR 2016, Table 5.3.11) and the Horton Maximum (Initial) Infiltration Rate is 66.3 mm/hr, the Minimum (Final) Infiltration Rate is 13 mm/hr and the Shape Factor/Decay Rate k is 2 /hour (refer ARR 2016, Table 5.3.12).

Group C— soils having slow infiltration rates when thoroughly wetted and consisting chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine texture. These soils have a slow rate of transmission. For design purposes, it is assumed that the Antecedent Moisture Condition is "Rather wet" (refer to ARR 2016, Table 5.3.11) and the Horton Maximum (Initial) Infiltration Rate is 33.7 mm/hr, the Minimum (Final) Infiltration Rate is 6 mm/hr and the Shape Factor/Decay Rate k is 2 /hour (refer ARR 2016, Table 5.3.12).

Group D— soils having very slow infiltration rates when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a high water table, soils with a clay layer, and shallow soils over nearly impervious material. These soils have a very slow rate of transmission. For stormwater design purposes, it is assumed that the Antecedent Moisture Condition is "Rather wet" (refer to ARR 2016, Table 5.3.11) and the Horton Maximum (Initial) Infiltration Rate is 7.4 mm/hr, the Minimum (Final) Infiltration Rate is 3 mm/hr and the Shape Factor/DecayRate k is 2 /hour (refer ARR 2016, Table 5.3.12).





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MGA Zone 56

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Map identification number :
HSG_004B_020_20170124

Port Stephens Hydrologic Soil Group Mapping

Hydrologic Soil Group Map - Sheet HSG_004C

Hydrologic Soil Group

- A
- B
- C
- D
- Not Assessed
- Water

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NOTES

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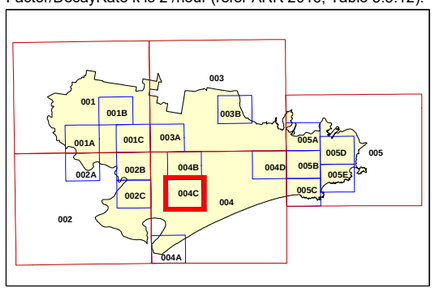
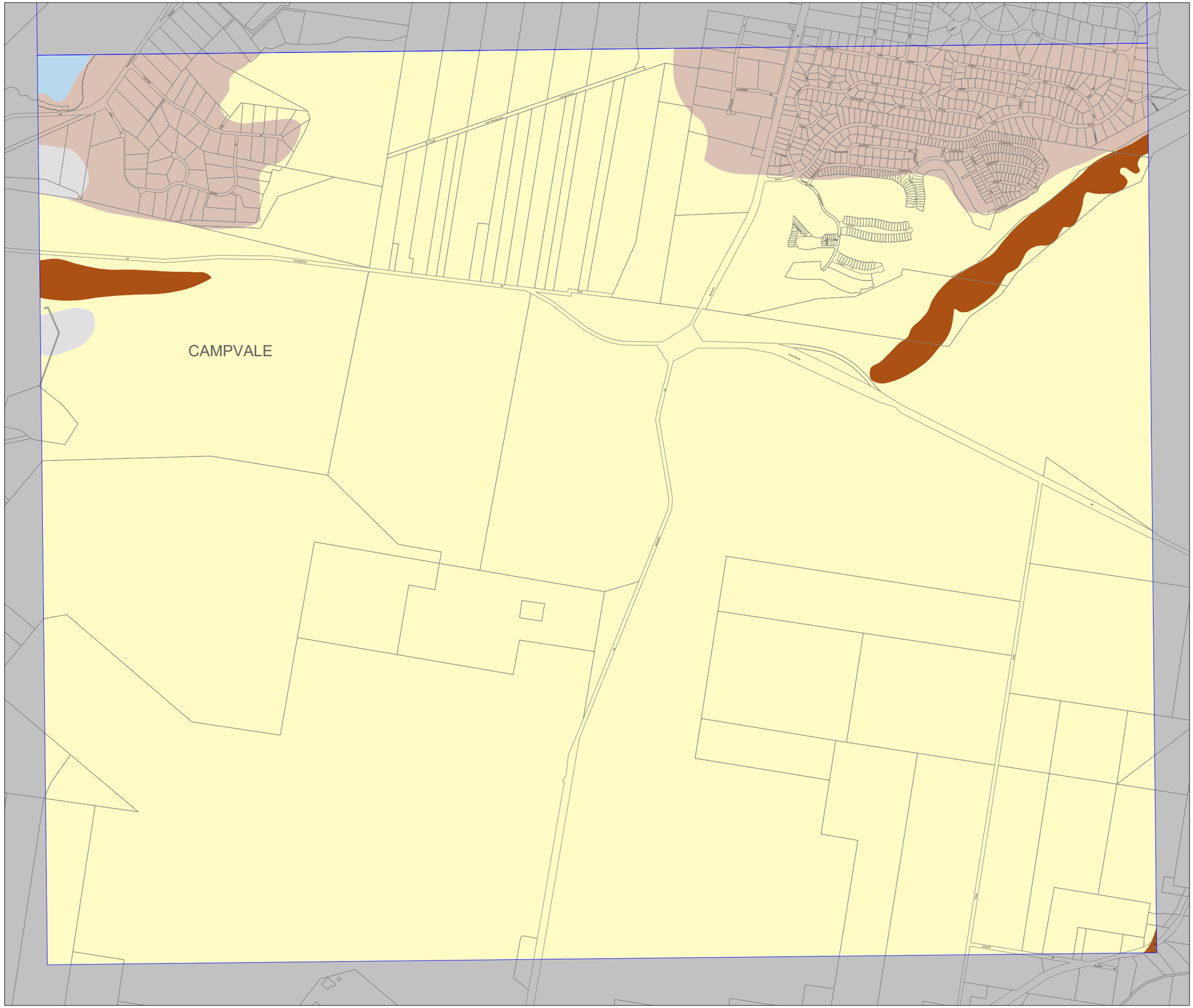
Group A— soils having high infiltration rates, even when thoroughly wetted and consisting chiefly of deep, well to excessively-drained sands or gravels.These soils have a high rate of water transmission. For design purposes, it is assumed that the Antecedent Moisture Condition is "Rather wet" (refer to Australian Rainfall and Runoff (ARR) 2016, Table 5.3.11) and the Horton Maximum (Initial) Infiltration Rate is 83.6 mm/hr, the Minimum (Final) Infiltration Rate is 25 mm/hr and the Shape Factor/Decay Rate k is 2 /hour (refer ARR 2016, Table 5.3.12).

Group B— soils having moderate infiltration rates when thoroughly wetted and consisting chiefly of moderately deep to deep, moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission. For design purposes, it is assumed that the Antecedent Moisture Condition is "Rather wet" (refer to ARR 2016, Table 5.3.11) and the Horton Maximum (Initial) Infiltration Rate is 66.3 mm/hr, the Minimum (Final) Infiltration Rate is 13 mm/hr and the Shape Factor/Decay Rate k is 2 /hour (refer ARR 2016, Table 5.3.12).

Group C— soils having slow infiltration rates when thoroughly wetted and consisting chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine texture. These soils have a slow rate of transmission. For design purposes, it is assumed that the Antecedent Moisture Condition is "Rather wet" (refer to ARR 2016, Table 5.3.11) and the Horton Maximum (Initial) Infiltration Rate is 33.7 mm/hr, the Minimum (Final) Infiltration Rate is 6 mm/hr and the Shape Factor/Decay Rate k is 2 /hour (refer ARR 2016, Table 5.3.12).

Group D— soils having very slow infiltration rates when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a high water table, soils with a clay layer, and shallow soils over nearly impervious material. These soils have a very slow rate of transmission. For stormwater design purposes, it is assumed that the Antecedent Moisture Condition is "Rather wet" (refer to ARR 2016, Table 5.3.11) and the Horton Maximum (Initial) Infiltration Rate is 7.4 mm/hr, the Minimum (Final) Infiltration Rate is 3 mm/hr and the Shape Factor/DecayRate k is 2 /hour (refer ARR 2016, Table 5.3.12).





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GDA 1994
MGA Zone 56

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Port Stephens Hydrologic Soil Group Mapping

PORT STEPHENS COUNCIL

Hydrologic Soil Group Map - Sheet HSG_004D

Hydrologic Soil Group

- A
- B
- C
- D
- Not Assessed
- Water

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NOTES

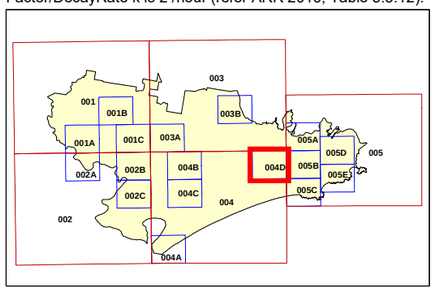
This map provides an estimation of Hydrologic Groups of Soils in NSW according to the four class system. The map was released by the NSW Government 11 October 2016. The map uses the best available soils mapping coverage and was derived by linking a Hydrologic Group class to a particular Great Soil Group.

Group A— soils having high infiltration rates, even when thoroughly wetted and consisting chiefly of deep, well to excessively-drained sands or gravels.These soils have a high rate of water transmission. For design purposes, it is assumed that the Antecedent Moisture Condition is "Rather wet" (refer to Australian Rainfall and Runoff (ARR) 2016, Table 5.3.11) and the Horton Maximum (Initial) Infiltration Rate is 83.6 mm/hr, the Minimum (Final) Infiltration Rate is 25 mm/hr and the Shape Factor/Decay Rate k is 2 /hour (refer ARR 2016, Table 5.3.12).

Group B— soils having moderate infiltration rates when thoroughly wetted and consisting chiefly of moderately deep to deep, moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission. For design purposes, it is assumed that the Antecedent Moisture Condition is "Rather wet" (refer to ARR 2016, Table 5.3.11) and the Horton Maximum (Initial) Infiltration Rate is 66.3 mm/hr, the Minimum (Final) Infiltration Rate is 13 mm/hr and the Shape Factor/Decay Rate k is 2 /hour (refer ARR 2016, Table 5.3.12).

Group C— soils having slow infiltration rates when thoroughly wetted and consisting chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine texture. These soils have a slow rate of transmission. For design purposes, it is assumed that the Antecedent Moisture Condition is "Rather wet" (refer to ARR 2016, Table 5.3.11) and the Horton Maximum (Initial) Infiltration Rate is 33.7 mm/hr, the Minimum (Final) Infiltration Rate is 6 mm/hr and the Shape Factor/Decay Rate k is 2 /hour (refer ARR 2016, Table 5.3.12).

Group D— soils having very slow infiltration rates when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a high water table, soils with a clay layer, and shallow soils over nearly impervious material. These soils have a very slow rate of transmission. For stormwater design purposes, it is assumed that the Antecedent Moisture Condition is "Rather wet" (refer to ARR 2016, Table 5.3.11) and the Horton Maximum (Initial) Infiltration Rate is 7.4 mm/hr, the Minimum (Final) Infiltration Rate is 3 mm/hr and the Shape Factor/DecayRate k is 2 /hour (refer ARR 2016, Table 5.3.12).



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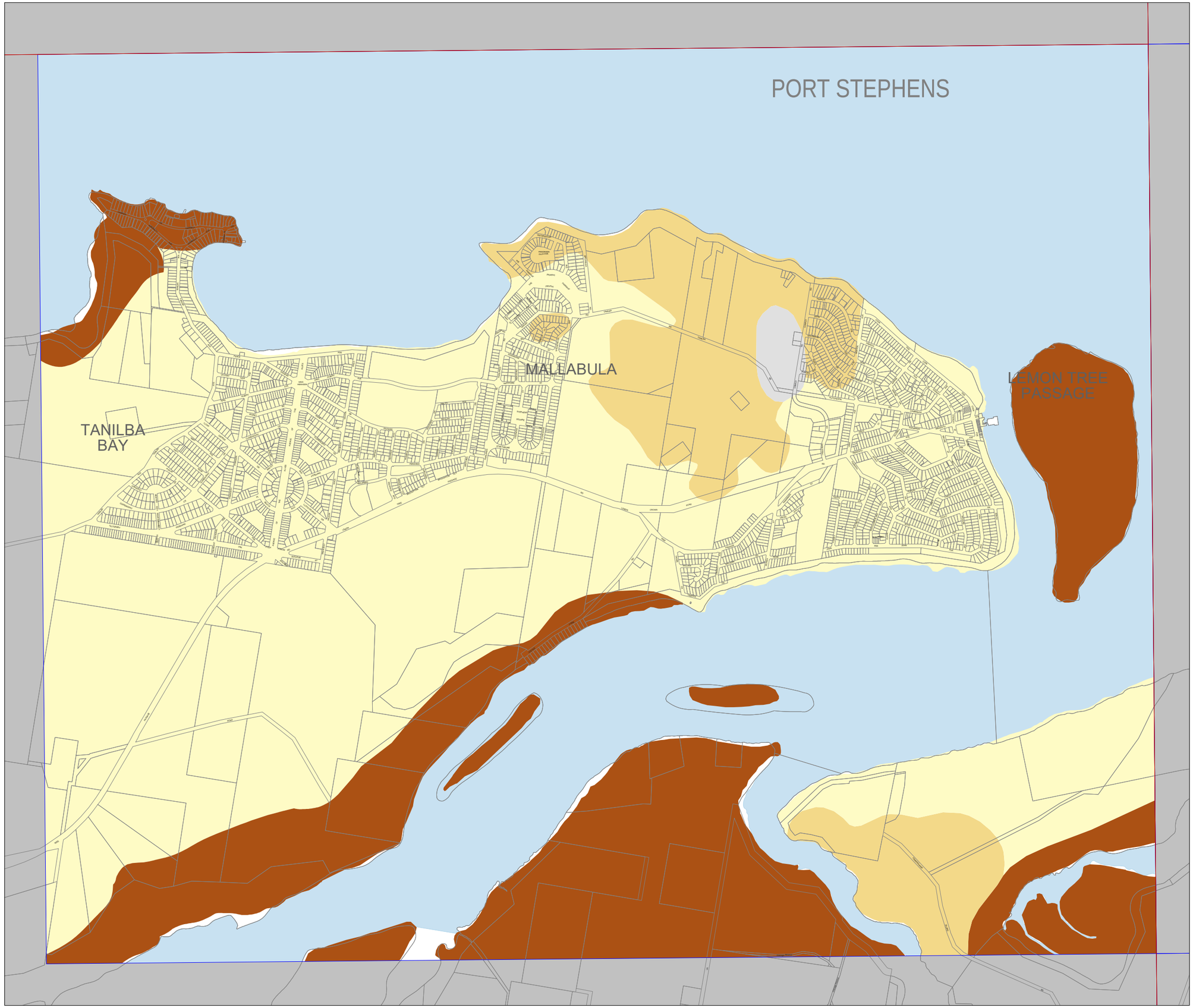

APPENDIX J: PHOTO PLATES


1. View south from access road


2. View north centre of site


3. Centre of site


4. Ridge system


5. Soil samples in liners (on-site PASS testing)



APPENDIX E

BIODIVSERISTY DEVELOPMENT ASSESSMENT REPORT

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Stockton Sand Quarry Dredging

Biodiversity Development Assessment Report | 21 February 2020

Prepared for Boral Resources (NSW) Pty Ltd



Document control

Project number	Client	Project manager	LGA
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Executive summary

Context

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Sand Quarry (the Quarry), a long standing operation that currently extracts sand from the windblown (transgressive) sand dunes of Stockton Bight and transports up to 500,000 tonnes per annum (tpa) of sand products for use in the building, landscaping and construction markets.

Due to current and future demand for sand in the Hunter and Sydney market, Boral is seeking approval for continued and expanded operations at the site through a State Significant Development (SSD) application.

The proposed development (hereafter referred to as the 'Project') involves the extraction of sand from within the former inland extraction area from the existing ground level to a depth of 15 m below sea level (-15 m AHD). As extraction will intercept the groundwater table (at approximately 1 m AHD) the primary method of sand extraction will involve dredging. To account for market fluctuations in demand, Boral are seeking a development consent period of 25 years for the SSD approval.

Niche Environment and Heritage Pty Ltd (Niche) was commissioned by Boral to assess the ecological values and impacts associated with the Project, and provide a Biodiversity Development Assessment Report (BDAR). This BDAR has applied the OEH (2017) Biodiversity Assessment Methodology (BAM) to describe and assess the ecological values within the Study Area and surrounds, and determine if the Project is likely to have an impact on threatened biodiversity listed under the NSW *Biodiversity Conservation Act 2016* (BC Act). This report also has assessed the potential impacts of the Project on Matters of National Environmental Significance (MNES) under the Commonwealth Environment *Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Study area

The Study Area for the Project contains all areas proposed for ground disturbance, and is approximately 38.14 hectares, predominately contained within the footprint of the former inland extraction area, which has since been rehabilitated with native tubestock.

In total the Study Area includes:

- 32.75 hectares of rehabilitated land comprising of native vegetation;
- 2.91 hectares of remnant native vegetation; and
- 2.48 hectares of non-native vegetation.

Survey overview

Surveys within the Study Area were undertaken in accordance with the BAM over a period of 27th – 29th of September 2017 by Accredited Assessors – Luke Baker and Alex Christie (section 3.2 and 4.2). The survey included the collection of flora plot and transect data, threatened flora surveys and random meanders, Ultrasonic call recording for bats (Anabats), diurnal bird surveys, spotlighting, Koala Spot assessments and opportunistic survey.

An additional targeted orchid survey was completed by Accredited Assessor and Ecologist Amanda Griffiths on the 20th August 2018.

Native vegetation Assessment

Vegetation validation was undertaken as per the BAM which confirmed that the Study Area contained the following best fit Plant Community Types (PCTs):

- PCT 1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland on coastal sands of the Central and Lower North Coast; and
- PCT 1644 - Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower North Coast.

One non-native vegetation type that does not align to any PCT was also recorded within the Study Area. Different condition classes were given to the PCTs which were generally related to the age of the rehabilitation that has taken place over the past decade.

Threatened flora

During the field survey, no threatened flora were recorded within the area proposed to be developed.

A population of the threatened orchid – *Diuris praecox* was recorded by ERM in 2003 approximately 300 metres from the Study Area to the east. A targeted survey for the orchid was undertaken within the Study Area during the recommended survey time in August 2018. The species was not detected during the field survey. This assessment concluded that there was a low likelihood for *Diuris praecox* to occur within the Study Area given the Study Area predominately consisted of rehabilitated land within a former quarry pit, the species was not recorded during the targeted survey, and the species was not recorded within the Study Area during surveys completed by ERM (2005).

Threatened fauna

Three threatened fauna were recorded with the Study Area: Greater Broad-nosed Bat, Eastern Bentwing Bat and White-bellied Sea Eagle. Both the threatened microbats were recorded on both anabats located in the Study Area, whilst the White-bellied Sea Eagle was recorded flying over the Study Area on all days of the field survey.

An additional 16 threatened fauna were regarded to have the potential to occur within the Study Area but were not recorded, most likely due to their potential use of the Study Area or wider locality being limited to sporadic occurrences (e.g. nomadic birds) (Appendix 1). These species include the following:

- Birds - Dusky Woodswallow, White-fronted Chat, Red Goshawk, White-throated Needletail, Black-faced Monarch, Australian Painted Snipe; and
- Mammals: Little Bentwing-bat, Eastern False Pipistrelle, Eastern Freetail-bat, Southern Myotis, Squirrel Glider, Koala Long-nosed Potoroo, New Holland Mouse, Grey-headed Flying-fox and Yellow-bellied Sheathtail-bat.

The Koala and Squirrel Glider, whilst not recorded during the field survey, have been previously recorded surrounding the Study Area based on Bionet records.

Under the BAM, only those threatened fauna that are regarded as 'species credit' fauna, or significantly impacted under the Commonwealth EPBC Act, require offsetting. Of the species recorded, or have habitat within the Study Area, only one threatened fauna species – the Squirrel Glider, has been regarded as a species credit fauna for this assessment. The remaining species are regarded as 'ecosystem credits' species due to the lack of breeding habitat, important habitat, or have been attributed as an 'ecosystem credit' fauna in the Bionet Atlas. Furthermore, no significant impacts to any EPBC Act listed fauna are likely to occur.

SEPP 44. Koala habitat

Our assessment has concluded that the Study Area does not contain *potential Koala habitat* as defined under the current SEPP 44, given Schedule 2 tree species do not meet at least 15% of the total number of trees within the Study Area. The site therefore does not constitute 'Core Koala habitat' under the current SEPP 44. A discussion on SEPP 44 Koala habitat is provided in section 4.8.

It is noted that the current SEPP 44, is to be replaced with the SEPP 44 Koala Habitat Protection 2019, which has changes to the definition of Koala habitat. Whilst the new SEPP 44 is not yet in effect, it is noted that the Study Area contains Koala feed trees (mainly planted tubestock), however is unlikely to be regarded as 'Core Koala habitat'.

Impacts – Native vegetation

The main impact on biodiversity associated with the Project is clearing of native vegetation and habitat, of which is predominately rehabilitation land from the former quarry pit. The extent of clearing of native vegetation communities is conservatively estimated at 38.14 hectares. An offset for the impact to native vegetation as per the BAM has been provided.

Impacts – Threatened flora

No threatened flora are likely to be impacted by the Project given the lack of suitable habitat and results of the field survey. It is therefore unlikely that the Project will result in a significant impact to any threatened flora. No biodiversity offset is therefore required for threatened flora.

Impacts – Threatened fauna

One species credit fauna, and eight EPBC listed threatened and migratory fauna are considered to be affected by the Project. Most of these species are likely to utilise the foraging habitat of the Study Area on an intermittent basis.

The Squirrel Glider would be offset according to the requirements of the BAM.

Assessments of Significance completed for the EPBC Act listed fauna, has indicated that the Project is unlikely to have a significant impact toward the Australian Painted Snipe, Black-faced Monarch, White-throated Needletail, Red Goshawk, Long-nosed Potoroo, Koala, New Holland Mouse and Grey-headed Flying-fox.

Avoidance and minimisation

As detailed in the Environmental Impact Statement (EIS), throughout the process of site planning Boral has considered alternative locations and processes. The current site utilises the former rehabilitated inland extraction area for most of the impact rather than remnant vegetation that occupies the remaining portion of the Boral site. A detailed discussion regarding avoidance and alternatives has been provided in section 5.1.

Mitigation and management

To minimise and mitigate potential indirect impact, a number of measures have been proposed, which would be updated in existing biodiversity management plans. The measures include:

- Undertaking vegetation clearing in accordance with the Vegetation Clearance Protocol described in section 5.1.4 (impacts arising from the construction will primarily relate to vegetation clearing);
- Fencing and signposting erected as close as possible to the edge of the Study Area as described in section 5.1.4;
- Educating employees and/or contractors involved in the construction and operation of the Project;
- Update and implementation of the existing Landscape and Rehabilitation Management Plan as described in section 5.1.5;
- Dust suppression;
- Procedures for the management of spills throughout the Study Area including the requirements for vehicles to carry spill kits; and
- Management and removal of all rubbish from the Study Area.

Credit calculations

As per the BAM, once impacts have been avoided and minimised as far as practical, the proponent must offset the development impacts. The offset is determined using the BAM calculator and is expressed in terms of ecosystem credits and species credits.

Based on our analysis, the ecosystem credits required to offset the Project equate to the following:

- Total of 396 credits for PCT 1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland on coastal sands of the Central and Lower North Coast; and
- Total of 37 credits for PCT 1644 - Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower North Coast.

The species credit required for the Project include:

- A total of 521 credits for the removal of 26.59 hectares of foraging habitat for the Squirrel Glider.

Offset strategy

In order to satisfy the biodiversity offset requirement for the Project, Boral proposes a number of options available to offset the credits for native vegetation and the Squirrel Glider. The options available to Boral include the following:

1. Purchase credits on market;
2. Payment into BCT Fund; and/or
3. Utilise existing Boral Landholdings and consider establishing Stewardship sites.

Given the options available, there is minimal risk in Boral not being able to satisfy their offset liability. No offset is required under the Commonwealth, given the project is unlikely to impact any threatened biodiversity under the EPBC Act.

Abbreviations

Acronym	Term/Definition
BAM	Biodiversity Assessment Methodology
BAM Calculator	Biodiversity Credit Calculator
BC Act	*Biodiversity Conservation Act 2016* (NSW)
BDAR	Biodiversity Development Assessment Report
BMP	Biodiversity Management Plan
BOS	*NSW Biodiversity Offsets Scheme*
DPIE	NSW Department of Planning, Industry and Environment
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EES	Environment, Energy and Science Group (part of the Department of Planning, Industry, and Environment)
ha	Hectare/s
IBRA	Interim Biogeographic Regionalisation for Australia
MNES	Matters of National Environmental Significance (from the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*).
OEH	Office of Environment and Heritage (formerly DECCW, DECC, DEC)
PEA	Preliminary Environmental Assessment
PCT	Plant Community Type
SAII	Serious and Irreversible Impacts
SEARs	Secretary's Environmental Assessment Requirements
SSD	State Significant Development
TEC	Threatened Ecological Community
tpa	tonnes per annum

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1. Introduction to Biodiversity Development Assessment

1.1 Introduction

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Sand Quarry (the Quarry), a long standing operation that currently extracts sand from the windblown (transgressive) sand dunes of Stockton Bight and transports up to 500,000 tonnes per annum (tpa) of sand products for use in the building, landscaping and construction markets.

Due to current and future demand for sand in the Hunter and Sydney market, Boral is seeking approval for continued operations at the site through a State Significant Development (SSD) application.

The proposed development (hereafter referred to as the 'Project'), involves the extraction of sand from within the former inland extraction area (inclusive of pits 1 – 6) from the existing ground level to a depth of 15 m below sea level (-15 m AHD). As extraction will intercept the groundwater table (at approximately 1 m AHD) the primary method of sand extraction will involve dredging.

There is an estimated 9 million tonnes of sand resource within the Project extraction area. The Project would seek to permit a site wide increase on the dispatch limit to 750,000 tpa (i.e. the windblown sand extraction area and the Project operations combined) up until 2028 when the site wide limit would reduce to no more than 500,000 tpa. The increase in the site wide dispatch limit is sought to permit maximum flexibility across the two projects areas (located on the same site).

To account for market fluctuations in demand, Boral are seeking a development consent period of 25 years

Niche Environment and Heritage Pty Ltd (Niche) was commissioned by Boral to assess the ecological values and impacts associated with the Project, and provide a Biodiversity Development Assessment Report (BDAR). This BDAR has applied the OEH (2017) Biodiversity Assessment Methodology (BAM) to describe and assess the ecological values within the Study Area and surrounds, and determine if the Project is likely to have an impact on threatened biodiversity listed under the NSW *Biodiversity Conservation Act 2016* (BC Act). This report has also assessed the potential impacts of the Project on Matters of National Environmental Significance (MNES) under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). This report also identifies avoidance, mitigation and offsets for the Project.

1.2 The Project

1.2.1 General description of the Site

The Stockton Sand Quarry is located in Fullerton Cove, approximately 9.8 kilometres (km) north north-east of the Newcastle Central Business District (CBD), within the Port Stephens Local Government Area (LGA) (Figure 1). Access to the site is via Nelson Bay Road and Coxs Lane.

The site owned and operated by Boral covers an approximate area of 246 hectares, comprising of:

- Lot 1 DP 1006399, comprising 234 hectares and located predominantly on the eastern side of Nelson Bay Road, with a small portion also situated on the western side of Nelson Bay Road;
- Lot 2 DP 1006399 comprising 10.4 hectares and located predominantly on the western side of Nelson Bay Road, with a small portion also positioned on the eastern side of Nelson Bay Road (formerly Part Lot 167, Part Portion 167); and

- Lot 3 DP 664552 comprising 1.619 hectares and located wholly on the eastern side of Nelson Bay Road, and within which the existing depot and weighbridge are located (formerly within Part Lot 3, Part Portion 3).

Access to the site is via Crown Reserve, Lot 7300 DP1130730, for which Boral has an existing licence.

Boral previously quarried sand in the central area of Lot 1, to the east of Nelson Bay Road. This extraction commenced in 1996 and was exhausted in 2007 with the consent lapsing on 1 May 2009.

Following the completion of the original extraction area in Lot 1 in 2007, Boral commenced extraction of windblown sand in the 2006 development consent area, which continues today.

1.3 Project description

1.3.1 Description of the Proposal

The Project involves the extraction of sand from within the former inland extraction area (inclusive of pits 1 – 6) from the existing ground level to a depth of 15 m below sea level (-15 m AHD). As extraction will intercept the groundwater table (at approximately 1 m AHD) the primary method of sand extraction will involve dredging.

There is an estimated 9 million tonnes of sand resource within the Project extraction area. The Project would seek to permit a site wide increase on the dispatch limit to 750,000 tpa (i.e. the windblown sand extraction area and the Project operations combined) up until 2028 when the site wide limit would reduce to no more than 500,000 tpa. The increase in the site wide dispatch limit is sought to permit maximum flexibility across the two projects areas (located on the same site). An administrative amendment to DA 140-5-2006 to allow for the site wide dispatch limit increase will also be lodged with Department of Planning Industry and Environment (DPIE).

Mobile plant and equipment utilised at the site would operate across both project areas and a docket system at the weighbridge would monitor outgoing product as a site total.

To account for market fluctuations in demand, Boral are seeking a development consent period of 25 years for the SSD approval.

1.4 Study area

The Study Area occurs within Boral's landholding and encompasses the area of direct and indirect impact associated with the Project (Figure 2). In total the Study Area is 38.14 hectares in size which predominately includes the footprint of the former inland extraction area, which has since been rehabilitated with native tubestock.

In total the Study Area includes:

- 32.75 hectares of rehabilitated land comprising of native vegetation;
- 2.91 hectares of remnant native vegetation; and
- 2.48 hectares of non-native vegetation.

Within the Study Area, the land directly disturbed by the Project is referred to as the 'subject site'. The area of direct and indirect impact is referred to as the Study Area.

1.5 State approval and assessment process

1.5.1 Application of the BAM

This BDAR has applied the BAM in order to assess impacts on biodiversity. The BAM is a new framework for assessment of biodiversity impacts and determination of offsetting requirements for major Projects under the NSW Biodiversity Offsets Scheme (BOS).

This assessment has used the BAM Calculator (version 1.2.1.00).

1.6 Commonwealth approval and assessment process

Matters of National Environmental Significance (MNES) are protected under the EPBC Act. The BAM requires proponents to identify and assess the impacts on all nationally listed threatened species and threatened ecological communities that may be present on or near the Study Area. Therefore, the BAM has partly been used to perform assessment of impacts under the EPBC Act. Further assessment of impacts under the EPBC Act has been undertaken via assessments of significance for EPBC Act listed species with the potential to be affected by the Project (Appendix 7).

1.7 Secretary Environmental Assessment Requirements

In addition to requirements under the BAM and Commonwealth environmental approvals process, this BDAR addresses specific requirements provided in the SEARs for the SSD application relating to biodiversity, issued in October 2018 by the Department of Planning, Industry and Environment (DPIE). Table 1 below cross-references this report with the relevant SEARs.

Table 1. SEARs addressed in this BDAR

Requirement	Section addressed in report
Biodiversity – including: - accurate predictions of any vegetation to be cleared on site; - a detailed assessment of the likely biodiversity impacts of the development, paying particular attention to threatened species, populations and ecological communities and groundwater dependent ecosystems, undertaken in accordance with the Biodiversity Assessment Method and documented in a Biodiversity Development Assessment Report; and	This report follows the BAM. It provides an assessment of the impacts as per the BAM, and assesses the Commonwealth EPBC Act Matters in relation to biodiversity.
- a strategy to offset any residual impacts of the development in accordance with the offset rules under the Biodiversity Offsets Scheme.	Section 6.
Office of Environment and Heritage	
1. Biodiversity impacts related to the proposed development (SSD 9490) are to be assessed in accordance with the Biodiversity Assessment Method and documented in a Biodiversity Development Assessment Report (BDAR). The BDAR must include information in the form detailed in the Biodiversity Conservation Act 2016 (s6.12), Biodiversity Conservation Regulation 2017 (s6.8) and Biodiversity Assessment Method.	This assessment follows the BAM.

Requirement	Section addressed in report
2. The BDAR must document the application of the avoid, minimise and offset framework including assessing all direct, indirect and prescribed impacts in accordance with the Biodiversity Assessment Method.	Section 5.1 details avoidance and minimisation. Section 5.2 details impacts. Section 5.3 details offsets.
3. The BDAR must include details of the measures proposed to address the offset obligation as follows: The total number and classes of biodiversity credits required to be retired for the development/project The number and classes of like-for-like biodiversity credits proposed to be retired; The number and classes of biodiversity credits proposed to be retired in accordance with the variation rules; Any proposal to fund a biodiversity conservation action; Any proposal to conduct ecological rehabilitation (if a mining project); Any proposal to make a payment to the Biodiversity Conservation Fund. If seeking approval to use the variation rules, the BDAR must contain details of the reasonable steps that have been taken to obtain requisite like-for-like biodiversity credits.	The offset strategy is detailed in section 6. Rehabilitation of the site is discussed in detail in the EES (2019) Landscape and Rehabilitation Strategy.
4. The BDAR must be prepared by a person accredited in accordance with the Accreditation Scheme for the Application of the Biodiversity Assessment Method Order 2017 under s6.10 of the Biodiversity Conservation Act 2016.	This assessment and field survey has been completed by an Accredited Assessor (section 1.9)

1.8 Assessment objectives and format

The primary objective of this assessment is to use the guidelines and methodology provided in the BAM to determine the impact the Project would have on biodiversity, avoid and mitigate these impacts and then calculate the Project's biodiversity offset requirement. In addition, impacts on Commonwealth MNES are addressed through the process of the BAM and by assessments of significance for potentially impacted species.

This BDAR has two broad stages consistent with the BAM methodology:

Stage 1 – Biodiversity Assessment

- assessment of landscape features;
- assessment of native vegetation; and
- assessment of threatened species and populations.

Stage 2 – Impact Assessment

- avoid and minimise impacts on biodiversity values;
- consider impact and offset thresholds; and
- determine and calculate offset requirements.

To address the SEARs, section 6 of this BDAR has detailed the offset strategy associated with the Project.

1.9 Assessment resources and assessor qualifications

This BDAR has been prepared by the following accredited assessors or experts:

- Luke Baker – Senior Ecologist/Ecology Team Leader/Accredited Biodiversity Assessor: flora and fauna field survey, data management, data entry, credit calculations, review of credit calculations, report preparation;
- Alex Christie – Field survey, data collation; and
- Amanda Griffiths – Targeted orchid survey.

1.10 Consultation

As part of the project planning, Element Environment submitted correspondence to the Department of Planning, Industry and Environment (DPIE) - Biodiversity and Conservation Division (BCD) on the 17th July 2019 requesting to provide comments for the preparation of the Environmental Impact Statement.

A response was provided by DPIE on the 2nd August 2019, stating that the BCD has provided input into SEARs (reference DOC18/691590-1) which outline assessment requirements for Aboriginal cultural heritage, threatened biodiversity, impacts to National Parks and Wildlife Estate, soils and water, flooding, floodplain management and coastal erosion. BCD had no further assessment requirements at this stage of the project.

2. Landscape assessment

2.1 Landscape assessment - methods

As detailed in section 4 of the BAM (OEH 2017), a landscape assessment for the Project is required, which was conducted within the BAM Calculator. Landscape value is an assessment of a number of factors including:

- native vegetation cover;
- rivers, streams and estuaries;
- areas of geological significance; and
- habitat connectivity.

For each factor the current state of the landscape is assessed then compared with the state of the landscape if the Project were to proceed.

2.1.1 Landscape features

The inputs into the landscape features component of the BAM Calculator, along with the associated Figure reference, has been detailed in Table 2 below.

Table 2: Landscape features and scoring under the NSW BAM

Landscape features	Description	Figure reference
IBRA bioregion/subregion	NSW North Coast IBRA region, and within Karuah Manning IBRA subregion.	Figure 3. Study Area Figure 4
Mitchell Landscapes	One Mitchell landscape occurs across the Study Area: Sydney - Newcastle Barrier and Beaches.	Figure 3. Study Area Figure 4
Rivers, streams and estuaries and Strahler stream order	No rivers, streams of estuaries occur within the Study Area.	Figure 3. Study Area Figure 4
Wetlands within and adjacent to development	None	-
Cleared areas	The native vegetation present within the Study Area has been subject to historic clearing. As such much of the vegetation within the Study Area comprises of native rehabilitation from tubestock planting and seeding. Cleared areas within the Study Area comprise the former inland extraction area and associated infrastructure. Within the locality, residential and rural land use is more predominant to the west.	Figure 3. Study Area Figure 4

Landscape features	Description	Figure reference
Connectivity features	The Study Area adjoins a large native vegetation corridor which extends to the north and south along Stockton beach encompassing Worimi Regional Park and Worimi State Conservation Area. The corridor also adjoins the wetlands (Long Bight Swamp) and riparian vegetation of Fullerton Cove approximately 2.3 km to the south-west.	Figure 3. Study Area Figure 4
Buffer area (percent native vegetation cover)	A 1,500 m buffer was applied to the Study Area resulting in an overall buffer area of 1,220 ha. Aerial interpretation was used to map the area of native vegetation, and introduced vegetation within the locality. In total, 579 ha is non-native vegetation (consisting of quarry pit, existing emplacement, infrastructure, rural residential and roads/rail links etc.), and 641 ha is native vegetation. ***Total native vegetation cover*** Combining the estimated native vegetation cover resulted in 52% of the buffer area supporting native vegetation. This falls into the 30-70% category within the BAM Calculator.	Figure 3. Study Area Figure 4
Site context	Site based assessment.	-
Geological significance	There are no karst, caves, crevices, cliffs or other areas of geological significance within the Study Area.	-

3. Native vegetation and flora assessment

3.1 Data review

3.1.1 Bionet - Atlas of NSW Wildlife Database

A review of spatial records of threatened flora within a 10 km radius of the Study Area was undertaken using data obtained from the Bionet - Atlas of NSW Wildlife. Utilising Data from the Atlas of NSW Wildlife, a review of threatened flora was undertaken within a 10km radius of the Study Area. This was used to inform and assist in planning the field survey.

3.1.2 EPBC Act Protected Matters Search

A Protected Matters Search (EPBC Act) was carried out for a 10 km radius of the Study Area. Results were considered during field survey planning and the likelihood of occurrence analysis (detailed in Appendix 1), performed prior to field survey and updated post field survey. The results of the search are provided in Appendix 1.

3.2 Plant community delineation and mapping

Vegetation within the Study Area was validated using the BAM during a field survey completed on the 27-29th September 2017. In total, 13 BAM plots/transects were completed within the Study Area to meet the minimum plot requirement as per the BAM (Figure 5).

Walking meanders were undertaken between plot locations. At a minimum, the combined foot traverses complied with the recommended number and length of traverses per area of stratification unit (vegetation community) according to DEC (2004) survey guidelines. The walking meanders were also used to survey for threatened flora species across the Study Area.

The field survey confirmed that the Study Area consisted predominately of native rehabilitation, mainly tubestock and some native seeding that had occurred over the past decade.

As detailed in the OEH (2018) Biodiversity Assessment Method Operational Manual, '*Planted native vegetation is treated in the same way as native vegetation if it meets the definition of native vegetation in Section 5A of the Local Land Services Act 2013. Where the vegetation is a mix of local and non-local planted species the assessor should consider the best matching PCT based on the local species present*'.

As such, the areas that have been rehabilitated have been attributed to two Plant Community Types (PCTs) which likely occurred within the Study Area prior to clearing or contain a structure similar to that of the rehabilitated land.

Different condition classes were assigned to vegetation where obvious differences in structure and quality occurred, resulting in two PCTs and five vegetation categories as shown in Table 3. The vegetation categories generally reflected the age of rehabilitation that has occurred within the Study Area over the past decade.

Descriptions for those communities which occur within the Study Area are provided in Appendix 2 and vegetation community mapping is shown in Figure 6.

Table 3. Vegetation mapping and alignment for vegetation types within the Study Area

Vegetation zone	Plant Community Type (PCT)	Vegetation formation	Vegetation class	Threatened Ecological Community (TEC)*	PCT % cleared	Condition identifier input used in Calculator	Total (ha)	Plots required	Plots completed
1	PCT1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland on coastal sands of the Central and Lower North Coast	Dry Sclerophyll Forests (Shrubby sub-formation)	Coastal Dune Dry Sclerophyll Forests	-	45	Rehabilitation_ Area 1	19.77	3	4
2						Rehabilitation_ Area 2	3.87	2	2
3						Rehabilitation_ Area 4	5.20	3	3
4						Remnant	2.91	2	2
5	1644 - Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower North Coast	Dry Sclerophyll Forests (Shrubby sub-formation)	South Coast Sands Dry Sclerophyll Forests	-	86	Rehabilitation_ Area 3	3.91	2	2
-	Non-native	-	-	-	-	Non-native	2.48	-	-
	Total						38.14	12	13
	Total native vegetation						35.66		

3.2.3 Plant community descriptions

Refer to Appendix 2 for plant community descriptions and diagnostic species for each plant community.

3.2.4 Site values

Flora

Floristic data recorded from floristic plots performed throughout the identified vegetation zones (Figure 6) is included within Appendix 3.

Plot and transect values

The results of the plot data and species list obtained during the field assessment is provided in Appendix 4.

Site integrity scores

The site value assessment was carried out by entering plot data into the BAM Calculator. The data provides quantitative measures of composition, structure and function for each vegetation zone (Appendix 4). The BAM Calculator compares the values recorded with the benchmark for the vegetation class to provide the site value score. This score represents the overall condition of the vegetation compared against the benchmark.

The vegetation scores for each zone in the Study Area have been provided in Table 4. The score from these inputs, coupled with data in the following section of this report, is used to determine the number of ecosystem credits that are required for development.

Vegetation zones that have a site integrity score of less than 17 out of 100 for non-threatened ecological community, do not need to be offset. As shown in Table 4, the 'Rehabilitation Area 4' vegetation zone had a score of 7.9, and as such, does not require to be offset. The remainder of the vegetation zones had a site integrity of 17 and therefore require biodiversity offsetting.

Table 4. Vegetation zones and site integrity scores

Vegetation zone	Plant Community Type (PCT)	Condition identifier input used in Calculator	Total (ha)	Site integrity	Offset required
1	PCT1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland on coastal sands of the Central and Lower North Coast	Rehabilitation_ Area 1	19.77	42.2	Yes
2		Rehabilitation_ Area 2	3.87	22.2	Yes
3		Rehabilitation_ Area 4	5.20	7.9	No
4		Remnant	2.91	46.4	Yes
5	1644 - Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower North Coast	Rehabilitation_ Area 3	3.91	19	Yes

3.2.5 High threat and priority weeds

The Environment, Energy and Science (EES) Group (formally OEH – now part of DPIE) has a list of 'High threat weeds' which need to be taken into consideration in the BDAR. During the field surveys, three high threat weeds were recorded within the BAM plots: *Bidens pilosa* (Farmers Friend), *Ehrharta erecta* (Panic Veldtgrass), and *Eragrostis curvula* (Africa Lovegrass). The three high threat weeds were generally located across all vegetation zones, however were concentrated adjacent to existing disturbance areas. The cover of 'high threatened weeds' are considered in the site value scores for each BAM plot (Appendix 4).

3.2.6 Threatened ecological communities

A list of Threatened Ecological Communities (TECs) occurring or potentially occurring within the locality as generated from the database searches detailed in section 3.1, is provided in Appendix 1. The database searches identified 25 TECs that have been identified as potentially occurring within the locality.

Based on the results of the detailed vegetation validation, and review of the Conservation Advice of the TECs, no TECs were recorded or are likely to occur within the Study Area.

3.3 Threatened flora

A total of 21 threatened flora with the potential to occur within the locality, or as generated by the BAM Calculator, are presented in Table 5 and Appendix 1.

The walking meanders and targeted threatened orchid survey, were used to survey for threatened flora across the Study Area. In total, approximately 18 hours of threatened flora random meanders were conducted between the 26 to 27th of September 2017, and 7 hours were completed on 20th August 2018.

The targeted field surveys were completed during the recommended survey times for most of the threatened flora as per the BAM calculator (Table 5). Surveys completed outside the recommended survey times have been addressed for each species in Table 5.

A targeted survey was completed during the recommended survey month (August) to determine the presence of *Diuris praecox*, given a total of 208 individual *Diuris praecox* were recorded within Boral landholding in September 2003 (ERM 2005). The population recorded in 2003 was adjacent to walking tracks and roads where it was noted there was reduced competition for light (ERM 2005). Follow up site visits in 2004 noted that the half the population were not flowering which may have been attributed to increased shrub density and competition for light (ERM 2005).

During the targeted survey, the population that had been previously recorded on Boral landholdings was not flowering. An inspection of the area where the population was recorded noted that the area of habitat was relatively dense with shrubs which may have been the reason for the known population to either not be in flower, or potentially no longer persist.

During the field survey, no BC Act or EPBC Act listed threatened flora were recorded. The previously cleared nature of the Study Area, which has changed the sites resilience, is likely attributed to the absence of threatened flora. Given the field survey was completed during the recommended survey times for those species identified in the BAM (Table 5), the flora habitat requirements, and the conspicuous nature of the species, it is highly unlikely that threatened flora occur within the Study Area. As such, all the threatened flora generated by the BAM calculator has been assumed absent.

Table 5. Recommended threatened flora survey time matrix as specified in BAM

Scientific Name	Recommended survey time (BAM)												Consideration
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Allocasuarina simulans	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Survey completed during recommended survey time - conspicuous species that is unlikely to remain undetected during field survey.
Angophora inopina	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Survey completed during recommended survey time - conspicuous species that is unlikely to remain undetected during field survey.
Callistemon linearifolius	Yes	Yes	Yes	Yes					Yes	Yes	Yes	Yes	Survey completed during recommended survey time – not detected during targeted flora survey. Unlikely to remain undetected during the survey.
Corybas dowlingii						Yes	Yes	Yes					Survey completed during recommended survey time – not detected during targeted flora survey. Unlikely to remain undetected during the survey.
Cryptostylis hunteriana	Yes	Yes									Yes	Yes	The survey was not completed during the recommended survey time. However, the species is unlikely to have habitat within the Study Area due to the following: • The majority of the Study Area consisted of a rehabilitated quarry pit and as such, the sandy soil does not have resilience. • The species prefers moist sands and moist to dry clay loam which are absent from Study Area.
Diuris arenaria								Yes	Yes				Survey completed during recommended survey time – not detected during targeted flora survey.
Diuris praecox							Yes	Yes					Survey completed during recommended survey time – not detected during targeted flora survey.
Eucalyptus camfieldii	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Survey completed during recommended survey time - conspicuous species that is unlikely to remain undetected during field survey.
Eucalyptus parramattensis subsp. decadens	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Survey completed during recommended survey time - conspicuous species that is unlikely to remain undetected during field survey.
Melaleuca groveana	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Survey completed during recommended survey time - conspicuous species that is unlikely to remain undetected during field survey.
Prostanthera densa	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Survey completed during recommended survey time - conspicuous species that is unlikely to remain undetected during field survey.
Rhizanthella slateri									Yes	Yes	Yes		Survey completed during recommended survey time– not detected during targeted flora survey.
Senecio spathulatus	Yes								Yes	Yes	Yes	Yes	Survey completed during recommended survey time – not detected during targeted flora survey.

Scientific Name	Recommended survey time (BAM)												Consideration
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Tetratheca juncea							Yes	Yes	Yes	Yes	Yes	Yes	Survey completed during recommended survey time - conspicuous species that is unlikely to remain undetected during field survey.
Thesium australe	Yes	Yes							Yes	Yes	Yes	Yes	Survey completed during recommended survey time – not detected during targeted flora survey.

4. Assessment of fauna and habitat

4.1 Bionet Atlas & EPBC Act Protected Matters Search

Similar to that in Section 3.1.1, a review of spatial records of threatened fauna within a 10 km radius of the Study Area was undertaken using data obtained from the Bionet Atlas, and predicted threatened biodiversity were generated from an EPBC Act Protected Matters Search.

Eighty-five threatened fauna have been previously recorded or have modelled habitat within a 10 km radius of the Study Area (Appendix 1) according to the database searches. The potential for these species to occur within the Study Area is discussed in Section 3.1 and Appendix 1. The results were considered during field survey planning and the likelihood of occurrence analysis, performed prior to field survey and updated post field survey.

4.2 Methods – field survey

The fauna field surveys incorporated both targeted survey using established survey techniques (as described in Table 6) and habitat-based assessment.

Habitat assessment considered the type and condition of habitats for fauna species. Habitat features recorded within the survey area included:

- Topographic features (such as slope, aspect and landscape position);
- Geology/soil type;
- Dominant vegetation community composition, structure and condition of strata levels;
- Form, quality and location of water sources;
- The presence, number, size and condition of unique habitat features (such as tree hollows and crevices, loose tree bark, fallen timber mistletoe and any rock outcropping or scattered surface rock); and
- The level of disturbance.

The fauna survey design effort had an emphasis on detection of species credit fauna and EPBC Act listed fauna where available habitat was present for such species. Since ecosystem credit species (see Appendix 1) have a high likelihood of being present on the site (based on the presence of habitat surrogates) specific targeted survey was not always performed for these species.

Table 6. Fauna survey details and effort within the Study Area

Method	Effort and Timing	Details	Targeted species (NSW listed)	Targeted species (Commonwealth listed)
Diurnal bird surveys	1 x survey 26/07/2017 (2 hours) 1 x survey 27/07/2017 (2 hours)	20 minute, 2 hectare bird surveys were extended in time due to relatively low bird activity in most areas and additional species being recorded after or at the end of the typical standard 20 min period. Incidental bird sightings were made throughout surveys activities with species of note being recorded spatially. Birds were identified with the use of 10 X 42 binoculars or from their calls.	All birds	All birds
Anabat survey	2 x Anabat left for 2 consecutive nights 26/09/2017 - 27/09/2017	Two Anabat II bat detector and Anabat CF recorder unit was deployed at two sites over two nights along potential flyways.	Eastern Cave Bat, Southern Myotis, Large-eared Pied Bat, Eastern False Pipestrelle.	-
Koala SAT	3 x survey 26/07/2017 1 x survey 27/07/2017	SAT (Koala scat) surveys were conducted across the Study Area. In addition to SAT surveys random tree inspections were carried out during traverses of the Study Area at selected feed trees searching for scats and characteristic bark scratches.	Koala	Koala
Opportunistic survey	During all activities	Opportunistic observations were made of fauna aided with binoculars and photography as appropriate. Opportunistic survey included searches of habitat such as under logs, rocks or waste piles (where limited areas of such habitat existed) or within heaped leaf litter, casual bird or mammal observations or observations of their calls.	All species	All species

4.3 Recommended fauna survey effort in BAM

Threatened fauna predicted or potentially occurring within the IBRA subregion were reviewed. This list was refined post field survey for the Study Area within the BAM Calculator on the basis of the vegetation types, condition and habitat features as well as the results of field survey. The list of predicted and candidate species generated via the BAM Calculator is in Table 7. A status for each species is provided which represents the basis for deciding whether a species was present or absent from the Study Area. No ecosystem credit species were omitted from the BAM Calculator, despite there being very limited or no habitat present within the Study Area for many of the predicted species.

Table 7. Recommended threatened fauna survey time matrix as specified in BAM

Common Name	Scientific Name	Recommended survey time												Consideration
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Candidate threatened species														
Regent Honeyeater (Breeding)	*Anthochaera Phrygia*									Yes	Yes	Yes	Yes	No breeding habitat likely. Study Area does not contain following habitat preferences: • rough-barked trees, including *Casuarina* sp, ironbarks and rough-barked *Angophora* sp. • Breeding timing and location appears tied to flowering of key Eucalypt and mistletoe species in box-ironbark woodlands and forests, including: *Eucalyptus sideroxylon, E. melliodora, E. albens, E. leucoxylon, E. robusta, Corymbia maculata,* and the mistletoe species *Amyema cambagei* on *Casuarina cunninghamiana, A miquelli* and *Dendropthoe vitelline* (DoE, 2016)
Bush Stone-curlew	*Burhinus grallarius*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No – species not detected during survey. Furthermore, only four records occur within the locality (Fern Bay 2011, Stockton beach 1998, Kooragang island 2008, Horseshoe Bay 2010). Unlikely to be present.
Gang-gang Cockatoo (Breeding)	*Callocephalon fimbriatum*	Yes									Yes	Yes	Yes	No – breeding habitat unlikely. Requires tree hollows in large living eucalypts for breeding – these were absent from the Study Area.
Glossy Black-Cockatoo (Breeding)	*Calyptorhynchus lathami*			Yes	Yes	Yes	Yes	Yes	Yes					No – no breeding habitat unlikely. Requires tree hollows in large living eucalypts for breeding – these were absent from the Study Area.
Eastern Pygmy-possum	*Cercartetus nanus*	Yes	Yes	Yes						Yes	Yes	Yes	Yes	No – closest record is 20 kilometres to the north of the Study Area. The Scientific Determination notes the species only occurs higher elevations north of Newcastle.
Large-eared Pied Bat	*Chalinolobus dwyeri*	Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No caves in the Study Area. Not within 2 kilometres of rocky outcrops or boulder piles.
Wallum Froglet	*Crinia tinnula*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No – no habitat present within the Study Area.

Common Name	Scientific Name	Recommended survey time												Consideration
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Emu population in the New South Wales North Coast Bioregion and Port Stephens local government area	*Dromaius novaehollandiae* - endangered population	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No – species not detected during survey. Unlikely to be present in Study Area. No records in Study Area.
White-bellied Sea-Eagle (Breeding)	*Haliaeetus leucogaster*							Yes	Yes	Yes	Yes	Yes	Yes	Recorded during field survey flying over the Study Area. Breeding habitat is not present in Study Area as no nests were recorded.
Little Eagle (Breeding)	*Hieraaetus morphnoides*								Yes	Yes	Yes			No – species not detected during survey. Breeding habitat is not present in Study Area as no nests were recorded.
Pale-headed Snake	*Hoplocephalus bitorquatus*	Yes	Yes	Yes								Yes	Yes	No - habitat within Study Area is not suitable. The species tends to occur in dry eucalypt forests and woodlands, cypress forest and occasionally in rainforest or moist eucalypt forest where there are large standing old and dead trees with hollows and exfoliating bark. The species prefers Callitris woodlands.
Swift Parrot (Breeding)	*Lathamus discolor*					Yes	Yes	Yes	Yes					No – species not detected during survey. Breeding habitat is not present in Study Area.
Green and Golden Bell Frog	*Litoria aurea*	Yes	Yes	Yes							Yes	Yes	Yes	No habitat present
Green-thighed Frog	*Litoria brevipalmata*	Yes	Yes	Yes								Yes	Yes	No habitat present
Square-tailed Kite (Breeding)	*Lophoictinia isura*	Yes								Yes	Yes	Yes	Yes	No – species not detected during survey. Breeding habitat is not present in Study Area as no nests were recorded.
Little Bentwing-bat (Breeding)	*Miniopterus australis*	Yes	Yes										Yes	No – breeding habitat which includes caves, mines, tunnels, do not occur in Study Area.
Eastern Bentwing-bat (Breeding)	*Miniopterus schreibersii oceanensis*	Yes	Yes									Yes	Yes	Recorded in Study Area however – breeding habitat which includes caves, mines, tunnels, do not occur in Study Area.
Southern Myotis (Breeding)	Myotis macropus	Yes	Yes	Yes							Yes	Yes	Yes	Not recorded in Study Area. Breeding habitat which includes caves, mines, tunnels, drains and beneath bridges within 200m of large permanent watercourses, does not occur in Study Area.

Common Name	Scientific Name	Recommended survey time												Consideration
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Barking Owl (Breeding)	*Ninox connivens*					Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No hollows of sufficient size in Study Area (Nest hollows are vertical or sloping with opening diameter 20-46cm and 20-300cm depth).
Powerful Owl (Breeding)	*Ninox strenua*					Yes	Yes	Yes	Yes					No hollows of sufficient size in Study Area (Nest hollows are vertical or sloping with opening diameter 20-46cm and 20-300cm depth).
Eastern Osprey (Breeding)	*Pandion cristatus*				Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		No – species not detected during survey. Breeding habitat is not present in Study Area as no nests were recorded.
Squirrel Glider	*Petaurus norfolcensis*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes - Detected during previous surveys within the Study Area and surrounds in 2003, and is known to occur throughout the Stockton Beach area.
Brush-tailed Rock-wallaby	*Petrogale penicillata*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No habitat present
Brush-tailed Phascogale	*Phascogale tapoatafa*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No – lack of habitat given the Study Area predominately consists of rehabilitation. The Study Area lacks trees with hollows. The species is known to hunt predominantly in rough-barked trees of >25cm DBH where available and requires numerous tree hollows of 2.5-4 cm entrance diameter which are absent throughout the majority of the Study Area.
Koala (important habitat)	*Phascolarctos cinereus*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes – not detected during field survey. However it is noted that the species has been recorded through the locality and adjacent to Boral's Landholding. The field survey results however demonstrates that if the Koala were present, it is unlikely to utilise the Study Area on a regular basis. Given the Study area is predominately planted tubestock, or juvenile eucalypts, the surrounding vegetation would likely provide a greater food source. The Koala is more likely to utilise the bushland surrounding the Study Area for movement given the ground cover is relatively bare across much of the Study Area offering the species little protection during movement.

Common Name	Scientific Name	Recommended survey time												Consideration
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Koala, Hawks Nest and Tea Gardens population	*Phascolarctos cinereus* - endangered population	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No – not detected during field survey.
Common Planigale	*Planigale maculata*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No – unlikely to have habitat in the Study Area as the species utilises dense ground cover for shelter, and also may build nests in in crevices, hollow logs, under bark or rocks. Within the Study Area, ground cover was sparse, along with hollow bearing logs. The site lacks surface rocks.
Grey-headed Flying-fox (Breeding)	*Pteropus poliocephalus*										Yes	Yes	Yes	No breeding camps in the Study Area.
Masked Owl (Breeding)	*Tyto novaehollandiae*					Yes	Yes	Yes	Yes					No breeding habitat present. The Study Area generally lacks hollows with >40cm diameter and >100cm depth. No evidence of usage.
Mahony's Toadlet	*Uperoleia mahonyi*	Yes	Yes	Yes							Yes	Yes	Yes	No habitat present
Eastern Cave Bat	*Vespadelus troughtoni*	Yes										Yes	Yes	No habitat. Not within 2 kilometres of caves, rocky outcrops or boulder piles
Predicted threatened species														
Regent Honeyeater	*Anthochaera phrygia*	No requirement to survey as assumed to be present based on habitat present												
Gang-gang Cockatoo	*Callocephalon fimbriatum*													
Glossy Black-Cockatoo	*Calyptorhynchus lathami*													
Speckled Warbler	*Chthonicola sagittata*													
Spotted Harrier	*Circus assimilis*													
Varied Sittella	*Daphoenositta chrysoptera*													
Spotted-tailed Quoll	*Dasyurus maculatus*													
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*													
Little Lorikeet	*Glossopsitta pusilla*													

Common Name	Scientific Name	Recommended survey time												Consideration
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
White-bellied Sea-Eagle	*Haliaeetus leucogaster*													
Little Eagle	*Hieraaetus morphnoides*													
Golden-tipped Bat	*Kerivoula papuensis*													
Swift Parrot	*Lathamus discolor*													
Square-tailed Kite	*Lophoictinia isura*													
Black-chinned Honeyeater (eastern subspecies)	*Melithreptus gularis gularis*													
Little Bentwing-bat	*Miniopterus australis*													
Eastern Bentwing-bat	*Miniopterus schreibersii oceanensis*													
Eastern Freetail-bat	*Mormopterus norfolkensis*													
Turquoise Parrot	*Neophema pulchella*													
Barking Owl	*Ninox connivens*													
Powerful Owl	*Ninox strenua*													
Eastern Osprey	*Pandion cristatus*													
Yellow-bellied Glider	*Petaurus australis*													
Koala	*Phascolarctos cinereus*													
Grey-crowned Babbler (eastern subspecies)	*Pomatostomus temporalis temporalis*													
Eastern Chestnut Mouse	*Pseudomys gracilicaudatus*													
Grey-headed Flying-fox	*Pteropus poliocephalus*													
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*													
Greater Broad-nosed Bat	*Scoteanax rueppellii*													
Diamond Firetail	*Stagonopleura guttata*													
Common Blossom-bat	*Syconycteris australis*													

Common Name	Scientific Name	Recommended survey time												Consideration
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Masked Owl	*Tyto novaehollandiae*													

4.4 Fauna habitat

There was a clear difference in fauna habitat across the Study Area attributed to the age of regeneration.

Areas of relatively young regeneration (Rehabilitation Area 4) contained scattered logs, generally sparse ground cover (<5% ground cover) and lacked a mid and canopy stratum (Photo 1). Whilst older regeneration areas (Rehabilitation Area 1, 2 and 3) had a developing canopy and midstorey cover, with Area 3 containing a relatively dense shrub layer (Photo 2), whilst the patch of remnant vegetation had stratum layers intact (Photo 3). As such, the remnant and older patches of rehabilitation would offer greater foraging habitat for a variety of fauna, including that of nectivorous birds and the Squirrel glider (*Petaurus norfolcensis*).

For the most part, all the rehabilitation areas did not contain trees old enough to contain hollows, and as such, roosting and breeding habitat for a range of hollow-dependent species, such as microbats, was absent. Few hollows within areas of the remnant vegetation occur, however none of these had any evidence of owl usage (e.g. pellets or caracisis).

Logs have been scattered throughout the rehabilitation areas which provide habitat for reptiles and small ground-dwelling mammals, and foraging resources for granivorous birds. There were no large den sites recorded that would be suitable for the spotted-tailed quoll (eg hollow-bearing logs of sufficient hollow depth).

As previously noted, the rehabilitation ground cover was particularly sparse, however the sandy substrate may provide habitat for small to medium-sized mammals to create burrows for shelter.

No habitat in the form of bush rock or rock platform was identified, or was there any permanent or ephemeral aquatic habitats on the site.



Photo 1. Open areas of rehabilitated mine pit. Occasional logs and tubestock.



Photo 2. Older areas of rehabilitation – some fallen logs and high leaf litter present.



Photo 3. Remnant vegetation – stratum layer intact

4.5 Connectivity of fauna habitat

The Study Area adjoins a large native vegetation corridor which extends along Stockton Beach to Anna Bay in the north and Stockton in the south. The stretch of the vegetation corridor encompasses Worimi Regional Park and Worimi State Conservation Area. The corridor also adjoins the wetlands (Long Bight Swamp) and riparian vegetation of Fullerton Cove approximately 2.3 kilometres to the south-west.

The removal of vegetation (mainly tubestock plantings within the former mine pit) and habitat within the Study Area are not limiting ie. the habitat features surrounding the site contains a range of habitat features which are not extensive within the Study Area (hollow-bearing trees, fallen logs). The removal of habitat within the Study Area is therefore unlikely to reduce the amount of important habitat features within the corridor so much that fauna roosting and foraging habitat would be significantly impacted.

The removal of the vegetation within the Study Area, is unlikely to restrict fauna movement along the Stockton Beach to Anna Bay corridor given the following:

- The area to be disturbed is centred on the former mine pit which was historically cleared.
- Vegetation would be retained along Nelson Bay Road and towards Stockton Beach allowing fauna movement along the corridor (as can be seen from Figure 3).
- The haul road that is currently in operation for the mine operations would not be widened as part of the current proposal, thus no changes to fauna movement are likely.

4.6 Fauna recorded during field surveys

Fauna field surveys using the methods described in Section 4.2 were undertaken in each of the identified habitats, with the suite of methods employed in each habitat type dependant on the potential presence of subject threatened fauna within that habitat type. Notable opportunistic sightings whilst travelling within the Study Area were also recorded. A complete species list is provided in Appendix 5.

A total of 28 fauna were recorded during field surveys within or immediately adjacent to the Study Area. The results comprised of three reptiles, four mammals, and 21 birds. A complete fauna list is provided in Appendix 5.

The suite of fauna recorded were predominantly locally common species tolerant of at least moderate disturbance and lower condition vegetation or degraded habitats.

Some mobile species recorded would primarily be dependent on the adjacent woodland areas but would take advantage of parts of the Study Area to forage (e.g. Squirrel Glider).

4.7 Threatened fauna

Three threatened fauna were recorded with the Study Area: Greater Broad-nosed Bat, Eastern Bentwing Bat and White-bellied Sea Eagle. Both the threatened microbats were recorded on both anabats located in the Study Area, whilst the White-bellied Sea Eagle was recorded flying over the Study Area on all days of the field survey.

An additional 16 threatened fauna have the potential to occur within the Study Area but were not recorded, most likely due to their potential use of the Study Area or wider locality being limited to sporadic occurrences (e.g. nomadic birds) (Appendix 1). These species include the following:

- Birds - Dusky Woodswallow, White-fronted Chat, Red Goshawk, White-throated Needletail, Black-faced Monarch, Australian Painted Snipe; and

- Mammals: Little Bentwing-bat, Eastern False Pipistrelle, Eastern Freetail-bat, Southern Myotis, Squirrel Glider, Koala Long-nosed Potoroo, New Holland Mouse, Grey-headed Flying-fox and Yellow-bellied Sheathtail-bat.

Of these threatened fauna, only the Squirrel Glider is regarded as species credit fauna that would require offsetting under the BC Act.

The Eastern Bentwing Bat, Sooty Owl and White-belled Sea Eagle, are regarded as both an ecosystem and species credit species, with the species credit component triggered by the presence of breeding habitat. The Eastern Bentwing Bat has breeding habitat within caves and artificial tunnels, neither of which occur within the Study Area, and as such, has been regarded as an ecosystem credit species for this assessment.

The field survey confirmed that no White-belled Sea Eagle nests occur within the Study Area, and as such, this species has been regarded as an ecosystem credit species for this assessment. And similarly, breeding habitat for the Sooty Owl which includes large tree hollows (hollows approximately 12 metres high in the tree, of approximately 35–50cm internal diametre and approximately 1–3+ metres deep (LMCC 2014)) were absent, thus has been regarded as an ecosystem credit species.

In relation to the Koala, the EES database notes that the Koala is also listed as dual credit species, with the 'species credit' component triggered if the species has 'important habitat' within the Study Area.

The Koala has been recorded throughout the locality, with the closest records according to Bionet being along Nelson Bay Road approximately 100 metres to the north of the Study Area. The Koala has been recorded throughout the stretch of the vegetation corridor which encompasses Worimi Regional Park and Worimi State Conservation Area.

As stated in OEH (2018) one of the most important factors influencing the distribution and numbers of Koalas in any area is the presence and density of their food tree species. Koalas feed almost exclusively on a few preferred tree species which are of primary and secondary importance. If primary tree food species are not present or occur in low density, Koalas must rely on secondary food tree species, but the number of animals per hectare is lower.

Eucalyptus robusta is regarded as a primary feed tree, however did not occur in the Study Area in large numbers. It was also not a tubestock species that was planted in abundance.

For the most part of the Study Area, dominant canopy species that have been planted include *Eucalyptus pilularis, Corymbia gummifera* and *Angophora costata*, none of which are regarded as primary or secondary feed trees. As such, the Study Area does not contain a large portion of important feed trees and are therefore not of foraging preference. This is supported by the absence of scratches and Koala scats observed during the field survey.

This is further supported in the DECC (2008) Recovery Plan for the Koala, which notes that '*arguably the most important factor influencing koala occurrence is the suite of tree species available. In any one area, koalas rely primarily on regionally specific primary and/or secondary food tree species. If primary food tree species are not present or occur in low density, koalas will rely on secondary food tree species, but the carrying capacity of the habitat (i.e. number of animals per hectare) is inevitably lower. Adequate floristic diversity is also important. Although primary and secondary food trees provide the bulk of a koala's diet, leaves from other species, including non-eucalypts, may provide a seasonal or supplementary dietary resource (Smith 1992). The quality of habitat is also influenced by the presence of suitable shelter trees, particularly in harsh climates*.'

In regards to suitable Koala shelter trees, the canopy height is generally less than 10 metres, with some portions of the rehabilitation not reaching 2 metres in height. Furthermore the density of canopy cover is quite low across all vegetation zones, on average at 5 percent cover. Given the generally low canopy height and cover, the Study Area is unlikely to contain suitable shelter trees for the species.

A discussed further in section 4.8, the site also does not contain 'potential habitat' as described in the SEPP 44. Thus, the site also does not meet the definition of 'core habitat' as per the SEPP 44.

It is therefore our conclusion, that important habitat for the Koala does not occur within the Study Area, and thus has been regarded as an ecosystem credit species. Key considerations in regards to this conclusion include:

- Lack of primary and secondary feed trees;
- The Study Area is not regarded as 'potential habitat' or 'core habitat' under the SEPP 44;
- The canopy height and cover is low – thus is unlikely to provide suitable shelter trees;
- Koalas are more likely to move within the surrounding intact bushland; and
- Koalas are more likely to utilise the surrounding intact bushland given the variety of foraging habitat present.

4.7.1 Species credit fauna

As discussed in section 4.7, the survey resulted in only one species credit fauna being assumed present within the Study Area, namely the Squirrel Glider.

The Squirrel Glider was recorded within the Study Area during the ERM (2005) field survey, and throughout vegetation that aligned to PCT 1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland on coastal sands. Bionet records for the species occur within the stretch vegetation corridor encompasses Worimi Regional Park and Worimi State Conservation Area.

According the OEH (2019) threatened species profile, the Squirrel Glider inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest and Blackbutt-Bloodwood forest with heath understorey in coastal areas, and prefers mixed species stands with a shrub or Acacia midstorey. It is also noted that the species requires abundant tree hollows for refuge and nest sites.

The Study Area offers little refuge and nest sites, given 32.75 hectares consists of rehabilitation which contains juvenile eucalypts that have not yet development hollows. Refuge and nest sites are more likely to occur within the remnant vegetation that surrounds the Study Area.

The Study Area does provide foraging habitat for the Squirrel Glider given the presence of Acacias, Leptospermums and Banksias. However, as described in the vegetation descriptions in Appendix 2, the shrubs are relatively sparsely scattered throughout the vegetation zones, with the exception of the 'remnant' and 'rehabilitation zone Area 3'. As such, we have attributed the following vegetation zones within the Study Area to foraging habitat for the species:

- Rehabilitation Area 1 – approximately 19.77 hectares;
- Rehabilitation Area 3 – approximately 3.91 hectares; and
- Remnant – approximately 2.91 hectares.

In total, approximately 26.59 hectares of potential habitat for the Squirrel Glider has been mapped as per Figure 7.

The remaining vegetation zones, such as 'Rehabilitation zone Area 1' and 'Rehabilitation zones Area 2' are unlikely to provide sufficient foraging habitat at the time of the survey given the sparse shrub layer.

4.7.2 EPBC Act listed fauna

A total of 63 EPBC Act listed fauna were considered in the assessment based on the database reviews detailed in Section 4.1, with most the species being Marine or Migratory bird species. Of these species considered, eight were considered to have a moderate to high likelihood to utilise the habitat features of the Study Area for foraging: Australian Painted Snipe, Black-faced Monarch, White-throated Needletail, Red Goshawk, Long-nosed Potoroo, Koala, New Holland Mouse and Grey-headed Flying-fox.

The threatened/migratory birds (Australian Painted Snipe, Black-faced Monarch, White-throated Needletail, Red Goshawk) may utilise the Study Area on occasion for foraging. None of these species were detected during the bird surveys completed as part of this assessment. Based on the specific habitat requirements of each of the species (Appendix 1), and the lack detection during surveys, it is likely that the habitat features within the Study Area would only be used on an intermittent basis for foraging. The extensive native vegetation that occurs throughout the land to the north and south within Worimi Regional Park and Worimi State Conservation Area are likely to offer greater habitat availability for each of the species.

The Grey-headed Flying Fox is only likely to utilise the Study Area on occasion for foraging. No roosting camp sites were observed in the Study Area, nor known to occur within close proximity to the Study Area.

The Long-nosed Potoroo, Koala and New Holland Mouse have been attributed a moderate likelihood of occurrence as both these species have been recorded within Worimi Regional Park and Worimi State Conservation Area and may utilise the Study Area for foraging.

Impacts of the Project on these EPBC Act listed species are considered further in Section 5.

4.8 State Environment Planning Policy 44 – Koala Habitat

State Environment Planning Policy 44 – Koala Habitat (SEPP 44) aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas to ensure a permanent free-living population over their present range and reverse the current trend of koala population *decline:*

(a) by requiring the preparation of plans of management before development consent can be granted in relation to areas of core koala habitat, and

(b) by encouraging the identification of areas of core koala habitat, and

(c) by encouraging the inclusion of areas of core koala habitat in environment protection zones.

SEPP 44 applies to Local Government Areas (LGAs) listed in Schedule 1, and where a development has an area of more than 1 ha.

The Study Area exceeds 1 ha and is located within the Port Stephens LGA which is listed in Schedule 1 of SEPP 44, and as such, the SEPP applies to the Study Area.

Under SEPP 44, 'potential Koala habitat' is defined as -

'*areas of native vegetation where the trees of the types listed in Schedule 2 constitute at least 15% of the total number of trees in the upper or lower strata of the tree component*'.

Of the tree species listed in Schedule 2, only *Eucalyptus robusta* was recorded within and near the Study Area. *E. robusta* comprised less than 15 per cent of the total number of trees present in the Study Area, and therefore, as per the definition of SEPP 44, the habitat present is not regarded as 'potential Koala habitat'.

Under SEPP 44, 'Core Koala habitat' is defined as -

'*an area of land with a resident population of koalas, evidenced by attributes such as breeding females (that is, females with young) and recent sightings of and historical records of a population*'.

The Koala has not been recorded on the Study Area and there are no historical records of the species in the Study Area. As discussed in section 4.7.1, the Koala has been recorded within the locality, with the closest records being along Nelson Bay Road approximately 100 metres to the north of the Study Area (OEH Bionet).

If a resident population of the Koala was present within the Study Area, it is highly likely that there would be extensive sightings by Boral staff and rehabilitation contractors whilst working within the Study Area. Given the lack of recent sightings and/or historical records in the Study Area, the Study Area is not considered to constitute 'core Koala habitat'. Furthermore, as detailed in section 4.7.1, the Study Area predominately comprises areas of native rehabilitation with no canopy cover. Also, given the only potential food tree present (E. *robusta*) is relatively scarce across the Study Area, the Study Area is considered unlikely to provide vital habitat for any potential local breeding population, should it occur. For these reasons, the Study Area does not meet the definitions of 'potential Koala habitat' and 'Core Koala habitat' as per SEPP 44.

It should be noted that the current SEPP 44, is to be replaced with SEPP Koala Habitat Protection 2019 (SEPP KHP), which will take effect on 1 March 2020. Whilst SEPP KHP is not yet in effect, it is noted that the definition of 'Koala habitat' will be amended and is supported by an expanded list of Koala feed trees under schedule 2.

Under SEPP KHP, the study area contains tree species (*Eucalyptus robusta, Angophora costata* and *Corymbia gummifera*) which are listed as Koala feed trees listed in schedule 2 of SEPP KPH. However it should be noted, that the majority of these trees have been planted within the Study Area, and the large list of feed trees in the SEPP KPH includes species that are associated with most of the PCTs that occur along the coastal stretch along Worimi Regional Park and Worimi State Conservation Area.

As discussed in section 4.7.1, Niche did not detect any usage of the Study Area by the Koala. However, we note that there are records for the Koala along the coastal corridor of Worimi Regional Park and Worimi State Conservation Area (section 4.7.1), with the closest record located approximately 100 metres from the Study Area. These records are associated with a number of PCTs, with the closest records being associated with PCT 1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland.

Within the Study Area, 31.75 hectares of PCT 1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland occurs, with only approximately 2.91 hectares being remnant vegetation, and the remainder consisting of planted tubestock. As discussed in section 4.7.1, our findings indicate less favourable conditions for the Koala given the lack of foliage protection in the rehabilitation areas within the Study Area despite the Koala potentially being associated with PCT 1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland within the locality.

In relation to 'Core Koala' habitat under SEPP KPH, it is defined as –

' (a) an area of land where koalas are present, or

(b) an area of land—

(i) which has been assessed by a suitably qualified and experienced person in accordance with the Guideline as being highly suitable koala habitat, and

(ii) where koalas have been recorded as being present in the previous 18 years.'

Similar to the assessment completed under the existing provisions of SEPP 44, we conclude that the Study Area does not meet the definition of 'Core Koala habitat'. We have based this conclusion on the following:

- The Koala, or evidence of the Koala utilising the Study Area was not detected by Niche during the field surveys undertaken (section 4.2).
- Boral staff and rehabilitation contractors have not reported any Koala activity within the Study Area. It is likely that if a resident population was present within the Study Area, regular occurrence of the Koala would be sighted by staff and contractors.
- There are no records of the Koala within the Study Area in the past 18 years.
- We do not regard the habitat as being 'highly suitable' given:
    - The vegetation consists predominately of native rehabilitation, which lack a canopy layer.
    - As discussed in section 4.7.1, the canopy height and vegetation cover are low – thus the Study Area is unlikely to provide suitable shelter habitat, which restricts ~~u~~se of the Study Area as an important movement corridor for the Koala.
    - Preferred feed trees make up less than 15% of trees within the vegetation zone.
- Koalas are more likely to move/occur within the surrounding intact bushland.
- Koalas are more likely to utilise the surrounding intact bushland given the diversity of foraging and shelter resources present.

4.9 Port Stephens Koala Plan of Management

The Port Stephens Council Comprehensive Koala Plan of Management (CKPoM) has been prepared by Port Stephens Council and the Australian Koala Foundation (AKF) for the Port Stephens LGA. The CKPoM has an aim to '*encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas, to ensure permanent free-living populations over their present range and to reverse the current trend of population decline*'.

The CKPoM includes a Koala habitat map for the Port Stephens LGA (PSC 2007), which classifies Koala habitat into different categories based off a range of attributes and survey results. The Study Area has been mapped as 'Supplementary" Koala habitat, which is defined as habitat 'where Marginal Koala Habitat Middle-ranking Community overlap' (PSC 2002). This habitat is regarded in the CKPoM as 'important to the long-term conservation of Koalas in Port Stephens and thus also requires protection, albeit with less restrictions on development than Preferred Koala Habitat'.

The CKPoM also includes performance criteria to assist development applications in the Port Stephens LGA demonstrate that developments are consistent with the objectives associated with the CKPoM. Given this BDAR is associated with an SSD rather than a local government development application, the performance criteria are not relevant to this Project, however Boral has considered the aims and objectives of the performance criteria to minimise potential impact to the Koala as detailed in Table 8.

Given the Project will largely impact upon a rehabilitated former quarry pit, and will avoid decreasing the width of a wildlife corridor along Nelson Bay Road, it is highly unlikely that the Project would result in an

impact to a Koala population in the Port Stephens LGA. The Project will also implement a series of mitigation measures (section 5.1.4) to avoid any potential indirect impacts to surrounding habitat.

Table 8. Consideration of aim and objectives of CKPoM

General Aims and Objectives of CKPoM Performance Criteria for Developments	Consideration in the Project
i) To ensure that the koala population in the Port Stephens LGA is sustainable over the long-term.	The area to be impacted is not known to contain a resident Koala population. Area to be disturbed consists predominately of native rehabilitation land, which occurs within, and immediately adjacent to a former quarry pit. The Project is highly unlikely to result in any decrease in the Koala population of the Port Stephens LGA.
ii) To protect koala habitat areas from any development which would compromise habitat quality or integrity.	The vegetation disturbance associated with the Project does not occur within areas of 'important' or 'core Koala' habitat as discussed in section 4.7.1. The Project would predominately involve the clearing of rehabilitated native vegetation within a former quarry pit. As such, impacts to large tracts of native vegetation and habitat have largely been avoided. The Project will not result in an impact to a Koala corridor, core habitat, important habitat or extensive koala habitat that would decrease a population of the Koala.
iii) To ensure that any development within or adjacent to koala habitat areas occurs in an environmentally sensitive manner.	Boral will implement the mitigation measures detailed in section 5.1.4 to minimise all potential indirect impacts.
iv) To ensure that acceptable levels of investigation are undertaken, considered and accepted prior to any development in or adjacent to koala habitat areas.	This assessment has utilised the methodology of the BAM and associated threatened survey guidelines.
v) To encourage koala habitat rehabilitation and restoration.	The Project would result in the clearing of native vegetation, conservatively estimated to be 35.66 ha of which 32.75 ha is rehabilitation. Given the Project is located predominately within a former quarry pit and historically impacted areas, largely avoids impacts to remnant vegetation. Mitigation measure to reduce potential habitat impacts are detailed in section 5.1.4.
vi) Maintain interconnection between areas of Preferred and Supplementary Koala Habitat and minimise threats to safe koala movements between such areas.	The Project will impact areas mapped as 'supplementary Koala habitat' as per the CKPoM. Much of the areas to be impacted occur within the former quarry pit, and immediately adjacent areas. The removal of the vegetation would not restrict Koala movement throughout the landscape.
vii) To ensure that development does not further fragment habitat areas either through the removal of habitat or habitat links or through the imposition of significant threats to koalas.	As discussed in section 4.7.1, the 'supplementary Koala habitat' would not restrict Koala connectivity and movement through the landscape.
viii) To provide guidelines and standards to minimise impacts on koalas during and after development, including any monitoring requirements.	Boral will implement the mitigation measures detailed in section 5.1.4 to minimise all potential indirect impacts.
ix) To provide readily understandable advice to proponents preparing development applications and for	Not relevant

General Aims and Objectives of CKPoM Performance Criteria for Developments	Consideration in the Project
Council officers involved in the assessment of those applications.	

5. Impact Assessment

The Impact Assessment below forms Stage 2 of the BDAR as detailed in the BAM.

5.1 Avoid and minimise impacts

In accordance with the BAM, proponents must demonstrate the measures employed to avoid, mitigate and offset impacts of a Project on biodiversity values. This section of the report outlines the details from the Environment Impact Statement (Element Environment 2019) associated with avoidance planning, management and mitigation measures that Boral has incorporated into the Project design or will employ during construction, operation or completion of the Project to reduce impacts on biodiversity values.

5.1.1 Justification for the Project

As detailed in the Environmental Impact Statement (Element Environment 2019), Boral is a leading producer and supplier of building and construction materials in the country. Accordingly, a significant amount of development in NSW, including many of NSW's best known structures, are underpinned by Boral-supplied concrete, cement, asphalt and construction materials such as natural sand.

With the significant increase in approved infrastructure Projects in Sydney and other parts of NSW, the leading suppliers of natural sand are under pressure to meet this increased demand as natural sand has unique structural characteristics to manufactured sand and is essential to meet design specifications on many infrastructure and associated development Projects.

As Stockton Sand Quarry is one of Boral's few remaining natural sand quarries, Boral propose to meet part of this increased demand in natural sand by extracting the remaining sand from the same inland extraction area previously approved under the former 1996 development consent.

As detailed in the Environmental Impact Statement (Element Environment 2019), the expanded operations at Stockton Sand Quarry will provide:

- supply of essential natural sand to major infrastructure and associated development Projects;
- continued employment of four full time employees, one casual employee and truck/transportation drivers, with an additional two full time positions and two casual positions also created along with further employment benefits created through flow-on effects;
- optimal use of a regionally-significant resource; and
- economic benefits to the local community through the purchase of goods and services and local expenditure both directly and indirectly through employee wages.

Boral's operations provide substantial economic benefits at Federal, State and local levels while being committed to maintaining a good working relationship with the local community and implementing best practice environmental management across the site.

5.1.2 Justification for the Study Area

Resource quality

Sand suitable for use in the construction and foundry industries occurs in the Stockton Bight dunes. Although the entire sand unit possesses some potential for a particular use, there are optimum areas from which these materials can be obtained. The sand within Boral's land holding comprises a fine to medium grained sand suitable for use as a fine aggregate in concrete.

Sand suitable for concrete use must comply with Australian Standard 2758.1-1998 "Aggregates and Rock for Engineering Purposes - Concrete Aggregates". Factors such as grain shape, composition and grading of the sand must be considered. The sand must be clean, fine to medium grained, and free of deleterious materials including friable particles, organic impurities, structurally weak substances, and alkali reactive materials. The sand in Boral's land holding meets these requirements and the main use proposed for the sand is concrete production within Boral's own concrete plants in the region.

Foundry sand suitable for the use and manufacture of cores and moulds in the casting of metal products must have chemical and physical properties that allow them to withstand the high temperatures of molten metal. The sand should be a fine silica sand, even grained, and low in deleterious matter such as shell, silica and limonite, as is the case with the dune sands at Anna Bay at the northern end of Stockton Bight. Sand in the Boral land holding does not generally meet foundry requirements due to unsuitable grading, given it is too coarse grained. Conversely, the very fine grained windblown dune sands along the northern end of Stockton Bight are generally not optimal for use in concrete, being too fine grained.

Leaching of the upper layers of vegetated dune sands, by organic acids, produces white, low iron sand below the organically enriched sandy topsoil layer. The leached white sand layer on Boral's property is of variable thickness but is generally thin. Below this thin white sandy capping there is a zone of iron enrichment, the sandy material within this zone being commonly termed ‘coffee rock’ or ‘waterloo rock’. This material varies in character from a thin crusty layer of loosely bound iron coated sand grains to a thick layer of moderately iron stained amber-brown sand. ‘Coffee rock’ or ‘waterloo rock’ is unsuitable for concrete production and (where it occurs) is blended with the thin white sand layer above (where it occurs) to produce a fill sand.

Fill sand is used in numerous construction applications, including use as a support filler under house slabs, as a filter material for pipe bedding and as a drainage layer under roads. Sand used for this purpose does not have to conform to the rigid specifications outlined for specialised sands. The sand, however, needs to be reasonably 'clean' (some impurities such as charcoal, shell material, and iron-staining can be tolerated) and not too fine grained.

Sand suitable for use in glass manufacture must comply with rigid specifications. It should consist of almost pure quartz (i.e. minimum silica content of 99.5 percent), and be fine in grain size and low in shell, iron, and organic materials. Very few sand deposits, including sand on Boral's holding, meet these stringent requirements.

In the manufacture of Concrete, the fine aggregate component is achieved by blending Fine Sand with a Course Sand. In Boral’s case, the Course sand is Manufactured Sand which is a made from further processing of Quarry Dust which is a by-product of the crushing process.

Stockton Fine Sand is ideally matched to Boral’s Peppertree Manufactured Sand which supplies most of Boral’s Concrete production requirements in the Sydneyand Hunter market. This means that Stockton Sand allows the greatest utilisation of manufactured sand in the Concrete blend, and therefore better utilises this scarce resource over a greater volume of total production that would otherwise have been produce with a less superior grading.

In this regard, Boral’s Stockton fine sand reduces the natural fine sand usage, and avoids the need to find and develop a more resource intensive source of fine sand.

Locational factors

In terms of weight and volume, more sand products have to be quarried and transported to construction sites than any other type of resource material. It is for these reasons that extractive sand sources need to be located as close as possible to the point of usage. The value to weight ratio is very low, making transport costs to the market highly sensitive.

Establishing sand extraction operations close to the construction market represents considerable savings in terms of construction and associated transport costs for Projects undertaken in the region that are to be serviced by the quarry. Over the life of the quarry this represents a significant benefit to the local community and the state in terms of reduced transport and associated infrastructure maintenance costs.

Adjoining operations

Existing operations providing fine to medium grained sand suitable as fine concrete aggregate in the Lower Hunter Region are principally located in the barrier dune systems between Stockton and the Port Stephens peninsula. In addition to Boral's sand extraction operation at Fullerton Cove, operations in the Stockton Bight area are located at Salt Ash, Williamtown, Bobs Farm, Anna Bay and Raymond Terrace.

Minor quantities of manufactured sand are derived from quarrying and processing of hard rock (quarry dust). Manufactured sand is assisting to prolong the life of the natural sand reserves, however manufactured sand is generally not suitable for use in concrete on its own and is typically either used in road base or blended with natural sand to produce an acceptable grade concrete sand.

As transport distance adds significantly to the delivered price of sand into the Hunter Region, very little sand is imported into the region from outside.

Future demand

The demand for construction materials in major infrastructure and construction Projects in the Lower Hunter Region and Sydney has been high in recent years and is expected to be strong for the foreseeable future.

Fine grained construction sand is a major component of concrete, particularly for domestic applications. For example, an average three bedroom brick veneer home on a concrete slab foundation, with concrete paths and driveways, consumes in the order of 50 cubic metres of concrete, which contains 17.5 tonnes of fine grained construction sand.

Boral uses sand extracted from the site as the fine sand component in concrete production. The future demand for construction sand will correlate with anticipated growth in residential development, commercial development, and major infrastructure and construction Projects in the Lower Hunter Region and Sydney during the next 15 to 20 years.

Life of operation

The Project proposes to extract approximately 9 million tonnes of sand resource over a potential 25 year period.

Taking into account the sites existing operation, extracting sand from the transgressive dunes, the project is seeking to allow for maximum site transport limit of 750,000 tonnes per annum (tpa) (over the two projects) up until 2028 when the extraction on the transgressive dunes is due to cease. At this time the transport limit will reduce to 500,000 tpa.

To allow for flexibility between the two projects, the project has been assessed on the basis of a site wide maximum extraction and transport rate of 750,000 tpa.

5.1.3 Project alternatives

Do nothing

Sand extracted from the Stockton Sand Quarry is used within the Hunter and Sydney regions. At present, due to sustained demand across the building and construction industry, Boral's sand resource across all assets have been substantially depleted.

If the proposed extraction of additional sand is not approved, the quarry will cease to operate in approximately three years' time due to current demand trends for natural sand products. This would result in loss of employment, reduced revenue to local service providers, reduced regional expenditure in the Port Stephens and Newcastle Local Government Areas (LGA), sterilisation of a valuable resource and shortages of raw materials for essential NSW infrastructure and associated development Projects.

The sand deposit at the site is highly suitable for use in concrete, is close to markets, and environmental impacts are less than for other alternatives on Boral's land and possibly less than for other sites in the region.

As detailed in the Environmental Impact Statement (Element Environment 2019), given that local demand for natural construction sand is unlikely to diminish, and given that the site is ideally located at the southern end of Stockton Bight to supply the Lower Hunter and Sydney market, it is most likely that other Stockton Bight sand suppliers further to the north would take up a shortfall in Boral's production. As such, there is a possibility that sand would be purchased from elsewhere, likely further away from the end use. In this case, it is likely that road transport impacts would be compounded, and would increase the cost of sand and concrete. Additionally, Boral would be required to purchase sand from other approved or yet to be approved Stockton Bight quarries. While it is not possible to clearly compare environmental impacts in this case, the Project has a limited environmental effect as it is confined to an area which has been disturbed by quarrying operations in the past. Because of the likelihood of alternate supply being a different grading there is a greater likelihood that more fine sand will be required for extraction and transport in order to produce one cubic metre of Concrete, when compared to the combination for Stockton Sand Grading with Boral's Manufactured Sand source.

In summary, should the Project not proceed, Boral would close the quarry in due course and have to rely on other sand sources locally or further afield, depleting those resources sooner. Importantly, not proceeding would mean that the community would lose the opportunity to allow the further development of an existing quarry operation. Conversely, alternative developments may require the disturbance of greenfield land parcels with more inherent environmental risks.

Alternative locations

As outlined earlier, Stockton Sand Quarry is one of Boral's few remaining natural sand quarries. With the significant increase in demand for natural sand, all of Boral's natural sand quarries are operating at full capacity.

As the quarry has a substantial remaining natural sand resource and is relatively close to Boral's existing Hunter and Sydney supply contracts, it is an ideal site to meet current and predicted future market demand for natural sand.

Other sand resources on Stockton Bight lie on Crown lands and, to a lesser extent, on freehold lands. Most sand deposits on freehold lands are already owned or being extracted by the construction sand industry. A few isolated sand bearing properties remain but the size of the sand deposits are generally too small for economical development.

Many millions of tonnes of sand lie on Crown lands on Stockton Bight but are currently unavailable for extraction by virtue of environmental protection zoning. Sand on Crown lands closer to Anna Bay which have appropriate zoning for extraction is generally too fine grained for concrete, being more suited to foundry applications and glass manufacture.

The dune sands on Stockton Bight need little or no processing to produce a grain size grading suitable for concrete manufacture. The only other source of sand in the region is the processing of soft rock. Friable sandstones at Blackhill, matrix sand from conglomerates at Teralba and overburden sediments in coal mines are examples, but in each of these cases, the cost of extraction and processing to produce suitably graded sand would be considerably higher than extracting the loose, naturally graded sands of Stockton Bight.

There are millions of tonnes of remaining sand suitable for production of concrete at the site. A number of alternative development scenarios were explored for the development of this remaining sand, culminating in the conclusion that the Project represents the most environmentally, socially and economically sensible option.

The proposed extraction area has been previously disturbed and as such the recommencement of sand extraction is considered to have a reduced direct environmental impact. The location of the site is separated from sensitive receptors, with Boral's current operations largely going unnoticed by the surrounding community and visually unobtrusive due to the presence of the dune system that surrounds the extraction area.

Alternative materials

There are few alternative materials to replace natural sand in the production of concrete. Alternative materials are emerging, which represent viable supplements to natural sands, but not as replacements to natural sands. In recognition of the value of such alternatives, Boral is becoming increasingly more active in recycling and in the production of manufactured sand.

Manufactured sand is a sand product created from quarry dust generated by the crushing of hard rock. Quarry dust is mainly blended into road bases, but many quarries process some of the dust to produce coarse sand for blending with finer grained natural sands to produce acceptable grade concrete sand.

To a significant extent, therefore, the alternative manufactured sand option is already being used to extend the life of natural fine grained sand sources. The inability of manufactured sand to be a complete replacement for natural sands is due to a number of factors. Quarry dust generally has a particle shape that is angular and often elongated, making concrete flow and concrete workability very difficult. Quarry dust also tends to be deficient in the fine end of the particle range and the addition of fine grained natural sand is required to fill out the grading. The addition of fine grained natural sand also helps concrete workability as the natural sands are often rounded.

Barmac crushing can be used to produce a dust with a better particle shape, but this in turn produces greater volumes of dust. A compromise is usually made, which invariably requires the use of natural sand to even out grain shape and particle size deficiencies.

Boral is engaged in ongoing research and development into the production of manufactured sand to supplement the natural sand market. In the immediate term Boral are investigating options to utilise glass sand or recovered sand from virgin excavated natural material (VENM). However, these sources are yet to receive approvals. In the case of glass sand, commercial production levels are low (as a new recovered resource and burgeoning industry) and the planning approvals necessary to permit the importation and blending of these materials to create building products is not widely accepted by consent authorities. Additionally, recovered sand product from processing VENM does not typically yield the same high quality product as that proposed to be extracted from the Stockton Sand Quarry. Cumulatively this would impact on the production of key building materials, in particular the production of concrete which would have wider implications for the building and construction industry within the Hunter and Sydney regions.

Alternative non-naturally occurring materials exist which can substitute to some extent for the naturally occurring construction sand sources. Examples are recycled building and demolition waste, granulated blast furnace slag and fly ash from coal fired power stations. However, these alternatives generally have high handling, transport and processing costs, although they are commonly used for roadbase and other applications.

Boral is actively involved in construction and demolition recycling with a major plant at Wetherill Park in Sydney and approved operations at Somersby on the Central Coast and Kooragang Island. The products from these operations supplement the natural sand market.

Whilst new innovation in alternative materials is emerging, the need for constant supply of natural sands for concrete production remains integral.

Alternative Project Design

Various options were considered when formulating the preferred concept of the Project. Such options included:

- extension of the extraction footprint beyond the 1996 development consent boundary, and subsequent extraction and dredging of this footprint. It was determined that this option would maximise access to sand resource, however would increase the clearing of remnant vegetation and habitat compared to the current proposal, and subsequently increase the projects offsetting requirement, and as such was not investigated further from a biodiversity perspective; and
- extension of the extraction footprint beyond the 1996 development consent boundary, inclusive of sand extraction to 4 m AHD with no dredging operations. It was determined that this option would reduce the degree of ground disturbance as is experienced with dredging, however would also increase the area of environmental impact (vegetation clearing, noise, and dust emissions) and fail to maximise use of the sand resource beneath 4m AHD.

With the above considered, confinement of the Project to the previously disturbed 1996 development consent boundary was considered to result in the most favourable environmental and social impacts.

Several configurations of infrastructure for the Project were considered to minimise the potential for adverse noise and air impacts to the closest sensitive receivers. Such options included positioning the wash plant in the southern extremity of the extraction area in order to maximise separation distance to these receivers.

5.1.4 Mitigation measures (construction and post-construction)

Impacts arising from the construction will primarily relate to vegetation clearing. Boral proposes to undertake the following mitigation and management actions during construction.

Fencing and signposting

Fencing and/or the use of highly visible rope or tape boundaries will be used to delineate the boundary of vegetation clearing at the edge of the proposed extraction area.

Signposting will be used to inform Project personnel and site visitors of areas of conservation value to restrict entry or inform behaviour that will reduce incidental interactions with threatened species - e.g. speed limits along access roads to reduce potential for fauna vehicle strikes.

Employee Education and General Environmental Controls

Employees and contractors would be educated on and required to implement the following controls, to avoid or at least minimise potential environmental impacts associated with the Project:

- Minimise dust generation by minimising the extent and time that bare sand is exposed and by appropriate sand suppression;
- Procedures for the management of hydrocarbon and/or chemical spills throughout the Project site including the requirements for vehicles to carry spill kits;
- Ensuring vehicles remain on designated roads and tracks and abide by site speed limits, through use of signposting and driver education during the induction process and in on-going Project discussions; and
- Management and removal of all rubbish from the Project site.

Vegetation Clearance Protocol

The vegetation clearing protocol provided in Boral's Landscape and Rehabilitation Management Plan (ERM 2010) is to be adhered to. This Plan includes the following key protocols:

- Prior to clearing of native vegetation, ecologists are to survey for ground dwelling fauna and to remove any fauna/ fauna habitats to adjacent areas that would not be further disturbed;
- Prior to clearing of remnant hollow-bearing trees or habitat trees, ecologists are to be engaged to supervise felling. All hollow-bearing trees that are accessible safely from the ground are to be checked and identified fauna relocated. Hollows higher up and not accessible from the ground are to be identified and trees felled gently by an excavator or dozer and left overnight to allow fauna to relocate;
- Any fauna displaced during clearing are to be captured where possible and relocated to pre-planned areas (fauna to be captured and handled only by personnel trained to do so); and
- In an event that fauna are injured during clearing, the NSW Wildlife Information, Rescue and Education Service (WIRES) will be contacted to handle and collect for appropriate care and rehabilitation.

5.1.5 Rehabilitation

The disturbance would be rehabilitated in accordance with the projects Rehabilitation Management Strategy (EES 2019). As described in the Plan, a pond would be established with stable banks that would be rehabilitated with native vegetation, which would enhance fauna habitat surrounding the water body.

Update of Stockton Quarry Landscape and Rehabilitation Management Plan

Boral's Stockton Sand Quarry Landscape and Rehabilitation Management Plan (ERM 2010) will be updated to reflect biodiversity management measures associated with the Project in order to protect and manage

important biodiversity values. Currently, the existing Plan discusses key commitments relating to threatened species management, pest and weed management, fire management and site hygiene practices.

5.1.6 Pest and weed management

The existing Plan (ERM 2010) would be updated to include a section relating to pest and weed management activities of the Project including:

- Management protocols for feral animals such as dogs, rabbits and foxes within the rehabilitation area; and
- Management protocols for the identification of noxious or important environmental weeds within areas to be cleared (in order to avoid transporting the weeds to rehabilitation areas or other parts of the site).

5.1.7 Fire management

Boral currently have a Bushfire Management Plan included in the Boral (2010) Stockton Transgressive Dune Quarry Environmental Management Strategy. Fire prevention and suppression are detailed within the Plan including emergency protocols should a fire occur. This Plan would be updated where required to reflect the findings and recommendations provided in the Bushfire Hazard Assessment for the Project (BPAD 2019).

5.2 Impact Summary

The Project would affect biodiversity, including threatened biodiversity, through both direct and indirect impacts during construction and operation. The majority of impacts on biodiversity would occur during construction from clearing of native vegetation and removal of habitat.

The direct and indirect impacts associated with Project and measures to offset and manage biodiversity in the long term are outlined the following sections.

5.2.1 Direct Impacts

The following residual direct impacts would result from the Project:

- Clearing of native vegetation and associated habitat, conservatively estimated to be 35.66 ha of which 32.75 ha is rehabilitation; and
- Clearing of species credit fauna habitat for the following:
    - Squirrel Glider habitat estimated to be 26.59 ha.

Direct impact to native vegetation and habitat

The Project would result in the clearing of 35.66 hectares of vegetation regarded as 'native vegetation,' as defined in the BAM, which comprises of:

- 31.75 ha of PCT1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland, of which 28.84 ha is rehabilitated land and 2.91 hectares is remnant native vegetation; and
- 3.91 ha of PCT1644 - Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes.

The rehabilitated land has been subject to previous clearing for the former inland extraction area, and now comprises of planted tubestock of varying ages as described in Section 3.2. The previous site disturbance is evident in all vegetation zones, in particular that of 'Rehabilitation Area 4' which contained a very low vegetation integrity score of 7 (see Section 5.3).

Direct impact to Squirrel Glider habitat

As previously discussed in Section 4.7, the Squirrel Glider was not recorded during the field survey however has been previously recorded at the site by ERM (2005), and is known to occur throughout the locality.

As previously discussed the following vegetation zones within the Study Area provide foraging habitat for the species:

- Rehabilitation Area 1 – approximately 19.77 ha;
- Rehabilitation Area 3 – approximately 3.91 ha; and
- Remnant – approximately 2.91 ha.

In total, approximately 26.59 ha of potential habitat for the Squirrel Glider would be cleared as part of the Project (Figure 7).

Direct impacts to EPBC Act listed fauna

As discussed above, the Project is not likely to result in a significant impact to any threatened biodiversity listed under the EPBC Act.

As discussed in Section 4.7, seven threatened fauna species listed on the EPBC Act may utilise the Study Area on occasional foraging. The Project would result in the loss of 35.66 ha of foraging habitat which for the most part, consists of sparsely scattered tubestock with a general lack of microhabitat features such as fallen logs and hollow-bearing trees.

Assessments of Significance have been completed in Appendix 7 for the following EPBC Act listed threatened or migratory species: Australian Painted Snipe, Black-faced Monarch, White-throated Needletail, Red Goshawk, Long-nosed Potoroo, New Holland Mouse and Grey-headed Flying-fox. The Assessments of Significance have concluded that a significant impact to these species is unlikely.

5.2.2 Indirect impacts

Indirect impacts associated with the Project will largely occur during the construction of the Project, resulting in a short term impact (i.e. the construction and rehabilitation phases of the Project) and will be minimised where possible through management procedures. A range of indirect impacts are likely to, or could, occur as a result of the Project including:

- Increased noise and dust;
- Changes to ground-water levels and flow patterns; and
- Increased spreading of weed propagules.

The indirect impacts described above are variable in terms of the distance they may extend from the Study Area, and in many cases, due to mitigation measures, indirect impacts will be completely contained within the Study Area.

Indirect impacts on the biodiversity values of areas surrounding the Study Area, along with recommended mitigation measures to minimise identified impacts, are discussed in Table 9. Boral would be responsible for carrying out the mitigation measures.

Table 9. Indirect impacts and mitigation measures

Indirect impact	Likely impact from the Project	Potential extent of the indirect impact prior to mitigation measure	Mitigation measure	Expected success of mitigation measure
Edge effects	The establishment of the new extraction area would result in the creation of new edges adjacent to areas of existing native vegetation immediately adjacent to the extraction area. The new edges could facilitate the establishment and spread of introduced plant species, however appropriate monitoring and control measures would be implemented during and after construction, to counter act the potential for weed occurrences. The extraction area would be progressively rehabilitated creating a pond structure, with stable vegetated banks.	Varying distance from subject site. Potentially occurring within 50 metres from the disturbance area throughout the active life of the Project.	Fencing and/or the use of highly visible rope or tape boundaries will be used to delineate the boundary of vegetation clearing at the edge of the extraction area. Signposting and education will be also be used to inform Project personnel of no-go areas. Weed management and monitoring to be included in the updated Landscape & Rehabilitation Management Plan.	Active weed, and pest management are anticipated to be successful at managing edge effects from the Project.
Weeds	Weeds have the opportunity to establish themselves in areas of disturbed vegetation. The greatest establishment of weeds are in areas already disturbed. The Project has the potential to increase or lead to the establishment of weed species where they do not currently exist through the operation of machinery during construction. New weed species can potentially be introduced as a result of the movement of construction vehicles and materials into the Study Area. Areas more likely to be exposed to weed increases are areas of native vegetation that occur to the south of the Study Area. However, weeds will be controlled during and after construction in accordance with the Landscape and Rehabilitation Management Plan and thus indirect impacts from weeds is likely to be minor within the adjacent woodland areas.	Variable depending on topography. However, typically would occur within close proximity to disturbance area.	Weed management and monitoring to be implemented in accordance with the updated Landscape and Rehabilitation Management Plan.	Active weed control methods are likely to be successful in managing the spread of weeds within adjacent areas.
Erosion and sedimentation	Erosion of sand and associated sedimentation associated with the Projectmay involve the following: • Alteration of sand structure beneath haul roads; and • The deposition of soil particulates in drainage lines and remnant vegetation surrounding the Study Area.	Variable depending on topography and operation.	Sediment management measures will be implemented in accordance with the recommendations in the Stockton Transgressive Dune Quarry Erosion and Sedimentation Control Plan (ERM 2010).	Sedimentation control are known to reduce sedimentation spills.

Indirect impact	Likely impact from the Project	Potential extent of the indirect impact prior to mitigation measure	Mitigation measure	Expected success of mitigation measure
Dust	Dust will be generated from the construction and operation of the Project, however will be mitigated with dust suppression from a water truck, which is the practice with the current operations.	Variable depending on wind conditions. Potential for dust emissions likely throughout life of Project.	Dust impacts will be mitigated through the onsite use of water suppression. Further, vegetation clearing protocols for the Project will seek to minimise exposed areas with the potential to generate dust by completing vegetation clearing as close to mining operations as practical.	Successful implementation of dust control would minimise dust. Current dust suppression mitigation works are on-going at the Stockton Sand Quarry.
Fire	Historically, arid zone bushfires tend to be associated with a proficient growth of native grasses following large rain events. During summer, following rain events, dry swards of grasses pose a bushfire hazard when placed near a source of ignition. Vehicles driven through long grass with hot exhausts may cause a fire particularly during the hotter months of the year.	Potential to be widespread in locality, though unlikely.	A bushfire hazard assessment has been completed by BPAD (2019) as part of the Project. Boral also currently have a Bushfire Management Plan included in the Boral (2010) Stockton Transgressive Dune Quarry Environmental Management Strategy. Fire prevention and suppression are detailed within the Plan including emergency protocols should a fire occur. This Plan would be updated to reflect the recommendations of BPAD (2019) where required to reflect the Project.	Given the existing quarry operations have not resulted in any significant fires, the continued implementation of the Stockton Transgressive Dune Quarry Environmental Management Strategy would likely assist in fire prevention.
Groundwater changes resulting in impacts to vegetation	Groundwater impacts as a result of the dredging are detailed in EES (2019). The report concludes that the groundwater movement accounts for less than 0.5% of catchment drainage even in the driest recorded years, excavation of the aquifer sediments should have no discernible effect on catchment hydrology other than increasing the area available for water storage and direct recharge to the Stockton Sandbeds Aquifer in the Study Area. The report concludes that the Project is unlikely to have an impact on vegetation surrounding the Study Area.	EES (2019) concludes that the Project it is unlikely to result in any impact to surrounding vegetation.	Groundwater monitoring and mitigation requirements will be included in an update to the existing Groundwater Monitoring and Management Plan (GMMP) (Jacobs, 2017). The GMMP describes the objectives of the groundwater management and monitoring and detail the proposed types and locations of monitoring. It also describes the monitoring observations which would trigger actions, and the	Implementation of the Groundwater Monitoring and Management Plan wold assist in minimising impacts to vegetation from groundwater changes.

Indirect impact	Likely impact from the Project	Potential extent of the indirect impact prior to mitigation measure	Mitigation measure	Expected success of mitigation measure
			proposed action and/or mitigation should triggers be exceeded. In summary, water levels and pH will need to be monitored in the field weekly during excavation and rehabilitation, and quarterly thereafter. Further laboratory analysis of collected samples will be required monthly throughout the Project duration and quarterly following completion of rehabilitation.	

5.2.3 Cumulative impacts

Cumulative impacts are the successive, incremental and combined impacts (both positive and negative) of an activity on the environment (Franks et al., 2010). They can arise from the compounding activities of a single operation given the interaction of that operation with past, current and future activities that may or may not be related to the existing development. Cumulative impacts may also arise through the interaction of one development with other types of activities and industries, such as grazing and broad scale agriculture.

In relation to the Project, the cumulative impacts are considered to be the total impact on the environment that would result from the current proposal plus any additional impacts likely to occur due to subsequent Projects that are of a similar nature or that are partly or wholly contingent on the Project.

Identifiable cumulative impacts to be considered in the locality include the following quarry operations:

- Salt Ash Sand Project (Nelson Bay Road), which has approval to operate until 2030.
- Cabbage Tree Road Sand Quarry, which has approval to operation until 2033
- Mackas Sand Project,Nelson Bay Road.

Each of the above quarry operations have a range of approved biodiversity impacts, and it is likely that over the next few decades, modification to existing operations may entail clearing of native vegetation and habitat. Niche is not able to quantify this is part of this BDAR, however it is likely that such impact would be within the existing operations leases.

Residential, commercial and industrial development is also identified as a continuous cumulative biodiversity pressure associated with the wider Port Stephens and Newcastle LGAs.

Whilst the Project will result in removal of native vegetation which predominately is rehabilitation within the North Coast IBRA region, the Project will also involve an offset that will contribute to in-perpetuity managed conservation areas within the Bioregion.

5.2.4 Serious and irreversible impacts

No threatened species which have potential to experience Serious and Irreversible Impacts (SAII) as a result of the Project were recorded in the Study Area.

5.3 Quantifying offset requirements

The BAM identifies the BAM Calculator as the appropriate tool for quantifying the offsets required in both Ecosystem Credit and Species Credit terms. A calculation of the nature and extent of offset credits required due to biodiversity impacts associated with the Project has been undertaken using the BAM Calculator.

5.3.1 Summary of ecosystem credits required

The ecosystem credits to be retired for the Project as determined by the Biodiversity Credit Calculator are shown in Table 10.

Table 10 : Ecosystem credit requirements

Zone	PCT	Vegetation zone name	Vegetation integrity loss	Area (ha)	Biodiversity risk weighting	Potential SAII	Ecosystem credits	Total
1	Smooth-barked Apple - Blackbutt - Old Man Banksia woodland on coastal sands of the Central and Lower North Coast	Rehab_Area1	42.2	19.8	1.5	-	313	396
2		Rehab_Area2	22.2	3.9	1.5	-	32	
3		Rehab_Area4	7.9	5.3	1.5	-	0	
4		Remnant	46.4	2.9	1.5	-	51	
5	Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower North Coast	Rehab_Area3	19	3.9	2	-	37	37

5.3.2 Summary of species credits required

The species credits to be retired for the Project have been provided in Table 11 which indicates that 521 Squirrel Glider species credits are required for the impact to 26.59 ha of foraging habitat.

Table 11: Species credit species requirements – Squirrel Glider

Vegetation zone name	Habitat condition (vegetation integrity) loss	Area (ha)	Biodiversity risk weighting	Species credits
1644_Rehab_Area3	19	3.91	2	37
1646_Rehab_Area1	42.2	19.77	2	417
1646_Remnant	46.4	2.91	2	67
		26.59	Total	521

6. Offset strategy

Under the BAM, an offset strategy is not required to be submitted with the BDAR, as the credits are to be formally retired with the establishment of a Biodiversity Stewardship Site, purchasing of credits from the market or payment into the Biodiversity Conservation Fund (BCF). However, as noted in the SEARs for the Project, a biodiversity offset strategy is required to be included in the Biodiversity Assessment.

6.1 NSW Offset Requirements

Under the BAM, the biodiversity offsets must provide benefits to biodiversity to compensate for the adverse impacts of an action. Biodiversity offsets assist in achieving long-term conservation outcomes while providing development proponents with the ability to undertake actions that have unavoidable impacts on biodiversity.

Unavoidable impacts to biodiversity are those impacts that are residual (i.e. impacts that remain after impact avoidance, management and mitigation measures are employed to reduce the type or magnitude of biodiversity impacts). Section 5.1 of this report outlines the planning and consideration of alternative emplacement options that Boral has considered. Section 5.1.4 to Section 5.1.7 of this report outline the management and mitigation actions that Boral will employ to further reduce direct and indirect impacts to biodiversity values as a result of this Project.

This section of the report describes the approach to biodiversity offsetting proposed for the Project in order to satisfy the BAM Offsetting requirements.

Based on the results of the MNES Assessments of Significance contained in this report, the Project would not result in a significant impact to any threatened biodiversity listed on the EPBC Act, and thus would not require a Commonwealth offset.

6.2 Offset strategy options

Boral has identified a range of options to meet the required offsets for the Project, these are provided in Table 12. As demonstrated in the table, given Boral has the option to pay into the BCT Payment Fund to satisfy the offset requirement, there is minimal risk for Boral not to meet the offsetting liability.

Table 12. Options to satisfy the offset requirement

Offset requirement	Credits required	Purchase credits on market	Payment into BCF	Utilise existing Boral Landholdings	Risk of offset not met
PCT1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland on coastal sands of the Central and Lower North Coast	396	If credits become available, Boral may pursue this option.	Yes – Boral can pay the equivalent credit cost into the BCF	The surrounding Boral landholdings may be considered as a biodiversity stewardship site. The surrounding vegetation consists of the same PCTs and would contain Squirrel Glider habitat. However, Boral will only explore this option dependant on the BCT Payment Fund feasibility.	No risk given the option to pay into the BCT Payment Fund.
1644 - Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower North Coast	37				
Squirrel Glider	521				

7. Conclusion

This report provides a BDAR in accordance with the BAM in order to address the potential impacts associated with the Project. This report also provides assessments for threatened biodiversity listed under the EPBC Act.

The Project will result in the disturbance of 35.66 ha of native vegetation. Indirect impacts may include dust, erosion and sedimentation which will be mitigated by measures provided in section 5.1 of this report.

During the field survey it was confirmehad that the Study Area mainly comprised of native regeneration. The 'best fit' PCT associated with the vegetation included the following PCTs:

- PCT1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland on coastal sands of the Central and Lower North Coast; and
- 1644 - Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower North Coast.

Both the PCTs do not align to any TECs under the BC Act or EPBC Act.

No threatened flora are likely to be impacted by the Project given the lack of habitat and absence of threatened flora during the field survey.

Sixteen threatened and migratory fauna species are considered to have a moderate or higher likelihood of occurrence within the Study Area, however most of these species were determined to only utilise the Study Area for foraging on an intermittent basis. Of these species, only one species credit fauna, the Squirrel Glider was assumed to be present within the Study Area, and impacted by the development. No further assessment of impacts are required for the ecosystem credit fauna species based on the requirements of the BAM and the offsetting of the associated PCTs.

Those threatened fauna species which are listed under the EPBC Act that were attributed a moderate likelihood to forage within the Study Area include: Australian Painted Snipe, Black-faced Monarch, White-throated Needletail, Red Goshawk, Long-nosed Potoroo, Koala, New Holland Mouse and Grey-headed Flying-fox. An EPBC Act Assessment of Significance for each of these species has been completed and concluded that a significant impact to any EPBC Act listed threatened fauna is unlikely.

Mitigation measures associated with indirect impacts have been proposed through the revision and implementation of existing management plans.

In accordance with the BAM, the following credits will be required to be offset:

Ecosystem credits:

- Total of 396 credits for PCT 1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland on coastal sands of the Central and Lower North Coast; and
- Total of 37 credits for PCT 1644 - Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower North Coast.

Species credits:

- A total of 521 credits for the removal of 26.59 ha of foraging habitat for the Squirrel Glider.

In order to satisfy the biodiversity offset requirement for the Project, Boral proposes a number of options available to offset the credits for native vegetation and Squirrel Glider. The options available to Boral include the following:

1. Purchase credits on market;
2. Payment into BCT Fund; and/or
3. Utilise existing Boral Landholdings and consider establishing Stewardship sites. However, at present, this is the last resort given the BCT Payment Fund option.

Given the options available, there is minimal risk in Boral not being able to satisfy their offset liability. No offset is required under Commonwealth legislation, given the Project is unlikely to impact any threatened biodiversity under the EPBC Act.

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Figures

Figure 1a
Regional context (Element 2019)

STOCKTON SAND QUARRY DREDGING
ENVIRONMENTAL IMPACT STATEMENT



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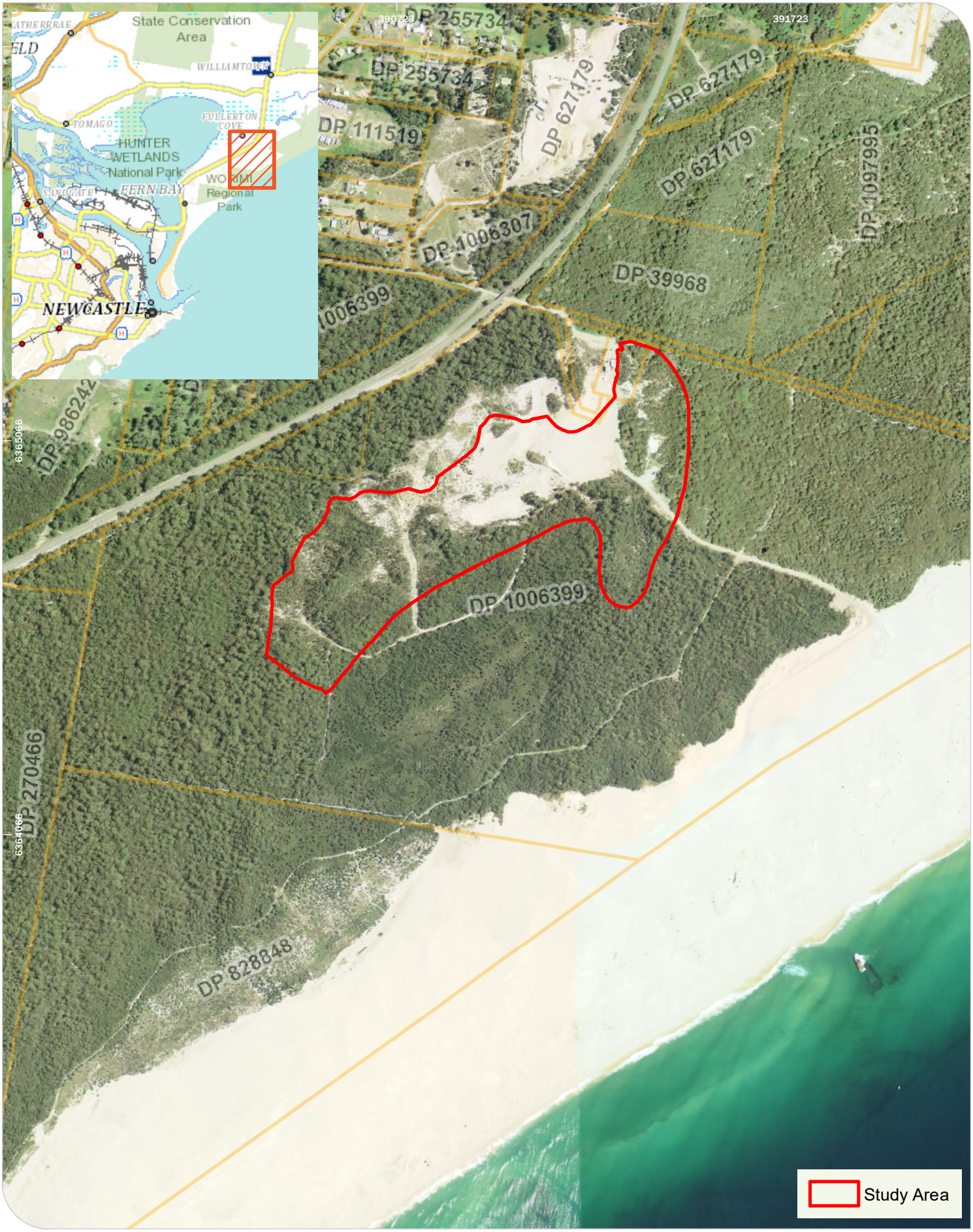

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Regional
Stockton Sand Quarry Dredging Project

Figure 1b

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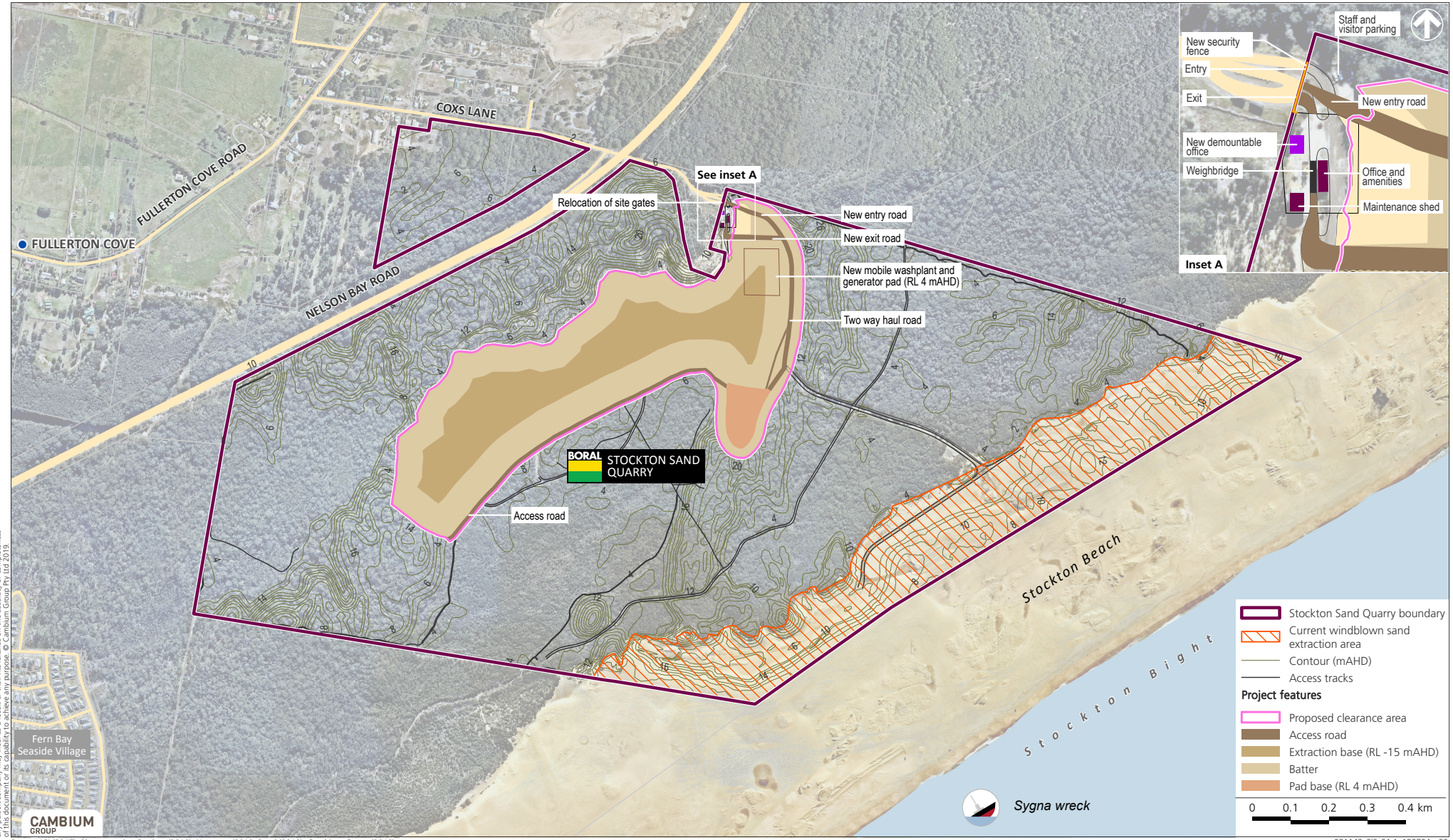
Figure 2a
The Project (Element 2019)

STOCKTON SAND QUARRY DREDGING
ENVIRONMENTAL IMPACT STATEMENT



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Study Area
Stockton Sand Quarry Dredging Project

Figure 3

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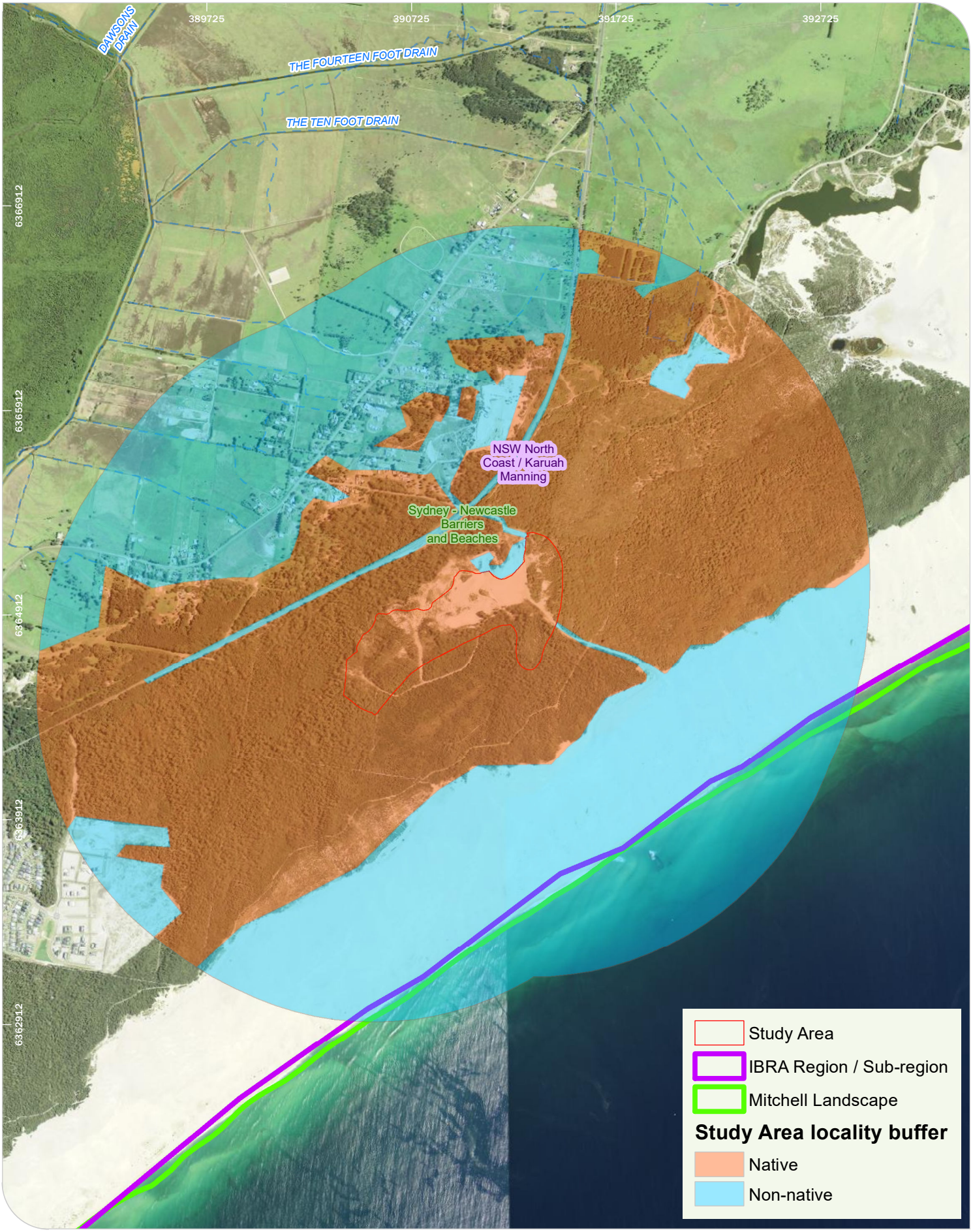

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Landscape Assessment
Stockton Sand Quarry Dredging Project

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Client: Boral Resources (NSW) Pty

Figure 3

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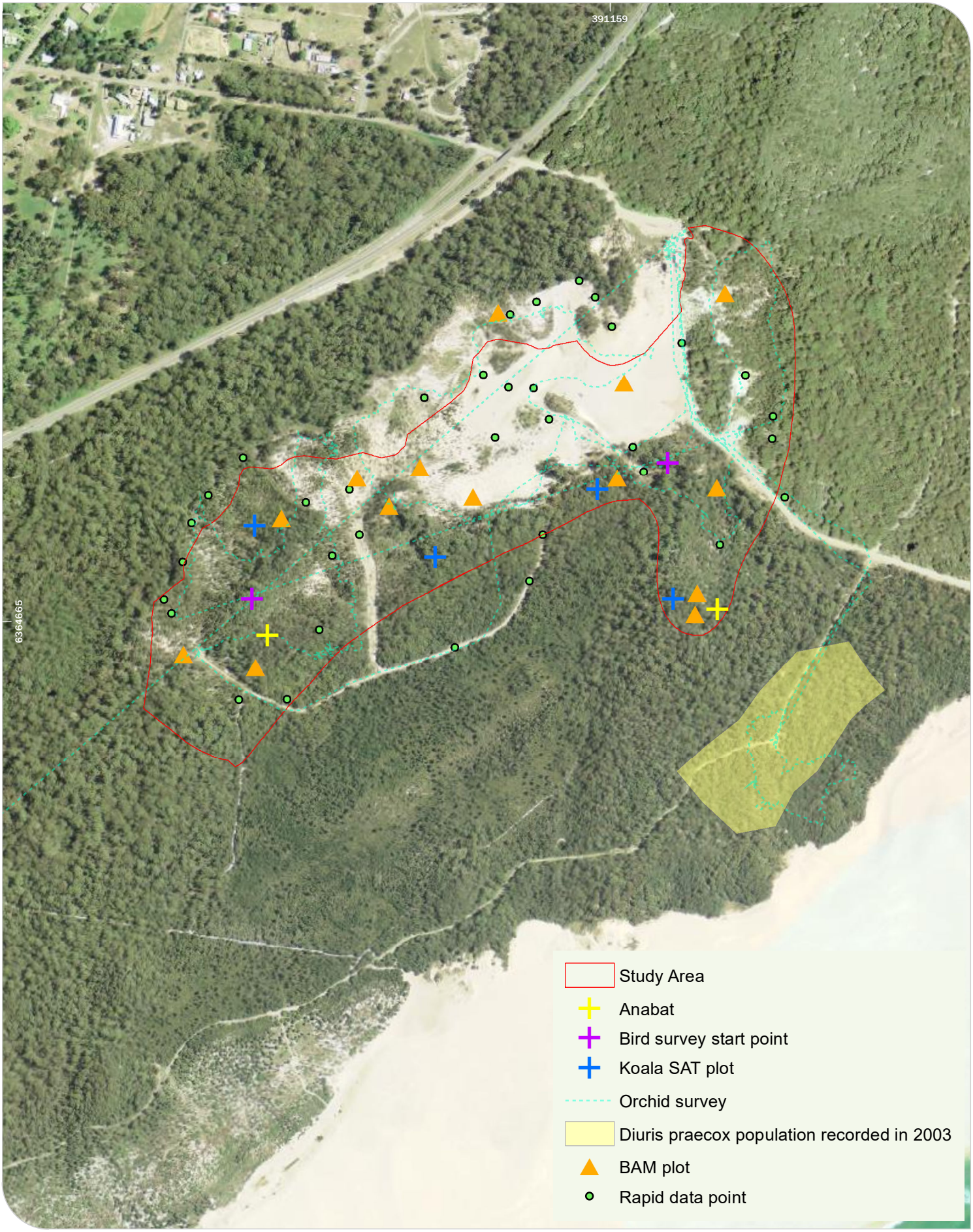

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Survey effort
Stockton Sand Quarry Dredging Project

Figure 4

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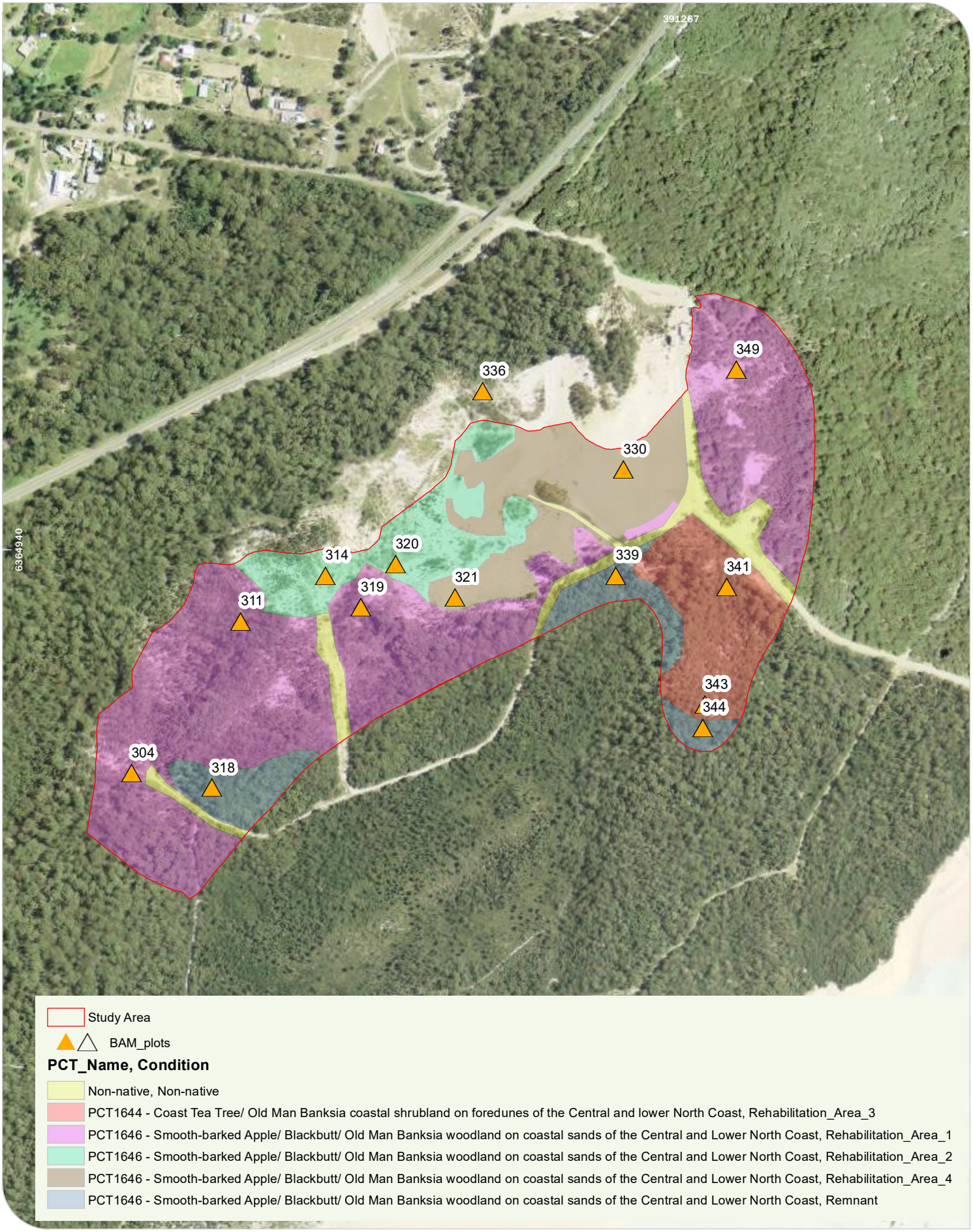

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Validated vegetation mapping

Stockton Sand Quarry Dredging Project

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Figure 5

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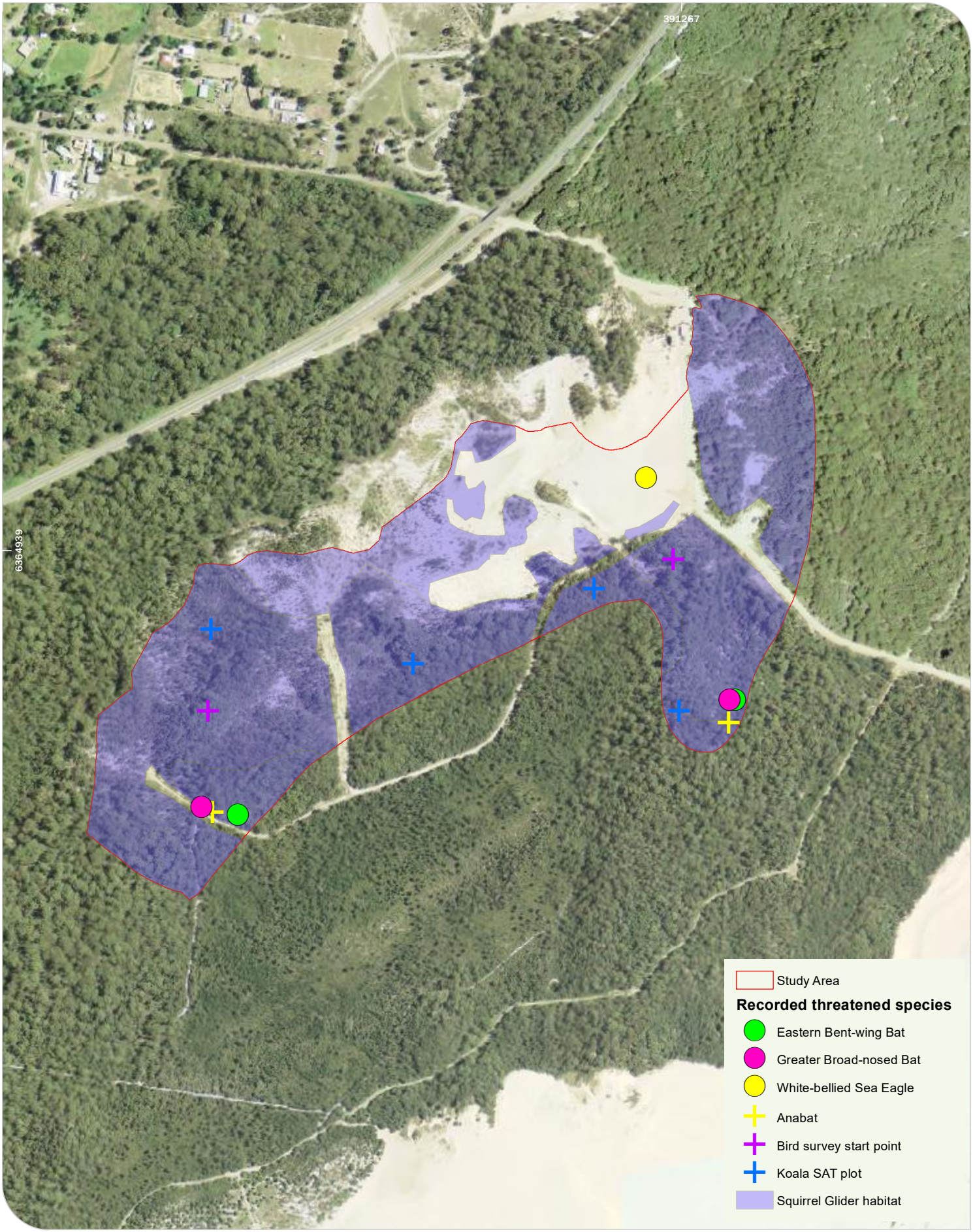

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Recorded Threatened Species
Stockton Sand Quarry Dredging Project

Figure 6

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Appendix 1. Likelihood of occurrence

Threatened biodiversity likelihood of occurrence

A list of subject threatened flora and fauna and threatened ecological communities within the locality (10 km radius) was determined from database searches detailed in section 3.1 and section 4.1. The list of potentially impacted species is determined from consideration of this list. In order to adequately determine the relevant level of assessment to apply to potentially affected species, further analysis of the likelihood of those species occurring within the Study Area was completed.

Five categories for 'likelihood of occurrence' (Table 13) were attributed to species after consideration of criteria such as known records, presence or absence of important habitat features on the subject site, results of the field surveys and professional judgement. This process was completed on an individual species basis.

Species considered further in formal assessments of significance (BC Act, EPBC Act) were those in the 'Known', 'High' or 'Moderate' categories and where adverse impacts for the species could reasonably occur from the development. Species listed as a 'Low' or 'None' likelihood of occurrence are those for which there is limited or no habitat present within the Study Area.

Table 13: Likelihood of occurrence criteria

Likelihood rating	Threatened flora criteria	Threatened and migratory fauna criteria
Known	The species was observed within the Study Area.	The species was observed within the Study Area.
High	It is likely that a species inhabits or utilises habitat within the Study Area.	It is likely that a species inhabits or utilises habitat within the Study Area.
Moderate	Potential habitat for a species occurs on the site. Adequate field survey would determine if there is a 'high' or 'low' likelihood of occurrence for the species within the Study Area.	Potential habitat for a species occurs on the site and the species may occasionally utilise that habitat. Species unlikely to be wholly dependent on the habitat present within the Study Area.
Low	It is unlikely that the species inhabits the Study Area.	It is unlikely that the species inhabits the Study Area. If present at the site the species would likely be a transient visitor. The site contains only very common habitat for this species which the species would not rely on for its on-going local existence.
None	The habitat within the Study Area is unsuitable for the species.	The habitat within the Study Area is unsuitable for the species.

Table 14. Likelihood of occurrence threatened biodiversity

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
Amphibians						
Crinia tinnula	Wallum Froglet	V	-	Wallum Froglets are found in paperbark swamps and sedge swamps of the coastal 'wallum' country. Their tadpoles are adapted to acid conditions and may be outcompeted by the Common Froglet. Males call from the base of vegetation in and around the breeding site and are almost impossible to locate. Calling occurs from Autumn to Spring, being most strongly associated with flooding following rainfall. Its range extends from SE QLD to the Kurnell Peninsular of Sydney.	Low – no Paperbark swamps and sedge swamps.	Species
Heleioporus australiacus	Giant Burrowing Frog	V	V	The Giant Burrowing Frog has been recorded breeding in a range of water bodies associated with sandy environments of the coast and adjacent ranges from the Sydney Basin south the eastern Victoria. It breeds in hanging swamps, perennial non-flooding creeks and occasionally permanent pools, but permanent water must be present to allow its large tadpoles time to reach metamorphosis.	None – no potential habitat given absence of waterbodies	Species
Litoria aurea	Green and Golden Bell Frog	E	V	Inhabits a very wide range of water bodies including marshes, dams and streams, particularly those containing emergent vegetation such as bullrushes or spikerushes. It also inhabits numerous types of man-made water bodies including quarries and sand extraction sites. Optimum habitat includes water-bodies that are un-shaded, free of predatory fish such as Plague Minnow, have a grassy area nearby and diurnal sheltering sites available.	None – no potential habitat given absence of waterbodies	Species
Mixophyes balbus	Stuttering Frog	E	V	Associated with streams in dry sclerophyll and wet sclerophyll forests and rainforests of more upland areas of the Great Dividing Range of NSW and down into Victoria. Breeding occurs along forest streams with permanent water where eggs are deposited within nests excavated in riffle zones by the females and the tadpoles swim free into the stream when large enough to do so. Outside of breeding, individuals range widely across the forest floor and can be found hundreds of metres from water.	None – no potential habitat given absence of waterbodies	Species
Birds						
Actitis hypoleucos	Common Sandpiper	-	M, MA	Utilises a wide range of coastal wetlands and some inland wetlands, mostly found around muddy margins or rocky shores. Forages in shallow water and on soft mud, roosts on rocks or vegetation such as mangroves. Northern hemisphere breeding.	Low – no wetlands or mangroves within Study Area.	N/A
Anthochaera phrygia	Regent Honeyeater	CE	CE	The Regent Honeyeater mainly inhabits temperate woodlands and open forests of the inland slopes of south-east Australia. Birds are also found in drier coastal woodlands and forests in some years. There are only three known key breeding regions remaining: north-east Victoria (Chiltern-Albury), and in NSW at Capertee	Low – lack of woodland habitat. Study area predominately comprises of rehabilitation.	Species

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
				Valley and the Bundarra-Barraba region. In NSW the distribution is very patchy and mainly confined to the two main breeding areas and surrounding fragmented woodlands. In some years flocks converge on flowering coastal woodlands and forests.		
Apus pacificus	Fork-tailed Swift	-	M	The Fork-tailed Swift is almost exclusively aerial, flying from less than one metre to at least 300 m above ground and probably much higher.	Low – no nests found in Study Area. May fly over Study Area on occasion.	N/A
Arenaria interpres	Ruddy Turnstone	-	M	Mainly found in coastal regions with exposed rock coast lines or coral reefs. Also found on rock platforms with shallow tidal pools, and occasionally beaches and estuaries. Northern hemisphere breeding.	None – no rock platforms and tidal pools.	N/A
Artamus cyanopterus cyanopterus	Dusky Woodswallow	V	-	Often reported in woodlands and dry open sclerophyll forests, usually dominated by eucalypts, including mallee associations. It has also been recorded in shrublands and heathlands and various modified habitats, including regenerating forests; very occasionally in moist forests or rainforests.	Moderate – can occur in range of habitats.	N/A
Botaurus poiciloptilus	Australasian Bittern	E	E	The Australasian Bittern is widespread but uncommon over south-eastern Australia. In NSW they may be found over most of the state except for the far north-west. Favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes and spikerushes.	Low – lack of habitat in Study Area.	Species
Burhinus grallarius	Bush Stone-curlew	E	-	The Bush Stone-curlew is found throughout Australia except for the central southern coast and inland, the far south-east corner, and Tasmania. Only in northern Australia is it still common however and in the south-east it is either rare or extinct throughout its former range. Inhabits open forests and woodlands with a sparse grassy ground layer and fallen timber. Largely nocturnal, being especially active on moonlit nights.	Low – not detected during survey.	Ecosystem
Calidris acuminata	Sharp-tailed Sandpiper	-	M	Prefers muddy edges of shallow or brackish wetlands, with inundated or emergent sedges, saltmarsh or other low vegetation. Also found foraging in sewage ponds and flooded paddocks. Northern hemisphere breeding.	Low – lack of habitat within Study Area.	N/A
Calidris canutus	Red Knot	-	M, E	Usually found foraging in soft substrate near the edge of the water on intertidal mudflats. Also have been recorded at nearby lakes, sewage ponds and floodwaters. Roosts on sandy beaches, spits and islands. Northern hemisphere breeding.	Low – habitat preferences not in Study Area.	N/A
Calidris ferruginea	Curlew Sandpiper	E	CE, M	It occurs along the entire coast of NSW, particularly in the Hunter Estuary, and sometimes in freshwater wetlands in the Murray-Darling Basin. It generally occupies littoral and estuarine habitats, and in New South Wales is mainly found in intertidal mudflats of sheltered coasts. It also occurs in non-tidal swamps, lakes and lagoons on the coast and sometimes the inland. Northern hemisphere breeding.	Low – habitat preferences not in Study Area.	N/A

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
Calidris melanotos	Pectoral Sandpiper	-	M	Prefers shallow fresh to saline wetlands, found at coastal lagoons, estuaries, bays, swamps, inundated grasslands, saltmarshes and artificial wetlands. Northern hemisphere breeding.	Low – habitat preferences not in Study Area.	N/A
Calidris ruficollis	Red-necked Stint	-	M	Mostly found in coastal areas including inlets, bays, lagoons and estuaries with intertidal mudflats. Occasionally on exposed ocean beaches and sometimes rocky shores and reefs. Northern hemisphere breeding.	Low – habitat preferences not in Study Area.	N/A
Calidris tenuirostris	Great Knot	V	M, CE	In NSW, this species has been recorded at scattered sites along the coast to about Narooma. It has also been observed inland at Tullakool, Armidale, Gilgandra and Griffith. Occurs within sheltered, coastal habitats containing large, intertidal mudflats or sand flats, including inlets, bays, harbours, estuaries and lagoons. Often recorded on sandy beaches with mudflats nearby, sandy spits and islets and sometimes on exposed reefs or rock platforms. Northern hemisphere breeding.	Low – habitat preferences not in Study Area.	N/A
Charadrius bicinctus	Double-banded Plover	-	M	Found on littoral, estuarine and fresh or saline terrestrial wetlands, rocky beaches, bays and inlets. Sometimes found on exposed reefs and rock platforms. Migrates to breed in New Zealand.	Low – habitat preferences not in Study Area.	N/A
Charadrius leschenaultii	Greater Sand Plover	V	M, V	Occur on sheltered sandy, shelly or muddy beaches with large intertidal mudflats or sandbanks, as well as sandy estuarine lagoons. Non-breeding in Australia.	Low – habitat preferences not in Study Area.	N/A
Charadrius mongolus	Lesser Sand Plover	V	M, E	Inhabits large intertidal sand flats or mudflats in sheltered bays, harbours and estuaries, and occasionally sandy ocean beaches, coral reefs, wave-cut rock platforms and rocky outcrops. Non-breeding in Australia.	Low – habitat preferences not in Study Area.	N/A
Cuculus optatus, Cuculus saturatus	Oriental Cuckoo	-	M, MA	Mainly inhabits coniferous, deciduous and mixed forests. Breeds in northern hemisphere. Brood parasite, laying eggs in nests of other birds.	Low – habitat preferences not in Study Area.	N/A
Dasyornis brachypterus	Eastern Bristlebird	E	E	Found in coastal woodlands, dense scrub and heathlands, particularly where it borders taller woodlands.	Low – not within known range of species. No records occur within locality.	Species
Diomedea antipodensis	Antipodean Albatross	V	V, M, MA	The species ranges across the southern Pacific Ocean, east to the coast of Chile and west to eastern Australia. The Antipodean Albatross breeds biennially in colonies on ridges, slopes and plateaus of isolated subantarctic islands, usually in vegetation such as grass tussocks. This species regularly occurs in small numbers off the NSW south coast from Green Cape to Newcastle during winter where they feed on cuttlefish.	None	N/A
Diomedea exulans	Wandering Albatross	E	V, M, MA	The Wandering Albatross is marine, pelagic and aerial. The Wandering Albatross visits Australian waters from Fremantle, Western Australia to northern New South Wales between June and September each year.	None	N/A

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
Diomedea gibsoni, Diomedea antipodensis gibsoni	Gibson's Albatross	V	V, M, MA	The species is regularly encountered on trans-Tasman shipping routes and at seas off Sydney, and regularly occurs off the NSW coast usually between Green Cape and Newcastle. This species is known only to breed on the Adams, Disappointment and Auckland Islands in the subantarctic Auckland Island group. Potential forage in NSW waters during the winter is considered significant for the species.	None	N/A
Ephippiorhynchus asiaticus	Black-necked Stork	E	-	Mainly found on shallow, permanent, freshwater terrestrial wetlands, and surrounding marginal vegetation, including swamps, floodplains, watercourses and billabongs, freshwater meadows, wet heathland, farm dams and shallow floodwaters, as well as extending into adjacent grasslands, paddocks and open savannah woodlands. They also forage within or around estuaries and along intertidal shorelines, such as saltmarshes, mudflats and sand flats, and mangrove vegetation.	Low – habitat preferences not in Study Area.	Species
Epthianura albifrons	White-fronted Chat	V	-	Low vegetation in salty coastal and inland areas and crops. Runs along ground and is found in local flocks in Winter.	Moderate	Ecosystem
Erythrotriorchis radiatus	Red Goshawk	CE	V	Distributed sparsely through northern and eastern Australia, from the western Kimberley Division of northern Western Australia to north-eastern Queensland and south to far north-eastern NSW, and with scattered records in central Australia. In NSW, preferred habitats include mixed subtropical rainforest, Melaleuca swamp forest and riparian Eucalyptus forest of coastal rivers. Very rare in NSW.	Moderate	Species
Gallinago hardwickii	Latham's Snipe	-	M	Latham's Snipe is a non-breeding migrant to the south east of Australia including Tasmania, passing through the north and New Guinea on passage. Latham's Snipe breed in Japan and on the east Asian mainland. Seen in small groups or singly in freshwater wetlands on or near the coast, generally among dense cover. They are found in any vegetation around wetlands, in sedges, grasses, lignum, reeds and rushes and also in saltmarsh and creek edges on migration.	Low – habitat preferences not in Study Area.	N/A
Gallinago megala	Swinhoe's Snipe	-	M	Occurs at edges of wetlands, swamps and freshwater streams. Also known to occur in grasslands, sewage ponds and drying claypans. Northern hemisphere breeding.	Low – habitat preferences not in Study Area.	N/A
Gallinago stenura	Pin-tailed Snipe	-	M	Occurs at edges of shallow freshwater swamps, ponds and lakes with emergent, sparse to dense cover of grass/sedge or other vegetation. Also found on more open wetlands, claypans and sewage ponds. Breeds in the northern hemisphere.	Low – habitat preferences not in Study Area.	N/A
Glossopsitta pusilla	Little Lorikeet	V	-	Distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range in NSW, extending westwards to the vicinity of Albury, Parkes, Dubbo and Narrabri. Mostly occur in dry, open eucalypt forests and woodlands. They feed primarily on nectar and pollen in the tree canopy. Nest hollows are located at heights of between 2 m and 15 m, mostly in living, smooth-barked eucalypts. Most breeding records come from the western slopes.	Low – very marginal habitat for nesting given absence of hollow. May occasionally forage in Study Area.	Ecosystem

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
Grantiella picta	Painted Honeyeater	V	V	The Painted Honeyeater is nomadic and occurs at low densities throughout its range. The greatest concentrations of the bird and almost all breeding occurs on the inland slopes of the Great Dividing Range in NSW, Victoria and southern Queensland. During the winter it is more likely to be found in the north of its distribution. Inhabits boree, brigalow and box-gum woodlands and box-ironbark forests.	None – out of range for species.	Ecosystem
Haematopus fuliginosus	Sooty Oystercatcher	V	-	In NSW the Sooty Oystercatcher occupies rocky headlands, reefs and offshore islands along the entire coast, apparently as a single continuous population.	Low – habitat preferences not in Study Area.	Species
Haematopus longirostris	Pied Oystercatcher	E	-	The Pied Oystercatcher inhabits marine littoral habitats, including islands. It occupies muddy, sandy, stony or rocky estuaries, inlets and beaches, particularly intertidal mudflats and sandbanks in large marine bays.	Low – habitat preferences not in Study Area.	Species
Haliaeetus leucogaster	White-bellied Sea Eagle	V	MA	Inhabits coastal and near coastal areas, building large stick nests, and feeding mostly on marine and estuarine fish and aquatic fauna.	Known -. Recorded during field survey flying over the Study Area. No nest in Study Area.	Ecosystem/species
Hieraaetus morphnoides	Little Eagle	V	-	Most abundant in lightly timbered areas with open areas nearby. Often recorded foraging in grasslands, crops, treeless dune fields, and recently logged areas. May nest in farmland, woodland and forest in tall trees.	Low - No nest in Study Area. May fly over site.	Ecosystem/species
Hirundapus caudacutus	White-throated Needletail	-	M, MA	An aerial species found in feeding concentrations over cities, hilltops and timbered ranges.	Moderate – species can occur in a range of habitat types.	N/A
Lathamus discolor	Swift Parrot	E	CE	The Swift Parrot occurs in woodlands and forests of NSW from May to August, where it feeds on eucalypt nectar, pollen and associated insects. The Swift Parrot is dependent on flowering resources across a wide range of habitats in its wintering grounds in NSW. This species is migratory, breeding in Tasmania and also nomadic, moving about in response to changing food availability.	Low – no records in locality. Highly unlikely to have breeding habitat in Study Area.	Ecosystem/species
Limicola falcinellus	Broad-billed Sandpiper	V	M	Favours sheltered parts of the coast such as estuarine sand flats and mudflats, harbours, embayments, lagoons, saltmarshes and reefs as feeding and roosting habitat. Occasionally, individuals may be recorded in sewage farms or within shallow freshwater lagoons. Broad-billed Sandpipers roost on banks on sheltered sand, shell or shingle beaches. Breeds in the northern hemisphere.	Low – habitat preferences not in Study Area.	Species
Limosa lapponica baueri	Bar-tailed Godwit	-	M, V	Bar-tailed Godwit (spp baueri) is the eastern Australian / New Zealand sub species. Mainly found in coastal habitats such as intertidal sand flats, mudflats, estuaries, inlets, coastal lagoons and bays. Often found around beds of seagrass and saltmarsh. Northern hemisphere breeding.	Low – habitat preferences not in Study Area.	N/A
Limosa limosa	Black-tailed Godwit	V	M	Primarily a coastal species. Usually found in sheltered bays, estuaries and lagoons with large intertidal mudflats and/or sand flats. Further inland, it can also be found	Low – habitat preferences not in Study Area.	Ecosystem

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
				on mudflats and in water less than 10 cm deep, around muddy lakes and swamps. Northern hemisphere breeding.		
Macronectes giganteus	Southern Giant Petrel	E	E	The Southern Giant Petrel has a circumpolar pelagic range from Antarctica to approximately 20 S and is a common visitor off the coast of NSW. Over summer, the species nests in small colonies amongst open vegetation on antarctic and subantarctic islands, including Macquarie and Heard Islands and in Australian Antarctic territory.	None	EEC/Marine
Macronectes halli	Northern Giant-petrel	V	V	Breeding in Australian territory is limited to Macquarie Island and occurs during spring and summer.	None	EEC/Marine
Monarcha melanopsis	Black-faced Monarch	-	M	Found along the coast of eastern Australia, becoming less common further south. Inhabits rainforests, eucalypt woodlands, coastal scrub and damp gullies. It may be found in more open woodland when migrating.	Moderate – can occur in a range of habitat types.	N/A
Monarcha trivirgatus	Spectacled Monarch	-	M	Coastal north-eastern and eastern Australia, including coastal islands, from Cape York, Queensland to Port Stephens, New South Wales. Prefers thick understorey in rainforests, wet gullies and waterside vegetation, as well as mangroves.	Low – habitat preferences not in Study Area.	N/A
Motacilla flava	Yellow Wagtail	-	M	Breeds in temperate Europe and Asia. The Yellow Wagtail is a regular wet season visitor to northern Australia. Increasing records in NSW suggest this species is an occasional but regular summer visitor to the Hunter River region. The species is considered a vagrant to Victoria, South Australia and southern Western Australia. Habitat requirements for the Yellow Wagtail are highly variable, but typically include open grassy flats near water. Habitats include open areas with low vegetation such as grasslands, airstrips, pastures, sports fields; damp open areas such as muddy or grassy edges of wetlands, rivers, irrigated farmland, dams, waterholes; sewage farms, sometimes utilise tidal mudflats and edges of mangroves.	Low – habitat preferences not in Study Area.	N/A
Myiagra cyanoleuca	Satin Flycatcher	-	M	The Satin Flycatcher is found along the east coast of Australia from far northern Queensland to Tasmania, including south-eastern South Australia. Found in tall forests, preferring wetter habitats such as heavily forested gullies, but not rainforests.	Low – habitat preferences not in Study Area.	N/A
Neophema pulchella	Turquoise Parrot	V	-	The Turquoise Parrot's range extends from southern Queensland through to northern Victoria, from the coastal plains to the western slopes of the Great Dividing Range. Lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland. Nests in tree hollows, logs or posts, from August to December. It lays four or five white, rounded eggs on a nest of decayed wood dust.	Low – habitat preferences not in Study Area.	Ecosystem
Ninox strenua	Powerful Owl	V	-	Occupies wet and dry eucalypt forests and rainforests. Can occupy both un-logged and lightly logged forests as well as undisturbed forests where it usually roosts on	Low – lack of tree hollows in Study Area	Ecosystem/species

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
				the limbs of dense trees in gully areas. It is most commonly recorded within turpentine tall open forests and black she-oak within open forests. Large mature trees with hollows at least 0.5 m deep are required for nesting. Tree hollows are particularly important for the Powerful Owl because a large proportion of the diet is made up of hollow-dependent arboreal marsupials. Nest trees for this species are usually emergent with a diameter at breast height of at least 100 cm.		
Numenius madagascariensis	Eastern Curlew	-	CE, MA, M	A primarily coastal distribution. Found in all states, particularly the north, east, and south-east regions including Tasmania. Rarely recorded inland. Mainly forages on soft sheltered intertidal sand flats or mudflats, open and without vegetation or cover. Breeds in the northern hemisphere.	Low – habitat preferences not in Study Area Not detected during field survey.	Ecosystem
Numenius minutus	Little Curlew	-	M	Feeds in short, dry grassland and sedgeland, including dry floodplains and black soil plains, which have scattered, shallow freshwater pools. Northern hemisphere breeding.	Low – habitat preferences not in Study Area.	N/A
Numenius phaeopus	Whimbrel	-	M	Usually found on intertidal mudflats of sheltered coasts. Also found in harbours, lagoons, estuaries and river deltas, often those with mangroves. Northern hemisphere breeding.	Low – habitat preferences not in Study Area.	N/A
Pandion cristatus, Pandion haliaetus	Eastern Osprey	V	M, MA	Ospreys are found right around the Australian coast line, except for Victoria and Tasmania. They are common around the northern coast, especially on rocky shorelines, islands and reefs. The species is uncommon to rare or absent from closely settled parts of south-eastern Australia. Favour coastal areas, especially the mouths of large rivers, lagoons and lakes. Feed on fish over clear, open water.	No nests in Study Area. May occasionally fly over the Study Area.	Species
Philomachus pugnax	Ruff	-	M	Generally found in fresh, brackish to saline wetlands with exposed mudflats at the edges. Breeds in northern hemisphere.	Low – habitat preferences not in Study Area.	N/A
Phoebetria fusca	Sooty Albatross	V	-	In Australian waters, this species is generally recorded in winter off the south coast from Tasmania to Western Australia, while there are occasional sightings off the NSW coast, north of Grafton. This pelagic or ocean-going species inhabits subantarctic and subtropical marine waters, spending the majority of its time at sea, and rarely occurs in continental shelf waters.	None	EEC/Marine
Pluvialis fulva	Pacific Golden Plover	-	M	Coastal habitats such as beaches, mudflats, sand flats, estuaries, lagoons and evaporation ponds in salt works. Northern hemisphere breeding.	Low – habitat preferences not in Study Area.	N/A
Pluvialis squatarola	Grey Plover	-	M	Almost entirely in coastal areas including sheltered embayment's, estuaries and lagoons with mudflats and sand flats, and occasionally on rocky coasts with platforms or reef flats. Breeds in northern hemisphere.	Low – habitat preferences not in Study Area.	N/A
Pterodroma neglecta neglecta	Kermadec Petrel (west Pacific subspecies)	V	V	Typically nests on the surface in loose colonies among rocks and vegetation. On Ball's Pyramid it nests only on steep cliffs above 400 m. On Phillip I. it nests under	None	EEC/Marine

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
				stands of African Olive. This species is marine and highly pelagic, rarely approaching land except at colonies.		
Rhipidura rufifrons	Rufous Fantail	-	M	Found along the east coast of Australia from far northern Queensland to Tasmania, including south-eastern South Australia. Inhabits tall forests, preferring wetter habitats such as heavily forested gullies, but not rainforests.	Low – habitat preferences not in Study Area.	Species
Rostratula australis	Australian Painted Snipe	E	E, MA	In NSW, this species has been recorded at the Paroo wetlands, Lake Cowell, Macquarie Marshes and Hexham Swamp. Most common in the Murray-Darling Basin. Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber. Nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds.	Moderate	Ecosystem
Sternula albifrons	Little Tern	E	M	In Australia, Little Terns inhabit sheltered coastal environments, including lagoons, estuaries, river mouths and deltas, lakes, bays, harbours and inlets, especially those with exposed sandbanks or sand-spits, and also on exposed ocean beaches.	Low – not recorded in Study Area.	Species
Thalassarche cauta (sensu stricto), Thalassarche cauta cauta	Shy Albatross, Tasmanian Shy Albatross	V	V, M, MA	The Shy Albatross is a marine species occurring in subantarctic and subtropical waters, reaching the tropics in the cool Humboldt Current off South America.	None	EEC/Marine
Thalassarche melanophris	Black-browed Albatross	V	V, M, MA	The Black-browed Albatross has a circumpolar range over the southern oceans, and are seen off the southern Australian coast mainly during winter. Inhabits antarctic, subantarctic, subtropical marine and coastal waters over upwellings and boundaries of currents.	None	N/A
Tringa brevipes, Heteroscelus brevipes	Grey-tailed Tattler	-	M, MA	Found on sheltered coasts with reefs and rock platforms, intertidal mudflats, estuaries and coastal lagoons, especially fringed with mangroves. Northern hemisphere breeding.	Low – habitat preferences not in Study Area.	N/A
Tringa nebularia	Common Greenshank	-	M	Variety of inland wetlands and sheltered coastal habitats of varying salinity. Found on mudflats, saltmarsh, mangroves in embayments, harbours, deltas and lagoons. Breeds in northern hemisphere.	Low – habitat preferences not in Study Area.	N/A
Tringa stagnatilis	Marsh Sandpiper	-	M	Permanent or ephemeral wetlands of varying salinity, including swamps, lagoons, billabongs, saltpans, saltmarshes, estuaries, sewage farms and salt works. Northern hemisphere breeding.	Low – habitat preferences not in Study Area.	N/A
Tyto novaehollandiae	Masked Owl	V	-	Inhabits a diverse range of wooded habitat that provide tall or dense mature trees with hollows suitable for nesting and roosting. Mostly recorded in open forest and woodlands adjacent to cleared lands. Nest in hollows, in trunks and in near vertical spouts or large trees, usually living but sometimes dead. Nest hollows are usually located within dense forests or woodlands. Masked Owls prey upon hollow-dependent arboreal marsupials, but terrestrial mammals make up the largest proportion of the diet.	Low – lack of hollows in Study Area.	Species/Ecosystem

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
Xenus cinereus	Terek Sandpiper	V	M, MA	The Terek Sandpiper mostly forages in the open, on soft wet intertidal mudflats or in sheltered estuaries, embayments, harbours or lagoons. Northern hemisphere breeding.	Low – habitat preferences not in Study Area.	Ecosystem
Mammals						
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Located in a variety of drier habitats, including the dry sclerophyll forests and woodlands to the east and west of the Great Dividing Range. Can also be found on the edges of rainforests and in wet sclerophyll forests. This species roosts in caves and mines in groups of between 3 and 37 individuals.	None – Study Area not within 2 km of rocky cliff lines	Ecosystem and species
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-	Inhabit sclerophyll forests, preferring wet habitats where trees are more than 20 m high. Two observations have been made of roosts in stem holes of living eucalypts. There is debate about whether or not this species moves to lower altitudes during winter, or whether they remain sedentary but enter torpor. This species also appears to be highly mobile and records showing movements of up to 12 km between roosting and foraging sites.	High	Ecosystem
Miniopterus australis	Little Bentwing-bat	V	-	Coastal north-eastern NSW and eastern Queensland. The Little Bentwing-bat is an insectivorous bat that roost in caves, in old mines, in tunnels, under bridges, or in similar structures. They breed in large aggregations in a small number of known caves and may travel hundreds of kilometres from feeding home ranges to breeding sites. They have a preference for moist eucalypt forest, rainforest or dense coastal banksia scrub where it forages below the canopy for insects.	Moderate – thought unlikely to have breeding habitat given lack of hollows in Study Area.	Ecosystem and species
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	-	Eastern Bentwing-bats occur along the east and north-west coasts of Australia. Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures. Form discrete populations centred on a maternity cave that is used annually in spring and summer for the birth and rearing of young.	Known – recorded in Study Area, though no breeding habitat.	Ecosystem and species
Mormopterus norfolkensis	Eastern Freetail-bat	V	-	Most records are from dry eucalypt forests and woodlands to the east of the Great Dividing Range. Appears to roost in trees, but little is known of this species' habits.	Moderate	Ecosystem
Myotis macropus	Southern Myotis	V	-	The Southern Myotis is found in the coastal band from the north-west of Australia, across the top-end and south to western Victoria. Generally roost in groups of 10 - 15 close to water in caves, mine shafts, hollow-bearing trees, stormwater channels, buildings, under bridges and in dense foliage.	Moderate – though no breeding habitat.	Ecosystem and species
Petauroides volans	Greater Glider	-	V	The Greater Glider is restricted to eastern Australia, occurring from the Windsor Tableland in north Queensland through to central Victoria. It is typically found in highest abundance in taller, montane, moist eucalypt forests with relatively old trees and abundant hollows.	None – lack of old trees and tree hollows	Species

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
Petaurus norfolcensis	Squirrel Glider	V	-	Generally occurs in dry sclerophyll forests and woodlands but is absent from dense coastal ranges in the southern part of its range. Requires abundant hollow bearing trees and a mix of eucalypts, banksias and acacias. There is only limited information available on den tree use by Squirrel gliders, but it has been observed using both living and dead trees as well as hollow stumps. Within a suitable vegetation community at least one species should flower heavily in winter and one species of eucalypt should be smooth barked. Endangered population in the Wagga Wagga LGA.	Previously been recorded in the Study Area.	Species
Phascogale tapoatafa	Brush-tailed Phascogale	V	-	The Brush-tailed Phascogale has a patchy distribution around the coast of Australia. In NSW it is mainly found east of the Great Dividing Range although there are occasional records west of the divide. Prefer dry sclerophyll open forest with sparse groundcover of herbs, grasses, shrubs or leaf litter. Also inhabit heath, swamps, rainforest and wet sclerophyll forest.	Low – species not recorded along Stockton beach corridor. Closest record is approximately 8km inland.	Species
Phascolarctos cinereus	Koala	V	V	Inhabits eucalypt forests and woodlands. The suitability of these forests for habitation depends on the size and species of trees present, soil nutrients, climate and rainfall.	Low likelihood to utilise the Study Area on a regular basis. This is supported by the SAT and spotlighting survey which did not detect any usage of the Study Area by Koalas. However it is noted that there are records throughout the locality. The Koala may move through the area, but given the site is predominately regeneration, is unlikely to use as main source of foraging habitat, and would likely utilise the surrounding bushland for movement given the protection from predators.	Species
Phascolarctos cinereus	Koala, Hawks Nest and Tea Gardens population	EP	-	Inhabits eucalypt forests and woodlands. The suitability of these forests for habitation depends on the size and species of trees present, soil nutrients, climate and rainfall.	As above	N/A
Potorous tridactylus tridactylus	Long-nosed Potoroo	V	V	Inhabits coastal heath and wet and dry sclerophyll forests. Generally found in areas with rainfall greater than 760 mm. Requires relatively thick ground cover where the soil is light and sandy.	Moderate	Ecosystem
Pseudomys novaehollandiae	New Holland Mouse	-	V	The New Holland Mouse currently has a disjunct, fragmented distribution across Tasmania, Victoria, New South Wales and Queensland. Across the species' range	Moderate	Ecosystem

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
				the New Holland Mouse is known to inhabit open heathlands, open woodlands with a heathland understorey, and vegetated sand dunes.		
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	This species is a canopy-feeding frugivore and nectarivore of rainforests, open forests, woodlands, melaleuca swamps and banksia woodlands. Bats commute daily to foraging areas, usually within 15 km of the day roost although some individuals may travel up to 70 km.	High – however no breeding habitat in Study Area.	Ecosystem and species
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	-	Roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows. When foraging for insects, flies high and fast over the forest canopy, but lower in more open country. Forages in most habitats across its very wide range, with and without trees; appears to defend an aerial territory.	Moderate	Ecosystem
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-	Prefer moist gullies in mature coastal forests and rainforests, between the Great Dividing Range and the coast. They are only found at low altitudes below 500 m. In dense environments they utilise natural and human-made opening in the forest for flight paths. Creeks and small rivers are favoured foraging habitat. This species roosts in hollow tree trunks and branches.	Known – recorded in Study Area	Ecosystem
Flora						
Angophora inopina	Charmhaven Apple	V	V	Endemic to the Central Coast region of NSW. The known northern limit is near Karuah where a disjunct population occurs; to the south populations extend from Toronto to Charmhaven with the main population occurring between Charmhaven and Morisset. Occurs most frequently in Red Bloodwood Scribbly Gum woodland, wet heath, Red Mahogany Paperbark Sedge woodland and Stringybark Red Bloodwood forest.	Low – not detected during survey. Relatively conspicuous species. Not previously recorded in Study Area or surrounds.	Species
Callistemon linearifolius	Netted Bottle Brush	V	-	Recorded from the Georges River to Hawkesbury River in the Sydney area, and north to the Nelson Bay area of NSW. Recorded in 2000 at Coalcliff in the northern Illawarra. For the Sydney area, recent records are limited to the Hornsby Plateau area near the Hawkesbury River. The species was more widespread in the past, and there are currently only 5-6 populations remaining from the 22 populations historically recorded in the Sydney area. Three of the remaining populations are reserved in Ku-ring-gai Chase National Park, Lion Island Nature Reserve and Spectacle Island Nature Reserve. The species has also been recorded from Yengo National Park.	Low – not detected during survey. Relatively conspicuous species. Not previously recorded in Study Area or surrounds.	Species
Commersonia prostrata	Dwarf Kerrawang	E	E	Occurs on sandy, sometimes peaty soils in a wide variety of habitats: snow gum woodland at Rose Lagoon; Blue-leaved Stringybark open forest at Tallong; and in Brittle Gum low open woodland at Penrose; Scribbly Gum - Swamp Mahogany ecotonal forest at Tomago.	Low – not detected during survey. Relatively conspicuous species. Not previously recorded in Study Area or surrounds.	Species

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
Corybas dowlingii	Red Helmet Orchid	E	-	Corybas dowlingii is restricted to the central coast and Hunter regions of New South Wales where it is currently known from the Port Stephens, Bulahdelah, Lake Macquarie and Freemans Waterhole areas. It is known from the local government areas of Cessnock, Great Lakes, Lake Macquarie and Port Stephens. Sheltered areas such as gullies and southerly slopes in tall open forest on well-drained gravelly soil at elevations of 10-200 m	Low – habitat not suitable as species occurs in sheltered gullies.	Species
Cryptostylis hunteriana	Leafless Tongue-orchid	V	V	Does not appear to have well defined habitat preferences and is known from a range of communities, including swamp-heath and woodland. The larger populations typically occur in woodland dominated by Scribbly Gum, Silvertop Ash, Red Bloodwood and Black She-oak and appears to prefer open areas in the understorey of this community.	Low – lack of remnant habitat given the Study Area is mainly rehabilitated mine pit. Lack of associated canopy species.	Species
Diuris arenaria	Sand Doubletail	E	-	Known from the Tomaree Peninsula near Newcastle. This species occurs in coastal heath and dry grassy eucalypt forest on sandy flats. Grows in gently undulating country in eucalypt forest with a grassy understorey on clay soil.	Low – lack of clay soil. Not previously recorded in the locality of the Study Area.	Species
Diuris praecox	Rough Doubletail	V	V	Occurs between Ourimbah and Nelson Bay. Grows on hills and slopes of near-coastal districts in open forests which have a grassy to fairly dense understorey. Exists as subterranean tubers most of the year. It produces leaves and flowering stems in winter.	Low – species has been recorded adjacent to the Study Area in remnant coastal dry sclerophyll forest. Targeted survey during the recommended survey time did not detect the species. However, it is recognised that the species is cryptic. Regardless, given the disturbed nature of the majority of the Study Area which comprises of rehabilitation with a lack of resilience, it is unlikely the species would be present.	Species
Eucalyptus camfieldii	Heart-leaved Stringybark	V	V	Restricted distribution in a narrow band with the most northerly records in the Raymond Terrace Area south to Waterfall. Poor coastal country in shallow sandy soils overlying Hawkesbury sandstone. Coastal heath mostly on exposed sandy ridges. Occurs mostly in small scattered stands near the boundary of tall coastal heaths and low open woodland of the slightly more fertile inland areas.	Low – not detected during survey. Relatively conspicuous species. Not previously recorded in Study Area or surrounds.	Species
Eucalyptus parramattensis subsp. decadens		V	V	Generally occupies deep, low-nutrient sands, often those subject to periodic inundation or where water tables are relatively high. It occurs in dry sclerophyll	Low – not detected during survey. Relatively conspicuous	Species

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
				woodland with dry heath understorey. It also occurs as an emergent in dry or wet heathland. Often where this species occurs, it is a community dominant.	species. Not previously recorded in Study Area or surrounds.	
Grevillea parviflora subsp. parviflora	Small-flowered Grevillea	V	V	Grows in sandy or light clay soils usually over thin shales. Occurs in a range of vegetation types from heath and shrubby woodland to open forest. Found over a range of altitudes from flat, low-lying areas to upper slopes and ridge crests. Often occurs in open, slightly disturbed sites such as along tracks.	Low – not detected during survey. Relatively conspicuous species. Not previously recorded in Study Area or surrounds.	Species
Maundia triglochinoides		V	-	Grows in swamps, creeks or shallow freshwater 30 - 60 cm deep on heavy clay, low nutrients. Flowering occurs during warmer months. Diaspore is the seed and root tubers, which are probably dispersed by water.	None – no waterbodies	Species
Melaleuca biconvexa	Biconvex Paperbark	V	V	Grows in damp places, often near streams or low-lying areas on alluvial soils of low slopes or sheltered aspects. Scattered and dispersed populations found in the Jervis Bay area in the south and the Gosford-Wyong area in the north.	Low – not detected during survey. Relatively conspicuous species. Not previously recorded in Study Area or surrounds.	Species
Melaleuca groveana	Groves Paperbark	V	-	Widespread, scattered populations in coastal districts north of Yengo National Park to southeast Queensland. Also found as a disjunct population near Torrington on the nothern tablelands. Grove's Paperbark grows in heath and shrubland, often in exposed sites, in low coastal hills, escarpment ranges and tablelands on outcopping granite, rhyolite and sandtone on rocky outcrops and cliffs.	Low – not detected during survey. Relatively conspicuous species. Not previously recorded in Study Area or surrounds.	Species
Persicaria elatior	Tall Knotweed	V	V	This species normally grows in damp places, especially beside streams and lakes. Occasionally in swamp forest or associated with disturbance.	Low – not detected during survey. Relatively conspicuous species. Not previously recorded in Study Area or surrounds.	Species
Phaius australis	Southern Swamp Orchid	E	E	Swampy grassland or swampy forest including rainforest, eucalypt or paperbark forest, mostly in coastal areas.	Low – lack of habitat preferences. Not detected during survey. Not previously recorded in Study Area or surrounds.	Species
Prostanthera densa	Villous Mint Bush	V	V	This species has been recorded from the Currarong area in Jervis Bay, Royal National Park (Marley), Cronulla, Helensburgh and Port Stephens (Nelson Bay). The Sydney and Royal National Park populations were thought possibly extinct, but the species is now known to occur at Bass and Flinders Point in Cronulla. Prostanthera densa generally grows in sclerophyll forest and shrubland on coastal headlands and near coastal ranges, chiefly on sandstone, and rocky slopes near the sea.	Low – not detected during survey. Relatively conspicuous species. Not previously recorded in Study Area or surrounds.	Species

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
Rhizanthella slateri	Eastern Australian Undergrown Orchid	V	E	Occurs from south-east Queensland to south-east NSW. In NSW, currently known from fewer than 10 locations, including near Bulahdelah, the Watagan Mountains, the Blue Mountains, Wiseman's Ferry area, Agnes Banks and near Nowra. Habitat requirements are poorly understood and no particular vegetation type has been associated with the species, although it is known to occur in sclerophyll forest. Highly cryptic given that it grows almost completely below the soil surface, with flowers being the only part of the plant that can occur above ground. Therefore usually located only when the soil is disturbed.	Low – no previous records and the majority of the Study Area consists of rehabilitation which has changed the natural sandy soil base.	Species
Senecio spathulatus	Coast Groundsel	E	-	Coast Groundsel occurs in Nadgee Nature Reserve (Cape Howe) and between Kurnell in Sydney and Myall Lakes National Park (with a possible occurrence at Cudmirrah). In Victoria there are scattered populations from Wilsons Promontory to the NSW border. Coast Groundsel grows on primary dunes.	Low – not detected during survey. Relatively conspicuous species. Not previously recorded in Study Area or surrounds.	Species
Syzygium paniculatum	Magenta Lilly Pilly	E	V	Found only in NSW, in a narrow, linear coastal strip from Bulahdelah to Conjola State forest. On the south coast the species occurs on grey soils over sandstone, restricted mainly to remnant stands of littoral rainforest. On the central coast it occurs on gravels, sands, silts and clays in riverside gallery rainforests and remnant littoral rainforest communities.	Low – not detected during survey. Relatively conspicuous species. Not previously recorded in Study Area or surrounds.	Species
Tetratheca juncea	Black-eyed Susan	V	V	Confined to the northern portion of the Sydney Basin bioregion and the southern portion of the North Coast bioregion in the local government areas of Wyong, Lake Macquarie, Newcastle, Port Stephens, Great Lakes and Cessnock. It is usually found in low open forest-woodland with a mixed shrub understorey and grassy groundcover. The majority of populations occur on low nutrient soils associated with the Awaba Soil Landscape. Cryptic species that requires survey in September-October.	Low – not detected during survey. Not previously recorded in Study Area or surrounds. Habitat preferences absent given the Study Area has been previously cleared.	Species
Thesium australe	Austral Toadlax	V	V	Austral Toad-flax is found in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. It is also found in Tasmania and Queensland and in eastern Asia. Although originally described from material collected in the SW Sydney area, populations have not been seen in a long time. It may persist in some areas in the broader region. Occurs in grassland on coastal headlands or grassland and grassy woodland away from the coast. Often found in association with Kangaroo Grass (Themeda australis).	Low – headland habitat not present.	Species

Threatened Ecological Community (TEC) Likelihood of occurrence

Threatened Ecological Community	Description	BC Act Status	EPBC Act Status	Likelihood of occurrence within Study Area
Central Hunter Grey Box - Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	Central Hunter Grey Box-Ironbark Woodland occurs in the Central Hunter Valley between about Singleton and Muswellbrook. It is known to occur in the Cessnock, Singleton and Muswellbrook LGAs but may occur elsewhere within the Sydney Basin Bioregion. Central Hunter Grey Box-Ironbark Woodland occurs in areas of relatively low rainfall and high temperatures. It is associated mostly with Permian lithology, and is situated on gently undulating hills, slopes and valleys, or occasionally on rocky knolls. Central Hunter Grey Box–Ironbark Woodland typically forms a woodland dominated by Narrow-leaved Ironbark (*Eucalyptus crebra*), Kurrajong (*Brachychiton populneus* subsp. *populneus*) and Grey Box (*Eucalyptus moluccana*). Other tree species such as Rough-barked Apple (*Angophora floribunda*) and Black Cypress Pine (*Callitris endlicheri*) may be present and occasionally dominate or co-dominate. A shrub layer is often present and common shrub species include Velvet Mock Olive (*Notelaea microcarpa* var. *microcarpa*), Coffee Bush (*Breynia oblongifolia*), Blackthorn (*Bursaria spinosa* subsp. *spinosa*), *Cassinia quinquefaria* and Sticky Hop-bush (*Dodonaea viscosa*). Subshrubs may also be common and include Narrawa Burr (*Solanum cinereum*), *Phyllanthus virgatus* and Small-leaf Bluebush (*Maireana microphylla*). Ground cover can be moderately dense to dense, and consist of numerous forbs and grass species as well as a small number of ferns, sedges and twiners. The more common species include Barbed Wire Grass (*Cymbopogon refractus*), Purple Wiregrass (*Aristida ramosa*), Kidney Weed (*Dichondra repens*), Poison Rock Fern (*Cheilanthes sieberi* subsp. *sieberi*), Bristly Cloak Fern (*Cheilanthes distans*), Tall Chloris (*Chloris ventricosa*), Slender Tick-trefoil (*Desmodium varians*), Yellow Burr-daisy (*Calotis lappulacea*), Many-flowered Mat-rush (*Lomandra multiflora* subsp. *multiflora*), Blue Trumpet (*Brunoniella australis*) and *Glycine tabacina*.	Endangered	Critically Endangered	None
Central Hunter Ironbark - Spotted Gum - Grey Box Forest in the New South Wales North Coast and Sydney Basin Bioregions	Central Hunter Ironbark-Spotted Gum-Grey Box Forest occurs in the central Hunter Valley mainly between Maitland and Muswellbrook. It has been recorded from Singleton, Cessnock and Muswellbrook LGAs but may occur elsewhere within the North Coast and Sydney Basin Bioregions. Central Hunter Ironbark-Spotted Gum-Grey Box Forest occupies undulating country including low rises and slopes, occurring on all aspects. It may also occur on alluvial and colluvial soils in valleys. It mostly occurs on clayey soils found on Permian sediments. Central Hunter Ironbark-Spotted Gum-Grey Box Forest typically forms an open forest or woodland dominated by Narrow-leaved Ironbark (*Eucalyptus crebra*), Spotted Gum (*Corymbia* maculata) and Grey Box (*Eucalyptus moluccana*). Other tree species such as Red Ironbark (*Eucalyptus fibrosa*) and Forest Red Gum (*Eucalyptus* tereticornis) may be present, and occasionally dominate or co-dominate. A sparse layer of small trees including Bulloak (*Allocasuarina* luehmannii) or Silver-stemmed Wattle (*Acacia parvipinnula*) may be present in some areas. The shrub layer varies from sparse to moderately dense. Common shrub species include Gorse Bitter Pea (*Daviesia ulicifolia* subsp. *ulicifolia*), Grey Bush-pea (*Pultenaea spinosa*), Coffee Bush (*Breynia oblongifolia*), Needlebush (*Hakea* sericea) and Blackthorn (*Bursaria spinosa* subsp. *spinosa*). Ground cover can be sparse to moderately dense and consists of numerous forbs, a few grass species and occasional ferns and sedges. Common species include Poison Rock Fern (*Cheilanthes sieberi* subsp. *sieberi*), Barbed Wire Grass (*Cymbopogon refractus*), Whiteroot (*Pratia purpurascens*), Many-flowered Mat-rush (*Lomandra multiflora* subsp. *multiflora*), *Pomax umbellata*, *Glycine tabacina*, Blue Flax-lily (*Dianella revoluta*), Slender Wire Lily (*Laxmannia gracilis*), *Vernonia cinerea* var. *cinerea*, Slender Tick-trefoil (*Desmodium varians*) and Kidney Weed (*Dichondra repens*).	Endangered	Critically Endangered	None

Threatened Ecological Community	Description	BC Act Status	EPBC Act Status	Likelihood of occurrence within Study Area
Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	Coastal Saltmarsh occurs in the intertidal zone on the shores of estuaries and lagoons that are permanently or intermittently open to the sea. It is frequently found as a zone on the landward side of mangrove stands. Characteristic plants include *Baumea juncea*, Sea Rush (*Juncus krausii* subsp. australiensis), Samphire (*Sarcocornia quinqueflora* subsp. quinqueflora), Marine Couch (*Sporobolus virginicus*), Streaked Arrowgrass (*Triglochin striata*), Knobby Club-rush (*Ficinia nodosa*), Creeping Brookweed (*Samolus repens*), Swamp Weed (*Selliera radicans*), Seablite (*Suaeda* australis) and Prickly Couch (*Zoysia macrantha*). Occasionally mangroves are scattered through the saltmarsh. Tall reeds may also occur, as well as salt pans. Found in the tidal flats of estuaries and on the edges of intermittently opened coastal lagoons. Occurs in the upper limits of the tidal zone, and is frequently interspersed with bare ground and salt pans.	Endangered	Vulnerable	None
Coastal Upland Swamp in the Sydney Basin Bioregion	The Coastal Upland Swamp in the Sydney Basin Bioregion includes open graminoid heath, sedgeland and tall scrub associated with periodically waterlogged soils on the Hawkesbury sandstone plateaux. The Coastal Upland Swamp is generally associated with soils that are acidic and vary from yellow or grey mineral sandy loams with a shallow organic horizon to highly organic spongy black peat soils with pallid subsoils. The vegetation of the Coastal Upland Swamp may include tall open scrubs, tall closed scrubs, closed heaths, open graminoid heaths, sedgelands and fernlands. Larger examples may include a complex of these structural forms. The flora comprising the upland swamp is diverse there are 73 plant species listed as characterising the ecological community.	Endangered	Endangered	None
Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	Associated with coastal areas subject to periodic flooding and in which standing fresh water persists for at least part of the year in most years. Typically occurs on silts, muds or humic loams in low-lying parts of floodplains, alluvial flats, depressions, drainage lines, backswamps, lagoons and lakes but may also occur in backbarrier landforms where floodplains adjoin coastal sandplains. Generally occur below 20 m elevation on level areas. They are dominated by herbaceous plants and have very few woody species. The structure and composition of the community varies both spatially and temporally depending on the water regime: Those that lack standing water most of the time are usually dominated by dense grassland or sedgeland vegetation, often forming a turf less than 0.5 metre tall and dominated by amphibious plants including Paspalum distichum (water couch), Leersia hexandra (swamp rice-grass), Pseudoraphis spinescens (mud grass) and Carex appressa (tussock sedge). Where they are subject to regular inundation and drying the vegetation may include large emergent sedges over 1 metre tall, such as Baumea articulata, Eleocharis equisetina and Lepironia articulata, as well as emergent or floating herbs such as Hydrocharis dubia (frogbit), Philydrum lanuginosum(frogsmouth), Ludwigia peploides subsp. montevidensis (water primrose), Marsilea mutica (nardoo) and Myriophyllum spp. (milfoils).	Endangered		None
Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions	Hunter Floodplain Red Gum Woodland generally forms a tall to very tall (18-35 m) woodland on floodplains and associated rises along the Hunter River and tributaries within the NSW North Coast and Sydney Basin Bioregions. Stands on major floodplains are generally dominated by Eucalyptus camaldulensis (River Red Gum) in combinations with Eucalyptus tereticornis (Forest Red Gum), Eucalyptus melliodora (Yellow Box) and Angophora floribunda (Rough-barked Apple). Within the community stands of Casuarina cunninghamiana subsp. cunninghamiana (River Oak) and Casuarina glauca (Swamp Oak) can form a part of this community. Dominant groundcovers include Cynodon dactylon (Couch), Alternanthera denticulata (Lesser Joyweed), Austrostipa verticillata(Slender Bamboo Grass), Dichondra repens (Kidney Weed), Lepidium pseudohyssopifolium (Peppercress), Pratia concolor (Poison Pratia), Urtica incisa (Stinging Nettle), Einadia hastata (Berry Saltbush), Amaranthus macrocarpus var. macrocarpus (Dwarf Amaranth), Cyperus fulvus (Sticky Sedge), Cynoglossum australe (Australian Hound's Tongue), Cyperus gracilis(Slender Flat-sedge), Glycine tabacina (Variable Glycine), Geranium solanderi (Native Geranium) and Microlaena stipoides var. stipoides (Weeping Rice Grass).	Endangered		None

Threatened Ecological Community	Description	BC Act Status	EPBC Act Status	Likelihood of occurrence within Study Area
Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions	Hunter Lowland Redgum Forest is an open forest where the most common canopy tree species are *Eucalyptus tereticornis*(Forest Red Gum) and *E. punctata* (Grey Gum). Other frequently occurring canopy species are *Angophora floribunda* (Rough-barked Apple), *E. crebra* (Narrow-leaved Ironbark), *E. moluccana* (Grey Box) and *Corymbia maculata* (Spotted Gum). The shrub layer is open and common shrub species include *Breynia oblongifolia* (Coffee Bush), *Leucopogon juniperinus* (Prickly Beard-heath), *Daviesia ulicifolia* (Gorse Bitter Pea) and *Jacksonia scoparia* (Dogwood). The ground cover typically comprises grasses and herbs with common species being *Microlaena stipoides* var. *stipoides* Forest Weeping Grass, *Pratia purpurascens* (Whiteroot), *Lomandra multiflora* (Many-flowered Mat-rush), *Cymbopogon refractus* (Barbed Wire Grass), *Cheilanthes sieberi* (Poison Rock Fern) and *Dichondra repens* (Kidney Weed). Occurs between Muswellbrook, Beresfield, Mulbring and Cessnock in the Lower Hunter in the Sydney Basin and North Coast bioregions. It has been recorded from the Maitland, Cessnock, Port Stephens, Muswellbrook and Singleton LGAs, but may occur elsewhere in these bioregions. Probably less than 500 hectares of this community remains. Hunter Lowland Redgum Forest occurs on the Permian sediments of the Hunter Valley floor. Much of the remaining community is disturbed and fragmented. The floristic composition and structure of the community is influenced by both the size and disturbance history of the remaining fragments. Consequently at heavily disturbed sites only some of the species which characterise the community may be present. Occurs on gentle slopes of depressions and drainage flats on the Hunter Valley floor.	Endangered		None
Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion	Hunter Valley Footslopes Slaty Gum Woodland is a woodland, or occasionally an open forest, with a sparse to moderately dense tree layer with occasional small trees and a moderately dense to dense shrub layer. The tree canopy is typically dominated by *Eucalyptus dawsonii* (Slaty Gum) and/or *Eucalyptus moluccana* (Grey Box). *Acacia salicina*(Cooba) and *Allocasuarina luehmannii* (Bulloak) may form a small tree layer or be part of the upper-most canopy. Other trees which may be present include *Brachychiton populneus* subsp. *populneus* (Kurrajong), *Callitris endlicheri*(Black Cypress Pine), *Eucalyptus crebra* (Narrow-leaved Ironbark) and *Eucalyptus punctata* (Grey Gum). The shrub layer includes species such as *Olearia elliptica* (Sticky Daisy Bush), *Acacia cultriformis* (Knife-leaved Wattle), *Canthium odoratum* (Shiny-leaved Canthium), *Notelaea microcarpa* var. *microcarpa* (Native Olive), *Dodonaea viscosa* subsp. *cuneata* (Wedge-leaf Hopbush), *Acacia decora* (Western Golden Wattle) and *Solanum brownii* (Violet Nightshade). The groundcover is typically sparse to very sparse and is relatively species poor. The most frequently occurring species include *Dichondra repens*(Kidney Weed), *Lomandra multiflora* subsp. *multiflora* (Many-flowered Mat-rush), *Aristida ramosa* (Wire Grass), *Brunoniella australis* (Blue Trumpet), *Cymbopogon refractus* (Barbed Wire Grass), *Desmodium brachypodum* (Large Tick-trefoil), *Fimbristylis dichotoma* (Common Fringe-rush) and *Sida corrugata*(Corrugated Sida).	Vulnerable	Critically Endangered	None

Threatened Ecological Community	Description	BC Act Status	EPBC Act Status	Likelihood of occurrence within Study Area
Hunter Valley Vine Thicket in the NSW North Coast and Sydney Basin Bioregions	Hunter Valley Vine Thicket typically forms a low forest, usually less than 10 m tall, with a closed canopy dominated by small trees. The canopy may include *Elaeodendron australe*(Red Olive Plum), *Geijera parviflora* (Wilga), *Notelaea microcarpa* var. *microcarpa* (Native Olive), *Alectryon oleifolius* subsp. *elongatus*(Western Rosewood), *Melia azedarach* (White Cedar) and *Brachychiton populneus* subsp. *populneus* (Kurrajong). Emergent eucalypts are common and include *Eucalyptus albens* (White Box), *E. dawsonii* (Slaty Box) and *E. crebra*(Narrow-leaved Ironbark). A shrub stratum is usually present and includes *Olearia elliptica* subsp. *elliptica* (Sticky Daisy Bush) and *Rhagodia parabolica*(Mealy Saltbush). Vines are common and include *Cissus opaca* (Small-leaved Water Vine), *Marsdenia flavescens* (Hairy Milk Vine), *Parsonsia eucalyptophylla*(Gargaloo) and *Pandorea pandorana* subsp. *pandorana* (Wonga Vine). Ground cover is generally sparse and includes *Urtica incisa* (Stinging Nettle) and *Austrostipa verticillata* (Slender Bamboo Grass). Hunter Valley Vine Thicket has a highly restricted geographic distribution in the central Hunter Valley. The community occurs mostly as patches of less than 10 ha, with a few larger patches exceeding 100 ha. Approximately 85% of the pre-European distribution of the community remains. The largest occurrence is at Brushy Hill adjacent to Glenbawn Dam, north east of Scone. The only stand known to occur in a conservation reserve is at Mt Dangar within the Goulburn River National Park. Hunter Valley Vine Thicket has been recorded from the local government areas of Muswellbrook, Singleton, and Upper Hunter but may occur elsewhere within the Sydney Basin Bioregion and NSW North Coast Bioregion.	Endangered		None
Hunter Valley Weeping Myall Woodland in the Sydney Basin Bioregion	Hunter Valley Weeping Myall Woodland of the Sydney Basin bioregion typically has a dense to open tree canopy up to about 15 m tall, depending on disturbance and regrowth history. The most common tree is *Acacia pendula* (Weeping Myall), which may occur with *Eucalyptus crebra* (Narrow-leaved Ironbark), *A. salicina* (Cooba) and/or trees within the *A. homalophylla* - *A. melvillei* complex. Understorey shrubs may include *Canthium buxifolium* (Stiff Canthium), *Dodonaea viscosa* (Sticky Hopbush), *Geijera parviflora* (Wilga), *Notelaea microphylla* var. *microphylla*(Native Olive) and *Senna zygophylla* (Silver Cassia). However, these shrubs are absent from some stands. The groundcover varies from dense to sparse, and is comprised of grasses such as *Austrodanthonia fulva* (a wallaby grass) and *Themeda australis* (Kangaroo Grass), and low shrubs and herbs such as *Chrysocephalum apiculatum* (Common Everlasting), *Einadia nutans* subsp. *nutans* (Climbing Saltbush), *Enchylaena tomentosa* (Ruby Saltbush), *Maireana microphylla* (Eastern Cotton Bush) and *Ptilotus semilanatus*.	Critically Endangered	Critically Endangered	None
Littoral Rainforest in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	Littoral Rainforest is generally a closed forest, the structure and composition of which is strongly influenced by its proximity to the ocean. The plant species of this community are predominantly rainforest species. Several species have compound leaves, and vines may be a major component of the canopy. Littoral Rainforest occurs only on the coast and is found at locations in the NSW North Coast Bioregion, Sydney Basin Bioregion and South East Corner Bioregion. Littoral Rainforest is very rare and occurs in many small stands. In total, it comprises less than one percent of the total area of rainforest in NSW. The largest known stand occurs in Iluka Nature Reserve, which is about 136 hectares in size. Not all stands of this community have been included in mapping for the Environmental Planning Policy 26, Littoral rainforest. Occurs on sand dunes and on soil derived from underlying rocks. Stands on headlands exposed to strong wind-action may take the form of dense, wind-pruned thickets. Stands are generally taller in sheltered sites such as hind dunes, although wind-pruning may still occur on their windward sides. Most stands occur within two kilometres of the sea, though are occasionally found further inland within reach of the maritime influence.	Endangered	Critically Endangered	Low

Threatened Ecological Community	Description	BC Act Status	EPBC Act Status	Likelihood of occurrence within Study Area
Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions	Restricted to a range of approximately 65 km by 35 km centred on the Cessnock - Beresfield area in the Central and Lower Hunter Valley. Within this range, the community was once widespread. A fragmented core of the community still occurs between Cessnock and Beresfield. Remnants occur within the Local Government Areas of Cessnock, Maitland, Singleton, Lake Macquarie, Newcastle and Port Stephens but may also occur elsewhere within the bioregion. Outliers are also present on the eastern escarpment of Pokolbin and Corrabare State Forests on Narrabeen Sandstone.	Endangered		None
Lower Hunter Valley Dry Rainforest in the Sydney Basin and NSW North Coast Bioregions	Lower Hunter Valley Dry Rainforest mainly occurs on the Barrington footslopes along the northern rim of the Hunter Valley Floor, where it occupies gullies and steep hillslopes with south facing aspects. It is also known from south of the Hunter River at Mt Bright and Mt View. Lower Hunter Valley Dry Rainforest has been recorded from the local government areas of Cessnock, Maitland and Port Stephens, and is also likely to occur or have occurred in Muswellbrook, Singleton, Upper Hunter and Dungog LGAs. Lower Hunter Valley Dry Rainforest typically occurs on Carboniferous sediments in gullies and on steep hillslopes with south facing aspects. It is generally found at elevations less than 300 m ASL with a mean annual rainfall less than 900 mm	Vulnerable		None
Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions	Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions is an ecological community of subtropical rainforest and some related, structurally complex forms of dry rainforest. Lowland Rainforest, in a relatively undisturbed state, has a closed canopy, characterised by a high diversity of trees whose leaves may be mesophyllous and encompass a wide variety of shapes and sizes. Typically, the trees form three major strata: emergents, canopy and sub-canopy which, combined with variations in crown shapes and sizes results in an irregular canopy appearance. The trees are taxonomically diverse at the genus and family levels, and some may have buttressed roots. A range of plant growth forms are present in Lowland Rainforest, including palms, vines and vascular epiphytes. In disturbed stands of this community the canopy cover may be broken, or the canopy may be smothered by exotic vines. The Hawkesbury River notionally marks the southern limit of Lowland Rainforest in the NSW North Coast and Sydney Basin bioregions. South of the Sydney metropolitan area, Lowland Rainforest is replaced by Illawarra Subtropical Rainforest of the Sydney Basin Bioregion, which is listed as an endangered ecological community. Milton Ulladulla Subtropical Rainforest is also a related rainforest endangered ecological community that occurs still further south in the South East Corner Bioregion.	Endangered	Critically Endangered	None

Threatened Ecological Community	Description	BC Act Status	EPBC Act Status	Likelihood of occurrence within Study Area
Lowland Rainforest on Floodplain in the New South Wales North Coast Bioregion	Lowland Rainforest on Floodplain is a rainforest community which now occurs only as small remnants in scattered localities on the NSW north coast, with less than 1000ha in total thought to remain. Larger stands of the community typically have a dense canopy, which blocks most light from reaching the ground, creating cool, moist conditions within. Lowland Rainforest on Floodplain supports a rich diversity of plants and animals. Typical tree species in the community include figs *(Ficus macrophylla, F. obliqua* and *F. watkinsiana),* palms *(Archontophoenix cunninghamiana* and *Livistona australis),*Silky Oak *(Grevillea robusta)*, Black Bean *(Castanospermum australe)* and Brush Cherry *(Syzygium australe).* Animals present include fruit-eating rainforest pigeons, Noisy Pitta, Brush-turkey, pademelons, flying foxes, the Land Mullet skink and rainforest snails. Lowland Rainforest on Floodplain generally occupies riverine corridors and alluvial flats with rich, moist silts often in subcatchments dominated by basic volcanic substrates. Major examples once occurred, and remnants remain, on the floodplains of the Tweed, Richmond, Clarence, Bellinger, Macleay, Hastings, Manning, and Hunter Rivers. Other minor river systems also support the community. This community occurs on fertile soils in lowland river valleys.	Endangered	Critically Endangered	None
Quorrobolong Scribbly Gum Woodland in the Sydney Basin Bioregion	Quorrobolong Scribbly Gum Woodland is a low shrubby woodland with the overstorey dominated by *Eucalyptus racemosa* (Scribbly Gum). Other tree species present include *E. piperita* (Sydney Peppermint), *E. resinifera* (Red Mahogany), *Angophora costata* (Smooth-barked Apple) and *E. punctata* (Grey Gum). There is usually a well developed shrub layer with common species being *Leptospermum trinervium* (Slender Tea-tree), *Acacia parvipinnula* (Silver-stemmed Wattle), *Persoonia linearis*(Narrow-leaved Geebung) and *Leptospermum polygalifolium* (Tantoon). The ground layer is often sparse and frequently occurring species are *Imperata cylindrica* var. *major* (Blady Grass), *Panicum simile* (Two-colour Panic), *Pratia purpuracens* (Whiteroot), *Lomandra cylindrica* (Needle Mat-rush) and *Dianella revoluta*. Currently known from only a small area between Quorrobolong and Mulbring in the Cessnock local government area, but may also occur elsewhere within the Hunter Valley. The current known extent is about 70 hectares; the pre-European extent is estimated to have been only 160 hectares, reflecting the limited area of the sand deposit on which it occurs. Not known to occur within any conservation reserves. Occupies gentle slopes and rises on a residual sand deposit overlying the Permian clay sediments of the Hunter Valley floor.	Endangered		None
River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	As the name suggests, this EEC is found on the river flats of the coastal floodplains. It has a tall open tree layer of eucalypts, which may exceed 40 m in height, but can be considerably shorter in regrowth stands or under conditions of lower site quality. While the composition of the tree stratum varies considerably, the most widespread and abundant dominant trees include Eucalyptus tereticornis (forest red gum), E. amplifolia (cabbage gum), Angophora floribunda (rough-barked apple) and A. subvelutina (broad-leaved apple). Eucalyptus baueriana (blue box), E. botryoides (bangalay) and E. elata (river peppermint) may be common south from Sydney, E. ovata (swamp gum) occurs on the far south coast, E. saligna (Sydney blue gum) and E. grandis (flooded gum) may occur north of Sydney, while E. benthamii is restricted to the Hawkesbury floodplain.	Endangered		None

Threatened Ecological Community	Description	BC Act Status	EPBC Act Status	Likelihood of occurrence within Study Area
Subtropical Coastal Floodplain Forest of the New South Wales North Coast Bioregion	Subtropical Coastal Floodplain Forest of the NSW North Coast bioregion has a tall open tree layer of eucalypts, which may exceed 40 m in height, but can be considerably shorter in regrowth stands or under conditions of lower site quality. While the composition of the tree stratum varies considerably, the most widespread and abundant dominant trees include *Eucalyptus tereticornis* (forest red gum), *E. siderophloia* (grey ironbark), *Corymbia intermedia* (pink bloodwood) and, north of the Macleay floodplain, *Lophostemon suaveolens* (swamp turpentine). Other trees may be scattered throughout at low abundance or locally common at few sites, particularly where there is an influence from lithic substrates upslope. These include *Eucalyptus moluccana* (grey box), *E. propinqua* (grey gum), *E. seeana*(narrow-leaved red gum), *Angophora subvelutina* (broad-leaved apple), *E. robusta* (swamp mahogany), *Eucalyptus resinifera* subsp. *hemilampra* (red mahogany), *E. acmenoides* (white mahogany), *Angophora woodsiana, A. paludosa* and rainforest trees such as *Ficus*spp. (figs) and *Cupaniopsis* spp (tuckeroos). A layer of small trees may be present, including *Allocasuarina torulosa* (forest oak), *Alphitonia excelsa* (red ash), *Glochidion ferdinandi* (cheese tree), *Callistemon* spp. (bottlebrushes), *Melaleuca* spp. (paperbarks) *andCasuarina glauca* (swamp oak). Scattered shrubs include *Breynia oblongifolia* (coffee bush), *Acacia concurrens* (curracabah), *Commersonia* spp., and *Hibiscus* spp. Occasional vines include *Eustrephus latifolius* (wombat berry), *Parsonsia straminea* (common silkpod) and *Geitonoplesium cymosum* (scrambling lily). The groundcover is composed of abundant forbs, scramblers and grasses including *Imperata cylindrica* var. *major* (blady grass), *Themeda australis* (kangaroo grass), *Vernonia cinerea, Dianella caerulea* (blue flax lily), *Pratia purpurascens* (whiteroot), *Cheilanthes sieberi* subsp. *sieberi,* and *Dichondra repens* (kidney weed). The composition and structure of the understorey is influenced by grazing and fire history, changes to hydrology and soil salinity and other disturbance, and may have a substantial component of exotic grasses, vines and forbs.	Endangered		None
Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	This community is found on the coastal floodplains of NSW. It has a dense to sparse tree layer in which *Casuarina glauca* (swamp oak) is the dominant species northwards from Bermagui. Other trees including *Acmena smithii* (lilly pilly), *Glochidion* spp. (cheese trees) and *Melaleuca* spp. (paperbarks) may be present as subordinate species, and are found most frequently in stands of the community northwards from Gosford. Tree diversity decreases with latitude, and *Melaleuca ericifolia* is the only abundant tree in this community south of Bermagui. The understorey is characterised by frequent occurrences of vines, *Parsonsia straminea, Geitonoplesium cymosum* and *Stephania japonica* var. *discolor*, a sparse cover of shrubs, and a continuous groundcover of forbs, sedges, grasses and leaf litter. The composition of the ground stratum varies depending on levels of salinity in the groundwater. Under less saline conditions prominent ground layer plants include forbs such *Centella asiatica, Commelina cyanea, Persicaria decipiens*and *Viola banksii*; graminoids such as *Carex appressa, Gahnia clarkei, Lomandra longifolia, Oplismenus imbecillis*; and the fern *Hypolepis muelleri*. On the fringes of coastal estuaries, where soils are more saline, the ground layer may include the threatened grass species, *Alexfloydia repens*, as well as *Baumea juncea, Juncus kraussii, Phragmites australis, Selliera radicans* and other saltmarsh species. Known from parts of the Local Government Areas of Tweed, Byron, Lismore, Ballina, Richmond Valley, Clarence Valley, Coffs Harbour, Bellingen, Nambucca, Kempsey, Hastings, Greater Taree, Great Lakes, Port Stephens, Maitland, Newcastle, Cessnock, Lake Macquarie, Wyong, Gosford, Pittwater, Warringah, Hawkesbury, Baulkham Hills, Hornsby, Lane Cove, Blacktown, Auburn, Parramatta, Canada Bay, Rockdale, Kogarah, Sutherland, Penrith, Fairfield, Liverpool, Bankstown, Wollondilly, Camden, Campbelltown, Wollongong, Shellharbour, Kiama, Shoalhaven, Eurobodalla and Bega Valley but may occur elsewhere in these bioregions. Major examples once occurred on the floodplains of the Clarence, Macleay, Hastings, Manning, Hunter, Hawkesbury, Shoalhaven and Moruya Rivers.	Endangered	Endangered	Low

Threatened Ecological Community	Description	BC Act Status	EPBC Act Status	Likelihood of occurrence within Study Area
Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	This swamp community has an open to dense tree layer of eucalypts and paperbarks although some remnants now only have scattered trees as a result of partial clearing. The trees may exceed 25 m in height, but can be considerably shorter in regrowth stands or under conditions of lower site quality where the tree stratum is low and dense. For example, stands dominated by *Melaleuca ericifolia* typically do not exceed 8 m in height. The community also includes some areas of fernland and tall reedland or sedgeland, where trees are very sparse or absent. The most widespread and abundant dominant trees include *Eucalyptus robusta*(swamp mahogany), *Melaleuca quinquenervia* (paperbark) and, south from Sydney, *Eucalyptus botryoides* (bangalay) and *Eucalyptus longifolia*(woollybutt). Other trees may be scattered throughout at low abundance or may be locally common at few sites, including *Callistemon salignus* (sweet willow bottlebrush), *Casuarina glauca* (swamp oak) and *Eucalyptus resinifera* subsp. *hemilampra* (red mahogany), *Livistona australis* (cabbage palm) and *Lophostemon suaveolens* (swamp turpentine). A layer of small trees may be present, including *Acacia irrorata* (green wattle), *Acmena smithii* (lilly pilly), *Elaeocarpus reticulatus* (blueberry ash), *Glochidion ferdinandi* (cheese tree), *Melaleuca linariifolia* and *M. styphelioides*(paperbarks). Shrubs include *Acacia longifolia, Dodonaea triquetra, Ficus coronata, Leptospermum polygalifolium* subsp. *polygalifolium* and *Melaleuca* spp. Occasional vines include *Parsonsia straminea, Morinda jasminoides* and *Stephania japonica* var. *discolor*. The groundcover is composed of abundant sedges, ferns, forbs, and grasses including *Gahnia clarkei, Pteridium esculentum, Hypolepis muelleri, Calochlaena dubia, Dianella caerulea, Viola hederacea, Lomandra longifolia, Entolasia marginata* and *Imperata cylindrica*. On sites downslope of lithic substrates or with soils of clay-loam texture, species such as *Allocasuarina littoralis, Banksia oblongifolia, B. spinulosa, Ptilothrix deusta* and *Themeda australis*, may also be present in the understorey.	Endangered		Low
Sydney Freshwater Wetlands in the Sydney Basin Bioregion	A complex of vegetation types largely restricted to freshwater swamps in coastal areas. These also vary considerably due to fluctuating water levels and seasonal conditions. Characteristic species include sedges and aquatic plants such as *Baumea* species, *Eleocharis sphacelata*, *Gahnia* species, *Ludwigia peploides* subsp. *montevidensis* and *Persicaria* species. Occurs on sand dunes and low-nutrient sandplains along coastal areas in the Sydney Basin bioregion. It is known from the Lake Macquarie, Wyong, Gosford, Pittwater, Warringah, Woollahra, Waverley, Botany, Rockdale, Randwick, Sutherland and Wollongong local government areas, but is likely to occur elsewhere within the bioregion. Has been extensively cleared and filled and remnants are often small and disturbed. Largely restricted to freshwater swamps in swales and depressions on sand dunes and low nutrient sandplains such as those of the Warriewood and Tuggerah soil landscapes. Swampy areas on alluvium with a saline influence do not fall within this community.	Endangered		None

Threatened Ecological Community	Description	BC Act Status	EPBC Act Status	Likelihood of occurrence within Study Area
Themeda grassland on seacliffs and coastal headlands in the NSW North Coast, Sydney Basin and South East Corner Bioregions	Themeda Grassland on seacliffs and coastal headlands is found on a range of substrates in the NSW North Coast, Sydney Basin and South East Corner bioregions. Stands on sandstone are infrequent and small. Larger stands are found on old sand dunes above cliffs, as for example at Cape Banks and Henry Head in Botany Bay National Park, and on metasedimentary headlands, as for example at McCauleys Headland in Coffs Coast Regional Park, Look-at-me-now Headland, Dammerels Head and Bare Bluff in Moonee Beach Nature Reserve and Wilson's Headland in Yuraygir National Park. Individual stands of the community are often very small, a few square metres, but at some sites larger stands of up to several hectares or tens of hectares occur. Overall, the community has a highly restricted geographic distribution comprising small, but widely scattered patches. The community is found on a range of substrates, although stands on sandstone are infrequent and small. Larger stands are found on old sand dunes above cliffs, for example at Cape Banks and Henry Head in Botany Bay National Park, and on metasedimentary are rarely adamellite headlands on the north coast. Individual stands of the community are often very small, a few square metres, but at some sites larger stands of up to several hectares or tens of hectares occur. Overall, the community therefore has a highly restricted geographic distribution comprising small, but widely scattered patches.	Endangered		None
Umina Coastal Sandplain Woodland in the Sydney Basin Bioregion	A low woodland dominated by trees of Eucalyptus botryoides and Angophora floribunda with a diverse understorey of sclerophyllous shrubs species including Banksia integrifolia, Banksia serrata, Monotoca elliptica, Macrozamia communis, Acacia ulicifolia, Platysace lanceolata, Acacia suaveolens and Allocasuarina littoralis. Eucalyptus botryoides is the dominant tree in the zone immediately behind the beach, while Angophora floribunda is dominant in the zone beyond up to 2 km from the beach. Largely restricted to coastal sands on the Umina, Woy Woy and Ettalong Sandplain, a beach ridge system within the Gosford local government area. Including ecotonal areas, less than 10% (being less than 10 hectares) of the community's estimated original cover of about 80 hectares remains. This comprises four main remnants at Umina, while a few smaller remnant patches and scattered trees around Pearl Beach and Patonga and elsewhere on the 'Peninsula' indicate its former distribution.	Endangered		None
Warkworth Sands Woodland in the Sydney Basin Bioregion	Warkworth Sands Woodland is a low woodland dominated by *Angophora floribunda* (Rough-barked Apple) and *Banksia integrifolia* subsp. *integrifolia*(Coast Banksia). Other tree species may be present such as *Eucalyptus tereticornis* (Forest Red Gum)and *E. glaucina* (Slaty Red Gum). Shrub and ground layer species commonly present include *Acacia filicifolia* (Fern-leaved Wattle), *Melaleuca thymifolia* (Thyme Honey-myrtle), *Brachyloma daphnoides* (Daphne Heath), *Pteridium esculentum* (Bracken), *Pimelea linifolia* (Slender Rice Flower), *Imperata cylindrica* var. *major* (Blady Grass), *Chrysocephalum apiculatum* (Common Everlasting) and *Glycine clandestina*. Small drainage lines within the area occuied by this community may support the presence or higher abundance of certain species (such as *Melaleuca thymifolia*) and the absence or lower abundance of others (such as *Banksia integrifolia* subsp. *integrifolia*). Such areas are included as part of this community.	Endangered	Critically Endangered	None
White Box, Yellow Box, Blakely's Red Gum Woodland and Derived Native Grassland	White Box Yellow Box Blakely's Red Gum Woodland (commonly referred to as Box-Gum Woodland) is an open woodland community (sometimes occurring as a forest formation), in which the most obvious species are one or more of the following: White Box Eucalyptus albens, Yellow Box E. melliodora and Blakely's Red Gum E. blakelyi. Intact sites contain a high diversity of plant species, including the main tree species, additional tree species, some shrub species, several climbing plant species, many grasses and a very high diversity of herbs. The community also includes a range of mammal, bird, reptile, frog and invertebrate fauna species. Intact stands that contain diverse upper and mid-storeys and groundlayers are rare.	Endangered	Critically Endangered	None

Appendix 2. Plant Community Type Descriptions

PCT1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland on coastal sands of the Central and Lower North Coast

Habitat: PCT1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland has been mapped as occurring throughout the majority of the Study Area, in four different condition classes:

- Rehabilitation Area 1 = 19.72 ha (Photo 4)
- Rehabilitation Area 2 = 3.87 ha (Photo 5)
- Rehabilitation Area 4 = 5.20 ha (Photo 6)
- Remnant = 3.91 ha (Photo 7).

Whilst it is noted in this report that much of the Study Area consists of planting, as per the OEH (2018) Biodiversity Assessment Method Operational Manual, '*Planted native vegetation is treated in the same way as native vegetation if it meets the definition of native vegetation in Section 5A of the Local Land Services Act 2013. Where the vegetation is a mix of local and non-local planted species the assessor should consider the best matching PCT based on the local species present*'. As such, we have aligned the areas of native rehabilitated land to PCT1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland due to the following:

- PCT1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland occupied the Study Area prior to vegetation clearing for the former inland extraction area; and
- The canopy tubestock planted within the Study Area (*Eucalyptus pilularis, Corymbia gummifera*, and *Angophora costata*) are the dominant species of PCT1646.

The structure of the PCT within the Study Area is highly attributed to the age of the regeneration that has taken place over the past decade. The structure associated with each of the vegetation zones have been provided in the table below.

In summary, the vegetation recorded within the Study Area is consistent with the description of the PCT due to the following:

- The dominant canopy species recorded within the Study Area comprised of *Eucalyptus pilularis, Corymbia gummifera,* and *Angophora costata* which are dominants of PCT1646;
- The Study Area occurs on quaternary dune sands;
- The structure of the remnant condition class is an open Forests to woodlands dominated in the canopy by Angophora's;
- The structure of the remnant condition class consists of a sparse mid-stratum is typically characterised by Banksia's; and
- The structure of the remnant condition class is relatively sparse and is characterised by grasses and ferns.

Conservation Status: PCT1646 does not align to any TECs under the BC Act or EPBC Act.

Condition classes: Four condition classes were assigned to PCT1646 within the Study Area:

Condition class	Description	Photo of vegetation zone
Rehabilitation Area 1 Area = 19.72 ha	Canopy: dominated by planted E*ucalyptus pilularis,* and *Corymbia gummifera.* The age of eucalypts are approximately 10 years old. None have developed hollows and are approximately 5 metres in height. Midstorey and shrub layer: Relatively sparse shrub layer consisting of planted native species: *Acacia sophorae, A. suaveolens, A. ulicifolia, Allocasuarina littoralis, Angophora costata, Aotus ericoides,* and *Leptospermum* species. Ground cover: Very sparse ground cover dominated by planted and naturally regenerating species including: *Lomandra longifolia, Pteridium esculentum, Imperata cylindrica, Hibbertia virgata,* and *Themeda australis.*	 **Photo 4. PCT1646 Rehabilitation_Area_1 within the Study Area**
Rehabilitation Area 2 Area = 3.87 ha	Canopy: No large canopy present. Very sparse planted *Angophora costata* and *Corymbia gummifera*. Many of the canopy species are less than 2 metres in height and are sparsely scattered throughout the zone. Midstorey: Very sparsely scattered tubestock of *Acacia suaveolens, Allocasuarina littoralis, Banksia serrata, Bossiaea heterophylla* and *Dillwynia retorta*. Ground cover was particularly sparse in term of native vegetation cover. Some planted success of *Carpobrotus glaucescens, Lomandra longifolia, Pteridium esculentum, Imperata cylindrica, Hibbertia virgata,* and *Themeda australis.*	 **Photo 5. PCT1646 Rehabilitation_Area_2 within the Study Area**
Rehabilitation Area 4 Area = 5.20 ha	Canopy: No large canopy present. Very sparse planted *Angophora costata* and *Corymbia gummifera*. Many of the canopy species are less than 1 metres in height and are sparsely scattered throughout the zone. Midstorey: Very sparsely scattered tubestock of *Acacia suaveolens, Allocasuarina littoralis, Banksia serrata, Bossiaea heterophylla* and *Dillwynia retorta.* Ground cover was particularly sparse in term of native vegetation cover. Some planted success of *Carpobrotus glaucescens, Lomandra longifolia, Imperata cylindrica,* and *Themeda australis.*	 **Photo 6. PCT1646 Rehabilitation_Area_4 within the Study Area**

Condition class	Description	Photo of vegetation zone
Remnant Area = 3.91 ha	Canopy: dominated by *Eucalyptus pilularis, Angophora costata* and *Corymbia gummifera*. Typical height is approximately 12 metres and 30% Projected foliage cover. Midstorey and shrub layer: Relatively moderate to dense cover of shrubs including: *Acacia sophorae, A. ulicifolia, Banksia integrifolia, B. serrata, Bossiaea rhombifolia, Leptospermum* species. Ground cover: Dominant species include: *Pteridium esculentum, Imperata cylindrica, Themeda australis, Glycine* species, *Hibbertia virgata.*	 **Photo 7. PCT1646 Remnant within the Study Area**

PCT1644 - Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower North Coast

Habitat: PCT1646 - Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes has been mapped as occurring to the east of the Study Area as a 3.91 hectare patch. The area has been historically cleared and rehabilitated with tubestock and natural regeneration comprising predominately of *Leptospermum laevigatum* (Photo 8).

The area of rehabilitation has been aligned to PCT1646 given the following:

- Dominance of *Leptospermum laevigatum* which is a key diagnostic species of the PCT;
- Occasional *Banksia serrata* and *Angophora costata* which are also key diagnostic upper stratum species; and
- The following species were recorded in the vegetation zone and are diagnostic species of the PCT - *Acacia longifolia, Dodonaea triquetra, Ricinocarpos pinifolius, Monotoca elliptica, Kennedia rubicunda, Pteridium esculentum, Lomandra longifolia* and *Hardenbergia violacea.*

The structure of the PCT within the Study Area is described as follows:

Canopy: Occasional presence of *Angophora costata* more towards the patch boundaries. The canopy has a Projected foliage cover of approximately 5-10 percent and is approximately 15 metres in height.

Midstorey and shrub layer: Dominated by *Leptospermum laevigatum* which forms a thicket in areas. Other shrubs include *Allocasuarina littoralis*, *Acacia longifolia, Dodonaea triquetra, Ricinocarpos pinifolius, Monotoca elliptica.*

Ground layer: A very sparse ground layer which is likely attributed to the high amounts of leave litter and the shading from the *Leptospermum laevigatum* across the vegetation zone. Common ground cover recorded included: *Imperata cylindrica, Themeda australis, Dianella caerulea,* and *Pomax umbellata.*

Conservation Status: This PCT does not align to a TEC under State or Commonwealth legislation.



Photo 8. PCT1644 - Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes within the Study Area

Non-native vegetation

Portions of the Study Area where there are no native species present have been attributed to a 'non-native' vegetation type. These areas typically include existing access tracks, haul road, areas of bare sand, and existing infrastructure.

Appendix 3. Floristic plot data

Plot Data extracted from Fulcrum digital data collection – Evidence of the raw Fulcrum data files can be provided upon request as handwritten datasheets are no longer used. The below species lists can be provided in excel format upon request.

Species	Common Name	3706LB343		3706LB320		3706LB319		3706LB314		3706LB311		3706LB344		3706LB339		3706LB336		3706LB330		3706LB321		3706LB304		3706LB341		3706LB349	
		C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A
Carpobrotus glaucescens	Pigface			1	20	1	30	0.5	10							5	30	0.2	3			0.5	10	1	5	1	5
*Hydrocotyle bonariensis**																		0.1	2								
Platysace lanceolata	Shrubby Platysace	1	5											2	20												
*Bidens pilosa**	Cobbler's Pegs					0.2	20	0.3	20							0.1	5										
Cassinia arcuata	Sifton Bush					0.2	1									0.2	1										
*Chrysanthemoides monilifera**		5	10			0.5	5					2	30	0.1	1	0.2	1					0.1	1	2	10		
*Heterotheca grandiflora**	Telegraph Weed			1	50			50	1000							0.1	20	1	100								
*Hypochaeris radicata**	Catsear															0.1	2										
*Sonchus oleraceus**	Common Sowthistle					0.1	1																				
Pandorea pandorana	Wonga Wonga Vine	0.1	1									2	50	0.1	1												
Wahlenbergia gracilis	Sprawling Bluebell			0.5	30	0.1	20	0.1	1					0.2	20	0.5	50					0.1	1				
*Petrorhagia dubia**								0.1	1																		
Allocasuarina littoralis	Black She-Oak	1	1	1	2					2	5			2	3	0.5	1			0.5	1			1	3	5	5
Carex spp.						0.1	1																				
Pteridium esculentum	Bracken	3	100			0.1	1					70	200	1	20							0.5	5				

Species	Common Name	3706LB343		3706LB320		3706LB319		3706LB314		3706LB311		3706LB344		3706LB339		3706LB336		3706LB330		3706LB321		3706LB304		3706LB341		3706LB349	
		C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A
Hibbertia virgata										0.1	1	0.5	5			0.2	5										
Leucopogon parviflorus	Coastal Beard-heath	5	10	2	10	5	5			20	50	40	30	2	10	1	20					2	10	15	20		
Ricinocarpos pinifolius	Wedding Bush									0.5	10					0.1	1					0.2	5				
Aotus ericoides										0.5	3									0.5	1					1	3
Bossiaea heterophylla	Variable Bossiaea			0.2	2											0.2	1					0.2	2				
Bossiaea rhombifolia						0.5	5			1	30	1	20			0.2	15	0.2	2			30	50	5	20	1	5
Bossiaea scolopendria				0.5	5											0.5	1										
Dillwynia retorta				1	20					1	10							1	5	2	10					2	8
Glycine tabacina	Variable Glycine			0.1	1							0.5	20			0.1	1							1	3		
Hardenbergia violacea	False Sarsaparilla			1	20	0.5	5			0.1	2							0.5	2	0.1	1	0.1	1	1	2		
Kennedia rubicunda	Dusky Coral Pea											2	10	0.5	10	0.1	2			0.2	3					0.5	3
Acacia longifolia		5	20	20	20	5	5	2	10	0.1	3	1	10			5	10	10	50	0.5	1	5	15	10	20	2	5
Acacia suaveolens	Sweet Wattle			0.1	1	0.2	1			0.1	2																
Acacia ulicifolia	Prickly Moses					0.2	1			0.1	1	0.1	1					0.1	1			0.5	10				
Gonocarpus tetragynus	Poverty Raspwort											0.5	10														
Gonocarpus teucrioides	Germander Raspwort	2	10	0.5	20					0.5	20					0.5	20					0.1	1				
Lomandra longifolia	Spiny-headed Mat-rush			0.2	2	0.2	3			5	50	2	50	1	10	0.5	10					2	20	5	15		
Eustrephus latifolius	Wombat Berry											0.1	1														

Species	Common Name	3706LB343		3706LB320		3706LB319		3706LB314		3706LB311		3706LB344		3706LB339		3706LB336		3706LB330		3706LB321		3706LB304		3706LB341		3706LB349	
		C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A
Angophora costata	Sydney Red Gum	3	3	3	5	0.5	2	3	6	2	2	60	20	5	3	5	10			5	10	2	3	5	3	20	20
Corymbia gummifera	Red Bloodwood	3	2	2	4					10	10	5	2	3	1							2	3			3	2
Eucalyptus pilularis	Blackbutt	2	2			40	30			10	20			30	15							40	25			10	5
Leptospermum laevigatum	Coast Teatree	60	50	1	1																			80	100		
*Oenothera indecora subsp. bonariensis**				0.5	20			15	500									5	150								
Corybas aconitiflorus	Spurred Helmet Orchid											0.2	10														
Gastrodia sesamoides	Cinnamon Bells													0.1	1												
Oxalis rubens														0.5	20												
*Passiflora spp.**						0.5	1																				
Dianella caerulea var. producta		3	6	0.5	20	5	100			0.1	1	0.5	10	20	200	0.3	10					2	30	3	25		
Breynia oblongifolia	Coffee Bush					0.1	1																	1	1		
Poranthera corymbosa										0.1	1																
Poranthera ericifolia																0.1	1										
Cynodon dactylon	Common Couch													0.2	10												
*Ehrharta erecta**	Panic Veldtgrass																							1	10		
Eragrostis brownii	Brown's Lovegrass							0.2	3													0.5	10				
*Eragrostis curvula**	African Lovegrass			5	100	5	50											5	50							0.5	6
Imperata cylindrica	Blady Grass	3	200			0.1	5	20	1000	0.5	20	1	50	10	100	40	1000					10	50				

Species	Common Name	3706LB343		3706LB320		3706LB319		3706LB314		3706LB311		3706LB344		3706LB339		3706LB336		3706LB330		3706LB321		3706LB304		3706LB341		3706LB349	
		C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A
*Melinis repens**	Red Natal Grass			40	1000	40	1000	50	1000					0.2	20	50	1000	1	30			0.5	5	2	100		
*Panicum maximum**	Guinea Grass					40	1000							1	50									3	80		
Rytidosperma spp.												0.1	1														
Themeda australis	Kangaroo Grass	2	100									2	50			3	50					0.5	30	11	100		
Banksia integrifolia	Coast Banksia											0.5	1											1	2	2	3
Banksia serrata	Old-man Banksia	2	3	1	2	1	3	0.5	1			1	3	2	3					2	10						
Persoonia levis	Broad-leaved Geebung											2	1														
Persoonia oblongata		5	10	1	3	0.8	3	0.5	1	0.1	1			0.2	1	10	30			1	3	2	5			1	2
Pomaderris elliptica																										0.1	1
Pomax umbellata	Pomax															0.5	15										
Exocarpos cupressiformis	Cherry Ballart											1	1														
*Gnidia squarrosa**				2	100			5	500							0.1	2	0.1	5								

Note: * = exotic species; C = Cover; A = Abundance

Appendix 4. Plot BAM attribute scores

Composition and structure

PCT	Condition	Plot	Easting	Northing	Zone	Compass direction	Tree	Shrub	Grass and grass like	Forb	Fern	Other
1646	Rehab_Area1	3706LB304	6364611	390457.51	56	270	5	7	3	3	1	1
1646	Rehab_Area1	3706LB311	6364835	390618.45	56	250	4	10	1	4	0	1
1646	Rehab_Area2	3706LB314	6364902	390742.93	56	53	4	2	2	3	0	5
1646	Rehab_Area1	3706LB319	6364855	390795.4	56	8	5	7	2	4	1	2
1646	Rehab_Area2	3706LB320	6364919	390846.3	56	43	6	6	0	5	0	2
1646	Rehab_Area4	3706LB321	6364870	390933.9	56	38	3	3	0	2	0	1
1646	Rehab_Area4	3706LB330	6365058	391182.0	56	272	1	3	0	1	0	1
1646	Rehab_Area4	3706LB353	6265083	391077.0	56	96	0	10	3	2	0	1
1646	Remnant	3706LB339	6364923	391167.8	56	175	6	2	2	7	1	0
1644	Rehab_Area3	3706LB341	391334	6364885	56	88	4	5	1	3	0	2
1644	Rehab_Area3	3706LB343	6364712	391302.1	56	92	2	4	1	2	1	2
1646	Remnant	3706LB344	6364678	391298.6	56	190	4	7	3	6	1	2
1646	Rehab_Area1	3706LB349	6365205	391348.1	56	200	6	5	0	2	0	0

Function scores

PCT	Condition	Plot	Tree	Shrub	Grass and grass like	Forb	Fern	Other	Regen
1646	Rehab_Area1	3706LB304	44.6	39.9	11.0	4.1	0.5	0.1	Absent
1646	Rehab_Area1	3706LB311	24.0	22.6	0.5	6.6	0.0	0.1	Absent
1646	Rehab_Area2	3706LB314	4.1	2.5	20.2	0.0	0.0	0.0	Absent
1646	Rehab_Area1	3706LB319	42.6	11.8	0.2	45.4	0.0	1.0	Absent
1646	Rehab_Area2	3706LB320	8.5	24.3	0.0	2.7	0.0	1.1	Absent
1646	Rehab_Area4	3706LB321	7.5	2.0	0.0	2.2	0.0	0.1	Absent

PCT	Condition	Plot	Tree	Shrub	Grass and grass like	Forb	Fern	Other	Regen
1646	Rehab_Area4	3706LB330	0.2	10.3	0.0	1.0	0.0	0.5	Absent
1646	Rehab_Area4	3706LB353	0	5	1	0.5	0	0.1	Absent
1646	Remnant	3706LB339	42.2	2.2	10.2	23.2	1.0	0.0	Present
1644	Rehab_Area3	3706LB341	8.0	80.0	11.0	11.0	0.0	2.0	Absent
1644	Rehab_Area3	3706LB343	11.0	75.0	5.0	5.1	3.0	0.0	Absent
1646	Remnant	3706LB344	66.5	45.6	3.1	7.2	70.0	0.6	Present
1646	Rehab_Area1	3706LB349	41.0	5.1	0.0	2.5	0.0	0.0	Absent

Function scores (continued)

PCT	Condition	Plot	5-9	10 to 19	20-29	30-49	50-79	No >50cm	HBT	Litter cover	FL	High threat weed
1646	Rehab_Area1	3706LB304	Y	Y	N	N	N	0	0	90.0	12.0	0.0
1646	Rehab_Area1	3706LB311	Y	Y	N	N	N	0	0	70.0	22.0	0.0
1646	Rehab_Area2	3706LB314	Y	N	N	N	N	0	0	30.0	10.0	0.3
1646	Rehab_Area1	3706LB319	Y	Y	Y	N	N	0	0	80.0	8.0	5.2
1646	Rehab_Area2	3706LB320	Y	N	N	N	N	0	0	20.0	14.0	5.0
1646	Rehab_Area4	3706LB321	Y	N	N	N	N	0	0	5.0	26.0	0.0
1646	Rehab_Area4	3706LB330	Y	N	N	N	N	0	0	5.0	0.0	5.0
1646	Rehab_Area4	3706LB353	Y	N	N	N	N	0	0	5	5	0
1646	Remnant	3706LB339	Y	Y	Y	Y	Y	0	4	80.0	10.0	0.0
1644	Rehab_Area3	3706LB341	Y	Y	N	N	N	0	0	85.0	1.0	1.0
1644	Rehab_Area3	3706LB343	Y	N	N	N	N	0	0	90.0	0.0	0.0
1646	Remnant	3706LB344	Y	Y	Y	Y	Y	0	5	75.0	10.0	0.0
1646	Rehab_Area1	3706LB349	Y	Y	Y	N	N	0	0	50.0	0.0	0.5

Appendix 5. Fauna species list in Study Area

Group	Scientific name	Common name	Status	Observation type
Aves	*Cracticus tibicen*	Australian Magpie	P	H
Aves	*Corvus coronoides*	Australian Raven	P	O H
Aves	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike	P	H
Aves	*Platycercus elegans*	Crimson Rosella	P	O H
Aves	*Acanthorhynchus tenuirostris*	Eastern Spinebill	P	O H
Aves	*Psophodes olivaceus*	Eastern Whipbird	P	O H
Aves	*Eopsaltria australis*	Eastern Yellow Robin	P	O H
Aves	*Cacomantis flabelliformis*	Fan-tailed Cuckoo	P	O H
Aves	*Rhipidura albiscapa*	Grey Fantail	P	H
Aves	*Dacelo novaeguineae*	Laughing Kookaburra	P	O H
Aves	*Dicaeum hirundinaceum*	Mistletoebird	P	O H
Aves	*Phylidonyris novaehollandiae*	New Holland Honeyeater	P	O H
Aves	*Manorina melanocephala*	Noisy Miner	P	O H
Aves	*Strepera graculina*	Pied Currawong	P	O H
Aves	*Zosterops lateralis*	Silvereye	P	O H
Aves	*Cacatua galerita*	Sulphur-crested Cockatoo	P	O H
Aves	*Malurus cyaneus*	Superb Fairy-wren	P	O H
Aves	*Sericornis frontalis*	White-browed Scrubwren	P	O H
Aves	*Rhipidura leucophrys*	Willie Wagtail	P	O H
Aves	*Acanthiza nana*	Yellow Thornbill	P	O H
Aves	*Corvus coronoides*	Australian Raven	P	H
Mammalia	*Trichosurus vulpecula*	Common Brushtail Possum	P	O
Mammalia	*Oryctolagus cuniculus*	Rabbit	U	O
Mammalia	*Miniopterus schreibersii*	Eastern Bentwing Bat	V	Anabat
Mammalia	*Scoteanax rueppellii*	Greater Broad-nosed Bat	V	Anabat
Reptilia	*Physignathus lesueurii*	Eastern water dragon	P	O
Reptilia	*Pseudechis porphyriacus*	Red-bellied black snake	P	O
Reptilia	*Eulamprus quoyii*	Eastern water-skink	P	O

Key: P = Protected; V = Vulnerable; E = Endangered; - U = not listed under act (exotic/introduced species).

Appendix 6. Biodiversity Credit Calculator Report

BAM Credit Summary Report

Proposal Details

Assessment Id	Proposal Name	BAM data last updated *
00016526/BAAS17033/19/00016527	3706 Stockton SSD	26/11/2019
Assessor Name	Report Created	BAM Data version *
	09/12/2019	22
Assessor Number	BAM Case Status	Date Finalised
	Open	To be finalised
Assessment Revision	Assessment Type	
0	Major Projects	

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

Ecosystem credits for plant communities types (PCT), ecological communities & threatened species habitat

Zone	Vegetation zone name	Vegetation integrity loss / gain	Area (ha)	Constant	Species sensitivity to gain class (for BRW)	Biodiversity risk weighting	Potential SAII	Ecosystem credits
Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower North Coast								
5	1644_Rehab_Area 3	19.0	3.9	0.25	High Sensitivity to Potential Gain	2.00		37
							Subtotal	**37**

Smooth-barked Apple - Blackbutt - Old Man Banksia woodland on coastal sands of the Central and Lower North Coast								
1	1646_Rehab_Area 1	42.2	19.8	0.25	High Sensitivity to Potential Gain	1.50		313
2	1646_Rehab_Area 2	22.2	3.9	0.25	High Sensitivity to Potential Gain	1.50		32
3	1646_Rehab_Area 4	7.5	5.3	0.25	High Sensitivity to Potential Gain	1.50		0
4	1646_Remnant	46.4	2.9	0.25	High Sensitivity to Potential Gain	1.50		51
							Subtotal	**396**
							Total	**433**

Species credits for threatened species

Vegetation zone name	Habitat condition (HC)	Area (ha) / individual (HL)	Constant	Biodiversity risk weighting	Potential SAII	Species credits
Petaurus norfolcensis / Squirrel Glider (Fauna)						
1646_Rehab_Area1	42.2	19.77	0.25	2	False	417
1646_Rehab_Area4	7.5	0	0.25	2	False	0
1646_Remnant	46.4	2.91	0.25	2	False	67
1644_Rehab_Area3	19.0	3.91	0.25	2	False	37
					Subtotal	**521**

Appendix 7. Threatened species assessments of significance under the EPBC Act

Matters for Assessment

Assessments of Significance and supplementary information (where relevant) are presented for the following MNES in relation to the Project:

- Australian Painted Snipe
- Black-faced Monarch
- White-throated Needletail
- Red Goshawk
- Long-nosed Potoroo
- Koala
- New Holland Mouse
- Grey-headed Flying-fox.

Koala

In assessing the significance of the impact from the proposed action on the Koala the '*EPBC Act referral guidelines for the vulnerable koala*' were applied to the assessment. The following information is presented prior to the Assessment of Significance for the Koala to demonstrate application of the guidelines and to assist with understanding the assessment and its conclusion.

Koala Habitat Assessment Scoring (Department of the Environment (2014). EPBC Act Referral Guidelines for the vulnerable Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory). Commonwealth of Australia, 2014.):

Attribute	Score	Habitat Appraisal
Koala occurrence	+1	Koalas have been encountered infrequently adjacent to the Study Area as evident with the records from Bionet. This is within 2 km of the Study Area boundary. Survey data concludes that the Koala is not frequently using the Study Area.
Vegetation Structure and composition	0	Habitat scoring was applied across the Study Area using floristic data and cover values from 400m^2 quadrats. The mapping indicated that the majority of the Project area did not contain either two or more known primary or secondary feed trees that occupied more than 50% of the quadrat.
Habitat connectivity	+2	The area is part of a contiguous landscape of > than 500 hectare.
Key existing threats	+1	There is no known documented or anecdotal evidence of Koala mortality from dog attack or vehicle collision within the Study Area or surrounds. Dogs, trucks, and vehicle movements are all present within the Study Area.
Recovery value	0	Uncertain whether the habitat within the Study Areas will be important in achieving the interim recovery objectives. The habitat is not thought to specifically act as a habitat refuge. The Study Area has already been impacted and Koalas are still occurring within the locality which demonstrates that the Study Area is not of significance importance to the survival of the population.
Total	**4/10**	

Koala (vulnerable)	
Criteria (Vulnerable Species)	Likelihood
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
lead to a long-term decrease in the size of an important population of a species;	
It is considered unlikely that the Project would lead to a long-term decrease in the size of an important population of the Koala. Given the Study Area has been previously cleared, and the population of Koala within the locality are still utilising the habitat features of the stretch of the vegetation corridor which encompasses Worimi Regional Park and Worimi State Conservation Area, indicates that the removal of the vegetation within the Study Area is unlikely to decrease the size of the Koala population within the locality.	Unlikely
reduce the area of occupancy of an important population;	
No important population occurs within the Study Area. The Study Area has historically been cleared and now predominately costs of rehabilitated native vegetation. The Project would not impact the area of occupancy of any population of the Koala as the areas to be cleared are not sufficient in extent to impact the area of occupancy of the Koala at such as scale to decrease foraging and sheltering habitat. Koalas would still be expected to occur within the vicinity of the locality.	Unlikely
fragment an existing important population into two or more populations;	
The Project is unlikely to increase fragmentation for the identified population. As previously discussed, the Study Area has been previously cleared, and the Koalas has still persisted within the locality. The removal of native vegetation within the Study Area would not isolate a population. Movement would not be restricted.	Unlikely
adversely affect habitat critical to the survival of a species;	
The habitat within the Study Area is not regarded as habitat critical to the survival of the Koala as determined through application of the Koala habitat assessment tool (DOE 2014), which is illustrated in the table above. The habitat within the disturbance area scores a 4/10. A score of less than 5 does not indicate critical habitat.	Unlikely
disrupt the breeding cycle of an important population	
Habitat within the disturbance area is not thought to be a key breeding area due to the low number of records, lack of evidence during field surveys, and the historic cleared habitat. Therefore removal of the habitat is unlikely to disrupt the breeding cycle of the population. The area constitutes a very small proportion of the overall habitat for the population as clearing evidence by the scale of the vegetation corridor along Stockton Beach.	Unlikely
modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;	
The Study Area has been previously cleared and rehabilitated. The current rehabilitation does not contain primary or secondary feed trees. The surrounding locality offers a greater availability of foraging habitat for the Koala. The removal of the vegetation within the Study Area is unlikely to have any impact on patterns of Koala movement.	Unlikely
result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;	
Invasive species such as foxes that may impact on the Koala are already established within the locality. The Project is unlikely to further encourage these threats from occurring.	Unlikely
introduce disease that may cause the species to decline, or	

The main diseases affecting Koalas are chlamydial infections. The Project would not increase exposure to such infections as Koalas from the local population would not have increased contact with other Koala populations including infected populations.	Unlikely
interfere substantially with the recovery of the species.	
The following aspects are considered in relation to the possibility of the Project to interfere with the recovery of the Koala (from DOE 2014): *Increasing koala fatalities in habitat critical to the survival of the koala due to dog attacks to a level that is likely to result in multiple, ongoing mortalities.* There is no reason to suspect that dogs would become more prevalent within the Study Area or surrounds as a result of the Project; *Increasing koala fatalities in habitat critical to the survival of the koala due to vehicle-strikes to a level that is likely to result in multiple, ongoing mortalities.* There have been no reported Koala fatalities due to vehicle strike within the quarry or along access roads. Additional vehicle movements are expected to occur as a result of the Project but would be negligible, with the Project mostly ensuring the continuation of the current regime of vehicle movements within the Project area. There are strict speed controls on the vehicles operating within the quarry and as such it is considered that the risk of increased fatalities such that multiple ongoing fatalities occur is very low; *Facilitating the introduction or spread of disease or pathogens for example Chlamydia or Phytophthora cinnamomi, to habitat critical to the survival of the koala, that are likely to significantly reduce the reproductive output of koalas or reduce the carrying capacity of the habitat*; This is considered unlikely as there would be no new sources of contamination as a result of the Project. The Project would not lead to Koalas being transported to the site from other areas. If vehicles coming to and from the quarry are considered to be a potential agent of *Phytophthora cinnamomi,* the Project would not lead to a change in the source areas where vehicles travel from to arrive at the quarry and therefore it is not considered that the Project increases the risk of *Phytophthora cinnamomi* spread; *Creating a barrier to movement to, between or within habitat critical to the survival of the koala that is likely to result in a long-term reduction in genetic fitness or access to habitat critical to the survival of the koala.* The proposed disturbance footprint is an extremely small proportion of Koala habitat for the population and the species. Its removal would have a minor impact on patterns of Koala movement and no isolation between populations would occur from the Project; and *Changing hydrology which degrades habitat critical to the survival of the koala to the extent that the carrying capacity of the habitat is reduced in the long-term.* The Project is unlikely to alter the hydrology to the extent that it would result in the degradation of remaining habitat critical to the survival of the Koala.	Unlikely
Conclusion: Impacts from the Project largely relate to the removal of habitat that has not been defined as being critical to the survival of the Koala. Due to the apparent limited use of the Study Area and its extremely small extent in relation to other habitat where Koala records occur, it is not considered that removal of this habitat alone would significantly adversely impact a Koala population.	

Migratory Species - Black-faced Monarch, White-throated Needletail	
Preamble: The above species all have potential habitat within the Study Area that would be impacted from the proposed action. All of the species subject to this assessment are considered to occur within the Study Area on an irregular basis and the habitat within the Study Area is similar to widespread and common habitat within the locality for these species.	
Criteria (Migratory Species)	**Likelihood**
An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:	
substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species, or	
No important habitat for any of the potentially occurring migratory species is considered to occur within the Study Area.	Unlikely
result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or	
No invasive species of particular significance to the identified migratory species are expected to be established as a result of the Project. The Study Area is already affected by invasive plants including some high threat weeds and introduced fauna such as the Rabbit which have some potential to adversely impact most fauna occurring within the Study Area and surrounds. New invasive species are unlikely to become established due to the Project if mitigation measures are adhered to, including pest and weed management.	Unlikely
seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.	
None of the potentially occurring migratory species would have a significant proportion of their population occurring within the Study Area.	Unlikely
Conclusion: The Project would remove 35.66 hectares of native vegetation, which for the most part, consists of sparsely scattered tubestock with a lack of microhabitat features such as fallen logs and hollow-bearing trees. None of the above species occur in significant numbers within the Study Area and the Study Area does not support significant breeding habitat such that it may be used by a significant number of individuals to conduct any aspect of their lifecycle including foraging, breeding, overwintering or sheltering. The Project is not likely to result in a significant impact on the Black-faced Monarch or the White-throated Needletail.	

Australian Painted Snipe (Endangered)	
Preamble The Australian Painted Snipe requires habitat that provides cover, foraging substrate and close proximity to water. The size of waterbodies used is variable from lakes and rivers to ephemeral puddles although the most important habitats appear to be those that are routinely wet. Cover requirements are variable and relatively flexible with grasses, rushes and reeds, low scrub, lignum, cane grasses or samphire all used (Marchant and Higgins, 2003). Occasionally wet-sown crops are used. There are no NSW BioNet records of the species within a 10 kilometre radius of the Study Area. While the area does not appear to be a stronghold for the species, it can be cryptic due to choosing habitats that people do not typically frequent. There is a marginal quantity of habitat found in the Study Area. The Project would remove 35.66 hectares of native vegetation which provides potential foraging habitat for the Australian Painted Snipe, which for the most part, consists of sparsely scattered tubestock with a lack of microhabitat features such as fallen logs and hollow-bearing trees. Australian Painted Snipe was not detected during the bird surveys completed as part of this assessment. Based on the specific habitat requirements, and the lack detection during surveys, it is likely that the habitat features within the Study Area would only be used on an intermittent basis for foraging. The extensive native vegetation that occurs throughout the land to the north and South within Worimi Regional Park and Worimi State Conservation Area are likely to offer greater habitat availability for the species.	
Criteria (Endangered Species)	**Likelihood**
An action is likely to have a significant impact on an endangered species if there is a real chance or possibility that it will:	
lead to a long-term decrease in the size of a population of a species;	
The population is considered to be a single Australia wide unit thus it is an important population. The Project would remove 35.66 hectares of marginal foraging habitat for the species, which is a minor component of the species potential habitat. Therefore the chance of any long term decrease in the population size due to this action is negligible.	Very unlikely
reduce the area of occupancy of the species;	
The extent of impact within the Study Area is limited to the removal of approximately 35.66 ha of marginal foraging habitat for the species, most of which is rehabilitation. This will not reduce the overall area of occupancy of the population as it occurs Australia wide and is not in any way restricted to that patch. The species is likely to persist throughout the broader Study Area and region at similar levels to present. It should be noted that the rehabilitation of the Study Area would involve the establishment of a pond, which would provide habitat for the species.	Unlikely
fragment an existing population into two or more populations;	
The action will not fragment the population of this highly mobile species.	Unlikely
adversely affect habitat critical to the survival of a species;	
Critical habitat for this species includes a wide range of lakes and wetlands of many forms. The action will not change drainage to or from any wetland.	Unlikely
disrupt the breeding cycle of a population	
It seems unlikely that the Study Area would form regular breeding habitat for the species, given the lack of waterbodies.	Unlikely
modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;	
The action will remove around 35.66 ha of marginal potential foraging habitat. The species will not decline from this habitat impact alone.	Unlikely
result in invasive species that are harmful to a endangered species becoming established in the endangered species' habitat;	

The Project is unlikely to result in an increase in the presence and establishment of invasive species which may impact the Australian Painted Snipe. Any invasive species already have access to establish in the Study Area. The action could potentially improve habitat by controlling weed species and replacing them with native species., which is to be undertaken as part of the proposed mitigation measures.	Unlikely
introduce disease that may cause the species to decline, or	
The Project is unlikely to introduce disease which may lead to a decline of this species.	Unlikely
interfere substantially with the recovery of the species.	
The Project will not impede or interfere substantially with any targeted recovery actions for this species.	Unlikely
Conclusion: The Project is unlikely to have a significant impact on the Australian Painted Snipe.	

Red Goshawk (Vulnerable)	
Preamble This species inhabits coastal and sub-coastal tall open forests and woodlands, tropical savannas traversed by wooded or forested rivers, and the edges of rainforests, usually on fertile soils. The Red Goshawk rarely breeds in areas with fragmented native vegetation. The stick nests, in which 1–2 eggs are laid, are restricted to trees that are taller than 20 m and within 1 km of a watercourse or wetland. The species hunts within a home range of up to 200 km^2 in open forests and gallery forests, taking mostly medium to large birds. The Project would remove 35.66 hectares of native vegetation which provides potential foraging habitat for the Red Goshawk, which for the most part, consists of sparsely scattered tubestock with a lack of microhabitat features such as fallen logs and hollow-bearing trees. Red Goshawk was not detected during the bird surveys completed as part of this assessment. Based on the specific habitat requirements, and the lack detection during surveys, it is likely that the habitat features within the Study Area would only be used on an intermittent basis for foraging. The extensive native vegetation that occurs throughout the land to the north and South within Worimi Regional Park and Worimi State Conservation Area are likely to offer greater habitat availability for the species.	
Criteria (Vulnerable Species)	**Likelihood**
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
lead to a long-term decrease in the size of an important population of a species;	
It is not expected that any impacts on breeding habitat for Red Goshawk would result from the Project as nests were not recorded in the Study Area. Impacts from the Project constitute impacts to foraging habitat of which approximately 35.66 hectares would be cleared. The foraging habitat is considered to be of marginal quality for the species, being mostly rehabilitated land, with a small area of remnant woodland. The significance of this contribution is not expected to be high as the expanse of similar foraging habitat within the locality is high. Over time, foraging habitat would be at least partially restored through rehabilitation works. Regardless of rehabilitation works, potential foraging habitat would remain abundant within the locality and the currently proposed removal of foraging habitat is not expected to cause a long-term decrease to any population of the species.	Unlikely
reduce the area of occupancy of an important population;	
The Project would not impact the area of occupancy of the Red Goshawk for the following reasons: • The areas to be cleared are not sufficient in extent to impact the area of occupancy of the species at a 2 km grid square scale (which is the standard unit for measuring area of occupancy according to the IUCN); and • Red Goshawk would still be expected to forage within the vicinity of the Study Area, given potential habitat extends beyond the Study Area boundary.	Unlikely
fragment an existing important population into two or more populations;	
The Project is unlikely to increase fragmentation for any population of the species. The Red Goshawk is a mobile species and the Project would not impact on breeding habitat.	None
adversely affect habitat critical to the survival of a species;	
Foraging habitat of the type to be removed by the Project is not considered important for the species. Further, given that similar habitat is locally common and well represented within adjacent conservation reserves, the habitat to be removed is not considered critical to the species survival.	Unlikely
disrupt the breeding cycle of an important population	
The Project is unlikely to disrupt the breeding cycle of the species as no nests were recorded in the Study Area.	None
modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;	

The extent of foraging habitat to be removed is not considered sufficient to result in the decline of the species given the local abundance of similar habitat. The Project would not isolate areas of foraging habitat.	Unlikely
result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;	
The Project is unlikely to increase the likelihood of weeds being established in areas adjacent to disturbance areas that constitute potential foraging habitat for the species. The Project will include measures to control weeds becoming established in such areas through the implementation of the Landscape and Rehabilitation Plan. Potential invasive predators such as the fox are likely to be already present within the Study Area and the Project is not expected to increase the level of predation threat for the Red Goshawk.	Unlikely
introduce disease that may cause the species to decline, or	
The Project in not expected to cause an increased risk of any diseases.	Unlikely
interfere substantially with the recovery of the species.	
The Project does not directly or substantially interfere with any of the specific recovery objectives under the National Recovery Plan (Department of Environment and Resource Management 2012), which include: • Monitor Red Goshawk habitat and determine territory occupancy and productivity, and use DNA analyses of feathers to determine adult survival rates; • Collate information on known nest sites from the past 25 years and produce descriptive maps of important habitat and ensure information is secure; • Conduct searches to identify previously unknown pairs of Red Goshawks, nest sites, and habitats critical for Red Goshawk survival; • Identify important populations and nest sites, and use the information to inform monitoring programs and state and federal government planning frameworks; • Provide specific information and advice to assist with the identification, acquisition and management of important habitat for the Red Goshawk; • Conduct research to understand the relationship between habitat fragmentation, prey density and population persistence to better inform management; • Protect habitat through acquisition or voluntary conservation agreements; • Reduce the effects of Red Goshawk habitat fragmentation and degradation by encouraging landholders to protect and manage threatened Red Goshawk territories; • Train personnel from state and local government to identify and understand the threats to Red Goshawk habitat; • Produce and distribute information on the conservation status and habitat requirements of the Red Goshawk; • Provide feedback to the public and agency personnel on progress of Red Goshawk recovery; and • Review the effectiveness of the community awareness program. The removal of marginal foraging habitat as a result of the Project is not considered to constitute substantial interference with the recovery of the species.	Unlikely
Conclusion: Impacts from the Project relate to the removal of foraging habitat for the Red Goshawk within the Study Area. Whilst protection of foraging habitat is considered important for this species, impacts from the Project are not considered to be significant for the following reasons: • The habitat to be removed is not considered to be particularly important foraging habitat in terms of its constitution or size; • Similarly important foraging habitat occurs throughout the locality including within protected areas	

Grey-headed Flying-fox (Vulnerable)	
Preamble This species is a canopy-feeding frugivore and nectarivore of rainforests, open forests, woodlands, melaleuca swamps and banksia woodlands. Bats commute daily to foraging areas, usually within 15 km of the day roost although some individuals may travel up to 70 km. The Grey-headed Flying Fox is only likely to utilise the Study Area on occasion for foraging. No roosting camp sites were observed in the Study Area, nor known to occur within close proximity to the Study Area.	
Criteria (Vulnerable Species)	**Likelihood**
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
lead to a long-term decrease in the size of an important population of a species;	
It is not expected that any impacts on breeding or roosting habitat for the Grey-headed Flying-fox would result from the Project as breeding/roosting camps will not be impacted and do not occur in the Study Area. Impacts from the Project constitute impacts to foraging habitat of which approximately 35.66 hectares would be cleared. The foraging habitat is considered to be of marginal quality for the species, being mostly rehabilitation, with a small area of remnant woodland. There are a variety of different canopy species present within proposed disturbance areas, some of which may contribute to winter and spring food availability. The significance of this contribution is not expected to be high as the expanse of similar foraging habitat within the locality is high. Over time, foraging habitat would be at least partially restored through rehabilitation works and retention of the topsoil would occur as part of rehabilitation works, aiding in maintaining fertility of habitats. Regardless of rehabilitation works, potential foraging habitat would remain abundant within the locality and the currently proposed removal of foraging habitat is not expected to cause a long-term decrease to any population of the species.	Unlikely
reduce the area of occupancy of an important population;	
The Project would not impact the area of occupancy of the Grey-headed Flying-fox for the following reasons: • The areas to be cleared are not sufficient in extent to impact the area of occupancy of the species at a 2km grid square scale (which is the standard unit for measuring area of occupancy according to the IUCN); and • Grey-headed Flying-fox would still be expected to forage within the vicinity of the Study Area, given potential habitat extends beyond the Study Area boundary.	Unlikely
fragment an existing important population into two or more populations;	
The Project is unlikely to increase fragmentation for any population of the species. The Grey-headed Flying-fox is a mobile species and the Project would not impact on areas where the species is known to breed and roost.	None
adversely affect habitat critical to the survival of a species;	
Habitat critical to the survival of the species has been loosely nominated within the draft National Recovery Plan for this species (Commonwealth of Australia 2017) guidelines or a recovery plan for the species, however "productive" areas are acknowledged as potentially being foraging habitat critical to the survival of the species. However, no measure of productivity is given. Whilst the timing of productivity is considered to be important in determining whether habitat is critical to the survival of the species, the timing given as being important covers the entirety of the year (see Commonwealth of Australia 2017). Foraging habitat of the type to be removed by the Project is considered important for the species, due to its capacity to add in some measure to locally available winter foraging resources.	Unlikely

However, given that similar habitat is locally common, is well represented within adjacent conservation reserves, and that winter flowering pulses are not considered to be particularly high within the habitat to be cleared, the habitat to be removed is not considered critical to the species survival.	
disrupt the breeding cycle of an important population	
The Project is unlikely to disrupt the breeding cycle of the species as breeding events for this species primarily take place within camps, none of which would be adversely impacted by the Project.	None
modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;	
The extent of foraging habitat to be removed is not considered sufficient to result in the decline of the species given the local abundance of similar habitat. The Project would not isolate areas of foraging habitat.	Unlikely
result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;	
The Project is unlikely to increase the likelihood of weeds being established in areas adjacent to disturbance areas that constitute potential foraging habitat for the species. The Project will include measures to control weeds becoming established in such areas through the implementation of a Landscape and Rehabilitation Plan. Potential invasive predators such as the fox are likely to be already present within the Study Area and the Project is not expected to increase the level of predation threat for the Grey-headed Flying-fox.	Unlikely
introduce disease that may cause the species to decline, or	
There are no known documented diseases that are currently contributing to the decline of the species. The Project in not expected to cause an increased risk of any bat diseases.	Unlikely
interfere substantially with the recovery of the species.	
The Project does not directly or substantially interfere with any of the specific recovery objectives under the draft National Recovery Plan (Commonwealth of Australia 2017). A general objective is to lessen the currently operating threats to the species which includes the removal of foraging habitat. The Project is therefore not consistent with this general objective. However, the amount and type of foraging habitat removal is not considered to constitute substantial interference with the recovery of the species.	Unlikely
Conclusion: Impacts from the Project relate to the removal of foraging habitat for the Grey-headed Flying-fox within the proposed disturbance areas. Whilst protection of foraging habitat is considered important for this species, impacts from the Project are not considered to be significant for the following reasons: • The habitat to be removed is not considered to be particularly important foraging habitat in terms of its constitution or size; • Similarly important foraging habitat occurs throughout the locality including within protected areas; and • Rehabilitation of areas to be cleared will occur which should mitigate the loss of foraging habitat to some extent.	

Long-nosed Potoroo (Vulnerable)	
Preamble This species inhabits coastal heath and wet and dry sclerophyll forests. Generally found in areas with rainfall greater than 760 mm. Requires relatively thick ground cover where the soil is light and sandy. The Long-nosed Potoroo has been attributed a moderate likelihood of occurrence as the species has been recorded within Worimi Regional Park and Worimi State Conservation Area and may utilise the Study Area for foraging.	
Criteria (Vulnerable Species)	**Likelihood**
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
lead to a long-term decrease in the size of an important population of a species;	
Impacts from the Project constitute impacts to foraging habitat of which approximately 35.66 hectares would be cleared. The foraging habitat is considered to be of marginal quality for the species, being mostly rehabilitation, with a small area of remnant woodland. Over time, foraging habitat would be at least partially restored through rehabilitation works. Regardless of rehabilitation works, potential foraging habitat would remain abundant within the locality and the currently proposed removal of foraging habitat is not expected to cause a long-term decrease to any population of the species.	Unlikely
reduce the area of occupancy of an important population;	
It is unlikely that an important population of the Long-nosed Potoroo occurs in the Study Area, as there is only one previous record of the species within a 10 km radius of the Study Area. The Project would not impact the area of occupancy of the Long-nosed Potoroo for the following reasons: • The areas to be cleared are not sufficient in extent to impact the area of occupancy of the species at a 2km grid square scale (which is the standard unit for measuring area of occupancy according to the IUCN); and • Long-nosed Potoroo would still be expected to forage within the vicinity of the Study Area, given potential habitat extends beyond the Study Area boundary.	Unlikely
fragment an existing important population into two or more populations;	
The Project is unlikely to increase fragmentation for any population of the species. The Long-nosed Potoroo is a mobile species and the Project would not impact on areas where the species is known to occur.	None
adversely affect habitat critical to the survival of a species;	
Habitat critical to the survival of the species is not likely to include the Study Area, as no known previous records occur in the Study Area. Further, the majority of the Study Area does not support the dense understorey that is considered important for the species, as it consists of rehabilitated areas where the understorey and ground cover is sparse. Therefore, the potential foraging habitat to be removed is not considered critical to the species survival.	Unlikely
disrupt the breeding cycle of an important population	
The Project is unlikely to disrupt the breeding cycle of the species as the habitat to be impacted by the Project is marginal and no known populations occur in the Study Area.	None
modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;	
The extent of foraging habitat to be removed is not considered sufficient to result in the decline of the species given the local abundance of similar habitat. The Project would not isolate areas of foraging habitat.	Unlikely

result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;	
The Project is unlikely to increase the likelihood of weeds being established in areas adjacent to disturbance areas that constitute potential foraging habitat for the species. The Project will include measures to control weeds becoming established in such areas through the implementation of a Landscape and Rehabilitation Plan. Potential invasive predators such as the fox are likely to be already present within the Study Area and the Project is not expected to increase the level of predation threat for the Long-nosed Potoroo.	Unlikely
introduce disease that may cause the species to decline, or	
There are no known documented diseases that are currently contributing to the decline of the species. The Project in not expected to cause an increased risk of any diseases.	Unlikely
interfere substantially with the recovery of the species.	
Currently, there is no recovery plan for this species. The amount and type of foraging habitat removal required for the Project is not considered to constitute substantial interference with the recovery of the species.	Unlikely
Conclusion: Impacts from the Project relate to the removal of foraging habitat for the Long-nosed Potoroo within the proposed disturbance areas. Whilst protection of foraging habitat is considered important for this species, impacts from the Project are not considered to be significant for the following reasons: • The habitat to be removed is not considered to be particularly important foraging habitat in terms of its constitution (understorey sparse) or size; • Similarly important foraging habitat occurs throughout the locality including within protected areas; and • Rehabilitation of areas to be cleared will occur which should mitigate the loss of foraging habitat to some extent.	

New Holland Mouse (Vulnerable)	
Preamble The New Holland Mouse currently has a disjunct, fragmented distribution across Tasmania, Victoria, New South Wales and Queensland. Across the species' range the New Holland Mouse is known to inhabit open heathlands, open woodlands with a heathland understorey, and vegetated sand dunes. The New Holland Mouse has been attributed a moderate likelihood of occurrence as the species has been recorded within Worimi Regional Park and Worimi State Conservation Area and may utilise the Study Area for foraging.	
Criteria (Vulnerable Species)	**Likelihood**
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
lead to a long-term decrease in the size of an important population of a species;	
Impacts from the Project constitute impacts to foraging habitat of which approximately 35.66 hectares would be cleared. The foraging habitat is considered to be of marginal quality for the species, being mostly rehabilitation, with a small area of remnant woodland. Over time, foraging habitat would be at least partially restored through rehabilitation works. Regardless of rehabilitation works, potential foraging habitat would remain abundant within the locality and the currently proposed removal of foraging habitat is not expected to cause a long-term decrease to any population of the species.	Unlikely
reduce the area of occupancy of an important population;	
The Project would not impact the area of occupancy of the New Holland Mouse for the following reasons: • The areas to be cleared are not sufficient in extent to impact the area of occupancy of the species at a 2km grid square scale (which is the standard unit for measuring area of occupancy according to the IUCN); and • New Holland Mouse would still be expected to forage within the vicinity of the Study Area, given potential habitat extends beyond the Study Area boundary.	Unlikely
fragment an existing important population into two or more populations;	
The Project is unlikely to increase fragmentation for any population of the species. The New Holland Mouse is a mobile species and the Project would not impact on areas where the species is known to occur.	None
adversely affect habitat critical to the survival of a species;	
Habitat critical to the survival of the species is not likely to include the Study Area, as no known previous records occur in the Study Area. The potential foraging habitat to be removed is not considered critical to the species survival, given the majority of the area to be impacted consists of rehabilitated areas.	Unlikely
disrupt the breeding cycle of an important population	
The Project is unlikely to disrupt the breeding cycle of the species as the habitat to be impacted by the Project is marginal (mostly rehabilitation) and no known populations occur in the Study Area.	None
modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;	
The extent of foraging habitat to be removed is not considered sufficient to result in the decline of the species given the local abundance of similar habitat. The Project would not isolate areas of foraging habitat.	Unlikely
result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;	

The Project is unlikely to increase the likelihood of weeds being established in areas adjacent to disturbance areas that constitute potential foraging habitat for the species. The Project will include measures to control weeds becoming established in such areas through the implementation of a Landscape and Rehabilitation Plan. Potential invasive predators such as the fox are likely to be already present within the Study Area and the Project is not expected to increase the level of predation threat for the New Holland Mouse.	Unlikely
introduce disease that may cause the species to decline, or	
There are no known documented diseases that are currently contributing to the decline of the species. The Project in not expected to cause an increased risk of any diseases.	Unlikely
interfere substantially with the recovery of the species.	
Currently, there is no recovery plan for this species. The amount and type of foraging habitat removal required for the Project is not considered to constitute substantial interference with the recovery of the species.	Unlikely
Conclusion: Impacts from the Project relate to the removal of foraging habitat for the New Holland Mouse within the proposed disturbance areas. Whilst protection of foraging habitat is considered important for this species, impacts from the Project are not considered to be significant for the following reasons: • The habitat to be removed is not considered to be particularly important foraging habitat in terms of its constitution (mostly rehabilitation areas) or size; • Similarly important foraging habitat occurs throughout the locality including within protected areas; and • Rehabilitation of areas to be cleared will occur which should mitigate the loss of foraging habitat to some extent.	

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APPENDIX F

AIR QUALITY IMPACT ASSESSMENT

AIR QUALITY IMPACT ASSESSMENT

STOCKTON SAND QUARRY

Boral Resources (NSW) Pty Ltd

23 September 2019

Job Number 17070718

Prepared by

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Air Quality Impact Assessment
Stockton Sand Quarry

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1 INTRODUCTION

Todoroski Air Sciences has prepared this report for Element Environment Pty Ltd on behalf of Boral Resources (NSW) Pty Ltd (Boral). The report presents an assessment of potential air quality impacts associated with the proposed dredging operation of the inland dunes at the Stockton Sand Quarry (hereafter referred to as the Project). The Project involves the extraction of sand from the inland vegetated dunes, Stage 1 of the Project involves dry extraction by front-end loader/ excavator to a depth of 4 metres (m) Australian Height Datum (AHD) with all subsequent stages (2-6 inclusive) dredged from 4m AHD to 15m below sea level (-15m AHD).

To assess the potential air quality impacts associated with the proposed Project, this report incorporates the following aspects:

- A background and description of the existing operations and proposed Project;
- A review of the meteorological and air quality environment surrounding the Project site;
- A description of the dispersion modelling approach used to assess potential air quality impacts; and,
- Presentation of the predicted results and a discussion of the potential air quality impacts.

This air quality impact assessment has been prepared in general accordance with the New South Wales (NSW) Environment Protection Authority (EPA) document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW EPA, 2017**). The assessment forms part of the environmental impact statement (EIS) prepared to accompany the State Significant Development (SSD) application for the Project.

2 STUDY REQUIREMENTS

The purpose of this report is to provide an assessment of the maximum likely effects on air quality that may arise due to the Project. The assessment presented in this report addresses planning and regulatory agency requirements, as set out below.

2.1 Secretary's Environmental Assessment Requirements

In preparing this Air Quality Assessment, the Secretary's Environmental Assessment Requirements issued for the Project in October 2018 have been addressed. The key matters raised for consideration in this Air Quality Assessment are outlined in **Table 2-1** along with a reference as to where the requirements are addressed in the report.

Table 2-1: Secretary's Environmental Assessment Requirements (SEAR No. 9490)

Specific Issue	General requirements	Section
Air quality – including:	A detailed air quality impact assessment (AQIA) of potential construction and operational impacts, in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*, and with a particular focus on dust emissions including $PM_{2.5}$ and PM_{10}, and having regard to the Voluntary Land Acquisition and Mitigation Policy.	This report

2.2 NSW Environmental Protection Authority

This Air Quality Assessment has been prepared in general accordance with the NSW EPA document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW EPA, 2017**) and the specific requirements outlined in **Table 2-2** along with a reference to where the requirements are addressed in the report.

Table 2-2: NSW EPA agency comments for air quality (SEAR No. 9490)

Air quality		Section
Assessment Objective	Demonstrate the proposed project will incorporate and apply best management practice emission controls; and	8
	Demonstrate that the project will not cause violation of the project adopted air quality impact assessment criteria at any residential dwelling or other sensitive receptor.	7
Assessment Criteria	Define applicable assessment criteria for the proposed development referencing the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, including appendices and updates	4
	Demonstrate the proposal's ability to comply with the relevant regulatory framework, specifically the *Protection of the Environment Operations* (POEO) *Act* (1997) and the POEO (Clean Air) Regulation (2010).	4.4
Existing Environment	Provide a detailed description of the existing environment within the assessment domain, including: ○ geophysical form and land-uses; ○ location of all sensitive receptors; ○ existing air quality; and ○ local and regional prevailing meteorology.	3 & 5
	Justify all data used in the assessment, specifically including analysis of inter-annual trends (preferably five consecutive years of data), availability of monitoring data, and local topographical features.	5 & Appendix A
	Meteorological modelling must be verified against monitored data. Verification should involve comparative analysis of wind speed, wind direction and temperature, at a minimum.	6.2.1
	A review of all existing, recently approved and planned developments likely to contribute to cumulative air quality impacts must be completed.	6.4.3
Emissions Inventory	Provide a detailed description of the project and identify the key stages with regards to the potential for air emissions and impacts on the surrounding environment.	2

Air quality		Section
	Identify all sources of air emissions, including mechanically generated, combustion and transport related emissions likely to be associated with the proposed development.	6.3 & 6.4
	Estimate emissions of TSP, PM_{10}, $PM_{2.5}$, NO_x, (tonnes per year), at a minimum, for all identified sources during each key development stage. The emissions inventory should: ○ utilise USEPA (1995) (and updates) emission estimation techniques, direct ○ measurement or other method approved in writing by EPA; ○ calculate uncontrolled emissions (with no particulate matter controls in place); and ○ calculate controlled emissions (with proposed particulate matter controls in place).	6.4
	The emissions inventory must be explicitly coupled with the project description	6.4
	Provide a detailed summary and justification of all parameters adopted within all emission estimation calculations, including site specific measurements, proponent recommended values or published literature.	6.5 & Appendix C
	Document, including quantification and justification, all air quality emission control techniques/practices proposed for implementation during the project. As a minimum, consideration must be given to source control techniques, emission control through planning and reactive/predictive management techniques.	Appendix C
Best Practice Determination	Based on the TSP, PM_{10} and $PM_{2.5}$ emissions inventories calculated for the proposed development.	Appendix C
	Demonstrate that the proposed control techniques/practices are consistent with best management practice.	Appendix C
	Detail all sources possible sources of air pollution and activities/processes with the potential to cause air pollutants, including odours and fugitive dust emissions; and	Appendix C
	Describe in detail the measures proposed to mitigate the impacts and quantify the extent to which the mitigation measures are likely to be effective in achieving the relevant environmental outcomes.	Appendix C
Dispersion Modelling and Interpretation of Results	Atmospheric dispersion modelling should be undertaken in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, including appendices and updates.	6
	Modelling must implement fit for purpose modelling techniques that: ○ have regard for the most up to date and scientifically accepted dispersion modelling techniques; ○ contextualise all assumptions based on current scientific understanding and available data; and ○ include a thorough validation of adopted methods and model performance.	6
	Use an appropriate atmospheric dispersion model to predict, at a minimum, incremental ground level concentrations/levels of the following: ○ 24-hour and annual average PM_{10} concentrations; ○ 24-hour and annual average $PM_{2.5}$ concentrations; and ○ 1-hour and annual average NO_2 concentrations. NO_2 concentrations should be assessed using a well justified approach for the transformation of NO_x to NO_2.	6 & 7
	Ground level concentrations of pollutants should be presented for surrounding privately-owned properties, quarry-owned properties and other sensitive receptors (as applicable).	7
	Undertake a cumulative assessment of predicted impacts. The contribution of all identified existing and recently approved developments should be accounted for in the cumulative assessment.	7
	Cumulative 24-hour PM_{10} and $PM_{2.5}$ concentrations must be assessed in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, including appendices and updates, and/or a suitably justified probabilistic methodology.	7
	Cumulative annual average PM_{10}, $PM_{2.5}$, and NO_2 should be assessed using a sufficiently justified background concentration(s);	7

Air quality		Section
	Results of dispersion modelling should be presented as follows: ○ isopleth plots showing the geographic extent of maximum pollutant concentrations (incremental and cumulative); ○ tables presenting the maximum predicted pollutant concentrations (increment and cumulative) and the frequency of any predicted exceedances at each surrounding privately-owned properties, quarry-owned properties and other sensitive receptors (as applicable); and ○ time series and frequency distribution plots of pollutant concentrations at each private receptor location at which an exceedance is predicted to occur. Where no exceedances are predicted, the analysis must be performed for the most impacted offsite sensitive receptor.	7 & Appendix D
Air Quality Emissions Control Measures	Provide a detailed discussion of all proposed air quality emission control measures, including details of a reactive/predictive management system. The information provided must include: ○ explicit linkage of proposed emission controls to the site specific best practice determination assessment ○ timeframe for implementation of all identified emission controls; ○ key performance indicators for emission controls; ○ monitoring methods (location, frequency, duration); ○ response mechanisms; ○ responsibilities for demonstrating and reporting achievement of KPIs; ○ record keeping and complaints response register; and ○ compliance reporting.	8

3 PROJECT BACKGROUND

3.1 Project setting

The Project site is located in Fullerton Cove, approximately 9.8 kilometres (km) north-northeast of Newcastle Central Business District (CBD), within the Port Stephens LGA. The surrounding land use is a mixture of rural, residential, public recreation and environment conservation areas.

Figure 3-1 presents the location of the Project site and nearest residential receptor locations assessed as discrete receptors in this assessment. The nearest residential receptors to the Project site are located on Coxs Lane approximately 0.5km to the northwest of the site entrance. Two residential receptors located in the Fern Bay Seaside Village residential development have been included and are considered representative of this location.

Figure 3-2 presents a pseudo three-dimensional visualisation of the topography in the general vicinity of the Project. The Project site can be characterised as gently undulating with flat terrain to west and northwest and sand dunes to the east on Stockton Beach.

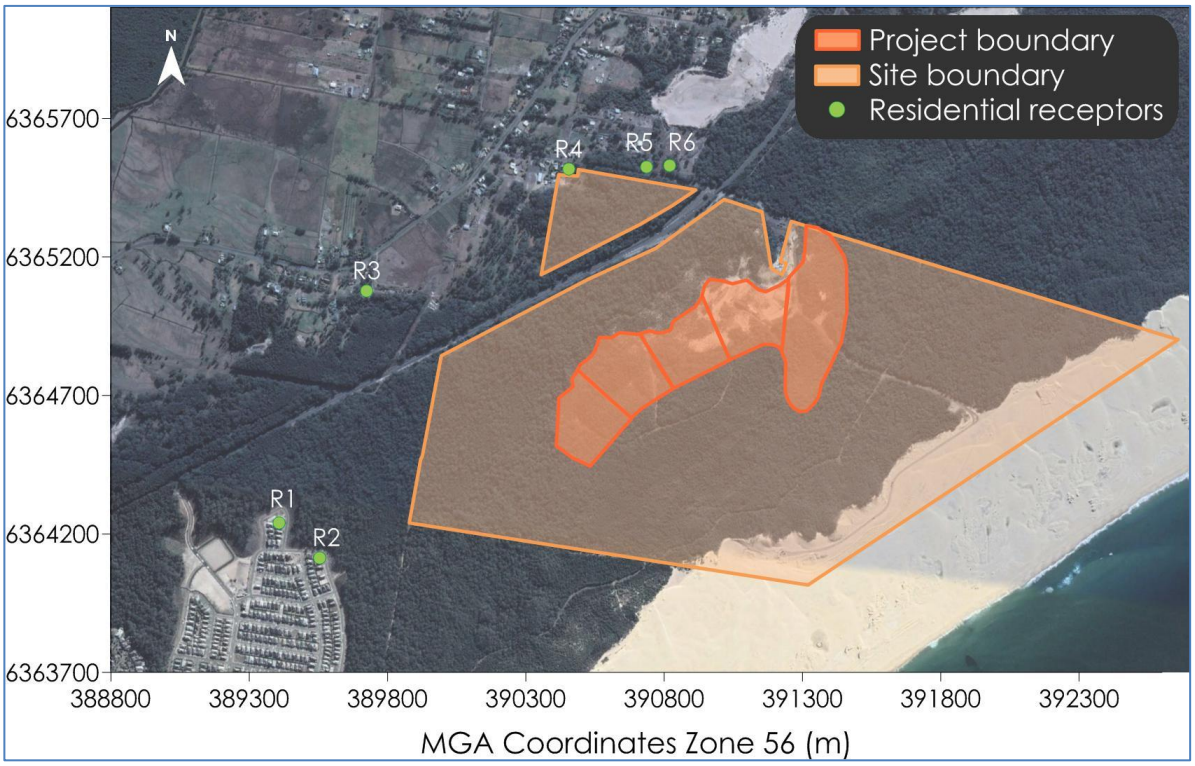


Figure 3-1: Project setting

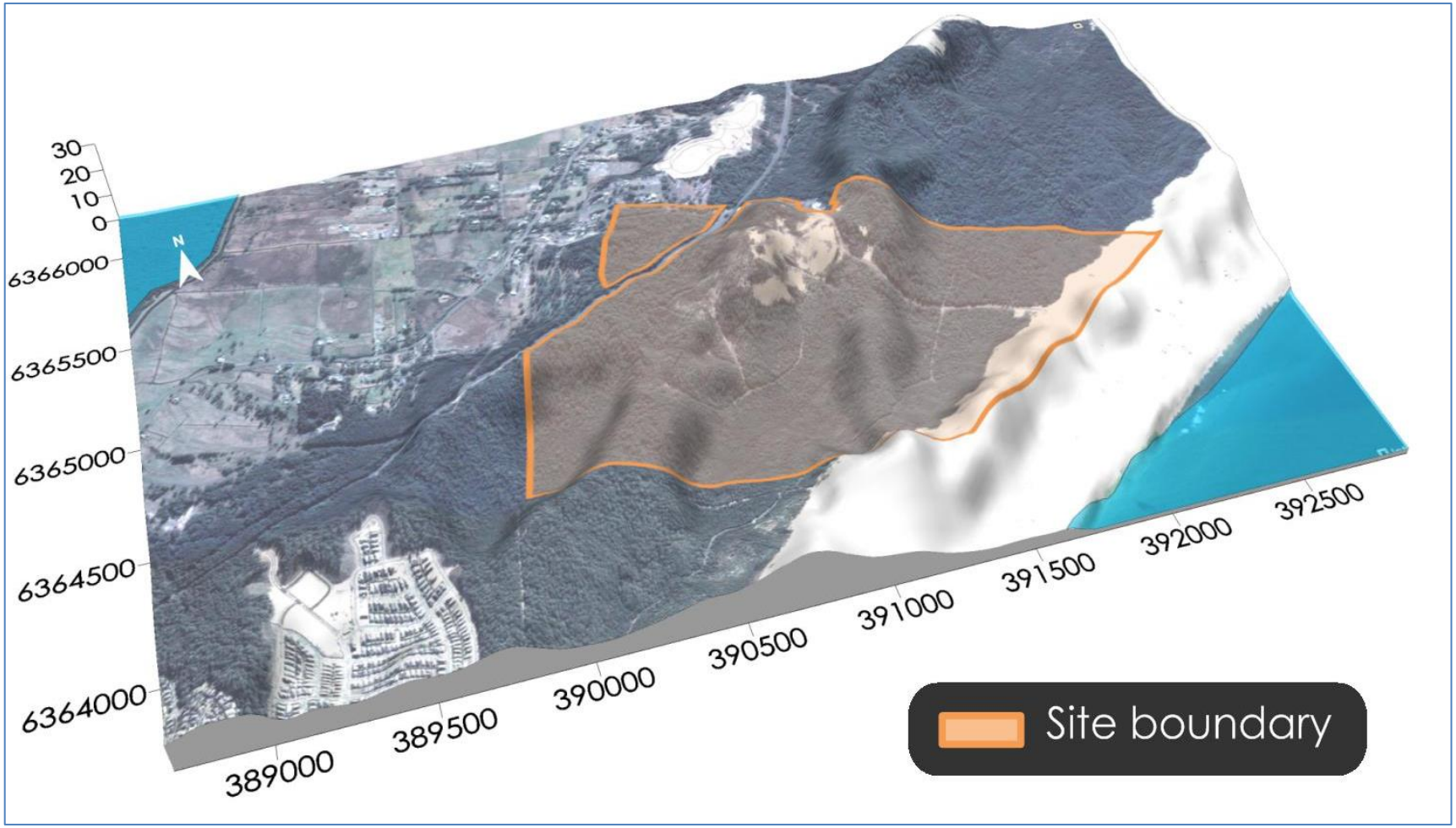


Figure 3-2: Representative visualisation of topography in the area surrounding the Project

3.2 Historical and existing operations

Under Boral's ownership there have been two primary development consents granted, including:

- DA 2010/94: The "inland extraction area" (also known as pits 1 – 6) granted by Port Stephens Council in May 1996; and
- DA 140-6-2005: The "windblown sand extraction area" (also known as the "windblown project" or pit 7) located on the transgressive dunes adjoining Stockton Beach granted by the Department of Planning in 2006.

The inland operation, DA2010/94, ceased operations in 2008, under this consent sand was extracted from the inland dunes to approximately RL 5m AHD. This project ceased operating soon after the windblown project commenced.

The windblown project is located approximately 375m south east of the Project site, and is approved to operate until 2028 and dispatch up to 500,000tpa from the site.

The windblown sand extraction area started operations in 2008 and has 20-year life, it is due to cease in 2028.

The approved scope of works and method generally includes the following:

- extraction of up to 500,000 tonnes of sand annually through regular harvesting of windblown sand and dry excavation of the dune mass;
- processing at the pit face by mobile power screen;
- maintenance of the haul road to transport sand from extraction area;
- haulage of product from existing depot/weighbridge to Nelson Bay Road and the wider road network; and
- progressive rehabilitation of extracted areas.

Extraction of sand from the windblown project is current and ongoing.

3.3 Project description

As set out in **Section 3.2**, an earlier consent was granted for extraction of sand from the inland dunes. This operation was limited to the extraction of sand from above 5m AHD and ceased in 2008, rehabilitation has been ongoing.

This former extraction area is generally consistent with the Project extraction area and is the focus of this Development Application that proposes to extract sand from within the existing disturbance footprint from the existing ground level to a depth of 15m below sea level (-15m AHD). As extraction will intercept the groundwater table (at approximately 1m AHD) the primary method of sand extraction will involve dredging.

There is an estimated 9 million tonnes of sand resource within the Project extraction area. The Project would seek to permit a site wide increase in the dispatch limit to 750,000tpa (i.e. the windblown sand extraction area and the Project operations combined) up until 2028 after which the site wide limit

would reduce to no more than 500,000tpa. The increase in the site wide dispatch limit is sought to permit maximum flexibility across the two project areas (located on the same site).

The Project is to be undertaken progressively in six stages, commencing with Stage 1. Similar to previous operations of the inland extraction area, sand extraction will involve clearing and grubbing of established vegetation from previous rehabilitation and possible screening of accumulated leaf litter and organic matter. Cleared vegetation will either be mulched or stockpiled on-site for later reuse in rehabilitation. Similarly, any stripped topsoil would be retained for use in rehabilitation efforts across the site.

Stage 1 will involve dry extraction, removing sand via a front-end loader which pushes into the exposed sand face. As the sand is relatively free-flowing, material falls towards the front-end loader at the natural angle of repose.

The sand will then be screened and stockpiled before a front-end loader loads road trucks in-pit with screened raw sand for transport off-site via the weighbridge.

Following initial extraction of sand in Stage 1 above the water table to a depth of 4m AHD, a pond will be created in the area of Stage 2 and will be large enough to float a dredge and accommodate fresh water pumping for the proposed wash plant.

The dredge will move progressively through the extraction area generally following the nominated stages. In most cases, the sand in each extraction stage is fully extracted unless constraints are encountered.

The dredge will move backwards and forwards across the active dredge pond, suctioning away against the underwater sand face. The sand / water mix will be pumped directly from the dredge via a pontoon-mounted pipeline to the wash plant in the processing area. The dredge manoeuvres around the pond and its position is stabilised by tie ropes connected to the banks around the active pond.

The dredge will then progressively extract sand in a south westerly direction in a staged process. Extraction will move to the east and culminate with the relocation of the proposed processing and stockpile area to a confined area in Stage 1 and subsequent dredging of the majority of the Stage 1 extraction area (to be known as Stage 6).

Sand will be extracted to a maximum depth of approximately 15m below the sea level (-15m AHD).

An overview of the staging plan for the Project is presented in **Figure 3-3**.

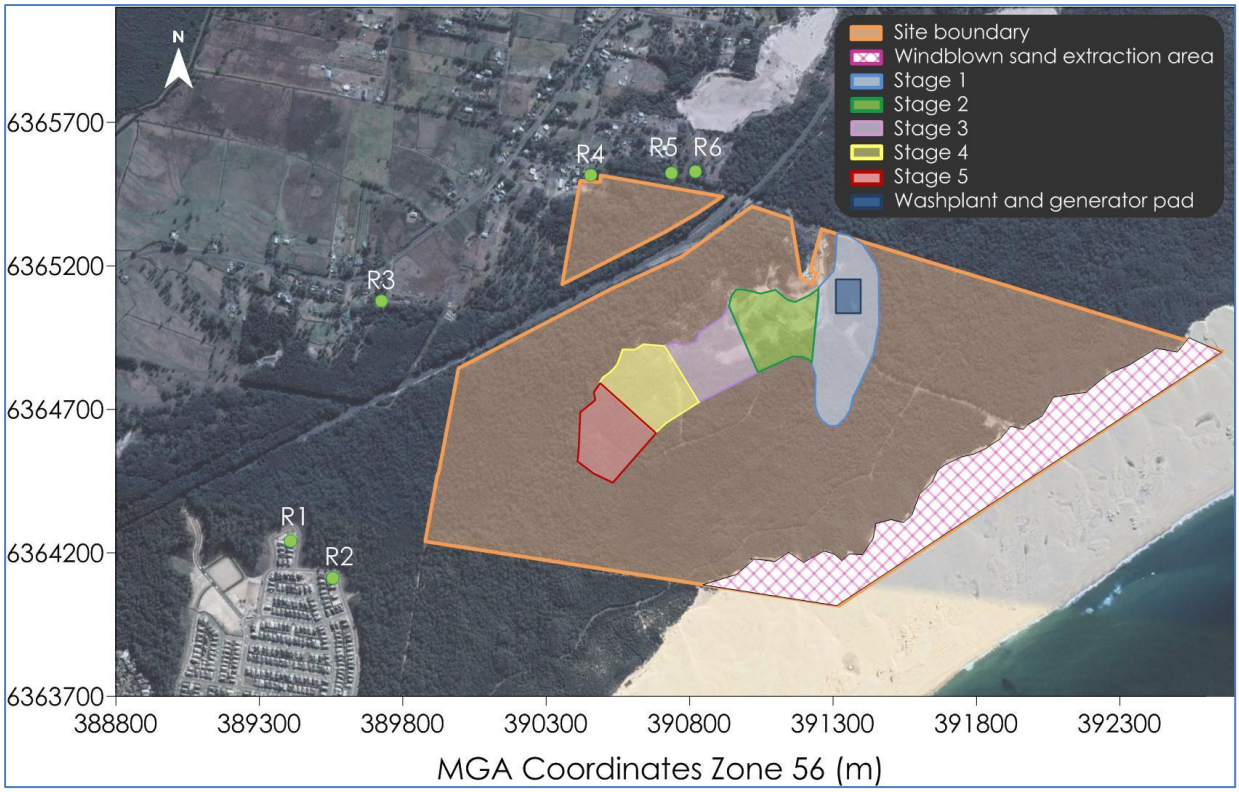


Figure 3-3: Overview of staging plan for the Project

4 AIR QUALITY CRITERIA

4.1 Particulate matter

Particulate matter consists of dust particles of varying size and composition. Air quality goals refer to measures of the total mass of all particles suspended in air defined as the Total Suspended Particulate matter (TSP). The upper size range for TSP is nominally taken to be 30 micrometres (µm) as in practice particles larger than 30 to 50µm will settle out of the atmosphere too quickly to be regarded as air pollutants.

Two sub-classes of TSP are also included in the air quality goals, namely PM_{10}, particulate matter with equivalent aerodynamic diameters of 10µm or less, and $PM_{2.5}$, particulate matter with equivalent aerodynamic diameters of 2.5µm or less.

Particulate matter, typically in the upper size range, that settles from the atmosphere and deposits on surfaces is characterised as deposited dust. The deposition of dust on surfaces may be considered a nuisance and can adversely affect the amenity of an area by soiling property in the vicinity.

4.2 Nitrogen dioxide

Nitrogen dioxide (NO_2) is reddish-brown in colour (at high concentrations) with a characteristic odour and can irritate the lungs and lower resistance to respiratory infections such as influenza. NO_2 belongs to a family of reactive gases called oxides of nitrogen (NO_X). These gases form when fuel is burned at high temperatures, mainly from motor vehicles, power generators and industrial boilers (**US EPA, 2011**). It is important to note that when formed, NO_2 is generally a small fraction of the total NO_X generated.

4.3 NSW EPA impact assessment criteria

Table 4-1 summarises the air quality goals that are relevant to this assessment as outlined in the NSW EPA document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW EPA, 2017**).

The air quality goals for total impact relate to the total pollutant burden in the air and not just the contribution from the Project. Consideration of background pollutant levels needs to be made when using these goals to assess potential impacts.

Table 4-1: NSW EPA air quality impact assessment criteria

Pollutant	Averaging Period	Impact	Criterion
TSP	Annual	Total	90 µg/m^3
PM_{10}	Annual	Total	25 µg/m^3
	24 hour	Total	50 µg/m^3
$PM_{2.5}$	Annual	Total	8 µg/m^3
	24 hour	Total	25 µg/m^3
Deposited dust	Annual	Incremental	2 g/m^2/month
		Total	4 g/m^2/month
NO_2	1 hour	Total	246 µg/m^3
	Annual	Total	62 µg/m^3

Source: **NSW EPA, 2017**

µg/m^3 = micrograms per cubic metre

g/m^2/month = grams per square metre per month

4.4 NSW Voluntary Land Acquisition and Mitigation Policy (VLAMP)

Part of the NSW VLAMP dated September 2018 describes the NSW Government's policy for voluntary mitigation and land acquisition to address particulate matter impacts from state significant mining, petroleum and extractive industry developments.

Voluntary mitigation rights may apply per the VLAMP where, even with best practice management, the development contributes to exceedances of the criteria in **Table 4-2** at any residence on privately owned land or workplace. [1]

Table 4-2: Particulate matter mitigation criteria

Pollutant	Averaging period	Mitigation criterion		Impact type
$PM_{2.5}$	Annual	8 µg/m³*		Human health
$PM_{2.5}$	24 hour	25 µg/m³**		Human health
PM_{10}	Annual	25 µg/m³*		Human health
PM_{10}	24 hour	50 µg/m³**		Human health
TSP	Annual	90 µg/m³*		Amenity
Deposited dust	Annual	2 g/m²/month**	4 g/m²/month*	Amenity

Source: NSW Government (2018)

*Cumulative impact (i.e. increase in concentration due to the development plus background concentrations due to all other sources).

**Incremental impact (i.e. increase in concentrations due to the development alone), with zero allowable exceedances of the criteria over the life of the development.

Voluntary acquisition rights may apply per the VLAMP where, even with best practice management, the development contributes to exceedances of the criteria in **Table 4-3** at any residence on privately owned land, workplace or on more than 25 per cent (%) of any privately owned land where there is an existing dwelling or where a dwelling could be built under existing planning controls (vacant land).

Table 4-3: Particulate matter acquisition criteria

Pollutant	Averaging period	Acquisition criterion		Impact type
$PM_{2.5}$	Annual	8 µg/m³*		Human health
$PM_{2.5}$	24 hour	25 µg/m³**		Human health
PM_{10}	Annual	25 µg/m³*		Human health
PM_{10}	24-hour	50 µg/m³**		Human health
TSP	Annual	90 µg/m³*		Amenity
Deposited dust	Annual	2 g/m²/month**	4 g/m²/month*	Amenity

Source: NSW Government (2018)

*Cumulative impact (i.e. increase in concentration due to the development plus background concentrations due to all other sources).

**Incremental impact (i.e. increase in concentrations due to the development alone), with up to five allowable exceedances of the criteria over the life of the development.

4.5 Crystalline silica

Silica occurs in nature in a crystalline or amorphous form, and may be synthetically produced in amorphous forms. Silica is commonly found in soil and rocks, the most common form is quartz, followed by cristobalite and tridymite. The crystalline form of silica has potential to cause adverse health effects in humans. Occupational exposure to respirable crystalline silica has potential to result in silicosis (**NIOSH, 1974**).

Various jurisdictions have developed criteria for acceptable levels of exposure to crystalline silica. These include the Victorian criterion adopted from Californian reference exposure level values, and

[1] Where any exceedance would be unreasonably detrimental to workers health or carrying out of the business.

occupational standards. **Table 4-4** presents the Victorian impact assessment criteria (**VIC EPA, 2007**) which are the most stringent available standards for respirable crystalline silica and which are applied to the Project.

Table 4-4: Air Quality Criterion for Respirable Silica

Pollutant	Averaging period	Criterion (µg/m³)	Organisation
Respirable crystalline silica (as $PM_{2.5}$)	Annual	3	VIC EPA

Source: VIC EPA (2007)

4.6 Protection of the Environment Operations Act, 1997

The general obligations of the NSW *Protection of the Environment Operations Act, 1997* and the Regulations made under the Act (namely the NSW *Protection of the Environment Operations (Clean Air) Regulation, 2010*) would be followed for the Project. The Project would operate in accordance with the relevant regulatory framework for air quality to ensure compliance with this legislation.

5 EXISTING ENVIRONMENT

This section describes the existing environment including the climate and ambient air quality in the area surrounding the Project.

5.1 Local climatic conditions

Long-term climatic data from the closest Bureau of Meteorology (BoM) weather station at Williamtown Royal Australian Air Force (RAAF) (Site No. 061078) were analysed to characterise the local climate in the proximity of the Project. Williamtown RAAF weather station is located approximately 6.1km north- northwest of the Project.

Table 5-1 and **Figure 5-1** present a summary of data from the Williamtown RAAF weather station collected over a 59 to 69 year period for the various meteorological parameters.

The data indicate that January is the hottest month with a mean maximum temperature of 28.2 degrees Celsius (°C) and July is the coldest month with a mean minimum temperature of 6.4°C.

Rainfall decreases during the latter half of the year, with an annual average rainfall of 1123.8 millimetres (mm) over 85.7 days. The data indicate that June is the wettest month with an average rainfall of 124.7mm over 8.4 days and September is the driest month with an average rainfall of 60.4mm over 5.6 days.

Relative humidity levels exhibit little variability over the day and seasonal fluctuations. Mean 9am relative humidity ranges from 64% in October to 80% in June. Mean 3pm relative humidity levels range from 50% in August and September to 62% in February.

Wind speeds during the warmer months have a greater spread between the 9am and 3pm conditions compared to the colder months. Mean 9am wind speeds range from 10.2 kilometres per hour (km/h) in March to 16.8km/h in August. Mean 3pm wind speeds range from 15.8km/h in May to 23.5km/h in November and December.

Table 5-1: Monthly climate statistics summary – Williamtown RAAF weather station

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann.
Temperature													
Mean max. temp. (°C)	28.2	27.7	26.3	23.7	20.4	17.7	17.2	18.7	21.5	23.8	25.6	27.4	23.2
Mean min. temp. (°C)	18.1	18.1	16.4	13.2	10.1	8.0	6.4	6.9	9.1	12.0	14.4	16.6	12.4
Rainfall													
Rainfall (mm)	98.7	117.0	120.5	111.6	109.6	124.7	70.9	72.9	60.4	73.9	82.3	78.6	1123.8
No. of rain days	7.1	7.3	8.1	7.5	7.6	8.4	6.3	6.1	5.6	7.3	7.3	7.1	85.7
9am conditions													
Mean temp. (°C)	23.0	22.5	21.2	18.2	14.3	11.6	10.5	12.2	15.7	18.8	20.5	22.2	17.6
Mean R.H. (%)	72	76	77	76	79	80	77	71	66	64	66	68	73
Mean W.S. (km/h)	11.9	10.6	10.2	11.4	13.7	15.9	16.4	16.8	15.3	14.4	14.4	12.9	13.7
3pm conditions													
Mean temp. (°C)	26.5	26.1	24.9	22.5	19.3	16.8	16.2	17.6	20.0	21.9	23.8	25.6	21.8
Mean R.H. (%)	59	62	61	59	60	60	55	50	50	54	55	56	57
Mean W.S. (km/h)	21.9	20.6	18.9	17.2	15.8	17.5	18.7	20.9	22.0	22.5	23.5	23.5	20.2

Source: **Bureau of Meteorology, 2019 (March 2019)**

R.H. – Relative Humidity, W.S. – wind speed

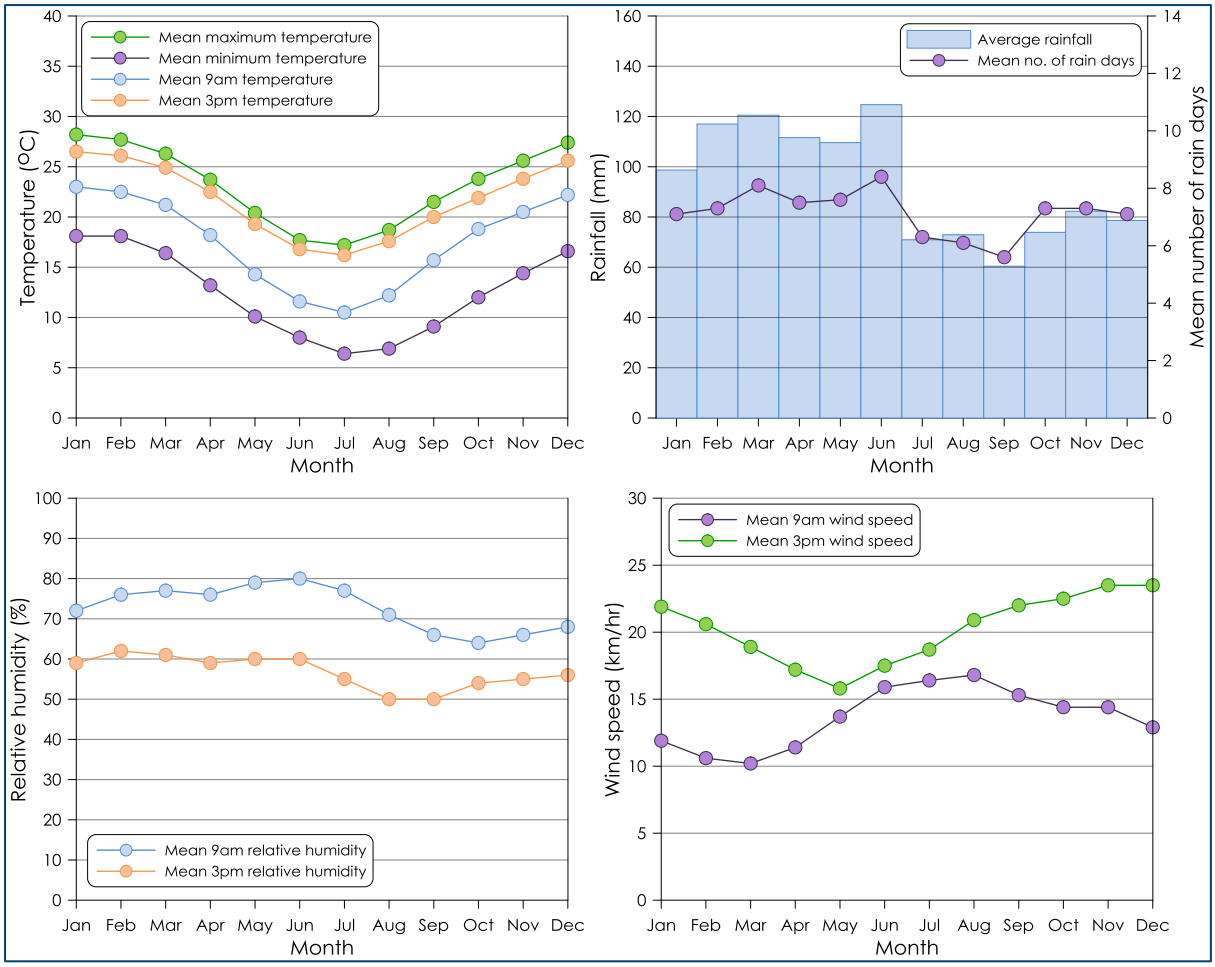


Figure 5-1: Monthly climate statistics summary – Williamtown RAAF weather station

5.2 Local meteorological conditions

Annual and seasonal windroses for the Williamtown RAAF weather station during the 2015 calendar period are presented in **Figure 5-2**.

The 2015 calendar year was selected as the meteorological year for the dispersion modelling based on an analysis of long-term data trends in meteorological data recorded for the area as outlined in **Appendix A**.

On an annual basis, winds predominantly occur from the west-northwest and northwest. In summer, winds occur from the east-northeast, northeast, and the southeast quadrant. Autumn and winter have a similar distribution to the annual distribution with the dominant winds from the west-northwest and northwest. In spring, winds are varied, with winds from the northwest, northeast and east-northeast sectors most prevalent.

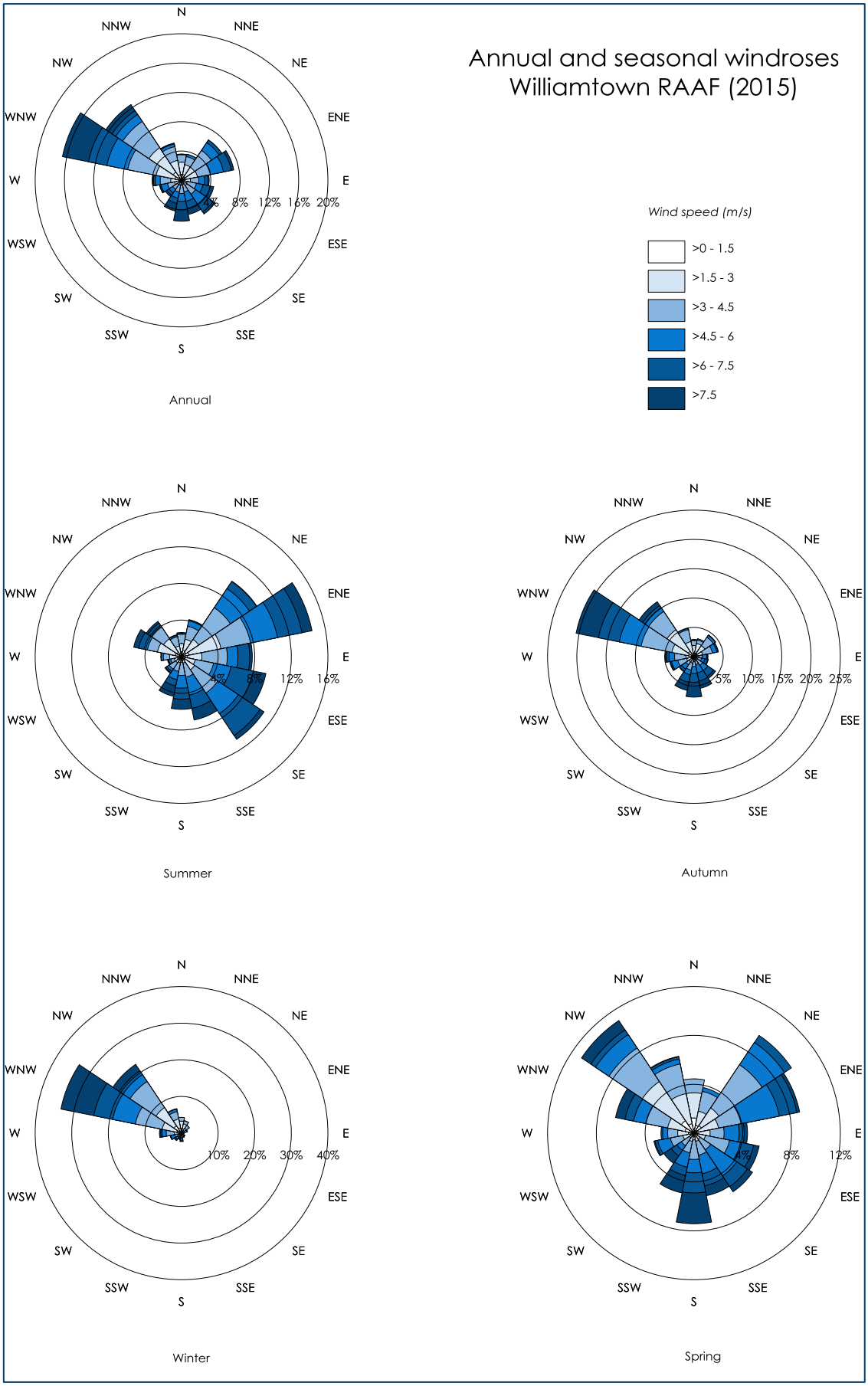


Figure 5-2 : Annual and seasonal windroses – Williamtown RAAF weather station (2015)

5.3 Local air quality monitoring

The main sources of air pollutants in the area surrounding the Project would include emissions from active sand quarrying, agricultural activities, anthropogenic activities such as various industrial and commercial activities and motor vehicle exhaust and also natural sources such as the local sand dunes.

Ambient air quality monitoring data from the Project site are not available. Therefore, the available data from air quality monitors operated by the NSW Office of Environment and Heritage (OEH) were used to quantify the existing background level for assessed pollutants at the Project site.

These include the Stockton, Beresfield and Wallsend monitors. The location of these monitors relative to the Project site is shown in **Figure 5-3**.

We note that there are other NSW OEH monitors within Newcastle which are subject to local industrial and urban sources which are not typically representative of the Project site. The Stockton, Beresfield and Wallsend monitors positioned in areas similar to the Project site and thus taken to be generally representative of the background levels and have been used to quantify the existing ambient levels of air pollutants in this study.

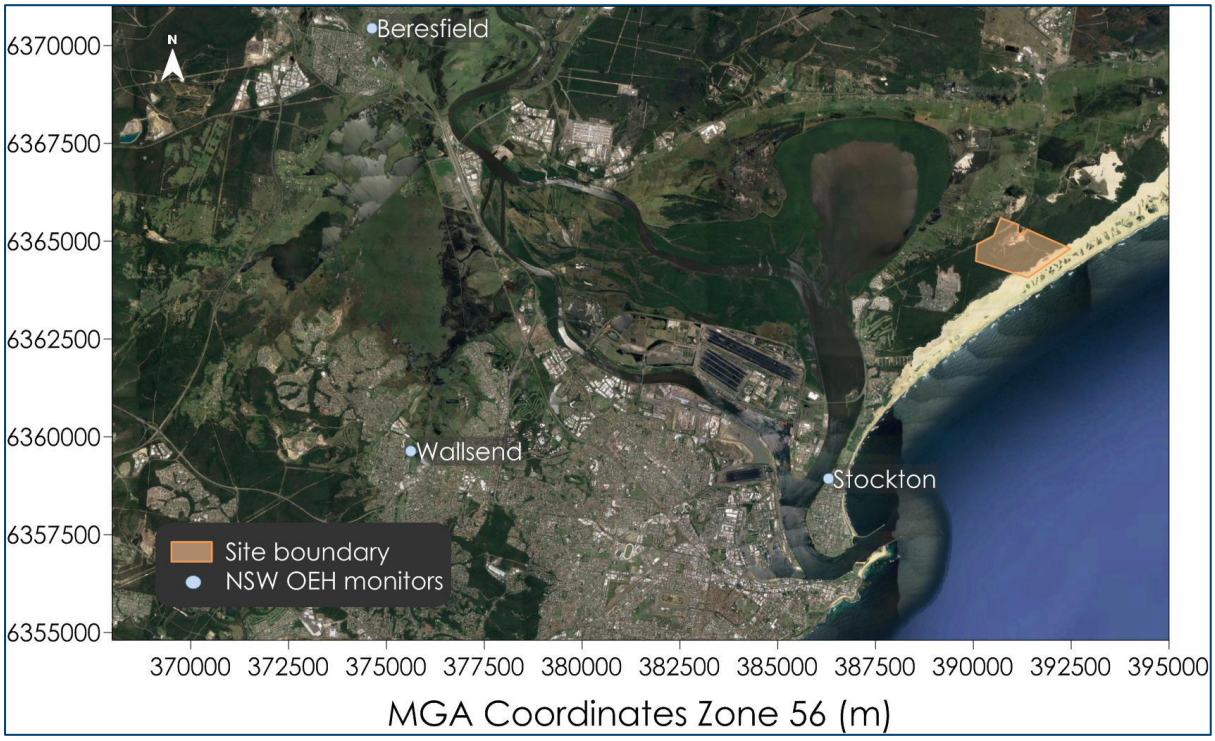


Figure 5-3: Location of NSW OEH monitors

5.3.1 PM_{10} monitoring

A summary of the available PM_{10} monitoring data from the NSW OEH monitoring stations is presented in **Table 5-2**. Recorded 24-hour average PM_{10} concentrations are presented in **Figure 5-4.**

A review of **Table 5-2** indicate that the annual average PM_{10} concentrations for all monitoring stations review were below the relevant criterion of 25µg/m^3 with the exception of the Stockton monitor which exceeded the relevant criterion in each year of the review. The maximum 24-hour average PM_{10}

concentrations were found to exceed the relevant criterion of 50µg/m^3 on occasion during the review period.

Table 5-2: Summary of PM_{10} levels from NSW OEH monitoring (µg/m³)

Year	Stockton	Beresfield	Wallsend	Criterion
	Annual average			
2014	-	19.4	16.9	**25**
2015	**35.8**	18.8	16.7	**25**
2016	**35.1**	19.1	16.6	**25**
2017	**36.4**	19.6	17.4	**25**
2018	**38.7**	21.6	19.4	**25**
	Maximum 24-hour average			
2014	**104.3**	45.4	43.4	**50**
2015	**101.4**	**64.9**	**77.5**	**50**
2016	**108.1**	48	**65.5**	**50**
2017	**96.7**	49.4	47.9	**50**
2018	**196.6**	**149.1**	**136.5**	**50**

It can be seen from **Figure 5-4** that PM_{10} concentrations nominally peak in spring and summer with the warmer weather raising the potential for drier ground, elevating the occurrence of windblown dust. Elevated PM_{10} concentrations at the Stockton monitor are largely due to heavily salt laden air or particulates blowing from the east along the surf break of Stockton Beach.

Anomalously high PM_{10} concentrations were recorded on 22 November 2018. An analysis into available satellite imagery (**NASA, 2019**) and other sources (**NSW OEH, 2018**) concludes elevated concentrations were due to a regional dust storm associated with a cold front which occurred on 22 November 2018. **Figure 5-5** presents satellite imagery showing the dust storm (circled in yellow) on 22 November 2018.

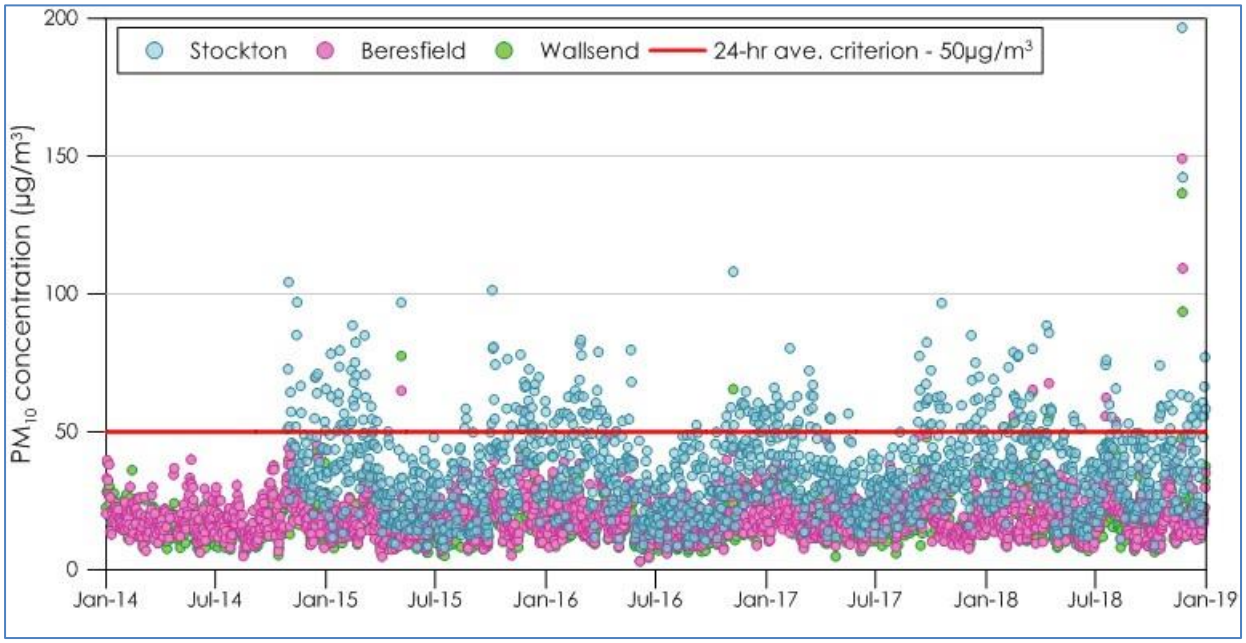
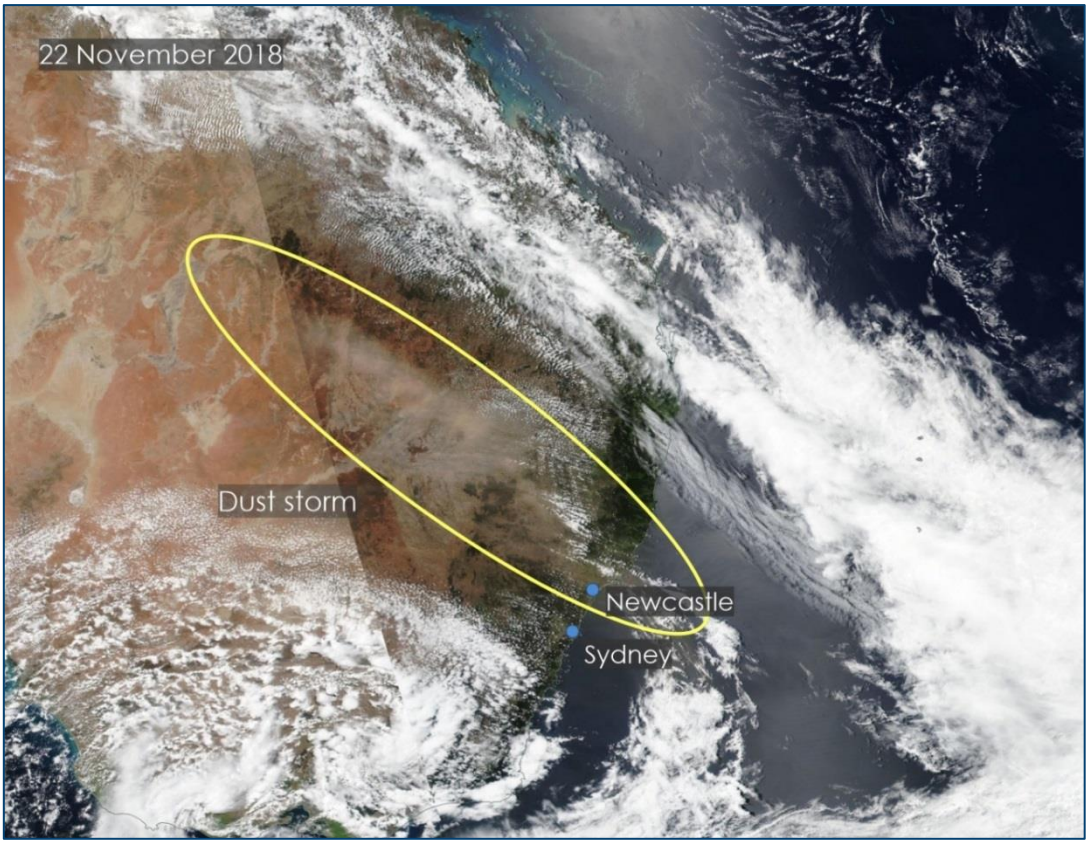


Figure 5-4: 24-hour average PM_{10} concentrations



Source: **NASA, 2019**

Figure 5-5: Satellite imagery showing dust storm on 22 November 2018

5.3.2 $PM_{2.5}$ monitoring

A summary of the available data from the NSW OEH monitoring stations is presented in **Table 5-3**. Recorded 24-hour average $PM_{2.5}$ concentrations are presented in **Figure 5-6**.

Table 5-3 indicates that the annual average $PM_{2.5}$ concentrations for the monitoring stations were below the annual average criterion of 8µg/m^3 with the exception of the Stockton monitor where data were available and the Beresfield monitor during 2018. The maximum 24-hour average $PM_{2.5}$ concentrations were found to exceed the relevant criterion of 25µg/m^3 on occasion during the review period.

Table 5-3: Summary of $PM_{2.5}$ levels from NSW OEH monitoring (µg/m^3)

Year	Stockton	Beresfield	Wallsend	Criterion
	Annual average			
2014	-	7.5	6.7	**8**
2015	**9.5**	7.3	7.3	**8**
2016	**9.7**	7.4	8.0	**8**
2017	**9.8**	7.6	7.3	**8**
2018	**10.0**	**8.7**	7.5	**8**
	Maximum 24-hour average			
2014	**25.5**	19	18	**25**
2015	**30.9**	**25.9**	24	**25**
2016	**66.4**	**27.9**	**50.7**	**25**
2017	**32**	18.7	20.4	**25**
2018	**26.9**	24.9	20.2	**25**

It can be seen from **Figure 5-6** that 24-hour average $PM_{2.5}$ concentrations are relatively evenly distributed through the year with the Stockton monitor recording overall higher levels largely due to heavily salt laden air or particulates blowing from the east along the surf break of Stockton Beach.

High $PM_{2.5}$ concentrations were recorded in November 2016. Satellite imagery indicates that the elevated concentrations were associated with bushfire events that occurred on 6 November 2018 with high temperatures "expected in the Hunter region…and strong winds" (**ABC News, 2019**). **Figure 5-7** presents satellite imagery showing the extent of the smoke plume on 6 November 2016.

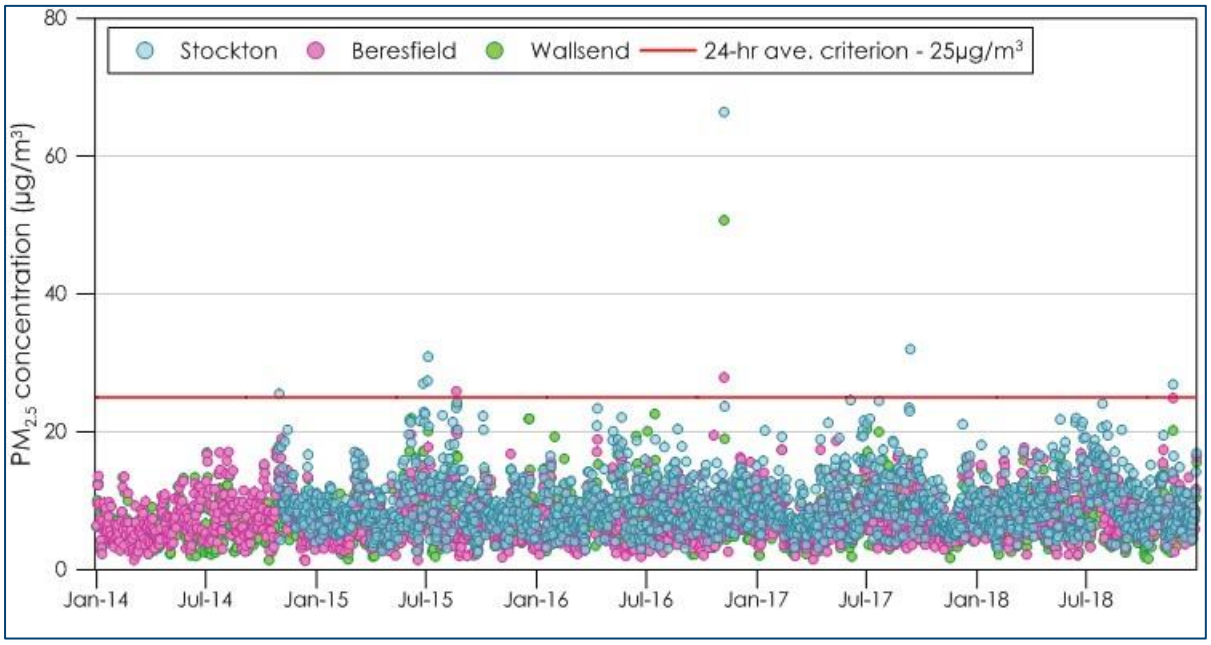


Figure 5-6: 24-hour average $PM_{2.5}$ concentrations

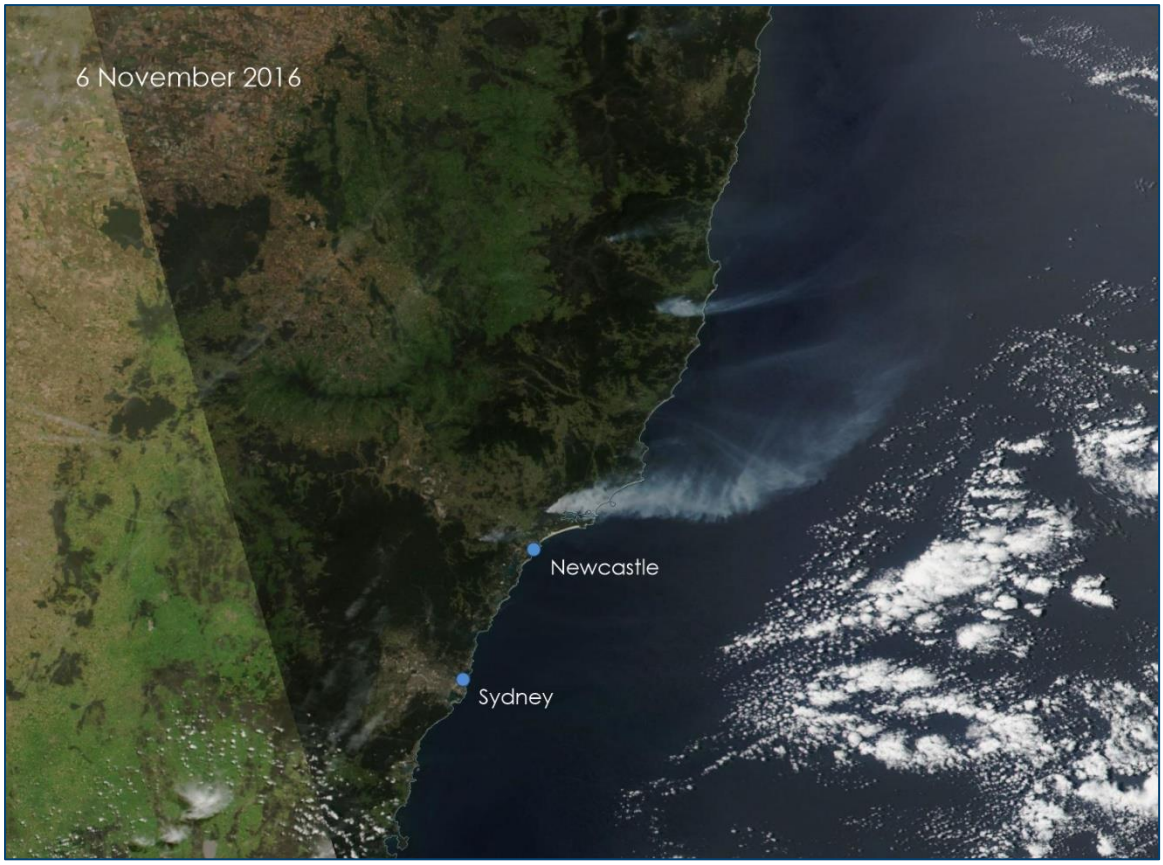


Figure 5-7: Satellite imagery showing smoke plume from bushfires on 6 November 2016

5.3.3 NO_2 monitoring

A summary of the available NO_2 data from the NSW OEH monitoring stations is presented in **Table 5-4**. The daily 1-hour maximum NO_2 concentrations are presented in **Figure 5-8**.

Table 5-4 indicates that the annual and maximum 1-hour average NO_2 concentrations for all monitors during the review period are well below the respective criterion.

It can be seen from **Figure 5-8** that concentrations are generally higher in cooler months when temperatures are low and there is less sunlight, making it more difficult for NO_2 to convert to ozone (**Department of the Environment, Climate Change and Water [DECCW], 2010**).

Table 5-4: Summary of NO_2 levels from available NSW OEH monitoring (µg/m³)

Year	Stockton	Beresfield	Wallsend	Criterion
	Annual average			
2014	-	18.8	15.5	**62**
2015	15.0	18.4	15.8	**62**
2016	16.5	16.0	14.8	**62**
2017	16.3	18	15.6	**62**
2018	15.5	18.0	14.1	**62**
	Maximum 1-hour average			
2014	-	80.0	69.7	**246**
2015	80.0	100.5	86.1	**246**
2016	92.3	84.1	75.9	**246**
2017	94.3	82.0	75.9	**246**
2018	90.2	82.0	71.8	**246**

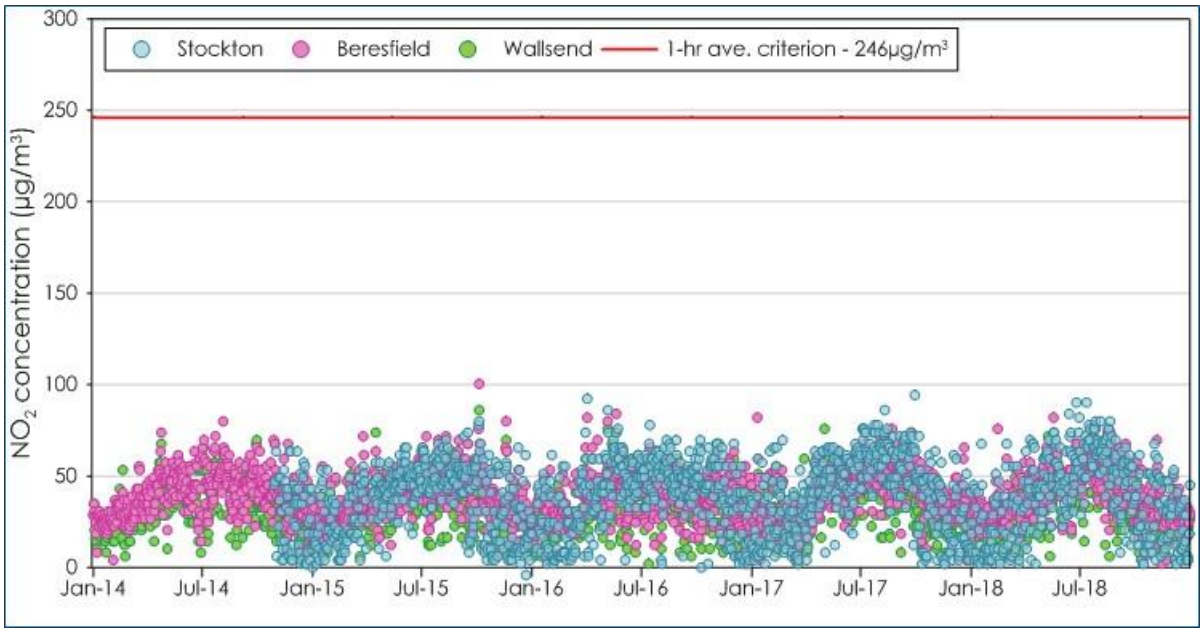


Figure 5-8: Daily 1-hour maximum NO_2 concentrations

5.3.4 Estimated background levels

As outlined above, there are no readily available site specific monitoring data, and therefore the background air quality levels from the Stockton monitor for the 2015 calendar year were used to represent the background levels for the Project.

The 2015 calendar period corresponds to the period of meteorological modelling based on an analysis of long-term data trends in meteorological data recorded for the area as outlined in **Appendix A**.

5.3.4.1 $PM_{2.5}$ and PM_{10}

As noted, the $PM_{2.5}$ and PM_{10} concentrations at the Stockton monitor are elevated due to heavily salt laden air or particulates blowing from the east along the surf break of Stockton Beach. Fresh sea salt aerosol arises from the wave-breaking in the ocean and is a natural source of particles.

To account for this, background $PM_{2.5}$ and PM_{10} concentrations have been adjusted to discount the contribution associated with salt laden air and we estimate an approximate annual average $PM_{2.5}$ and PM_{10} concentration of 7.3µg/m³ and 17.0µg/m³, respectively. Further detailed calculations of background $PM_{2.5}$ and PM_{10} estimates are provided in **Appendix B**.

These estimates for the annual average $PM_{2.5}$ and PM_{10} concentrations are comparable with levels measured at the Beresfield and Wallsend monitors.

5.3.4.2 TSP and Deposited dust

In the absence of available data, estimates of the annual average background TSP and deposited dust concentrations can be determined from a relationship between PM_{10}, TSP and deposited dust concentrations and the measured PM_{10} levels.

This relationship assumes that an annual average PM_{10} concentration of 25µg/m^3 corresponds to a TSP concentration of 90µg/m^3 and a dust deposition value of 4g/m^2/month. This assumption is based on the NSW EPA air quality impact criteria.

Applying this relationship with the measured annual average PM_{10} concentration of 17.0µg/m^3 indicates an approximate annual average TSP concentration and deposition value of 61.2µg/m^3 and 2.7g/m^2/month, respectively.

5.3.4.3 Summary of background levels

The background air quality levels applied in this assessment are as follows:

- 24-hour average $PM_{2.5}$ and PM_{10} concentrations - variable
- Annual average $PM_{2.5}$ concentrations – 7.3µg/m^3;
- Annual average PM_{10} concentrations – 17.0µg/m^3;
- Annual average TSP concentrations – 61.2µg/m^3;
- Annual average deposited dust levels – 2.7g/m^2/month;
- 1-hour average NO_2 concentrations – 80µg/m^3; and,
- Annual average NO_2 concentrations – 15.0µg/m^3.

6 DISPERSION MODELLING APPROACH

6.1 Introduction

For this assessment, the CALPUFF modelling suite is applied to dispersion modelling. The model setup used is in general accordance with methods provided in the NSW EPA document *Generic Guidance and Optimum Model Setting for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modelling and Assessments of Air Pollutants in NSW, Australia'* (**TRC Environmental Corporation, 2011**).

6.2 Meteorological modelling

The meteorological modelling methodology applied a 'hybrid' approach which includes a combination of prognostic model data from The Air Pollution Model (TAPM) with surface observations in the CALMET model.

The centre of analysis for TAPM was 32deg51min south and 151deg50min east. The simulation involved an outer grid of 30 km, with three nested grids of 10 km, 3 km and 1 km with 35 vertical grid levels. The CALMET domain was run on a 10 x 10km area with 0.1 km grid resolution.

The 2015 calendar year was selected as the meteorological year for the dispersion modelling based on analysis of long-term data trends in meteorological data and ambient air quality data recorded for the area as outlined in **Appendix A**.

The outputs of the CALMET modelling are evaluated using visual analysis of the wind fields and extracted data.

Figure 6-1 presents a visualisation of the wind field generated by CALMET for a single hour of the modelling period. The wind fields are seen to follow the terrain well and indicate the simulation produces realistic fine scale flow fields (such as terrain forced flows) in surrounding areas.

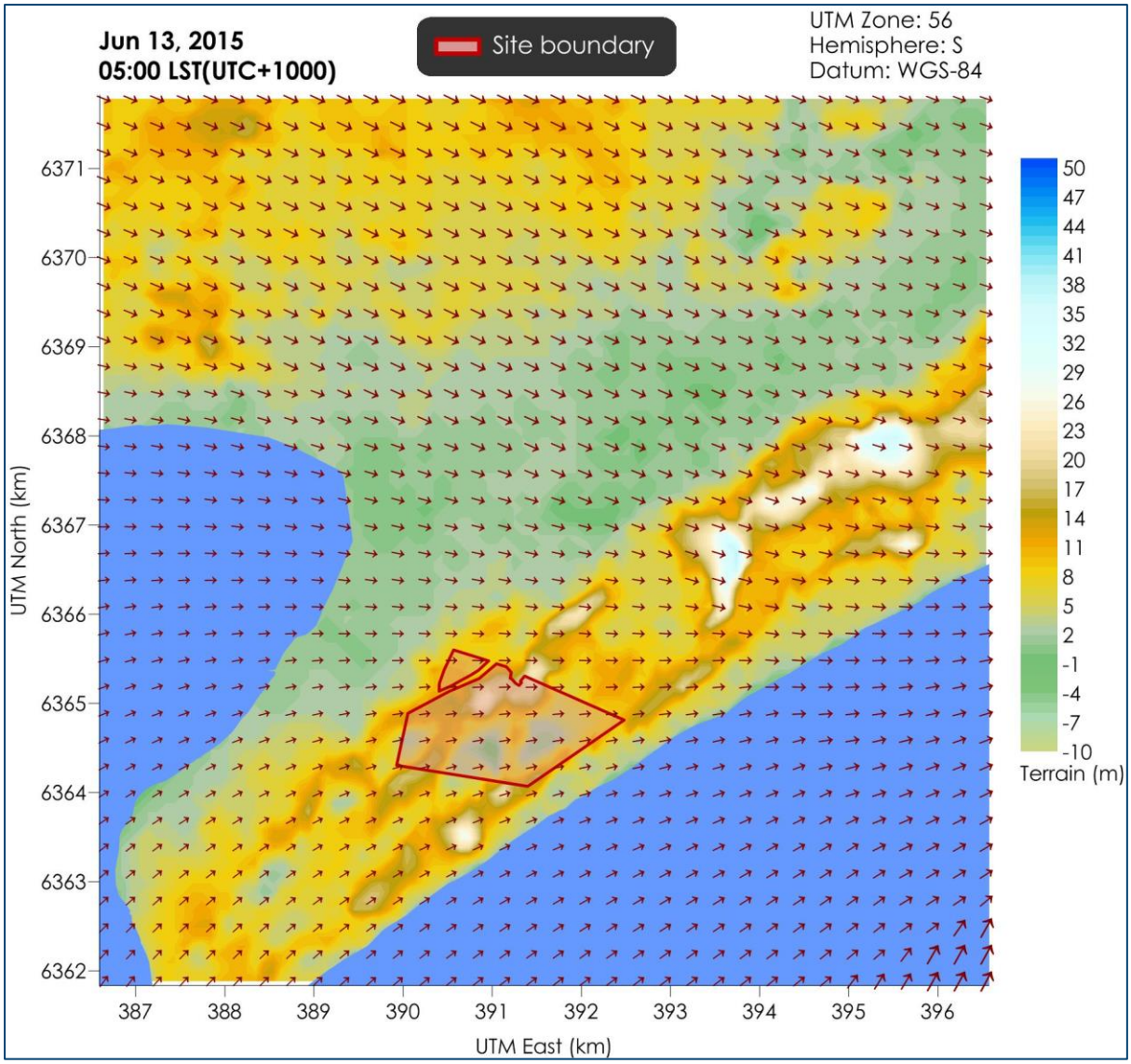


Figure 6-1: Representative snapshot of wind field for the Project

CALMET generated meteorological data were extracted from a point within the CALMET domain and are graphically represented in **Figure 6-2** and **Figure 6-3**.

Figure 6-2 presents the annual and seasonal windroses from the CALMET data. Overall, the windroses generated in the CALMET modelling reflect the expected wind distribution patterns of the area as determined based on the available measured data and the expected terrain effects on the prevailing winds.

Figure 6-3 includes graphs of the temperature, wind speed, mixing height and stability classification over the modelling period and shows sensible trends considered to be representative of the area.

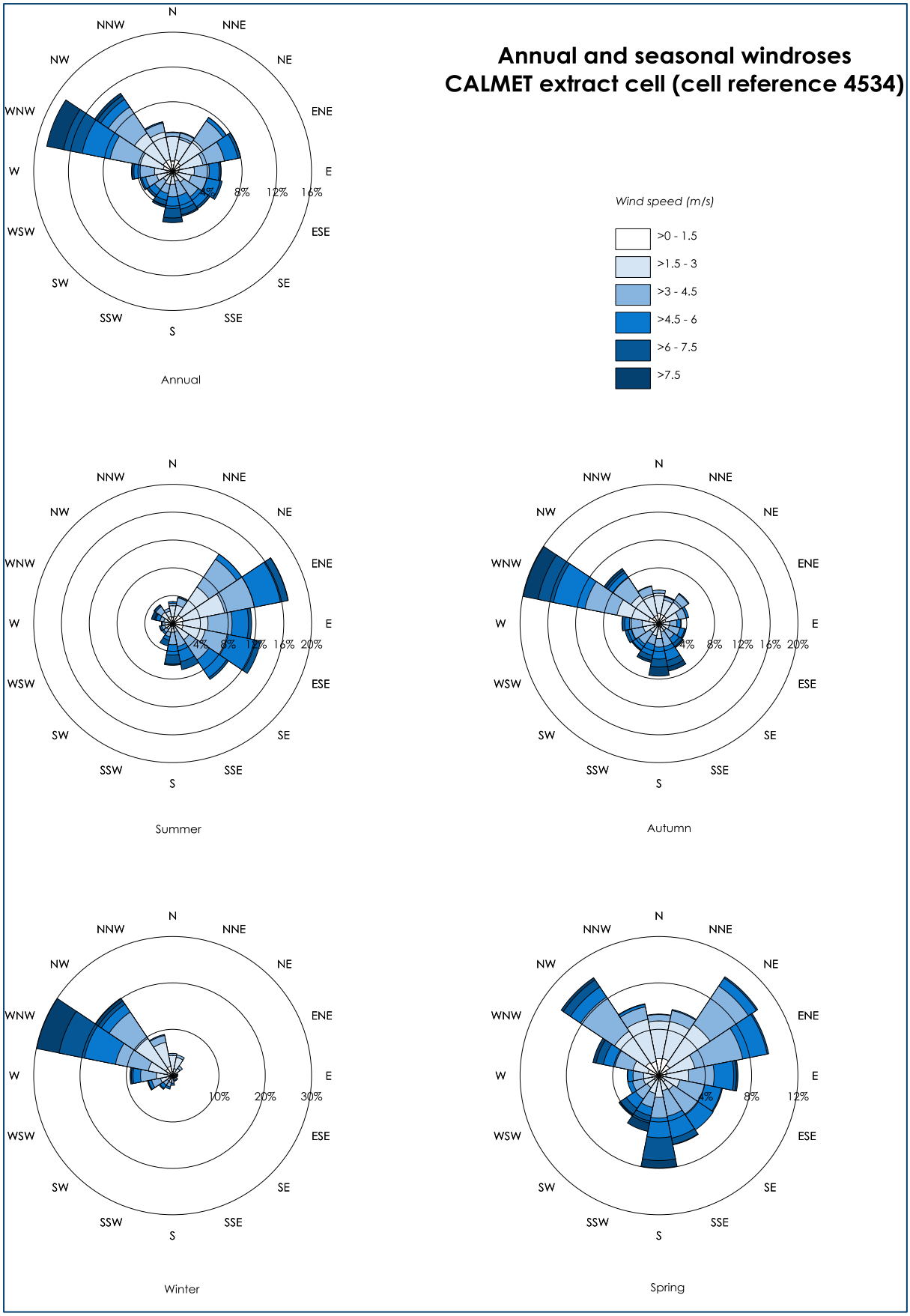


Figure 6-2: Annual and seasonal windroses from CALMET (Cell reference 4534)

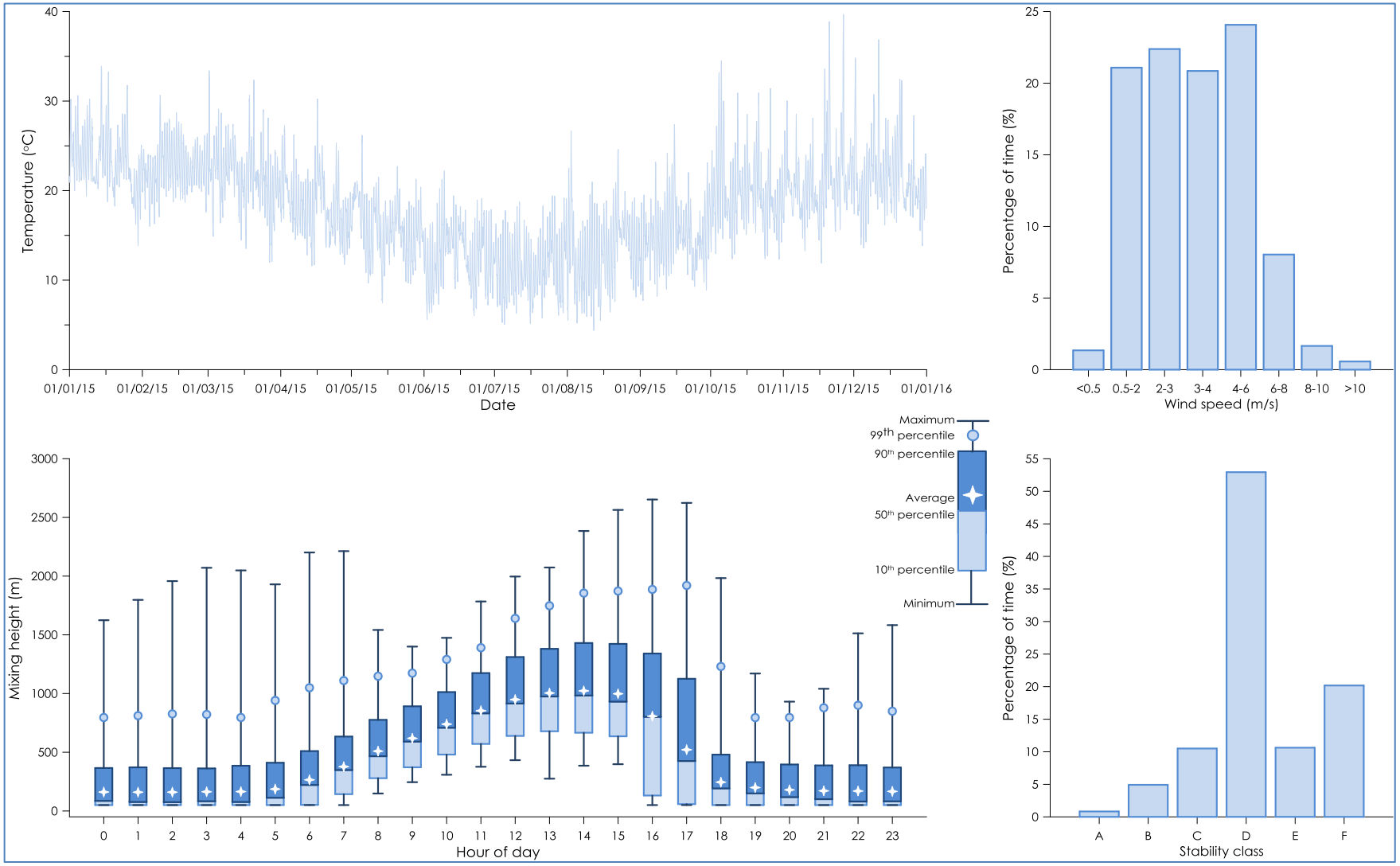


Figure 6-3: Meteorological analysis of CALMET (Cell Ref 4534)

6.3 Dispersion modelling

Dust emissions from each operational activity of the Project were represented by a series of volume sources and were included in the CALPUFF model via an hourly varying emission file. Meteorological conditions associated with dust generation (such as wind speed) and levels of dust generating activity were considered in calculating the hourly varying emission rate for each source.

It should be noted that as a conservative measure, the effect of the precipitation rate (rainfall) in reducing dust emissions has not been considered in this assessment.

NO_2 emissions from each operational activity of the Project were represented by a series of point sources to represent the engine exhaust associated with the diesel powered equipment in the CALPUFF model via an hourly varying emission file.

6.4 Modelling scenario

To identify a potential worst-case operating scenario for the Project, each of the activities associated with the different stages were analysed in regard to the quantity of material extracted and handled in each year, the location of the activity and the potential to generate dust at the receptor locations.

Three potential operating scenarios representing the Project were investigated in detail to identify which would likely represent a worst-case operating scenario. These include:

- Scenario 1: Sand extraction occurring from the existing windblown sand extraction area concurrently with sand extraction using an excavator in Stage 1. A maximum production rate of 750,000tpa is assumed with a maximum capacity of 250,000tpa extracted from the existing windblown sand extraction area and 500,000tpa from Stage 1 of the Project. Sand processing is occurring at the new mobile wash plant pad positioned at the north near the site entrance and 70,000 tonnes of VENM material is also imported and stockpiled within the Stage 1 area. In this scenario, activity is occurring closest to the nearest receptors to the Project (refer to **Figure 3-3**) with a maximum potential for dust generation to occur from both existing and proposed operations.

- Scenario 2: Sand extraction occurring from Stage 1 only at a maximum production rate of 750,000tpa. Sand extraction is conducted with an excavator and sand processing is occurring at the new mobile wash plant pad with 70,000 tonnes of VENM material is also imported and stockpiled within the Stage 1 area. In this scenario, activity is occurring closest to the nearest receptors to the Project (refer to **Figure 3-3**) with a maximum potential for dust generation to occur from proposed operations only.

- Scenario 3: Sand extraction occurring from only Stage 5 at a maximum production rate of 750,000tpa. Sand extraction is conducted with an excavator and sand processing is occurring at the new mobile wash plant pad with 70,000 tonnes of VENM material is also imported and stockpiled within the Stage 1 area. The VENM is used to assist with bank stabilisation in Stage 5. In this scenario, activity is occurring closest to the receptors at Fern Bay to the Project (refer to **Figure 3-3**) with a maximum potential for dust generation to occur from proposed operations only.

6.5 Emission estimation

The significant dust generating activities associated with operation of the Project are identified as loading/unloading of material, vehicles travelling on-site, screening sand material and windblown dust from exposed areas and stockpiles. The on-site vehicle and plant equipment also have the potential to generate particulate emissions from the diesel exhaust.

Dust emission estimates for each of the scenarios have been calculated by analysing the various types of dust generating activities taking place and utilising suitable emissions sourced from both locally developed and United States Environmental Protection Agency (US EPA) developed documentation.

The estimated TSP emissions for activities associated with the operation of the Project for each of the scenarios are presented in **Table 6-1**. Detailed calculations of the dust emission estimates are provided in **Appendix C**.

Table 6-1: Comparison of estimated dust emissions for the Project (kg)

Activity	TSP Emissions		
	Scenario 1	Scenario 2	Scenario 3
Loading sand to haul truck at windblown sand area	357	-	-
Hauling RAW sand from windblown sand area to offsite	14,829	-	-
Excavator loading topsoil to haul truck	0.089	0.089	0.051
Hauling to topsoil stockpile	0.427	0.427	0.904
Emplacing at topsoil stockpile	0.089	0.089	0.051
Loading sand to screen	714	1,072	-
Dredging sand with dredge	-	-	-
Pumping sand to stockpile at processing area	-	-	-
Screening RAW sand (controlled - wet sand)	-	-	-
Unloading processed sand to stockpile	714	1,072	1,072
Rehandle processed sand material at product stockpile	71	107	107
Loading product sand material to haul truck	714	1,072	1,072
Hauling product sand offsite	5,931	8,897	6,117
Hauling VENM material onsite	1,038	1,165	1,165
Unloading VENM material at stockpile	100	100	100
Loading VENM material to haul truck	-	-	100
Hauling VENM material to Stage 5	-	-	1,773
Unloading VENM material at Stage 5	-	-	100
Wind erosion - exposed area	1,445	1,488	1,488
Exhaust emissions from on-site equipment	562	562	762
Total emissions	**26,478**	**15,535**	**13,856**

Based on the estimated dust emissions set out in **Table 6-1**, Scenario 1 is estimated to generate the most dust overall for the scenarios considered. It is noted that the majority of activity in Scenario 1 occurs closest to the nearest receptors compared with the activity in Scenario 3 and thus would likely show higher impacts in comparison. The dispersion modelling for the Project is based on Scenario 1 which would represent a worst-case potential operating scenario.

6.5.1 Estimated NO_X emissions

The NO_X emissions associated with operation of the Project are identified from exhaust emissions from on-site vehicle and plant equipment.

NO_X emission estimates for the Project have been calculated by analysing the various types of vehicle and plant equipment and utilising suitable emission factors sourced from DieselNet (**Ecopoint DieselNet, 2019**).

The estimated NO_X emissions associated with the Project are summarised in **Table 6-2**.

Table 6-2: Estimated annual NO_X emissions for the Project (kg)

Equipment type	Scenario 1
Cat D7 Dozer	1,435
Front end loaders - Volvo 180H	1,793
Front end loaders - Volvo 180G	2,434
Water truck - 1987 Volvo F86	1,000
Truck and dog	867
Mobile screen - Power Screen M90	765
Excavator - 40 tonne	1,566
Dump truck - 40 tonne	1,772
Suction dredge	3,716
Diesel generator	253
Wash plant	785
Total NO_X emissions	**16,387**

6.5.2 Emissions from other quarry operations

In addition to the estimated dust emissions from the Project, emissions from other nearby sand quarry operations were also modelled, in accordance with their current consents (or current proposed projects), to assess potential cumulative air quality impacts.

This assessment has included the Fullerton Cove Sand Quarry (operated by Coastal Sand and Quarry Products), located approximately 0.7km to the north of the Project and has the potential to influence the cumulative dust levels at receptors near the Project. Other sand quarry operations in the area are considered too far removed to have any tangible effect.

Emissions estimates for Fullerton Cove Sand Quarry were derived from information provided in the latest air quality assessments available in the public domain at the time of modelling (**GHD Pty Ltd, 2015**). These estimates are likely to be conservative, as in many cases, these operations do not continually operate at the maximum extraction rates assessed in their respective assessments.

Operations at the Fullerton Cove Sand Quarry are expected to cease in 2020 and there would be no dust generated from this source.

Table 6-3 summarises the emissions adopted in this assessment from Fullerton Cove Sand Quarry.

Table 6-3: Estimated annual dust emissions Fullerton Cove Sand Quarry (kg)

Operation	Emissions		
	TSP	PM_{10}	$PM_{2.5}$
Fullerton Cove Sand Quarry	26,286	7,284	791

7 DISPERSION MODELLING RESULTS

This section presents the predicted air quality levels which may arise from air emissions generated by the Project.

7.1 Dust concentrations

The dispersion model predictions presented in this section include those for the operation of the Project in isolation (incremental impact) and the operation of the Project with consideration of other sources (total cumulative impact). The results show the predicted:

- Maximum 24-hour average $PM_{2.5}$ and PM_{10} concentrations;
- Annual average $PM_{2.5}$, PM_{10} and TSP concentrations; and,
- Annual average dust (insoluble solids) deposition rates.

It is important to note that when assessing impacts per the maximum 24-hour average levels, these predictions are based on the highest predicted 24-hour average concentrations which were modelled at each point within the modelling domain for the worst day (i.e. a 24-hour period) during the one year long modelling period.

Associated isopleth diagrams of the dispersion modelling results are presented in **Appendix D**.

Table 7-1 presents the predicted incremental particulate dispersion modelling results at each of the assessed residential receptor locations. The results show that minimal incremental effects would arise at the residential receptor locations due to the Project.

Table 7-1: Dust dispersion modelling results for residential receptors – Incremental impact

Receptor ID	$PM_{2.5}$ (µg/m³)		PM_{10} (µg/m³)		TSP (µg/m³)	DD* (g/m²/month)
	24-hour average	Annual average	24-hour average	Annual average	Annual average	Annual average
	Air quality impact criteria					
	-	-	-	-	-	2
R1	0.1	<0.1	0.5	<0.1	0.1	<0.1
R2	<0.1	<0.1	0.5	<0.1	0.1	<0.1
R3	0.1	<0.1	0.5	<0.1	0.1	<0.1
R4	0.2	<0.1	1.1	<0.1	0.2	<0.1
R5	0.3	<0.1	1.8	0.2	0.4	<0.1
R6	0.4	<0.1	2.1	0.2	0.5	<0.1

*Deposited dust

The cumulative (total) impact is defined as the modelling impact associated with the operation of the Project combined with estimated emissions from Fullerton Cove Sand Quarry and the estimated ambient background levels in **Section 5.4**.

The predicted cumulative annual average $PM_{2.5}$, PM_{10}, TSP and dust deposition levels due to the Project with the estimated background levels are presented in **Table 7-2**. The results in **Table 7-2** indicate that all of the assessed residential receptors are predicted to experience levels below the relevant criteria.

Table 7-2: Dust dispersion modelling results for residential receptors – Cumulative impact

Receptor ID	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	TSP (µg/m³)	DD (g/m²/month)
	Annual average			
	Air quality impact criteria			
	8	25	90	4
R1	7.3	17.1	61.4	2.7
R2	7.3	17.1	61.4	2.7
R3	7.3	17.1	61.4	2.7
R4	7.3	17.3	62.1	2.8
R5	7.4	18.2	65.2	2.9
R6	7.6	19.9	71.5	3.3

7.2 NO_X concentrations

Dispersion modelling of the potential NO_X emissions associated with diesel powered equipment was conducted for the modelling scenario. Modelling sources were described as point sources and impacts due to the Project were added to the ambient background level to assess potential impacts.

For the transformation of NO_x to NO_2 it has been assumed a hypothetical complete conversion level of 100% conversion occurs.

Associated isopleth diagrams of the dispersion modelling results are presented in **Appendix D**.

Table 7-3 presents the predicted incremental and cumulative NO_2 dispersion modelling results at each of the assessed residential receptor locations. The results show that minimal incremental effects would arise at the residential receptor locations due to NO_2 emissions associated with the Project and predicted cumulative levels would be below the relevant criteria.

Table 7-3: NO_2 dispersion modelling results for residential receptors

Receptor ID	Incremental		Cumulative	
	1-hour average	Annual average	1-hour average	Annual average
	Air quality impact criteria			
	-	-	246	62
R1	22.5	<0.1	102.5	15.1
R2	19.5	<0.1	99.5	15.1
R3	26.4	<0.1	106.4	15.1
R4	32.2	0.2	112.2	15.2
R5	49.1	0.3	129.1	15.3
R6	52.1	0.3	132.1	15.3

7.3 Assessment of Total (Cumulative) 24-hour average $PM_{2.5}$ and PM_{10} Concentrations

As shown in **Section 5.3**, the maximum measured 24-hour concentrations of $PM_{2.5}$ and PM_{10} have in the past exceeded or come close to the relevant criterion level on occasion.

As a result, the NSW EPA Level 1 contemporaneous assessment approach of adding maximum background levels to maximum predicted levels from the Project would show levels above the criterion whether or not the Project was operating.

In such situations, the NSW EPA applies a Level 2 contemporaneous assessment approach where the measured background levels are added to the day's corresponding predicted dust level from the Project.

Ambient (background) $PM_{2.5}$ and PM_{10} concentration data corresponding with the year of modelling (2015) from the NSW OEH monitoring site at Stockton have been applied in this case to represent the prevailing background levels in the vicinity of the Project and at representative residential receptor locations surrounding the Project.

Table 7-4 provides a summary of the findings from the Level 2 assessment at receptor locations for both $PM_{2.5}$ and PM_{10}. The results in **Table 7-4** indicate that the Project does not increase the number of days above the 24-hour average criterion at the assessed receptors for $PM_{2.5}$ and PM_{10}. Based on this result it can be inferred that the Project does not increase the number of days above the 24-hour average $PM_{2.5}$ and PM_{10} criterion at any of the receptor locations surrounding the Project.

Detailed tables of the contemporaneous assessment results are provided in **Appendix E**.

Table 7-4: NSW EPA contemporaneous assessment - maximum number of additional days above 24-hour average criterion

Receptor ID	$PM_{2.5}$	PM_{10}
R1	0	0
R2	0	0
R3	0	0
R4	0	0
R5	0	0
R6	0	0

Time series plots of the predicted cumulative 24-hour average $PM_{2.5}$ and PM_{10} concentrations for selected Receptors R2, R5 and R6 are presented in **Figure 7-1** to **Figure 7-3**.

The orange bars in the figures represent the contribution from the Project and the blue bars represent the background levels. It is clear from the figures that the Project has a small influence at the assessed receptor locations and in most cases would be difficult to discern beyond the expected background level.

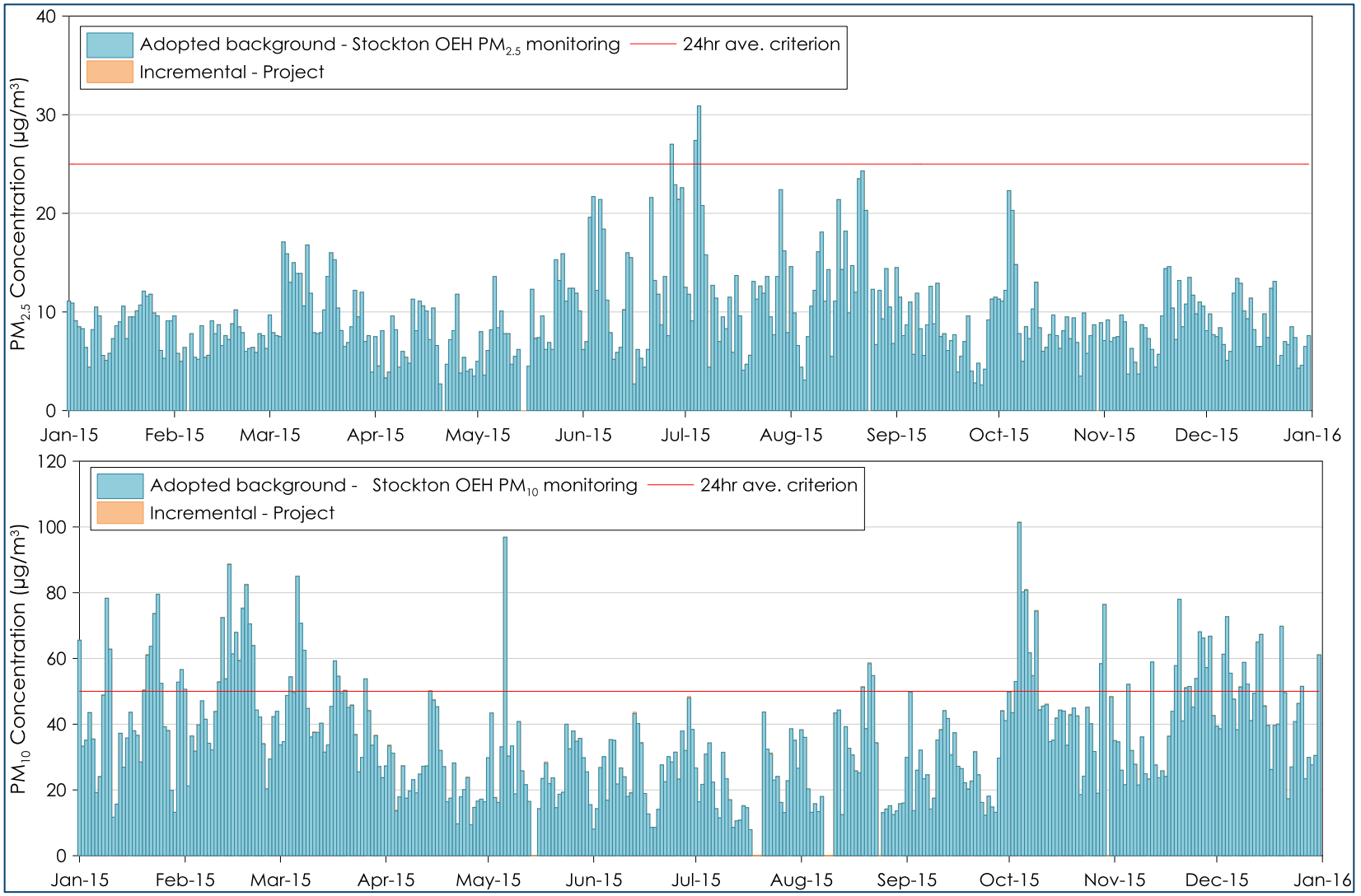


Figure 7-1: Time series plots of predicted cumulative 24-hour average $PM_{2.5}$ (above) and PM_{10} (below) concentrations for R2

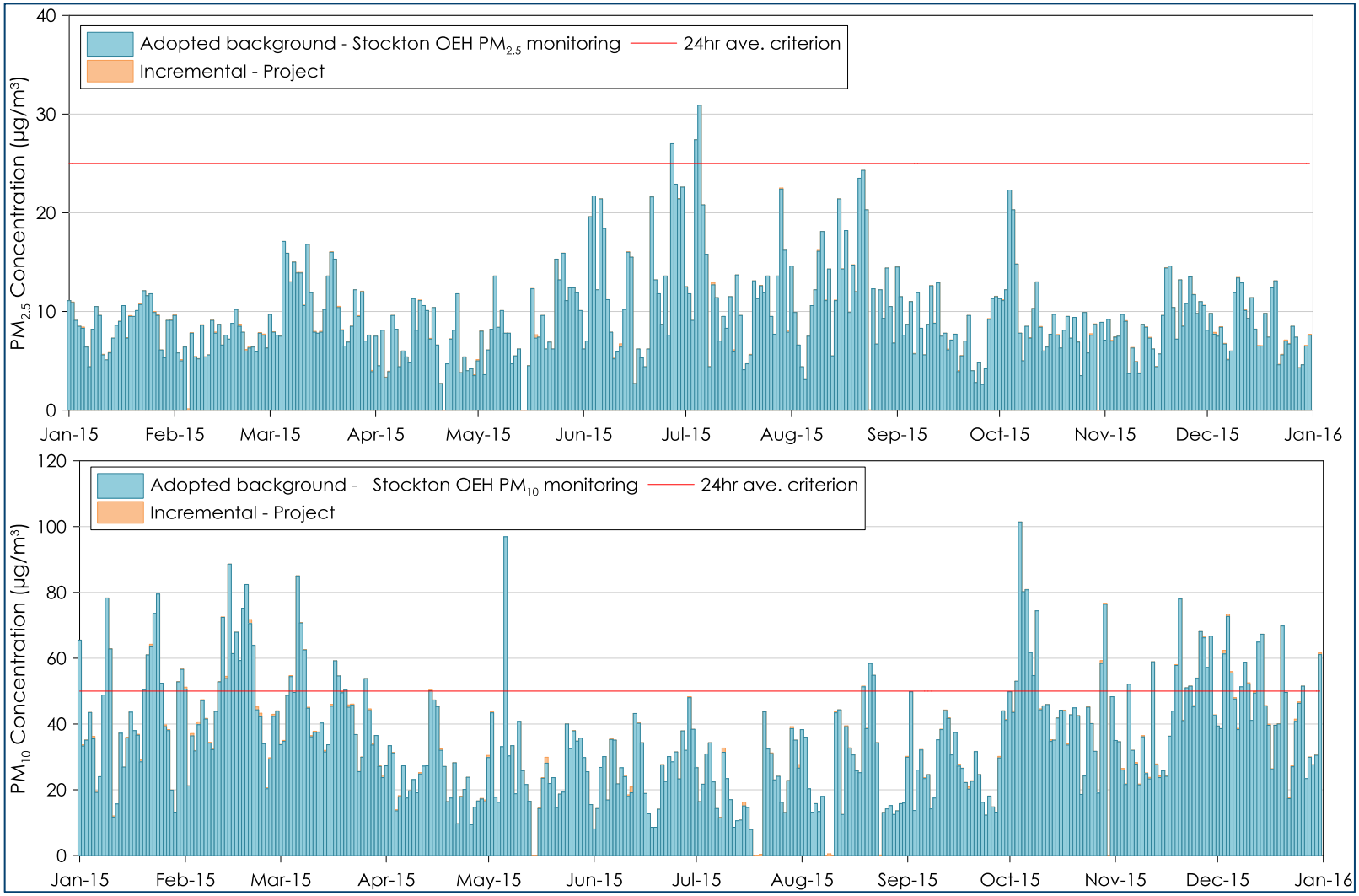


Figure 7-2: Time series plots of predicted cumulative 24-hour average $PM_{2.5}$ (above) and PM_{10} (below) concentrations for R5

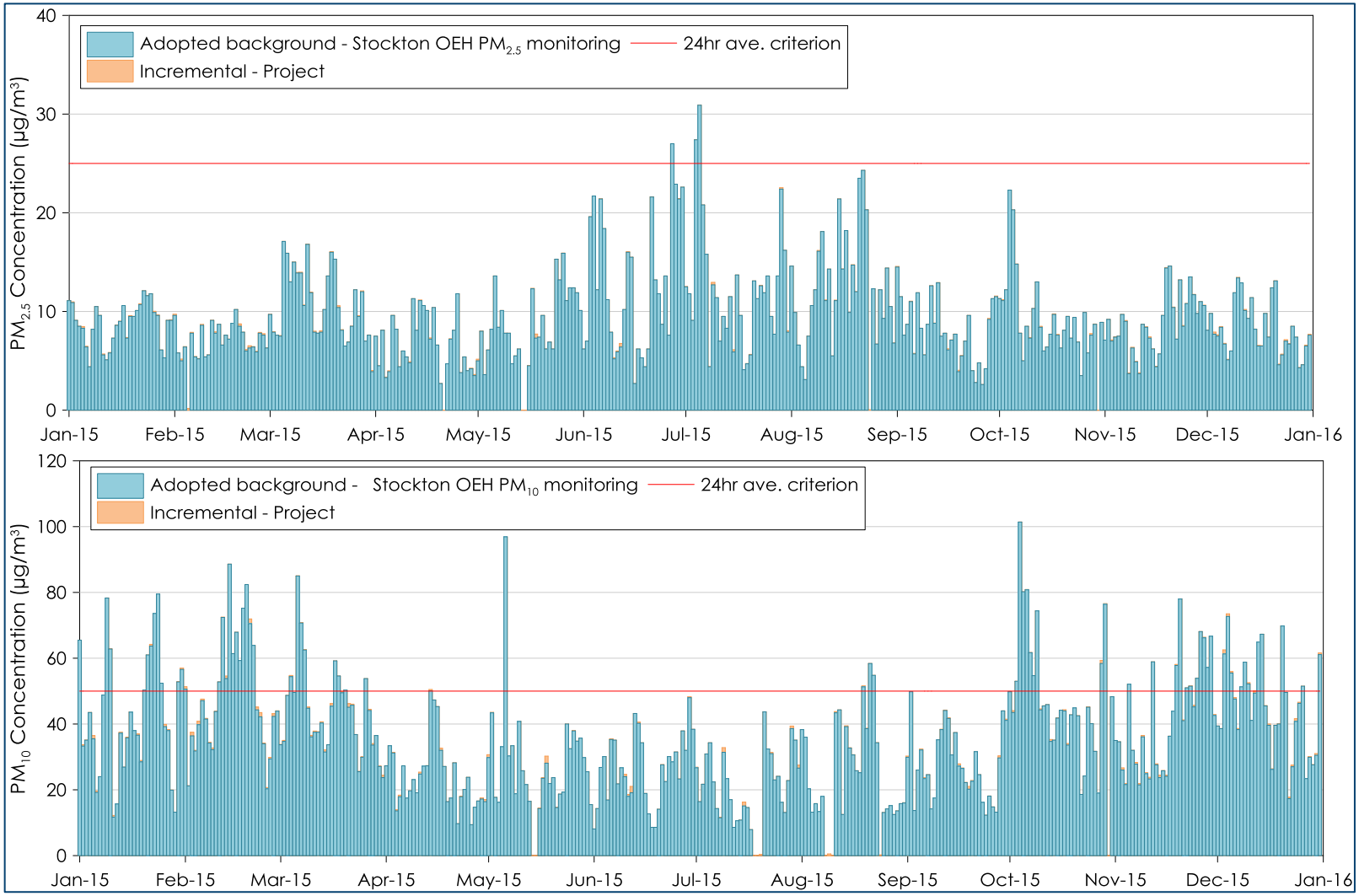


Figure 7-3: Time series plots of predicted cumulative 24-hour average $PM_{2.5}$ (above) and PM_{10} (below) concentrations for R6

7.4 Respirable crystalline silica

The assessment results show that the most affected residential receptor has a total maximum predicted incremental annual average $PM_{2.5}$ concentration level of less than 0.1µg/m^3. This level is due to the total dust from the site, and only a small portion of this dust would contain silica.

As the total level is over thirty times below the VIC EPA criteria of 3µg/m^3 for respirable crystalline silica, the actual level from the Project would be significantly below the criteria and thus, the Project would not result in an unacceptable level of respirable crystalline silica in the ambient air at residential receptors.

7.5 Assessment of impacts per VLAMP criteria

The results in **Table 7-2** indicate the predicted level at the assessed receptors would be below the applicable VLAMP mitigation and acquisition criteria.

The potential impacts due to the Project, extending over more than 25% of any privately-owned land, have been evaluated using the predicted pollutant dispersion contours.

The results at the criteria level concentrations show the maximum 24-hour PM_{10} predictions would have the most spatial extent, relative to any of the other assessed dust metrics and hence 24-hour average PM_{10} represents the most impacting parameter.

Based on the isopleth diagrams in **Appendix D**, the extent of the predicted maximum 24-hour average PM_{10} level of 50µg/m^3 would not extend over more than 25% of any privately-owned land parcels, and it can be concluded that the Project would not cause impact per this criterion.

8 DUST MITIGATION AND MANAGEMENT

The proposed operations at the Project have the potential to generate dust emissions.

To ensure that activities associated with the Project have a minimal effect on the surrounding environment and at residential receptor locations, it is recommended that appropriate operational and physical mitigation measures should be implemented where feasible and reasonable as outlined in **Table 8-1**.

Table 8-1: Potential operational dust mitigation options

Source	Mitigation Measure
General	Activities to be assessed during adverse weather conditions and modified as required (e.g. cease activity where reasonable levels of dust cannot be maintained using the available means).
	Weather forecast to be checked prior to undertaking material handling or processing.
	Engines of on-site vehicles and plant to be switched off when not in use.
	Vehicles and plant are to be fitted with pollution reduction devices where practicable.
	Vehicles are to be maintained and serviced according to manufacturer's specifications.
	Visual monitoring of activities is to be undertaken to identify dust generation.
Exposed areas/stockpiles	The extent of exposed surfaces and stockpiles is to be kept to a minimum.
	Exposed areas and stockpiles are either to be covered or are to be dampened with water as far as is practicable if dust emissions are visible, or there is potential for dust emissions outside operating hours.
	Minimise dust generation by undertaking rehabilitation earthworks when topsoil and subsoil stockpiles are moist and/or wind speed is below 10 m/s.
Material handling	Reduce drop heights from loading and handling equipment where practical.
	Dampen material when excessively dusty during handling.
Hauling activities	Haul roads should be watered using water carts such that the road surface has sufficient moisture to minimise on-road dust generation but not so much as to cause mud/dirt track out to occur.
	Regularly inspect haul roads and maintain surfaces to remove potholes or depressions
	Driveways and hardstand areas to be swept/cleaned regularly as required etc.
	Vehicle traffic is to be restricted to designated routes.
	Speed limits are to be enforced.
	Vehicle loads are to be covered when travelling off-site.

Prior to commencement of operations at the Project, a detailed Air Quality Management Plan will be developed for the site. The Air Quality Management Plan would outline the measures to manage dust emissions at the site and include aspects such as key performance indicators, response mechanisms, compliance reporting and complaints management.

9 SUMMARY AND CONCLUSIONS

This report has assessed the potential air quality impacts associated with the Project at the Stockton Sand Quarry.

Air dispersion modelling was used to predict the potential for off-site dust and NO_2 impacts in the surrounding area due to the operation of the Project. The estimated emissions of dust and NO_2 applied in the modelling are likely to be conservative and would overestimate the actual impacts.

It is predicted that the Project would have a negligible incremental and cumulative impacts at the surrounding residential receptor locations and would comply with the relevant air quality criteria.

Nevertheless, the site would apply appropriate dust management measures to ensure it minimises the potential occurrence of excessive air emissions from the site.

Overall, the assessment demonstrates that even using conservative assumptions, the Project can operate without causing any significant air quality impact at residential receptors in the surrounding environment.

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Appendix A

Selection of Meteorological Year

Selection of meteorological year

A statistical analysis of the latest five contiguous years of meteorological data from the nearest BoM weather station with suitable available data, Williamtown RAAF weather station, is presented in **Table A-1**.

The standard deviation of the latest five years of meteorological data spanning 2014 to 2018 was analysed against the long-term measured wind speed, temperature and relative humidity spanning an approximate 59 to 69-year period recorded at the station.

The analysis indicates that 2014, 2016 and 2018 are closest to the long-term average for wind speed. 2014 and 2015 are closest for temperature and 2015 is closest to the long-term average for relative humidity.

This analysis indicates that considering all three variables, the 2015 period is most representative on the long-term average and was selected for modelling.

Table A-1: Statistical analysis results for Williamtown RAAF

Year	Wind speed	Temperature	Relative humidity
2014	0.5	0.6	4.0
2015	0.7	0.6	2.6
2016	0.5	0.8	4.4
2017	0.6	1.0	4.9
2018	0.5	0.8	5.1

Figure A-1 shows the frequency distributions for wind speed, temperature and relative humidity for the 2015 year compared with the mean of the 2014 to 2018 data set. The 2015 year data appear to be well aligned with the mean data, particularly wind direction which is one the most critical parameters for dispersion.

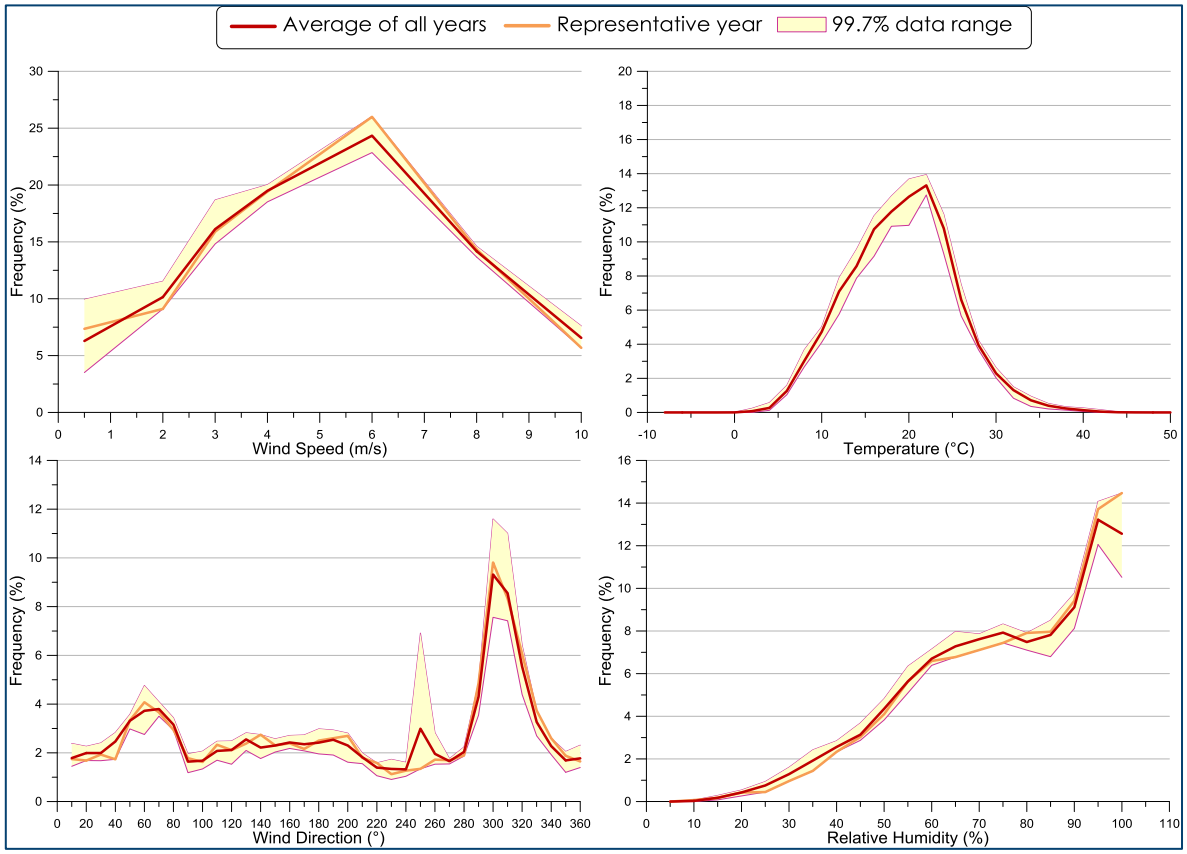

Figure A-1: Frequency distributions for wind speed, wind direction, temperature and relative humidity

Appendix B

Estimated background levels for Stockton Monitor

Estimated background levels for Stockton Monitor

Due to the location of the Stockton OEH monitoring site, it is subject to heavily salt laden air or particulates blowing from the northeast along the surf break of Stockton Beach.

Figure B-1 presents a pollution rose of the hourly $PM_{10,}$ wind speed and wind direction data recorded at Stockton during the 2015 calendar year. Recorded pollutant concentrations are presented as pseudo source locations based on the concurrent wind speed and direction data recorded at the Stockton OEH monitor. White spaces in the figures represent conditions in which no data has been recorded, and outliers are identifiable as points largely surrounded by white space.

It can be seen in **Figure B-1** that higher PM_{10} levels originate from the north-eastern directions under wind speeds below 6m/s. Higher PM_{10} levels were also recorded from the northwest and west-northwest direction under high and moderate wind speeds.

Elevated levels can be seen as patchy red areas in **Figure B-1** along a north-east axis from the monitor. This indicates that heavily salt laden air or particulates blowing from the northeast along the surf break of Stockton Beach were the likely primary contributors to the elevated PM_{10} levels. This is assumed for $PM_{2.5}$ levels as well.

A particle characterisation study that was conducted in the Lower Hunter has estimated that of the recorded annual averages at the Stockton OEH monitor 23% and 63% of $PM_{2.5}$ and $PM_{2.5\text{-}10}$ concentrations, respectively, are contributed from fresh sea salt particles at Stockton **(CSIRO, ANSTO & OEH 2016)**. Fresh sea salt aerosol arises from the wave-breaking in the ocean and is a natural source of particles.

To estimate the annual average concentrations at the Stockton OEH Monitor without contribution from fresh sea salt particles, the difference in the measured $PM_{2.5}$ and PM_{10} annual averages excluding 63% are summed with the measured $PM_{2.5}$ annual average excluding 23% to estimate the annual average PM_{10} concentration with the contribution of fresh sea salt particles removed. The annual average $PM_{2.5}$ concentration is estimated by excluding 23% of the measured value.

Using these contributions approximate annual average $PM_{2.5}$ and PM_{10} concentrations of 7.3µg/m^3 and 17.0µg/m^3 were calculated respectively.

These estimates for the annual average $PM_{2.5}$ and PM_{10} concentrations are comparable with level measured at the Beresfield and Wallsend monitors.

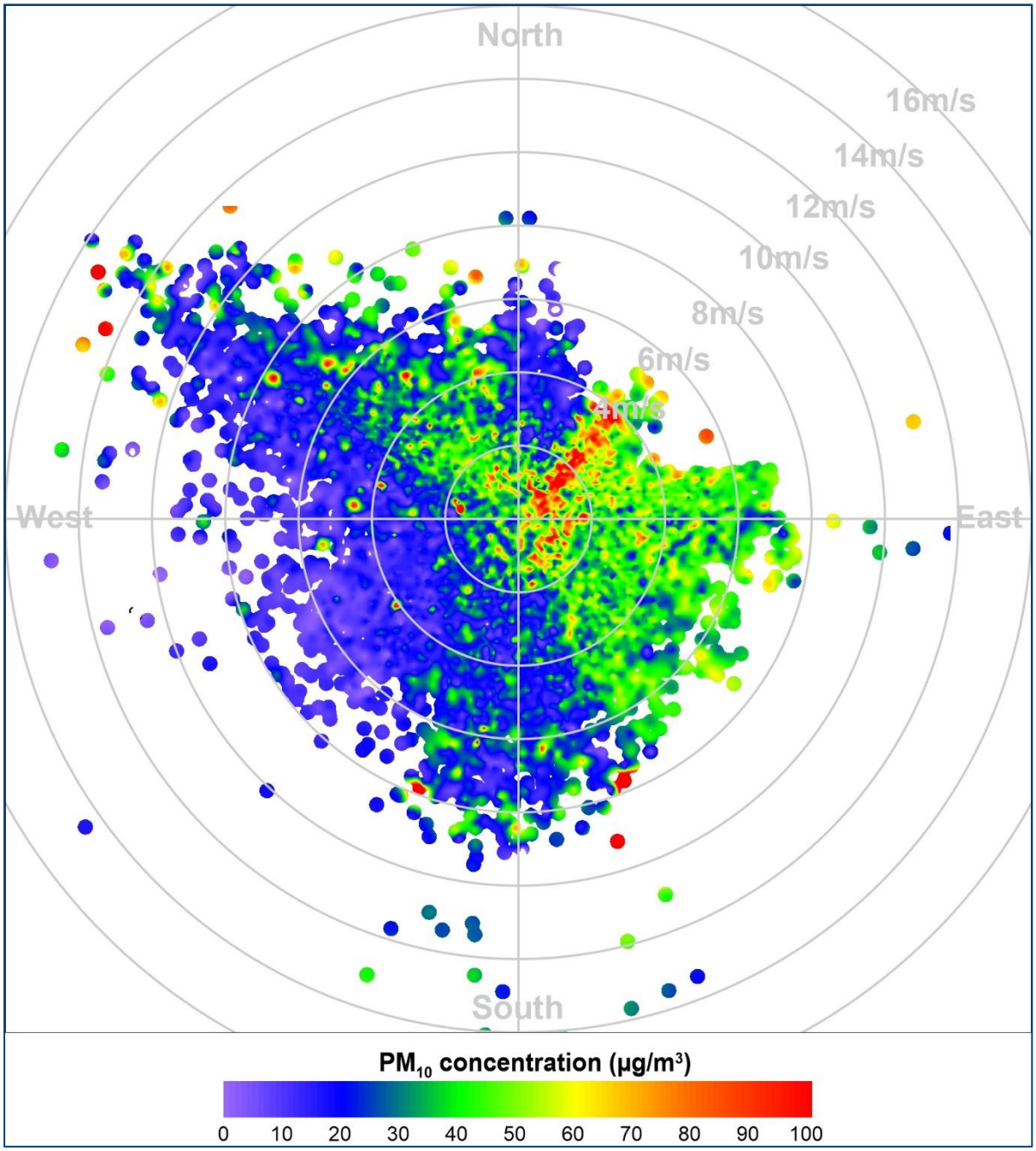

Figure B-1: PM_{10} pollution rose for Stockton Monitor for 2015

Appendix C

Emission Calculations

Emission Calculation

The dust emissions from the Project have been estimated from the operational description of the proposed activities provided by the Proponent and have been combined with emissions factor equations and utilising suitable emission and load factors that relate to the quantity of dust emitted from particular activities based on intensity, the prevailing meteorological conditions and composition of the material being handled.

Emission factors and associated controls have been sourced from:

- United States (US) EPA AP42 Emission Factors (**US EPA, 1985 and Updates**);
- Office of Environment and Heritage document, "NSW Coal Mining Benchmarking Study: Best Practise Measures for Reducing Non-Road Diesel Exhaust Emissions, Final Report" (**EPA NSW, 2015**).

The emission factor equations used for each dust generating activity are outlined in **Table C-1** below. A detailed dust emission inventory for the different scenarios are presented in **Table C-2** to **Table C-4.**

Control factors include the following:

- Hauling on unpaved surfaces – 80% control for watering of trafficked areas; and,
- Wind erosion from exposed areas – 50% control for watering of exposed areas.

Table C-1: Emission factor equations

Activity	Emission factor equation		
	TSP	**PM_{10}**	**$PM_{2.5}$**
Loading / emplacing material	$EF = 0.74 \times 0.0016 \times \left(\frac{U}{2.2}^{1.3} / \frac{M}{2}^{1.4}\right) kg/tonne$	$EF = 0.35 \times 0.0016 \times \left(\frac{U}{2.2}^{1.3} / \frac{M}{2}^{1.4}\right) kg/tonne$	$EF = 0.053 \times 0.0016 \times \left(\frac{U}{2.2}^{1.3} / \frac{M}{2}^{1.4}\right) kg/tonne$
Hauling on unsealed surfaces	$EF = \left(\frac{0.4536}{1.6093}\right) \times 4.9 \times (s/12)^{0.7} \times (1.1023 \times M/3)^{0.45} kg/VKT$	$EF = \left(\frac{0.4536}{1.6093}\right) \times 1.5 \times (s/12)^{0.9} \times (1.1023 \times M/3)^{0.45} kg/VKT$	$EF = \left(\frac{0.4536}{1.6093}\right) \times 0.15 \times (s/12)^{0.9} \times (1.1023 \times M/3)^{0.45} kg/VKT$
Screening	$EF = 0.0125\ kg/tonne$	$EF = 0.0043\ kg/tonne$	$0.075 \times TSP$
Wind erosion on exposed areas, stockpiles	$EF = 850\ kg/ha/year$	$0.5 \times TSP$	$0.075 \times TSP$

EF = emission factor, U = wind speed (m/s), M = moisture content (%), s = silt content (%), VKT = vehicle kilometres travelled (km).

Table C-2: Dust Emissions Inventory – Scenario 1

Activity	TSP emission	PM10 emission	PM2.5 emission	Intensity	Units	Emission Factor TSP	Emission Factor PM10	Emission Factor PM2.5	Units	Var. 1	Units	Var. 2	Units	Size specific EF - TSP/PM10/ PM25	Units	Var. 3	Units	Var. 4	Units	Var. 5	Units
Loading sand to haul truck at windblown sand area	357	169	26	250,000	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Hauling RAW sand from windblown sand area to offsite	14,829	3,779	378	250,000	t/yr	0.297	0.076	0.008	kg/t	28.00	t/load	4.0	km/trip	2.1/0.5/0.1	kg/VKT	4.8	S.C. in %	28	A.W. (t)	80	% Control
Excavator loading topsoil to haul truck - Stage 1	0.089	0.042	0.006	63	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Hauling to topsoil stockpile	0.427	0.109	0.011	63	t/yr	0.034	0.009	0.001	kg/t	40.00	t/load	0.5	km/trip	2.6/0.7/0.1	kg/VKT	4.8	S.C. in %	48	A.W. (t)	80	% Control
Emplacing at topsoil stockpile	0.089	0.042	0.006	63	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Loading sand to screen in Stage 1	714	338	51	500,000	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Dredging sand with dredge	-	-	-	-	t/yr																
Pumping sand to stockpile at processing area	-	-	-	-	t/yr																
Screening RAW sand (controlled - wet sand)	-	-	-	-	t/yr	0.0011	0.000	0.0000	kg/t												
Unloading processed sand to stockpile	714	338	51	500,000	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Rehandle processed sand material at product stockpile	71	34	5	50,000	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Loading product sand material to haul truck	714	338	51	500,000	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Hauling product sand offsite	5,931	1,512	151	500,000	t/yr	0.059	0.015	0.002	kg/t	28.00	t/load	0.8	km/trip	2.1/0.5/0.1	kg/VKT	4.8	S.C. in %	28	A.W. (t)	80	% Control
Hauling VENM material onsite	1,038	265	26	70,000	t/yr	0.074	0.019	0.002	kg/t	28.00	t/load	1.0	km/trip	2.1/0.5/0.1	kg/VKT	4.8	S.C. in %	28	A.W. (t)	80	% Control
Unloading VENM material at stockpile	100	47	7	70,000	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Wind erosion - exposed area	1,445	723	108	3.4	ha	850	425	64	kg/ha/yr											50	% Control
Exhaust emissions from on-site equipment	562	562	546																		
Total TSP emissions (kg/yr)	**26,478**	**8,105**	**1,401**																		

Table C-3: Dust Emissions Inventory – Scenario 2

Activity	TSP emission	PM10 emission	PM2.5 emission	Intensity	Units	Emission Factor TSP	Emission Factor PM10	Emission Factor PM2.5	Units	Var. 1	Units	Var. 2	Units	Size specific EF - TSP	Units	Var. 3	Units	Var. 4	Units	Var. 5	Units
Loading sand to haul truck at windblown sand area	-	-	-	-	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Hauling RAW sand from windblown sand area to offsite	-	-	-	-	t/yr	0.000	0.000	0.000	kg/t	28.00	t/load	0.0	km/trip	2.1/0.5/0.1	kg/VKT	4.8	S.C. in %	28	A.W. (t)	80	% Control
Excavator loading topsoil to haul truck - Stage 1	0.089	0.042	0.006	63	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Hauling to topsoil stockpile	0.427	0.109	0.011	63	t/yr	0.034	0.009	0.001	kg/t	40.00	t/load	0.5	km/trip	2.6/0.7/0.1	kg/VKT	4.8	S.C. in %	48	A.W. (t)	80	% Control
Emplacing at topsoil stockpile	0.089	0.042	0.006	63	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Loading sand to screen in Stage 1	1,072	507	77	750,000	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Dredging sand with dredge	-	-	-	-	t/yr																
Pumping sand to stockpile at processing area	-	-	-	-	t/yr																
Screening RAW sand (controlled - wet sand)	-	-	-	-	t/yr	0.0125	0.004	0.0009	kg/t												
Unloading processed sand to stockpile	1,072	507	77	750,000	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Rehandle processed sand material at product stockpile	107	51	8	75,000	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Loading product sand material to haul truck	1,072	507	77	750,000	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Hauling product sand offsite	8,897	2,268	227	750,000	t/yr	0.059	0.015	0.002	kg/t	28.00	t/load	0.8	km/trip	2.1/0.5/0.1	kg/VKT	4.8	S.C. in %	28	A.W. (t)	80	% Control
Hauling VENM material onsite	1,165	297	30	70,000	t/yr	0.083	0.021	0.002	kg/t	28.00	t/load	1.1	km/trip	2.1/0.5/0.1	kg/VKT	4.8	S.C. in %	28	A.W. (t)	80	% Control
Unloading VENM material at stockpile	100	47	7	70,000	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Wind erosion - exposed area	1,488	744	112	3.5	ha	850	425	64	kg/ha/yr											50	% Control
Exhaust emissions from on-site equipment	562	562	546																		
Total TSP emissions (kg/yr)	**15,535**	**5,489**	**1,159**																		

Table C-4: Dust Emissions Inventory – Scenario 3

Activity	TSP emission	PM10 emission	PM2.5 emission	Intensity	Units	Emission Factor TSP	Emission Factor PM10	Emission Factor PM2.5	Units	Var. 1	Units	Var. 2	Units	Size specific EF - TSP	Units	Var. 3	Units	Var. 4	Units	Var. 5	Units
Loading sand to haul truck at windblown sand area	-	-	-	-	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Hauling RAW sand from windblown sand area to offsite	-	-	-	-	t/yr	0.267	0.068	0.007	kg/t	28.00	t/load	3.6	km/trip	2.1/0.5/0.1	kg/VKT	4.8	S.C. in %	28	A.W. (t)	80	% Control
Excavator loading topsoil to haul truck - Stage 5	0.051	0.024	0.004	36	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Hauling to topsoil stockpile	0.904	0.230	0.023	36	t/yr	0.127	0.032	0.003	kg/t	40.00	t/load	1.9	km/trip	2.6/0.7/0.1	kg/VKT	4.8	S.C. in %	48	A.W. (t)	80	% Control
Emplacing at topsoil stockpile	0.051	0.024	0.004	36	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Dredging sand with dredge	-	-	-	750,000	t/yr																
Pumping sand to stockpile at processing area	-	-	-	750,000	t/yr																
Screening RAW sand (controlled - wet sand)	-	-	-	-	t/yr	0.0125	0.004	0.0009	kg/t												
Unloading processed sand to stockpile	1,072	507	77	750,000	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Rehandle processed sand material at product stockpile	107	51	8	75,000	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Loading product sand material to haul truck	1,072	507	77	750,000	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Hauling product sand offsite	6,117	1,559	156	750,000	t/yr	0.041	0.010	0.001	kg/t	28.00	t/load	0.6	km/trip	2.1/0.5/0.1	kg/VKT	4.8	S.C. in %	28	A.W. (t)	80	% Control
Hauling VENM material onsite	1,165	297	30	70,000	t/yr	0.083	0.021	0.002	kg/t	28.00	t/load	1.1	km/trip	2.1/0.5/0.1	kg/VKT	4.8	S.C. in %	28	A.W. (t)	80	% Control
Unloading VENM material at stockpile	100	47	7	70,000	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Loading VENM material to haul truck	100	47	7	70,000	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Hauling VENM material to Stage 5	1,773	452	45	70,000	t/yr	0.127	0.032	0.003	kg/t	40.00	t/load	1.9	km/trip	2.6/0.7/0.1	kg/VKT	4.8	S.C. in %	48	A.W. (t)	80	% Control
Unloading VENM material at Stage 5	100	47	7	70,000	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Wind erosion - exposed area	1,488	744	112	3.5	ha	850	425	64	kg/ha/yr											50	% Control
Exhaust emissions	762	762	739																		
Total TSP emissions (kg/yr)	**13,856**	**5,020**	**1,265**																		

Best Practice Assessment

Table C-5 presents the estimated presents the estimated baseline dust emissions estimates for the Project, with and without the proposed particulate matter controls in place. The activities highlighted in blue shading indicate where control measures have been applied.

From **Table C-5**, the application of the proposed particulate matter controls results in total dust emissions of approximate 32% of the uncontrolled baseline emissions estimates for the Project.

Table C-5: Estimated baseline dust emission estimates for the modelling Project

Activity	Controlled			Uncontrolled		
	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Loading sand to haul truck at windblown sand area	357	169	26	357	169	26
Hauling RAW sand from windblown sand area to offsite	14,829	3,779	378	74,143	18,896	1,890
Excavator loading topsoil to haul truck - Stage 1	0.089	0.042	0.006	0.089	0.042	0.006
Hauling to topsoil stockpile	0.427	0.109	0.011	2.134	0.544	0.054
Emplacing at topsoil stockpile	0.089	0.042	0.006	0.089	0.042	0.006
Loading sand to screen in Stage 1	714	338	51	714	338	51
Dredging sand with dredge	-	-	-	-	-	-
Pumping sand to stockpile at processing area	-	-	-	-	-	-
Screening RAW sand (controlled - wet sand)	-	-	-	-	-	-
Unloading processed sand to stockpile	714	338	51	714	338	51
Rehandle processed sand material at product stockpile	71	34	5	71	34	5
Loading product sand material to haul truck	714	338	51	714	338	51
Hauling product sand offsite	5,931	1,512	151	29,657	7,558	756
Hauling VENM material onsite	1,038	265	26	5,190	1,323	132
Unloading VENM material at stockpile	100	47	7	100	47	7
Wind erosion - exposed area	1,445	723	108	2,890	1,445	217
Exhaust emissions from on-site equipment	562	562	546	562	562	546
Total TSP emissions (kg/yr)	**26,478**	**8,105**	**1,401**	**115,117**	**31,049**	**3,732**

From **Table C-5**, top three dust generating activities at the Project are identified as:

- Hauling on unpaved roads;
- Wind erosion from exposed areas; and,
- Loading and unloading material.

These three activities account for approximately 98% of the estimated controlled dust emissions estimates for the Project.

A summary of the evaluation of potential additional control measures is presented in **Table C-6**.

The proposed and additional recommended control measures for the Project, based on the top four dust generating activities at the Project include:

- Watering of unpaved haul roads;
- Restriction of vehicle speed to 30km/hr at the site;
- Minimise extent of exposed area;
- Watering of exposed areas for stabilisation;

- Establish rehabilitation goals and report annually on progress;
- Reduce drop height of material where practical; and,
- Assess handling activity during adverse weather conditions.

Table C-6: Summary of application of control measures for the Project

Control measure		Application at Project	Comment
Hauling on unpaved roads			
Vehicle restrictions	Reduction from 75km/hr to 50km/hr.	-	-
	Reduction from 65km/hr to 30km/hr.	Recommended	A speed limit of 30km/hr is recommended for the site. Measure is applied via signage.
Surface improvements	Pave the surface.	-	Not practical/ feasible.
	Low silt aggregate.	Yes	Haul road surfaces will be regularly maintained via watering and grading to ensure a smooth compacted surface with reduced loose surface silt.
	Oil and double chip surface.	-	Not practical/ feasible.
Surface Treatments	Watering (standard procedure).	-	-
	Watering Level 1 (2L/m²/hr).	-	-
	Watering Level 2 (>2L/m²/hr).	Yes	Application via watercart capable to delivering more than 2L/m²/ hr (multiple passes are preferred to a single drenching pass).
	Watering grader routes.	-	Not a regular control measure, but if significant dust is generated from graders, target watering is recommended at these times.
	Watering twice a day for industrial unpaved road.	-	Not a regular measure, but may be practiced, say on a very hot and windy day
	Suppressants.	-	-
	Hygroscopic salts.	-	-
	Lignosulphonates.	-	-
	Polymer emulsions.	-	-
	Tar and bitumen emulsions.	-	-
Other	Use larger vehicles rather than smaller vehicles to minimise number of trips.	-	Not practical/ feasible. Road going vehicles required.
	Use conveyors in place of haul roads.	-	Not practical/ feasible.
Wind erosion			
Avoidance	Minimise pre-strip. Environmental Management Plan (EMP) should specify a benchmark for optimal performance and report annually against benchmark.	Recommended	Recommended for this Project.
Surface stabilisation	Watering.	Yes	Targeted watering of active areas when in use (considered an appropriate control measure for this source.
	Chemical suppressants.	-	-
	Paving and cleaning.	-	-
	Apply gravel to stabilise disturbed open areas.	-	Could be considered depending on available material.
	Rehabilitation. EMP should specify a rehabilitation goal and report annually against progress to meeting goal.	Recommended	Recommended for this Project.
Wind speed reduction	Fencing, bunding, shelterbelts or in-pit dump. Height should be greater than the	-	-

Control measure		Application at Project	Comment
	height of the erodible surface.		
	Vegetative ground cover.	-	May be considered in the rehabilitation goal.
Loading and unloading			
Minimise drop height	Reduce from 3m to 1.5m	Recommended	Recommended for this Project.
Water application	Apply water during activity.	-	Not practical/ feasible.
Modify activities in windy conditions	Activities to be assessed during adverse weather conditions and modified as required. Weather forecast to be checked prior to undertaking material handling or processing.	Recommended	Recommended for this Project.

Appendix D

Isopleth Diagrams

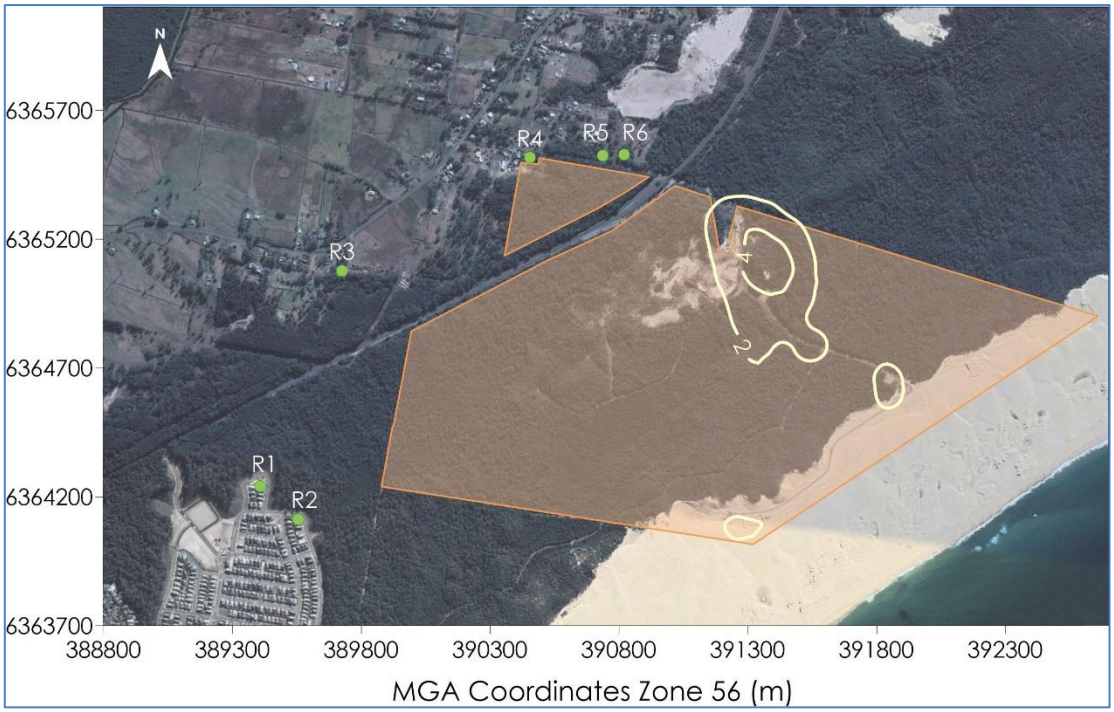

Figure D-1: Predicted incremental maximum 24-hour average $PM_{2.5}$ concentrations (µg/m³)

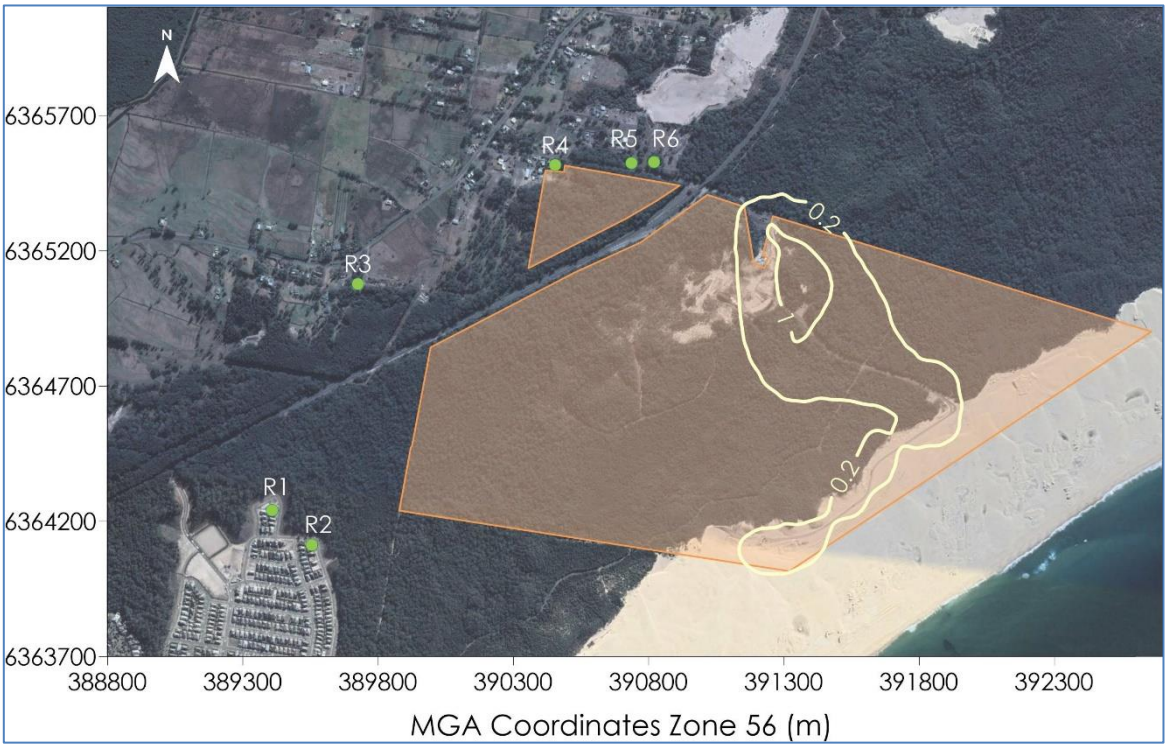

Figure D-2: Predicted incremental annual average $PM_{2.5}$ concentrations (µg/m³)

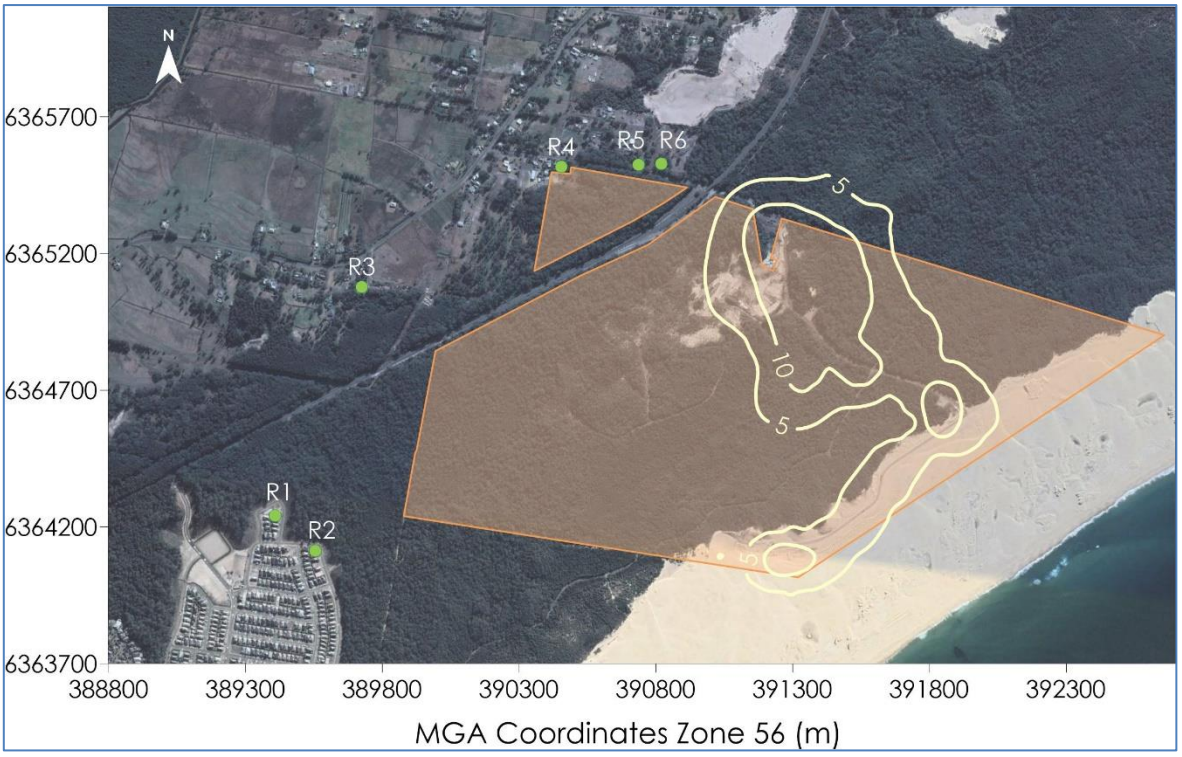

Figure D-3: Predicted incremental maximum 24-hour average PM_{10} concentrations (µg/m³)

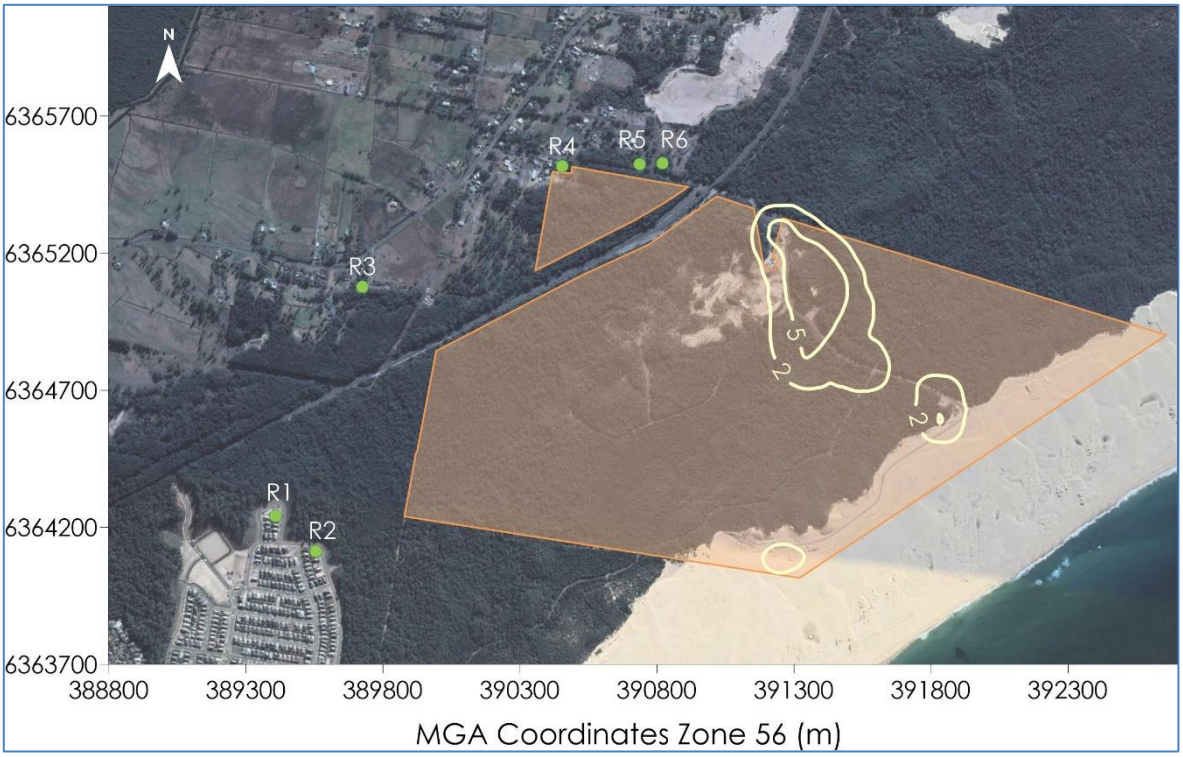

Figure D-4: Predicted incremental annual average PM_{10} concentrations (µg/m³)

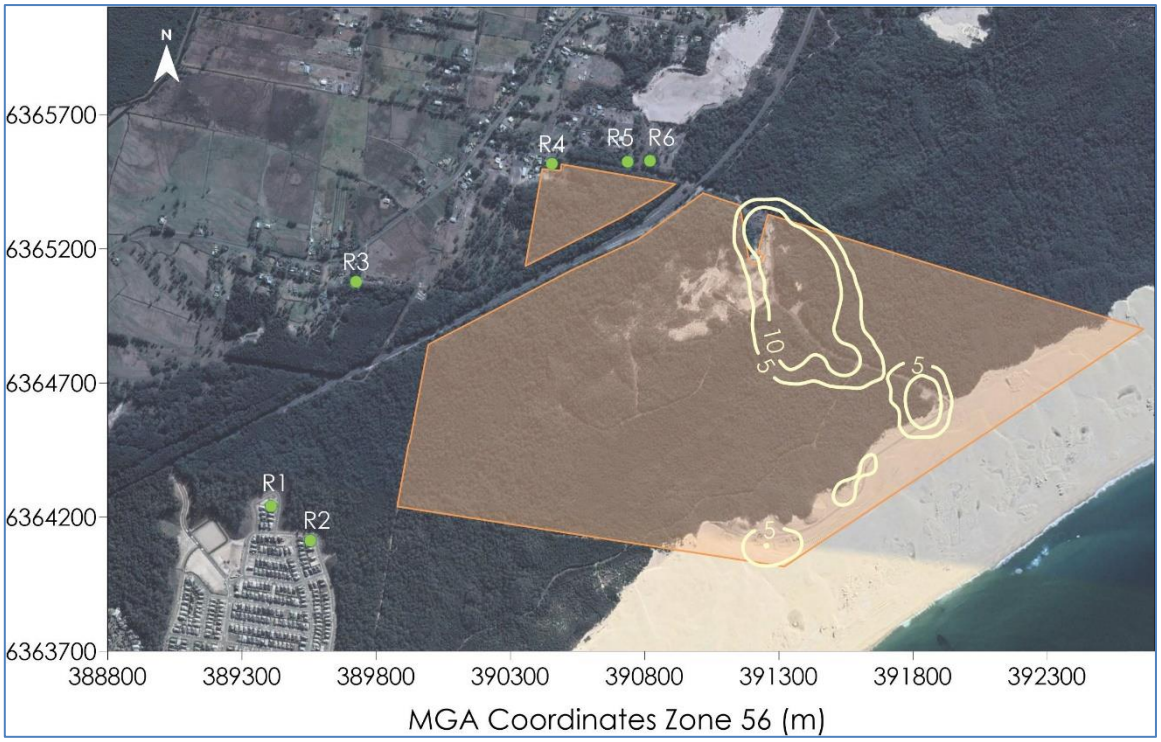

Figure D-5: Predicted incremental annual average TSP concentrations (µg/m³)

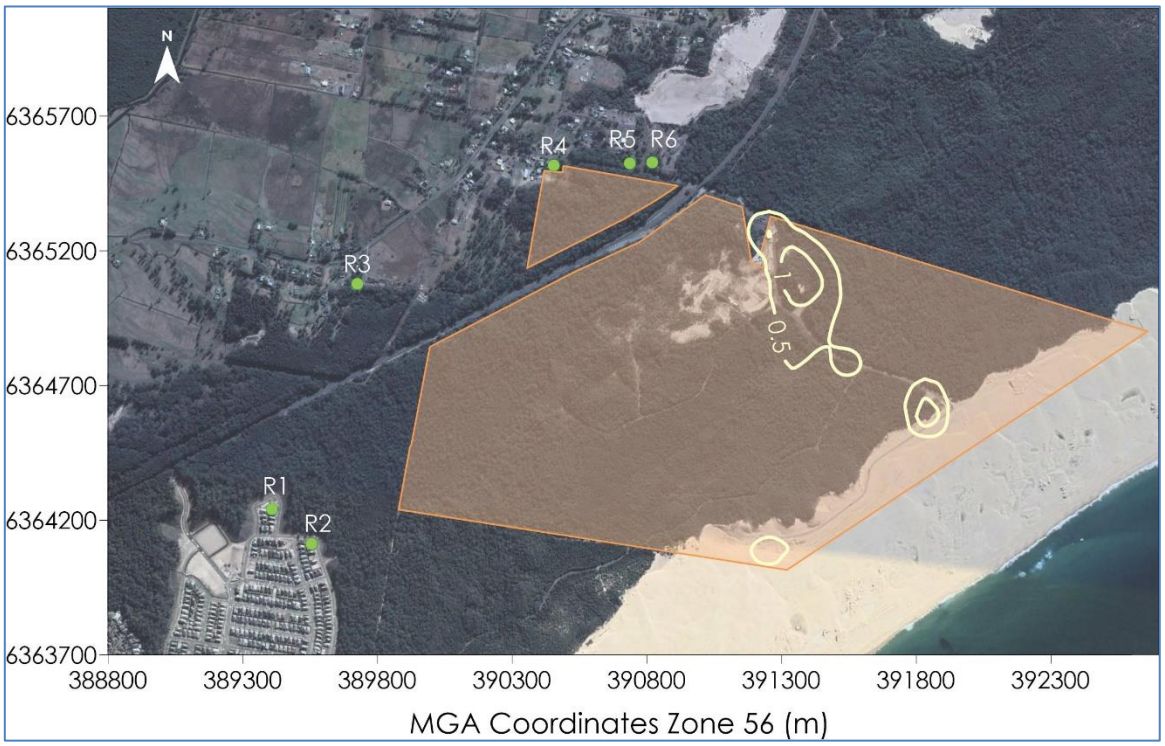

Figure D-6: Predicted incremental annual average dust deposition levels (g/m²/month)

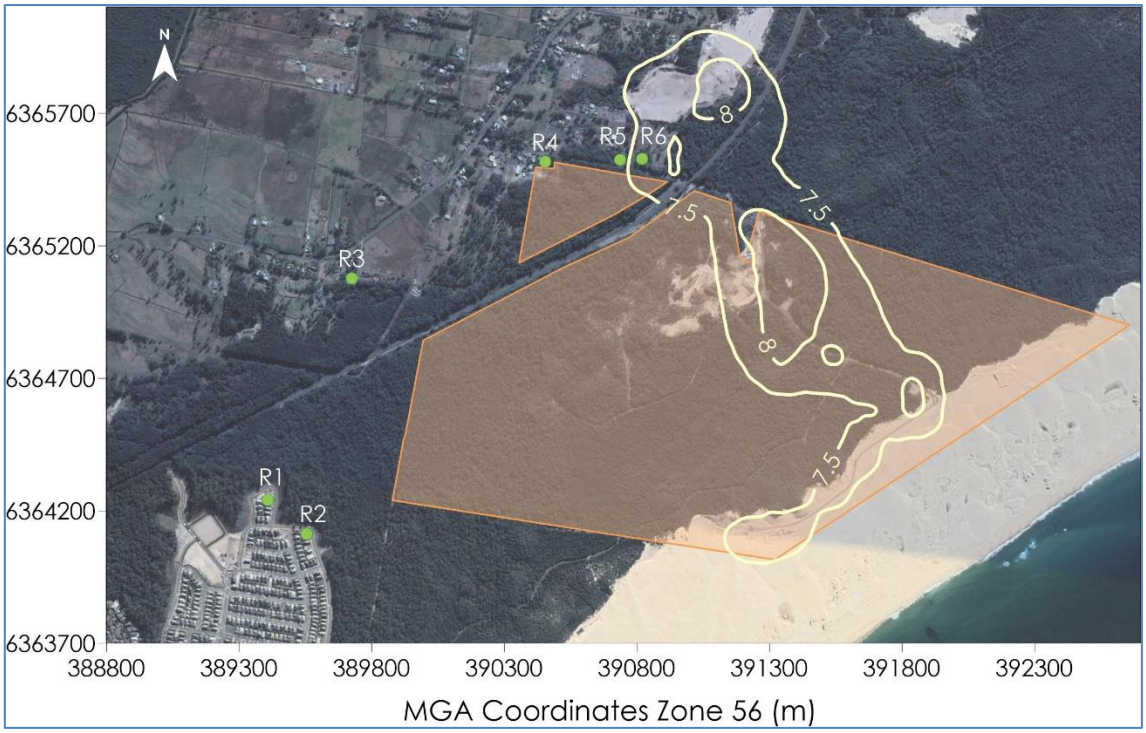

Figure D-7: Predicted cumulative annual average $PM_{2.5}$ concentrations (µg/m³)

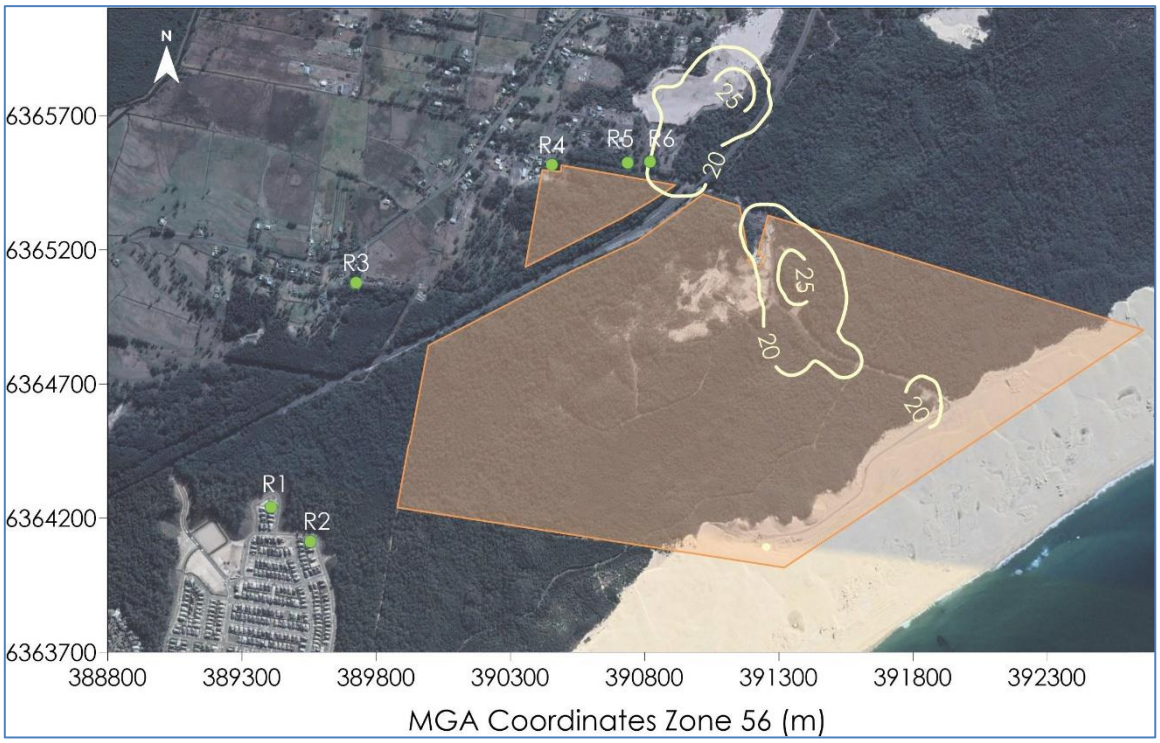

Figure D-8: Predicted cumulative annual average PM_{10} concentrations (µg/m³)

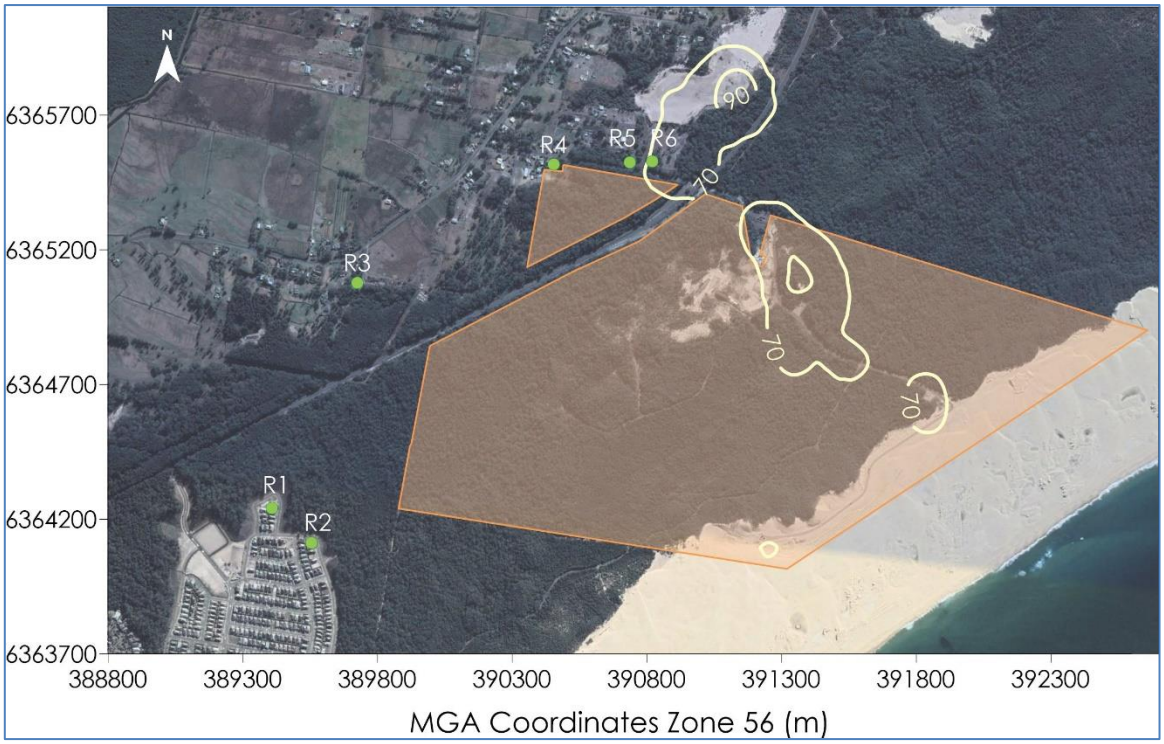

Figure D-9: Predicted cumulative annual average TSP concentrations (µg/m³)

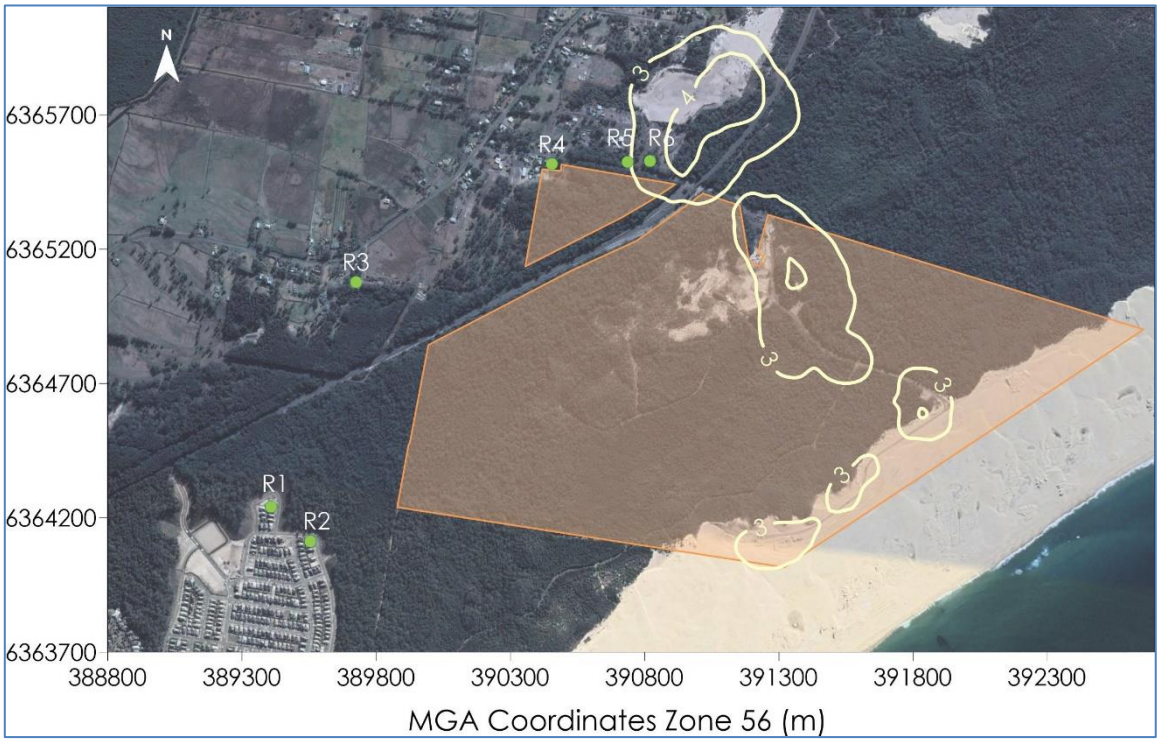

Figure D-10: Predicted cumulative annual average dust deposition levels (g/m²/month)

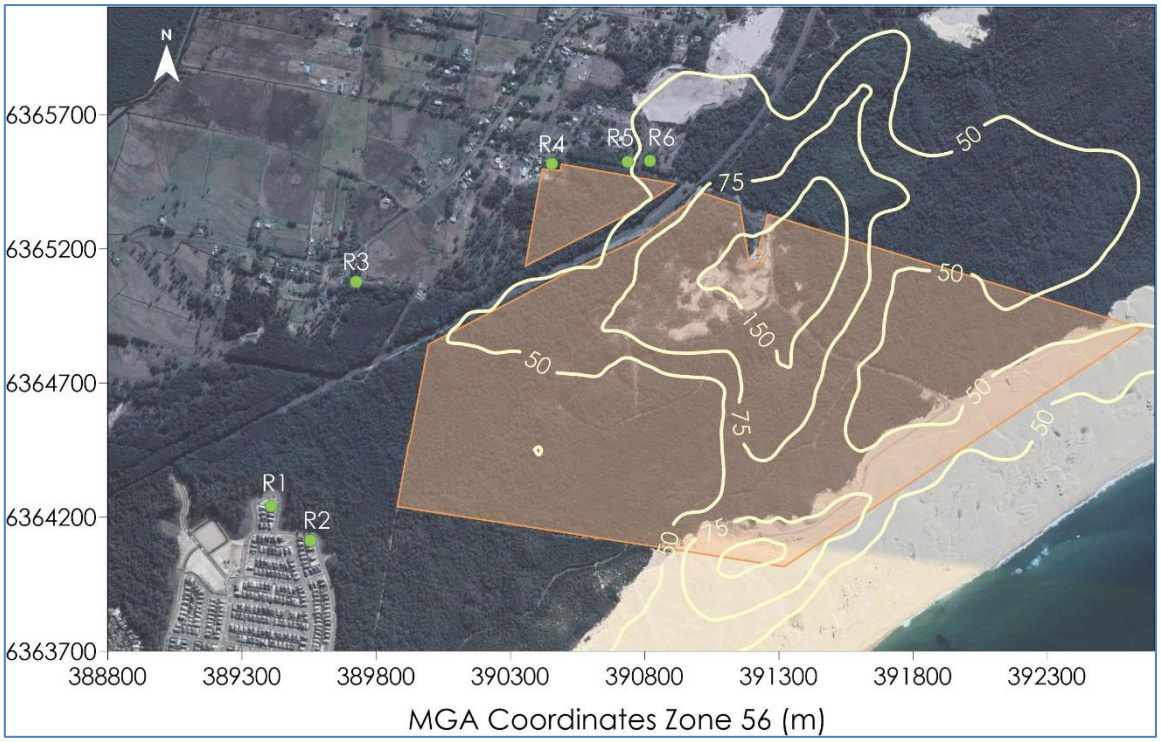

Figure D-11: Predicted incremental maximum 1-hour average NO_2 concentrations (µg/m³)

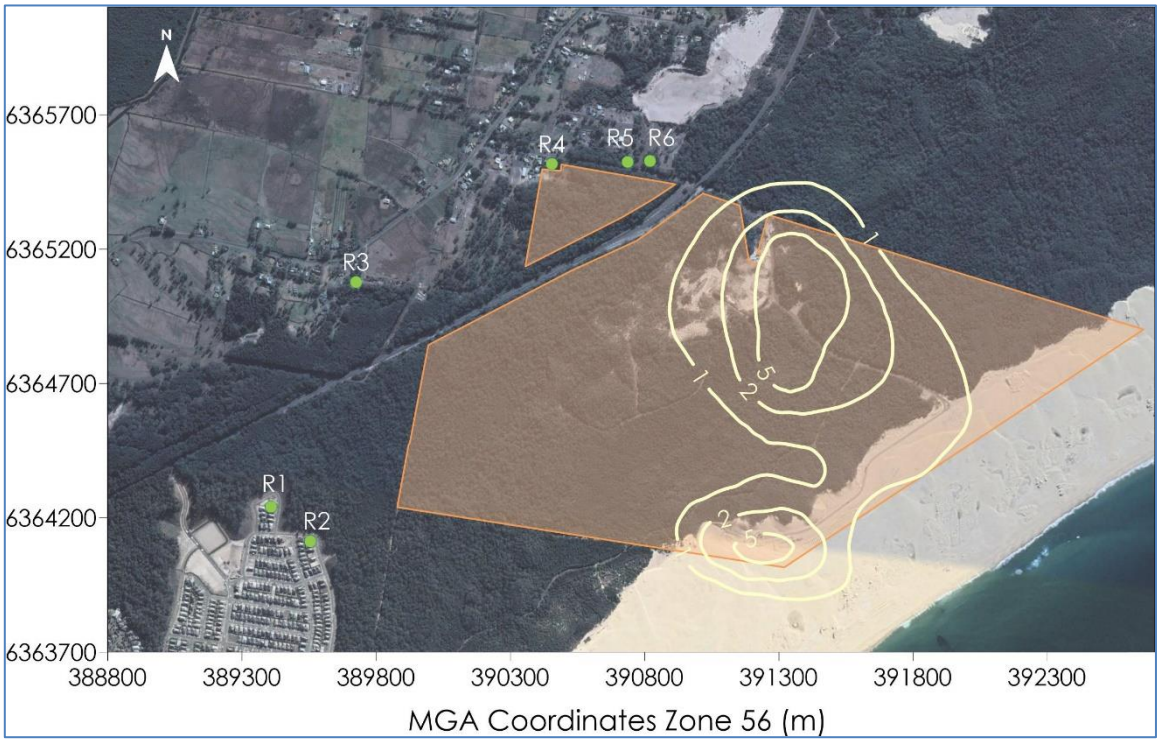

Figure D-12: Predicted incremental annual average NO_2 concentrations (µg/m³)

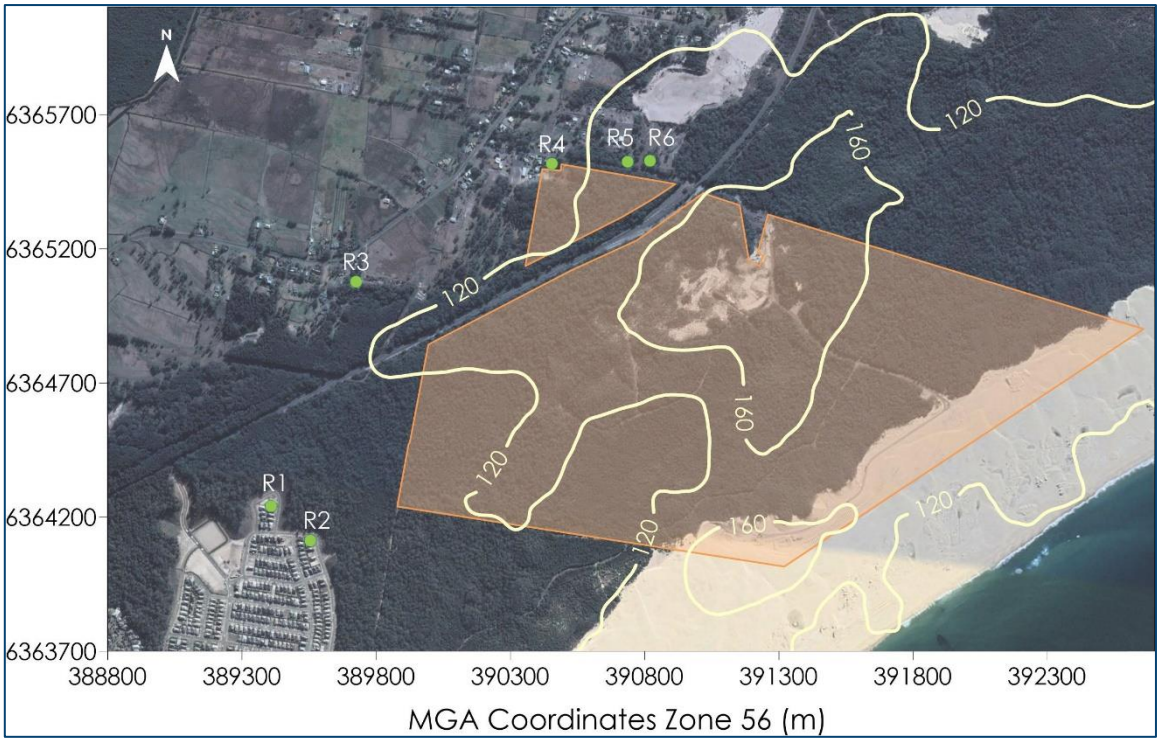

Figure D-13: Predicted cumulative maximum 1-hour average NO_2 concentrations (µg/m³)

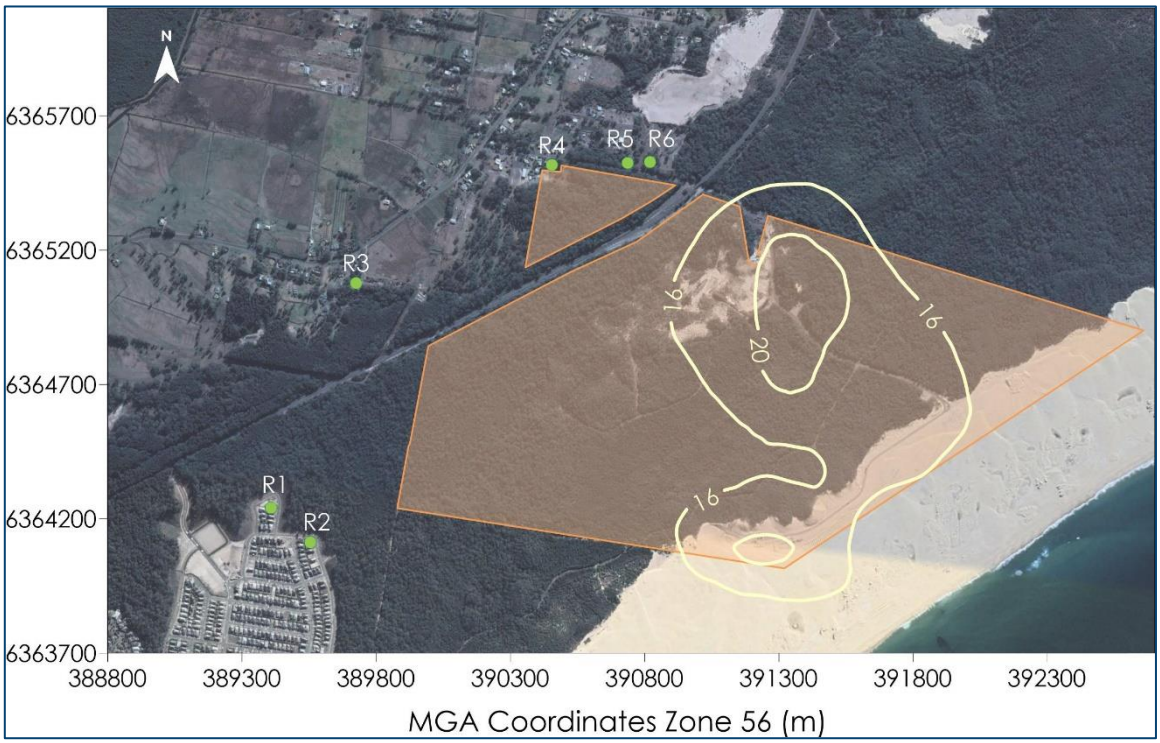

Figure D-13: Predicted cumulative annual average NO_2 concentrations (µg/m³)

Appendix E

Further detail regarding 24-hour $PM_{2.5}$ and PM_{10} analysis

Further detail regarding 24-hour average $PM_{2.5}$ and PM_{10} analysis

The analysis below provides a cumulative 24-hour $PM_{2.5}$ and a cumulative 24-hour PM_{10} impact assessment in accordance with the NSW EPA Approved Methods; refer to the worked example on Page 46 to 47 of the Approved Methods.

The background level is the ambient level at Stockton monitoring station for $PM_{2.5}$ and PM_{10}.

The predicted increment is the predicted level to occur at the receptor due to the Project.

The total is the sum of the background level and the predicted level. The totals may have minor discrepancies due to rounding.

Tables E-1 to **E-6** and **E-8** to **E-13** each assess one receptor and shows the predicted maximum cumulative levels at each receptor surrounding the Project. The left half of the table examines the cumulative impact during the periods of highest background levels and the right half of the table examines the cumulative impact during the periods of highest contribution from the Project.

Tables E-7 show the periods of highest background PM_{10} levels where the measured background level is already over the criteria of 50µg/m^3 at each receptor surrounding the Project which has been excluded from **Tables E-8** to **E-13**.

The green shading represents days ranked per the highest background level but below the criteria.

The blue shading represents days ranked per the highest predicted increment level but below the criteria.

The orange shading represents days where the measured background level is already over the criteria.

Any value above the $PM_{2.5}$ criterion of 25µg/m^3 or above the PM_{10} criterion of 50µg/m^3 is in **bold red.**

Table E-1: Cumulative 24-hour average $PM_{2.5}$ concentration (µg/m³) – Receptor R1

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
5/07/2015	30.9	0.0	30.9				
4/07/2015	27.4	0.0	27.4				
27/06/2015	27.0	0.0	27.0				
22/08/2015	24.3	0.0	24.3	18/05/2015	7.3	0.1	7.4
21/08/2015	23.5	0.1	23.6	29/06/2015	21.4	0.1	21.5
28/06/2015	22.9	0.0	22.9	4/04/2015	3.3	0.1	3.4
30/06/2015	22.6	0.0	22.6	23/07/2015	12.6	0.1	12.7
29/07/2015	22.4	0.0	22.4	21/08/2015	23.5	0.1	23.6
4/10/2015	22.3	0.0	22.3	15/07/2015	5.9	0.0	5.9
4/06/2015	21.7	0.0	21.7	2/04/2015	4.5	0.0	4.5
21/06/2015	21.6	0.0	21.6	20/09/2015	5.5	0.0	5.5
6/06/2015	21.4	0.0	21.4	20/07/2015	5.6	0.0	5.6
29/06/2015	21.4	0.1	21.5	14/10/2015	6	0.0	6.0

Table E-2: Cumulative 24-hour average $PM_{2.5}$ concentration (µg/m³) – Receptor R2

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
5/07/2015	30.9	0.0	30.9				
4/07/2015	27.4	0.0	27.4				
27/06/2015	27	0.0	27.0				
22/08/2015	24.3	0.0	24.3	18/05/2015	7.3	0.1	7.4
21/08/2015	23.5	0.1	23.6	13/06/2015	10.2	0.1	10.3
28/06/2015	22.9	0.0	22.9	29/06/2015	21.4	0.1	21.5
30/06/2015	22.6	0.0	22.6	2/04/2015	4.5	0.1	4.6
29/07/2015	22.4	0.0	22.4	23/07/2015	12.6	0.1	12.7
4/10/2015	22.3	0.0	22.3	21/08/2015	23.5	0.1	23.6
4/06/2015	21.7	0.0	21.7	4/04/2015	3.3	0.1	3.4
21/06/2015	21.6	0.0	21.6	19/10/2015	6.3	0.0	6.3
6/06/2015	21.4	0.0	21.4	12/10/2015	13	0.0	13.0
29/06/2015	21.4	0.1	21.5	15/04/2015	10.6	0.0	10.6

Table E-3: Cumulative 24-hour average $PM_{2.5}$ concentration (µg/m³) – Receptor R3

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
5/07/2015	30.9	0.0	30.9				
4/07/2015	27.4	0.0	27.4				
27/06/2015	27	0.0	27.0				
22/08/2015	24.3	0.0	24.3	15/07/2015	5.9	0.1	6.0
21/08/2015	23.5	0.0	23.5	20/07/2015	5.6	0.1	5.7
28/06/2015	22.9	0.0	22.9	4/04/2015	3.3	0.1	3.4
30/06/2015	22.6	0.0	22.6	12/06/2015	6.4	0.1	6.5
29/07/2015	22.4	0.0	22.4	29/06/2015	21.4	0.1	21.5
4/10/2015	22.3	0.0	22.3	2/05/2015	8	0.1	8.1
4/06/2015	21.7	0.0	21.7	23/07/2015	12.6	0.1	12.7
21/06/2015	21.6	0.0	21.6	18/05/2015	7.3	0.1	7.4
6/06/2015	21.4	0.0	21.4	19/09/2015	3.9	0.1	4.0
29/06/2015	21.4	0.1	21.5	31/07/2015	7.9	0.1	8.0

Table E-4: Cumulative 24-hour average $PM_{2.5}$ concentration (µg/m³) – Receptor R4

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
5/07/2015	30.9	0.0	30.9				
4/07/2015	27.4	0.0	27.4				
27/06/2015	27	0.0	27.0				
22/08/2015	24.3	0.0	24.3	12/06/2015	6.4	0.2	6.6
21/08/2015	23.5	0.0	23.5	18/05/2015	7.3	0.2	7.5
28/06/2015	22.9	0.0	22.9	31/07/2015	7.9	0.2	8.1
30/06/2015	22.6	0.0	22.6	15/07/2015	5.9	0.2	6.1
29/07/2015	22.4	0.0	22.4	9/07/2015	12.7	0.2	12.9
4/10/2015	22.3	0.0	22.3	22/02/2015	6	0.1	6.1
4/06/2015	21.7	0.0	21.7	20/02/2015	8.5	0.1	8.6
21/06/2015	21.6	0.0	21.6	23/02/2015	6.3	0.1	6.4
6/06/2015	21.4	0.0	21.4	3/12/2015	7.7	0.1	7.8
29/06/2015	21.4	0.1	21.5	31/03/2015	3.9	0.1	4.0

Table E-5: Cumulative 24-hour average $PM_{2.5}$ concentration (µg/m³) – Receptor R5

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
5/07/2015	30.9	0.0	30.9				
4/07/2015	27.4	0.0	27.4				
27/06/2015	27	0.0	27.0				
22/08/2015	24.3	0.0	24.3	18/05/2015	7.3	0.3	7.6
21/08/2015	23.5	0.0	23.5	12/06/2015	6.4	0.3	6.7
28/06/2015	22.9	0.0	22.9	9/07/2015	12.7	0.2	12.9
30/06/2015	22.6	0.0	22.6	15/07/2015	5.9	0.2	6.1
29/07/2015	22.4	0.1	22.5	20/02/2015	8.5	0.2	8.7
4/10/2015	22.3	0.0	22.3	23/02/2015	6.3	0.2	6.5
4/06/2015	21.7	0.0	21.7	3/12/2015	7.7	0.2	7.9
21/06/2015	21.6	0.0	21.6	31/07/2015	7.9	0.2	8.1
6/06/2015	21.4	0.0	21.4	22/02/2015	6	0.2	6.2
29/06/2015	21.4	0.0	21.4	5/02/2015	ND	0.1	0.1

ND – no data

Table E-6: Cumulative 24-hour average $PM_{2.5}$ concentration (µg/m³) – Receptor R6

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
5/07/2015	30.9	0.0	30.9				
4/07/2015	27.4	0.0	27.4				
27/06/2015	27	0.0	27.0				
22/08/2015	24.3	0.0	24.3	18/05/2015	7.3	0.4	7.7
21/08/2015	23.5	0.0	23.5	12/06/2015	6.4	0.4	6.8
28/06/2015	22.9	0.0	22.9	9/07/2015	12.7	0.3	13.0
30/06/2015	22.6	0.0	22.6	20/02/2015	8.5	0.2	8.7
29/07/2015	22.4	0.1	22.5	15/07/2015	5.9	0.2	6.1
4/10/2015	22.3	0.0	22.3	23/02/2015	6.3	0.2	6.5
4/06/2015	21.7	0.0	21.7	3/12/2015	7.7	0.2	7.9
21/06/2015	21.6	0.0	21.6	21/03/2015	10.4	0.2	10.6
6/06/2015	21.4	0.0	21.4	3/02/2015	5	0.2	5.2
29/06/2015	21.4	0.0	21.4	5/01/2015	8.3	0.2	8.5

Table E-7: Summary of 24-hour average PM_{10} concentration (µg/m³) above the criteria

Ranked by Highest to Lowest Background Concentrations							
Date	Measured background level	Predicted increment					
		R1	R2	R3	R4	R5	R6
4/10/2015	101.4	0.1	0.1	0.0	0.0	0.0	0.0
6/05/2015	96.9	0.0	0.0	0.0	0.0	0.0	0.0
14/02/2015	88.6	0.1	0.2	0.0	0.0	0.0	0.0
6/03/2015	85	0.0	0.0	0.0	0.0	0.0	0.1
19/02/2015	82.4	0.2	0.2	0.1	0.0	0.0	0.0
6/10/2015	80.8	0.1	0.2	0.0	0.1	0.1	0.1
5/10/2015	80.2	0.0	0.0	0.0	0.0	0.0	0.0
24/01/2015	79.5	0.1	0.1	0.1	0.1	0.1	0.1
9/01/2015	78.3	0.1	0.1	0.0	0.0	0.0	0.0
20/11/2015	78	0.0	0.0	0.0	0.0	0.0	0.0
29/10/2015	76.4	0.1	0.0	0.2	0.3	0.3	0.2
18/02/2015	75.2	0.2	0.2	0.0	0.0	0.0	0.0
9/10/2015	74.4	0.2	0.2	0.0	0.0	0.0	0.0
23/01/2015	73.6	0.1	0.1	0.0	0.0	0.0	0.0
4/12/2015	72.7	0.0	0.0	0.1	0.4	0.7	0.8
12/02/2015	72.4	0.0	0.1	0.1	0.2	0.1	0.1
7/03/2015	70.7	0.1	0.1	0.1	0.1	0.1	0.1
20/02/2015	70.5	0.0	0.0	0.1	0.6	1.2	1.4
20/12/2015	69.8	0.0	0.0	0.0	0.0	0.0	0.0
26/11/2015	68.1	0.0	0.0	0.0	0.0	0.0	0.0
16/02/2015	67.9	0.1	0.1	0.0	0.0	0.0	0.0
14/12/2015	67.3	0.1	0.1	0.0	0.0	0.0	0.0
29/11/2015	66.7	0.1	0.1	0.0	0.0	0.0	0.0
27/11/2015	66.2	0.1	0.1	0.2	0.2	0.2	0.2
1/01/2015	65.5	0.1	0.1	0.0	0.0	0.0	0.0
13/12/2015	64.9	0.2	0.2	0.0	0.0	0.0	0.0
21/02/2015	63.9	0.1	0.1	0.3	0.1	0.1	0.0
22/01/2015	63.7	0.1	0.0	0.2	0.4	0.5	0.5
10/01/2015	62.8	0.1	0.1	0.1	0.0	0.1	0.0
8/03/2015	62.5	0.0	0.0	0.0	0.1	0.1	0.1
7/10/2015	61.7	0.0	0.0	0.0	0.0	0.0	0.0
15/02/2015	61.4	0.1	0.1	0.0	0.0	0.0	0.0
3/12/2015	61.3	0.0	0.0	0.1	0.6	1.1	1.2
31/12/2015	61.1	0.0	0.0	0.1	0.4	0.5	0.5
21/01/2015	61	0.2	0.2	0.0	0.0	0.0	0.0
17/02/2015	59.3	0.2	0.2	0.0	0.0	0.0	0.0
17/03/2015	59.2	0.1	0.1	0.0	0.0	0.0	0.0
12/11/2015	58.9	0.1	0.1	0.0	0.0	0.0	0.0
9/12/2015	58.8	0.0	0.0	0.0	0.0	0.0	0.0
21/08/2015	58.4	0.3	0.3	0.0	0.0	0.0	0.0
28/10/2015	58.4	0.0	0.0	0.1	0.5	0.8	0.9
19/11/2015	57.8	0.0	0.1	0.0	0.1	0.3	0.3
28/11/2015	57.2	0.2	0.1	0.2	0.0	0.0	0.0
31/01/2015	56.6	0.0	0.0	0.0	0.2	0.3	0.4
5/12/2015	55.5	0.1	0.0	0.1	0.3	0.4	0.4
22/08/2015	54.8	0.0	0.0	0.0	0.0	0.0	0.0
8/10/2015	54.7	0.2	0.1	0.2	0.1	0.0	0.0
18/03/2015	54.6	0.0	0.0	0.0	0.0	0.0	0.0
4/03/2015	54.4	0.0	0.0	0.0	0.2	0.3	0.4
25/11/2015	53.9	0.0	0.1	0.0	0.1	0.1	0.1
13/02/2015	53.8	0.0	0.0	0.1	0.4	0.7	0.8
26/03/2015	53.8	0.0	0.0	0.0	0.0	0.0	0.0
3/10/2015	53	0.0	0.0	0.0	0.0	0.0	0.0
30/01/2015	52.8	0.0	0.0	0.0	0.0	0.1	0.1
11/02/2015	52.8	0.2	0.2	0.1	0.1	0.0	0.0

Ranked by Highest to Lowest Background Concentrations							
Date	Measured background level	Predicted increment					
		R1	R2	R3	R4	R5	R6
25/01/2015	52.4	0.0	0.0	0.0	0.0	0.0	0.0
10/12/2015	52.2	0.0	0.0	0.0	0.2	0.3	0.4
5/11/2015	52.1	0.0	0.1	0.0	0.0	0.0	0.0
23/11/2015	51.5	0.0	0.0	0.0	0.0	0.0	0.0
26/12/2015	51.5	0.0	0.1	0.0	0.0	0.0	0.0
19/08/2015	51.3	0.1	0.1	0.2	0.2	0.2	0.2
8/12/2015	51.3	0.1	0.1	0.0	0.0	0.0	0.0
22/11/2015	51	0.2	0.2	0.1	0.0	0.0	0.0
1/02/2015	50.6	0.0	0.0	0.0	0.3	0.6	0.7
20/01/2015	50.3	0.1	0.1	0.0	0.0	0.0	0.0
20/03/2015	50.3	0.0	0.0	0.0	0.0	0.0	0.0
14/04/2015	50.1	0.1	0.1	0.2	0.3	0.4	0.4

Table E-8: Cumulative 24-hour average PM_{10} concentration (µg/m³) – Receptor R1

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
2/09/2015	49.8	0.0	49.8	18/05/2015	28.1	0.5	28.6
1/10/2015	49.8	0.1	49.9	29/06/2015	48	0.4	48.4
5/03/2015	49.6	0.0	49.6	23/07/2015	31	0.3	31.3
21/12/2015	49.6	0.0	49.6	4/04/2015	13.6	0.3	13.9
19/03/2015	49.5	0.0	49.5	21/08/2015	**58.4**	0.3	**58.7**
12/12/2015	49.4	0.0	49.4	2/04/2015	33.4	0.3	33.7
8/01/2015	48.8	0.1	48.9	15/07/2015	15.1	0.3	15.4
3/03/2015	48.7	0.1	48.8	20/09/2015	22.6	0.2	22.8
31/10/2015	48.3	0.1	48.4	20/07/2015	ND	0.2	0.2
29/06/2015	48	0.4	48.4	14/10/2015	35.1	0.2	35.3

ND – no data

Table E-9: Cumulative 24-hour average PM10 concentration (µg/m³) – Receptor R2

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
2/09/2015	49.8	0.1	49.9	18/05/2015	28.1	0.5	28.6
1/10/2015	49.8	0.2	50.0	13/06/2015	43.2	0.4	43.6
5/03/2015	49.6	0.0	49.6	29/06/2015	48	0.4	48.4
21/12/2015	49.6	0.0	49.6	2/04/2015	33.4	0.3	33.7
19/03/2015	49.5	0.0	49.5	23/07/2015	31	0.3	31.3
12/12/2015	49.4	0.0	49.4	21/08/2015	**58.4**	0.3	**58.7**
8/01/2015	48.8	0.1	48.9	4/04/2015	13.6	0.3	13.9
3/03/2015	48.7	0.1	48.8	19/10/2015	42.8	0.2	43.0
31/10/2015	48.3	0.1	48.4	15/04/2015	47.3	0.2	47.5
29/06/2015	48	0.4	48.4	13/12/2015	**64.9**	0.2	**65.1**

Table E-10: Cumulative 24-hour average PM10 concentration (µg/m³) – Receptor R3

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
2/09/2015	49.8	0.0	49.8	15/07/2015	15.1	0.5	15.6
1/10/2015	49.8	0.0	49.8	20/07/2015	ND	0.5	0.5
5/03/2015	49.6	0.0	49.6	4/04/2015	13.6	0.4	14.0
21/12/2015	49.6	0.0	49.6	2/05/2015	43.4	0.4	43.8
19/03/2015	49.5	0.1	49.6	29/06/2015	48	0.4	48.4
12/12/2015	49.4	0.0	49.4	12/06/2015	19.1	0.4	19.5
8/01/2015	48.8	0.0	48.8	23/07/2015	31	0.4	31.4
3/03/2015	48.7	0.1	48.8	18/05/2015	28.1	0.3	28.4
31/10/2015	48.3	0.0	48.3	19/09/2015	20.2	0.3	20.5
29/06/2015	48	0.4	48.4	31/07/2015	26.6	0.3	26.9

ND – no data

Table E-11: Cumulative 24-hour average PM10 concentration (µg/m³) – Receptor R4

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
2/09/2015	49.8	0.0	49.8	12/06/2015	19.1	1.1	20.2
1/10/2015	49.8	0.0	49.8	31/07/2015	26.6	1.0	27.6
5/03/2015	49.6	0.0	49.6	18/05/2015	28.1	0.9	29.0
21/12/2015	49.6	0.0	49.6	15/07/2015	15.1	0.8	15.9
19/03/2015	49.5	0.2	49.7	9/07/2015	31.4	0.8	32.2
12/12/2015	49.4	0.3	49.7	22/02/2015	44.3	0.7	45.0
8/01/2015	48.8	0.0	48.8	20/02/2015	**70.5**	0.6	**71.1**
3/03/2015	48.7	0.0	48.7	23/02/2015	42.2	0.6	42.8
31/10/2015	48.3	0.0	48.3	3/12/2015	**61.3**	0.6	**61.9**
29/06/2015	48	0.3	48.3	31/03/2015	23.7	0.6	24.3

Table E-12: Cumulative 24-hour average PM_{10} concentration (µg/m³) – Receptor R5

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
2/09/2015	49.8	0.0	49.8	18/05/2015	28.1	1.8	29.9
1/10/2015	49.8	0.1	49.9	12/06/2015	19.1	1.7	20.8
5/03/2015	49.6	0.0	49.6	9/07/2015	31.4	1.3	32.7
21/12/2015	49.6	0.0	49.6	20/02/2015	**70.5**	1.2	**71.7**
19/03/2015	49.5	0.3	49.8	15/07/2015	15.1	1.1	16.2
12/12/2015	49.4	0.5	49.9	3/12/2015	**61.3**	1.1	**62.4**
8/01/2015	48.8	0.0	48.8	23/02/2015	42.2	1.1	43.3
3/03/2015	48.7	0.0	48.7	31/07/2015	26.6	1.1	27.7
31/10/2015	48.3	0.0	48.3	22/02/2015	44.3	0.9	45.2
29/06/2015	48	0.3	48.3	5/02/2015	39.8	0.9	40.7

Table E-13: Cumulative 24-hour average PM_{10} concentration (µg/m³) – Receptor R6

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
2/09/2015	49.8	0.0	49.8	18/05/2015	28.1	2.1	30.2
1/10/2015	49.8	0.1	49.9	12/06/2015	19.1	1.9	21.0
5/03/2015	49.6	0.0	49.6	20/02/2015	**70.5**	1.4	**71.9**
21/12/2015	49.6	0.1	49.7	9/07/2015	31.4	1.4	32.8
19/03/2015	49.5	0.4	49.9	23/02/2015	42.2	1.3	43.5
12/12/2015	49.4	0.6	50.0	3/12/2015	**61.3**	1.2	**62.5**
8/01/2015	48.8	0.0	48.8	15/07/2015	15.1	1.2	16.3
3/03/2015	48.7	0.0	48.7	21/03/2015	45.1	1.1	46.2
31/10/2015	48.3	0.0	48.3	3/02/2015	36.4	1.1	37.5
29/06/2015	48	0.2	48.2	5/02/2015	39.8	1.0	40.8



APPENDIX G

NOISE IMPACT ASSESSMENT

ACOUSTICS AND AIR

STOCKTON SAND QUARRY DREDGING

NOISE IMPACT ASSESSMENT

REPORT NO. 17220
VERSION C

OCTOBER 2019

PREPARED FOR

BORAL RESOURCES (NSW) PTY LTD

WILKINSON MURRAY

DOCUMENT CONTROL

Version	Status	Date	Prepared By	Reviewed By
A	Final	29 July 2019	Ash Stevens	Ben Lawrence
B	Final	4 September 2019	Ash Stevens	
C	Final	15 October 2019	Ash Stevens	

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GLOSSARY OF ACOUSTIC TERMS

Most environments are affected by environmental noise which continuously varies, largely as a result of road traffic. To describe the overall noise environment, a number of noise descriptors have been developed and these involve statistical and other analysis of the varying noise over sampling periods, typically taken as 15 minutes. These descriptors, which are demonstrated in the graph below, are here defined.

Maximum Noise Level (L_{Amax}) – The maximum noise level over a sample period is the maximum level, measured on fast response, during the sample period.

L_{A1} – The L_{A1} level is the noise level which is exceeded for 1% of the sample period. During the sample period, the noise level is below the L_{A1} level for 99% of the time.

L_{A10} – The L_{A10} level is the noise level which is exceeded for 10% of the sample period. During the sample period, the noise level is below the L_{A10} level for 90% of the time. The L_{A10} is a common noise descriptor for environmental noise and road traffic noise.

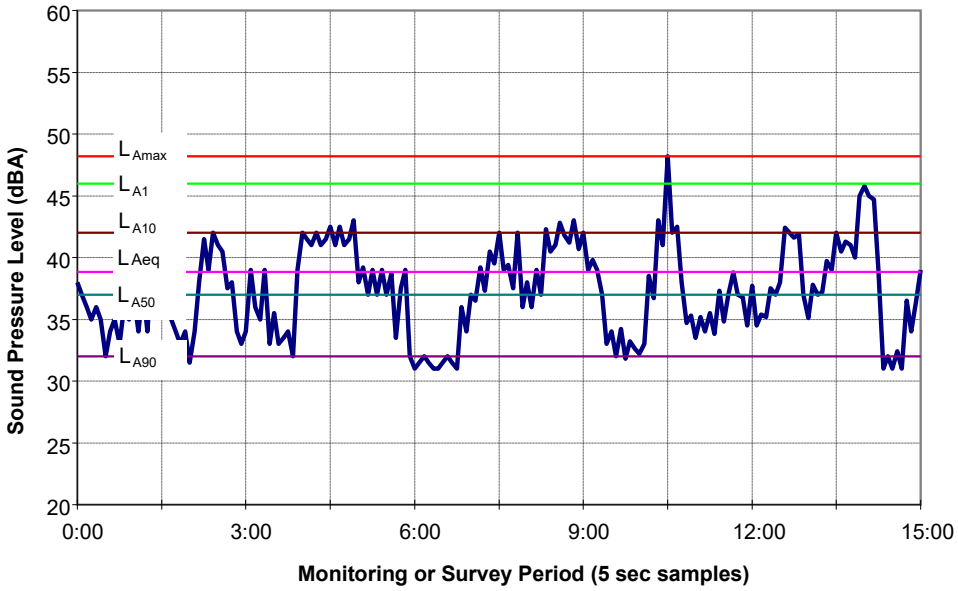
L_{A90} – The L_{A90} level is the noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the L_{A90} level for 10% of the time. This measure is commonly referred to as the background noise level.

L_{Aeq} – The equivalent continuous sound level (L_{Aeq}) is the energy average of the varying noise over the sample period and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is also a common measure of environmental noise and road traffic noise.

ABL – The Assessment Background Level is the single figure background level representing each assessment period (daytime, evening and night time) for each day. It is determined by calculating the 10th percentile (lowest 10th percent) background level (L_{A90}) for each period.

RBL – The Rating Background Level for each period is the median value of the ABL values for the period over all of the days measured. There is therefore an RBL value for each period – daytime, evening and night time.

Typical Graph of Sound Pressure Level vs Time



1 INTRODUCTION

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Sand Quarry (hereafter referred to as the 'site' or the 'quarry'), a long standing operation that currently extracts sand from the windblown (transgressive) sand dunes of Stockton Bight and transports up to 500,000 tonnes per annum (tpa) of sand product for use in the building, landscaping and construction markets.

Due to current and future demand for sand in the Hunter and Sydney regions, Boral is seeking approval for continued and expanded operations at the site through a State Significant Development (SSD) application. The proposed development (hereafter referred to as the 'Project') involves the extraction of sand from the inland vegetated dunes by front-end loader/excavator to a depth of 4 metres (m) Australian Height Datum (AHD) in Stage 1, and subsequent dredging from 4 m AHD to 15 m below sea level (-15 m AHD) in Stages 2 to 6. The Project would seek to permit a site wide increase on the dispatch limit to 750,000 tpa (i.e. the windblown sand extraction area and the Project operations combined) up until 2028 after which the site wide limit would reduce to no more than 500,000 tpa. The Project would be for a period of up to 25 years, subject to demand of sand resources.

Wilkinson Murray Pty Limited (WMPL) has been engaged by Element Environment (Element) on behalf of Boral to conduct a Noise Impact Assessment for the Project. This report provides a detailed assessment of potential operational noise impacts. The assessment has been conducted in general accordance with the NSW Environmental Protection Authority (EPA) document *Noise Policy for Industry* (NPfI).

The Project will generate heavy vehicle movements along Nelson Bay Road, Cabbage Tree Road and Medowie Road. A detailed assessment of road traffic noise has therefore also been conducted in accordance with the EPA's NSW *Road Noise Policy* (RNP).

It should be noted that no significant sources of vibration have been identified for the Project. Additionally, the distance between the quarry and the closest receivers is over 500m, therefore a detailed assessment of potential vibration impacts is not considered necessary.

1.1 Secretary's Environmental Assessment Requirements

The following table identifies Planning Secretary's Environmental Assessment Requirements (SEAR) that are relevant to this NIA, and which sections of the report they are addressed.

Table 1-1 Secretary's Environmental Assessment Requirements

Key Issue	Description	Section
Noise	A detailed assessment of the likely construction, operational and off-site transport noise impacts of the development in accordance with the Interim Construction Noise Guideline, NSW Noise Policy for Industry and the NSW Road Noise Policy respectively, and having regard to the Voluntary Land Acquisition and Mitigation Policy;	Section 3, Section 4

2 PROJECT DESCRIPTION

2.1 Location and Surrounding Receivers

The Project site is located at the end of Coxs Road to the east of Fullerton Cove from Nelsons Bay Road to Stockton Beach, covering an area of approximately 37 ha. The site is accessed by road from Coxs Lane and Nelson Bay Road. The nearest and most potentially affected receivers comprise:

- Residences along Coxs Lane, George Street and Fullerton Cove Road in Fullerton Cove to the north-west of the site; and
- Residences along Tuckeroo Circuit and Norfolk Street within the Fern Bay Seaside Village, Fern Bay to the south west of the site.

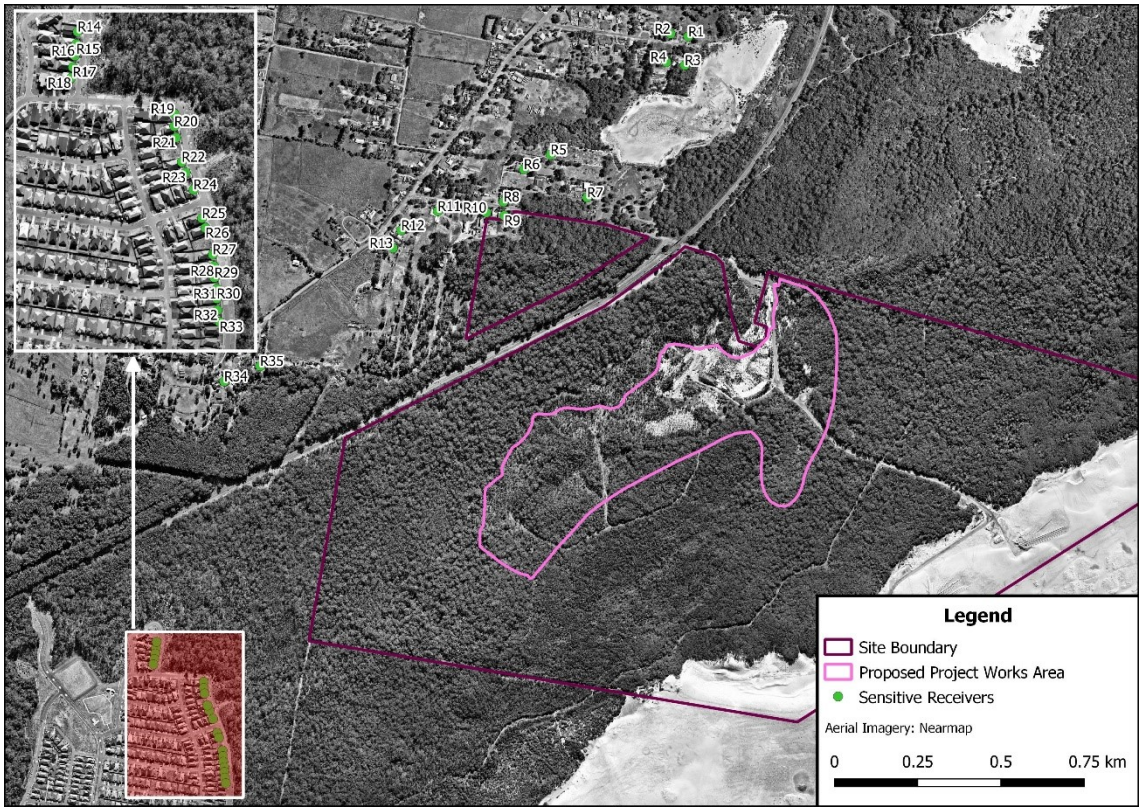
These receivers are all residential. There are no other sensitive receiver types identified in the surrounding area. The nearby sensitive receivers are described in Table 2-1 and shown in Figure 2-1.

Table 2-1 Sensitive receivers

Receiver	Address	Lot/DP Number
R1	11 George Street, Fullerton Cove	Lot 7 DP 255734
R2	9 George Street, Fullerton Cove	Lot 6 DP 255734
R3	14 George Street, Fullerton Cove	Lot 8 DP 255734
R4	12 George Street, Fullerton Cove	Lot 9 DP 255734
R5	Unknown Address, Fullerton Cove	Lot 5 DP 1105459
R6	6 Coxs Lane, Fullerton Cove	Lot 6 DP 998656
R7	1 Zircon Lane, Fullerton Cove	Lot 72 DP 876716
R8	17a Coxs Lane, Fullerton Cove	Lot 8 DP 742586
R9	12 Coxs Lane, Fullerton Cove	Lot 1 DP 120634
R10	10 Coxs Lane, Fullerton Cove	Lot 11 DP 881613
R11	4 Coxs Lane, Fullerton Cove	Lot 1 DP 724265
R12	306 Fullerton Cove Road, Fullerton Cove	Lot 100 DP 819758
R13	304 Fullerton Cove Road, Fullerton Cove	Lot 101 DP 819758
R14	14 Tuckeroo Circuit, Fern Bay	Lot 28 DP 280063
R15	16 Tuckeroo Circuit, Fern Bay	Lot 29 DP 280063
R16	18 Tuckeroo Circuit, Fern Bay	Lot 30 DP 280063
R17	20 Tuckeroo Circuit, Fern Bay	Lot 31 DP 280063
R18	22 Tuckeroo Circuit, Fern Bay	SP98989
R19	101 Norfolk Street, Fern Bay	Lot 49 DP 280063
R20	99 Norfolk Street, Fern Bay	Lot 48 DP 280063
R21	97 Norfolk Street, Fern Bay	Lot 47 DP 280063
R22	93 Norfolk Street, Fern Bay	Lot 45 DP 280063
R23	91 Norfolk Street, Fern Bay	Lot 44 DP 280063

Receiver	Address	Lot/DP Number
R24	2 Uralla Street, Fern Bay	Lot 43 DP 280063
R25	87 Norfolk Street, Fern Bay	Lot 37 DP 280057
R26	85 Norfolk Street, Fern Bay	Lot 38 DP 280057
R27	81 Norfolk Street, Fern Bay	Lot 40 DP 280057
R28	79 Norfolk Street, Fern Bay	Lot 41 DP 280057
R29	77 Norfolk Street, Fern Bay	Lot 42 DP 280057
R30	75 Norfolk Street, Fern Bay	Lot 43 DP 280057
R31	73 Norfolk Street, Fern Bay	Lot 44 DP 280057
R32	71 Norfolk Street, Fern Bay	Lot 45 DP 280057
R33	69 Norfolk Street, Fern Bay	Lot 46 DP 280057
R34	248 Fullerton Cove Road, Fullerton Cove	Lot 3421 DP 1232950
R35	260 Fullerton Cove Road, Fullerton Cove	Lot 1 DP 745337

Figure 2-1 Site and surrounding sensitive receivers



2.2 Project Overview

The site contains an existing operation located approximately 375 m south east of the Project site, referred to as the windblown sand extraction area (or pit 7). The windblown sand extraction area is approved to operate until 2028 and dispatch up to 500,000 tpa from the site (refer to condition 6 of DA 140-6-2005).

Sand from the former inland extraction area was only extracted to 5 m AHD under the original 1996 development consent. The sand resource above 5 m AHD was exhausted in 2008 and in accordance with the conditions of consent the operations have ceased.

The Project involves the extraction of sand from within the former inland extraction area (inclusive of Stages 1 – 6) from the existing ground level to a depth of 15 m below sea level (-15 m AHD). As extraction will intercept the groundwater table (at approximately 1 m AHD) the primary method of sand extraction will involve dredging.

There is an estimated 9 million tonnes of sand resource within the Project extraction area. The Project would seek to permit a site wide increase on the dispatch limit to 750,000 tpa (i.e. the windblown sand extraction area and the Project operations combined) up until 2028 after which the site wide limit would reduce to no more than 500,000 tpa.

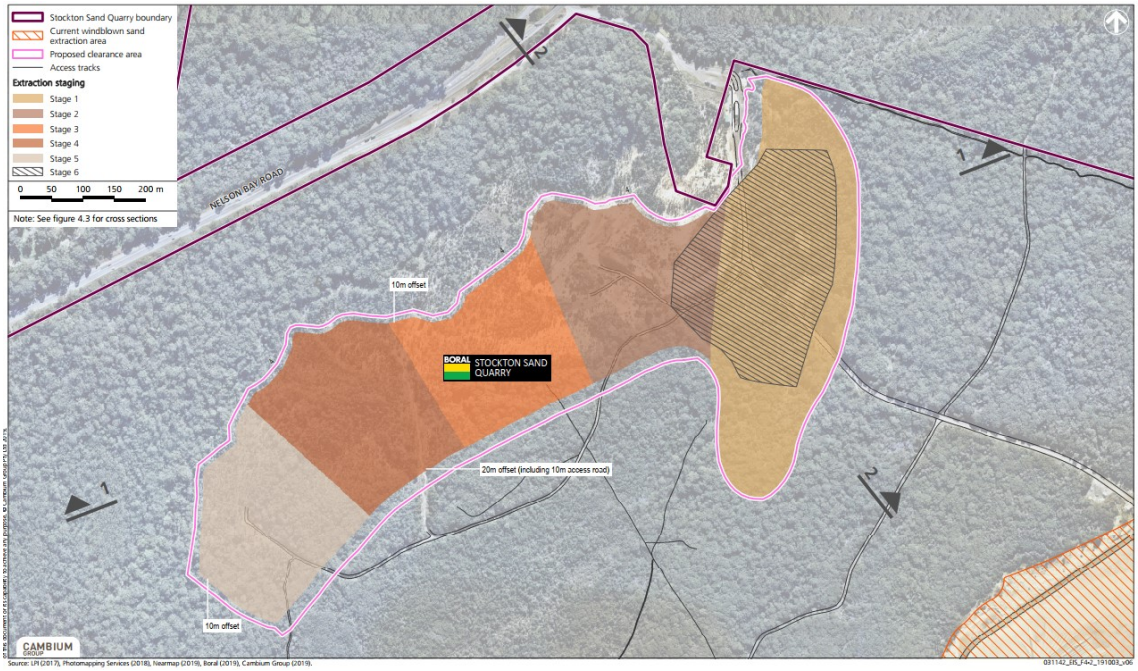
Mobile plant and equipment utilised at the site would operate across both project areas and a docket system at the weighbridge would monitor outgoing product as a site total.

To account for market fluctuations in demand, Boral are seeking a development consent period of 25 years for the SSD approval.

2.3 Sand Extraction & Staging Overview

The Project is to be undertaken progressively in six stages, commencing with Stage 1. An overview of the extraction staging plan for the Project is presented in Figure 2-2**.**

Figure 2-2 Extraction staging plan



Similar to previous operations of the inland extraction area, sand extraction will involve clearing and grubbing of established vegetation from previous rehabilitation and possible screening of accumulated leaf litter and organic matter. Cleared vegetation will either be mulched or stockpiled on-site for later reuse in rehabilitation. Similarly, any stripped topsoil would be retained for use in rehabilitation efforts across the site.

Stage 1 will involve dry extraction to a depth of 4 m AHD. A front-end loader will push into the exposed sand face and as the sand is relatively free-flowing, material will fall towards the front-end loader at the natural angle of repose.

The sand will then be screened and stockpiled before a front-end loader then loads road trucks in-pit with screened raw sand for transport off-site via the weighbridge.

A pond will be created in the area of Stage 2 following initial dry extraction of sand in Stage 1. The pond will be large enough to float a dredge and accommodate fresh water pumping for the proposed wash plant.

The dredge will move progressively through the Stage 2 to 6 extraction area generally following the nominated stages. In most cases, the sand in each extraction stage is fully extracted unless constraints are encountered.

The dredge will move backwards and forwards across the active dredge pond, sucking the underwater sand face. The sand/water mix will be pumped directly from the dredge via a pontoon-mounted pipeline to the wash plant in the processing area. The dredge will manoeuvre around the pond and its position will be stabilised by wire ropes connected to the pond banks.

The dredge will move progressively through the extraction area in a south-westerly direction in a staged process. Extraction will then move to the east and culminate with relocation of the proposed processing and stockpile area to a confined area in Stage 1 and subsequent dredging of the majority of the Stage 1 extraction area (to be known as Stage 6).

Sand will be extracted to a maximum depth of approximately 15 m below the sea level (0 m AHD).

2.3.1 Stage 1

The Stage 1 extraction area is located along the eastern portion of the Project site (refer to Figure 2-2).

Stage 1 of the Project would involve the following activities:

- removal of vegetation from across the whole footprint of the Stage 1 extraction area and a small portion of land to the north-east of the existing depot to allow for the construction of a new haul route that will extend around the north, east and southern perimeter of Stage 1 and link to the existing haul road to the windblown sand extraction area;
- where present, stripping topsoil and store on site within designated stockpile areas;
- extraction of sand in the Stage 1 extraction area via front end loader and excavator to a depth of 4 m AHD;
- screening and stockpiling sand;
- levelling of the Stage 1 extraction area as required;
- establishing a level pad at the north-western boundary of Stage 1 and establishing the wash plant and diesel generators; and
- delivery and installation of a prefabricated office building and commencement of other alterations to the existing site depot.

2.3.2 Stage 2

As Stage 1 is nearing completion, Stage 2 will be commenced. To limit the loss of sand product to wind erosion, a maximum extent of 200 - 300 m of vegetation and ground cover will be cleared at any one time. The general area of Stage 1 will be used for stockpiling of processed sand ready for dispatch.

The typical method for sand extraction in Stage 2 will be:

- progressive stripping of areas in 200-300 m segments across the stage;
- excavation of an initial dredge window to allow for a suitable water to sand ratio to develop, and may involve excavation from 2-6 m AHD;
- once a suitable sand/water ratio has been established the dredge will be floated. The dredge will be fixed to a pontoon which is connected to the wash plant via a pipeline;
- a sand/water mix will be dredged by suction to the wash plant, where sand will be extracted and excess water will be returned via a separate pipeline to dredge pond;
- the wash plant will screen out oversize material in excess of 20 mm in size; and
- dredging will be to a maximum depth of 15 m below sea level.

2.3.3 Stages 3 – 5

The methodology described in Stage 2 would be repeated in each subsequent stage culminating with the completion of Stage 5.

At the completion of Stage 5 progressive rehabilitation of the stages 2-5 dredge pond banks will commence. Initial rehabilitation will not include the Stage 1 extraction area as this will continue to be disturbed for Stage 6 of the project.

2.3.4 Stage 6

Except for the southern portion of Stage 1, containing the wash plant and generator, the Stage 1 extraction area will be excavated to reveal the groundwater table and subsequently dredged in an identical manner to stages 2-5. The stage 2-5 dredge pond will be extended into the Stage 1 extraction area and dredging of the pond will also be to a depth of 15 m below the water table.

2.4 Hours of Operation

The Project will continue to operate in accordance with the following approved hours of operation in the 2006 development consent:

- Monday to Friday – 6:15am to 5:00pm;
- Saturday – 6:15am to 12 noon; and
- no operation on Sundays or Public Holidays.

The site is also approved to operate extended hours during major supply contracts as follows:

- Monday to Friday – 6:15am to 6:00pm;
- Saturday – 6:15am to 3:00pm; and
- no operation on Sundays or Public Holidays.

3 NOISE CRITERIA

3.1 Existing Noise Levels

Unattended noise monitoring was conducted between 3 December and 17 December 2018 to determine the existing ambient and traffic noise levels. The monitoring was undertaken at three locations, as shown and described in Table 3-1. The monitoring at location M1 was redone between 05 July and 15 July 2019 as the original data was unsuitable. The new data was used for the assessment.

Table 3-1 Noise monitoring locations

Location	Purpose	Address
M1	Existing ambient noise levels	4 Coxs Lane, Fullerton Cove (R11)
M2	Existing traffic noise levels	157 Cabbage Tree Road, Williamtown
M3	Existing traffic noise levels	1051 Nelson Bay Road, Fern Bay

Measured ambient noise levels at location M1 are considered representative of the ambient environment for all receivers in the Fullerton Cove region surrounding the site. These measured levels are also used to assess the noise impact on receivers in the Fern Bay Seaside Village. There is a significant amount of construction currently being undertaken within the Fern Bay Seaside Village making the area not suitable for background monitoring. However, due to the proximity of these receivers to the coastline, the levels are considered conservative.

The noise monitoring equipment used for these measurements consisted of an ARL NGARA environmental noise logger set to A-weighted, fast response. This equipment is capable of remotely monitoring and storing noise level descriptors for later detailed analysis. The equipment calibration was checked before and after the survey and no significant drift was noted.

From the background noise levels (L_{A90}) the Rating Background Levels (RBLs) were determined using the methodology recommended in the NSW *Noise Policy for Industry* (NPfI). The existing windblown sand operation was not audible during deployment or collection of unattended noise monitoring equipment and is unlikely to contribute significantly to background levels in the vicinity of the Project. However, it should be noted that Appendix A1 of the *NPfI* addresses modifications to existing premises. The policy acknowledges that where the premises has been operating for a significant period of time, as is the case here, then it is considered a feature of the acoustic environment and may be included in the background noise assessment.

The existing ambient noise levels are presented in Table 3-2. Due to the operating hours of the site, the results from the morning (AM) shoulder period are also presented. Daily plots of the noise logger data are presented in Appendix A.

Table 3-2 Existing ambient noise levels

Monitoring Location	Time of Day	Noise Levels (dBA)	
		RBL	L_{Aeq}
M1	AM shoulder	38	48
	Day	41	56
	Evening	36	47
	Night	33	46
	15-hour	-	55
	9-hour	-	46
M2	AM shoulder	48	67
	Day	46	66
	Evening	41	62
	Night	33	62
	15-hour	-	65
	9-hour	-	62
M3	AM shoulder	49	71
	Day	55	71
	Evening	47	67
	Night	38	66
	15-hour	-	70
	9-hour	-	66

Day = 7:00am – 6:00pm; Evening = 6:00pm – 10:00pm; Night = 10:00pm – 7:00am; AM Shoulder = 5:00am – 7:00am.

3.2 Operational Noise Trigger Levels

The *Noise Policy for Industry* (NPfI) (EPA, 2017) provides a framework for assessing environmental noise impacts from industrial premises and industrial development proposals in New South Wales.

The *NPfI* recommends the development of project noise trigger levels, which provide a benchmark for assessing a proposal or site. The project noise trigger levels should not be interpreted as mandatory noise criteria but, rather, as noise levels that, if exceeded, would indicate a potential noise impact on the community.

The project noise trigger level is the lower value of the project intrusiveness noise level and the project amenity noise level. The project intrusiveness noise level assesses the likelihood of noise being intrusive above the ambient noise level and is applied to residential receivers only. The project amenity noise level ensures the total industrial noise from all sources in the area does not rise above a maximum acceptable level.

In addition to the requirements above, the site also operates under Environmental Protection License 10132, issued by the EPA.

3.2.1 EPL License Conditions

Section L3 of the EPL states the noise limit conditions. These conditions are described in Table 3-3 below. Compliance with Limit L3.1 is to be assessed in conjunction with operational noise criteria outlined in the *NPfI*.

Table 3-3 EPL noise limits

Limit	Description
L3.1	Noise emissions from the premises must not exceed an Leq(15 minute) noise emission criterion of 35 dB(A) at the nearest residential receiver.
L3.2	Noise from the premises is to be measured at the worst affected point or within the residential boundary, or the most affected point within 30 metres of a dwelling (rural situations) where the dwelling is more than 30 metres from the boundary, to determine compliance with the noise limit in this licence.
L3.2	The noise emission limit identified in this licence applies in the following weather conditions: - wind speed up to 3m/s at 10m above ground level; or - temperature inversion conditions of up to 30C/100m and wind speed up to 2m/s at 10m above ground level.

3.2.2 NPfI Project Intrusiveness Noise Levels

The intrusiveness noise level is the noise level 5 dBA above the background noise level (RBL) for each time period (daytime, evening or night time) of interest at a residential receiver. The RBL is derived from the measured L_{A90} noise levels.

The *NPfI* stipulates that project intrusiveness noise levels should not be set below 40 dBA during the daytime and 35 dBA in the evening and night time. Additionally, the *NPfI* recommends that the project intrusiveness noise level for evening is set at no greater than that for the daytime, and that the project intrusiveness level for night time is set at no greater than that for the evening and daytime.

As the site currently has approval for operation from 6:15am, intrusiveness noise levels have been derived for the morning (AM) shoulder period.

Intrusiveness noise levels for the project are calculated from the RBLs at location M1, given it is the closest monitoring location to the site, and are presented in Table 3-4.

Table 3-4 Project intrusiveness noise levels

Receiver	Time of Day	RBL	Project Intrusiveness Noise Level ($L_{Aeq,15min}$)
All	Morning shoulder	38	43
	Day	41	46
	Evening	36	41
	Night	33	38

Day = 7:00am – 6:00pm; Evening = 6:00pm – 10:00pm; Night = 10:00pm – 7:00am; AM Shoulder = 5:00am – 7:00am.

3.2.3 NPfI Project Amenity Noise Levels

Project amenity noise levels aim to set a limit on continuing increases in noise levels from all industrial noise sources affecting a variety of receiver types; that is, the ambient noise level in an area from all industrial noise sources remains below recommended amenity noise levels.

The amenity assessment is based on noise criteria specific to land use and associated activities. The criteria relate only to industrial-type noise and do not include transportation noise (when on public transport corridors), noise from motor sport, construction noise, community noise, blasting, shooting ranges, occupational workplace noise, wind farms, amplified music/patron noise.

The amenity noise level aims to limit continuing increases in noise levels which may occur if the intrusiveness level alone is applied to successive development within an area.

The recommended amenity noise level represents the objective for total industrial noise at a receiver location. The project amenity noise level represents the objective for noise from a single industrial development at a receiver location.

To prevent increases in industrial noise due to the cumulative effect of several developments, the project amenity noise level for each new source of industrial noise is set at 5 dBA below the recommended amenity noise level.

The following exceptions apply to determining the project amenity noise level:

- For high-traffic areas the amenity criterion for industrial noise becomes the $L_{Aeq,period(traffic)}$ minus 15 dBA.
- In proposed developments in major industrial clusters.
- If the resulting project amenity noise level is 10 dB or more lower than the existing industrial noise level, the project amenity noise level can be set at 10 dB below existing industrial noise levels if it can be demonstrated that existing industrial noise levels are unlikely to reduce over time.
- Where cumulative industrial noise is not a consideration because no other industries are present in, or likely to be introduced into the area, the relevant amenity noise level is assigned as the project amenity noise level for the development.

Amenity noise levels are not used directly as regulatory limits. They are used in combination with the project intrusiveness noise level to assess the potential impact of noise, assess mitigation options and determine achievable noise requirements.

The project amenity noise levels are calculated from the recommended amenity noise levels presented in Table 3-5.

Table 3-5 Recommended amenity noise levels

Receiver	Noise Amenity Area	Time of Day	Recommended Amenity Noise Level (dBA $L_{Aeq,period}$)
Residential	Rural	Day	50
		Evening	45
		Night	40
	Suburban	Day	55
		Evening	45
		Night	40
	Urban	Day	60
		Evening	50
		Night	45
Hotels, motels, caretakers' quarters, holiday accommodation, permanent resident caravan parks	See column 4	See column 4	5 dB(A) above the recommended amenity noise level for a residence for the relevant noise amenity area and time of day.
School classroom-internal	All	Noisiest 1-hour period when in use	35
Hospital ward internal external	All	Noisiest 1-hour	35
	All	Noisiest 1-hour	50
Place of worship-internal	All	When in use	40
Area specifically reserved for passive recreation (e.g. national park)	All	When in use	50
Active recreation area (e.g. school playground, golf course)	All	When in use	55
Commercial premises	All	When in use	65
Industrial premises	All	When in use	65
Industrial interface (applicable only to residential noise amenity areas)	All	All	Add 5 dB(A) to recommended noise amenity area

Day = 7:00am – 6:00pm; Evening = 6:00pm – 10:00pm; Night = 10:00pm – 7:00am.

Recommended amenity noise levels presented in Table 3-5 above represent the objective for total industrial noise at a receiver location. In the case of a single new noise source being proposed, the project amenity noise level represents the objective for noise from a single industrial development at the receiver location. This is calculated as the recommended amenity noise level minus 5 dBA.

Due to different averaging periods for the $L_{Aeq,15min}$ and $L_{Aeq,period}$ noise descriptors, the values of project intrusiveness and amenity noise levels cannot be compared directly when identifying noise trigger levels i.e.; the most stringent values of each category. In order to make a comparison between descriptors, the *NPfI* assumes that the $L_{Aeq,15min}$ equivalent of an $L_{Aeq,period}$ noise level is equal to the $L_{Aeq,15min}$ level plus 3 dB.

Based on the methodology for determining residential receiver category in the *NPfI*, the area surrounding the site can be classified as 'Suburban Residential'. These amenity noise levels have been adopted and are presented in Table 3-6.

Table 3-6 Project amenity noise levels

Noise Amenity Area	Time of Day	Recommended Amenity Noise Level ($L_{Aeq,period}$)	Project Amenity Noise Level ($L_{Aeq,15min}$ dBA)
Suburban	Day	55	53
	Evening	45	43
	Night	40	38

Day = 7:00am – 6:00pm; Evening = 6:00pm – 10:00pm; Night = 10:00pm – 7:00am.

3.2.4 NPfI Project Noise Trigger Levels

Table 3-7 below shows the project noise levels for sensitive receivers, with the project noise trigger levels shown in **bold**.

Table 3-7 Project noise trigger levels

Receiver	Time of Day	Project Intrusiveness Noise Levels ($L_{Aeq,15min}$ dBA)	Project Amenity Noise Levels ($L_{Aeq,15min}$ dBA)
All	Morning shoulder	**43**	**43**
	Day	**46**	53
	Evening	**41**	43
	Night	**38**	**38**

Day = 7:00am – 6:00pm; Evening = 6:00pm – 10:00pm; Night = 10:00pm – 7:00am; AM Shoulder = 5:00am – 7:00am.
Project amenity noise levels are not specified for shoulder periods, therefore the day level has been adopted.

3.2.5 NPfI Maximum Noise Trigger Levels

Noise sources at night occurring over a short duration have the potential to cause sleep disturbance despite complying with project noise trigger levels. The site intends to operate from 6:15am, during the morning shoulder period. Therefore, maximum noise level events need to be considered for potential sleep disturbance.

The *NPfI* recommends that, where the night time L_{Amax} receiver noise levels from a development exceeds 52 dBA or the RBL plus 15 dBA, whichever is the greater, then a more detailed assessment of potential sleep disturbance impacts is warranted. Table 3-8 presents the maximum noise trigger levels for the receivers identified in this assessment. These noise levels are typically addressed at the facade of potentially affected dwellings and should consider multiple storey dwellings.

Table 3-8 Maximum noise trigger levels

Receiver	Night RBL (dBA)	RBL + 15 dBA	Maximum Noise Trigger Level (dBA)
All	33	48	52

Additionally, in instances where night time $L_{Aeq,15min}$ noise levels exceed 40 dBA or the prevailing RBL plus 5 dBA, whichever is the greater, then a detailed assessment of potential sleep disturbance impacts is warranted.

3.3 Road Traffic Noise Criteria

The EPA's NSW *Road Noise Policy* (RNP) provides criteria for managing noise levels associated with a development that will increase traffic on a particular road.

Although trucks accessing the site will continue to operate in the same manner as for the current operations, the increase in in total sand dispatched to 750,000 tpa will result in additional trucks on the surrounding road network until 2028.

The *RNP* assessment criteria for residential land uses are presented in Table 3-9.

Table 3-9 Road traffic noise assessment criteria for residential receivers

Road Category	Type of Proposal / Land Use	Noise Criteria (dBA)	
		Day (7am-10pm) (dBA)	Night (10pm-7am) (dBA)
Freeway / arterial / sub-arterial roads	Existing residences affected by additional traffic on existing freeways / arterial / sub-arterial roads generated by land use development	$L_{Aeq,15hr}$ 60 (external)	$L_{Aeq,9hr}$ 55 (external)
Local roads	Existing residences affected by additional traffic on existing local roads generated by land use development	$L_{Aeq,1hr}$ 55 (external)	$L_{Aeq,1hr}$ 50 (external)

The *RNP* also offers the relative increase criteria to manage the permissible increase in road traffic noise from a land use development. This criteria states that:

> "*For existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level should be limited to 2 dB above that of the corresponding 'no build option'.*"

As the measured $L_{Aeq,15hr}$ and $L_{Aeq,9hr}$ from Table 3-2 are above the *RNP* assessment criteria at both assessment locations, the relative increase criteria is to be adopted.

4 OPERATIONAL NOISE ASSESSMENT

4.1 Operational Noise Modelling Methodology

4.1.1 Computer Noise Model

Operational noise emissions associated with the Project were modelled using the CadnaA acoustic noise prediction software and the CONCAWE noise prediction algorithm. The CONCAWE noise propagation model is used around the world and is widely accepted as an appropriate model for predicting noise over significant distances. Factors addressed in the noise modelling are:

- Equipment noise level emissions and locations;
- Shielding from ground topography and structures;
- Noise attenuation due to geometric spreading;
- Ground absorption; and,
- Atmospheric absorption.

4.1.2 Ground Topography

Topographical data for the site and nearby surrounding area has been sourced from NSW Spatial Services as 1 m contours and has been incorporated in the model.

4.1.3 Ground Absorption

A ground absorption factor of 0.75 has been applied to the entire model. This global ground absorption value conservatively represents the mix of hard ground (absorption = 0) and soft ground (absorption = 1) on and around the site.

4.1.4 Meteorological Effects

At relatively large distances from a source, the resultant noise levels at receivers can be influenced by meteorological conditions, particularly temperature inversions and gradient winds. Where these factors are a feature of an area their effect on resultant noise levels should be taken into account.

'Fact sheet D' of the *NPfI* states that an assessment can incorporate noise-enhancing meteorological conditions into the modelling for all assessment periods without undertaking detailed meteorologic analysis. Stability class D with light winds (3 m/s at 10 m AGL) for day and evening periods and stability class F with winds up to 2 m/s at 10 m AGL for the night period should be adopted as a conservative approach. These conditions have been included in this assessment.

4.2 Operational Noise Sources

4.2.1 Sources of Operational Noise

The major noise sources associated with the operation of the Project are:

- Mobile plant, such as excavator, dozer, front end loader (FEL) and dump trucks;
- The mobile screen (Stage 1);
- The suction dredge (Stage 2 onwards);
- The wash plant (Stage 2 onwards);
- The booster pump; and,
- Road trucks exporting sand and importing virgin excavated natural material (VENM) during rehabilitation.

Source sound power levels for mobile plant items, including road trucks, have been taken from previous measurements of similar equipment conducted by Wilkinson Murray on similar sites. Wilkinson Murray undertook a site visit to Stockton Sand Quarry to measure sound power levels for existing plant. Results of these measurements validated the assumed sound power levels.

The wash plant operating on the site would be similar to those operating on existing Boral sand extraction sites. Accordingly, the sound power level for this item has been taken from the noise impact assessment conducted by Wilkinson Murray for the Boral operated Dunmore Lakes Sand Project (WM Report No. 18156, Version B, March 2019).

Table 4-1 summarises the operational noise sources associated with the Project and their respective SWL. Equipment used in each of the assessment scenarios is detailed in Section 4.3.

Table 4-1 Operational noise sources and sound power levels

Item	Description (typical)	SWL (dBA) per item
Dozer	Caterpillar D7	113
FEL	Volvo 180H	108
Excavator	40 tonne	113
Dump truck	Caterpillar 740	110
Road truck	Truck and dog	104
Water cart	1987 Volvo F86	103
Mobile screen	Powerscreen M90	101
Dredge	-	68
Wash plant	-	93
Diesel generator	-	80

4.3 Modelled Activities and Assessment Scenarios

Two separate scenarios have been chosen for modelling that represent the worst-case scenarios for the nearby receivers.

Receivers to the north-west of the site will be worst impacted during Stage 1 where a significant portion of the plant and activity is located at the northern most area of the site near the site entrance. During Stage 1, extraction will still be taking place in pit 7 (windblown sand extraction area) as well, and therefore plant has also been modelled in this area. Trucks and a water cart moving between pit 7 and the northern end of the site have been included in this scenario.

Site activities between Stages 2-5 will be reasonably similar, therefore the Stage 5 was selected as this is when plant and activities will be closest to the Fern Bay receivers to the south-west of the site. A water cart has been included moving between the Stage 5 area and the entrance to the site in Stage 1.

Table 4-2 presents the list of plant modelled in each scenario.

Table 4-2 Scenario plant list

Scenario (Extraction Stage)	Plant	Number	Area
Scenario 1 (Stage 1)	Dozer	1	Stage 1
	Mobile screen	1	Stage 1
	Excavator	1	Stage 1
	FEL	1	Stage 1
	FEL	1	Pit 7 (windblown)
	Truck	5	Stage 1
	Truck	2	Pit 7 (windblown)
	Truck	1	Haul road – Pit 7 to weighbridge
	Water cart	1	Haul road – Pit 7 to weighbridge
Scenario 2 (Stage 5)	Dozer	1	Stage 5
	Dredge	1	Boundary Stage 4/5
	Excavator	1	Stage 5
	FEL	1	Stage 1
	Generator	1	Boundary Stage 3/4
	Wash plant	1	Stage 1
	Dump truck	2	Stage 5
	Truck	4	Stage 1
	VENM truck (tipping)	1	Stage 5
	Water cart	1	Haul road – Stage 5 to weighbridge

4.3.1 Predicted Daytime $L_{Aeq,15min}$ Operational Noise Levels

The predicted $L_{Aeq,15min}$ noise levels associated with the operation of the Project during the day period are presented in Table 4-3.

Table 4-3 Predicted daytime $L_{Aeq,15min}$ operational noise levels

Receiver	Project Noise Trigger Level ($L_{Aeq,15min}$ dBA)	Predicted Noise Levels – Scenario 1 (dBA)	Predicted Noise Levels – Scenario 2 (dBA)	Compliance
R1	46	28	28	Yes
R2	46	29	28	Yes
R3	46	29	29	Yes
R4	46	30	29	Yes
R5	46	27	31	Yes
R6	46	26	30	Yes
R7	46	27	33	Yes
R8	46	26	31	Yes
R9	46	27	31	Yes
R10	46	26	30	Yes
R11	46	24	29	Yes
R12	46	24	30	Yes
R13	46	24	30	Yes
R14	46	15	23	Yes
R15	46	14	23	Yes
R16	46	13	23	Yes
R17	46	12	23	Yes
R18	46	13	22	Yes
R19	46	16	25	Yes
R20	46	15	24	Yes
R21	46	16	24	Yes
R22	46	18	24	Yes
R23	46	18	24	Yes
R24	46	17	24	Yes
R25	46	16	23	Yes
R26	46	17	23	Yes
R27	46	17	22	Yes
R28	46	17	22	Yes
R29	46	17	21	Yes
R30	46	15	21	Yes
R31	46	14	21	Yes
R32	46	13	21	Yes

Receiver	Project Noise Trigger Level ($L_{Aeq,15min}$ dBA)	Predicted Noise Levels – Scenario 1 (dBA)	Predicted Noise Levels – Scenario 2 (dBA)	Compliance
R33	46	14	21	Yes
R34	46	23	28	Yes
R35	46	23	29	Yes

Based on the results of Table 4-3 there are no exceedances of the project noise trigger level for either scenario during the day period.

4.3.2 Predicted AM Shoulder $L_{Aeq,15min}$ Operational Noise Levels

The predicted $L_{Aeq,15min}$ noise levels associated with the operation of the Project during the AM shoulder period are presented in Table 4-3.

Table 4-4 Predicted AM shoulder $L_{Aeq,15min}$ operational noise levels

Receiver	Project Noise Trigger Level ($L_{Aeq,15min}$ dBA)	Predicted Noise Levels – Scenario 1 (dBA)	Predicted Noise Levels – Scenario 2 (dBA)	Compliance
R1	43	29	29	Yes
R2	43	30	29	Yes
R3	43	30	29	Yes
R4	43	31	30	Yes
R5	43	28	32	Yes
R6	43	27	31	Yes
R7	43	28	33	Yes
R8	43	27	32	Yes
R9	43	27	32	Yes
R10	43	27	31	Yes
R11	43	25	30	Yes
R12	43	24	31	Yes
R13	43	24	31	Yes
R14	43	15	24	Yes
R15	43	14	24	Yes
R16	43	14	24	Yes
R17	43	12	23	Yes
R18	43	13	22	Yes
R19	43	16	26	Yes
R20	43	15	25	Yes
R21	43	16	25	Yes
R22	43	18	25	Yes

Receiver	Project Noise Trigger Level ($L_{Aeq,15min}$ dBA)	Predicted Noise Levels – Scenario 1 (dBA)	Predicted Noise Levels – Scenario 2 (dBA)	Compliance
R23	43	19	25	Yes
R24	43	18	24	Yes
R25	43	17	24	Yes
R26	43	17	24	Yes
R27	43	17	23	Yes
R28	43	17	22	Yes
R29	43	17	22	Yes
R30	43	16	22	Yes
R31	43	15	22	Yes
R32	43	14	21	Yes
R33	43	14	21	Yes
R34	43	23	29	Yes
R35	43	23	30	Yes

Based on the results of Table 4-4 there are no exceedances of the project noise trigger level for either scenario during the AM shoulder period.

4.3.3 Environmental Protection License Noise Limits

EPL Limit L3.1 states that *noise emissions from the premises must not exceed an Leq(15 minute) noise emission criterion of 35 dB(A) at the nearest residential receiver*. This assessment has predicted a maximum $L_{Aeq,15min}$ noise level at any receiver of 33dBA. Compliance with this limit condition is therefore predicted to be achieved at all times.

4.3.4 Cumulative Noise Impacts

The noise assessment methodology recommended by the *NPfI* implicitly considers potential cumulative impacts from multiple industrial activities through the amenity noise levels. Furthermore, all predicted $L_{Aeq,15min}$ noise levels are 10dB or more below the project noise trigger level. It is therefore expected that the quarry will have a negligible contribution to the total $L_{Aeq,15min}$ noise levels at receivers near the site.

4.3.5 L_{Amax} Operational Noise Levels

A typical L_{Amax} sound power level can range from 3-7 dBA above the operational L_{Aeq} sound power level. As detailed above, the predicted $L_{Aeq,15min}$ noise levels during the morning shoulder period are well below the project specific criterion at each receiver. Given this, the Project will also meet the maximum noise trigger levels detailed in Table 3-8. No further assessment of maximum noise levels is therefore warranted.

4.4 Road traffic noise assessment

Based on information sourced from the Traffic Impact Assessment for this Project (Transport & Urban Planning, 2019), the site will be accessed via the following routes:

a) Nelson Bay Road between Cabbage Tree Road and Seaside Boulevard and Cabbage Tree Road/Tomago Road for access to the Central Coast, Sydney and Hunter Valley. This route accounts for 50% of vehicle movements.

b) Nelson Bay Road (south of Coxs Lane) and Tourle Street/Cormorant Road for access to the Newcastle area. This route accounts for 45% of vehicle movements.

c) Nelson Bay Road, north of Cabbage Tree Road and Medowie Road for access to Port Stephens and North Coast. This route accounts for 5% of vehicle movements.

These roads are classified as arterial or sub-arterial based on the classification guidelines in the *RNP*.

Traffic generation for the Project is predicted to result in an increase of 84 heavy vehicle movements on an average weekday and 132 movements on a busy weekday. Traffic movements on Saturdays are predicted to be minimal based on current operations and therefore assessment of Saturday movements has not been conducted.

These movements have been divided evenly across the operating hours of the site and divided between the routes as described above. The breakdown of movements is presented in Table 4-5. As a conservative approach the assessment has been conducted based on the busy day scenario.

Two-way 5-day average traffic volumes for the surrounding road network have also been sourced from the Traffic Impact Assessment. The increase in traffic noise due to the additional heavy traffic from the Project has been assessed using the *CORTN* calculation method.

Table 4-5 Busy weekday movements

Route	% of Project Movements	Increase in Busy Day Heavy Vehicles from Project	Existing Daily (Weekday) Average Traffic Volume		Relative Noise Increase (dBA)
			Total	% of Heavy Vehicles	
a)	50	66	10857	10.5	<0.2
b)	45	59	26264	5.2	<0.1
c)	5	7	7206	6.1	<0.1

Compliance is expected to be achieved on a busy day at all assessment locations, with predicted relative increases of less than 0.2 dB along all routes. Based on compliance during the busy weekday, it is expected that compliance will be comfortably achieved during an average weekday.

5 CONCLUSION

Wilkinson Murray Pty Limited has been engaged by Element Environment on behalf of Boral to conduct a Noise Impact Assessment for the proposed continued and expanded operations at the Stockton Sand Quarry.

This NIA provides a detailed assessment of potential operational noise impacts associated with the Project and will accompany an Environmental Impact Statement for submission to the Department of Planning, Industry and Environment. The assessment has been conducted in general accordance with the *Noise Policy for Industry* (NPfI) and the Quarry's existing Environmental Protection License noise limits.

Unattended noise monitoring was conducted to determine the existing ambient noise levels at the most potentially affected residential receivers in the area surrounding the Project.

Based on information from Boral, operating parameters, equipment and source sound power levels have been developed to describe several noise assessment scenarios for the Project.

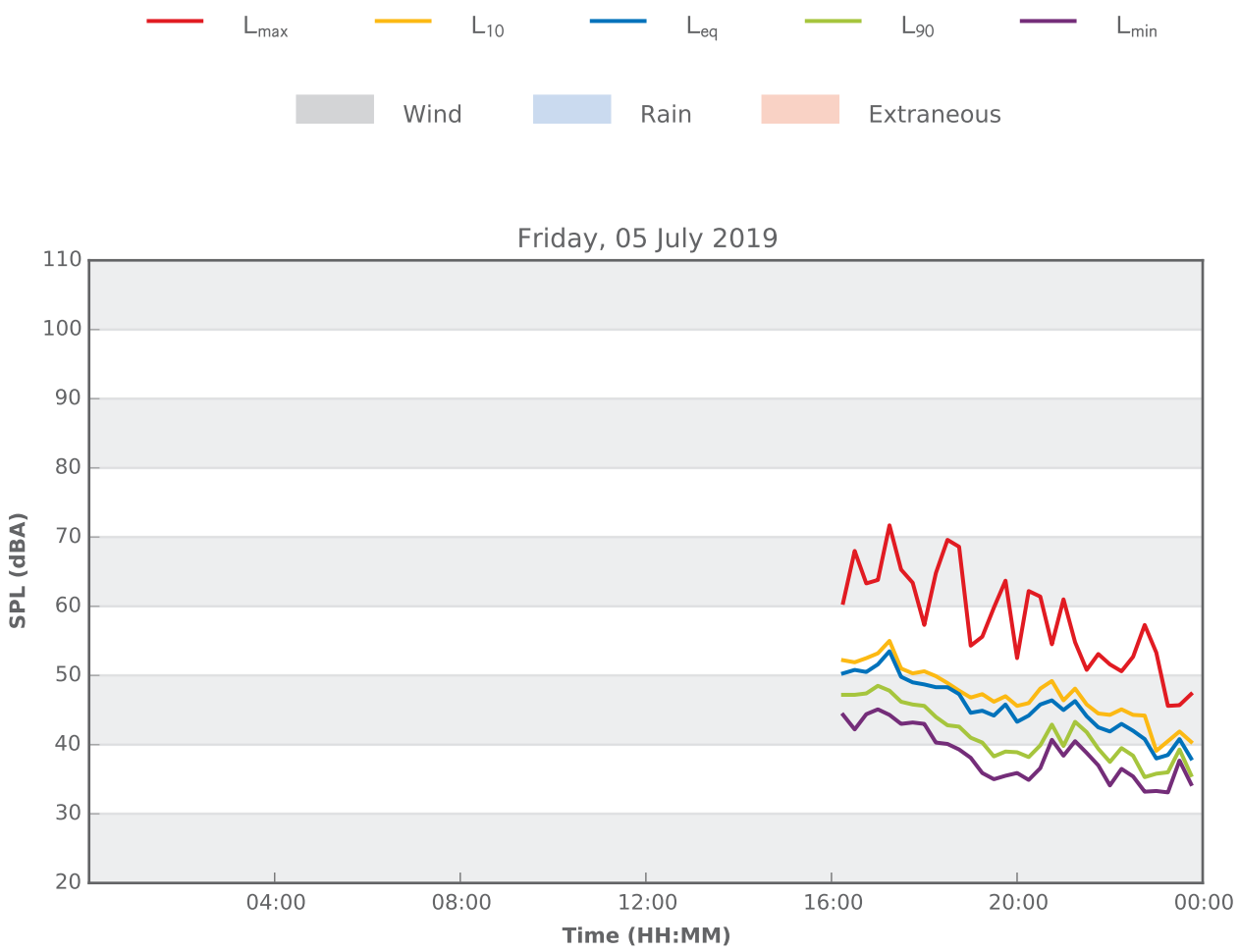
$L_{Aeq,15min}$ operational noise levels have been predicted at sensitive receivers for each assessment scenario. The predicted noise levels comply with the established project noise trigger levels. In accordance with the *Noise Policy for Industry* and *Voluntary Land Acquisition and Mitigation Policy*, no further noise mitigation measures or controls are warranted.

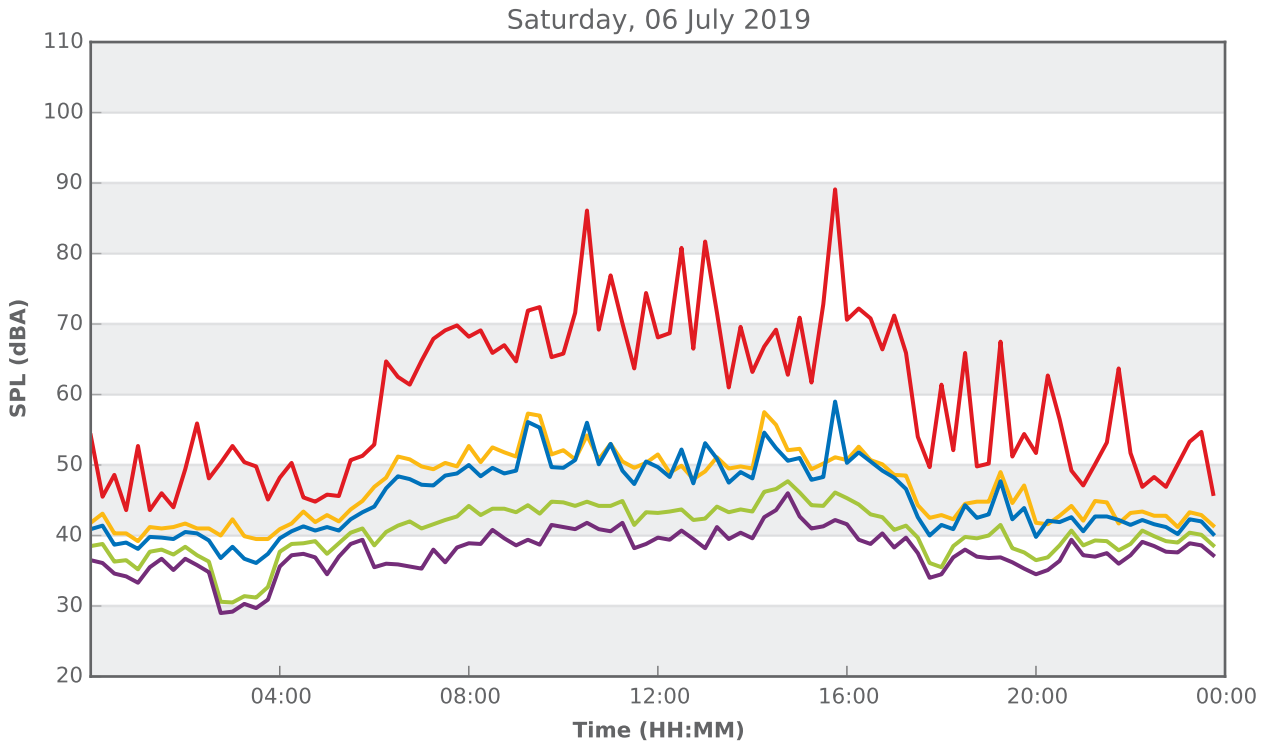
Noise impacts due to heavy vehicle movements on the surrounding road network have been assessed. The predicted relative increase in noise levels are within the allowable limits outlined in the *Road Noise Policy* on all designate access routes.

APPENDIX A

NOISE MEASUREMENT RESULTS

4 Coxs Lane Fullerton Cove Nsw





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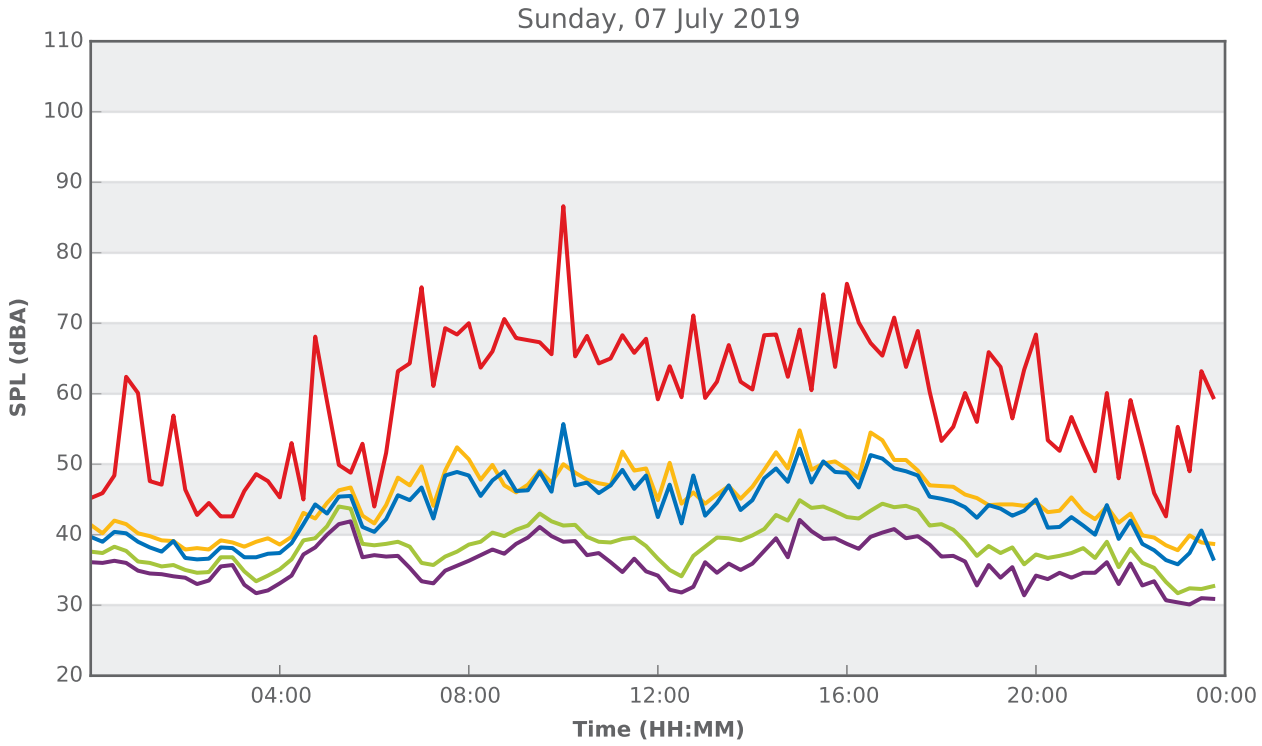

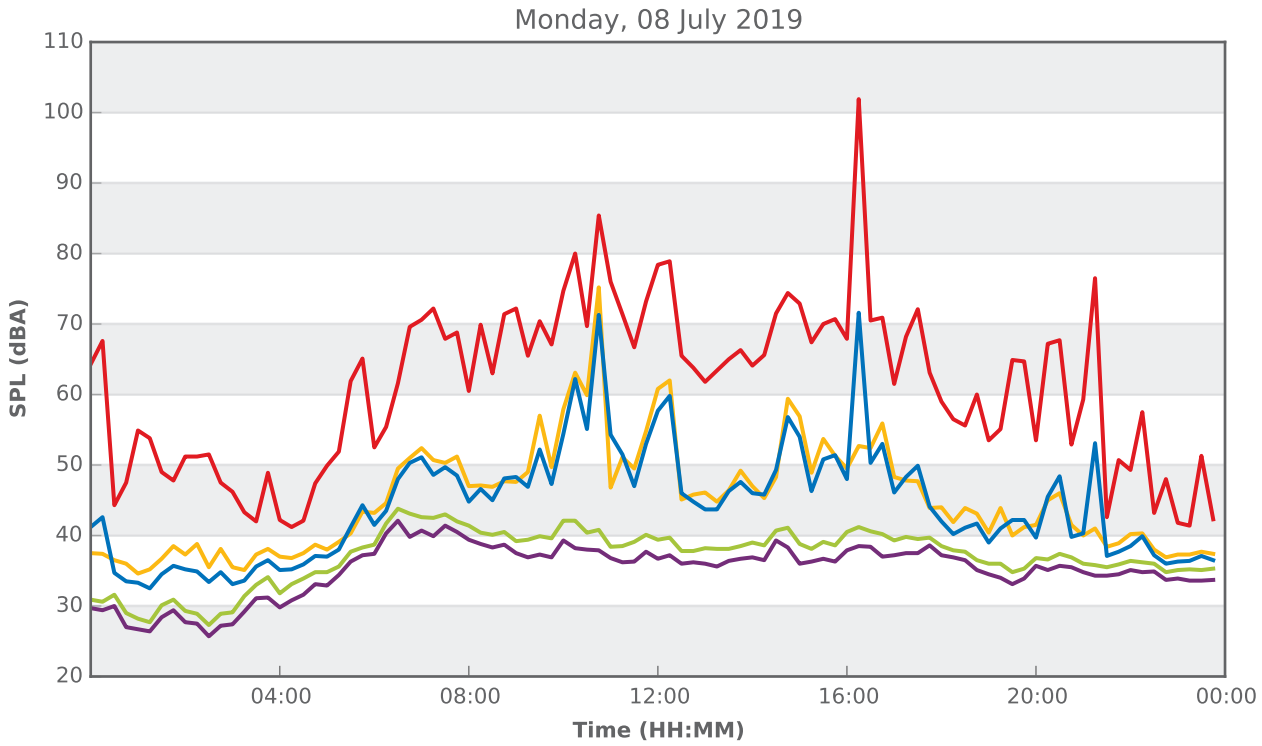

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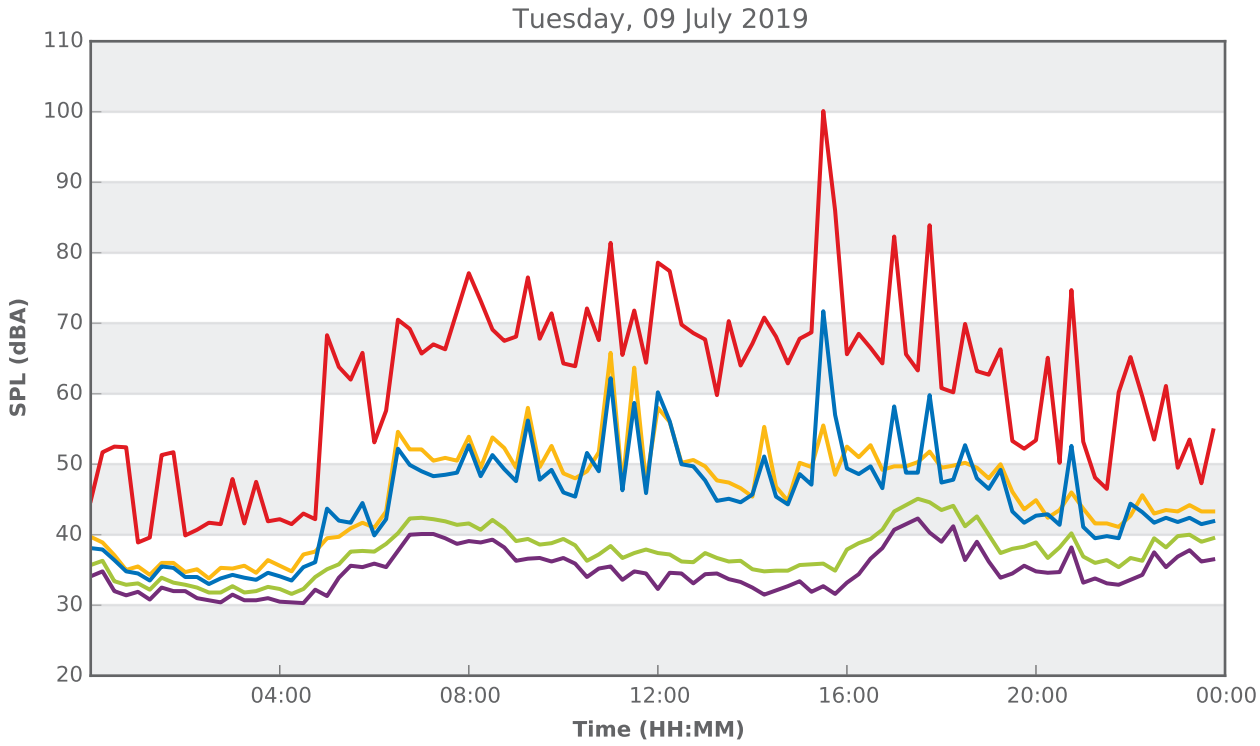

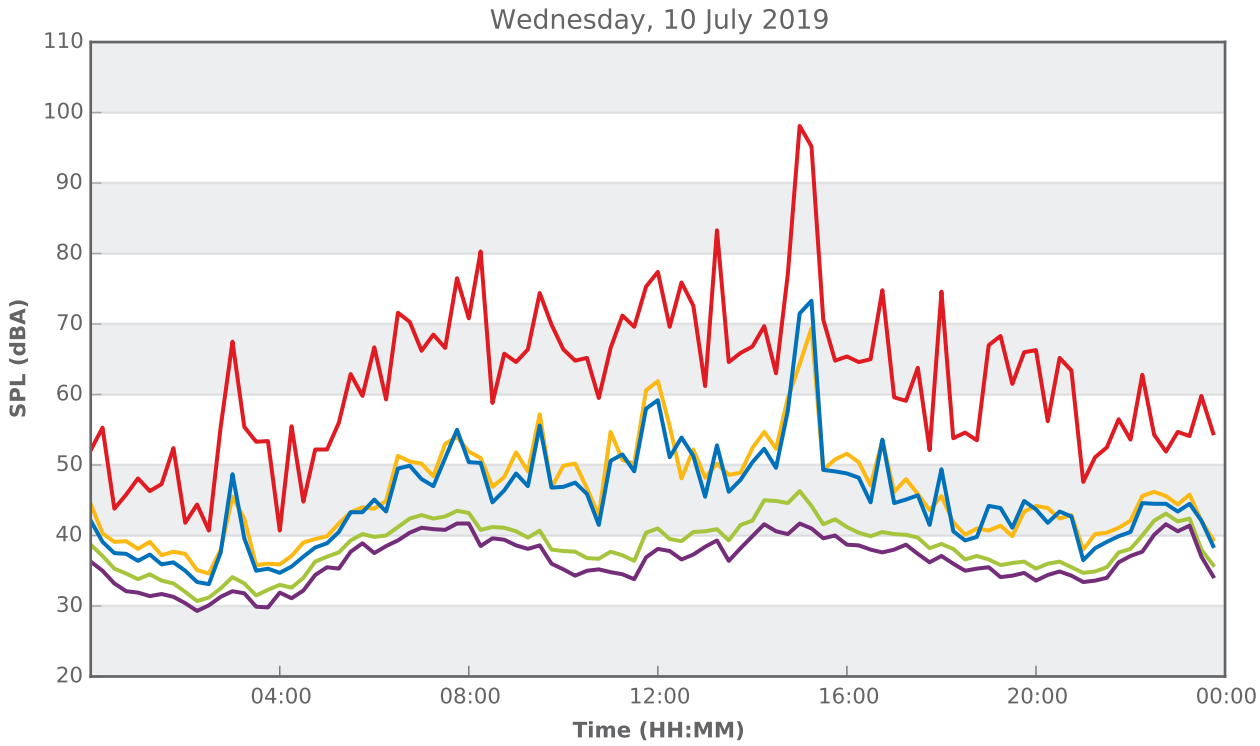

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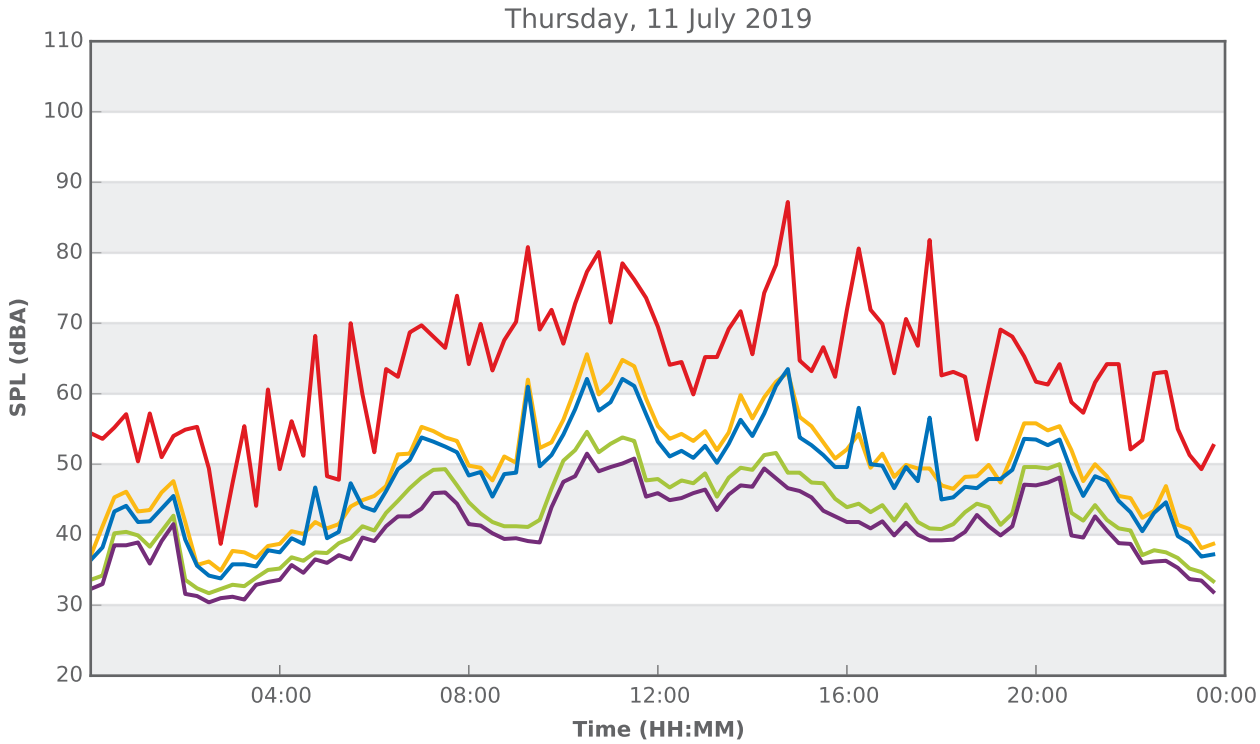

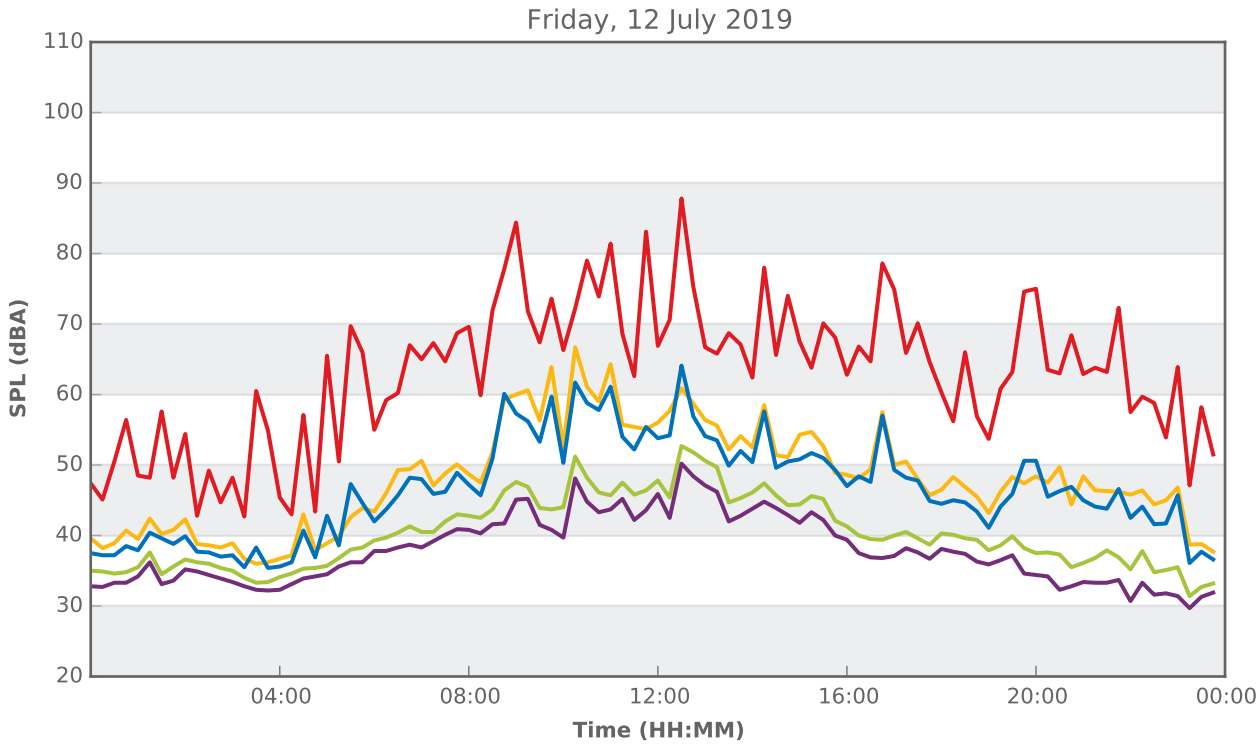

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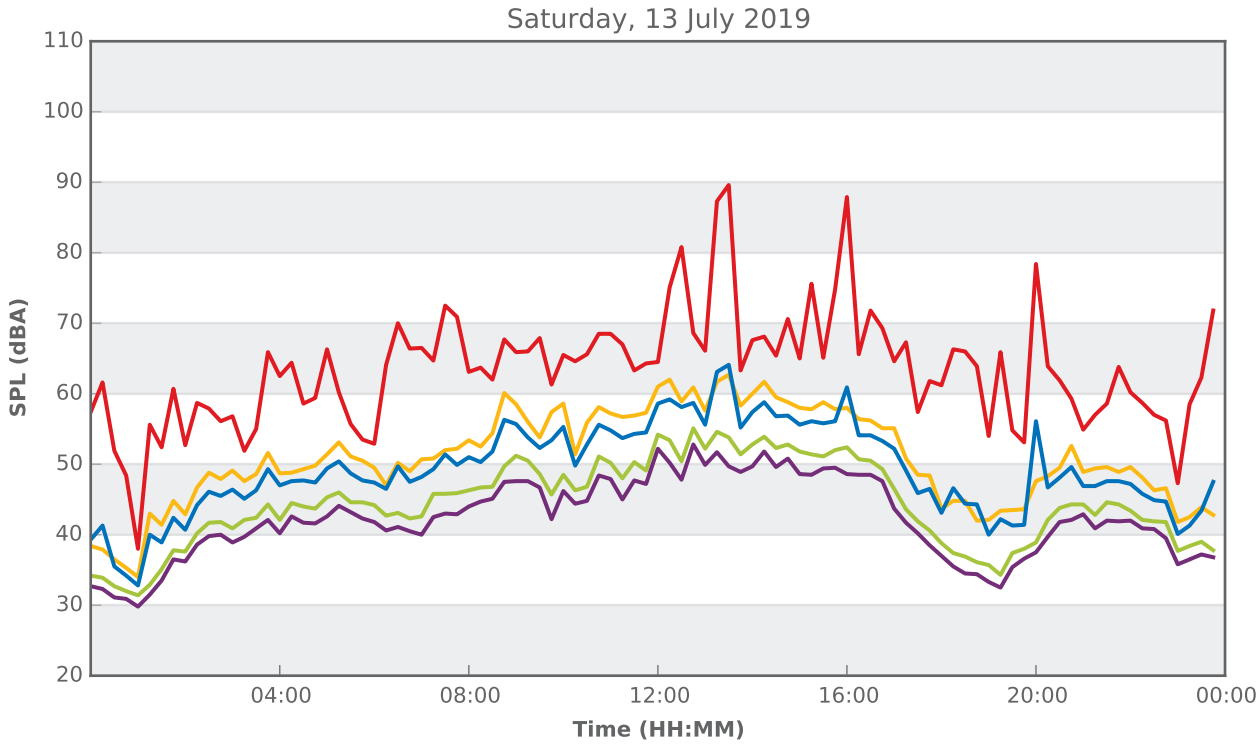

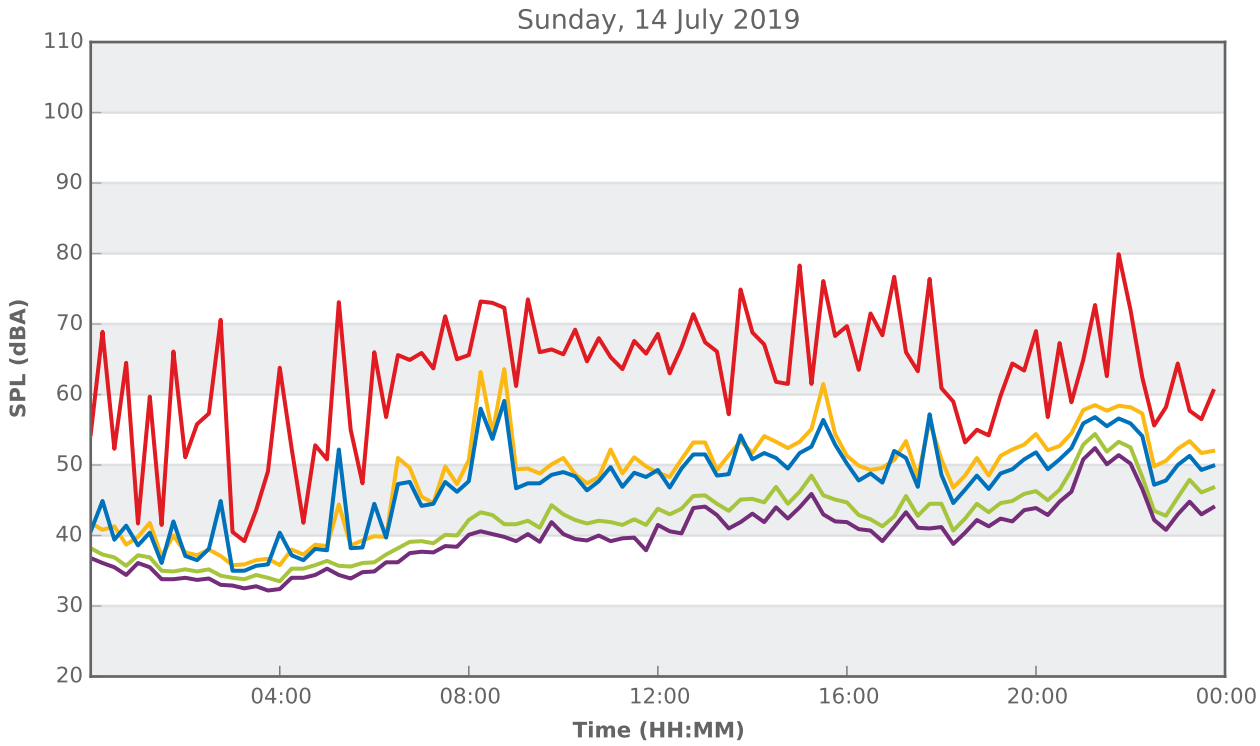

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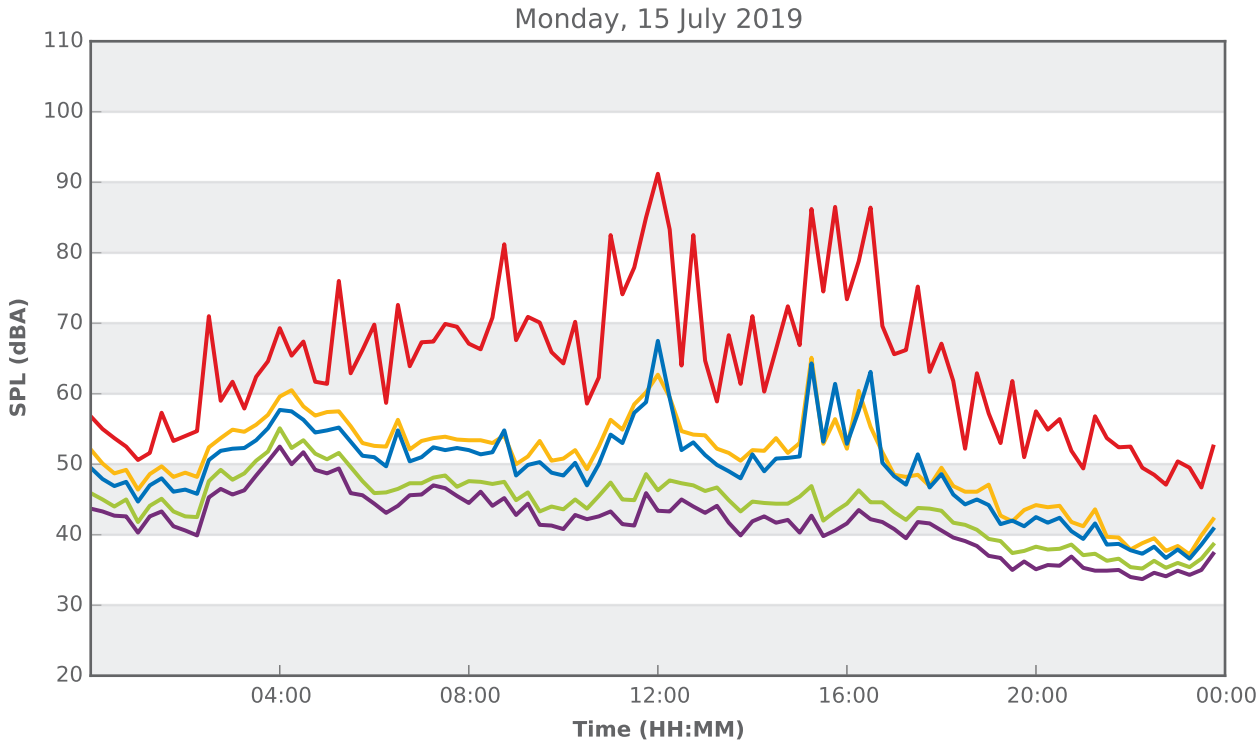
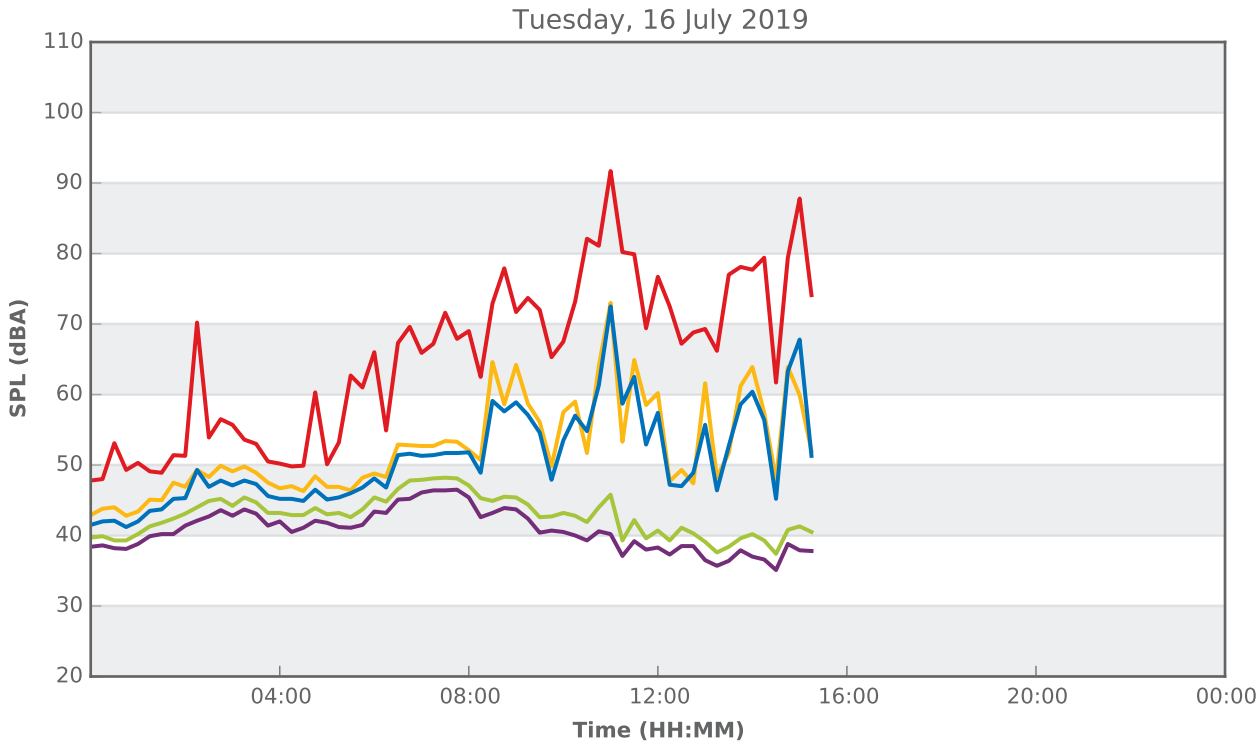
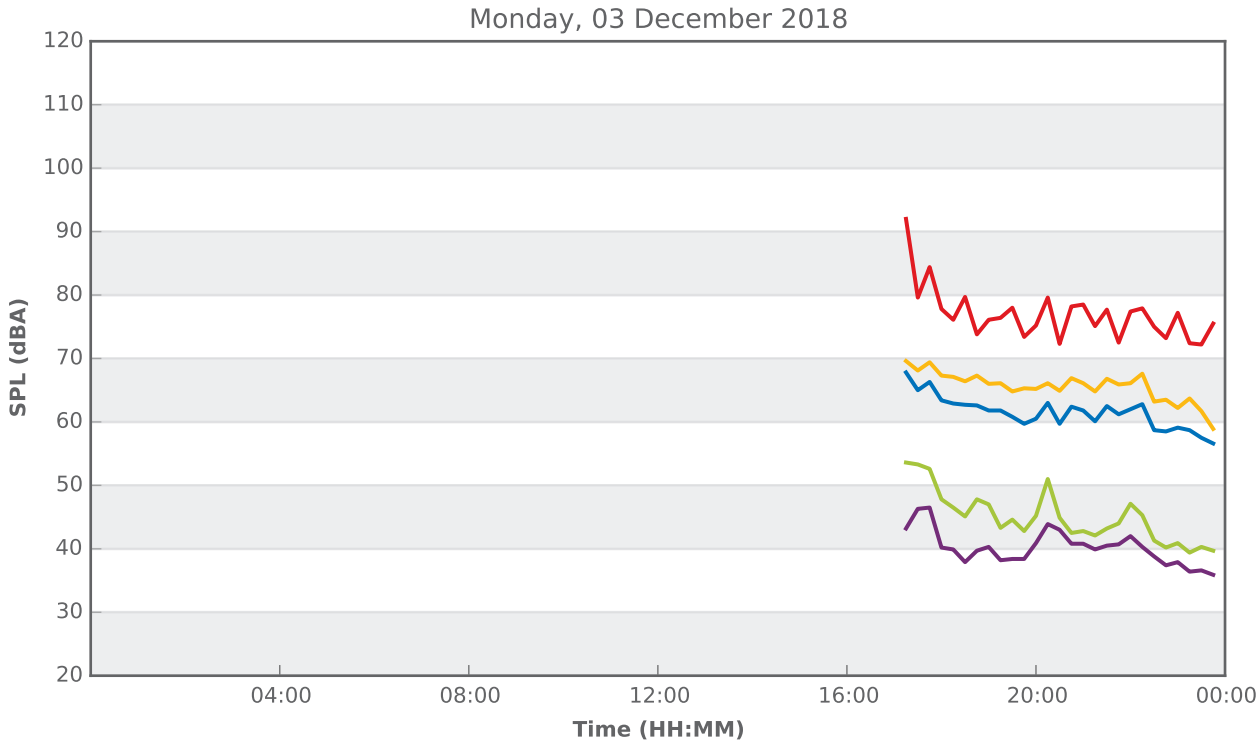
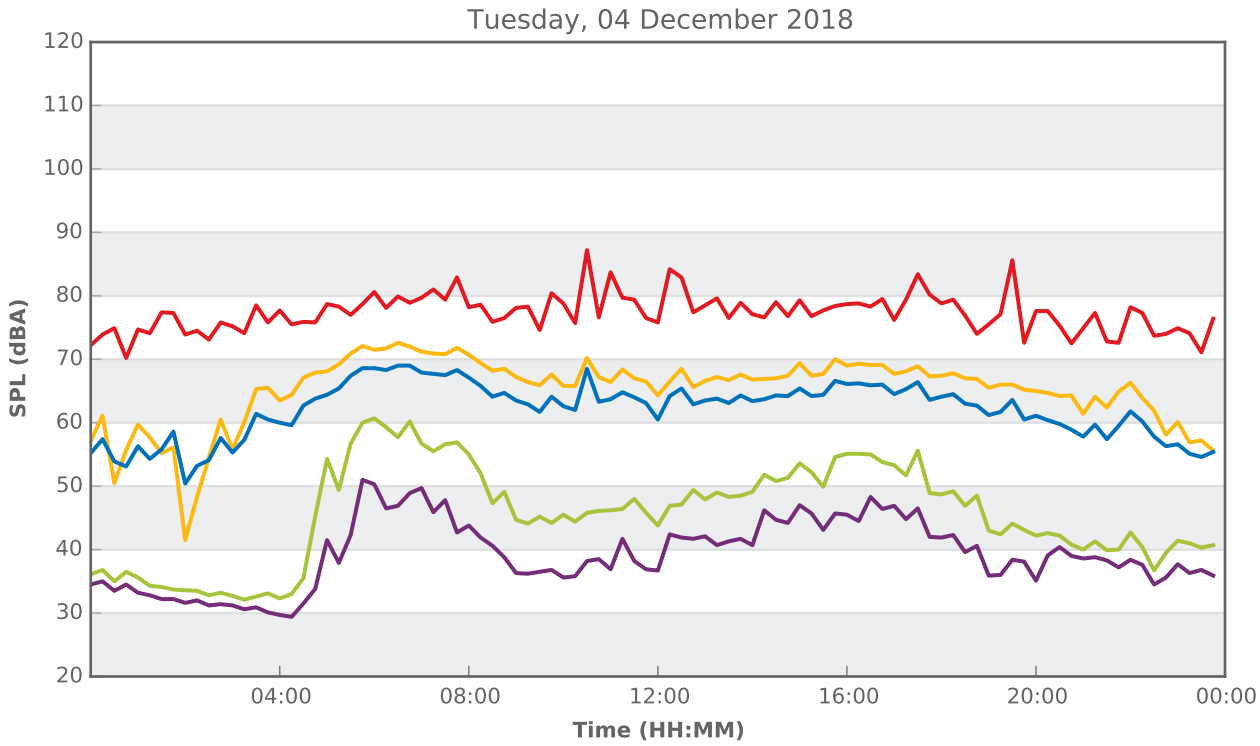




157 Cabbage Tree Road Williamtown Nsw







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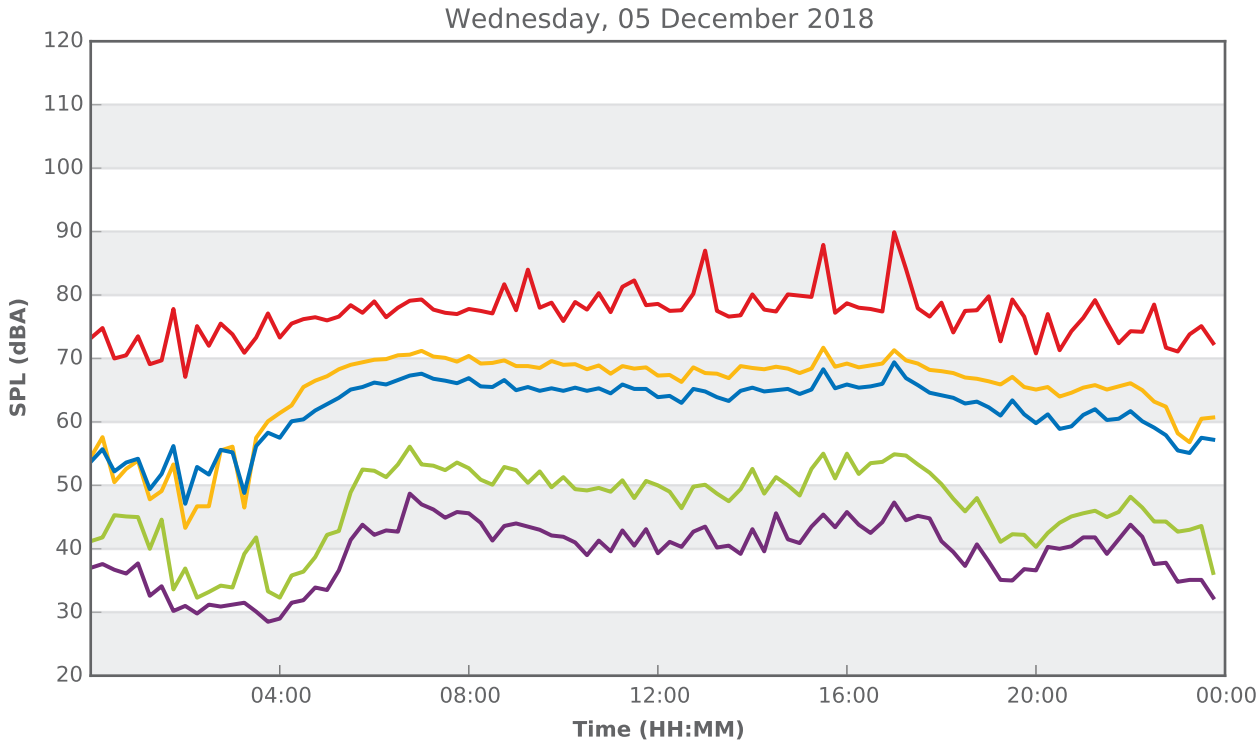

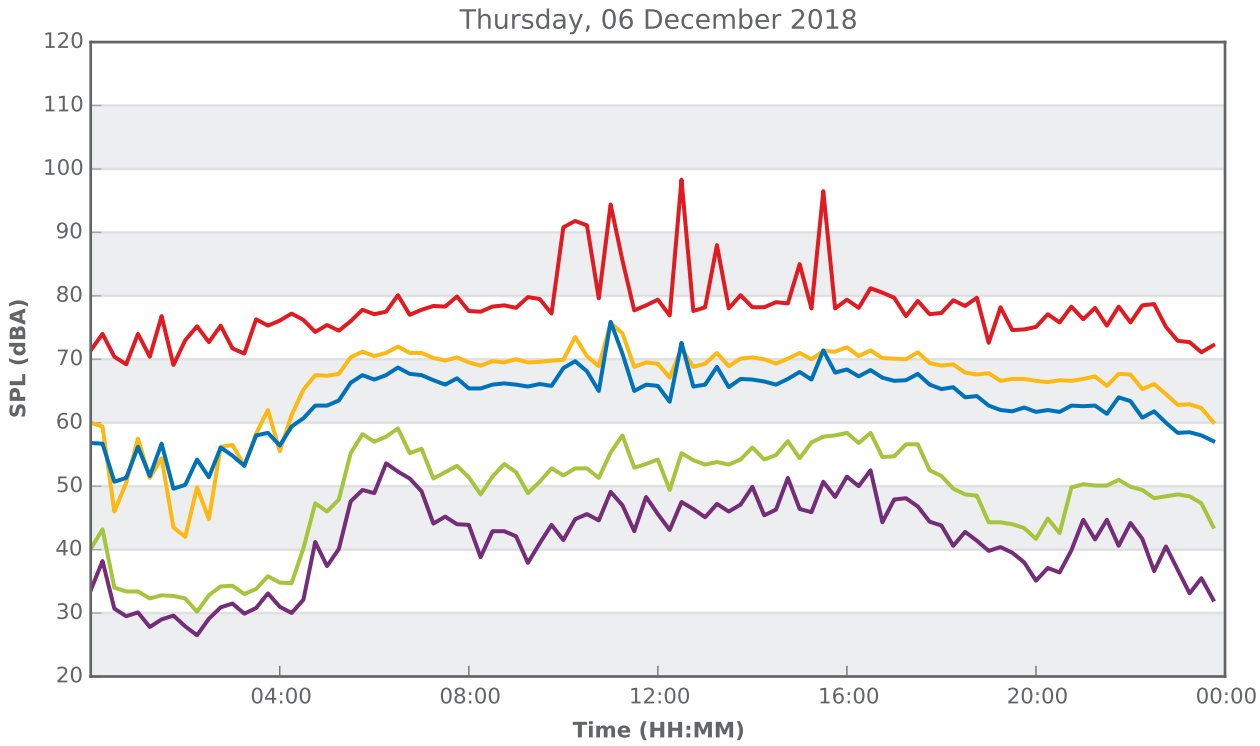

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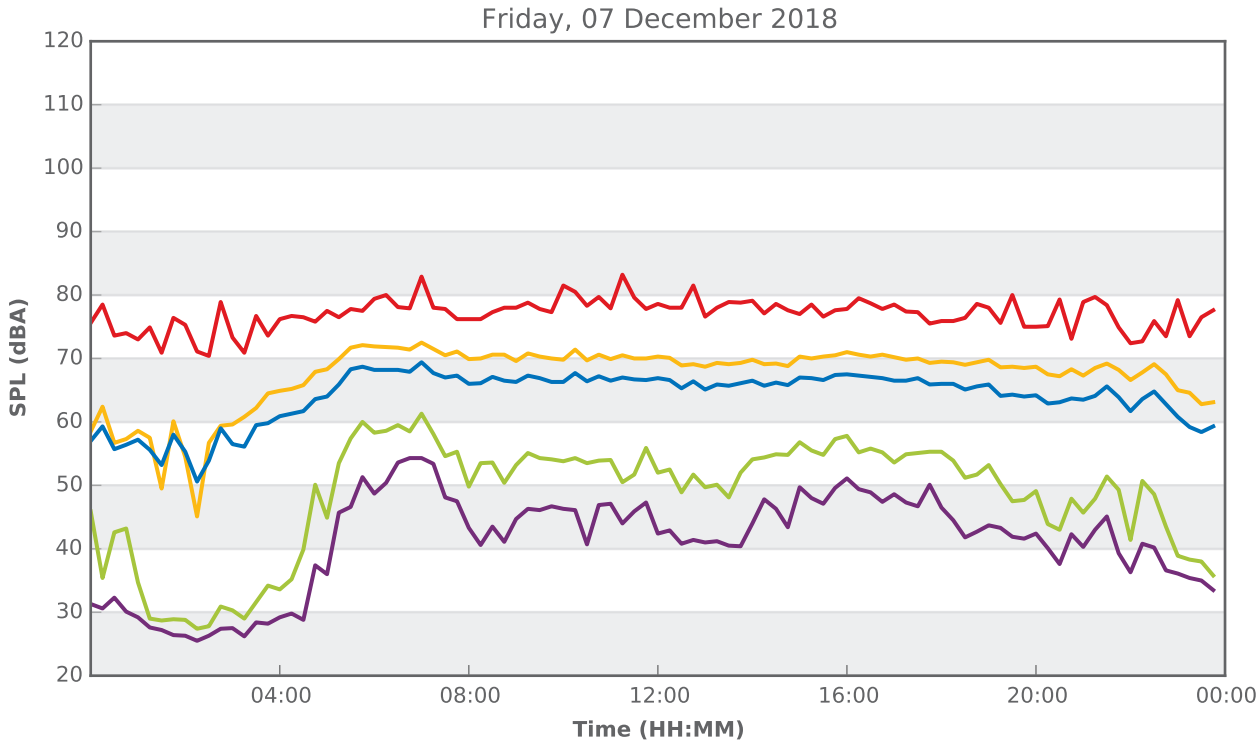

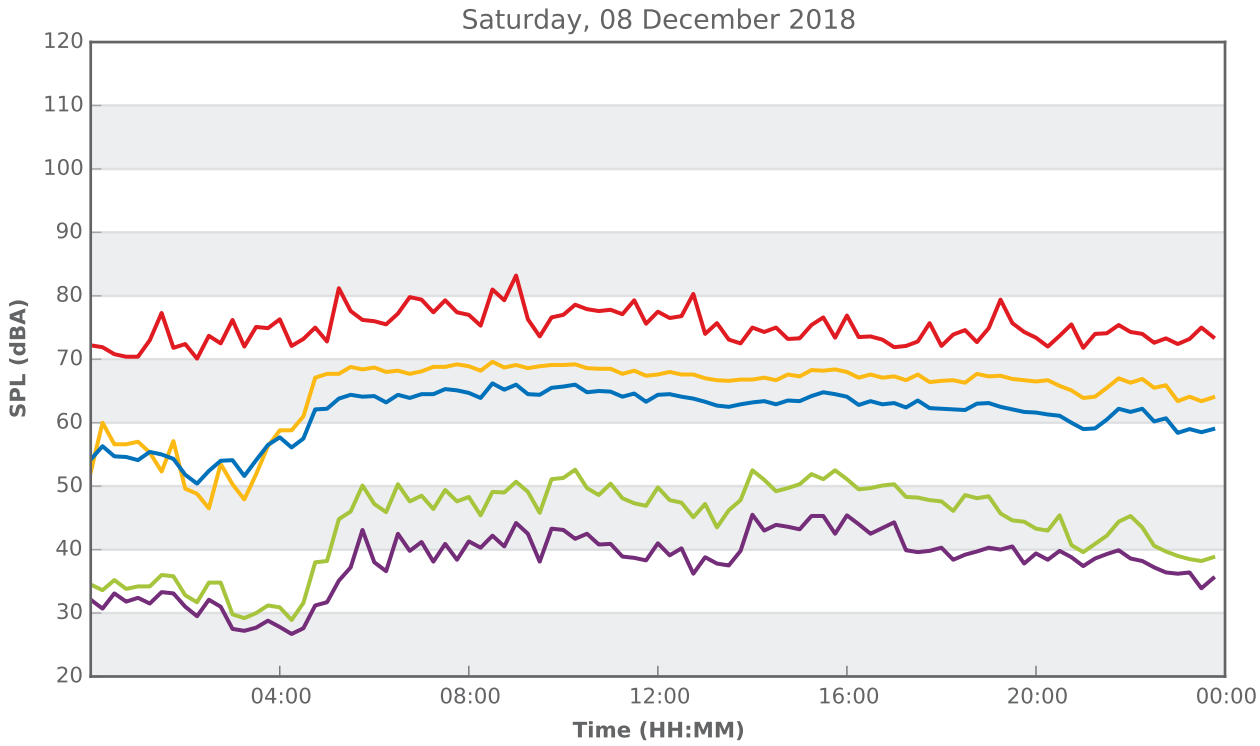

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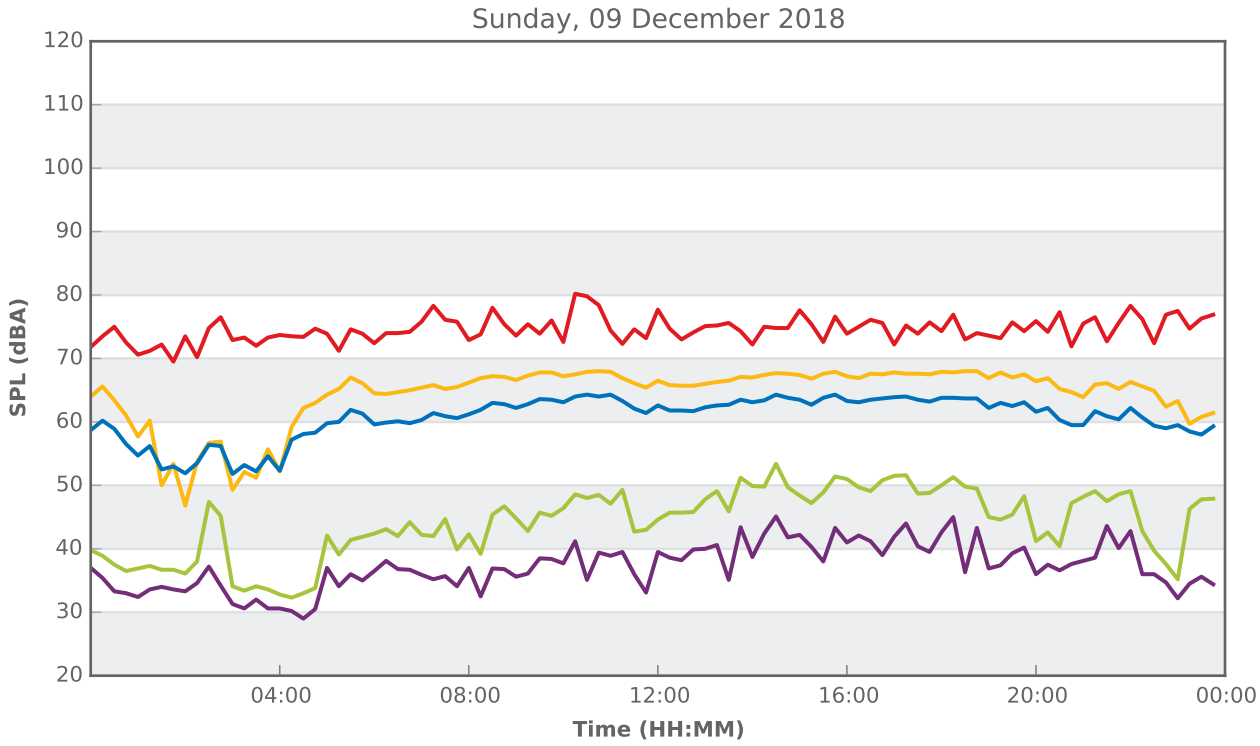

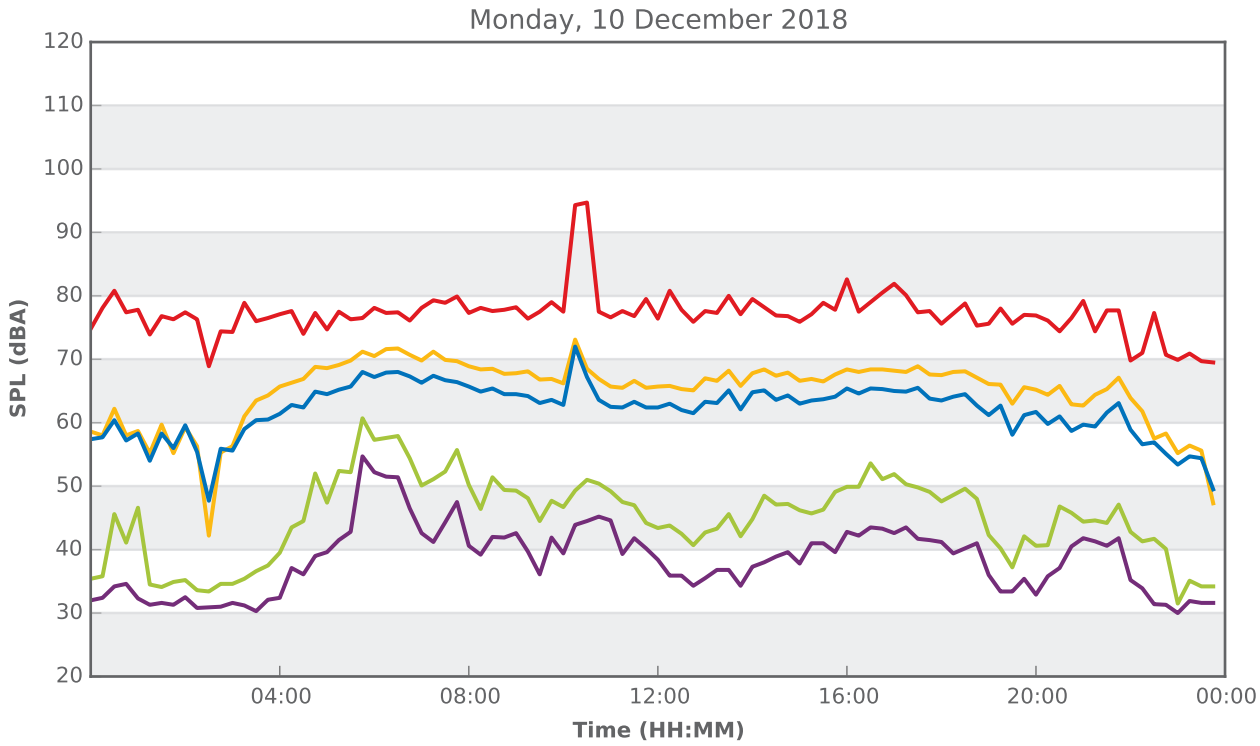

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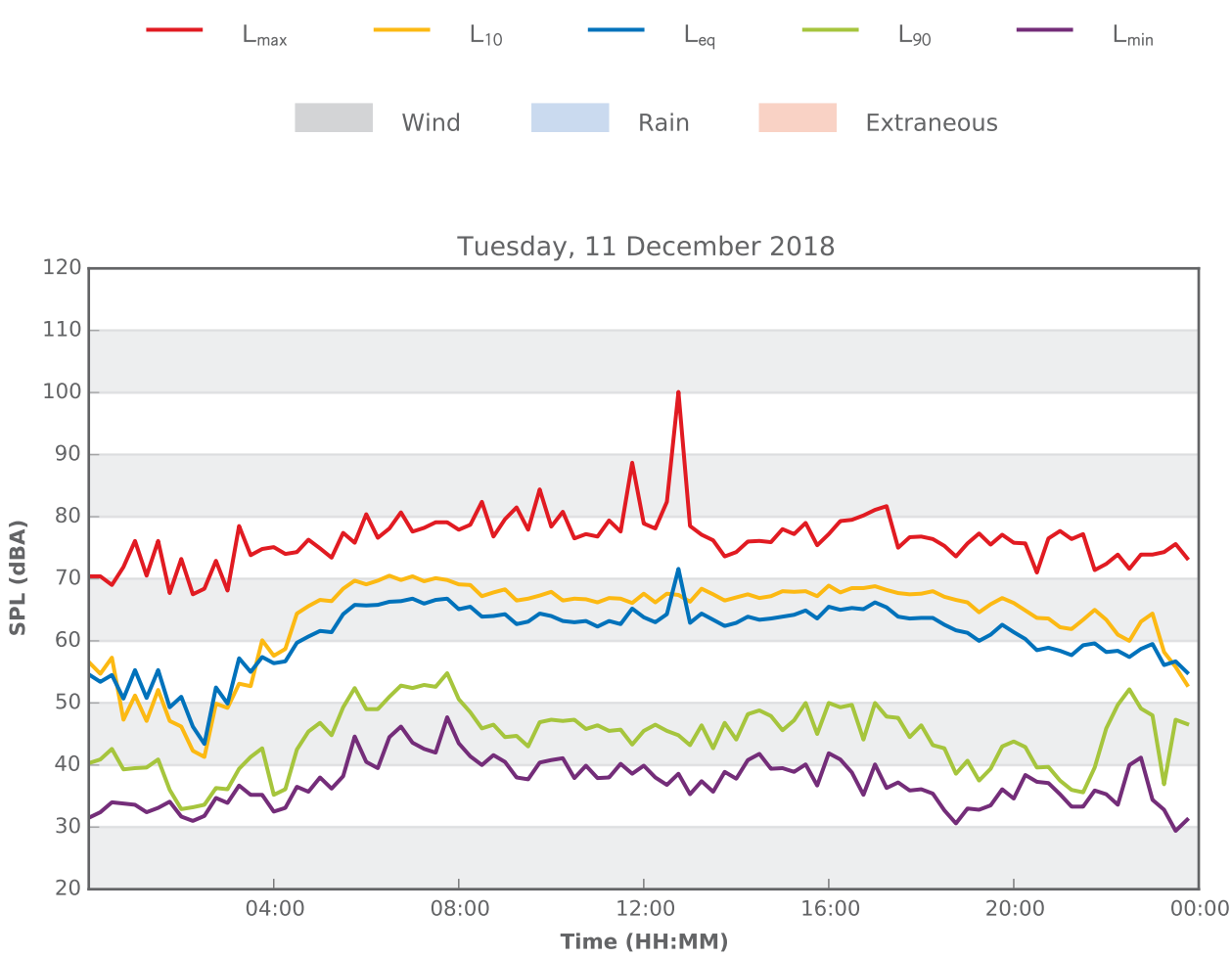

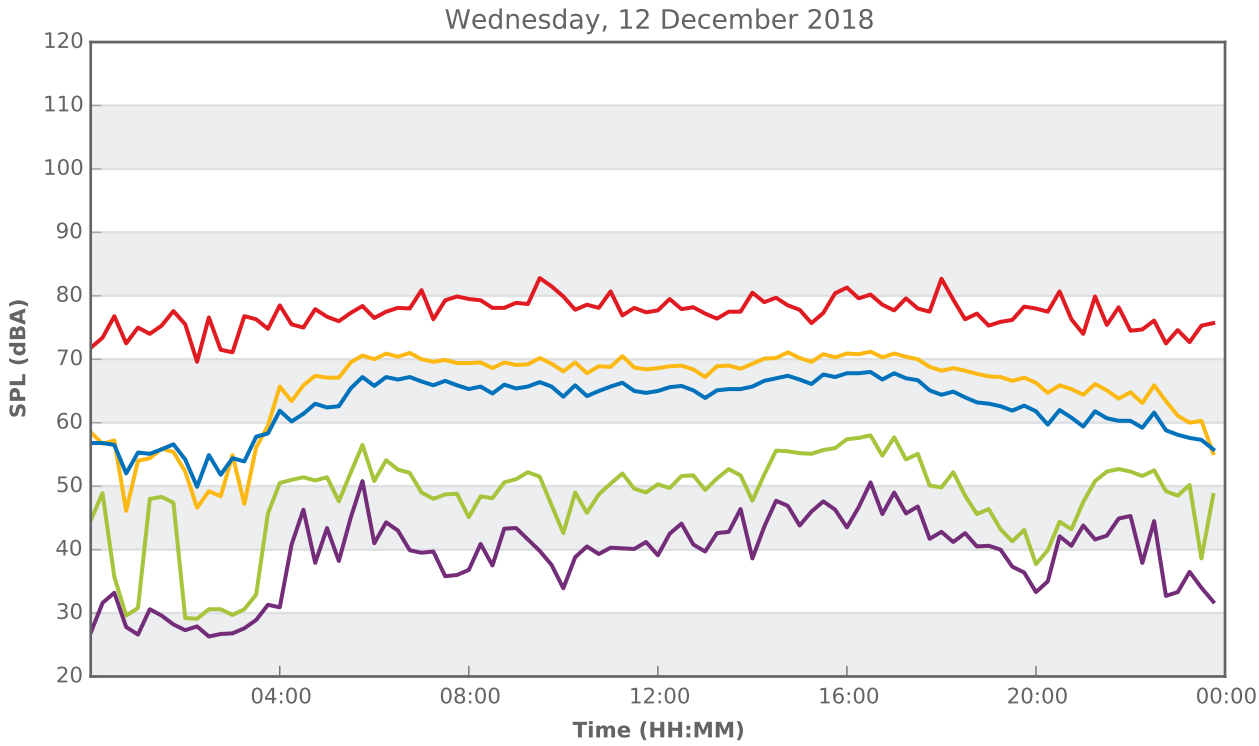

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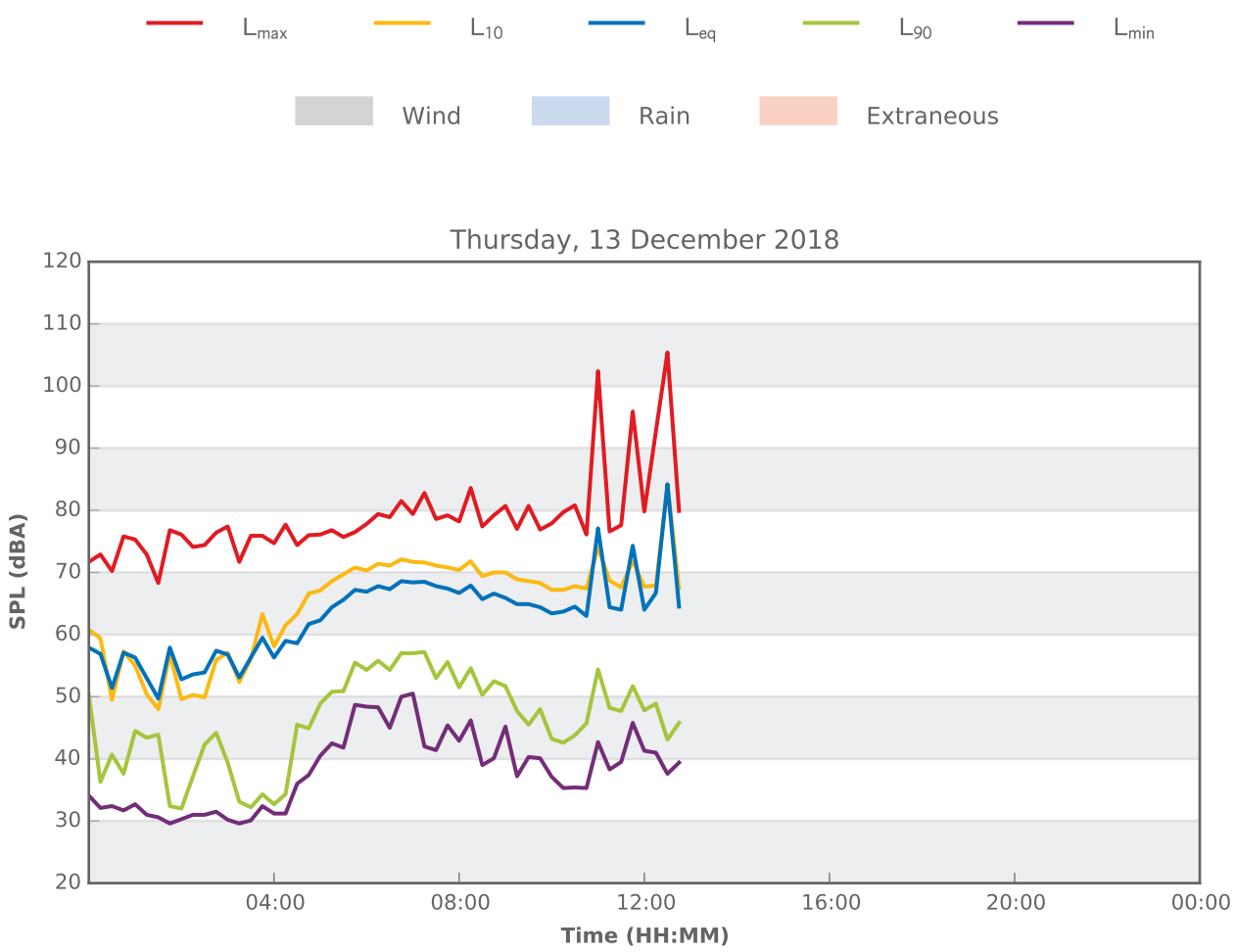

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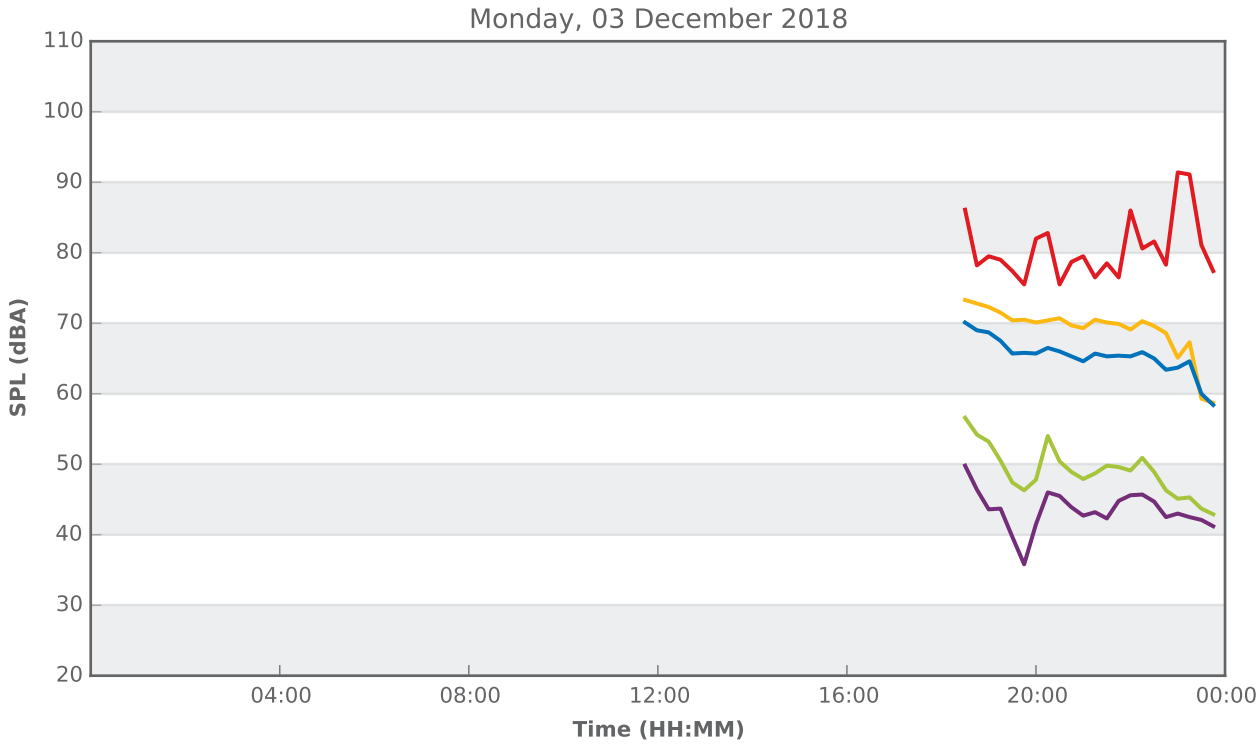

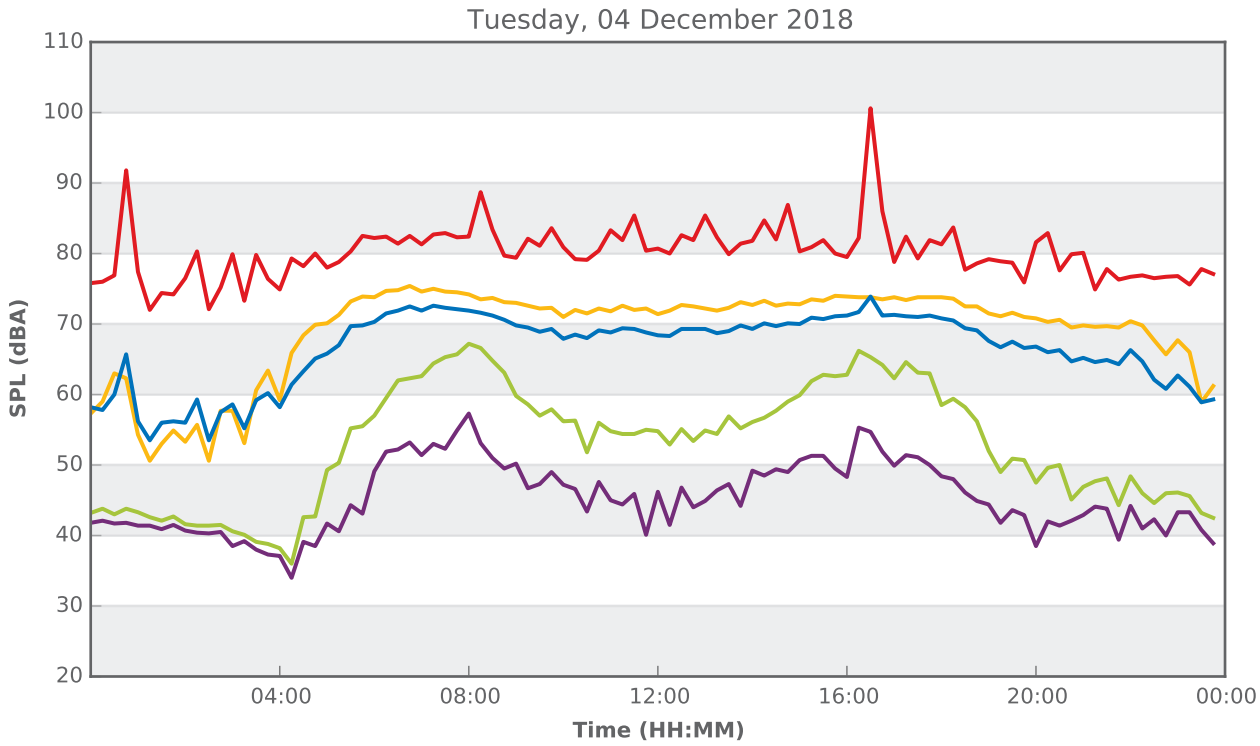

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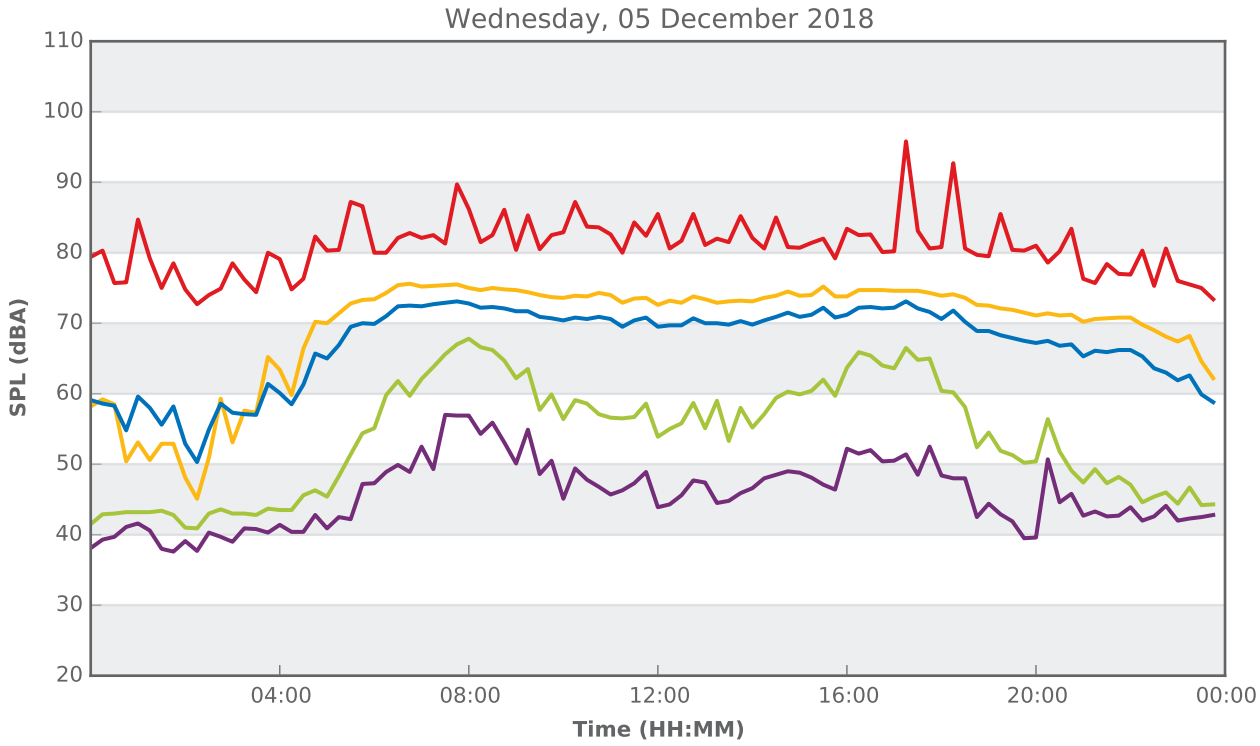

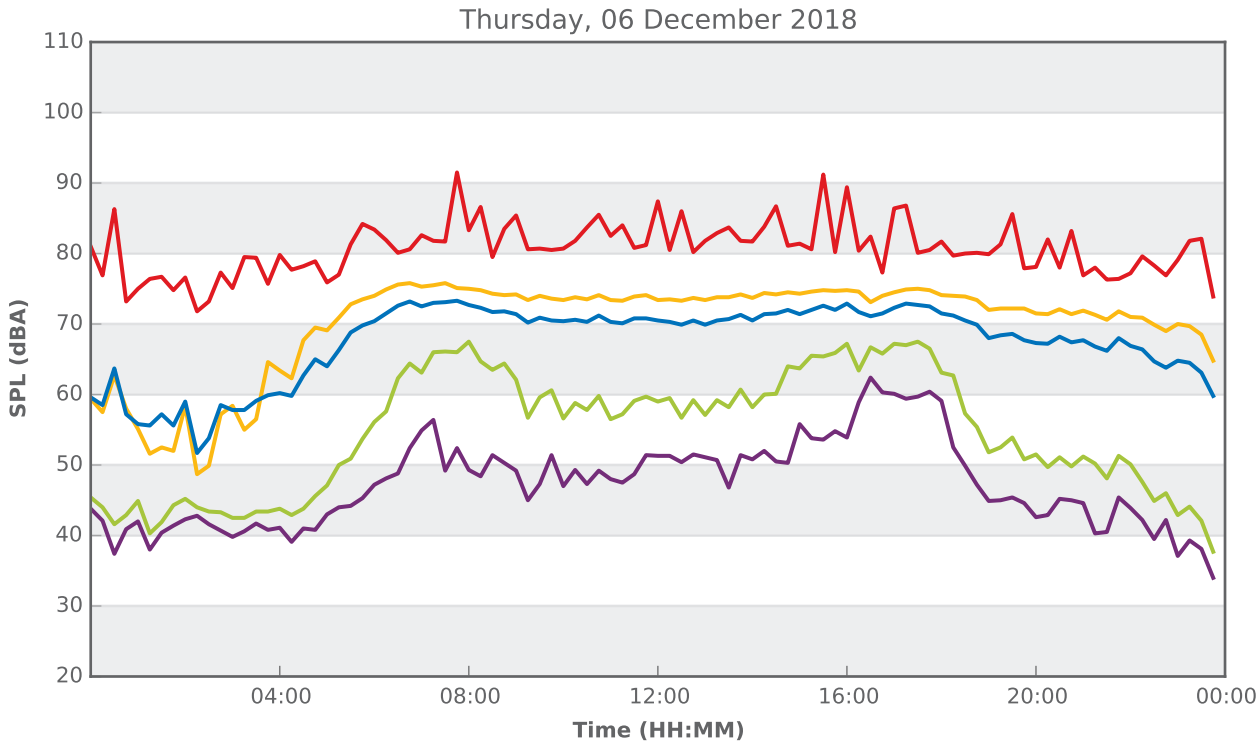

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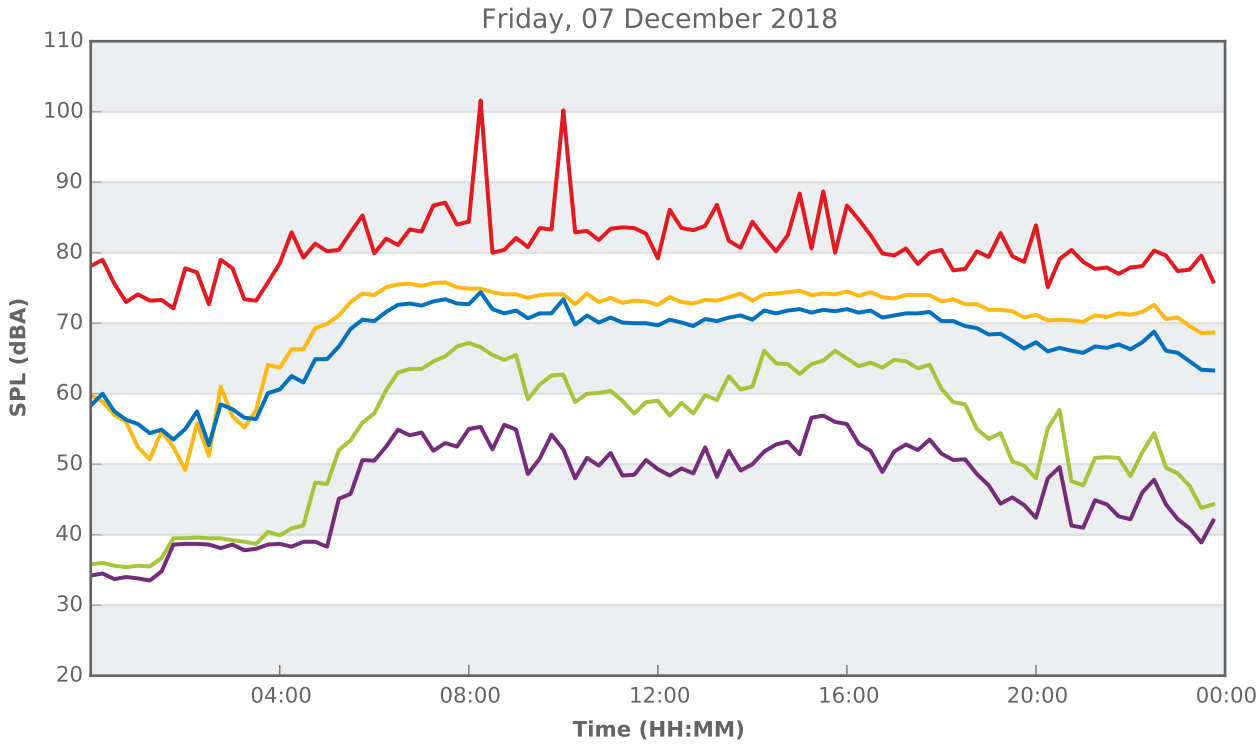

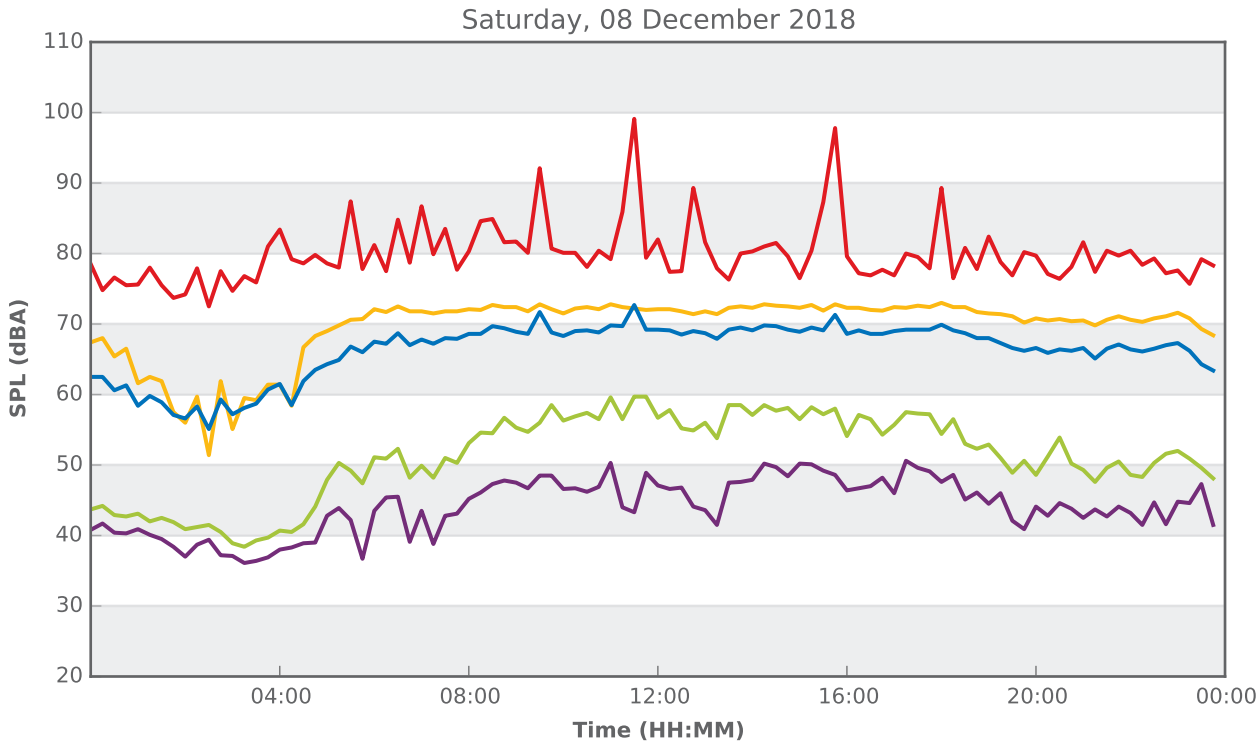

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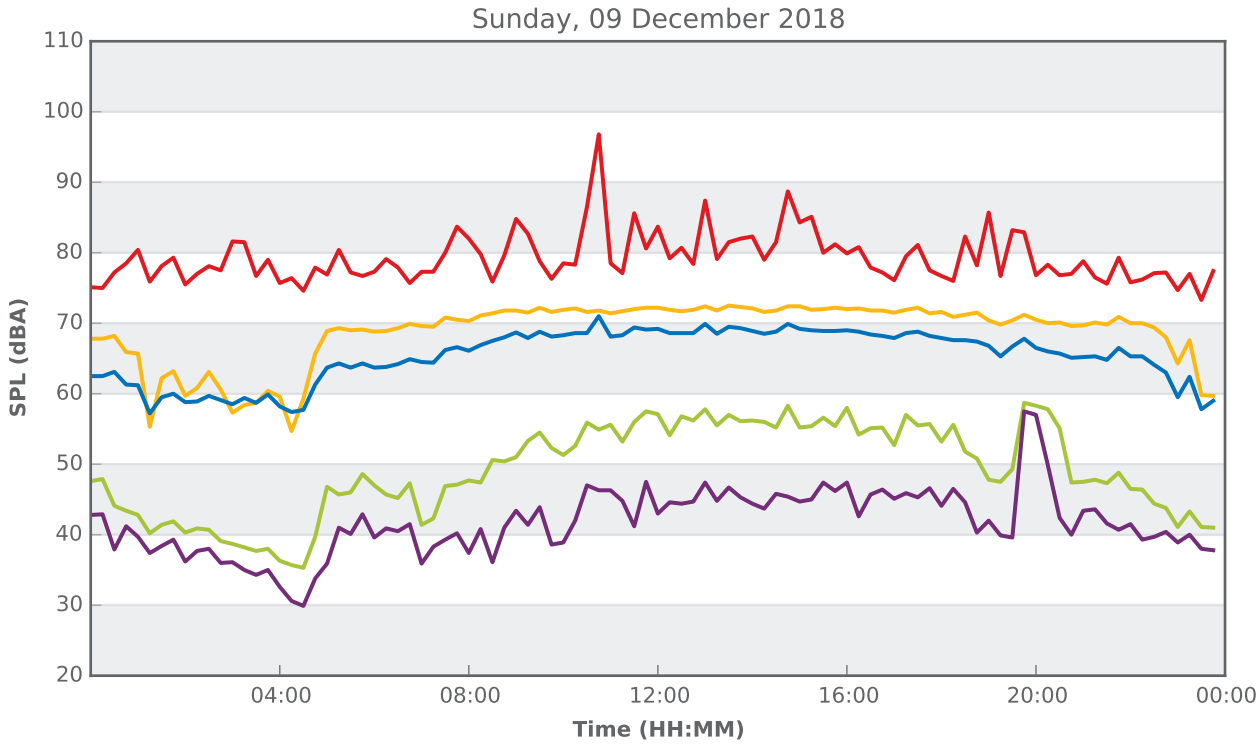

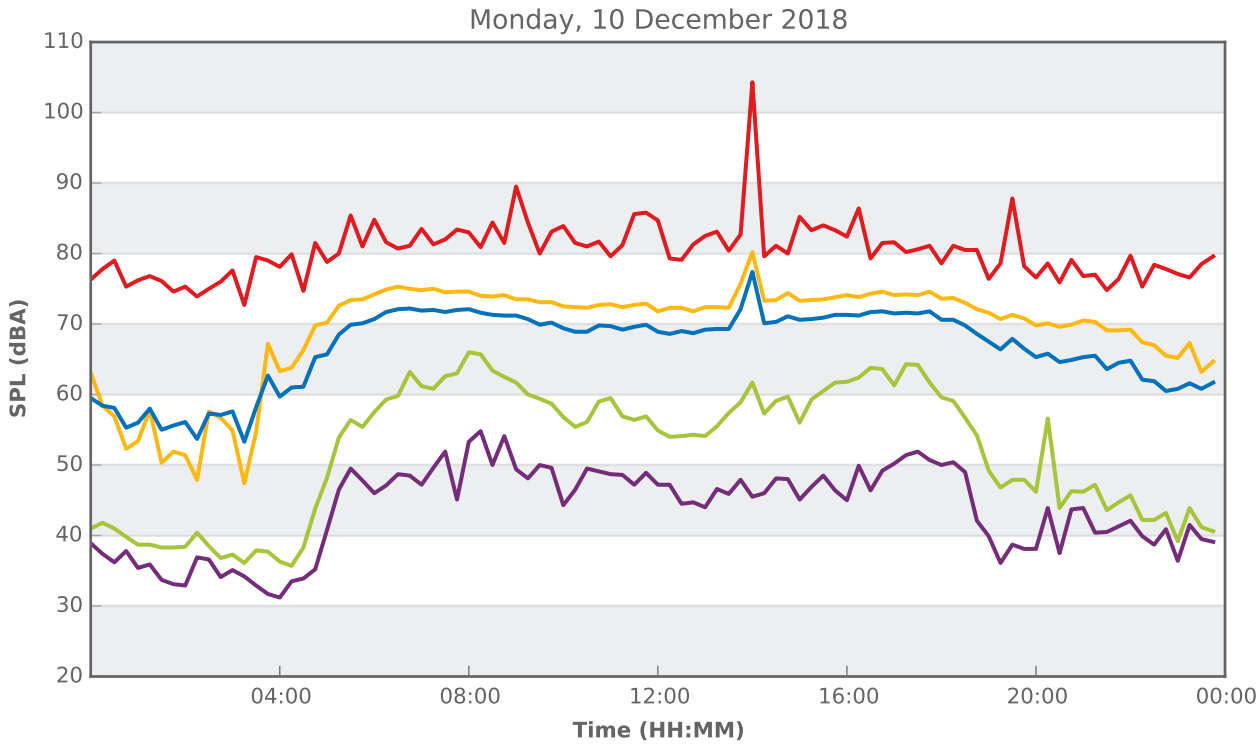

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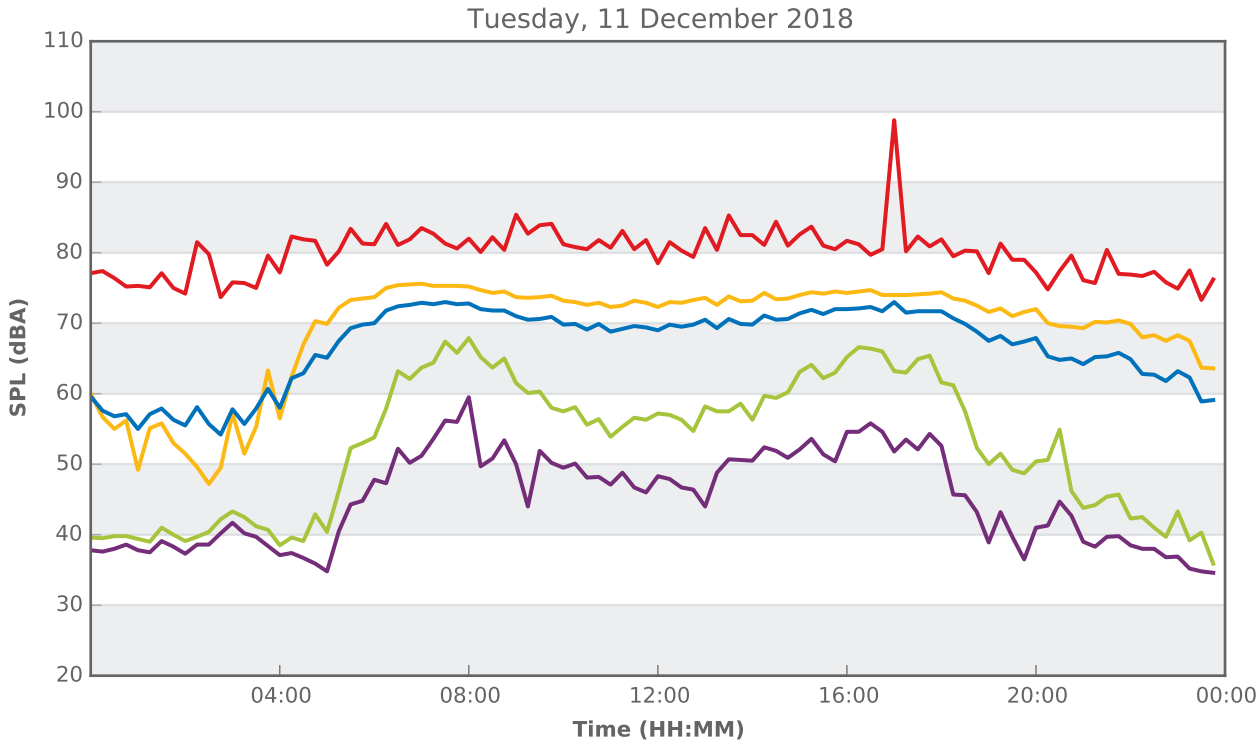

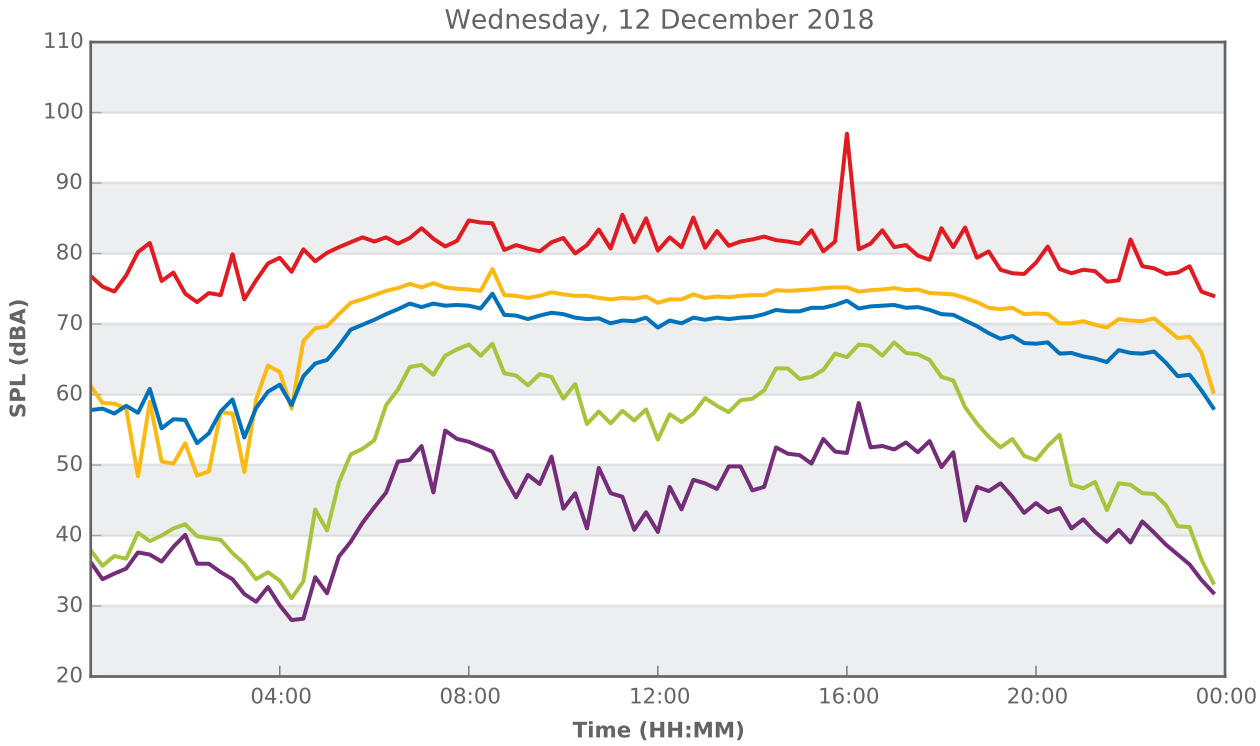

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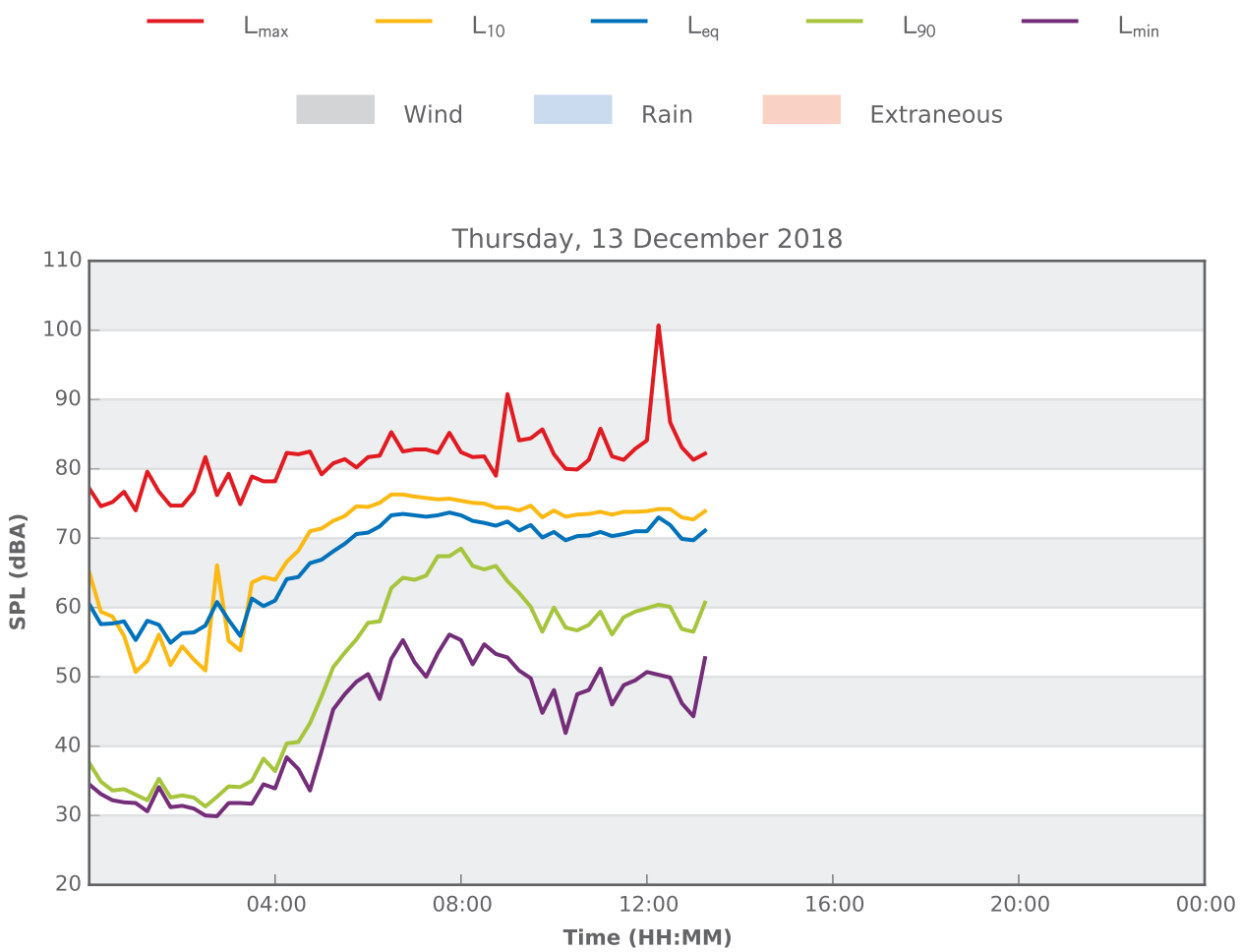
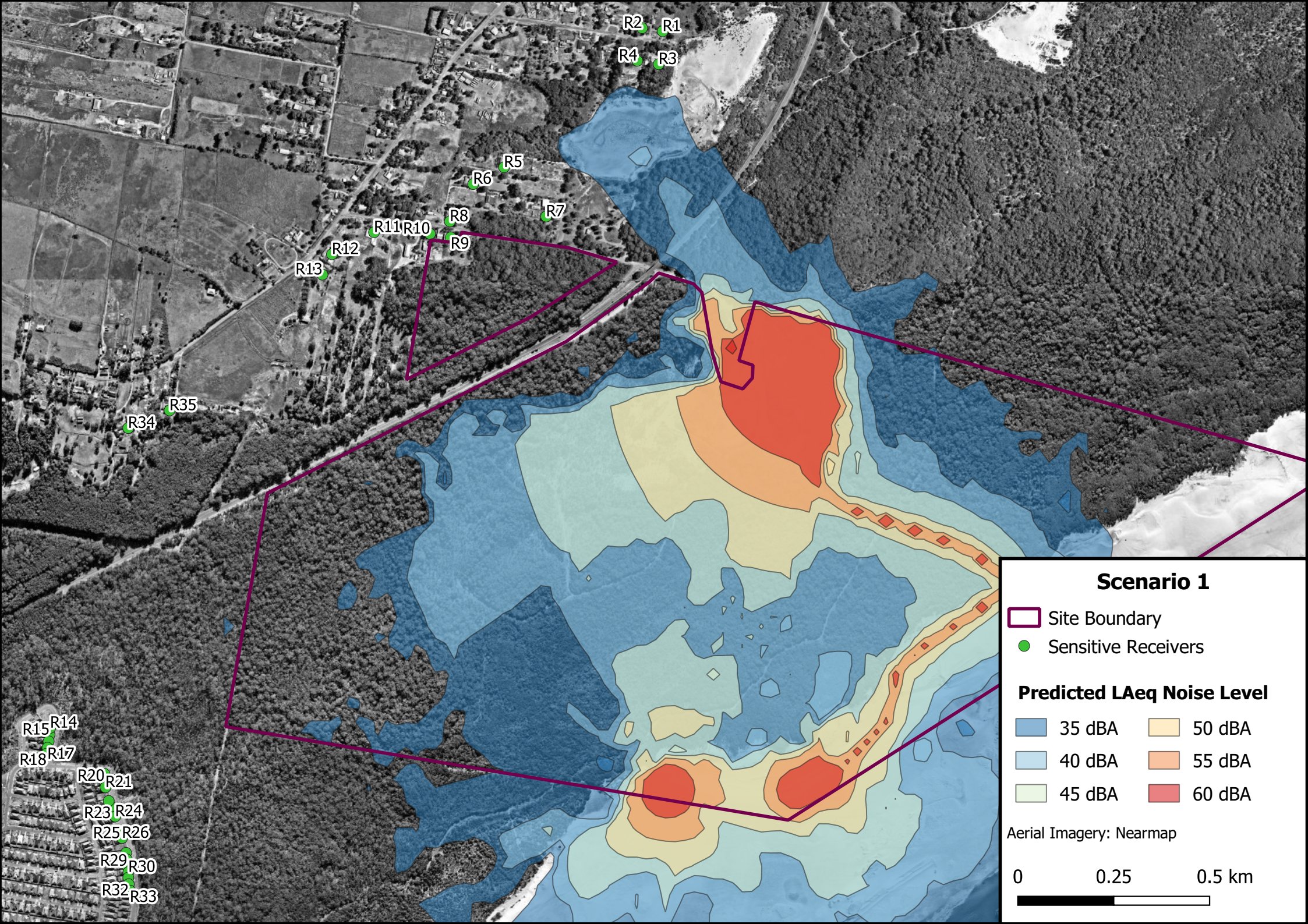


APPENDIX B

SCENARIO NOISE CONTOURS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R32
R33
R34
R35
Scenario 1
Site Boundary
Sensitive Receivers
Predicted LAeq Noise Level
35 dBA
40 dBA
45 dBA
50 dBA
55 dBA
60 dBA
Aerial Imagery: Nearmap
0
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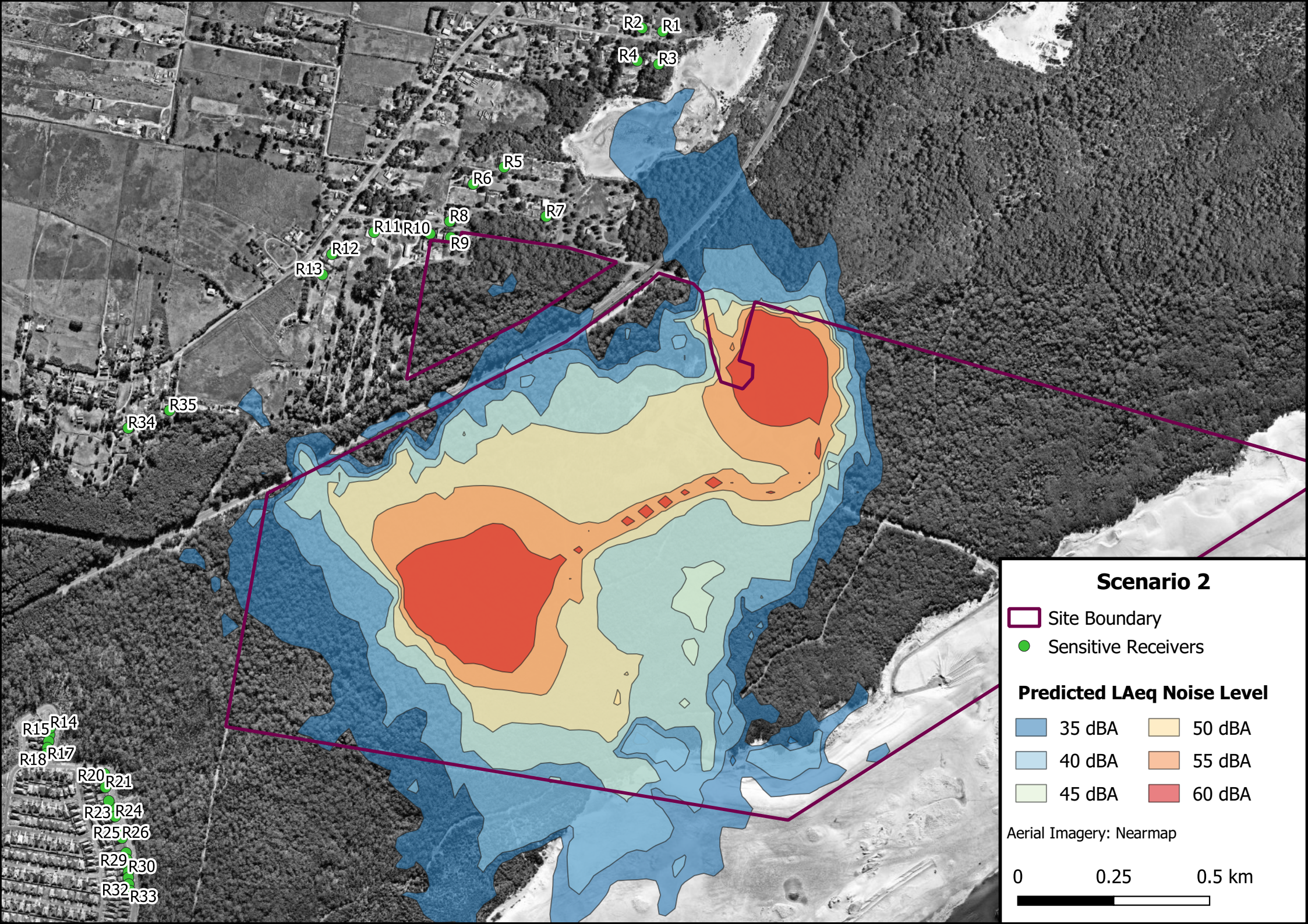
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R35
Scenario 2
Site Boundary
Sensitive Receivers
Predicted LAeq Noise Level
35 dBA
40 dBA
45 dBA
50 dBA
55 dBA
60 dBA
Aerial Imagery: Nearmap
0
0.25
0.5 km



APPENDIX H

TRAFFIC IMPACT ASSESSMENT

FINAL

TRAFFIC IMPACT ASSESSMENT

FOR

STOCKTON SAND QUARRY DREDGING

32 COXS LANE

FULLERTON COVE

VOLUME 1 REPORT

Ref. 17139R

20 August 2019

Prepared By

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EXECUTIVE SUMMARY

1. *This report documents the assessment of the traffic impacts for Stockton Sand Quarry Dredging (The Project) at 32 Coxs Lane Fullerton Cove.*

2. *Boral operates a quarry at this site that extracts and transports up to 500,000tpa of sand product under the existing windblown sand extraction area development consent (DA 140-5-2006), which will cease operation in 2028.*

3. *Due to current and future demand for sand in the local Hunter and Sydney regions, Boral is seeking approval for continued and expanded operations at the site. The Project involves the extraction of sand from the inland vegetated dunes by front-end loader/excavator to a depth of 4m AHD and subsequent dredging from 4m AHD to 15m below sea level (-15m AHD).*

4. *The Project would seek to permit a site wide increase on the despatch limit to 750000tpa (i.e. the windblown sand extraction area and the Project operations combine) up until 2028. As part of the Project, 70,000tpa of VENM will be imported to the quarry by road.*

5. *After 2028 extraction of sand on the windblown dunes would cease and transportation will reduce to a maximum of 500,000tpa.*

6. *Vehicle access to the quarry is via Coxs Lane, which has on/off ramps to/from Nelson Bay Road. Other principal intersections adjacent Stockton Quarry include the intersections of Nelson Bay Road/Cabbage Tree Road/Lavis Lane and Nelson Bay Road/Seaside Boulevard/Fullerton Cove Road, which are two lane roundabouts in Nelson Bay Road, north and south of Coxs Lane.*

7. *The quarry currently employs 5 people at the site which will increase to 9 people with the Project. Boral also employs truck drivers and associated support personnel.*

8. *The principal transport routes include:*

    - *Coxs Lane, Nelson Bay Road (south of Coxs Lane) and Tourle Street/Cormorant Road; and*

    - *Coxs Lane, Nelson Bay Road between Cabbage Tree Road and Seaside Boulevard and Cabbage Tree Road/Tomago Road.*

9. *Nelson Bay Road, north of Cabbage Tree Road and Medowie Road are minor transport routes and account for approximately 5% of product transport.*

10. *All of the above roads are approved 25-26 metres B-double routes.*

11. *The NSW Government has been, and is currently, upgrading sections of Nelson Bay Road at and north of Williamtown and has recently completed upgrades to the Tourle Street/Cormorant Road route. The section of Nelson Bay Road between Cabbage Tree Road and Fullerton Street is currently in the planning stage.*

12. *Boral's sand product trucks are 19 metre long truck and dog combinations with average loads of 34 tonne. The VENM trucks will be a mixture of 19 metre long truck and dog combinations (34 tonne load) and rigid trucks (12 tonne load).*

13. *The quarry will have the highest traffic generation on weekdays. The Project at 750,000tpa, including the importation of 70,000tpa of VENM will generate the following sand product and VENM truck volumes:*

    - *100 truck loads (200 two way truck movements) on an average day; and*
    - *142 truck loads (284 two way truck movements) on a maximum day.*

14. *When compared to the existing development consent (DA 140-5-2006) this will be an increase of:*

    - *42 truck loads (84 two way truck movements) on an average day; and*
    - *66 truck loads (132 two way truck movements) on a maximum day.*

15. *During a maximum hour the Project will generate 30 sand product and VENM truck loads (60 two way truck movements).*

16. *The total number of Boral's sand product and VENM trucks with the Project in place, using the road network on an average weekday, will make up a very small proportion of the total volumes using the road network, representing between 0.34% to 1.35% of total traffic volumes.*

17. *The assessment of the traffic impacts of the additional trucks associated with the operation of the Project on the adjacent road network including the principal intersections adjacent the quarry has found that the impacts will be satisfactory.*

18. *The assessment of the cumulative impacts for the future 2029 year with the Project also concludes that the traffic impacts on the principal intersections will be satisfactory.*

19. *Construction traffic impacts are also assessed as satisfactory, as the number of construction vehicles are relatively low in number and less than what has been assessed for the operational impacts.*

20. *The Project is not expected to have any negative impacts on other road users including pedestrians, cyclists and public transport vehicles (buses), and or on road safety.*

21. *After 2028, sand product and VENM truck numbers generated by the Quarry will reduce. When compared to the existing development consent (DA 140-5-2006), the additional truck volumes will be 14 truck loads (28 two way truck movements) on an average day and 28 truck loads (56 two way truck movements) on a maximum day. These truck movements will be spread over the road network.*

GLOSSARY

ADT	-	Average Daily Volume (7 day average)
AWT	-	Average Weekday Volume (5 day average)
AUL	-	Auxiliary left turn lane treatment
AUR	-	Auxiliary right turn lane treatment
AVD	-	Average vehicle delay per vehicle in seconds
BAL	-	Basic left turn treatment
BAR	-	Basic right turn treatment
CHR	-	Channelised right treatment/lane
DPIE	-	Department of Planning, Infrastructure and Environment
DS	-	Degree of Saturation, a measure of intersection performance based on the ratio of demand flow to capacity
Light Vehicles	-	Austroads 1 and 2 vehicle classifications and motorbikes
LS	-	Level of Service, a measure of intersection performance based on vehicle delay. There are six levels of service from A to F, where Level of Service A represents very good conditions and spare capacity and Level of Service F represents oversaturated conditions.
Heavy Vehicles	-	Austroads 3-12 vehicle classifications
RMS	-	Roads and Maritime Services, NSW (previously RTA)
SEARs	-	Secretary's Environmental Assessment Requirements
SIDRA	-	SIDRA Intersection Traffic Model
SSD	-	State Significant Development
vpd	-	Vehicles per day
vph	-	Vehicles per hour
95th% queue	-	95th percentile queue length in metres

1.0 INTRODUCTION

1.1 Overview

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Sand Quarry (hereafter referred to as the 'site' or the 'quarry'), a long standing operation that currently extracts sand from the windblown (transgressive) sand dunes of Stockton Bight and transports up to 500,000 tonnes of sand product per year for use in the building, landscaping and construction markets.

Due to current and future demand for sand in the lower and upper Hunter and Sydney regions, Boral is seeking approval for continued and expanded operations at the site through a State Significant Development (SSD) application. The proposed development (hereafter referred to as the 'Project') involves the extraction of sand from the inland vegetated dunes by front-end loader/excavator to a depth of 4 metres (m) Australian Height Datum (AHD) and subsequent dredging from 4 m AHD to 15 m below sea level (-15 m AHD). The Project would seek to permit a site wide increase on the dispatch limit to 750,000 tpa (i.e. the windblown sand extraction area and the Project operations combined) up until 2028 after which the site wide limit would reduce to no more than 500,000 tpa. The Project would be for a period of up to 25 years.

This report documents the traffic impacts of the Project.

1.2 Authority Requirements

The Project's Secretary's Environmental Assessment Requirements (SEAR's) for traffic and road transport are summarised in Table 1.1, together with where each requirement is addressed in this report or elsewhere in the EIS documentation.

TABLE 1.1

TRAFFIC AND ROAD TRANSPORT SEARS

Stakeholder	EIS Requirement Traffic and Road Transport		Comment
Department of Planning, Industry and Environment	(i)	Accurate predictions of the road traffic generated by the construction and operation of the development, including a description of the types of vehicles likely to be used for transportation of quarry products;	See Sections 2 and 3
	(ii)	A detailed assessment of potential traffic impacts on the capacity, condition, safety and efficiency of the local and State road network, paying particular attention to the intersections of Nelson Bay Road (MR108)/Coxs Lane (local road) and Nelson Bay Road/Seaside Boulevard (local road) (using SIDRA or similar traffic model) including a road safety audit.	See Section 5 for Traffic Impact Assessment See Sections 4.4 and 5.7 of this report for road safety and Volume 2 report for road safety audit.
	(iii)	A description of the measures that would be implemented to mitigate any impacts.	No mitigation measures are required for the Project.

TABLE 1.1 continued

TRAFFIC AND ROAD TRANSPORT SEARS

Stakeholder	EIS Requirement Traffic and Road Transport	Comment
Roads and Maritime Services (RMS)	1. RMS recommends that the EIS refer to the following guidelines with regard to the traffic and transport of the proposed development. - Road and Related Facilities within the Department of Planning EIS Guidelines; and - Section 2 Traffic Impact Studies of Roads and Maritime's *Guide to Traffic Generating Developments 2002.*	These guidelines have been referenced in the preparation of the Traffic Assessment Report.
	2. A traffic and transport study shall be prepared in accordance with the Roads and Maritime's *Guide to Traffic Generating Developments 2002* and is to include (but not limited to) the following.	See Section 1.3
	a) Assessment of all relevant vehicular traffic routes and intersections for access to/from the subject properties.	See Sections 4.3, 5.3 & 5.4
	b) Current traffic counts for all of the traffic routes and intersections.	See Section 4 and Figures 8, 9 & 10.
	c) The anticipated additional vehicular traffic generated from both the construction and operational stages of the Project.	See Sections 3.9, 5.2, 5.3 & 5.5
	d) The distribution on the road network of the trips generated by the proposed development. It is requested that the predicted traffic flows are shown diagrammatically to a level of detail sufficient for easy interpretation.	See Figure 11 and Sections 5.2 & 5.3
	e) Consideration of the traffic impacts on existing and proposed intersections, in particular the intersections of Nelson Bay Road (MR108)/Coxs Lane (local road) and Nelson Bay Road/Seaside Boulevard (local road) and the capacity of the local and classified road network to safely and efficiently cater for the additional vehicular traffic generated by the proposed development during both the construction and operational stages. The traffic impact shall also include the cumulative traffic impact of other	See Section 5

Stakeholder	EIS Requirement Traffic and Road Transport	Comment
	proposed or approved developments in the area.	
	f) Identify the necessary road network infrastructure upgrades that are required to maintain existing levels of service on both the local and classified road network for the development. In this regard, preliminary concept drawings shall be submitted with the EIS for any identified road infrastructure upgrades. However, it should be noted that any identified road infrastructure upgrades will need to be to the satisfaction of Roads and Maritime and Council.	No road network infrastructure upgrades are required by the Project.
	g) Traffic analysis of any major/relevant intersections impacted, using SIDRA or similar traffic model including;	
	- Current traffic counts and 10 year traffic growth projections; - With and without development scenarios; - 95th percentile back of queue lengths; - Delays and level of service on all legs for the relevant intersections; - Electronic data for Roads and Maritime review (i.e. SIDRA 8 model).	See Section 4.3 & Section 5.3 SIDRA electronic files will be supplied to RMS
	h) Any other impacts on the regional and state road network including consideration of pedestrian, cyclist and public transport facilities and provision for service vehicles.	See Sections 4.4, 4.5, 4.6, 5.6, 5.7 & 5.8
	3. RMS recommends that the following matters should be considered by the DPIE in determining this development;	Noted
	a) Roads and Maritime have no proposal that requires any part of the property.	Noted
	b) The property has a common boundary with Nelson Bay Road (MR108) which is classified as a State Road corridor. The property has alternative access via a local road network known as Coxs Lane. Accordingly, direct access to Nelson Bay Road is restricted and access to the property is permitted via Coxs Lane only.	Noted

Stakeholder	EIS Requirement Traffic and Road Transport	Comment
Port Stephens Council	(i) The proponent must prepare a traffic impact assessment, identifying the impacts of any increase in truck movements on the road network as a result of the proposed development and associated mitigation measures.	This report documents the traffic impact assessment of the Project.
	(ii) Any production cap needs to be based on maximum annual tonnage extracted, not on a number of truck movements, which was previously the case;	Noted
	(iii) For the life of the Project, the proponent shall pay Council $0.04 per tonne of extractive material transported from the site on a quarterly basis, in accordance with the Port Stephens Council Development Contributions Plan for the maintenance of Coxs Lane, Fullerton Cove. Each payment shall be; a) Based on weighbridge records of the quantity of extractive material transported from the site quarterly. These records are to be provided to Council within 14 days of the end of the relevant quarter; b) Paid within 21 days of receipt of the invoice receive from Council; and c) Adjusted in line with the Consumer Price index calculated from the date of approval and applied annually from the first day of operation.	These matters are addressed in the Environmental Impact Statement.

1.3 Structure of this Report

Structure of Report

This report has been prepared to assess the traffic impacts associated with the project and will inform the preparation of the Environmental Impact Statement (EIS).

The assessment has been undertaken in accordance with the requirements of Roads and Traffic Authority now Roads & Maritime Services (RMS) *Guide to Traffic Generating Developments October 2002*.

Other technical standards/publications referenced in this assessment include:

- Austroads Guide to Road Design and RMS supplements.
- Austroads Guide to Traffic Management and RMS supplements.
- Austroads Guide to Traffic Management Part 12. Traffic Impacts of Developments.

The remaining sections of this report address the following;

- Section 2 – provides an overview of the existing operations at the sand quarry;
- Section 3 – describes the Project;
- Section 4 – examines the existing traffic conditions on the road network;
- Section 5 – evaluates the traffic impacts of the proposed continued operations of the sand quarry including any cumulative impacts; and
- Section 6 – presents conclusions.

2.0 EXISTING OPERATIONS

2.1 Site

The site (**Figure 1**) is located in Fullerton Cove, approximately 9.8 kilometres (km) north north-east of the Newcastle Central Business District (CBD), within the Port Stephens Local Government Area.

Access to the site is via Nelson Bay Road and Coxs Lane.

Coxs Lane is a local roadway which terminates at the entrance to the quarry at its eastern end. Nelson Bay Road is a major arterial roadway which links the Newcastle CBD to Newcastle Airport, Nelson Bay and the wider Port Stephens area to the north. The site is owned and operated by Boral and covers an approximate area of 246 ha (**Figure 2**). Boral's land holding is identified as:

- Lot 1 DP 1006399 comprising 234 ha and located predominantly on the eastern side of Nelson Bay Road, with a small portion also situated on the western side of Nelson Bay Road;
- Lot 2 DP 1006399 comprising 10.4 ha and located predominantly on the western side of Nelson Bay Road, with a small portion also positioned on the eastern side of Nelson Bay Road (formerly Part Lot 167, Part Portion 167); and
- Lot 3 DP 664552 comprising 1.619 ha and located wholly on the eastern side of Nelson Bay Road, and within which the existing depot and weighbridge are located (formerly within Part Lot 3, Part Portion 3).

Access to the site is via Crown land title (Lot 7300 DP1130730) under licence agreement with the NSW Department of Planning, Industry and Environment (DPIE) – Crown Lands

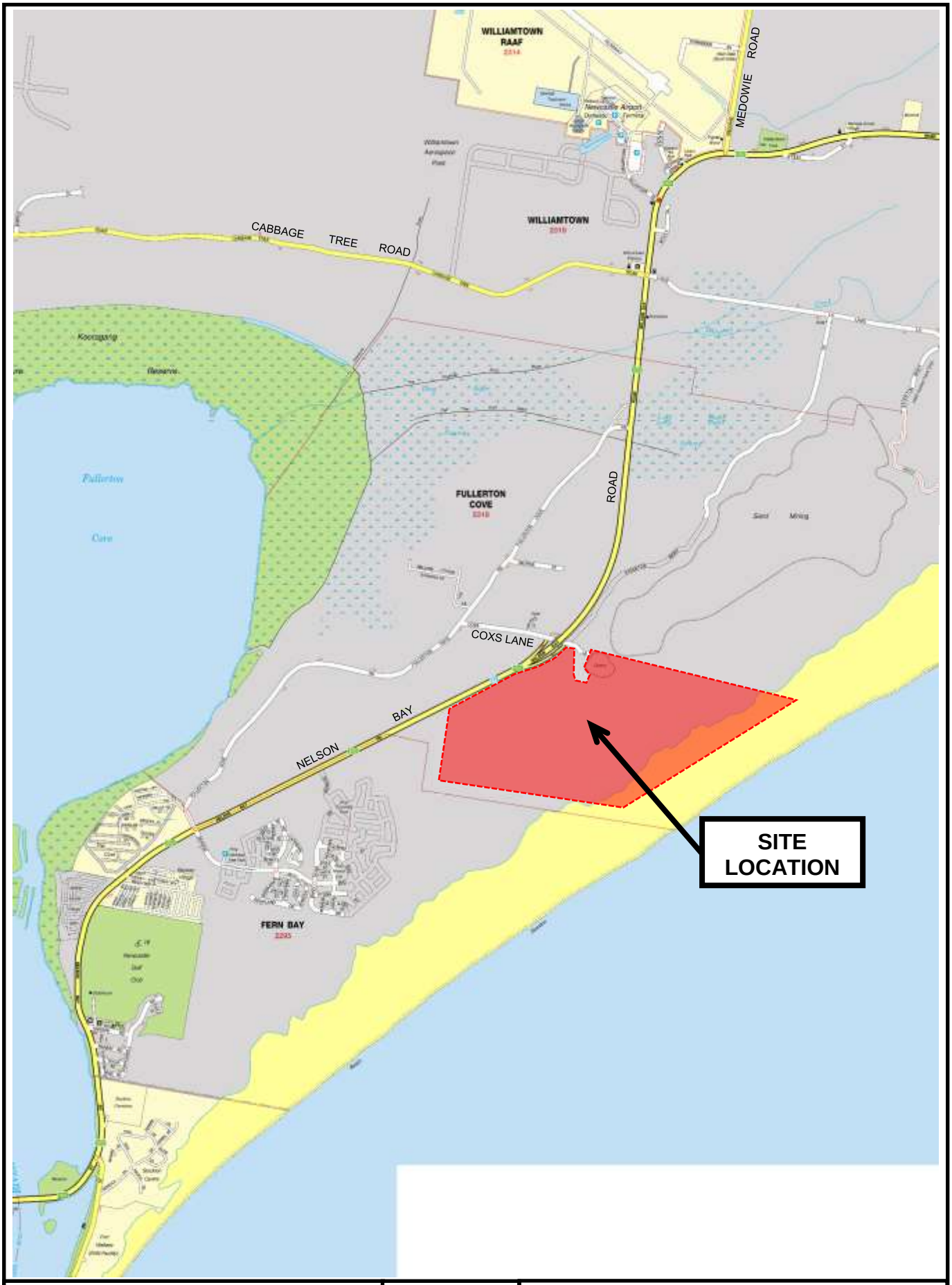
Land use surrounding the site is a mixture of rural, residential, public recreation, and environmental conservation areas.

2.2 Existing Operations

Existing and approved operations at the site include:

- extraction of up to 500,000 tonnes of sand annually through regular harvesting of transgressive sand and dry excavation of the dune mass. This is referred to as the 'windblown sand extraction area';
- processing at the pit face by mobile power screen;
- maintenance of the haul road transport sand from extraction area;
- haulage of product from existing depot/weighbridge to Nelson Bay Road and the wider road network; and
- progressive rehabilitation of extracted areas.

The existing operations were approved under DA140-05-2006. Operations commenced in 2008 and in accordance with the conditions of consent will cease operations in 2028.



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NOT TO SCALE

FIGURE 1

STOCKTON SAND QUARRY

LOCATION

JOB NO. 17139

16/07/19

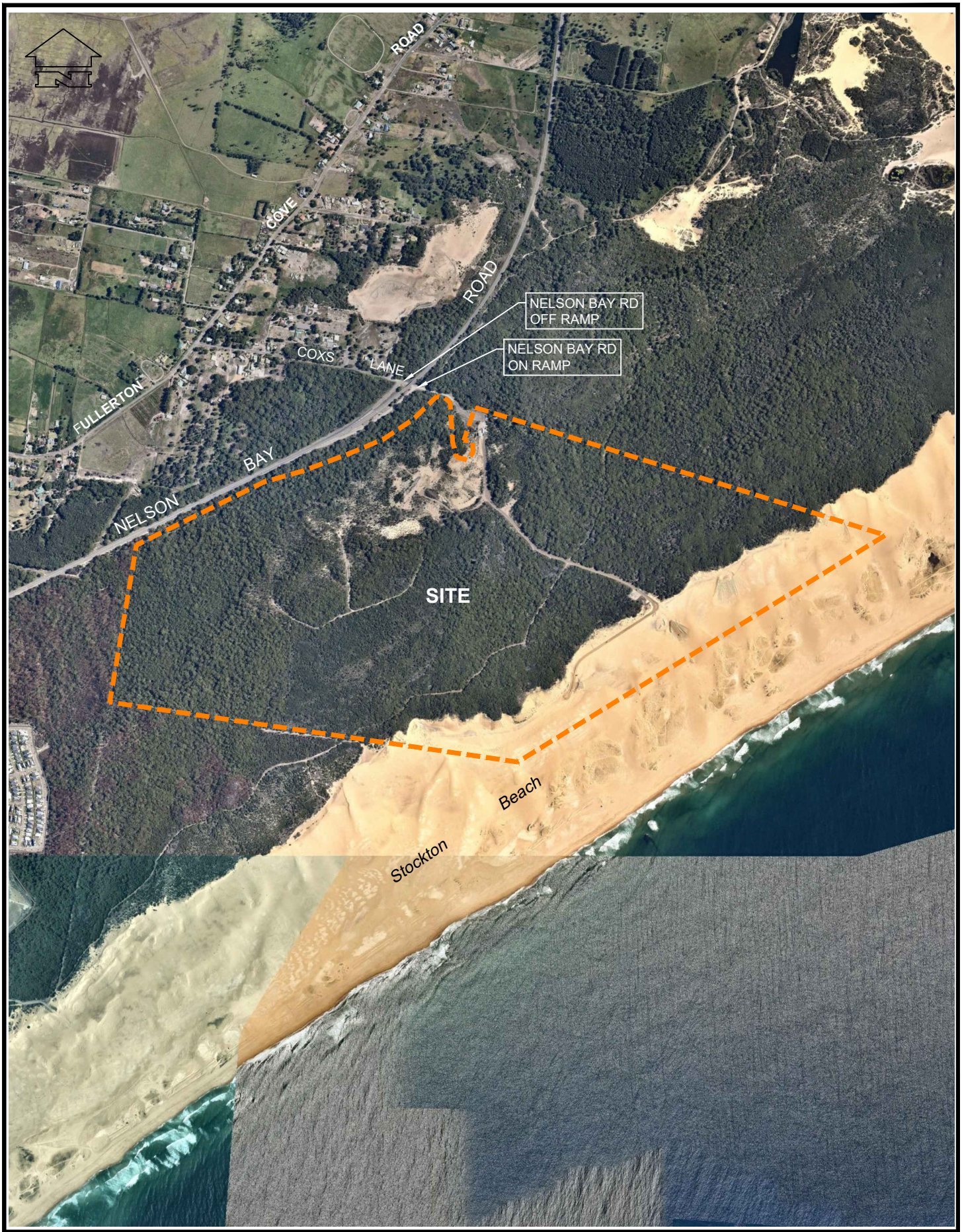

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FIGURE 2

STOCKTON SAND QUARRY

SITE

JOB NO.17139

16/07/19

2.3 Infrastructure and Equipment

The existing and approved operation includes a fenced depot at the site containing:

- an amenities/office building providing an office, lunchroom, toilet and shower;
- weighbridge;
- designated parking area for employees and visitors; and
- maintenance shed for the front-end loader and 4,200 L above ground bunded fuel tank.

Power and telecommunications are connected to the depot, whilst water is collected in rainwater tanks and wastewater is collected via a septic system.

Mobile equipment currently in operation at the site comprises:

- 2 x front end loader (capacity nine tonnes);
- a dozer (part time);
- a water truck (13,000 L capacity); and
- a mobile screen (20 mm mesh screen and a 5 cubic metre (m3) capacity receiving bin).

All product trucks are parked off site overnight at Boral's Seaham depot and arrive and depart Stockton Quarry at the start and end of the working day.

2.4 Employment

The quarry employs four full time staff along with one casual staff member. The quarry also provides employment opportunities for numerous Boral and customer truck drivers and associated service personnel.

2.5 Hours of Operation

The approved hours of operation are:

- Monday to Friday – 6:15am to 5:00pm;
- Saturday – 6:15am to 12 noon; and
- no operation on Sundays or Public Holidays.

The site is also approved to operate extended hours during major supply contracts as follows:

- Monday to Friday – 6:15am to 6:00pm;
- Saturday – 6:15am to 3:00pm; and
- no operation on Sundays or Public Holidays.

2.6 Transport Routes

There are two major transport routes and two minor routes.

Coxs Lane, Nelson Bay Road, (south of Coxs Lane) and Tourle Street/Cormorant Road forms the principal transport route to the Newcastle supply areas. Boral's records show that this route accounts for 45% of sand product.

Coxs Lane, Nelson Bay Road between Cabbage Tree Road and Seaside Boulevard and Cabbage Tree Road/Tomago Road forms the principal transport route to the Central Coast, Sydney and Hunter Valley supply contracts. This route accounts for 50% of sand product.

Nelson Bay Road, north of Cabbage Tree Road and Medowie Road form the separate transport routes for the supply areas of Port Stephens and the North Coast. However, these are minor transport routes and carry approximately 5% of sand product from the quarry, with Nelson Bay Road to Port Stephens accounting for 2% of sand product and Medowie Road route 3% of sand product.

All product trucks accessing the quarry are required to arrive from and depart to the south along Nelson Bay Road. As such, Coxs Lane and the section of Nelson Bay Road between Cabbage Tree Road and Seaside Boulevard forms the main section of all the transport routes and this section carries the highest number of product trucks generated by Stockton Quarry.

Figure 3 shows the transport routes.

2.7 Truck Size and Approved Transport Levels

Boral's product trucks are typically 19.0 metre long truck and dog combinations which have average loads of 34 tonnes.

Trucks used by local customers and for ex bin sales range in size between rigid trucks (small and heavy rigid trucks) and 19.0 metre articulated vehicles.

The current development consent (DA 140-5-2006) permits the transport of up to 500,000tpa. The underlying assumption used in the EIS for this development consent was based on a maximum of 152 heavy vehicle movements per day which is 76 loads per day. (i.e. 76 in/76 out per day).

2.8 Traffic Generation

The traffic generation of the existing operation includes:

- light vehicle trips associated with employees and any visitors estimated as up to 24 two way trips per day based on 12 in/12 out per day (NB this allows for some off site trips to get lunch etc).

- sand product transport which is estimated to be a maximum of 152 two way heavy vehicle movements based on 76 truck loads per day. (NB. There is no limit on truck volumes generated by the quarry on a day or per hour).

Sand product transport varies from day to day based on sales. For the month of November 2018, which was a busy month, product truck loads on a weekday ranged between 31-71 truck loads (i.e. 62-142 two way heavy vehicle movements) Saturday had lower sales with between 2-5 truck loads (i.e. 4-10 two way heavy vehicle trips) for the month.

For the week of traffic counts between 4-10 December 2018 average number of sand product truck loads on a weekday was 58 loads (i.e. 116 two way heavy vehicle trips). There were no sales/product transport on the Saturday in this week.

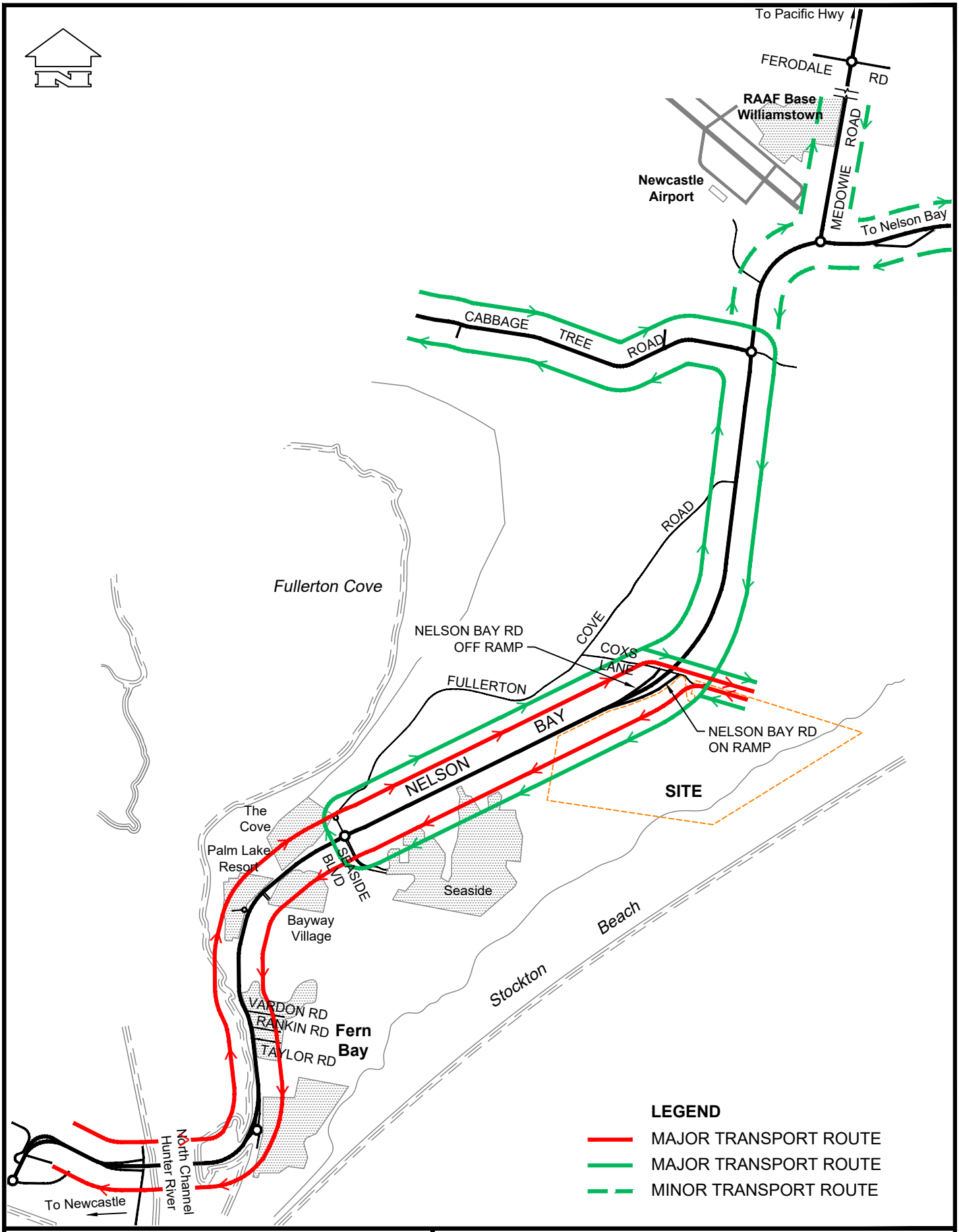

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FIGURE 3

STOCKTON SAND QUARRY

TRANSPORT ROUTES

JOB NO.17139

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Other vehicles that come to the Quarry include:

- Water tankers which range between 4 in/4 out movements per day in winter and up to 8 in/8 out in the summer months (i.e. total range of 8-16 trips per day).

- Fuel trucks which average 1 in/1 out per week (i.e. total of 2 trips per week).

- Waste pick up trucks which average 2 in/2 out per month (i.e. Total of 4 two way trips per month).

- Servicing and maintenance vehicles which are light vehicles and average 1 in/1 out per month (i.e. Total 2 two way trips per month).

- Septic system pump out trucks which average 1 in/1 out every 7 weeks (i.e. 2 two way trips every 7 weeks).

3.0 THE PROJECT

3.1 Project Description

The site contains an existing operation located approximately 375 m south east of the Project site, referred to as the 'windblown sand extraction area'. The windblown sand extraction area is approved to operate until 2028 and dispatch up to 500,000 tpa from the site (refer to condition 6 of DA 140-6-2005).

The Project involves the extraction of sand from the inland dunes from the existing ground level of 5 m AHD to a depth of 15 m below sea level (-15 m AHD). As extraction will intercept the groundwater table (at approximately 1 m AHD) the primary method of sand extraction will involve dredging.

There is an estimated 9 million tonnes of sand resource within the Project extraction area. The Project would seek to permit a site wide increase on the dispatch limit to 750,000 tpa (i.e. the windblown sand extraction area and the Project operations combined) up until 2028 after which the site wide limit would reduce to no more than 500,000 tpa. The increase in the site wide dispatch limit is sought to permit maximum flexibility across the two projects areas (located on the same site).

Mobile plant and equipment utilised at the site would operate across both project areas and a docket system at the weighbridge would monitor outgoing product as a site total.

To account for market fluctuations in demand, Boral are seeking a development consent period of 25 years for the SSD approval.

The sand extraction will be undertaken in 6 stages across the site.

3.2 Site Establishment

Where new or augmented infrastructure is required this will be delivered as part of Stage 1 of the Project and will include:

- Construction of new haul roads combined with a separated entry and exit points;
- a pad for the wash plant and diesel generators will be constructed as soon as practicable after vegetation removal and sand extraction in the northern portion of Stage 1; and
- The docketing kiosk registering vehicles entering the site will also be relocated.

The existing site depot will also be reconfigured to support the Project and include the following:

- installation of a new prefabricated office building;
- relocation of light vehicle parking;
- relocation of entry gates (inside Boral's boundary); and
- relocation of onsite of storage facilities.

Figure 4 shows the Project.

Source: Element Environmental 031142 Stockton EIS F4-1 The Project_191003_v04

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FIGURE 4

STOCKTON SAND QUARRY

PROJECT

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3.3 Internal Access Roads

During site establishment works in Stage 1, a new site entry exit and haulage route will be constructed that will extend around the north, east and southern perimeter of Stage 1 and link to the existing haul road to the windblown sand extraction area. The new road will create a one way entry and exit from the site, the balance of the road will support two way vehicle movements.

The construction of the perimeter haul road around the southern edge of the formed Stage 2 to 5 dredge pond would be progressive in line with the progress of sand extraction. A turning head will be constructed at progressive stages at the end of the perimeter haul road to allow vehicles to turn and travel in a forward direction back along the perimeter haul road and out of the site via the newly constructed exit road, which will proceed out of the site via the existing depot and weighbridge.

The perimeter haul road will be up to 10 m wide and when complete (at the end of Stage 5) the road will support movement of vehicles around the southern perimeter of the dredge pond and be used to support access for rehabilitation works and future site management.

3.4 Plant and Equipment

The plant and equipment currently operated at the site would be retained and used during the Project.

In addition, the following plant and equipment would be utilised for the Project:

- suction dredge;
- an additional front-end loader;
- wash plant; and
- diesel generators.

3.5 Employment

The Project would provide employment opportunity for an additional two full time personnel and two casual employees, bringing the total employment for the quarry to six full time and three casual employees. The quarry would continue to also provide flow on employment opportunities for numerous Boral and customer truck drivers and associated service personnel.

3.6 Hours of Operation

The Project will continue to operate with the existing approved hours of operation;

- Monday to Friday – 6:15am to 5:00pm;
- Saturday – 6:15am to 12 noon; and
- no operation on Sundays or Public Holidays.

The site is also approved to operate extended hours during major supply contracts as follows:

- Monday to Friday – 6:15am to 6:00pm;
- Saturday – 6:15am to 3:00pm; and
- no operation on Sundays or Public Holidays.

3.7 Transport

The Project seeks to transport up to 750,000tpa of sand products from the Quarry, subject to market demand up until 2028. This will be an increase of 250,000tpa over the current approval.

After 2028 the product transport will reduce to a maximum of 500,000tpa.

Also, as part of the Project, it is proposed to import up to 70,000tpa of virgin excavated natural material (VENM) material by road for use in stabilisation works as required.

3.8 Transport Routes

The transport routes for the Project will be the same as the existing transport routes (**Figure 3** refers).

Boral expects the split between the routes to be similar to the existing split with;

- 45% travelling south via Nelson Bay Road to the Newcastle market;
- 50% travelling north and west via Nelson Bay Road, Cabbage Tree Road and Tomago Road to the Central Coast, Hunter and Sydney Markets; and
- 5% travelling north via Nelson Bay Road and via Medowie Road for the Port Stephens and North Coast Markets.

Trucks importing the VENM are expected to use the same transport routes as used by the sand product trucks with a similar split.

3.9 Truck Size and Product and VENM Transport

Boral will continue to use 19.0 metre truck and dog combination trucks with average loads of 34 tonnes.

Trucks importing the VENM material will be truck and dog combinations with average loads of 34 tonnes (75% of VENM) and heavy rigid trucks with average load of 12 tonnes (25% of VENM). On an average day these will total 14 truck loads per day (i.e. 14 in/14 out) with an average of 2 truck loads per hour (i.e. 4 two way heavy vehicle trips per hour). On a busy/maximum day VENM importation is estimated at 28 truck loads per day (28 in/28 out) with 56 two way heavy trips per day. During a busy hour VENM importation is estimated as 4 truck loads per hour (8 two way heavy vehicle trips per hour).

The traffic generation of the product trucks is estimated to be a maximum of 228 two way heavy vehicle movements per day which is 114 truck loads per day (i.e. 114 in/114 out per day). The maximum hourly traffic generation for product transport is estimated as 52 two way heavy vehicle trips (i.e. 26 truck loads per hour or 26 in/26 out per hour.

The total traffic generation of product trucks and VENM importation on a maximum day and during a maximum hour until 2028 is estimated to be

- 284 two way heavy vehicle movements per day, which is 142 truck loads per day (i.e. 142 in/142 out); and
- 60 two way heavy vehicle movements per hour, which is 30 truck loads per hour (i.e. 30 in/30 out).

3.10 Traffic Generation

The traffic generation of the Project includes:

- Light vehicle trips associated with employees/visitors and miscellaneous trips (i.e. trips for lunch etc) which is estimated as up to 34 two way trips per day (i.e. 17 in/17 out). This is an increase of 10 two way vehicle trips per day;

- Product transport trucks which is a maximum of 114 truck loads per day (228 two way heavy vehicle movements per day). This is an increase of 38 truck loads per day, up until 2028. After 2028, product transport reduces to 500,000tpa which is a maximum of 76 loads per day (152 two way heavy vehicle movements per day) and is the same traffic generation as the existing consent;

- Importation of VENM material which is estimated as 14 truck loads per day (28 two way heavy vehicle movements per day). On a busy/maximum day VENM importation is estimated at 28 truck loads per day (28 in/28 out) with 56 two way heavy trips per day;

- Other light vehicle and heavy vehicle trips associated with deliveries and maintenance which are:

  - Water tankers – between 4-8 in/4-8 out per day (8-16 two way trips per day);

  - Fuel truck – 1-2 in/1-2 out per week (2-4 two way trips per week);

  - Waste pick up truck – 2 in/2 out per month (4 two way trips per month);

  - Servicing and maintenance (light vehicles) – 1-2 in/1-2 out per month (2-4 two way trips per month); and

  - Septic pump out truck – 1 in/1 out every 7 weeks (2 two way trips every 7 weeks).

4.0 EXISTING TRAFFIC CONDITIONS

4.1 Principal Road Network

The principal road network that serves Stockton Sand Quarry includes;

- Coxs Lane (East section);
- Nelson Bay Road;
- Teale Street/Cormorant Road;
- Cabbage Tree Road/Tomago Road; and
- Medowie Road.

Coxs Lane, Nelson Bay Road, (south of Coxs Lane) and Tourle Street/Cormorant Road forms the principal transport route to the Newcastle supply areas.

Coxs Lane, Nelson Bay Road between Cabbage Tree Road and Seaside Boulevard and Cabbage Tree Road/Tomago Road forms the principal transport route to the Central Coast, Sydney and Hunter Valley supply contracts.

Nelson Bay Road north of Cabbage Tree Road and Medowie Road form the separate transport routes for the supply areas of Port Stephens and the North Coast. However, these are minor transport routes and carry approximately 5% of sand product from the quarry.

4.2 Description of Roads

4.2.1 Coxs Lane

Coxs Lane is an east west local road with northbound off and southbound on ramps that connect to Nelson Bay Road. Coxs Lane is grade separated from Nelson Bay Road by a bridge that takes Nelson Bay Road over Coxs Lane.

East of Nelson Bay Road, Coxs Lane serves the Stockton Sand Quarry. West of Nelson Bay Road, Coxs Lane intersects with Fullerton Cove Road and serves a number of rural and semi rural/residential properties.

The northbound off ramp from Nelson Bay Road to Coxs Lane is approximately 360 metres long including taper with a variable sealed road with between 3.5 metres and 7.5 metres.

The southbound on ramp from Coxs Lane to Nelson Bay Road is 460 metres long. The ramp continues in its own lane providing for two southbound lanes in Nelson Bay Road for approximately 1,100 metres before it merges into one (1) lane. The southbound on ramp has a variable width up to 7.5 metres wide.

East of Nelson Bay Road, Coxs Lane has a sealed road pavement 8.0-9.0 metres wide and caters for two way traffic. The sand quarry entrance is approximately 150 metres east of southbound on ramp intersection with Coxs Lane.

4.2.2 Nelson Bay Road

Nelson Bay Road is a state arterial road that links between Tourle Street/Cormorant Road at Koorang Island in the south and Nelson Bay in the north.

Nelson Bay Road is an approved 25 metre/26 metre B-double route.

In the section between Cabbage Tree Road and Seaside Boulevard it is mostly a two lane road with a section of four lanes, just south of Coxs Lane. Approximately 1.65km south of Seaside Boulevard Nelson Bay Road becomes a four lane divided road and connects to Cormorant Road/Teale Street.

The section of Nelson Bay Road between Cabbage Tree Road and Medowie Road at Williamtown is also a four lane divided road. North of Medowie Road, Nelson Bay Road is predominantly a two lane undivided road.

As a state road, Nelson Bay Road has a high level of traffic management with centre line marking, edgelines, guideposts and sealed shoulders in the two lane sections and auxiliary lanes for turning vehicles at minor intersections. Major intersections typically have roundabout treatments and or traffic signals. The four lane sections also have a high level of traffic management.

Speed limits vary as follows;

- At and north of Cabbage Tree Road, near Williamtown – 80km/h;
- Between south of Cabbage Tree Road and just north of Seaside Boulevard including at the Coxs Lane Ramps – 100km/h;
- Between north of Seaside Boulevard and Fullerton Street – 70km/h;
- Between south of Fullerton Street and Teale Street/Cormorant Road – 80km/h

Traffic management at principal intersections include;

- A two lane roundabout at Nelson Bay Road/Medowie Road;
- Traffic signals at Nelson Bay Road/Williamtown Drive;
- A two lane roundabout at Nelson Bay Road/Cabbage Tree Road/Lavis Lane;
- South facing ramps in Nelson Bay Road at Coxs Lane, providing a northbound off ramp and a southbound on ramp at Cox Lane;
- A two lane roundabout at Nelson Bay Road/Seaside Boulevard/Fullerton Cove Road.

South of Seaside Boulevard the traffic management at intersections include;

- Channelised CHR and AUL right and left turn treatments in Nelson Bay Road at;
  - Palm Lake Resort Access Road (NB left turn out only from Palm Lake Resort); and
  - Bayway Village Access Road;
- Right turn bay in Nelson Bay Road at Vardon Road and at Taylor Street;
- Left in/left out at Rankin Street; and
- Two lane roundabout with northbound slip lanes in Nelson Bay Road at Fullerton Street.

Figure 5 shows the traffic management and traffic controls on this section of Nelson Bay Road and on Coxs Lane.

NSW Government is currently upgrading strategic sections of Nelson Bay Road and further details are provided in Section 4.7.

4.2.3 Teale Street/Cormorant Road

Teale Street/Cormorant Road/Tourle Street are state arterial roads that form part of the route to Nelson Bay between Stockton Bridge and Industrial Drive at Mayfield. This route is an approved 25 metre/26 metre B-double route.

Tourle Street/Cormorant Road/Teale Street travel through the industrial area of Koorang Island and link to Nelson Bay Road at Stockton Bridge. The roads are generally four lane divided roads with auxiliary lanes at minor intersections and a high level of traffic management. The roads generally have 80km/h speed limit.

Traffic management at major intersections includes;

- Two lane roundabout at the Cormorant Road/Teale Street intersection; and
- Traffic signals at the Tourle Street/Industrial Drive intersection.

An at grade rail level crossing is located in Cormorant Road, west of Tourle Street.

Tourle Street/Cormorant Road, including Stockton Bridge has recently been upgraded by the NSW Government to improve traffic flow and cater for future traffic growth.

NSW Government is currently upgrading the Tourle Street/Industrial Drive intersection to increase the capacity at the intersection.

4.2.4 Cabbage Tree Road/Tomago Road

Cabbage Tree Road/Tomago Road is a state arterial road that links between Nelson Bay Road near Williamtown and Pacific Highway at Tomago. Cabbage Tree Road/Tomago Road is an approved 25 metre/26 metre B-double route.

The road is generally a two lane road with a high level of traffic management including centreline and edgeline road marking, sealed shoulders, guide posts and channelised treatments and auxiliary lanes at principal intersections.

The eastern section of the route generally has rural and semi rural residential land uses fronting the road.

The western section between Masonite Road and Pacific Highway generally has industrial uses adjacent the road.

Traffic management at principal intersections include;

- Two lane roundabout at Nelson Bay Road/Cabbage Tree Road/Lavis Lane;
- CHR and AUL right and left turn treatments at Cabbage Tree Road/Tomago Road/Masonite Road;
- Traffic signals at the intersection of Tomago Road/Westrac Access Road;

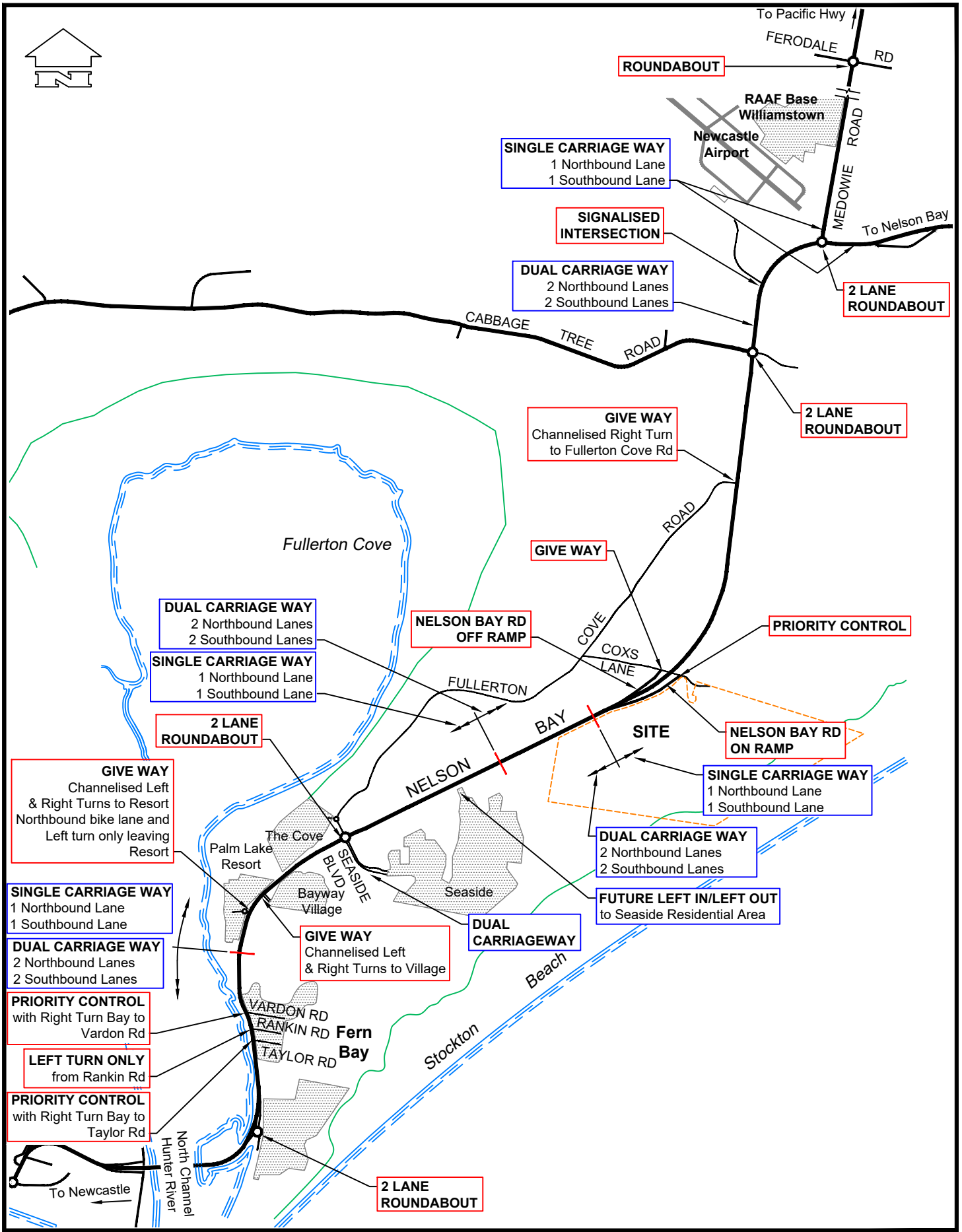

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FIGURE 5

STOCKTON SAND QUARRY

ROAD NETWORK AND TRAFFIC CONTROLS

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- CHR and AUL right and left turn treatments in Tomago Road at the;
  - Access Road to 606-608 Tomago Road; and
  - Tomago Aluminium Entrance Road.
- Two lane roundabout at Tomago Road/Old Punt Road; and
- Traffic signals at Tomago Road/Pacific Highway.

The speed limit in Cabbage Tree Road/Tomago Road is 80km/h, with a section of 60km/h between Old Punt Road and Pacific Highway.

4.2.5 Medowie Road

Medowie Road is a regional road and links between Nelson Bay Road near Williamtown and the Pacific Highway near Euwylong. Medowie Road passes Newcastle Airport/Williamtown RAAF air base and the township of Medowie.

It is predominantly a two lane road with a high level of traffic management including centerline, edgeline road markings, guide posts, sealed road shoulders. Principal intersections have channelised CHR and AUL right and left turn treatments, roundabouts and or traffic signals.

The speed limit along Medowie Road varies with 80km/h between Williamtown and the Medowie township, 50km/h in the township and 80 and 100km/h north of the Medowie township.

Medowie Road is an approved 25 metre/26 metre B-double route.

4.3 Existing Traffic Conditions on Road Network

4.3.1 Existing Traffic Volumes

Daily volumes including vehicle classification counts were undertaken on the road network adjacent Stockton Quarry between 4-10 December 2018.

The volume and vehicle classification count locations included Nelson Bay Road at several locations, Coxs Lane including the on and off ramps to/from Nelson Bay Road and Cabbage Tree Road.

Figure 6 shows the count locations and **Figure 7** shows a summary of daily volume and vehicle classification counts.

In addition, weekday AM and PM peak period intersection counts were undertaken on the 4th and 5th of December 2018 at the principal intersection adjacent to the Stockton Sand Quarry. **Figure 6** shows the count locations.

Weekdays have the highest traffic generation of Stockton Sand Quarry and AM and PM peak hours represent those periods with the highest traffic volumes using the road network.

4.3.2 Daily Volumes on Road Network

Table 4.1 and **Figure 7** shows the daily traffic volumes and the proportion of heavy vehicles using the road network in the area.

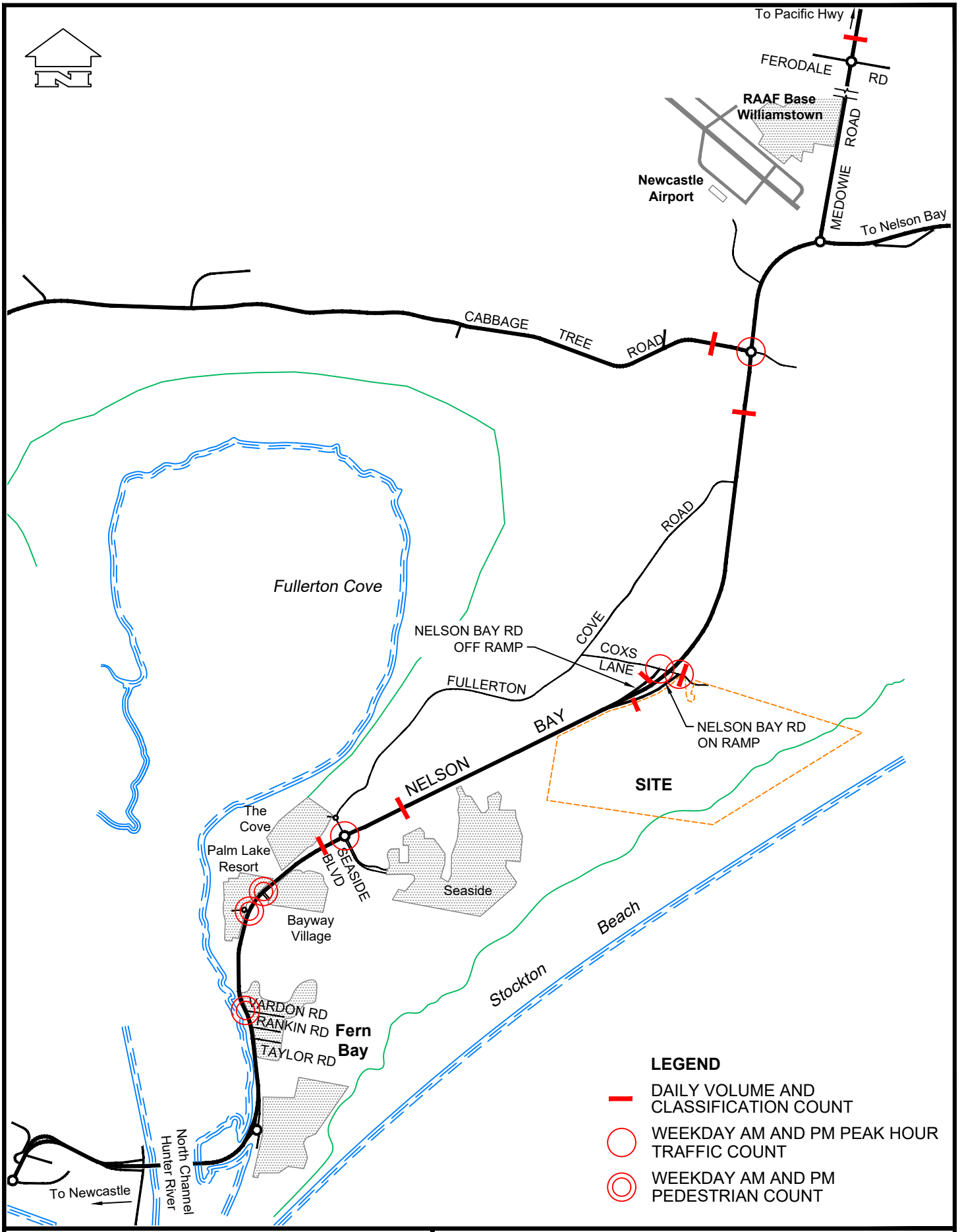

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FIGURE 6

STOCKTON SAND QUARRY

TRAFFIC COUNT LOCATIONS

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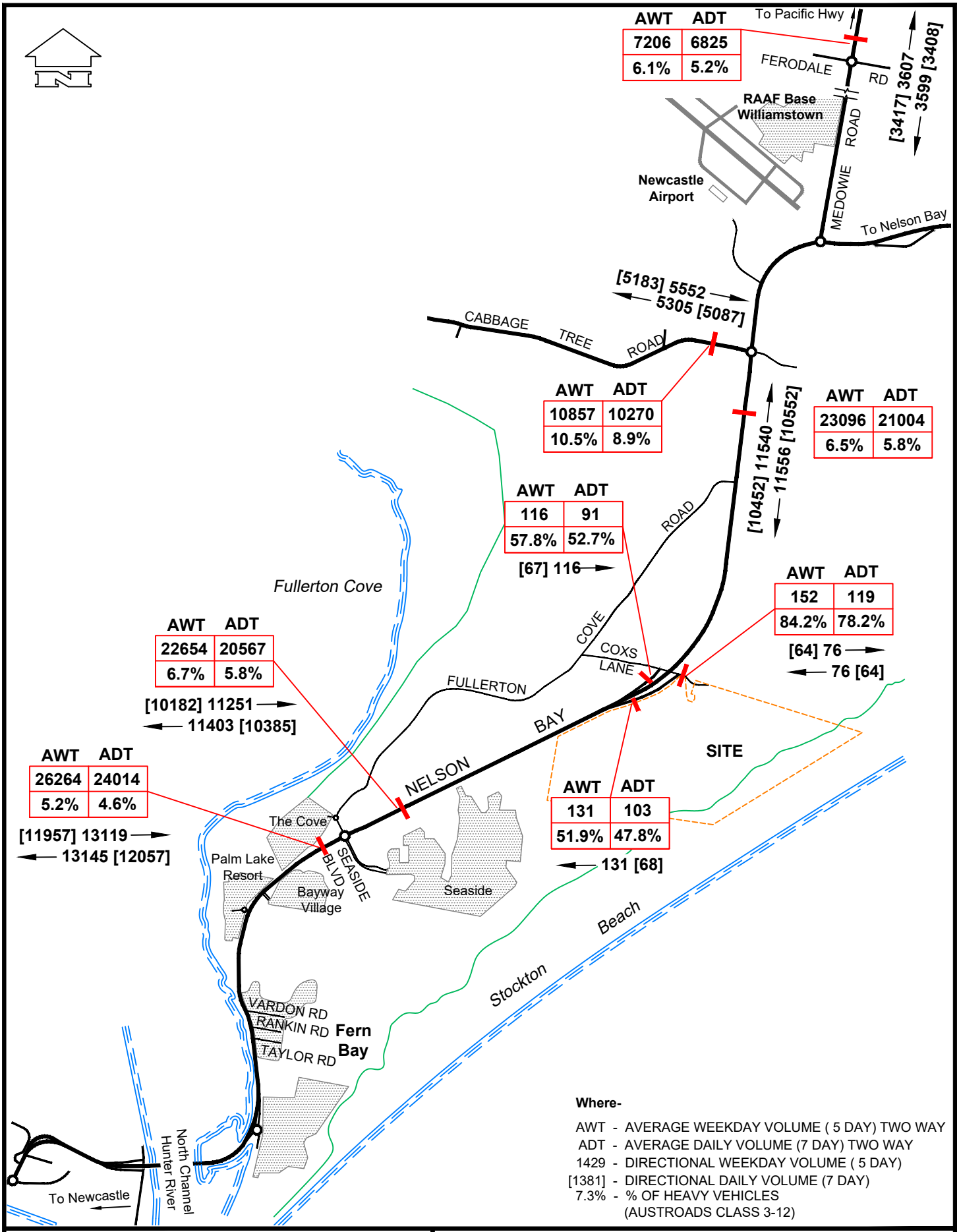

Where-

AWT - AVERAGE WEEKDAY VOLUME (5 DAY) TWO WAY
ADT - AVERAGE DAILY VOLUME (7 DAY) TWO WAY
1429 - DIRECTIONAL WEEKDAY VOLUME (5 DAY)
[1381] - DIRECTIONAL DAILY VOLUME (7 DAY)
7.3% - % OF HEAVY VEHICLES (AUSTROADS CLASS 3-12)

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FIGURE 7

STOCKTON SAND QUARRY

WEEKDAY & DAILY TRAFFIC VOLUMES

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Reference to Table 4.1 shows that on a typical weekday two way volumes in Nelson Bay Road between north of Coxs Lane and south of Seaside Boulevard range between 22,654 and 26,264 vehicles per day (vpd). The proportion of heavy vehicles (Austroad Class 3-12) represent around 5.2% to 6.7% of the total volumes using Nelson Bay Road.

Two way volumes in Coxs Lane east of Nelson Bay Road on an average weekday number 152 vpd with 84.2% being heavy vehicles (Austroads Class 3-12). Heavy vehicles include sand product trucks and water tankers used by the quarry.

The northbound off and southbound on ramps to/from Coxs Lane carry two way traffic volumes on an average weekday of 116 vpd and 131 vpd respectively.

Heavy vehicles (Austroads Class 3-12) represented 57.8% and 51.9% of total vehicles using the ramps.

Two way traffic volumes on an average weekday using other parts of the road network included:

- Cabbage Tree Road, west of Nelson Bay – 10,857 vpd of which 10.5% are heavy vehicle (Austroads Class 3-12)

- Medowie Road, north of Ferodale Road – 7,206 vpd of which 6.1% are heavy vehicles (Austroads Class 3-12)

TABLE 4.1

TWO WAY 5 DAY AVERAGE AND 7 DAY AVERAGE TRAFFIC VOLUMES AND VEHICLE CLASSIFICATIONS USING ROAD NETWORK

Location	5 Day Average (Weekday) Traffic Volumes			7 Day Average (ADT) Traffic Volumes		
	Total	No. of Heavy Vehicles[1]	% of Heavy Vehicles	Total	No. of Heavy Vehicles	% of Heavy Vehicles
Coxs Lane East of Nelson Bay Road	152	128	84.2%	119	93	78.2%
Northbound Off Ramp to Coxs Lane	116	67	57.8%	91	48	52.7%
Southbound On Ramp from Coxs Lane	131	68	51.9%	103	49	47.8%
Nelson Bay Road, north of Coxs Lane	23096	1512	6.5%	21004	1218	5.8%
Nelson Bay Road south of Coxs Lane	22654	1508	6.7%	20567	1192	5.8%
Nelson Bay Road south of Seaside Boulevard	26264	1368	5.2%	24014	1104	4.6%
Cabbage Tree Road, west of Nelson Bay Road	10857	1141	10.5%	10270	914	8.9%
Medowie Road, north of Ferodale Road	7206	442	6.1%	6825	354	5.2%

Source: Traffic Counts 4-10 December 2018

1. *Austroad Class 3-12*

4.3.3 Weekday AM and PM Peak Hour Traffic Volumes

AM Peak Hour

Figure 8 shows existing AM peak hour traffic volumes at the intersections on the road network adjacent Stockton Quarry. The AM peak hour generally occurred between 7.15am to 8.15am, although slightly higher volumes occurred at the Coxs Lane on/off ramp intersections during the 6.45am to 7.45am hour. Reference to **Figure 8** shows the following.

The principal intersections of Nelson Bay Road/Cabbage Tree Road/Lavis Lane and Nelson Bay Road/Seaside Boulevard/Fullerton Cove Road have the highest intersection volumes. Both of these intersections are two lane roundabouts.

At the Cabbage Tree Road roundabout, approach volumes in Cabbage Tree Road and in Lavis Lane entering the roundabout number 198 vehicles per hour (vph) and 279 vph respectively. Approach volumes in the northern southern approaches of Nelson Bay Road at this roundabout number 1161 vph and 1021 vph respectively.

At the Seaside Boulevard roundabout approach volumes in Seaside Boulevard and in Fullerton Cove Road number 330 vph and 43 vph, respectively. The approach volumes in Nelson Bay Road number 1205 vph in the northern approach and 1032 vph in the southern approach.

Traffic volumes using the Coxs Lane off ramp and on ramp intersections, which provide vehicle access to Stockton Quarry are very low and number less than 20 vph in the AM peak hour.

PM Peak Hour

Figure 9 shows the existing traffic volumes using the intersections during the PM peak hour. Reference to **Figure 9** shows the following.

For the roundabout intersections of Nelson Bay Road with Cabbage Tree Road/Lavis Lane and with Seaside Boulevard/Fullerton Cove Road, the PM peak hour occurred between 4.00pm – 5.00pm.

For the Coxs Lane intersections with the on and off ramps to/from Nelson Bay Road, the PM peak occurred between 3.00pm to 4.00pm. The traffic volumes using the Coxs Lane intersections are very low in PM peak hour and number less than 20 vph at both intersections.

At the Cabbage Tree Road roundabout approach vehicles in Cabbage Tree Road and Lavis Lane in the PM peak hour using the roundabout number 145 vph and 230 vph respectively. The approach volumes in the northern and southern approaches of Nelson Bay Road at this roundabout number 1366 vph and 1116 vph, respectively.

The approach volumes in Seaside Boulevard and in Fullerton Cove Road at the roundabout intersection with Nelson Bay Road in the PM peak hour number 102 vph and 37 vph respectively. The approach volumes in Nelson Bay Road in the northern and southern approaches of this roundabout number 1293 vph and 1254 vph.

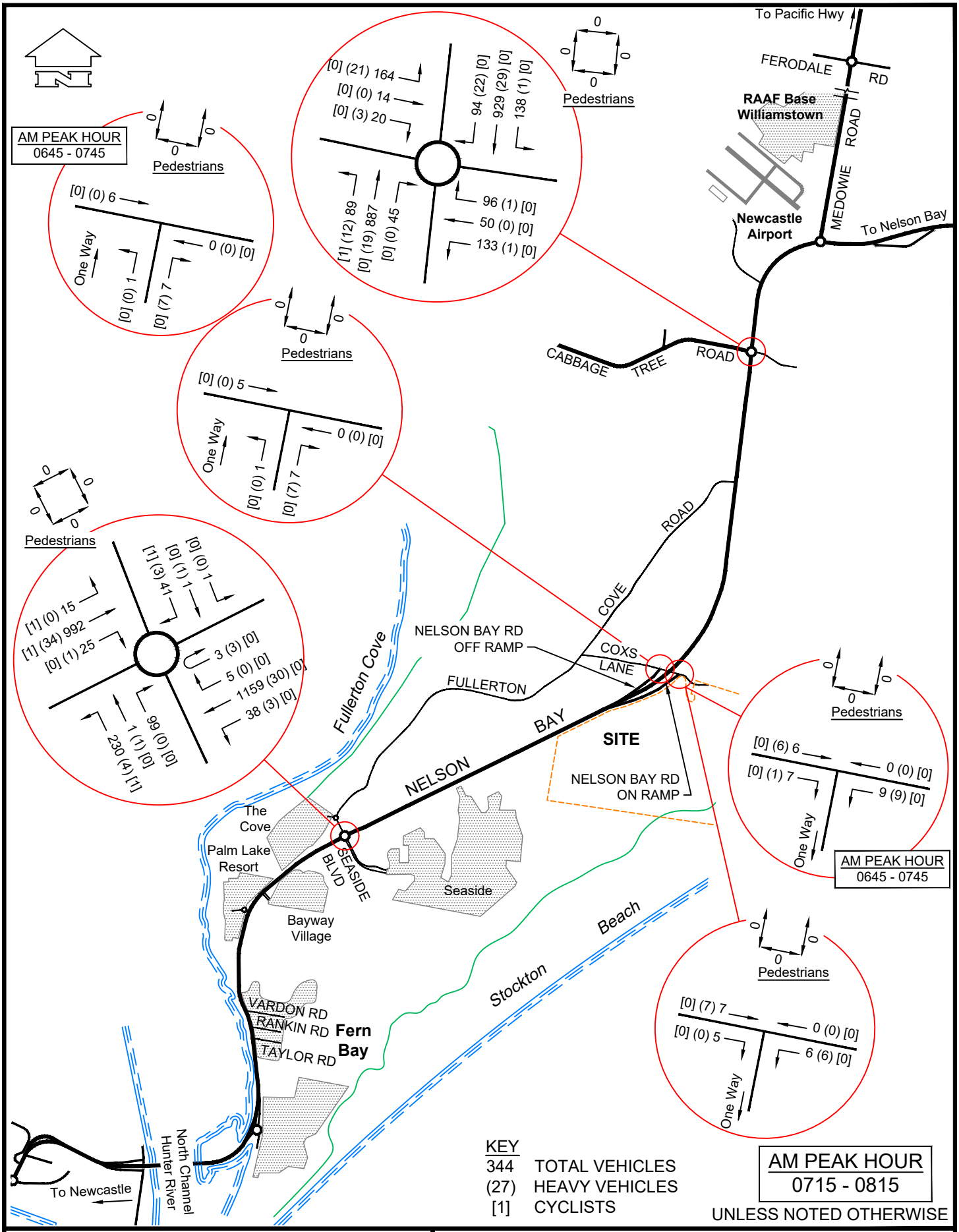

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FIGURE 8

STOCKTON SAND QUARRY

EXISTING AM PEAK HOUR TRAFFIC VOLUMES NELSON BAY RD & SEASIDE BLVD; NELSON BAY RD NORTHBOUND ON & OFF RAMPS & COX'S LANE; NELSON BAY RD & CABBAGE TREE RD

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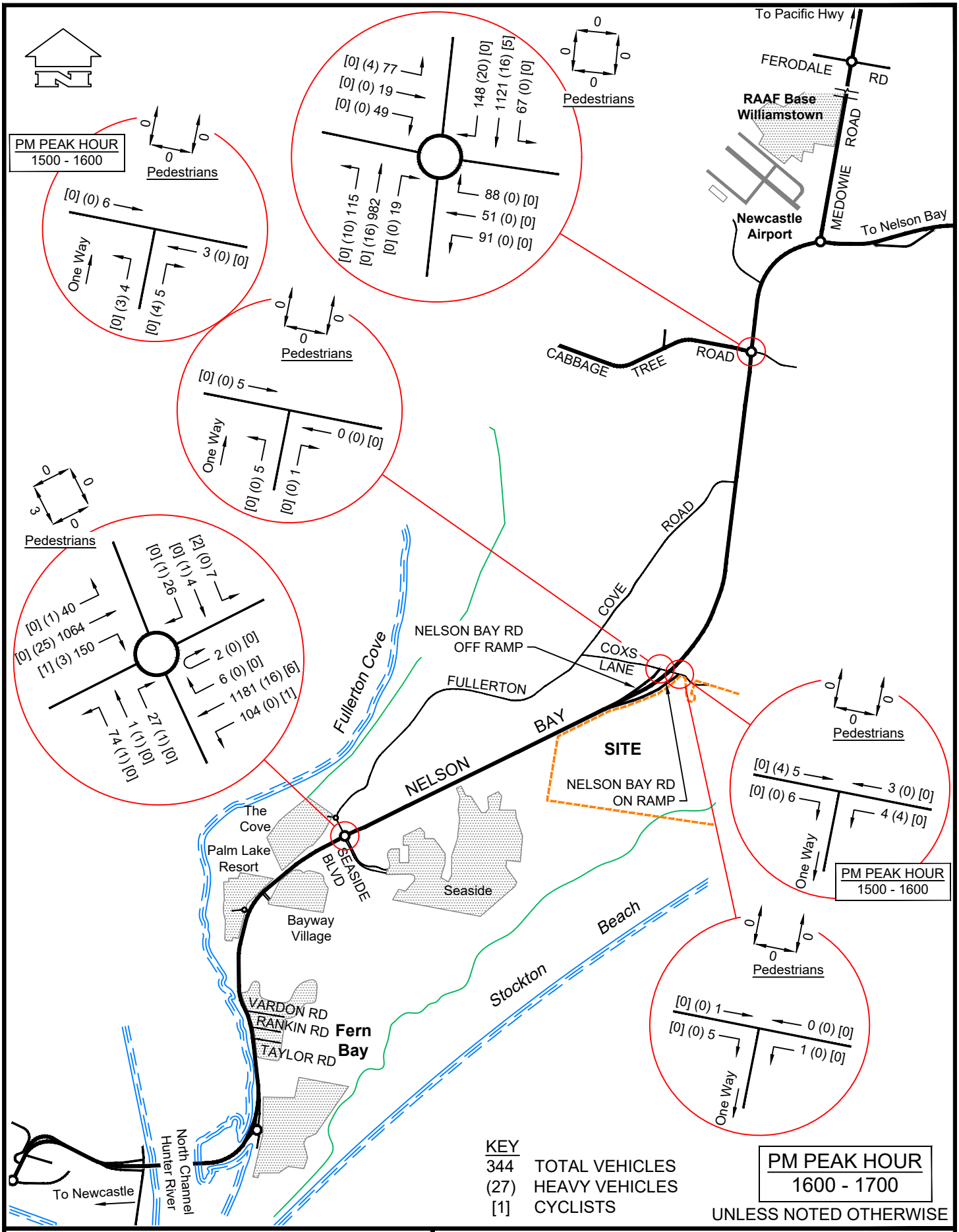

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FIGURE 9

STOCKTON SAND QUARRY

EXISTING PM PEAK HOUR TRAFFIC VOLUMES NELSON BAY RD & SEASIDE BLVD; NELSON BAY RD NORTHBOUND ON & OFF RAMPS & COX'S LANE; NELSON BAY RD & CABBAGE TREE RD

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4.3.4 Traffic Conditions on the Road Network

As part of the review of traffic conditions on the road network, the operational capacity of the principal intersections on the road network has been assessed using the SIDRA 8 traffic model.

SIDRA is a suitable model to assess the operational performance of intersections. Criteria for interpreting an intersections operation are Level of Service (LS), Degree of Saturation (DS) and Average Vehicle Delay (AVD). For intersections under Priority/Stop Sign control and Roundabout Control, Average Vehicle Delay for Individual Movements (HMD) is relevant.

Table 4.2 below is reproduced from the RTA's Guide to Traffic Generation Developments (October 2002) and provides an explanation of the various levels of service for intersections.

A Level of Service D or better (i.e. A, B, C or D) is generally considered to be minimum design requirement for intersections. The level of service for intersections controlled by Give Way/Stop Signs or under Roundabout Control is determined from the movement with highest average vehicle delay (HMD). For intersections controlled by traffic signals the level of service is determined by the Average Vehicle Delay for all vehicles using the intersection (AVD).

TABLE 4.2

LEVEL OF SERVICE CRITERIA FOR INTERSECTIONS

Level of Service	Average Delay per Vehicle (secs/veh)	Traffic Signals, Roundabout	Give Way & Stop Signs
A	<14	Good operation	Good operation
B	15 to 28	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	29 to 42	Satisfactory	Satisfactory, but accident study required
D	43 to 56	Operating near capacity	Near capacity and accident study required
E	57 to 70	At capacity; at signals, incidents will cause excessive delays. Roundabouts require other control mode	At capacity, requires other control mode
F	>70	Intersection is oversaturated	Oversaturated, requires other control mode

SIDRA models have been developed for the existing conditions in the AM and PM peak hours using the traffic volumes shown on **Figures 8** and **9** and the existing traffic management at the intersections and calibrated against observed traffic conditions at the intersections.

The results of the modelling are shown in Tables 4.3 to 4.6 and that;

- The principal intersections used by the Boral trucks namely the Coxs Lane Off and On Ramp intersections (Tables 4.3 and 4.4) and the two roundabout intersections of Nelson Bay Road/Cabbage Tree/Lavis Lane (Table 4.5) and Nelson Bay Road/Seaside Boulevard/Fullerton Cove Road (Table 4.6) all operate at a very good level of service with a Level of Service A operation in the AM and PM peak hours with low vehicle delays.

Traffic conditions at these intersections, as well as on the road network are considered to be satisfactory.

Extracts of the SIDRA traffic modelling outputs are contained in Appendix 1.

TABLE 4.3

SIDRA MODELLING RESULTS FOR COXS LANE/OFF RAMP INTERSECTION IN WEEKDAY AM AND PM PEAK HOURS FOR EXISTING CONDITIONS – PRIORITY CONTROL

Approach	AM Peak				PM Peak			
	DS	AVD	LS	95th% Queue Length	DS	AVD	LS	95th% Queue Length
South Off Ramp One Way								
Left	0.009	5.5	A	0.3	0.009	6.4	A	0.4
Right	0.009	6.2	A	0.3	0.009	6.6	A	0.4
East Coxs Lane								
Left	-	-	-	-	-	-	-	-
Through	0.001	0.0	A	0.0	0.002	0.0	A	0.0
West Coxs Lane								
Through	0.002	0.0	A	0.0	0.003	0.0	A	0.0
Right	-	-	-	-	-	-	-	-
TOTAL - All Vehicles	**0.009**	**3.5**	**A**	**0.3**	**0.009**	**3.3**	**A**	**0.4**

Where: *DS* - *Degree of Saturation*
AVD - *Average Vehicle Delay in Seconds*
LS - *Level of Service*
95th% Queue Length - *95th% Queue Length in Metres*

TABLE 4.4

SIDRA MODELLING RESULTS FOR COXS LANE/ON RAMP INTERSECTION IN WEEKDAY AM AND PM PEAK HOURS FOR EXISTING CONDITIONS – PRIORITY CONTROL

Approach	AM Peak				PM Peak			
	DS	AVD	LS	95th% Queue Length	DS	AVD	LS	95th% Queue Length
South On Ramp One Way								
Left	-	-	-	-	-	-	-	-
Right	-	-	-	-	-	-	-	-
East Coxs Lane								
Left	0.006	6.1	A	0.0	0.005	6.1	A	0.0
Through	0.006	0.0	A	0.0	0.005	0.0	A	0.0
West Coxs Lane								
Through	0.008	0.0	A	0.2	0.006	0.0	A	0.2
Right	0.008	5.5	A	0.2	0.006	5.5	A	0.2
TOTAL - All Vehicles	**0.008**	**3.4**	**A**	**0.2**	**0.006**	**3.2**	**A**	**0.2**

Where: *DS* - *Degree of Saturation*
AVD - *Average Vehicle Delay in Seconds*
LS - *Level of Service*
95th% Queue Length - *95th% Queue Length in Metres*

TABLE 4.5

SIDRA MODELLING RESULTS FOR NELSON BAY ROAD/CABBAGE TREE ROAD/LAVIS LANE INTERSECTION IN WEEKDAY AM AND PM PEAK HOURS FOR EXISTING CONDITIONS – ROUNDABOUT CONTROL

Approach	AM Peak				PM Peak			
	DS	AVD	LS	95th% Queue Length	DS	AVD	LS	95th% Queue Length
South Nelson Bay Road								
Left	0.400	6.5	A	19.0	0.449	6.7	A	21.7
Through	0.400	6.6	A	19.0	0.449	6.9	A	21.7
Right	0.400	13.6	A	17.7	0.449	13.9	A	20.4
East Lavis Lane								
Left	0.341	6.8	A	11.8	0.323	7.8	A	11.4
Through	0.341	6.6	A	11.8	0.323	7.6	A	11.4
Right	0.341	13.2	A	11.8	0.323	14.2	A	11.4
North Nelson Bay Road								
Left	0.285	5.6	A	10.2	0.329	5.6	A	13.3
Through	0.509	5.9	A	25.4	0.588	5.9	A	35.6
Right	0.509	13.1	A	25.4	0.588	13.0	A	35.6
West Cabbage Tree Road								
Left	0.176	5.6	A	7.2	0.082	5.4	A	2.9
Through	0.054	6.0	A	1.8	0.092	5.7	A	2.8
Right	0.054	13.2	A	1.8	0.092	12.3	A	2.8
TOTAL - All Vehicles	**0.509**	**6.9**	**A**	**25.4**	**0.588**	**7.2**	A	**35.6**

Where: *DS* - *Degree of Saturation*
AVD - *Average Vehicle Delay in Seconds*
LS - *Level of Service*
95th% Queue Length - *95th% Queue Length in Metres*

TABLE 4.6

SIDRA MODELLING RESULTS FOR NELSON BAY ROAD/SEASIDE BOULEVARD/FULLERTON COVE ROAD INTERSECTION IN WEEKDAY AM AND PM PEAK HOURS FOR EXISTING CONDITIONS – ROUNDABOUT CONTROL

Approach	AM Peak				PM Peak			
	DS	AVD	LS	95th% Queue Length	DS	AVD	LS	95th% Queue Length
South Nelson Bay Road								
Left	0.285	4.8	A	12.1	0.312	4.5	A	13.7
Through	0.447	5.0	A	24.1	0.490	4.6	A	28.0
Right	0.447	11.5	A	24.1	0.490	11.2	A	28.0
East Seaside Boulevard								
Left	0.236	6.6	A	8.9	0.083	6.5	A	3.2
Through	0.139	10.5	A	4.4	0.045	10.5	A	1.7
Right	0.139	13.4	A	4.4	0.045	13.5	A	1.7
North Nelson Bay Road								
Left	0.266	4.8	A	10.1	0.314	5.4	A	11.3
Through	0.544	4.8	A	30.8	0.643	5.5	A	36.7
Right	0.544	11.3	A	30.8	0.643	12.1	A	36.7
U-turn	0.544	13.1	A	30.8	0.643	13.0	A	36.7
West Fullerton Cove Road								
Left	0.060	6.5	A	2.1	0.054	6.9	A	1.8
Through	0.060	6.5	A	2.1	0.054	7.8	A	1.8
Right	0.060	13.1	A	2.1	0.054	13.4	A	1.8
TOTAL - All Vehicles	**0.544**	**5.6**	A	**30.8**	**0.643**	**5.7**	A	**36.7**

Where: *DS* - *Degree of Saturation*
AVD - *Average Vehicle Delay in Seconds*
LS - *Level of Service*
95th% Queue Length - *95th% Queue Length in Metres*

4.4 Road Safety

4.4.1 Crash Statistics

Road crash data was obtained from the RMS for the section of Nelson Bay Road between Cabbage Tree Road at Williamtown and Fullerton Street at Fern Bay.

The review of the RMS crash data for the 3 year period between 1 July 2015 and 30 June 2018 shows that there was a total of 21 crashes in the section of Nelson Bay Road between Cabbage Tree Road and Fullerton Street, including at the intersections in this section.

Twelve (12) of the crashes were casualty crashes and nine (9) non casualty crashes.

Seven (7) of the crashes occurred at or near the Nelson Bay Road/Cabbage Tree/Lavis Lane roundabout, three (3) of which were casualty crashes. There were a combination of different crash types including rear end, side swipe, same direction, right/through and right/far with no treatable pattern.

Five (5) crashes occurred at or near the Nelson Bay Road/Seaside Boulevard/Fullerton Cove Road roundabout, three (3) of which were casualty crashes. Crash types included rear end (3 crashes), off road and adjacent direction crashes, with no treatable pattern at the intersection.

The remainder of the crashes were spread along the 9.5km length of Nelson Bay Road and included two pedestrian crashes at different locations, rear end and run off road crashes.

One (1) of the pedestrian crashes was a fatal crash and involved an elderly pedestrian walking along Nelson Bay Road at night facing traffic, 1.6kms north of Seaside Boulevard. The other pedestrian crash involved a pedestrian crossing Nelson Bay Road 600 metres north of Vardon Road (adjacent a bus stop), at night.

An examination of the crash types and locational spread of the crashes indicates that there is no treatable pattern that could be addressed by specific remedial measures.

4.4.2 Road Safety Audit

A Stage 5 Road Safety audit, which is an audit of the existing roads, was undertaken on the section of Nelson Bay Road between Cabbage Tree Road at Williamtown and Fullerton Street, Fern Bay. The audit was undertaken on the existing road and traffic management along the route. The purpose of the audit was to examine the features of the existing road network which may affect road user safety and identify potential safety hazards.

The audit examined the existing road alignment, cross sections, road shoulders, intersections, delineation/signage, bridges and culverts, pavement, provision for heavy vehicles and other miscellaneous matters and assessed these against current road practice guidelines and standards, with the objective of identifying any real or potential road safety hazards.

While not normally part of a road safety audit, the most recent 3 year crash statistics for the route were also analysed.

The audit findings identified a number of minor maintenance issues along the route. The audit did not identify any specific road safety issues that required follow up.

A separate road safety audit report has been prepared and is presented as Volume 2.

4.5 Pedestrians and Cyclists

The frontage development of Nelson Bay Road between Cabbage Tree Road and Seaside Boulevard does not generate pedestrian activity. The development, south of Seaside Boulevard, generates small amounts of pedestrian activity associated with people going to and from bus stops.

There are no formal pedestrian crossing facilities along Nelson Bay Road between Cabbage Tree Road at Williamtown and Fullerton Street at Fern Bay.

The traffic counts undertaken for weekday AM and PM periods showed only minimal pedestrian activity crossing Nelson Bay Road at/near any of the intersections. **Figure 10** shows the pedestrian crossing volumes.

All of the pedestrian crossing movements are located in the section of Nelson Bay Road south of Seaside Boulevard. The pedestrian volumes shown in **Figure 10** are

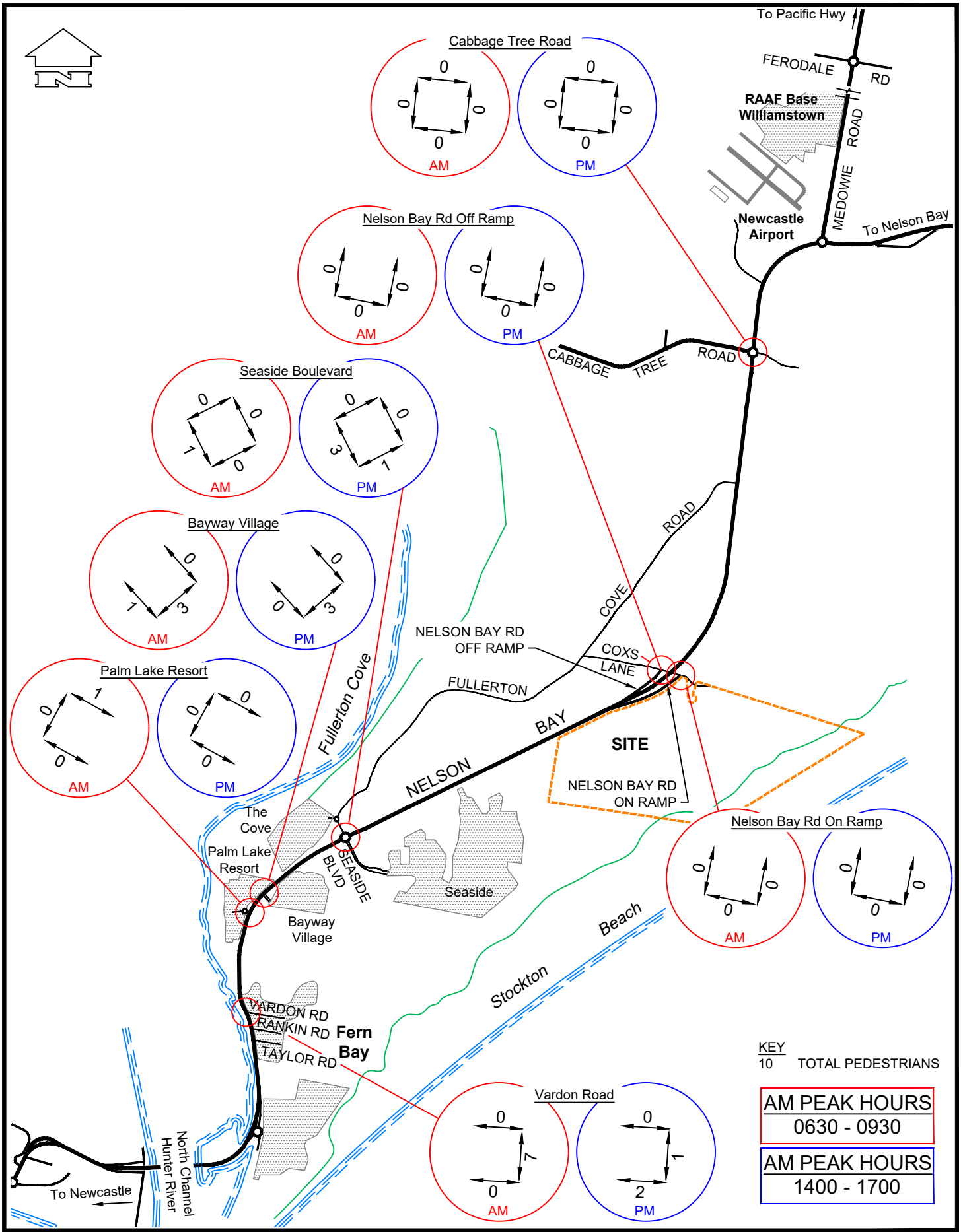

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FIGURE 10

STOCKTON SAND QUARRY

EXISTING AM & PM PEAK 3 HOUR PEDESTRIAN VOLUMES

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for the 3 hour AM and PM periods between 6.30am – 9.30am and 2.00pm – 5.00pm on a weekday.

The sealed road shoulders of Nelson Bay Road have sufficient room for cyclists to use. Recent channelisation work at the Palm Lake Resort Access Road provides a cyclist lane as part of the channelisation. The roundabout at Seaside Boulevard/Fullerton Cove Road also provides for cyclists with off path crossing opportunities.

The bridge over Coxs Lane in Nelson Bay Road is a pinch point for cyclists.

Port Stephens Council is proposing a future shared path along Fullerton Cove Road from Seaside Boulevard and rejoining Nelson Bay Road south of Cabbage Tree Road, which would be an alternative route to the section of Nelson Bay Road, adjacent Cox Lane.

The weekday AM and PM traffic counts indicates that small numbers of cyclists use sections of Nelson Bay Road.

4.6 Buses

Several bus routes use Nelson Bay Road including routes 131, 132, 136 and 138.

The 136 and 138 services use the section of Nelson Bay Road, south of Seaside Boulevard and at the section north of Fullerton Cove Road (north intersection) and have a number of bus stops south of Seaside Boulevard.

The 130 and 131 services have one stop in Nelson Bay Road which is the Bayway Village, south of Seaside Boulevard.

Pull off areas and bus bays are provided in sections of Nelson Bay Road between Fullerton Street and Seaside Boulevard.

4.7 Planned Road Upgrades

The NSW Government has undertaken recent road upgrades in Nelson Bay Road at Williamtown and is currently undertaking additional works to upgrade the Nelson Bay Corridor, north of Williamtown by way of intersection upgrades and widening to accommodate a four lane road in Nelson Bay Road for these works. Some $275 million is budgeted. This includes duplicating the road from Wiliamtown to Bobs Farm, together with the early intersection upgrades to Nelson Bay Road/Medowie Road and Nelson Bay Road and Lemon Tree Passage Road.

The section of Nelson Bay Road south of Cabbage Tree Road to Fern Bay which includes Coxs Lane is currently in the planning stages, so no details are available at this time regarding the future upgrading works in this section.

As noted in Section 4.1 recent road upgrades have been completed for the Tourle Street/Cormorant Road route and the Tourle Street/Industrial Drive intersection is currently being upgraded by the NSW government.

Other works planned in Nelson Bay Road is for a new northern intersection from the Fern Bay Seaside Village residential subdivision. This intersection which will be left in/left out at Nelson Bay Road is located between Seaside Boulevard and Coxs Lane. Further details are contained in Section 4.8.

4.8 Recent Approved Land Uses Adjacent Stockton Quarry

4.8.1 Quarries

Recent approvals to other quarries in the general area to Stockton Quarry are listed below.

Fullerton Cove Quarry

This sand quarry is located off Coxs Lane west of Nelson Bay Road at Fullerton Cove. Its most recent modification was to extend the quarry's operation for another 4 years to June 2020. Transport is limited to 20 laden trucks from the site per hour when averaged over a working week.

These trucks use Coxs Lane and Nelson Bay Road when accessing the quarry.

The traffic counts undertaken on the road network during 4-10 December 2019 would have captured the traffic generation of this quarry.

Maccas Sand Quarry

Maccas Sand Quarry is located at Lot 218 Nelson Bay Road, Salt Ash which is located 3.5km north of the Nelson Bay Road/Medowie Road roundabout.

The quarry's most recent modification (Modification 2 dated 15 March 2016) permits the following product transport during the weekday peak hours.

- AM (6am – 9am) – 8 laden trucks; and
- PM (9am – 10pm) – 24 laden trucks.

The traffic counts undertaken on the road network during 4-10 December 2019 would have captured the traffic generation of this quarry.

Cabbage Tree Quarry

This future quarry is located at 282 Cabbage Tree Road, Williamtown, which is located some 4 km west of the Nelson Bay Road intersection with Cabbage Tree Road.

The quarry is yet to be developed (i.e. currently not in operation). The quarry Traffic Impact Assessment (TIA) report by Intersect Traffic dated October 2015 identified the following traffic generation.

- AM peak hour (7am – 9am) – 20 truck movements i.e. 10 in/10 out; and
- PM peak hour (4pm – 5pm) – 20 truck movements i.e. 10 in/10 out.

(NB. 5pm – 6pm period has an additional 6 employee light vehicle trips).

The proposed site entrance will be restricted to left in/left out restrictions and the TIA identified the following additional truck movements at the Cabbage Tree Road/Nelson Bay Road/Lavis Lane roundabout in the AM and PM peak hours.

- 3 trucks turning right from Cabbage Tree Road to Nelson Bay Road to travel south; and

- 7 eastbound trucks in Cabbage Tree Road U-turning at the roundabout to travel west.

Salt Ash Quarry

Salt Ash Quarry is an existing quarry and is located off Janet Parade approximately 1.9km north of Lemon Tree Passage Road, Salt Ash. Its current operation is 3 laden trucks per hour.

Modification 4 approved 10/10/2018 requires the upgrading of the Janet Parade/Nelson Bay Road intersection and allows for 4 laden trucks per hour.

While this quarry is located 12.7km north of Stockton Quarry its existing traffic generation would have been captured in the traffic counts of 4-10 December 2018.

4.8.2 Fern Bay Seaside Village

Fern Bay Seaside Village is located to the south of Stockton Quarry and is accessed via Seaside Boulevard from Nelson Bay Road.

Its current consent and most recent modification, approved on 30 April 2019, allows up to 411 lots, including 370 residential lots, 38 super lots, 2 commercial lots and one (1) community lot.

The subdivision is currently around 80% completed and occupied.

As noted above its main access road is via Seaside Boulevard from Nelson Bay Road. A northern access intersection with left in and left out restrictions is to be constructed in Nelson Bay Road, some 1.14km north of the Seaside Boulevard intersection. This new intersection will be approximately 2.2km south of Coxs Lane.

The timing of this new intersection is expected to be in late 2019 or early in 2020.

5.0 ASSESSMENT OF TRAFFIC IMPACTS OF PROJECT

5.1 Traffic Increases

While there will be a small increase in light vehicles attending the quarry site as well as in the number of fuel and maintenance vehicles with the Project, the largest increase will be in product transport vehicles (heavy vehicles) associated with the additional 250,000 tonnes of sand product until 2028.

VENM importation of 70,000tpa will also increase heavy vehicle movements entering and exiting the quarry.

5.2 Increase in Heavy Vehicle Movements with Project

Currently the highest traffic generation of the quarry occurs on weekdays and this is expected to continue with the Project, given that on Saturdays the quarry normally operates for half a day and on some Saturdays there is no sand product transportation.

Table 5.1 and 5.2 shows the increase in heavy vehicle trips generated by the quarry with the Project for an average weekday and the maximum day, respectively until 2028.

For the average weekday shown in Table 5.1 it is assumed that limited sand product transport occurs on Saturdays, with an average of 10 truck loads for the existing operations and 20 truck loads with the Project on Saturdays.

Reference to Table 5.1 shows that the increase in two way heavy vehicles on an average weekday with the Project until 2028, is estimated as 84 two way heavy vehicle trips (i.e. 42 in/42 out).

On a maximum day (Table 5.2) the increase in two way heavy vehicles with the Project until 2028, is estimated as 132 two way heavy vehicle trips (i.e. 66 in/66 out).

TABLE 5.1

HEAVY VEHICLE MOVEMENTS ON AN AVERAGE WEEKDAY UNTIL 2028

	Existing 500,000tpa		Project 750,000tpa		Increase	
	Truck Loads	Two Way Trips	Truck Loads	Two Way Trips	Truck Loads	Two Way Trips
Product Transport	58	116	86	172	+28	+56
VENM Importation	-	-	14	28	+14	+28
Total	**58**	**116**	**100**	**200**	**+42**	**+84**

TABLE 5.2

HEAVY VEHICLE MOVEMENTS ON MAXIMUM DAY UNTIL 2028

	Existing 500,000tpa		Project 750,000tpa		Increase	
	Truck Loads	Two Way Trips	Truck Loads	Two Way Trips	Truck Loads	Two Way Trips
Product Transport	76	152	114	228	+38	+76
VENM Importation	-	-	28	56	+28	+56
Total	**76**	**152**	**142**	**284**	**+66**	**+132**

After 2028, sand product transport reduces to 500,000tpa which is the same as the existing consent and the only increase will be the importation of the VENM.

Tables 5.3. and 5.4 show the increase in heavy vehicle trips generated by the quarry with the Project after 2028 for an average weekday and maximum day, respectively.

When compared to the existing development consent (DA 140-5-2006), the increases in heavy vehicle trips, after 2028, are estimated as

- 28 two way heavy vehicle trips (14/ in14 out) on an average day; and
- 56 two way heavy vehicle trips (28 in/28 out) on a maximum day

TABLE 5.3

HEAVY VEHICLE MOVEMENTS ON AN AVERAGE WEEKDAY AFTER 2028

	Existing 500,000tpa		Project 500,000tpa		Increase	
	Truck Loads	Two Way Trips	Truck Loads	Two Way Trips	Truck Loads	Two Way Trips
Product Transport	58	116	58	116	-	-
VENM Importation	-	-	14	28	+14	+28
Total	**58**	**116**	**72**	**144**	**+14**	**+28**

TABLE 5.4

HEAVY VEHICLE MOVEMENTS ON MAXIMUM DAY AFTER 2028

	Existing 500,000tpa		Project 500,000tpa		Increase	
	Truck Loads	Two Way Trips	Truck Loads	Two Way Trips	Truck Loads	Two Way Trips
Product Transport	76	152	76	152	-	-
VENM Importation	-	-	28	56	+28	+56
Total	**76**	**152**	**104**	**208**	**+28**	**+56**

5.3 Assessment of Traffic Impacts

5.3.1 Impact on the Road Network

Before 2028

As noted in Table 5.1 total sand product and VENM trucks will number 200 two way truck movements based on 100 truck loads on an average weekday under the Project. When assigned to the road network sand product and VENM trucks on an average weekday will number:

- 110 two way truck movements in Nelson Bay Road north of Coxs Lane, which is an increase of 46 truck movements from an average day under the existing development consent.

- 310 two way truck movements in Nelson Bay Road, south of Coxs Lane. This figure is higher due to the required U-turn at the roundabout intersection in Nelson Bay Road at Seaside Boulevard, for those trucks traveling to and from the north and

north west. This will be an increase of 130 two way truck movements from an average day under the existing development consent.

- 90 two way truck movements in Nelson Bay Road south of Seaside Boulevard. This will be an increase of 38 two way truck movements from an average weekday under the existing development consent.

- 100 two way truck movements in Cabbage Tree Road, which is an increase of 42 two way truck movements from an average weekday under the existing development consent.

- 10 two way truck movements in Nelson Bay Road north of Cabbage Tree Road, which is an increase of 2 two way truck movements from an average weekday under the existing development consent.

Boral's sand product and VENM trucks will represent a small proportion of total vehicles using the road network on an average weekday, as detailed below:

- Nelson Bay Road, north of Coxs Lane – 0.47% of total weekday volumes and 6.8% of heavy vehicles.

- Nelson Bay Road, south of Coxs Lane – 1.35% of total weekday volumes and 17.1% of heavy vehicles.

- Nelson Bay Road, south of Seaside Boulevard – 0.34% of total weekday volumes and 6.2% of heavy vehicles.

- Cabbage Tree Road, west of Nelson Bay Road – 0.91% of total weekday volumes and 8.1% of heavy vehicles.

Sand product and VENM truck volumes on a maximum day will be higher, with a total of 284 two way truck movements (i.e. 142 truck loads) generated on maximum days. However maximum days are only expected to occur on approximately 5% of transport days, and typically when Boral is supplying major works/contracts.

After 2028

After 2028 the quarry will generate a lower volume of sand product trucks and the only increase, when compared to the existing development consent, will be 28 two way heavy vehicle movements (14 in/14 out) on an average day and up to 56 two way truck movements (28 in/28 out) on a maximum day.

These trucks will be spread over the road network.

5.3.2 Impact on Principal Intersections

The Project during the maximum one hour is expected to generate 30 inbound heavy vehicle trips and 30 outbound heavy vehicle trips associated with product transport and VENM importation (60 two way heavy vehicle trips).

Figure 11 shows the truck movements assigned to the road network based on the traffic assignment outlined in Section 3.7 with 45% to and from the south along Nelson Bay Road, 50% to the north west via Cabbage Tree Road and 5% to and from the north via Nelson Bay Road and Medowie Road.

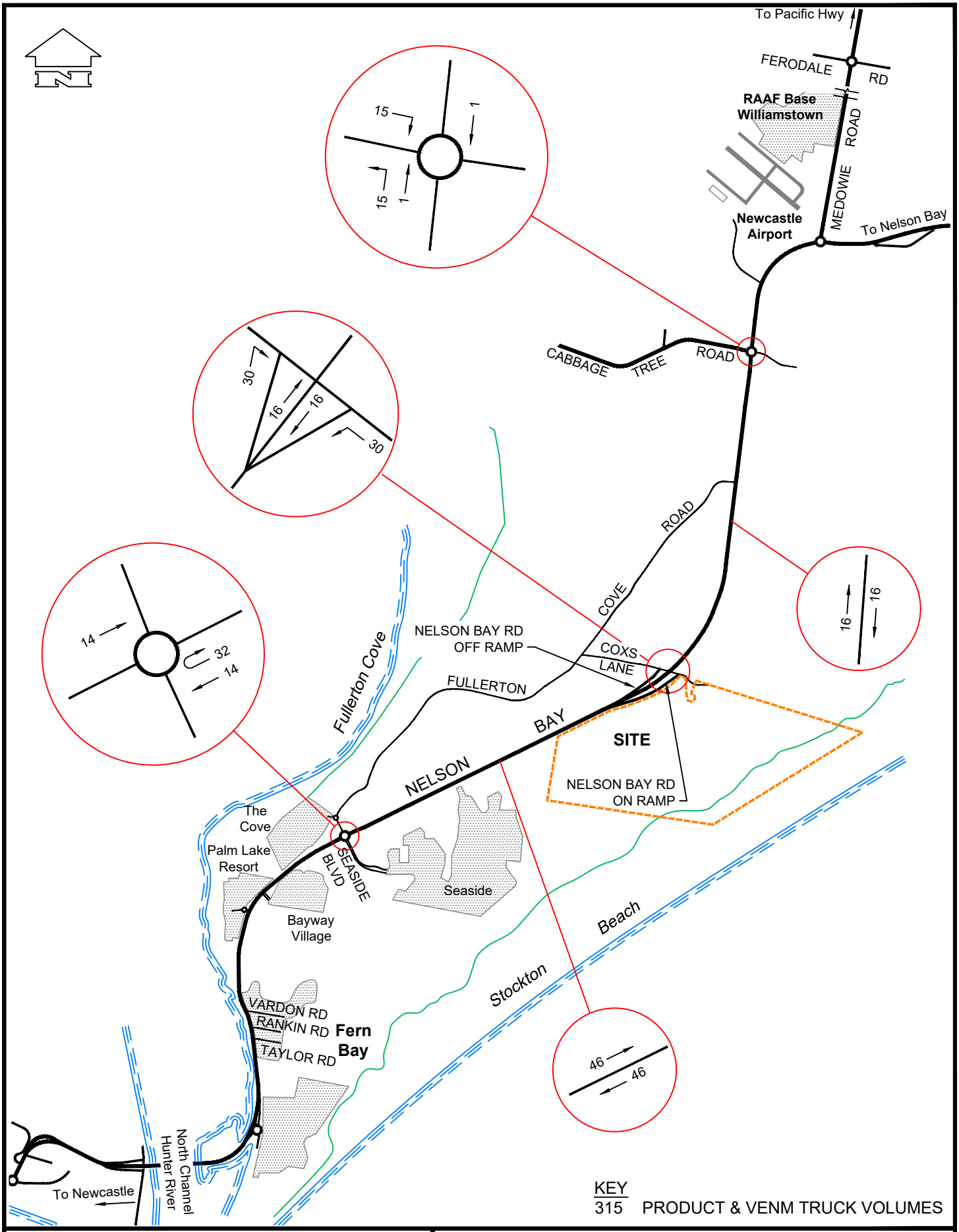

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FIGURE 11

STOCKTON SAND QUARRY

PRODUCT & VENM TRUCK VOLUMES IN MAXIMUM HOUR

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To examine the impact at the principal intersections of the additional traffic from the Project during the weekday AM and PM peak hour, SIDRA traffic modelling has been undertaken.

The modelling has adopted the maximum hour traffic volumes (**Figure 11**) overlaid onto the existing AM and PM peak hours, shown in **Figures 8** and **9**.

The results of the modelling are shown in Tables 5.5 to 5.8.

Reference to Tables 5.5 and 5.6 shows that the Coxs Lane/Off Ramp and Cox Lane/On Ramp intersection will continue to operate at a very good level of service (Level of Service A operation) with low vehicle delays, with the Project.

Reference to Tables 5.7 and 5.8 which shows the modelling results for the roundabout intersections of Nelson Bay Road/Cabbage Tree Road/Lavis Lane (Table 5.7) and Nelson Bay Road/Seaside Boulevard/Fullerton Cove Road (Table 5.8) shows that both these intersections will also continue to operate a very good level of service (Level of Service A operation) with low vehicle delays, with the Project.

This indicates that the additional traffic from the Project will have satisfactory traffic impacts on these intersections.

Extracts of the SIDRA traffic modelling outputs are contained in Appendix 1.

TABLE 5.5

SIDRA MODELLING RESULTS FOR COXS LANE/OFF RAMP INTERSECTION IN WEEKDAY AM AND PM PEAK HOURS WITH PROJECT – PRIORITY CONTROL

Approach	AM Peak				PM Peak			
	DS	AVD	LS	95th% Queue Length	DS	AVD	LS	95th% Queue Length
South Off Ramp One Way								
Left	0.036	5.5	A	1.5	0.040	6.4	A	1.6
Right	0.036	6.2	A	1.5	0.040	6.8	A	1.6
East Coxs Lane								
Left	-	-	-	-	-	-	-	-
Through	0.001	0.0	A	0.0	0.002	0.0	A	0.0
West Coxs Lane								
Through	0.002	0.0	A	0.0	0.003	0.0	A	0.0
Right	-	-	-	-	-	-	-	-
TOTAL - All Vehicles	**0.036**	**5.2**	**A**	**1.5**	**0.040**	**5.4**	**A**	**1.6**

Where: *DS* - *Degree of Saturation*
AVD - *Average Vehicle Delay in Seconds*
LS - *Level of Service*
95th% Queue Length - *95th% Queue Length in Metres*

TABLE 5.6

SIDRA MODELLING RESULTS FOR COXS LANE/ON RAMP INTERSECTION IN WEEKDAY AM AND PM PEAK HOURS WITH PROJECT – PRIORITY CONTROL

Approach	AM Peak				PM Peak			
	DS	AVD	LS	95th% Queue Length	DS	AVD	LS	95th% Queue Length
South On Ramp One Way								
Left	-	-	-	-	-	-	-	-
Right	-	-	-	-	-	-	-	-
East Coxs Lane								
Left	0.027	6.1	A	0.0	0.027	6.1	A	0.0
Through	0.027	0.0	A	0.0	0.027	0.0	A	0.0
West Coxs Lane								
Through	0.026	0.0	A	0.3	0.026	0.0	A	0.4
Right	0.026	5.6	A	0.3	0.026	5.6	A	0.4
TOTAL - All Vehicles	**0.027**	**3.2**	**A**	**0.3**	**0.027**	**3.1**	**A**	**0.4**

Where: *DS* - *Degree of Saturation*
AVD - *Average Vehicle Delay in Seconds*
LS - *Level of Service*
95th% Queue Length - *95th% Queue Length in Metres*

TABLE 5.7

SIDRA MODELLING RESULTS FOR NELSON BAY ROAD/CABBAGE TREE ROAD/LAVIS LANE INTERSECTION IN WEEKDAY AM AND PM PEAK HOURS WITH PROJECT – ROUNDABOUT CONTROL

Approach	AM Peak				PM Peak			
	DS	AVD	LS	95th% Queue Length	DS	AVD	LS	95th% Queue Length
South Nelson Bay Road								
Left	0.409	6.8	A	20.6	0.458	6.9	A	23.5
Through	0.409	6.6	A	20.6	0.458	6.9	A	23.5
Right	0.409	13.6	A	18.4	0.458	13.9	A	21.1
East Lavis Lane								
Left	0.349	7.0	A	12.5	0.334	8.1	A	12.2
Through	0.349	6.8	A	12.5	0.334	7.9	A	12.2
Right	0.349	13.4	A	12.5	0.334	14.5	A	12.2
North Nelson Bay Road								
Left	0.292	5.7	A	10.7	0.337	5.7	A	13.7
Through	0.522	6.0	A	26.8	0.337	6.0	A	37.0
Right	0.522	13.2	A	26.8	0.603	13.2	A	37.0
West Cabbage Tree Road								
Left	0.177	5.6	A	7.3	0.108	6.2	A	3.6
Through	0.091	6.0	A	4.5	0.095	5.0	A	4.2
Right	0.091	14.9	A	4.5	0.095	12.2	A	4.2
TOTAL - All Vehicles	**0.522**	**7.0**	**A**	**26.8**	**0.603**	**7.3**	A	**37.0**

Where: *DS* - *Degree of Saturation*
AVD - *Average Vehicle Delay in Seconds*
LS - *Level of Service*
95th% Queue Length - *95th% Queue Length in Metres*

TABLE 5.8

SIDRA MODELLING RESULTS FOR NELSON BAY ROAD/SEASIDE BOULEVARD/FULLERTON COVE ROAD INTERSECTION IN WEEKDAY AM AND PM PEAK HOURS WITH PROJECT – ROUNDABOUT CONTROL

Approach	AM Peak				PM Peak			
	DS	AVD	LS	95th% Queue Length	DS	AVD	LS	95th% Queue Length
South Nelson Bay Road								
Left	0.301	5.1	A	12.7	0.336	4.8	A	14.3
Through	0.472	5.2	A	25.2	0.528	4.9	A	29.6
Right	0.472	11.7	A	25.2	0.528	11.4	A	29.6
East Seaside Boulevard								
Left	0.245	6.9	A	9.4	0.089	6.8	A	3.5
Through	0.144	11.0	A	4.6	0.048	11.0	A	1.8
Right	0.144	13.7	A	4.6	0.048	13.9	A	1.8
North Nelson Bay Road								
Left	0.279	4.8	A	10.9	0.332	5.4	A	12.5
Through	0.571	4.8	A	35.1	0.679	5.6	A	43.7
Right	0.571	13.2	A	35.1	0.679	12.1	A	43.7
U-turn	0.571	13.2	A	35.1	0.679	15.1	A	43.7
West Fullerton Cove Road								
Left	0.063	6.8	A	2.3	0.059	7.3	A	2.1
Through	0.063	6.8	A	2.3	0.059	8.2	A	2.1
Right	0.063	13.4	A	2.3	0.059	13.8	A	2.1
TOTAL - All Vehicles	**0.571**	**5.8**	A	**35.1**	**0.679**	**6.0**	A	**43.7**

Where: *DS* - *Degree of Saturation*
AVD - *Average Vehicle Delay in Seconds*
LS - *Level of Service*
95th% Queue Length - *95th% Queue Length in Metres*

5.3.3 Impact on Saturdays

Normal hours of operation on Saturdays are 6.15am to 12 noon and product transport is lower than for weekdays. This is expected to continue under the Project.

During major supply contracts Boral can extend the hours of operation and operate between 6.15am to 3.00pm which would increase the product transport on such days.

Daily traffic volumes using the road network adjacent Stockton Quarry on Saturdays are significantly lower than for weekdays, based on the traffic counts undertaken between 4-10 December 2018.

In this regard Saturday's traffic volumes in Nelson Bay Road near the quarry are between 29% - 34% lower on Saturdays compared to weekdays.

In Cabbage Tree Road, west of Nelson Bay Road, Saturday traffic volumes are 21% lower than weekday traffic volumes.

Therefore, the impacts on the road network of higher product transport on Saturdays would be less than what occurs on weekdays, due to the lower traffic volumes using the road network.

5.4 Assessment of Cumulative Impacts

As part of the SEARs the cumulative impacts for a future 10 year time frame are required to be examined.

Section 4.8 detailed recently approved developments and or changes to approved developments which may impact on future traffic volumes using the road network.

There has been considerable traffic growth in Nelson Bay Road over the last 10 years due to the level of new development in the area, and the historical traffic growth is a good indication of the likely future traffic growth.

The RMS traffic counting station in Nelson Bay Road, 310 metres east of Greenleaf Road on Stockton Bridge (Station ID 05962) shows that between 2008 and 2018 there was a 24% increase in daily traffic volumes using Nelson Bay Road in this 10 year period. The RMS counting station (ID 05191) which is located in Nelson Bay Road, 70 metres north of Moxley Close, Williamtown shows that for the 8 year period between 2008 and 2016 the traffic growth in daily traffic volumes was 20.2%, which is similar to the growth at the Stockton Bridge counting station.

Adopting this growth rate (i.e. a lineal increase of 2.4% per year) in Nelson Bay Road and at the principal intersections, will account for the future traffic growth associated with development in the area, including the remainder of the Fern Bay Seaside Village.

Future 2029 traffic volumes using the principal intersections in Nelson Bay Road adjacent the quarry have been calculated based on the 2.4% lineal increase per year.

As the Cabbage Tree Quarry is not operating as yet, the traffic volumes as described in Section 4.8 for this quarry, have been added at the Nelson Bay Road/Cabbage Tree Road/Lavis Lane roundabout.

The proposed new northern left in/left out intersection in Nelson Bay Road associated with Fern Bay's Seaside Village should be operating in 2029. However, the calculation of the 2029 base case volumes at the Nelson Bay Road/Seaside Boulevard/Fullerton Cove Road intersection has assumed, that all access to the subdivision will be via this roundabout intersection (i.e. no or limited use of the northern intersection). This will ensure a conservative or worse case is modelled for the roundabout.

The operation of the principal intersections in 2029 for the base case and with the additional traffic from the Project in the maximum hour, has been modelled using the SIDRA model. It is assumed that the traffic generation of the maximum hour for the Project will be the same for the life of the Project (i.e. before and after 2028).

The results of the modelling for the AM and PM peak hours in 2029 with the base case volumes, as well as with the Project, are shown in Tables 5.9 to 5.16.

Reference to Tables 5.9 to 5.12 which show the operation of the Coxs Lane/Off Ramp and Coxs Lane/On Ramp show that these intersections in 2029 with and without the Project will continue to operate a Level of Service A operation with very low vehicle delays. This indicates that the very good level of service will be maintained at these intersections in 2029, with the Project in place.

Tables 5.13 and 5.14 show the modelling results in 2029 with and without the Project, for the roundabout intersection of Nelson Bay Road/Cabbage Tree Road/Lavis Lane. Reference to these tables indicates that the intersection will retain a good operation with a Level of Service A operation, with little difference in terms of vehicle delay due to the Project's traffic volumes. The increase in the total average vehicle delay due to the Project will be 0.2 seconds in the AM peak hour and 1.0 second in the PM peak hour, which is a very small increase.

Tables 5.15 and 5.16 show the modelling results for 2029 with and without the Project for the roundabout intersection of Nelson Bay Road/Seaside Boulevard/Fullerton Cove Road. Reference to these tables indicates that the intersection will retain a Level of Service A operation with relatively low total average vehicle delays. The increase in the total average vehicle delay in 2029 due to the Project will be 0.3 seconds per vehicle in the AM peak hour and 0.8 seconds per vehicle in the PM peak hour, which is a very small increase.

Most of the increase in vehicle delay in 2029 as compared to 2019 conditions will be due to the growth in the background traffic at both the above roundabout intersections.

In summary, the assessment of the cumulative impacts at the principal intersections adjacent the quarry indicates that the cumulative impacts in the year 2029 will be satisfactory.

Extracts of the SIDRA traffic modelling outputs are contained in Appendix 1.

TABLE 5.9

SIDRA MODELLING RESULTS FOR COXS LANE/OFF RAMP INTERSECTION IN 2029 WEEKDAY AM AND PM PEAK HOURS BASE – PRIORITY CONTROL

Approach	AM Peak				PM Peak			
	DS	AVD	LS	95th% Queue Length	DS	AVD	LS	95th% Queue Length
South Off Ramp One Way								
Left	0.012	5.5	A	0.5	0.014	6.3	A	0.6
Right	0.012	6.2	A	0.5	0.014	6.7	A	0.6
East Coxs Lane								
Left	-	-	-	-	-	-	-	-
Through	0.001	0.0	A	0.0	0.003	0.0	A	0.0
West Coxs Lane								
Through	0.003	0.0	A	0.0	0.004	0.0	A	0.0
Right	-	-	-	-	-	-	-	-
TOTAL - All Vehicles	**0.012**	**3.4**	**A**	**0.5**	**0.014**	**3.4**	**A**	**0.6**

Where: *DS* - *Degree of Saturation*
AVD - *Average Vehicle Delay in Seconds*
LS - *Level of Service*
95th% Queue Length - *95th% Queue Length in Metres*

TABLE 5.10

SIDRA MODELLING RESULTS FOR COXS LANE/ON RAMP INTERSECTION IN 2029 WEEKDAY AM AND PM PEAK HOURS BASE – PRIORITY CONTROL

Approach	AM Peak				PM Peak			
	DS	AVD	LS	95th% Queue Length	DS	AVD	LS	95th% Queue Length
South On Ramp One Way								
Left	-	-	-	-	-	-	-	-
Right	-	-	-	-	-	-	-	-
East Coxs Lane								
Left	0.008	6.1	A	0.0	0.007	6.1	A	0.0
Through	0.008	0.0	A	0.0	0.007	0.0	A	0.0
West Coxs Lane								
Through	0.010	0.0	A	0.3	0.008	0.0	A	0.3
Right	0.010	5.6	A	0.3	0.008	5.5	A	0.3
TOTAL - All Vehicles	**0.010**	**3.4**	**A**	**0.3**	**0.008**	**2.8**	**A**	**0.3**

Where: *DS* - *Degree of Saturation*
AVD - *Average Vehicle Delay in Seconds*
LS - *Level of Service*
95th% Queue Length - *95th% Queue Length in Metres*

TABLE 5.11

SIDRA MODELLING RESULTS FOR COXS LANE/OFF RAMP INTERSECTION IN 2029 WEEKDAY AM AND PM PEAK HOURS WITH PROJECT – PRIORITY CONTROL

Approach	AM Peak				PM Peak			
	DS	AVD	LS	95th% Queue Length	DS	AVD	LS	95th% Queue Length
South Off Ramp One Way								
Left	0.043	6.3	A	1.7	0.041	5.5	A	1.6
Right	0.043	6.8	A	1.7	0.041	6.7	A	1.6
East Coxs Lane								
Left	-	-	-	-	-	-	-	-
Through	0.003	0.0	A	0.0	0.001	0.0	A	0.0
West Coxs Lane								
Through	0.004	0.0	A	0.0	0.003	0.0	A	0.0
Right	-	-	-	-	-	-	-	-
TOTAL - All Vehicles	**0.043**	**5.0**	**A**	**1.7**	**0.041**	**5.3**	**A**	**1.6**

Where: *DS* - *Degree of Saturation*
AVD - *Average Vehicle Delay in Seconds*
LS - *Level of Service*
95th% Queue Length - *95th% Queue Length in Metres*

TABLE 5.12

SIDRA MODELLING RESULTS FOR COXS LANE/ON RAMP INTERSECTION IN 2029 WEEKDAY AM AND PM PEAK HOURS WITH PROJECT – PRIORITY CONTROL

Approach	AM Peak				PM Peak			
	DS	AVD	LS	95th% Queue Length	DS	AVD	LS	95th% Queue Length
South On Ramp One Way								
Left	-	-	-	-	-	-	-	-
Right	-	-	-	-	-	-	-	-
East Coxs Lane								
Left	0.027	6.1	A	0.0	0.030	6.6	A	0.0
Through	0.027	0.0	A	0.0	0.030	0.0	A	0.0
West Coxs Lane								
Through	0.028	0.0	A	0.4	0.028	0.0	A	0.4
Right	0.028	5.6	A	0.4	0.028	5.6	A	0.4
TOTAL - All Vehicles	**0.028**	**3.1**	**A**	**0.4**	**0.028**	**3.3**	**A**	**0.4**

Where: *DS* - *Degree of Saturation*
AVD - *Average Vehicle Delay in Seconds*
LS - *Level of Service*
95th% Queue Length - *95th% Queue Length in Metres*

TABLE 5.13

SIDRA MODELLING RESULTS FOR NELSON BAY ROAD/CABBAGE TREE ROAD/LAVIS LANE INTERSECTION IN 2029 WEEKDAY AM AND PM PEAK HOURS BASE – ROUNDABOUT CONTROL

Approach	AM Peak				PM Peak			
	DS	AVD	LS	95th% Queue Length	DS	AVD	LS	95th% Queue Length
South Nelson Bay Road								
Left	0.539	7.1	A	30.2	0.610	8.0	A	39.7
Through	0.539	7.3	A	30.2	0.610	8.4	A	39.7
Right	0.539	14.3	A	28.4	0.610	15.6	B	38.1
East Lavis Lane								
Left	0.550	11.7	A	27.9	0.591	16.6	B	31.2
Through	0.550	11.5	A	27.9	0.591	16.4	B	31.2
Right	0.550	18.1	B	27.9	0.591	23.0	B	31.2
North Nelson Bay Road								
Left	0.372	5.8	A	14.9	0.430	5.9	A	19.6
Through	0.667	6.2	A	42.9	0.769	6.3	A	66.7
Right	0.667	13.5	A	42.9	0.769	13.6	A	66.7
West Cabbage Tree Road								
Left	0.264	6.4	A	12.2	0.127	6.1	A	5.1
Through	0.113	6.6	A	4.6	0.182	6.8	A	6.6
Right	0.113	14.3	A	4.6	0.182	13.5	A	6.6
U-turn	0.113	20.6	B	4.6	0.182	20.7	B	6.6
TOTAL - All Vehicles	**0.667**	**7.9**	**A**	**42.9**	**0.769**	**8.7**	A	**66.7**

Where: *DS* - *Degree of Saturation*
AVD - *Average Vehicle Delay in Seconds*
LS - *Level of Service*
95th% Queue Length - *95th% Queue Length in Metres*

TABLE 5.14

SIDRA MODELLING RESULTS FOR NELSON BAY ROAD/CABBAGE TREE ROAD/LAVIS LANE INTERSECTION IN 2029 WEEKDAY AM AND PM PEAK HOURS WITH PROJECT – ROUNDABOUT CONTROL

Approach	AM Peak				PM Peak			
	DS	AVD	LS	95th% Queue Length	DS	AVD	LS	95th% Queue Length
South Nelson Bay Road								
Left	0.550	7.4	A	32.5	0.621	8.4	A	43.2
Through	0.550	7.4	A	32.5	0.621	8.5	A	43.2
Right	0.550	14.4	A	29.7	0.621	15.7	B	39.9
East Lavis Lane								
Left	0.576	12.6	A	30.4	0.629	18.7	B	34.7
Through	0.576	12.4	A	30.4	0.629	18.5	B	34.7
Right	0.576	19.0	B	30.4	0.629	25.1	B	34.7
North Nelson Bay Road								
Left	0.382	5.9	A	15.5	0.440	6.0	A	20.2
Through	0.683	6.3	A	45.3	0.788	6.5	A	69.6
Right	0.683	13.7	A	45.3	0.788	13.8	A	69.6
West Cabbage Tree Road								
Left	0.267	6.4	A	12.4	0.179	7.4	A	6.5
Through	0.159	6.7	A	8.2	0.165	5.7	A	8.2
Right	0.159	15.6	A	8.2	0.165	13.0	A	8.2
U-turn	0.159	20.6	B	8.2	0.165	17.9	B	8.2
TOTAL - All Vehicles	**0.683**	**8.1**	**A**	**26.8**	**0.788**	**9.7**	A	**69.6**

Where: *DS* - *Degree of Saturation*
AVD - *Average Vehicle Delay in Seconds*
LS - *Level of Service*
95th% Queue Length - *95th% Queue Length in Metres*

TABLE 5.15

SIDRA MODELLING RESULTS FOR NELSON BAY ROAD/SEASIDE BOULEVARD/FULLERTON COVE ROAD INTERSECTION IN 2029 WEEKDAY AM AND PM PEAK HOURS BASE – ROUNDABOUT CONTROL

Approach	AM Peak				PM Peak			
	DS	AVD	LS	95th% Queue Length	DS	AVD	LS	95th% Queue Length
South Nelson Bay Road								
Left	0.371	5.1	A	17.7	0.400	4.6	A	20.2
Through	0.582	5.2	A	38.5	0.628	4.8	A	46.8
Right	0.582	11.8	A	38.5	0.628	11.3	A	46.8
East Seaside Boulevard								
Left	0.386	9.6	A	18.5	0.156	9.0	A	7.4
Through	0.230	14.1	A	8.5	0.087	14.1	A	4.0
Right	0.230	15.8	B	8.5	0.087	16.2	B	4.0
North Nelson Bay Road								
Left	0.343	5.0	A	14.4	0.410	5.8	A	16.5
Through	0.702	5.1	A	53.3	0.839	7.6	A	91.1
Right	0.702	11.6	A	53.3	0.839	14.6	B	91.1
U-turn	0.702	13.5	A	53.3	0.839	15.5	B	91.1
West Fullerton Cove Road								
Left	0.100	8.1	A	4.1	0.091	8.9	A	3.5
Through	0.100	12.6	A	4.1	0.091	10.4	A	3.5
Right	0.100	14.7	B	4.1	0.091	15.6	B	3.5
TOTAL - All Vehicles	**0.702**	**6.2**	**A**	**53.3**	**0.839**	**6.8**	A	**91.1**

Where: *DS* - *Degree of Saturation*
AVD - *Average Vehicle Delay in Seconds*
LS - *Level of Service*
95th% Queue Length - *95th% Queue Length in Metres*

TABLE 5.16

SIDRA MODELLING RESULTS FOR NELSON BAY ROAD/SEASIDE BOULEVARD/FULLERTON COVE ROAD INTERSECTION IN 2029 WEEKDAY AM AND PM PEAK HOURS WITH PROJECT – ROUNDABOUT CONTROL

Approach	AM Peak				PM Peak			
	DS	AVD	LS	95th% Queue Length	DS	AVD	LS	95th% Queue Length
South Nelson Bay Road								
Left	0.390	5.3	A	18.0	0.429	4.9	A	21.4
Through	0.612	5.5	A	39.6	0.673	5.1	A	50.9
Right	0.612	12.1	A	39.6	0.673	11.6	A	50.9
East Seaside Boulevard								
Left	0.415	10.8	A	21.2	0.177	9.7	A	8.8
Through	0.245	15.1	A	9.3	0.097	15.1	A	4.6
Right	0.245	16.5	B	9.3	0.097	17.0	B	4.6
North Nelson Bay Road								
Left	0.358	5.0	A	15.5	0.430	5.8	A	18.3
Through	0.733	5.1	A	62.3	0.880	8.6	A	121.7
Right	0.733	11.6	A	62.3	0.880	15.8	B	121.7
U-turn	0.733	14.2	A	62.3	0.880	19.8	B	121.7
West Fullerton Cove Road								
Left	0.107	8.6	A	4.5	0.102	9.7	A	4.1
Through	0.107	13.4	A	4.5	0.102	11.3	A	4.1
Right	0.107	15.3	B	4.5	0.102	16.3	B	4.1
TOTAL - All Vehicles	**0.733**	**6.5**	**A**	**62.3**	**0.880**	**7.6**	A	**121.7**

Where: *DS* - *Degree of Saturation*
AVD - *Average Vehicle Delay in Seconds*
LS - *Level of Service*
95th% Queue Length - *95th% Queue Length in Metres*

5.4 Construction Impacts

The construction of new infrastructure associated with the Project will be undertaken in Stage 1 and will include:

- A new entry road and haul road;
- A separated exit road to allow trucks exiting the site to use the weighbridge;
- Installation of a new prefabricated office building;
- Relocation of light vehicle parking;
- Relocation of entry gates (inside Boral's boundary);
- Relocation of onsite storage facilities; and
- Relocation of the docketing kiosk.

Construction vehicles will include low loaders delivering earth working equipment, semi trailers and truck and dog trailers delivering road pavement and hard stand materials, concrete agitator trucks and light vehicles associated with the workforce.

Light vehicles are expected to number up to 6 vehicles per day (6 in/6 out). Heavy vehicles are expected to number between 5-15 vehicles per day (i.e. 5-15 in/5-15 out). All construction vehicles will access the site via Coxs Lane and Nelson Bay Road.

The number of construction vehicles accessing the quarry site per hour and on a daily basis will be less than what has been assessed for the operational impacts.

Therefore, the traffic impacts associated with construction are assessed as satisfactory.

5.6 Pedestrian, Cyclist and Public Transport

The Project is not expected to have any negative impacts on pedestrians, cyclists and buses that use Nelson Bay Road and the other roads that form the transport routes.

Boral's trucks already use these roads and the increase in the number of trucks would not negatively impact on other road uses.

Pedestrian crossing volumes on the transport routes are relatively low. Similarly, cyclist numbers are also low. Nelson Bay Road has road shoulder areas suitable for cyclists to use except at the bridge over Coxs Lane. Port Stephens Council is proposing a new shared path in Fullerton Cove Road which will be an alternative route to Nelson Bay Road between Seaside Boulevard and south of Cabbage Tree Road, for cyclists to use.

It would be expected that future upgrades to Nelson Bay Road will include suitable measures for cyclists.

5.7 Road Safety

The Project is not expected to have any negative impacts on road safety. The section of Nelson Bay Road adjacent Stockton Quarry, as well as the other roads that form the transport routes are all approved 25/26 metre B-double routes. The traffic modelling shows that the principal intersections used by Boral's product trucks will have sufficient capacity to cater for background traffic growth as well as the Project's traffic for the next 10 years.

As previously noted, NSW Government has upgraded sections of the road network in the area and is continuing to upgrade the section of Nelson Bay Road at and north of Williamtown. The section of Nelson Bay Road between Cabbage Tree Road and Fullerton Street is currently being investigated by the NSW Government for future road upgrades, and it would be expected that road upgrades will occur within the medium term (4-10 years).

5.8 Internal Site Changes

Boral will make changes to the internal operation of the quarry and upgrade/supplement the existing infrastructure as described in Section 3.2.

New internal roads will be designed and constructed to AS2890.2 requirements for one way or two way flow as appropriate to cater for the quarry's heavy vehicles.

The new parking area for the light vehicles will be designed and constructed to AS2890.1 requirements.

Sufficient parking will be provided for employees and visitors.

In concluding, all the internal changes to the quarry on site operation for the Project will be designed and constructed to AS2890.1 and AS2890.2, as appropriate.

6.0 CONCLUSIONS

This report documents the assessment of the traffic impacts for the Project at 32 Coxs Lane Fullerton Cove.

Boral operates a quarry at this site that extracts and transports up to 500,000tpa of sand product under the existing windblown sand extraction area development consent (DA 140-5-2006), which will cease operation in 2028.

Due to current and future demand for sand in the local Hunter and Sydney regions, Boral is seeking approval for continued and expanded operations at the site. The Project involves the extraction of sand from the inland vegetated dunes by front-end loader/excavator to a depth of 4 m AHD and subsequent dredging from 4 m AHD to 15 m below sea level (-15 m AHD).

The Project would seek to permit a site wide increase on the dispatch limit to 750,000 tpa (i.e. the windblown sand extraction area and the Project operations combined) up until 2028. As part of the Project, 70,000tpa of VENM will be imported to the quarry by road.

After 2028 and extraction of sand on the windblown dunes would cease and transportation associated with the Project will reduce to a maximum of 500,000tpa.

Vehicle access to the quarry is via Coxs Lane, which has on/off ramps to/from Nelson Bay Road. Other principal intersections adjacent Stockton Quarry include the intersections of Nelson Bay Road/Cabbage Tree Road/Lavis Lane and Nelson Bay Road/Seaside Boulevard/Fullerton Cove Road, which are two lane roundabouts in Nelson Bay Road, north and south of Coxs Lane.

The quarry currently employs 5 people at the site which will increase to 9 people with the Project. Boral also employs truck drivers and associated support personnel.

The assessment of the traffic impacts of the additional trucks associated with the operation of the Project on the adjacent road network including the principal intersections adjacent the quarry has found that the impacts will be satisfactory.

The assessment of the cumulative impacts for the future 2029 year with the Project also concludes that the traffic impacts on the principal intersections will be satisfactory.

Construction traffic impacts are also assessed as satisfactory, as the number of construction vehicles are relatively low in number and less than what has been assessed for the operational impacts.

The Project is not expected to have any negative impacts on other road users including pedestrians, cyclists and public transport vehicles (buses), and or on road safety.

After 2028, total sand product and VENM truck numbers generated by the Quarry will reduce.

REFERENCES

1. Austroads Guide to Road Design

2. RMS Guide to Traffic Generating Development October 2002

3. Austroads Guide to Traffic Management

4. RMS Austroads Guide Supplements – Austroads Guide to Traffic Management

5. RMS Supplement to Austroads Guide to Road Design

6. Austroads Guide to Traffic Management Part 12 – Traffic Impact of Developments

7. RMS Crash Data for Nelson Bay Road between Cabbage Tree Road Williamtown and Fullerton Street Fern Bay for period 1 July 2015 to 30 June 2018

8. RMS Website
    - Traffic Volume Viewer
    - Road Upgrades

APPENDIX 1

Extracts of SIDRA Modelling Outputs

MOVEMENT SUMMARY

▽ Site: 101 [Cox Lane & On Ramp -Ex AM]

Ex AM
Site Category: (None)
Giveway / Yield (Two-Way)

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
East: Cox Lane												
4	L2	6	100.0	0.006	6.1	LOS A	0.0	0.0	0.00	0.53	0.00	52.1
5	T1	1	0.0	0.006	0.0	LOS A	0.0	0.0	0.00	0.53	0.00	55.7
Approach		7	85.7	0.006	5.6	NA	0.0	0.0	0.00	0.53	0.00	52.6
West: Cox Lane												
11	T1	7	100.0	0.008	0.0	LOS A	0.0	0.2	0.04	0.15	0.04	57.7
12	R2	5	0.0	0.008	5.5	LOS A	0.0	0.2	0.04	0.15	0.04	55.8
Approach		12	58.3	0.008	1.5	NA	0.0	0.2	0.04	0.15	0.04	56.9
All Vehicles		19	68.4	0.008	3.4	NA	0.0	0.2	0.02	0.29	0.02	55.2

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

▽ Site: 101 [Cox Lane & On Ramp -Ex PM]

Ex PM
Site Category: (None)
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
East: Cox Lane												
4	L2	4	100.0	0.005	6.1	LOS A	0.0	0.0	0.00	0.42	0.00	53.3
5	T1	3	0.0	0.005	0.0	LOS A	0.0	0.0	0.00	0.42	0.00	57.0
Approach		7	57.1	0.005	4.4	NA	0.0	0.0	0.00	0.42	0.00	54.9
West: Cox Lane												
11	T1	5	80.0	0.006	0.0	LOS A	0.0	0.2	0.04	0.32	0.04	55.6
12	R2	6	0.0	0.006	5.5	LOS A	0.0	0.2	0.04	0.32	0.04	53.9
Approach		11	36.4	0.006	3.0	NA	0.0	0.2	0.04	0.32	0.04	54.6
All Vehicles		18	44.4	0.006	3.2	NA	0.0	0.2	0.03	0.36	0.03	54.7

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

▽ Site: 101 [Cox Lane & Off Ramp -Ex PM]

Ex PM
Site Category: (None)
Giveway / Yield (Two-Way)

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Off Ramp												
1	L2	4	75.0	0.009	6.4	LOS A	0.0	0.4	0.03	0.58	0.03	50.5
3	R2	5	80.0	0.009	6.6	LOS A	0.0	0.4	0.03	0.58	0.03	49.4
Approach		9	77.8	0.009	6.5	LOS A	0.0	0.4	0.03	0.58	0.03	49.9
East: Cox Lane												
5	T1	3	0.0	0.002	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
Approach		3	0.0	0.002	0.0	NA	0.0	0.0	0.00	0.00	0.00	60.0
West: Cox Lane												
11	T1	6	0.0	0.003	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
Approach		6	0.0	0.003	0.0	NA	0.0	0.0	0.00	0.00	0.00	60.0
All Vehicles		18	38.9	0.009	3.3	NA	0.0	0.4	0.02	0.29	0.02	54.5

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

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MOVEMENT SUMMARY

▽ Site: 101 [Cox Lane & Off Ramp -Ex AM]

Ex AM
Site Category: (None)
Giveway / Yield (Two-Way)

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Off Ramp												
1	L2	1	0.0	0.009	5.5	LOS A	0.0	0.3	0.02	0.60	0.02	53.5
3	R2	7	100.0	0.009	6.2	LOS A	0.0	0.3	0.02	0.60	0.02	50.7
Approach		8	87.5	0.009	6.2	LOS A	0.0	0.3	0.02	0.60	0.02	51.0
East: Cox Lane												
5	T1	1	0.0	0.001	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
Approach		1	0.0	0.001	0.0	NA	0.0	0.0	0.00	0.00	0.00	60.0
West: Cox Lane												
11	T1	5	0.0	0.002	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
Approach		5	0.0	0.002	0.0	NA	0.0	0.0	0.00	0.00	0.00	60.0
All Vehicles		14	50.0	0.009	3.5	NA	0.0	0.3	0.01	0.34	0.01	54.5

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Nelsons Bay Rd & Cabbage Tree Rd - Ex AM]

Ex AM
Site Category: (None)
Roundabout

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Nelsons Bay Rd												
1	L2	90	13.3	0.400	6.5	LOS A	2.5	19.0	0.45	0.53	0.45	59.8
2	T1	887	2.1	0.400	6.6	LOS A	2.5	19.0	0.46	0.54	0.46	67.8
3	R2	45	0.0	0.400	13.6	LOS A	2.4	17.7	0.47	0.56	0.47	63.0
Approach		1022	3.0	0.400	6.9	LOS A	2.5	19.0	0.46	0.54	0.46	66.8
East: Lavis Lane												
4	L2	133	0.8	0.341	6.8	LOS A	1.7	11.8	0.68	0.82	0.69	57.2
5	T1	50	0.0	0.341	6.6	LOS A	1.7	11.8	0.68	0.82	0.69	54.6
6	R2	96	1.0	0.341	13.2	LOS A	1.7	11.8	0.68	0.82	0.69	59.1
Approach		279	0.7	0.341	9.0	LOS A	1.7	11.8	0.68	0.82	0.69	57.3
North: Nelsons Bay Rd												
7	L2	138	0.7	0.285	5.6	LOS A	1.4	10.2	0.23	0.47	0.23	61.6
8	T1	929	3.1	0.509	5.9	LOS A	3.5	25.4	0.26	0.47	0.26	69.0
9	R2	94	23.4	0.509	13.1	LOS A	3.5	25.4	0.27	0.48	0.27	63.4
Approach		1161	4.5	0.509	6.4	LOS A	3.5	25.4	0.26	0.47	0.26	67.6
West: Cabbage Tree Rd												
10	L2	164	12.8	0.176	5.6	LOS A	0.8	7.2	0.63	0.67	0.63	56.9
11	T1	14	0.0	0.054	6.0	LOS A	0.2	1.8	0.61	0.75	0.61	53.8
12	R2	20	15.0	0.054	13.2	LOS A	0.2	1.8	0.61	0.75	0.61	55.0
Approach		198	12.1	0.176	6.4	LOS A	0.8	7.2	0.63	0.69	0.63	56.5
All Vehicles		2660	4.1	0.509	6.9	LOS A	3.5	25.4	0.41	0.55	0.41	65.1

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Nelsons Bay Rd & Cabbage Tree Rd - Ex PM]

Ex PM
Site Category: (None)
Roundabout

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Nelsons Bay Rd												
1	L2	115	8.7	0.449	6.7	LOS A	2.9	21.7	0.51	0.55	0.51	59.6
2	T1	982	1.6	0.449	6.9	LOS A	2.9	21.7	0.52	0.56	0.52	67.6
3	R2	19	0.0	0.449	13.9	LOS A	2.8	20.4	0.53	0.57	0.53	62.8
Approach		1116	2.3	0.449	7.0	LOS A	2.9	21.7	0.52	0.56	0.52	66.6
East: Lavis Lane												
4	L2	91	0.0	0.323	7.8	LOS A	1.6	11.4	0.74	0.86	0.75	56.4
5	T1	51	0.0	0.323	7.6	LOS A	1.6	11.4	0.74	0.86	0.75	53.7
6	R2	88	0.0	0.323	14.2	LOS A	1.6	11.4	0.74	0.86	0.75	58.3
Approach		230	0.0	0.323	10.2	LOS A	1.6	11.4	0.74	0.86	0.75	56.5
North: Nelsons Bay Rd												
7	L2	67	0.0	0.329	5.6	LOS A	1.9	13.3	0.27	0.46	0.27	61.3
8	T1	1126	1.4	0.588	5.9	LOS A	4.9	35.6	0.32	0.48	0.32	68.8
9	R2	148	13.5	0.588	13.0	LOS A	4.9	35.6	0.34	0.49	0.34	63.1
Approach		1341	2.7	0.588	6.7	LOS A	4.9	35.6	0.32	0.48	0.32	67.7
West: Cabbage Tree Rd												
10	L2	77	5.2	0.082	5.4	LOS A	0.4	2.9	0.63	0.65	0.63	58.6
11	T1	19	0.0	0.092	5.7	LOS A	0.4	2.8	0.64	0.77	0.64	53.4
12	R2	49	0.0	0.092	12.3	LOS A	0.4	2.8	0.64	0.77	0.64	57.8
Approach		145	2.8	0.092	7.7	LOS A	0.4	2.9	0.63	0.71	0.63	57.6
All Vehicles		2832	2.3	0.588	7.2	LOS A	4.9	35.6	0.45	0.56	0.45	65.6

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Nelsons Bay Rd & Seaside Blve - Ex AM]

Ex AM
Site Category: (None)
Roundabout

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Nelsons Bay Rd												
1	L2	16	0.0	0.285	4.8	LOS A	1.6	12.1	0.30	0.43	0.30	58.7
2	T1	993	3.4	0.447	5.0	LOS A	3.2	24.1	0.33	0.44	0.33	63.9
3	R2	25	4.0	0.447	11.5	LOS A	3.2	24.1	0.34	0.44	0.34	61.3
Approach		1034	3.4	0.447	5.1	LOS A	3.2	24.1	0.33	0.44	0.33	63.8
East: Seaside Blvde												
4	L2	231	1.7	0.236	6.6	LOS A	1.2	8.9	0.69	0.78	0.69	57.1
5	T1	1	100.0	0.139	10.5	LOS A	0.6	4.4	0.65	0.86	0.65	51.3
6	R2	99	0.0	0.139	13.4	LOS A	0.6	4.4	0.65	0.86	0.65	54.3
Approach		331	1.5	0.236	8.6	LOS A	1.2	8.9	0.68	0.80	0.68	56.2
North: Nelsons Bay Rd												
7	L2	38	7.9	0.266	4.8	LOS A	1.4	10.1	0.23	0.41	0.23	59.0
8	T1	1159	2.6	0.544	4.8	LOS A	4.3	30.8	0.27	0.41	0.27	64.5
9	R2	5	0.0	0.544	11.3	LOS A	4.3	30.8	0.28	0.41	0.28	62.0
9u	U	3	100.0	0.544	13.1	LOS A	4.3	30.8	0.28	0.41	0.28	62.2
Approach		1205	3.0	0.544	4.9	LOS A	4.3	30.8	0.27	0.41	0.27	64.3
West: Fullerton Cove Rd												
10	L2	1	0.0	0.060	6.5	LOS A	0.3	2.1	0.64	0.80	0.64	52.9
11	T1	1	0.0	0.060	6.5	LOS A	0.3	2.1	0.64	0.80	0.64	52.2
12	R2	41	7.3	0.060	13.1	LOS A	0.3	2.1	0.64	0.80	0.64	53.3
Approach		43	7.0	0.060	12.8	LOS A	0.3	2.1	0.64	0.80	0.64	53.2
All Vehicles		2613	3.0	0.544	5.6	LOS A	4.3	30.8	0.35	0.48	0.35	62.7

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Nelsons Bay Rd & Seaside Blve - Ex PM]

Ex PM
Site Category: (None)
Roundabout

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Nelsons Bay Rd												
1	L2	40	2.5	0.312	4.5	LOS A	1.9	13.7	0.17	0.39	0.17	59.5
2	T1	1065	2.3	0.490	4.6	LOS A	3.8	28.0	0.18	0.42	0.18	64.5
3	R2	151	2.0	0.490	11.2	LOS A	3.8	28.0	0.19	0.44	0.19	61.6
Approach		1256	2.3	0.490	5.4	LOS A	3.8	28.0	0.18	0.42	0.18	63.9
East: Seaside Blvde												
4	L2	74	1.4	0.083	6.5	LOS A	0.4	3.2	0.71	0.72	0.71	57.0
5	T1	1	100.0	0.045	10.5	LOS A	0.2	1.7	0.68	0.80	0.68	51.2
6	R2	27	3.7	0.045	13.5	LOS A	0.2	1.7	0.68	0.80	0.68	53.5
Approach		102	2.9	0.083	8.4	LOS A	0.4	3.2	0.70	0.74	0.70	55.9
North: Nelsons Bay Rd												
7	L2	105	0.0	0.314	5.4	LOS A	1.6	11.3	0.37	0.50	0.37	58.4
8	T1	1187	1.3	0.643	5.5	LOS A	5.2	36.7	0.47	0.49	0.47	63.1
9	R2	6	0.0	0.643	12.1	LOS A	5.2	36.7	0.49	0.48	0.49	60.6
9u	U	2	0.0	0.643	13.0	LOS A	5.2	36.7	0.49	0.48	0.49	62.8
Approach		1300	1.2	0.643	5.6	LOS A	5.2	36.7	0.46	0.49	0.46	62.7
West: Fullerton Cove Rd												
10	L2	7	0.0	0.054	6.9	LOS A	0.2	1.8	0.64	0.78	0.64	53.5
11	T1	4	25.0	0.054	7.8	LOS A	0.2	1.8	0.64	0.78	0.64	52.5
12	R2	28	3.6	0.054	13.4	LOS A	0.2	1.8	0.64	0.78	0.64	54.7
Approach		39	5.1	0.054	11.6	LOS A	0.2	1.8	0.64	0.78	0.64	54.3
All Vehicles		2697	1.9	0.643	5.7	LOS A	5.2	36.7	0.34	0.47	0.34	62.8

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

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MOVEMENT SUMMARY

▽ Site: 101 [Cox Lane & Off Ramp - AM Prop]

AM with Boral Proposal
Site Category: (None)
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Off Ramp												
1	L2	1	0.0	0.036	5.5	LOS A	0.1	1.5	0.04	0.60	0.04	53.5
3	R2	30	100.0	0.036	6.2	LOS A	0.1	1.5	0.04	0.60	0.04	50.6
Approach		31	96.8	0.036	6.2	LOS A	0.1	1.5	0.04	0.60	0.04	50.7
East: Cox Lane												
5	T1	1	0.0	0.001	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
Approach		1	0.0	0.001	0.0	NA	0.0	0.0	0.00	0.00	0.00	60.0
West: Cox Lane												
11	T1	5	0.0	0.002	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
Approach		5	0.0	0.002	0.0	NA	0.0	0.0	0.00	0.00	0.00	60.0
All Vehicles		37	81.1	0.036	5.2	NA	0.1	1.5	0.03	0.50	0.03	52.0

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

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MOVEMENT SUMMARY

▽ Site: 101 [Cox Lane & Off Ramp -PM Prop]

PM with Boral Proposal
Site Category: (None)
Giveway / Yield (Two-Way)

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Off Ramp												
1	L2	4	75.0	0.040	6.4	LOS A	0.1	1.6	0.04	0.59	0.04	50.4
3	R2	31	96.8	0.040	6.8	LOS A	0.1	1.6	0.04	0.59	0.04	48.7
Approach		35	94.3	0.040	6.8	LOS A	0.1	1.6	0.04	0.59	0.04	48.9
East: Cox Lane												
5	T1	3	0.0	0.002	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
Approach		3	0.0	0.002	0.0	NA	0.0	0.0	0.00	0.00	0.00	60.0
West: Cox Lane												
11	T1	6	0.0	0.003	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
Approach		6	0.0	0.003	0.0	NA	0.0	0.0	0.00	0.00	0.00	60.0
All Vehicles		44	75.0	0.040	5.4	NA	0.1	1.6	0.03	0.47	0.03	50.8

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

▽ Site: 101 [Cox Lane & On Ramp - AM Prop]

AM with Boral Proposal
Site Category: (None)
Giveway / Yield (Two-Way)

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
East: Cox Lane												
4	L2	30	100.0	0.027	6.1	LOS A	0.0	0.0	0.00	0.56	0.00	51.7
5	T1	1	0.0	0.027	0.0	LOS A	0.0	0.0	0.00	0.56	0.00	55.1
Approach		31	96.8	0.027	6.0	NA	0.0	0.0	0.00	0.56	0.00	51.8
West: Cox Lane												
11	T1	30	100.0	0.026	0.0	LOS A	0.0	0.3	0.04	0.05	0.04	59.1
12	R2	5	0.0	0.026	5.6	LOS A	0.0	0.3	0.04	0.05	0.04	57.2
Approach		35	85.7	0.026	0.5	NA	0.0	0.3	0.04	0.05	0.04	58.8
All Vehicles		66	90.9	0.027	3.2	NA	0.0	0.3	0.02	0.29	0.02	55.3

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

▽ Site: 101 [Cox Lane & On Ramp -PM Prop]

PM with Boral Proposal
Site Category: (None)
Giveway / Yield (Two-Way)

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
East: Cox Lane												
4	L2	30	100.0	0.027	6.1	LOS A	0.0	0.0	0.00	0.54	0.00	51.9
5	T1	3	0.0	0.027	0.0	LOS A	0.0	0.0	0.00	0.54	0.00	55.4
Approach		33	90.9	0.027	5.8	NA	0.0	0.0	0.00	0.54	0.00	52.2
West: Cox Lane												
11	T1	31	96.8	0.026	0.0	LOS A	0.0	0.4	0.04	0.10	0.04	55.6
12	R2	6	0.0	0.026	5.6	LOS A	0.0	0.4	0.04	0.10	0.04	53.9
Approach		37	81.1	0.026	0.9	NA	0.0	0.4	0.04	0.10	0.04	55.3
All Vehicles		70	85.7	0.027	3.1	NA	0.0	0.4	0.02	0.31	0.02	53.8

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Nelsons Bay Rd & Cabbage Tree Rd - AM Prop]

AM with Proposal
Site Category: (None)
Roundabout

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Nelsons Bay Rd												
1	L2	103	26.2	0.409	6.8	LOS A	2.6	20.6	0.46	0.53	0.46	59.4
2	T1	888	2.3	0.409	6.6	LOS A	2.6	20.6	0.47	0.54	0.47	67.7
3	R2	45	0.0	0.409	13.6	LOS A	2.5	18.4	0.48	0.56	0.48	63.0
Approach		1036	4.5	0.409	7.0	LOS A	2.6	20.6	0.47	0.54	0.47	66.6
East: Lavis Lane												
4	L2	133	0.8	0.349	7.0	LOS A	1.8	12.5	0.70	0.83	0.72	57.0
5	T1	50	0.0	0.349	6.8	LOS A	1.8	12.5	0.70	0.83	0.72	54.5
6	R2	96	1.0	0.349	13.4	LOS A	1.8	12.5	0.70	0.83	0.72	58.9
Approach		279	0.7	0.349	9.2	LOS A	1.8	12.5	0.70	0.83	0.72	57.2
North: Nelsons Bay Rd												
7	L2	138	0.7	0.292	5.7	LOS A	1.5	10.7	0.27	0.48	0.27	61.4
8	T1	930	3.2	0.522	6.0	LOS A	3.7	26.8	0.31	0.49	0.31	68.6
9	R2	94	23.4	0.522	13.2	LOS A	3.7	26.8	0.32	0.49	0.32	63.1
Approach		1162	4.6	0.522	6.5	LOS A	3.7	26.8	0.30	0.49	0.30	67.2
West: Cabbage Tree Rd												
10	L2	164	12.8	0.177	5.6	LOS A	0.8	7.3	0.63	0.68	0.63	56.9
11	T1	14	0.0	0.091	6.0	LOS A	0.4	4.5	0.64	0.81	0.64	53.5
12	R2	33	54.5	0.091	14.9	LOS B	0.4	4.5	0.64	0.81	0.64	47.6
Approach		211	18.5	0.177	7.1	LOS A	0.8	7.3	0.63	0.71	0.63	54.9
All Vehicles		2688	5.2	0.522	7.0	LOS A	3.7	26.8	0.43	0.56	0.44	64.7

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Nelsons Bay Rd & Cabbage Tree Rd - PM Dev]

PM with Boral Proposal
Site Category: (None)
Roundabout

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Nelsons Bay Rd												
1	L2	128	19.5	0.458	6.9	LOS A	3.0	23.5	0.52	0.56	0.52	59.3
2	T1	983	1.7	0.458	6.9	LOS A	3.0	23.5	0.52	0.56	0.52	67.6
3	R2	19	0.0	0.458	13.9	LOS A	2.9	21.1	0.53	0.57	0.53	62.8
Approach		1130	3.7	0.458	7.1	LOS A	3.0	23.5	0.52	0.56	0.52	66.4
East: Lavis Lane												
4	L2	91	0.0	0.334	8.1	LOS A	1.7	12.2	0.76	0.88	0.79	56.2
5	T1	51	0.0	0.334	7.9	LOS A	1.7	12.2	0.76	0.88	0.79	53.6
6	R2	88	0.0	0.334	14.5	LOS A	1.7	12.2	0.76	0.88	0.79	58.1
Approach		230	0.0	0.334	10.5	LOS A	1.7	12.2	0.76	0.88	0.79	56.3
North: Nelsons Bay Rd												
7	L2	67	0.0	0.337	5.7	LOS A	1.9	13.7	0.31	0.48	0.31	61.1
8	T1	1127	1.5	0.603	6.0	LOS A	5.1	37.0	0.37	0.50	0.37	68.4
9	R2	148	13.5	0.603	13.2	LOS A	5.1	37.0	0.39	0.51	0.39	62.7
Approach		1342	2.8	0.603	6.8	LOS A	5.1	37.0	0.37	0.50	0.37	67.3
West: Cabbage Tree Rd												
10	L2	77	5.2	0.108	6.2	LOS A	0.5	3.6	0.65	0.75	0.65	58.5
11	T1	19	0.0	0.095	5.0	LOS A	0.4	4.2	0.64	0.74	0.64	53.5
12	R2	62	24.2	0.095	12.2	LOS A	0.4	4.2	0.64	0.74	0.64	52.9
Approach		158	12.0	0.108	8.4	LOS A	0.5	4.2	0.64	0.75	0.64	55.5
All Vehicles		2860	3.4	0.603	7.3	LOS A	5.1	37.0	0.48	0.57	0.48	65.2

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Nelsons Bay Rd & Seaside Blve - AM Prop]

AM with Boral Proposal
Site Category: (None)
Roundabout

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Nelsons Bay Rd												
1	L2	16	0.0	0.301	5.1	LOS A	1.6	12.7	0.35	0.46	0.35	58.4
2	T1	1005	4.8	0.472	5.2	LOS A	3.3	25.2	0.38	0.46	0.38	63.5
3	R2	25	4.0	0.472	11.7	LOS A	3.3	25.2	0.39	0.46	0.39	61.0
Approach		1046	4.7	0.472	5.4	LOS A	3.3	25.2	0.38	0.46	0.38	63.3
East: Seaside Blvde												
4	L2	231	1.7	0.245	6.9	LOS A	1.3	9.4	0.71	0.80	0.71	57.0
5	T1	1	100.0	0.144	11.0	LOS A	0.6	4.6	0.68	0.87	0.68	51.0
6	R2	99	0.0	0.144	13.7	LOS A	0.6	4.6	0.68	0.87	0.68	54.1
Approach		331	1.5	0.245	8.9	LOS A	1.3	9.4	0.70	0.82	0.70	56.0
North: Nelsons Bay Rd												
7	L2	38	7.9	0.279	4.8	LOS A	1.5	10.9	0.23	0.41	0.23	58.9
8	T1	1171	3.8	0.571	4.8	LOS A	4.7	35.1	0.28	0.42	0.28	64.0
9	R2	5	0.0	0.571	11.3	LOS A	4.7	35.1	0.30	0.43	0.30	61.5
9u	U	32	100.0	0.571	13.2	LOS A	4.7	35.1	0.30	0.43	0.30	61.7
Approach		1246	6.3	0.571	5.3	LOS A	4.7	35.1	0.28	0.42	0.28	63.8
West: Fullerton Cove Rd												
10	L2	1	0.0	0.063	6.8	LOS A	0.3	2.3	0.67	0.81	0.67	52.6
11	T1	1	0.0	0.063	6.8	LOS A	0.3	2.3	0.67	0.81	0.67	51.9
12	R2	41	7.3	0.063	13.4	LOS A	0.3	2.3	0.67	0.81	0.67	53.0
Approach		43	7.0	0.063	13.1	LOS A	0.3	2.3	0.67	0.81	0.67	53.0
All Vehicles		2666	5.1	0.571	5.8	LOS A	4.7	35.1	0.38	0.49	0.38	62.3

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Nelsons Bay Rd & Seaside Blve - PM Prop]

PM with Boral Proposal
Site Category: (None)
Roundabout

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Nelsons Bay Rd												
1	L2	40	2.5	0.336	4.8	LOS A	1.9	14.3	0.26	0.42	0.26	58.9
2	T1	1077	3.6	0.528	4.9	LOS A	3.9	29.6	0.29	0.45	0.29	63.7
3	R2	151	2.0	0.528	11.4	LOS A	3.9	29.6	0.30	0.47	0.30	61.0
Approach		1268	3.4	0.528	5.7	LOS A	3.9	29.6	0.29	0.45	0.29	63.2
East: Seaside Blvde												
4	L2	74	1.4	0.089	6.8	LOS A	0.5	3.5	0.74	0.74	0.74	56.9
5	T1	1	100.0	0.048	11.0	LOS A	0.2	1.8	0.71	0.81	0.71	51.0
6	R2	27	3.7	0.048	13.9	LOS A	0.2	1.8	0.71	0.81	0.71	53.2
Approach		102	2.9	0.089	8.7	LOS A	0.5	3.5	0.73	0.76	0.73	55.8
North: Nelsons Bay Rd												
7	L2	105	0.0	0.332	5.4	LOS A	1.8	12.5	0.39	0.50	0.39	58.3
8	T1	1199	2.5	0.679	5.6	LOS A	6.0	43.7	0.50	0.50	0.50	62.7
9	R2	6	0.0	0.679	12.1	LOS A	6.0	43.7	0.54	0.50	0.54	60.3
9u	U	34	94.1	0.679	15.1	LOS B	6.0	43.7	0.54	0.50	0.54	58.8
Approach		1344	4.6	0.679	5.9	LOS A	6.0	43.7	0.50	0.50	0.50	62.3
West: Fullerton Cove Rd												
10	L2	7	0.0	0.059	7.3	LOS A	0.3	2.1	0.68	0.80	0.68	53.2
11	T1	4	25.0	0.059	8.2	LOS A	0.3	2.1	0.68	0.80	0.68	52.2
12	R2	28	3.6	0.059	13.8	LOS A	0.3	2.1	0.68	0.80	0.68	54.4
Approach		39	5.1	0.059	12.0	LOS A	0.3	2.1	0.68	0.80	0.68	54.0
All Vehicles		2753	4.0	0.679	6.0	LOS A	6.0	43.7	0.41	0.49	0.41	62.3

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

▽ Site: 101 [Cox Lane & Off Ramp -2029 AM Base]

2029 AM Base
Site Category: (None)
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Off Ramp												
1	L2	2	0.0	0.012	5.5	LOS A	0.0	0.5	0.03	0.60	0.03	53.5
3	R2	9	100.0	0.012	6.2	LOS A	0.0	0.5	0.03	0.60	0.03	50.7
Approach		11	81.8	0.012	6.2	LOS A	0.0	0.5	0.03	0.60	0.03	51.1
East: Cox Lane												
5	T1	2	0.0	0.001	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
Approach		2	0.0	0.001	0.0	NA	0.0	0.0	0.00	0.00	0.00	60.0
West: Cox Lane												
11	T1	7	0.0	0.003	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
Approach		7	0.0	0.003	0.0	NA	0.0	0.0	0.00	0.00	0.00	60.0
All Vehicles		20	45.0	0.012	3.4	NA	0.0	0.5	0.02	0.33	0.02	54.8

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

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MOVEMENT SUMMARY

▽ Site: 101 [Cox Lane & Off Ramp -2029 PM Base]

2029 PM base
Site Category: (None)
Giveway / Yield (Two-Way)

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Off Ramp												
1	L2	6	66.7	0.014	6.3	LOS A	0.0	0.6	0.04	0.58	0.04	50.8
3	R2	8	87.5	0.014	6.7	LOS A	0.0	0.6	0.04	0.58	0.04	49.1
Approach		14	78.6	0.014	6.6	LOS A	0.0	0.6	0.04	0.58	0.04	49.8
East: Cox Lane												
5	T1	5	0.0	0.003	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
Approach		5	0.0	0.003	0.0	NA	0.0	0.0	0.00	0.00	0.00	60.0
West: Cox Lane												
11	T1	8	0.0	0.004	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
Approach		8	0.0	0.004	0.0	NA	0.0	0.0	0.00	0.00	0.00	60.0
All Vehicles		27	40.7	0.014	3.4	NA	0.0	0.6	0.02	0.30	0.02	54.2

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

▽ Site: 101 [Cox Lane & Off Ramp -2029 AM Prop]

2029 AM with Proposal
Site Category: (None)
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Off Ramp												
1	L2	2	0.0	0.041	5.5	LOS A	0.1	1.6	0.04	0.59	0.04	53.5
3	R2	35	85.7	0.041	6.7	LOS A	0.1	1.6	0.04	0.59	0.04	49.2
Approach		37	81.1	0.041	6.6	LOS A	0.1	1.6	0.04	0.59	0.04	49.4
East: Cox Lane												
5	T1	2	0.0	0.001	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
Approach		2	0.0	0.001	0.0	NA	0.0	0.0	0.00	0.00	0.00	60.0
West: Cox Lane												
11	T1	7	0.0	0.003	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
Approach		7	0.0	0.003	0.0	NA	0.0	0.0	0.00	0.00	0.00	60.0
All Vehicles		46	65.2	0.041	5.3	NA	0.1	1.6	0.03	0.48	0.03	51.1

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

▽ Site: 101 [Cox Lane & Off Ramp -2029 PM Prop]

2029 PM with Proposal
Site Category: (None)
Giveway / Yield (Two-Way)

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Off Ramp												
1	L2	6	66.7	0.043	6.3	LOS A	0.1	1.7	0.05	0.59	0.05	50.7
3	R2	33	90.9	0.043	6.8	LOS A	0.1	1.7	0.05	0.59	0.05	48.9
Approach		39	87.2	0.043	6.7	LOS A	0.1	1.7	0.05	0.59	0.05	49.2
East: Cox Lane												
5	T1	5	0.0	0.003	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
Approach		5	0.0	0.003	0.0	NA	0.0	0.0	0.00	0.00	0.00	60.0
West: Cox Lane												
11	T1	8	0.0	0.004	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
Approach		8	0.0	0.004	0.0	NA	0.0	0.0	0.00	0.00	0.00	60.0
All Vehicles		52	65.4	0.043	5.0	NA	0.1	1.7	0.04	0.44	0.04	51.5

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

▽ Site: 101 [Cox Lane & On Ramp -2029 AM Base]

2029 AM Base
Site Category: (None)
Giveway / Yield (Two-Way)

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
East: Cox Lane												
4	L2	8	100.0	0.008	6.1	LOS A	0.0	0.0	0.00	0.51	0.00	52.4
5	T1	2	0.0	0.008	0.0	LOS A	0.0	0.0	0.00	0.51	0.00	55.9
Approach		10	80.0	0.008	5.4	NA	0.0	0.0	0.00	0.51	0.00	53.0
West: Cox Lane												
11	T1	9	100.0	0.010	0.0	LOS A	0.0	0.3	0.05	0.16	0.05	57.5
12	R2	7	0.0	0.010	5.5	LOS A	0.0	0.3	0.05	0.16	0.05	55.7
Approach		16	56.3	0.010	1.6	NA	0.0	0.3	0.05	0.16	0.05	56.7
All Vehicles		26	65.4	0.010	3.4	NA	0.0	0.3	0.03	0.30	0.03	55.2

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

▽ Site: 101 [Cox Lane & On Ramp -2029 PM Base]

2029 PM Base
Site Category: (None)
Giveway / Yield (Two-Way)

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
East: Cox Lane												
4	L2	5	100.0	0.007	6.1	LOS A	0.0	0.0	0.00	0.38	0.00	53.6
5	T1	5	0.0	0.007	0.0	LOS A	0.0	0.0	0.00	0.38	0.00	57.4
Approach		10	50.0	0.007	4.1	NA	0.0	0.0	0.00	0.38	0.00	55.4
West: Cox Lane												
11	T1	7	85.7	0.008	0.0	LOS A	0.0	0.3	0.04	0.27	0.04	55.5
12	R2	6	0.0	0.008	5.5	LOS A	0.0	0.3	0.04	0.27	0.04	53.8
Approach		13	46.2	0.008	2.6	NA	0.0	0.3	0.04	0.27	0.04	54.7
All Vehicles		23	47.8	0.008	2.8	NA	0.0	0.3	0.03	0.32	0.03	55.0

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

▽ Site: 101 [Cox Lane & On Ramp -2029 AM Prop]

2029 AM with Proposal
Site Category: (None)
Giveway / Yield (Two-Way)

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
East: Cox Lane												
4	L2	30	100.0	0.027	6.1	LOS A	0.0	0.0	0.00	0.55	0.00	51.8
5	T1	2	0.0	0.027	0.0	LOS A	0.0	0.0	0.00	0.55	0.00	55.3
Approach		32	93.8	0.027	5.9	NA	0.0	0.0	0.00	0.55	0.00	52.0
West: Cox Lane												
11	T1	33	90.9	0.028	0.0	LOS A	0.0	0.4	0.04	0.11	0.04	56.3
12	R2	7	0.0	0.028	5.6	LOS A	0.0	0.4	0.04	0.11	0.04	54.5
Approach		40	75.0	0.028	1.0	NA	0.0	0.4	0.04	0.11	0.04	56.0
All Vehicles		72	83.3	0.028	3.1	NA	0.0	0.4	0.02	0.31	0.02	54.1

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

▽ Site: 101 [Cox Lane & On Ramp -2029 PM Prop]

2029 PM with Proposal
Site Category: (None)
Giveway / Yield (Two-Way)

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
East: Cox Lane												
4	L2	33	90.9	0.030	6.6	LOS A	0.0	0.0	0.00	0.49	0.00	52.4
5	T1	5	0.0	0.030	0.0	LOS A	0.0	0.0	0.00	0.49	0.00	58.0
Approach		38	78.9	0.030	5.7	NA	0.0	0.0	0.00	0.49	0.00	53.1
West: Cox Lane												
11	T1	33	90.9	0.028	0.0	LOS A	0.0	0.4	0.04	0.10	0.04	56.4
12	R2	6	0.0	0.028	5.6	LOS A	0.0	0.4	0.04	0.10	0.04	54.7
Approach		39	76.9	0.028	0.9	NA	0.0	0.4	0.04	0.10	0.04	56.2
All Vehicles		77	77.9	0.030	3.3	NA	0.0	0.4	0.02	0.29	0.02	54.6

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Nelsons Bay Rd & Cabbage Tree Rd - 2029 AM Base]

2029 AM Base
Site Category: (None)
Roundabout

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Nelsons Bay Rd												
1	L2	113	13.3	0.539	7.1	LOS A	4.0	30.2	0.60	0.58	0.60	58.8
2	T1	1122	2.1	0.539	7.3	LOS A	4.0	30.2	0.61	0.60	0.62	66.6
3	R2	57	0.0	0.539	14.3	LOS A	3.9	28.4	0.62	0.62	0.63	61.9
Approach		1292	3.0	0.539	7.6	LOS A	4.0	30.2	0.61	0.60	0.62	65.6
East: Lavis Lane												
4	L2	168	1.2	0.550	11.7	LOS A	3.9	27.9	0.85	1.03	1.15	53.3
5	T1	64	0.0	0.550	11.5	LOS A	3.9	27.9	0.85	1.03	1.15	51.2
6	R2	122	1.6	0.550	18.1	LOS B	3.9	27.9	0.85	1.03	1.15	55.0
Approach		354	1.1	0.550	13.9	LOS A	3.9	27.9	0.85	1.03	1.15	53.5
North: Nelsons Bay Rd												
7	L2	175	1.1	0.373	5.8	LOS A	2.1	14.9	0.32	0.50	0.32	61.1
8	T1	1175	3.1	0.667	6.2	LOS A	5.9	42.9	0.40	0.51	0.40	67.9
9	R2	119	22.7	0.667	13.5	LOS A	5.9	42.9	0.43	0.51	0.43	62.3
Approach		1469	4.5	0.667	6.7	LOS A	5.9	42.9	0.40	0.51	0.40	66.5
West: Cabbage Tree Rd												
10	L2	208	13.0	0.264	6.4	LOS A	1.4	12.2	0.75	0.77	0.75	56.4
11	T1	18	0.0	0.113	6.6	LOS A	0.5	4.6	0.71	0.87	0.71	52.5
12	R2	29	24.1	0.113	14.3	LOS A	0.5	4.6	0.71	0.87	0.71	51.9
12u	U	7	100.0	0.113	20.6	LOS B	0.5	4.6	0.71	0.87	0.71	53.4
Approach		262	15.6	0.264	7.7	LOS A	1.4	12.2	0.74	0.79	0.74	55.5
All Vehicles		3377	4.4	0.667	7.9	LOS A	5.9	42.9	0.55	0.62	0.59	63.6

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

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MOVEMENT SUMMARY

Site: 101 [Nelsons Bay Rd & Cabbage Tree Rd - 2029 AM Prop]

2029 AM with Proposal
Site Category: (None)
Roundabout

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Nelsons Bay Rd												
1	L2	128	23.4	0.550	7.4	LOS A	4.1	32.5	0.62	0.59	0.62	58.6
2	T1	1123	2.2	0.550	7.4	LOS A	4.1	32.5	0.62	0.61	0.63	66.5
3	R2	57	0.0	0.550	14.4	LOS A	4.1	29.7	0.63	0.62	0.64	61.9
Approach		1308	4.2	0.550	7.7	LOS A	4.1	32.5	0.62	0.60	0.63	65.4
East: Lavis Lane												
4	L2	168	1.2	0.576	12.6	LOS A	4.2	30.4	0.88	1.05	1.21	52.7
5	T1	64	0.0	0.576	12.4	LOS A	4.2	30.4	0.88	1.05	1.21	50.5
6	R2	122	1.6	0.576	19.0	LOS B	4.2	30.4	0.88	1.05	1.21	54.3
Approach		354	1.1	0.576	14.7	LOS B	4.2	30.4	0.88	1.05	1.21	52.8
North: Nelsons Bay Rd												
7	L2	175	1.1	0.382	5.9	LOS A	2.2	15.5	0.36	0.51	0.36	60.9
8	T1	1176	3.2	0.683	6.3	LOS A	6.2	45.3	0.46	0.52	0.46	67.4
9	R2	119	22.7	0.683	13.7	LOS A	6.2	45.3	0.49	0.53	0.49	61.9
Approach		1470	4.6	0.683	6.9	LOS A	6.2	45.3	0.45	0.52	0.45	66.1
West: Cabbage Tree Rd												
10	L2	208	13.0	0.267	6.4	LOS A	1.4	12.4	0.75	0.77	0.75	56.4
11	T1	18	0.0	0.159	6.7	LOS A	0.7	8.2	0.72	0.88	0.72	52.1
12	R2	44	50.0	0.159	15.6	LOS B	0.7	8.2	0.72	0.88	0.72	47.3
12u	U	7	100.0	0.159	20.6	LOS B	0.7	8.2	0.72	0.88	0.72	53.0
Approach		277	20.2	0.267	8.3	LOS A	1.4	12.4	0.74	0.80	0.74	54.2
All Vehicles		3409	5.3	0.683	8.1	LOS A	6.2	45.3	0.58	0.63	0.62	63.1

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Nelsons Bay Rd & Cabbage Tree Rd - 2029 PM Base]

2029 PM Base
Site Category: (None)
Roundabout

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Nelsons Bay Rd												
1	L2	146	8.9	0.610	8.0	LOS A	5.3	39.7	0.68	0.68	0.74	58.5
2	T1	1242	1.7	0.610	8.4	LOS A	5.3	39.7	0.69	0.70	0.76	66.2
3	R2	24	0.0	0.610	15.6	LOS B	5.3	38.1	0.70	0.73	0.78	61.5
Approach		1412	2.4	0.610	8.5	LOS A	5.3	39.7	0.69	0.70	0.76	65.2
East: Lavis Lane												
4	L2	115	0.0	0.591	16.6	LOS B	4.5	31.2	0.93	1.10	1.34	49.9
5	T1	65	0.0	0.591	16.4	LOS B	4.5	31.2	0.93	1.10	1.34	47.9
6	R2	112	0.0	0.591	23.0	LOS B	4.5	31.2	0.93	1.10	1.34	51.5
Approach		292	0.0	0.591	19.0	LOS B	4.5	31.2	0.93	1.10	1.34	50.0
North: Nelsons Bay Rd												
7	L2	85	0.0	0.430	5.9	LOS A	2.8	19.6	0.38	0.50	0.38	60.6
8	T1	1417	1.5	0.769	6.3	LOS A	9.3	66.7	0.52	0.53	0.52	67.2
9	R2	187	13.4	0.769	13.6	LOS A	9.3	66.7	0.58	0.54	0.58	61.5
Approach		1689	2.7	0.769	7.1	LOS A	9.3	66.7	0.52	0.52	0.52	66.2
West: Cabbage Tree Rd												
10	L2	98	5.1	0.127	6.1	LOS A	0.7	5.1	0.75	0.74	0.75	58.1
11	T1	24	0.0	0.182	6.8	LOS A	0.8	6.6	0.75	0.87	0.75	52.3
12	R2	65	4.6	0.182	13.5	LOS A	0.8	6.6	0.75	0.87	0.75	55.5
12u	U	7	100.0	0.182	20.7	LOS B	0.8	6.6	0.75	0.87	0.75	53.1
Approach		194	7.7	0.182	9.3	LOS A	0.8	6.6	0.75	0.81	0.75	56.2
All Vehicles		3587	2.6	0.769	8.7	LOS A	9.3	66.7	0.63	0.66	0.69	63.5

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Nelsons Bay Rd & Cabbage Tree Rd - 2029 PM Prop]

2029 PM with Proposal
Site Category: (None)
Roundabout

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Nelsons Bay Rd												
1	L2	161	17.4	0.621	8.4	LOS A	5.6	43.2	0.70	0.69	0.76	58.2
2	T1	1243	1.8	0.621	8.5	LOS A	5.6	43.2	0.70	0.72	0.78	66.1
3	R2	24	0.0	0.621	15.7	LOS B	5.5	39.9	0.71	0.74	0.80	61.5
Approach		1428	3.5	0.621	8.6	LOS A	5.6	43.2	0.70	0.72	0.77	65.0
East: Lavis Lane												
4	L2	115	0.0	0.629	18.7	LOS B	5.0	34.7	0.95	1.13	1.43	48.6
5	T1	65	0.0	0.629	18.5	LOS B	5.0	34.7	0.95	1.13	1.43	46.6
6	R2	112	0.0	0.629	25.1	LOS B	5.0	34.7	0.95	1.13	1.43	50.1
Approach		292	0.0	0.629	21.1	LOS B	5.0	34.7	0.95	1.13	1.43	48.7
North: Nelsons Bay Rd												
7	L2	85	0.0	0.440	6.0	LOS A	2.9	20.2	0.41	0.51	0.41	60.4
8	T1	1418	1.6	0.788	6.5	LOS A	9.7	69.6	0.58	0.54	0.58	66.8
9	R2	187	13.4	0.788	13.8	LOS A	9.7	69.6	0.65	0.55	0.65	61.1
Approach		1690	2.8	0.788	7.3	LOS A	9.7	69.6	0.58	0.54	0.58	65.8
West: Cabbage Tree Rd												
10	L2	98	5.1	0.179	7.4	LOS A	0.8	6.5	0.75	0.85	0.75	57.7
11	T1	24	0.0	0.165	5.7	LOS A	0.8	8.2	0.76	0.84	0.76	52.8
12	R2	80	22.5	0.165	13.0	LOS A	0.8	8.2	0.76	0.84	0.76	52.5
12u	U	7	100.0	0.165	17.9	LOS B	0.8	8.2	0.76	0.84	0.76	53.7
Approach		209	14.4	0.179	9.8	LOS A	0.8	8.2	0.75	0.85	0.75	54.8
All Vehicles		3619	3.5	0.788	9.1	LOS A	9.7	69.6	0.67	0.67	0.73	63.0

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Nelsons Bay Rd & Seaside Blve - 2029 AM]

2029 AM Base
Site Category: (None)
Roundabout

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Nelsons Bay Rd												
1	L2	19	0.0	0.371	5.1	LOS A	2.4	17.7	0.39	0.46	0.39	58.1
2	T1	1254	3.4	0.582	5.2	LOS A	5.1	38.5	0.44	0.46	0.44	63.1
3	R2	32	6.2	0.582	11.8	LOS A	5.1	38.5	0.47	0.46	0.47	60.4
Approach		1305	3.4	0.582	5.4	LOS A	5.1	38.5	0.44	0.46	0.44	62.9
East: Seaside Blvde												
4	L2	291	1.7	0.386	9.6	LOS A	2.5	18.5	0.86	0.95	0.94	54.7
5	T1	2	100.0	0.230	14.1	LOS A	1.2	8.5	0.79	0.92	0.79	49.6
6	R2	125	0.0	0.230	15.8	LOS B	1.2	8.5	0.79	0.92	0.79	52.5
Approach		418	1.7	0.386	11.4	LOS A	2.5	18.5	0.84	0.94	0.90	54.0
North: Nelsons Bay Rd												
7	L2	48	8.3	0.343	5.0	LOS A	2.0	14.4	0.29	0.43	0.29	58.6
8	T1	1465	2.6	0.702	5.1	LOS A	7.4	53.3	0.40	0.44	0.40	63.5
9	R2	7	0.0	0.702	11.6	LOS A	7.4	53.3	0.43	0.44	0.43	61.0
9u	U	5	60.0	0.702	13.5	LOS A	7.4	53.3	0.43	0.44	0.43	60.8
Approach		1525	3.0	0.702	5.1	LOS A	7.4	53.3	0.39	0.44	0.39	63.3
West: Fullerton Cove Rd												
10	L2	2	0.0	0.100	8.1	LOS A	0.5	4.1	0.74	0.88	0.74	51.7
11	T1	2	100.0	0.100	12.6	LOS A	0.5	4.1	0.74	0.88	0.74	50.6
12	R2	52	7.7	0.100	14.7	LOS B	0.5	4.1	0.74	0.88	0.74	52.1
Approach		56	10.7	0.100	14.2	LOS A	0.5	4.1	0.74	0.88	0.74	52.0
All Vehicles		3304	3.1	0.702	6.2	LOS A	7.4	53.3	0.47	0.52	0.48	61.6

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Nelsons Bay Rd & Seaside Blve - 2029 PM Base]

2029 PM Base
Site Category: (None)
Roundabout

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Nelsons Bay Rd												
1	L2	51	3.9	0.400	4.6	LOS A	2.7	20.2	0.23	0.40	0.23	59.1
2	T1	1345	2.4	0.628	4.8	LOS A	6.4	46.8	0.27	0.43	0.27	63.9
3	R2	190	2.6	0.628	11.3	LOS A	6.4	46.8	0.29	0.44	0.29	61.0
Approach		1586	2.5	0.628	5.5	LOS A	6.4	46.8	0.27	0.43	0.27	63.4
East: Seaside Blvde												
4	L2	94	2.1	0.156	9.0	LOS A	1.0	7.4	0.89	0.87	0.89	55.2
5	T1	2	100.0	0.087	14.1	LOS A	0.5	4.0	0.83	0.90	0.83	49.5
6	R2	34	5.9	0.087	16.2	LOS B	0.5	4.0	0.83	0.90	0.83	51.2
Approach		130	4.6	0.156	10.9	LOS A	1.0	7.4	0.87	0.88	0.87	54.0
North: Nelsons Bay Rd												
7	L2	132	0.0	0.410	5.8	LOS A	2.3	16.5	0.47	0.54	0.47	57.8
8	T1	1493	1.3	0.839	7.6	LOS A	12.9	91.1	0.71	0.65	0.79	61.3
9	R2	8	0.0	0.839	14.6	LOS B	12.9	91.1	0.77	0.68	0.87	58.7
9u	U	3	0.0	0.839	15.5	LOS B	12.9	91.1	0.77	0.68	0.87	60.8
Approach		1636	1.2	0.839	7.5	LOS A	12.9	91.1	0.69	0.65	0.77	61.0
West: Fullerton Cove Rd												
10	L2	12	0.0	0.091	8.9	LOS A	0.4	3.5	0.75	0.87	0.75	52.2
11	T1	6	33.3	0.091	10.4	LOS A	0.4	3.5	0.75	0.87	0.75	51.2
12	R2	33	6.1	0.091	15.6	LOS B	0.4	3.5	0.75	0.87	0.75	52.9
Approach		51	7.8	0.091	13.4	LOS A	0.4	3.5	0.75	0.87	0.75	52.5
All Vehicles		3403	2.0	0.839	6.8	LOS A	12.9	91.1	0.50	0.56	0.54	61.6

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Nelsons Bay Rd & Seaside Blve - 2029 AM Prop]

2029 AM with Proposal
Site Category: (None)
Roundabout

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Nelsons Bay Rd												
1	L2	19	0.0	0.390	5.3	LOS A	2.4	18.0	0.44	0.48	0.44	57.8
2	T1	1270	3.7	0.612	5.5	LOS A	5.2	39.6	0.50	0.49	0.50	62.7
3	R2	32	6.2	0.612	12.1	LOS A	5.2	39.6	0.53	0.49	0.53	60.0
Approach		1321	3.7	0.612	5.7	LOS A	5.2	39.6	0.50	0.49	0.50	62.5
East: Seaside Blvde												
4	L2	291	1.7	0.415	10.8	LOS A	2.9	21.2	0.90	0.99	1.03	53.7
5	T1	2	100.0	0.245	15.1	LOS B	1.3	9.3	0.82	0.93	0.82	49.2
6	R2	125	0.0	0.245	16.5	LOS B	1.3	9.3	0.82	0.93	0.82	52.1
Approach		418	1.7	0.415	12.5	LOS A	2.9	21.2	0.87	0.97	0.96	53.2
North: Nelsons Bay Rd												
7	L2	48	8.3	0.358	5.0	LOS A	2.1	15.5	0.30	0.43	0.30	58.5
8	T1	1479	3.5	0.733	5.1	LOS A	8.4	62.3	0.42	0.44	0.42	63.3
9	R2	7	0.0	0.733	11.6	LOS A	8.4	62.3	0.47	0.45	0.47	60.7
9u	U	37	94.6	0.733	14.2	LOS A	8.4	62.3	0.47	0.45	0.47	59.2
Approach		1571	5.8	0.733	5.4	LOS A	8.4	62.3	0.42	0.44	0.42	63.0
West: Fullerton Cove Rd												
10	L2	2	0.0	0.107	8.6	LOS A	0.5	4.5	0.77	0.90	0.77	51.3
11	T1	2	100.0	0.107	13.4	LOS A	0.5	4.5	0.77	0.90	0.77	50.2
12	R2	52	7.7	0.107	15.3	LOS B	0.5	4.5	0.77	0.90	0.77	51.7
Approach		56	10.7	0.107	14.8	LOS B	0.5	4.5	0.77	0.90	0.77	51.6
All Vehicles		3366	4.5	0.733	6.5	LOS A	8.4	62.3	0.51	0.53	0.52	61.2

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Nelsons Bay Rd & Seaside Blve - 2029 PM Prop]

2029 PM with Proposal
Site Category: (None)
Roundabout

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Nelsons Bay Rd												
1	L2	51	3.9	0.429	4.9	LOS A	2.9	21.4	0.33	0.44	0.33	58.4
2	T1	1359	3.4	0.673	5.1	LOS A	6.8	50.9	0.39	0.47	0.39	63.0
3	R2	190	2.6	0.673	11.6	LOS A	6.8	50.9	0.43	0.48	0.43	60.2
Approach		1600	3.3	0.673	5.9	LOS A	6.8	50.9	0.40	0.47	0.40	62.5
East: Seaside Blvde												
4	L2	94	2.1	0.177	9.7	LOS A	1.2	8.8	0.93	0.91	0.93	54.6
5	T1	2	100.0	0.097	15.1	LOS B	0.5	4.6	0.86	0.92	0.86	49.0
6	R2	34	5.9	0.097	17.0	LOS B	0.5	4.6	0.86	0.92	0.86	50.8
Approach		130	4.6	0.177	11.6	LOS A	1.2	8.8	0.91	0.91	0.91	53.4
North: Nelsons Bay Rd												
7	L2	132	0.0	0.430	5.8	LOS A	2.6	18.3	0.49	0.54	0.49	57.7
8	T1	1507	2.3	0.880	8.6	LOS A	16.7	121.7	0.80	0.71	0.92	60.7
9	R2	8	0.0	0.880	15.8	LOS B	16.7	121.7	0.88	0.75	1.04	58.1
9u	U	35	91.4	0.880	19.8	LOS B	16.7	121.7	0.88	0.75	1.04	56.8
Approach		1682	3.9	0.880	8.7	LOS A	16.7	121.7	0.77	0.70	0.89	60.4
West: Fullerton Cove Rd												
10	L2	12	0.0	0.102	9.7	LOS A	0.5	4.1	0.79	0.89	0.79	51.7
11	T1	6	33.3	0.102	11.3	LOS A	0.5	4.1	0.79	0.89	0.79	50.7
12	R2	33	6.1	0.102	16.3	LOS B	0.5	4.1	0.79	0.89	0.79	52.4
Approach		51	7.8	0.102	14.2	LOS A	0.5	4.1	0.79	0.89	0.79	52.0
All Vehicles		3463	3.7	0.880	7.6	LOS A	16.7	121.7	0.60	0.60	0.66	60.9

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.



APPENDIX I

SOCIAL IMPACT ASSESSMENT

Stockton Sand Quarry Dredging | State Significant Development

SOCIAL IMPACT ASSESSMENT

Prepared for Boral Resources (NSW) Pty Ltd | 26 November 2019



Stockton Sand Quarry Dredging

STATE SIGNIFICANT DEVELOPMENT | SOCIAL IMPACT ASSESSMENT

Prepared for Boral Resources (NSW) Pty Ltd
26 November 2019

PR63

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Signature		
Date	26 November 2019	26 September 2019

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DOCUMENT CONTROL

Revision	Date	Description	Prepared by	Reviewed by
0	9 September 2019	For Boral review	Element Environment	Boral Resources (NSW) Pty Ltd
1	24 September 2019	Revised for Boral review	Element Environment	Boral Resources (NSW) Pty Ltd
2	26 November 2019	Revised for Boral review and submission to DPIE	Element Environment	Boral Resources (NSW) Pty Ltd

Certification Page

Lead author declaration

I, Dr Jamie Seaton, certify that the Social Impact Assessment (SIA) component of the Stockton Sand Dredging Environmental Impact Statement (EIS) contains all information relevant to the SIA for the project, and that the information is not false or misleading. My qualifications and experience are listed below.

Qualifications:

1. Bachelor of Science Hons. (Human Geography)

2. Community Development Diploma

3. Doctorate of Philosophy (Human Geography).

Experience:

I am trained in social science methodologies and I have demonstrated SIA skills in government, private and education settings. I have managed and authored SIAs for extractive industry projects in New South Wales and Queensland.

Date: 26 November 2019



Jamie Seaton - SIA and Community Engagement Lead

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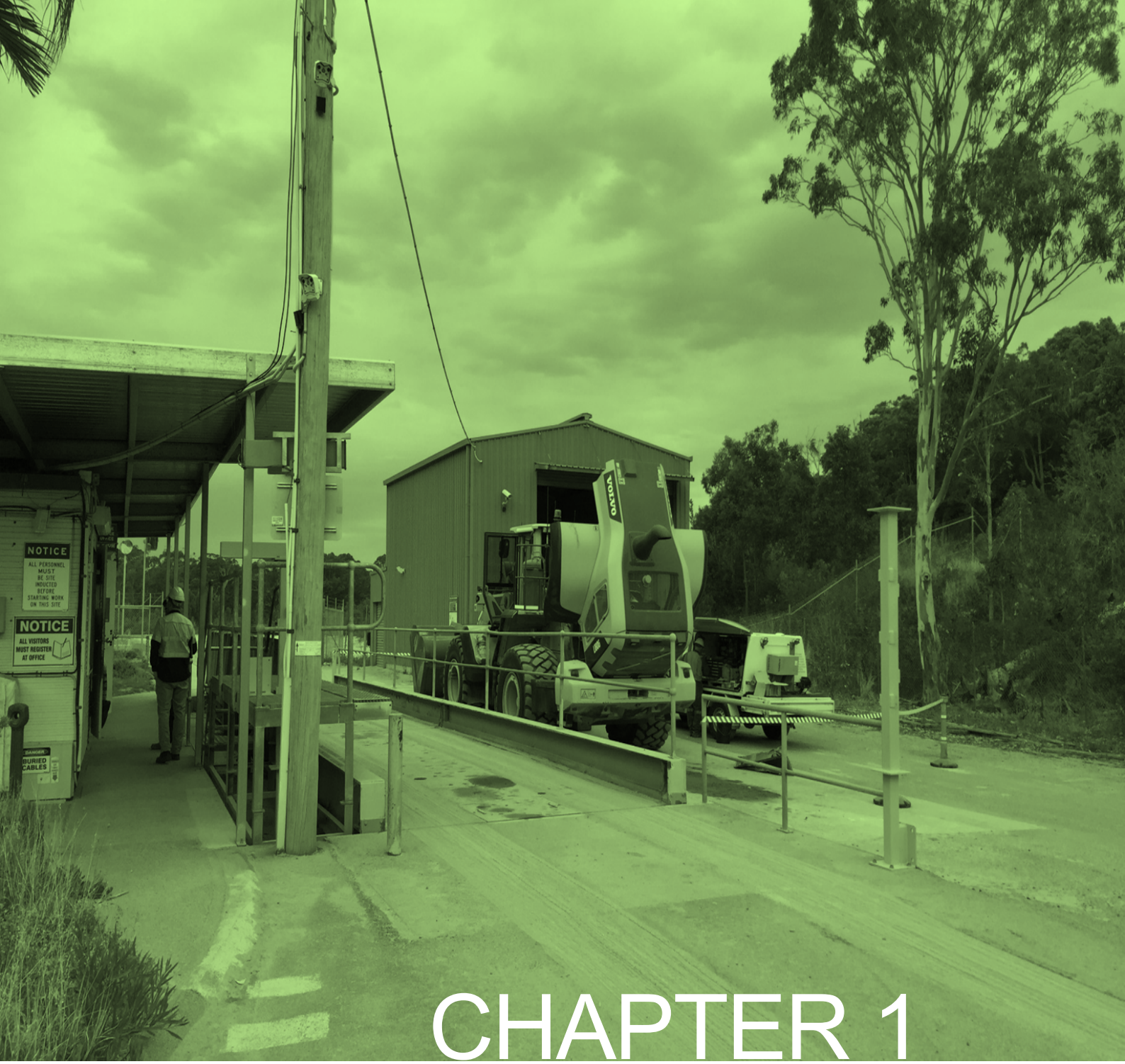


CHAPTER 1

INTRODUCTION

1 INTRODUCTION

This Social Impact Assessment (SIA) has been prepared to support the State Significant Development (SSD) application by Boral Resources (NSW) Pty Ltd (Boral), for the proposed dredging operation of the Stockton Sand Quarry (hereafter referred to as the 'site' or the 'quarry'). The SIA adopts the framework set out in the *Social Impact Assessment Guideline* (the Guideline), published in September 2017 by the NSW Department of Planning, Industry and Environment (DPIE) (NSW Department of Planning, Industry and Environment, 2017).

The first chapter of this report provides a project overview, a description of the site and existing operations, an outline of the proposed project, objectives of the SIA, the Secretary's environmental assessment requirements (SEARs), and a structural outline of this report.

1.1 Overview

Boral owns and operates the quarry, a long standing operation that currently extracts sand from the windblown (transgressive) sand dunes of Stockton Bight and transports up to 500,000 tonnes per annum (tpa) of sand product for use in the building, landscaping and construction markets.

Due to current and future demand for sand in the local Hunter and Sydney regions, Boral is seeking approval for continued and expanded operations at the site through a SSD application. The proposed development (hereafter referred to as the 'project') involves the extraction of sand from the inland vegetated dunes by front-end loader/excavator to a depth of 4 metres (m) Australian Height Datum (AHD) in Stage 1, and subsequent dredging from 4 m AHD to -15 m AHD. The project would seek to permit a site wide increase on the dispatch limit to 750,000 tpa (i.e. the windblown sand extraction area and the project operations combined) up until 2028 after which the site wide limit would reduce to no more than 500,000 tpa. The project would be for a period of up to 25 years.

This environmental impact statement (EIS) has been prepared by Element Environment Pty Ltd (Element), on behalf of Boral for submission to the DPIE to satisfy the provisions of Part 4 of the *Environmental Planning & Assessment Act 1979* (EP&A Act).

1.2 Existing operations

As highlighted in Chapter 3 of the EIS, sand extraction has taken place in various locations on the site since 1976 when G. Hawkins and Sons was initially granted consent.

Boral acquired the site in 1992. Under Boral's ownership there have been two primary development consents granted, including:

- DA 2010/94: The 'inland extraction area' (also known as pits 1 – 6) granted by Port Stephens Council in May 1996; and
- DA 140-6-2005: The 'windblown sand extraction area' (also known as pit 7) located on the transgressive dunes adjoining Stockton Beach granted by the Department of Planning in 2006.

The inland extraction operation on the vegetated dunes occurred above 5 metres AHD and ceased in 2008 and rehabilitation has been ongoing.

The windblown sand extraction area started operations in 2008 and in accordance with condition 5 of the development consent has 20-year life, due to cease in 2028.

The existing operation is located approximately 375 m south east of the project site, referred to as the windblown sand extraction area. This area is approved to operate until 2028 and dispatch

up to 500,000 tpa from the site. The approved scope of works and method for the existing operations generally includes the following:

- extraction of sand annually through regular harvesting of windblown sand and dry excavation of the dune mass, and transport of up to 500,000 tonnes annually;
- processing at the pit face by mobile power screen;
- maintenance of the haul road to transport sand from extraction area;
- haulage of product from existing depot/weighbridge to Nelson Bay Road and the wider road network; and
- progressive rehabilitation of extracted areas.Project area

The project area is wholly within Boral's existing quarry landholding. It is identified as the 'proposed clearance area' in Figure 1. It contains all areas to be disturbed by the project operations and covers an area of approximately 37 hectares (ha).

The project area is generally consistent with the same disturbance footprint associated with the former inland extraction area approved under the 1996 development consent with the exception of areas to east and south east of Lot 3 and along the southern edge to allow for the construction of new haul roads.

The approved scope of works and method for Boral's existing operations generally includes the following:

- extraction of sand annually through regular harvesting of windblown sand and dry excavation of the dune mass, and transport of up to 500,000 tonnes annually;
- processing at the pit face by mobile power screen;
- maintenance of the haul road to transport sand from extraction area;
- haulage of product from existing depot/weighbridge to Nelson Bay Road and the wider road network; and
- progressive rehabilitation of extracted areas.

1.3 The proposed project

Sand from the former inland extraction area was only extracted to 5 m AHD under the original 1996 development consent. The sand resource above 5 m AHD was exhausted in 2008 and in accordance with the conditions of consent the operations have ceased.

The project involves the extraction of sand from within the former inland extraction area (inclusive of pits 1 – 6) from the existing ground level to a depth of 15 m below sea level (-15 m AHD). As extraction will intercept the groundwater table (at approximately 1 m AHD) the primary method of sand extraction will involve dredging.

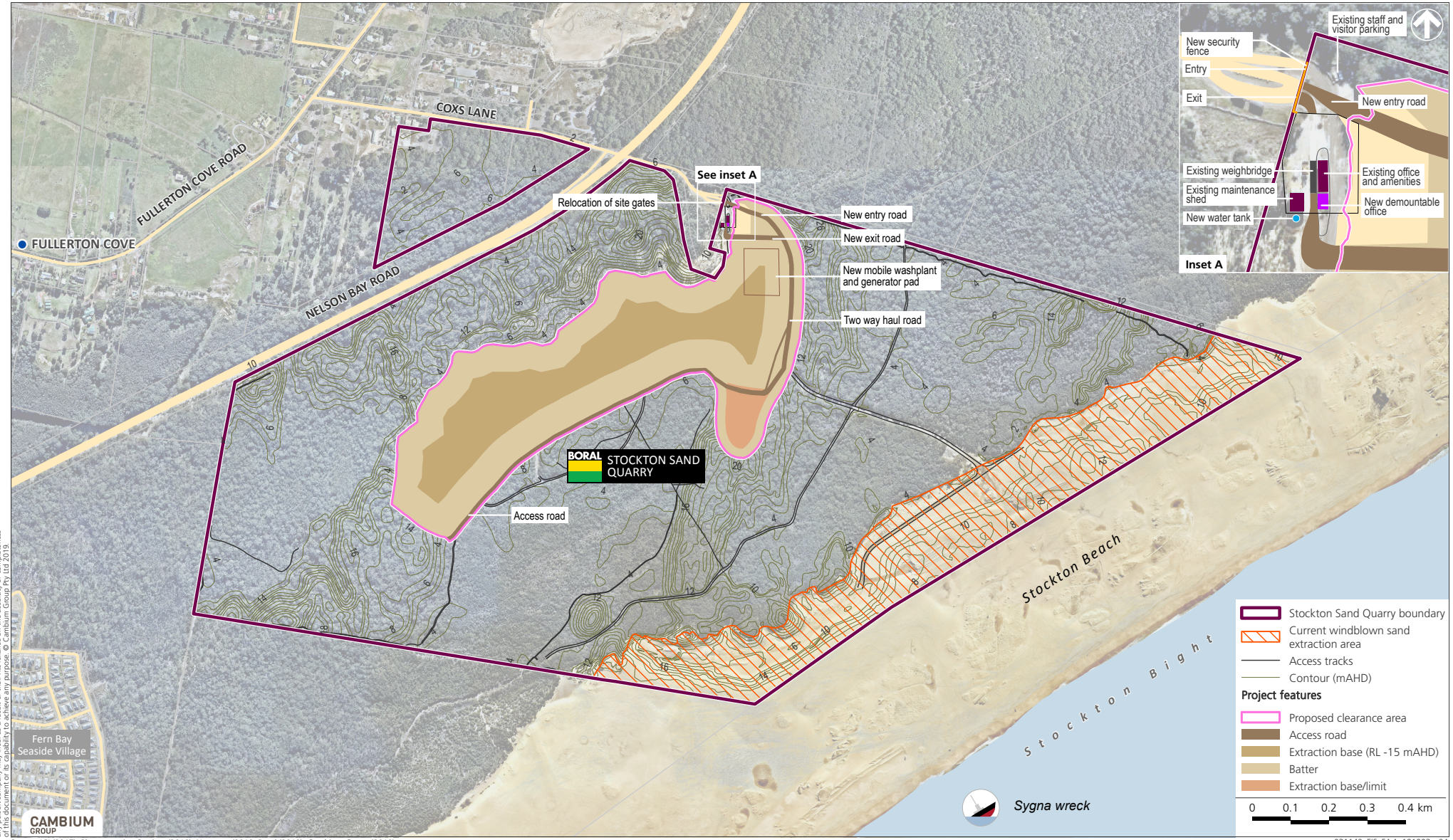
There is an estimated 9 million tonnes of sand resource within the project extraction area. The project would seek to permit a site wide increase on the dispatch limit to 750,000 tpa (ie the windblown sand extraction area and the Project operations combined) up until 2028 after which the site wide limit would reduce to no more than 500,000 tpa. The increase in the site wide dispatch limit is sought to permit maximum flexibility across the two projects areas (located on the same site). A concurrent administrative amendment to DA 140-5-2006 to allow for the site wide dispatch limit increase would be lodged with DPIE.

Mobile plant and equipment utilised at the site would operate across both project areas and a docket system at the weighbridge would monitor outgoing product as a site total.

To account for market fluctuations in demand, Boral are seeking a development consent period of 25 years for the SSD approval.

Figure 1
The Project

STOCKTON SAND QUARRY DREDGING
ENVIRONMENTAL IMPACT STATEMENT



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Source: LPI (2017), Photomapping Services (2018), Nearmap (2019, Boral (2019), Cambium Group (2019).

1.4 Objectives of the social impact assessment

The release of the Guideline (NSW Department of Planning, Industry and Environment, 2017) by DPIE has significantly increased the prominence of SIA in the broader NSW EIS process. Upon its release and at the present time, the Guideline applies to all SSD for resource projects, where the SEARs were issued after the publication date.

The Guideline outlines some mandatory requirements to be met by SIA practitioners in NSW. It contains objectives applicable to NSW state significant resource projects (ie state significant mining, petroleum production and extractive industry projects), outlines best practice engagement techniques, and provides a process for assessing, determining and responding to social impacts. The objectives contained in the Guideline have been adopted for this SIA and include:

- providing a clear, consistent and rigorous framework for identifying, predicting, evaluating and responding to the social impacts of state significant resource projects, as part of the overall environmental impact assessment (EIA) process;
- facilitating improved project planning and design through earlier identification of potential social impacts;
- promoting better development outcomes through a focus on minimising negative social impacts and enhancing positive social impacts;
- supporting informed decision-making by strengthening the quality and relevance of information and analysis provided to the consent authority;
- facilitating meaningful, respectful and effective community and stakeholder engagement on social impacts across each EIA phase, from scoping to post-approval; and
- ensuring that the potential social impacts of approved projects are managed in a transparent and accountable way over the project life cycle through conditions of consent and monitoring and reporting requirements.

1.5 Secretary's environmental assessment requirements

SEARs were issued for the project by DPIE in 2018 following the publication of the Guideline. The SEARs state that this report must address key social issues including a detailed assessment of the potential social impacts of the development that builds on the findings of the Social Impact Assessment Scoping Report, in accordance with the Guideline, paying particular consideration to:

- the full range of categories of potential social impacts identified in Section 1.1 of the Guideline;
- how impacts (positive and negative) may be distributed among different groups in the affected communities;
- the principles in Section 1.3 of the Guideline;
- ensuring that the person preparing the SIA has appropriate qualification and experience as outlined in the Box 4 of the Guideline; and
- the review questions in Appendix D of the Guideline.

Table 1 identifies where the SEARs are addressed in this report.

1.6 Structure of this report

The structure of this report is influenced by Guideline requirements. Once the legislative and social policy context of the study is established (Chapter 2), the methodology for scoping and preparing the SIA is described (Chapter 3). Results of the SIA data collection is presented in chapters titled SIA Scoping Phase and Community Engagement Outcomes, and Existing Social Baseline (Chapter 4 and Chapter 5 respectively). An analysis of the results, structured according

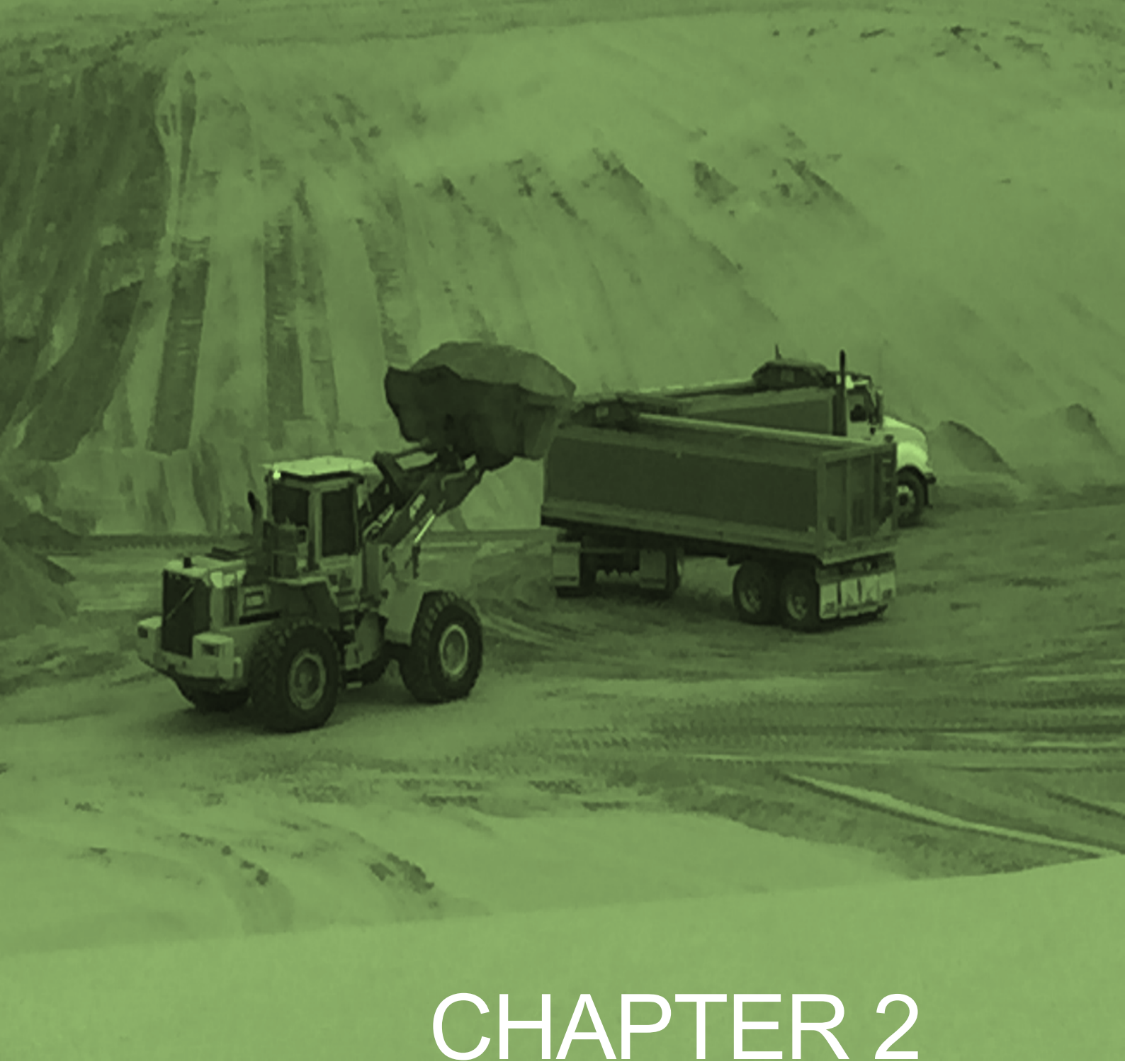
to the social impact categories outlined in section 1.1 of the Guideline (see Appendix A), is provided in Chapter 6, followed by the conclusion of the study (Chapter 7), and SIA recommendations (Chapter 8).

The structure of this report also observes the 'Review Questions' contained in Appendix D of the Guideline. The Review Questions are essentially a checklist for the author to confirm that the SIA Guideline has been complied with, in undertaking the SIA and preparing this report. A compliance matrix is presented in Table 1 to identify where the Review Questions are addressed in this report.

Table 1 – Compliance matrix

Review Question (Appendix D of Guideline)	Location in this report
General	
Has the applicant applied the principles in Section 1.3? How?	Chapter 3, 6 and 7
Does the lead author of the Scoping Report meet the qualification and skill requirements in Box 2?	Certification page
Does the lead author of the SIA component of the EIS meet the qualification and skill requirements in Box 4?	Certification page
Has the lead author of the SIA component of the EIS provided a signed declaration certifying that the assessment does not contain false or misleading information?	Certification page
Community engagement for social impact assessment (Section 2)	
Does the SIA include adequate explanations of how the engagement objectives have been applied? How?	Chapter 3
Does the SIA demonstrate that there has been a genuine attempt to identify and engage with a wide range of people, to inform them about the project, its implications and to invite their input? How?	Chapter 3
Does the SIA demonstrate that an appropriate range of engagement techniques have been used to ensure inclusivity and to ensure the participation of vulnerable or marginalised groups? How?	Chapter 3
Scoping – area of social influence (Section 3.1)	
Does the Scoping Report identify and describe all the different social groups that may be affected by the project?	Section 4.1.3
Does the Scoping Report identify and describe all the built or natural features located on or near the project site or in the surrounding region that have been identified as having social value or importance?	Section 5.2 and 5.3
Does the Scoping Report identify and describe current and expected social trends or social change processes being experienced by communities near the project site and within the surrounding region?	Chapter 4 and 5
Does the Scoping Report impartially describe the history of the proposed project, and how communities near the project site and within the surrounding region have experienced the project to date and others like it?	Chapter 4 and 6
Scoping – identifying social impacts (Section 3.2, Appendix A and Appendix B)	
Does the Scoping Report adequately describe and categorise the social impacts (negative and positive), and explain the supporting rationale, assumptions and evidence for those categories?	Chapter 4 and 6
How has feedback from potentially affected people and other interested parties been considered in determining those categories? Does the Scoping Report outline how they will be engaged to inform the preparation of the SIA component of the EIS?	Chapter 4
Does the Scoping Report identify potential cumulative social impacts?	Chapter 4

Review Question (Appendix D of Guideline)	Location in this report
Social baseline study (Appendix C – Section C1)	
Does the SIA component of the EIS discuss the local and regional context in sufficient detail to demonstrate a reasonable understanding of current social trends, concerns and aspirations?	Chapter 5
Does the SIA component of the EIS include appropriate justification for each element in the social baseline study, and provide evidence that the elements reflect the full diversity of views and potential experiences in the affected community?	Table 3
Does the social baseline study include an appropriate mix of quantitative and qualitative analysis, and explain data gaps and limitations?	Chapter 5 Section 3.2.5
Prediction and analysis of impacts (Appendix C – Section C2)	
Does the SIA component of the EIS include an appropriate description of the potential impacts in terms of the nature and severity of the change and the location, number, sensitivity and vulnerability of the affected stakeholders?	Chapter 6
Does the SIA component of the EIS identify potential impacts at all stages of the project life cycle?	Chapter 6
Does the SIA component of the EIS appropriately identify and justify any assumptions that have been made in relation to its predictions?	Chapter 6
Does the SIA component of the EIS include appropriate sensitivity analysis and multiple scenarios to allow for uncertainty and unforeseen consequences? If relevant, does it include comparisons with studies of similar projects elsewhere?	Chapter 6
Evaluation of significance (Appendix C – Section C3)	
Does the SIA component of the EIS explain how impacts were evaluated and prioritised in terms of significance?	Chapter 6
Does the evaluation of significance consider cumulative aspects where relevant?	Chapter 6
Does the evaluation of significance consider the potentially uneven experience of impacts by different people and groups, especially vulnerable groups?	Chapter 6
Responses and monitoring and management framework (Appendix C – Sections C4 and C5)	
Does the SIA identify appropriate measures to avoid, reduce, or otherwise mitigate any significant negative impacts of the project, and justify these measures?	Chapter 7
Does the SIA explain and justify measures to secure and/or enhance positive social impacts?	Chapter 7
Does the SIA component of the EIS impartially assess the acceptability, likelihood and significance of residual social impacts?	Chapter 7
Does the SIA component of the EIS propose an effective monitoring and management framework?	Chapter 7
Modifications (Introduction – application)	
Are the social impacts associated with the modification expected to be new or different (in terms of scale and/or intensity) to those that were approved under the original consent? If yes, apply the review questions above to the SIA component of the environmental assessment.	Not applicable



CHAPTER 2

LEGISLATION AND POLICY

2 LEGISLATIVE AND SOCIAL POLICY CONTEXT

2.1 Legislation

The EP&A Act sets the legislative context for this study. The objects of the EP&A Act are to:

- promote the social and economic welfare of the community and a better environment by the proper management, development and conservation of the state's natural and other resources;
- facilitate ecologically sustainable development by integrating relevant economic, environmental and social considerations in decision-making about environmental planning and assessment;
- promote the orderly and economic use and development of land;
- promote the delivery and maintenance of affordable housing;
- protect the environment, including the conservation of threatened and other species of native animals and plants, ecological communities and their habitats;
- promote the sustainable management of built and cultural heritage (including Aboriginal cultural heritage);
- promote good design and amenity of the built environment;
- promote the proper construction and maintenance of buildings, including the protection of the health and safety of their occupants;
- promote the sharing of the responsibility for environmental planning and assessment between the different levels of government in the state; and
- provide increased opportunity for community participation in environmental planning and assessment.

The SEARs (and therefore the Guideline) are issued under the provisions of the EP&A Act, and therefore set legislative requirements that this study must accommodate.

2.2 Community plans and strategies

Regional plans which reflect the aspirations of the community have been developed by the state Government and local authority associated with the project. These plans are outlined below.

2.2.1 Hunter Regional Plan 2036

The *Hunter Regional Plan 2036* (NSW Department of Planning and Environment, 2016) was released by the NSW State Government in 2016 and aimed to guide future land use planning priorities and decisions in NSW over a 20-year period. It is not intended to be a step-by-step approach to all land use planning, but instead intends to guide subsequent and more detailed land use plans, development proposals and infrastructure funding decisions. The plan was developed following consultation on a Lower Hunter discussion paper produced in 2014, involving councils and other stakeholders.

The 'vision' of the plan is for the Hunter Region to be the "leading regional economy in Australia with a vibrant new metropolitan city at its heart" (NSW Department of Planning and Environment, 2016, p.8). The plan outlines four goals (and subsequent directions) to achieve its vision. The Hunter Development Corporation will deliver, coordinate and be accountable for achieving the vision and goals of the Plan.

The goals are for the Hunter region to be/have:

1. the leading regional economy in Australia;
2. a biodiversity-rich natural environment;

3. thriving communities; and
4. greater housing choice and jobs.

2.2.2 Port Stephens Council Community Strategic Plan 2018-2028

The *Council Community Strategic Plan 2018-2028* (Port Stephens Council, 2018) developed by Port Stephens Council (PSC) is the primary corporate community strategy of the organisation. It was developed with input from residents, community groups, business and government representatives. The purpose of the plan is to:

- identify community aspirations and priorities over the next ten years;
- outline PSC's role in delivering these priorities;
- work with other governments and agencies to achieve our community's priorities;
- provide for community participation in decision making; and
- provide a basis of accountability and consistency in reporting.

The plan establishes four focus areas for Port Stephens. Each focus area has a sub-set of 'key directions' which outline its priorities. Subsequent to each focus area, there are also a range of objectives and outcomes which guide practitioners in implementing the plan until 2028.

The four focus areas of the plan are:

1. our community - Port Stephens is a thriving and strong community respecting diversity and heritage;
2. our place - Port Stephens is a liveable place supporting local economic growth;
3. our environment - Port Stephens' environment is clean, green, protected and enhanced; and
4. our council – PSC leads, manages and delivers valued community services in a responsible way.

2.2.3 Connecting the Hunter – a regional approach to infrastructure

Connecting the Hunter was developed by the Hunter Branch of Regional Development Australia (RDA) (Regional Development Australia Hunter, 2010) and aims to establish a regional approach to the Hunter Valley's growth strategies. It provides a framework to identify, assess and meet the Hunter's long-term future infrastructure needs. RDA Hunter consulted widely throughout 2010. It encouraged discussion with regional partners and government to identify infrastructure priorities.

The infrastructure priorities outlined in the strategy include:

- capitalising on past successes and the better use of existing infrastructure;
- addressing planning inefficiencies and inconsistencies that hinder investment;
- planning for future infrastructure needs within a long-term, strategic, comprehensive and consistent regional framework;
- maintaining appropriate levels of investment in human capital, knowledge and information infrastructure;
- improving the liveability, sustainability and productivity of Newcastle, the region's capital;
- securing north-south and east-west corridors for future rail capacity expansion;
- acquiring land for road and rail expansion;
- improving sea and air links to Newcastle Port;
- completing the F3 to M2 link road;
- developing the case for High Speed Rail between Newcastle and Sydney;
- establishing a Regional Transport Authority;
- advocating for the Hunter and Central Coast to be priority areas for the rollout of the NBN;
- encouraging further research development and investment in renewable energy technology; and
- securing future water security.

2.2.4 Port Stephens Planning Strategy 2011-2036

The strategy developed by PSC aims to provide high level strategic direction for spatial planning in the Port Stephens Local Government Area (LGA). It intends to guide land use allocation and other provisions of the Port Stephens Local Environmental Plan (LEP) (NSW Parliament, 2013), and a range of other planning documents used to regulate development and ensure conservation in the LGA. It recognises that "all communities in Port Stephens [LGA] are considered to be significant and all play an important role in how Port Stephens functions as an area" (Port Stephens Council, 2011, p. 64).

Council's strategy outlines eight directions for residential, commercial and industrial development in Port Stephens:

- a framework for growth and conservation;
- analysis of commercial and industrial land;
- centres and hierarchy;
- accommodating more housing;
- employment and industries;
- rural production and landscapes;
- conservation areas; and
- transport.

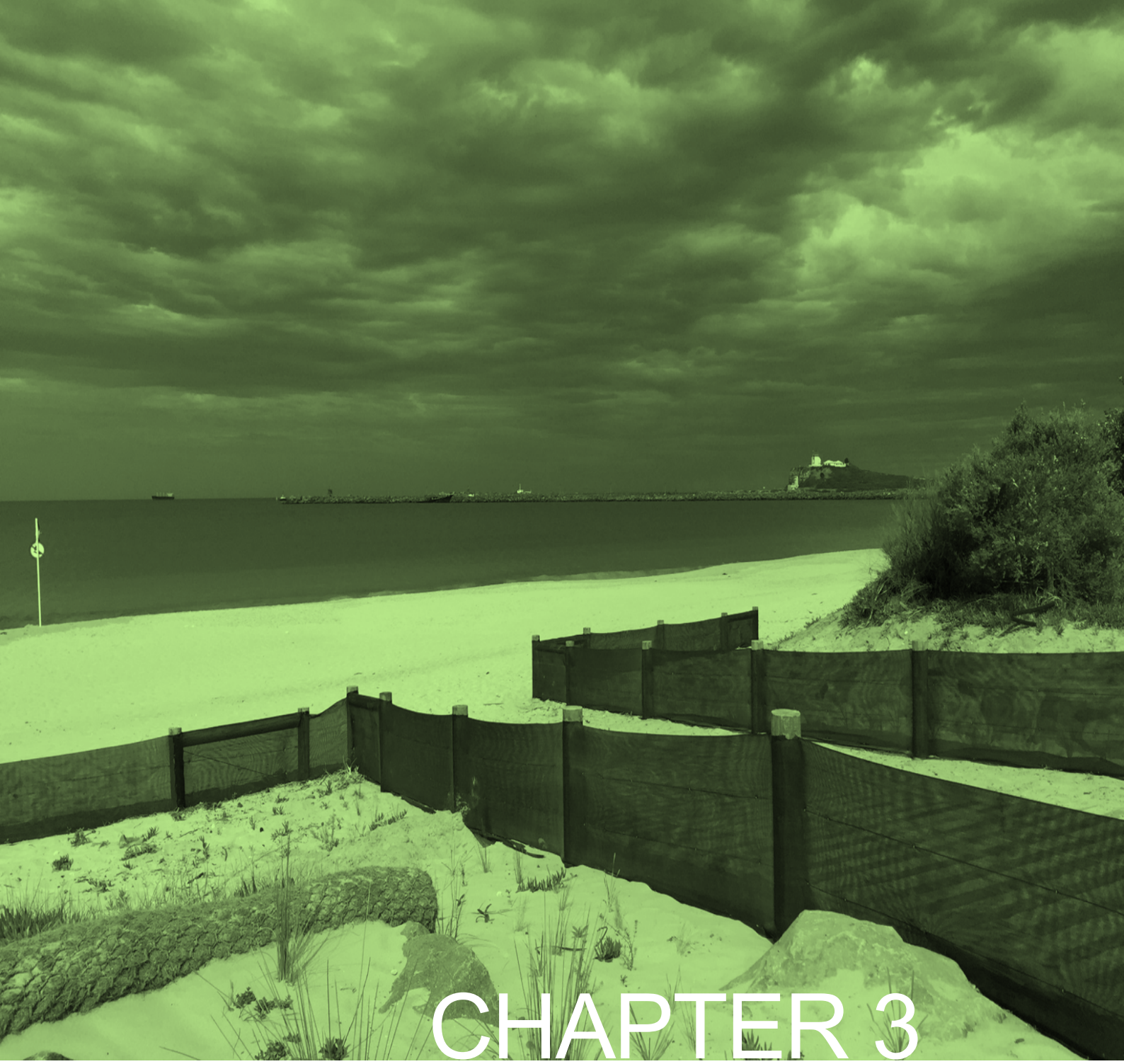
2.2.5 Hunter Economic Infrastructure Plan

The *Hunter Economic Infrastructure Plan* (Regional Development Australia Hunter, 2013) was created by the Hunter branch of RDA. It was developed to enable a whole of supply chain view of mining related activities in the Hunter region. The plan considered and assessed major infrastructure requirements in the Hunter region including:

- ports;
- rail;
- electricity;
- roads; and
- water.

RDA determined that that roads and water warranted further investigation in their assessment. Those issues attracted most attention in the plan, particularly from the perspective of coal mines operating in the Hunter region.

In relation to road infrastructure investment, the plan recommends road infrastructure upgrades, addressing safety needs associated with forecast additional mine traffic flows, improved freight and commuter travel times, and a focus on community and social issues. In relation to water security, the plan recommends that the Government undertakes an analysis of industry water requirements to support growth under various drought scenarios, and provide industry with the necessary up-to-date information to manage risks associated with water supply and drought.



CHAPTER 3

METHODOLOGY

3 METHODOLOGY

The methods described below enabled the collection of data to address the social impact categories defined in the Guideline (refer Appendix A). Whilst this chapter describes the SIA methodology, it does not identify which social impact category each method is designed to address. This link is made clear in Chapter 4 (and summarised in Table 10). Following Chapter 4, the results of the SIA are presented and discussed according to the social impact categories, to ensure compliance with the Guideline.

3.1 Methodology for scoping the SIA

The preliminary SIA for the project was supported by a number of methods outlined in the *Stockton Sand Quarry Dredging Preliminary Environmental Assessment* (Element Environment, 2018). These methods are summarised below.

3.1.1 Scoping tool

The scoping tool contained in the Guideline was a method implemented during the SIA scoping phase. The process of applying the scoping tool involved:

1. using early engagement result as inputs to the scoping tool and considering each 'matter' (ie amenity, access, built environment, heritage, community and economic) and its subcategories, before determining how likely it is that project activities will cause an impact to it;
2. for each matter, considering and assessing the material characteristics of any likely impact;
3. for each matter, considering stakeholder/community opinions and sentiment towards the project activities;
4. for each matter, determining whether or not a social impact will arise from the project activities, and then developing a rationale for the decision; and
5. for each matter, determining the level of assessment (and engagement) required in the EIS preparation phase, and selecting from the following list the most appropriate SIA type:

    - desktop: another specialist study or section of the EIS will provide all the information and analysis needed to predict, evaluate and develop a response to the social impact, including relevant primary and secondary research, qualitative and quantitative data, and appropriate engagement with potentially affected people, to establish a baseline and support predictions. If this is the case, the SIA component of the EIS only needs to review the data and findings from the other sources through a SIA lens and cross-reference and integrate them into the overall social baseline and assessment.
    - standard: most information and analysis needed to predict, evaluate and develop a response to the social impact will be provided by another specialist study or section of the EIS, but it will need to be supplemented with further evidence gathering and analysis to fill any gaps and obtain a complete picture from a SIA perspective.
    - comprehensive: only limited or no information and analysis will be provided by another specialist study or section of the EIS. If so, the author/s of the SIA component of the EIS will need to undertake the evidence gathering and analysis needed to predict, evaluate and develop a response to the social impact.

6. each matter and its associated level of assessment (determined by the scoping tool) was considered in the context of the social impact categories specified in section 1.1 of the Guideline. Refer to Appendix A for a list of these categories.

3.1.2 Stakeholder identification and analysis

A stakeholder is a group, individual or organisation that is interested in, affected by, or has the capacity to influence a project (Brereton, 2005). Figure 2 contains a general list of people and organisations that are likely to be stakeholders in most projects. This list was valuable for providing a starting point for the stakeholder analysis conducted in the SIA scoping phase. There will however, always be locally-specific groups and locally specific circumstances that influence the local cultural context (Vanclay, 2015).

The locally-specific Project stakeholders are known to Boral courtesy of their long-term presence in the Fullerton Cove area. As part of the scoping exercise, a high-level stakeholder analysis was undertaken first by leveraging the knowledge held by Boral staff. Two senior staff members were interviewed to determine the most prominent stakeholders associated with the project. The interviews were held during February 2018 and each had a one-hour duration (approximately). Following the interviews, a further desktop analysis (of files held by the project team related to previous community engagement, and online sources) was completed to identify other stakeholders potentially interested in the project. The project stakeholder list is contained in the stakeholder matrix (see section 4.1.3).

Residents	• Within the affacted area • Immediate neighbours
People in host communities	• Those that relocate as a result of a planned resettlement or through their own migration • People in communities near where construction workers or other in-migrants will be located
Other communities	• More distant residents whose livelihoods may be affected as a result of the project • Communities near associated works such as irrigation channels, quarries, roads, railways, and transmission line corridors
Project employees	• Construction workers and their families
Indigenous people	• Non-resident Indigenous or other land-connected peoples who may have spiritual attachment to the land/river
Non-government organisations (NGOs)	• Local, national and international NGOs (for example, conservationists) interested in ecological or heritage values that may be influenced by a project
Other stakeholders	• Developer and associated contractors, regulatory agencies, local regional and national governments, funding or development agencies

Figure 2 - Stakeholders likely to be involved with a project (Vanclay, 2015)

3.1.3 Written and interactive engagement methods

Early engagement for the project was implemented via a community engagement program, undertaken during 2018. A range of methods were utilised during the program to engage stakeholders and provide an opportunity to interface with Boral about the proposed operations. A

description of each method used is provided in Table 2. Note the intent of Table 2 is not to describe the engagement outcomes or identify the stakeholders targeted by each method. These are identified in section 4.1.3 (refer Table 11).

Table 2 – Written and interactive scoping phase engagement methods

Method	Description
Phone call	The project team contacted the Port Stephens Member of Parliament (MP) to provide a project update and answer any questions raised.
Letter	A letter inviting feedback about Boral's operations, via a link to an online survey. This was distributed to residents (via random sample) living near the project in early March 2018.
Email	The project team distributed emails to provide project updates to stakeholders. Emails included an overview of the project, details about consultation activities including interviews (below), and the project newsletter.
Interviews	Interviews with residents (via the random sample doorknock) living in Fern Bay and Fullerton Cove in early March 2018.
Newsletter	A newsletter inviting feedback about Boral's existing operations, informing the community about the project, and offering individual meetings with residents in Fern Bay and Fullerton Cove. Newsletters were distributed during May 2018, February 2019, and July 2019. The newsletter was made available for download from the project website, and emailed to government agencies and elected representatives.
Meeting and invitations to MPs	Meeting invitations were sent via email to the NSW Member for Port Stephens and the Federal Member for Paterson during April 2018. The email offered to provide a briefing of the project to the MPs.
Meetings with PSC	A meeting with PSC planning staff was held during May 2018. At the meeting Boral staff presented an overview of the project. A second meeting between Boral staff and Councillors from PSC was held during July 2018 and involved a briefing to inform Councillors about the project. Boral staff then invited questions from the Councillors in attendance.
Consultation with Worimi Local Aboriginal Land Council (LALC)	Boral's National Indigenous Affairs Manager consulted the Worimi LALC via a meeting with the Worimi LALC CEO and board members in January 2018.

3.1.4 Area of social influence development

The Area of Social Influence (ASI) for the project and a description of its development were contained in the project scoping report, included in the *Stockton Sand Quarry Dredging Preliminary Environmental Assessment* (Element Environment, 2018). Further engagement activities did not yield any information to warrant a modification of the ASI for the EIS.

The Guideline (NSW Department of Planning, Industry and Environment, 2017) explains that the term 'locality' does not have a prescribed meaning or refer to a fixed, pre-defined geographic boundary. This observation was adopted for the project. Care was taken to determine the ASI comprising the area within the actual project boundary, but also the geographies external to the site where social impacts may arise.

The ASI was developed on the premise that relationships within and between scales will affect what people understand as impacts (Vanclay & Esteves, 2011). This means that people may not perceive social impacts created by a project to be those felt exclusively within or immediately adjacent to the project boundary, or at a time when operations are conducted on site. Instead, it is possible for impacts to be felt at locations outside the project boundary and at any time of day (particularly in the event of long-distance haulage routes or complex supply chains). These time and space relationships between the project site and communities, economies, infrastructure, and resources (both human and natural), were explored using a mixed-methods approach during the ASI development. The specific methods adopted were:

1. semi-structured interviews with key Boral project personnel familiar with the existing operations on site and the local communities near the project site;
2. semi-structured interviews with residents (via random sample "Stakeholder Perception Benchmark" doorknock) living near the project site;
3. feedback from residents obtained during a doorknock of randomly selected residential properties in Fern Bay and Fullerton Cove in early March 2018; and
4. analysis of historical correspondence records.

The development of the ASI considered factors including but not limited to:

- supply chains;
- haulage of resources;
- transport of goods;
- materials and equipment;
- movement of workers (drive-in-drive-out/fly-in-fly-out working arrangements);
- natural features and recreational values (eg coastal sand dunes of Stockton Bight);
- ancillary infrastructure; and
- reputation of other extractive industries in the area.

Data Sources used to develop the ASI

Both primary and secondary data sources were collected and analysed in developing the ASI. Primary data derived from the semi-structured interviews was reliable given the comprehensive knowledge of the project that the key project personnel held (two interviews were conducted with long-term Boral employees). Interviews with residents in the two suburbs closest to the project site similarly provided reliable qualitative data.

Secondary data in the form of historical correspondence records associated with the existing operations was used to further develop an understanding of the ASI. This data provided an insight into the issues that the community have raised with Boral in past years, and the general sentiment towards the project.

Results of the scoping activities which assisted the development of the ASI are shown in Chapter 4.

3.2 Methodology for preparing the SIA

3.2.1 Existing social baseline

An analysis of the existing population was undertaken to establish the social baseline for the project. Secondary data was obtained from the most reliable sources available, primarily being the *2016 Australian Census of Population and Housing* (Australian Bureau of Statistics, 2018). During the scoping phase it was determined that the Fern Bay and Stockton (Fullerton Cove) populations should be included as distinct entities in the baseline. This is due to the fact that Fern Bay is a relatively new community with a residential estate under development at the time of writing, whereas the Stockton area closest to the project contains an established community with more mature properties. Socio-economic indicators for both populations were therefore collected.

Data collected for Fern Bay has been compared to the Statistical Area Level 2 Stockton – Fullerton Cove. The Fern Bay SSC (or State Suburb) and Stockton-Fullerton Cove SA2 (Statistical Area 2) census geographies were selected as the basis of the census data analysis below. This is because census data was only available for the Fern Bay area as a State Suburb dataset, and therefore it was the most accurate available. The Statistical Area 2 dataset was selected for Stockton-Fullerton Cove because the scale represents a community that interacts together socially and economically, and it allows a more detailed analysis than the inferior statistical area

or suburb datasets (Australian Bureau of Statistics, 2018). The socio-economic variables discussed below align with the community profile measures adopted by the Australian Bureau of Statistics (ABS). Where available and relevant, comparative data at the NSW state level was obtained and forms part of the baseline.

A wide range of social indicators were considered prior to conducting the statistical analysis and developing the baseline. The selection of social indicators was made based on those contained in the PSC *Community Strategic Plan 2018-2028* (Port Stephens Council, 2018). The strategic plan is PSC's primary corporate community strategy, developed with community input. It was therefore logical to use complimentary indicators in the baseline. This selection method provided confidence that the social indicators represented the health and wellbeing values, and interests of the communities (Vanclay, 2015) surrounding the project. Each social indicator and its relevance to the four focus areas[1] contained in Council's plan, is outlined in Table 3.

Table 3 - Relationship between social indicators and PSC Community Strategic Plan 2018-2028 (Port Stephens Council, 2018)

Focus Area listed in the *PSC Community Strategic Plan 2018-2028*	Relevant social indicator contained in the baseline
Community: C1 Community diversity - Our community accesses a range of services that support diverse community needs C2 Recognised - traditions and lifestyles - Our community supports the richness of its heritage and culture C3 Community partnerships - Our community works with Council to foster creative and active communities	Community profile Population projections Family composition Indigenous population Place of birth Multiculturalism Education, employment and training Educational status
Place: P1 Strong economy, vibrant local businesses, active investment - Our community has an adaptable, sustainable and diverse economy P2 Infrastructure and facilities - Our community's infrastructure and facilities are safe, convenient, reliable and environmentally sustainable P3 Thriving and safe place to live - Our community supports a healthy, happy and safe place	Employment by industry Weekly income; individual and household Council satisfaction survey (Q2) Road safety statistics SEIFA
Council: L1 Governance - Our Council's leadership is based on trust and values of Respect, Integrity, Teamwork, Excellence and Safety L2 Financial management - Our Council is financially sustainable to meet community needs L3 Communication and engagement - Our community understands Council's services and can influence outcomes that affect them	Council satisfaction survey (Q15) Election participation rates

[1] The 'Environment' focus area is not addressed in the SIA baseline, as a baseline consisting of environmental indicators is contained in the EIS.

3.2.2 Existing social infrastructure

An online desktop search was the method used to determine the existing social infrastructure associated with the project. Data was sourced from a range of websites including:

- PSC website (Port Stephens Council, 2019);
- PSC Community Directory (Port Stephens Council, 2018);
- NSW Department of Education (NSW Department of Education, 2018);
- NSW Health (NSW Health, 2018); and
- NSW National Parks and Wildlife Service (NSW National Parks and Wildlife Service, 2018).

3.2.3 Further engagement methods

As described above, scoping engagement for the project comprised a comprehensive community engagement program undertaken during 2018. Following the publication of the SEARs applicable to the project, a range of further engagement methods were implemented to emphasise and seek feedback about the project. Each of the methods implemented for further engagement are described in Table 4.

Table 4 - Further engagement methods

Method	Description
Written methods	
Project newsletter (including community drop-in sessions detail)	The newsletter was released during February 2019 and distributed online, via email, and in hard copy to project stakeholders. It explained the value of sand as a building and construction industries commodity, and the importance of sand operations at Stockton. It provided project details and described proposed operational changes. The newsletter also provided details about the community drop-in session and extended an invite to all readers. Another newsletter was released during July 2019. It provided an EIS progress update and advice about lodgement of the SSD. It presented the refined proposal for the quarry, listed the specialist studies underway, and invited ongoing feedback from the community.
Community drop-in sessions notification	On 7 February 2019, the notification was delivered to individual private properties located closest to the project, in the Fullerton Cove and Fern Bay residential areas. The notification invited recipients to the sessions to discuss any proposed operational changes. It emphasised proposed traffic changes, and the interest of the project team in obtaining feedback about that topic. It provided project contact details (including those of the Quarry Manager) for residents that could not attend on the scheduled date and encouraged recipients to provide feedback via the dedicated project communication channels.
Emails	Emails sent from Boral's Stakeholder Relations Manager to project stakeholders (including PSC Mayor and Councillors) during the first quarter of 2019. The emails contained a project update including project contact details, and the project newsletter and community drop-in sessions notification (for emails sent post its release). They invited feedback about the project. Similar emails were again sent to the stakeholders in July 2019, with a copy of the July 2019 newsletter.
In-person interactive methods	
Meeting - Worimi LALC	During February 2019 Boral's Indigenous Affairs Manager met with the CEO Worimi LALC. The purpose of the meeting was to consult the LALC on the aspects of the project and seek its feedback.
Site tour (Newcastle MP)	During February 2019 the Newcastle MP was consulted about the project and invited to a site visit. The invitation was accepted, and

Method	Description
	members of the project team escorted the Newcastle MP during the visit. Boral staff provided details about the project and addressed questions raised by the Newcastle MP.
Community drop-in sessions	Community drop-in sessions were advertised locally and held on 14 February 2019 in a reserved space in the McDonalds Restaurant at Williamtown. This venue was selected as it is a heavily patronised venue and easily accessible by communities nearby to the project. Two separate sessions were held (ie morning and late afternoon) to provide adequate opportunity for individuals to attend. Four members of the project team were present at all times, and available to all attendees. A Boral banner was erected in a prominent position at the restaurant entry, and directional posters were placed nearby to assist individuals to find the drop-in session location (see Figure 3).
Consultation with Office of Port Stephens MP	Following the meeting held at the office of the Port Stephens MP during the scoping phase of the project, a return visit was made on 14 February 2019. The MPs office was advised about the community drop-in session and provided an update about the project and planning process.
Consultation with local neighbours	Consultation via a doorknock with local quarry neighbours was undertaken in August 2019. The doorknock targeted a random selection of properties on Coxs Lane, Fullerton Cove Road, and George Street. Residents were invited to provide feedback about the existing quarry operations and the project, and provided with an update about the SSD.
Media methods	
Website	Information about the Project including the project newsletters and community drop-in sessions notification, details of the community drop-in sessions, and Project contact details was hosted on the Boral Quarries Stockton (Fullerton Cove) website (Boral, 2018). The website was referenced in all material developed for the project and provided a central repository of information associated with the project. A major update of the project information on the website was undertaken during February 2019.
Facebook campaign	On 12 February 2019, the Boral Facebook site hosted a social media post about the project. The post highlighted the demand for sand for building and construction industries and referred to the planning proposal. It encouraged readers to visit the Boral Quarries Stockton (Fullerton Cove) website to obtain more detail. The Facebook post is provided in Appendix B.





Figure 3 – Community drop-in session at McDonalds Restaurant Williamtown

3.2.4 Social impact assessment methods

A range of methods were selected for the SIA. Each method was adopted to address one or more of the matters determined by the DPIE scoping tool, to require further social impact investigations. The selection process involved:

1. populating the DPIE scoping tool with the relevant information;
2. determining the level of assessment prescribed by the scoping tool; and
3. selecting a method or a combination of methods to satisfy the level of assessment, bearing in mind:

    - the specific social matter to which the assessment related;
    - the availability of existing data held by the project team (if any); and
    - feasibility of the methods (eg time, cost, reliability).

The methods adopted for the study are outlined below. The social matters to which each method relates are identified in Chapter 4.

Ethnographic content analysis (media analysis)

Altheide's (1996) Ethnographic Content Analysis (ECA) was selected and adapted as the method to assess impacted social matters identified during the scoping exercise. ECA is a qualitative media analysis methodology used to obtain, categorise and analyse different media documents (such as newspapers and magazines) in addition to other forms of media delivered online and via television. ECA is an approach which blends the "traditional notion of objective content analysis with participant observation to form ethnographic content analysis" (Altheide, 1996, p. 2). It is therefore unlike the traditional positivist and quantitative approach to media analysis which engages in a rigorous quantitative testing of phenomena against a template devoid of human interface (Guba & Lincoln, 2005). Instead ECA encourages the investigator to be reflexive and interactive, and it enables an element of ongoing discovery as progress is made towards the SIA research goal. It is in this vein that ECA enables documents to be "studied to understand culture or the process and the array of objects, symbols, and meanings that make up social reality shared by members of a society" (Altheide 1996, p.2).

The characteristics of ECA are clearly distinguished from those associated with quantitative approaches (QA) to media analysis (see Table 5 for a comparison). Unlike QA which is concerned with statistical reliability, Altheide (1996) suggests that the emphasis of ECA is fixed more so on research 'validity'. Although itself a term commonly associated with statistical tests, validity in this sense refers instead to the degree of rigour in a research project, as determined by the interpretive community who check the research for credibility and good practice (Bradshaw & Stratford, 2005). ECA is also dissimilar to QA in terms of researcher involvement. Each of the research phases in an ECA approach is very individualistic in the sense that the main investigator is 'involved' with the concepts, relevance and development of the protocol and the way in which items are collected for purposes of later analysis (Altheide, 1996). Furthermore, in contrast to QA, data collection for ECA is predominantly undertaken using a purposive or theoretical sampling technique and is not intended to provide a representative sample (refer Bradshaw and Stratford, 2005).

As shown in Table 5, ECA focuses on narrative data (in addition to numerical data that is more commonly associated with QA) and always allows the researcher to make analytical commentary on this data. This approach not only involves the measurement of the frequency and extent of terms consistent with QA approaches, but it also enables the investigation of text meaning, and encourages the provision of descriptive information (Altheide, 1996). The qualitative text analyst produces this descriptive information by repeatedly exploring the sampled texts, and by noting the peculiarities contained in the sample (Roberts, 1997). It is through this process that the analytical concepts emerge and are applied to the text in ECA research. Roberts (1997) describes this as a key difference between QA and ECA; on the one hand "quantitative researchers specify

their measures and their tests in advance…on the other hand, qualitative [ECA] researchers typically explore their data, applying one classification scheme after another, before settling on that scheme (or schemes) that in their view resonates best with their data" (Roberts 1997, p.2). Analysis therefore "takes place throughout the entire research process, a study is shaped and reshaped as a study proceeds, and data is gradually transformed into findings" (Watt, 2007, p. 95).

Table 5: A comparison of quantitative media analysis and ECA (source: Altheide 1996)

Characteristic	Quantitative approach to media analysis (QA)	Ethnographic approach to media analysis (ECA)
Emphasis	Reliability	Validity
Primary Researcher involvement	Data analysis and interpretation	All phases
Sample	Random or stratified	Purposive or theoretical
Type of data	Numbers	Numbers; narrative
Narrative description and comments	Seldom	Always
Concepts emerge during research	Seldom	Always
Data analysis	Statistical	Textual; statistical
Data presentation	Tables	Tables and text

Applying ECA to the SIA using online news articles

The most important element of the entire ECA exercise is the protocol (or a data collection sheet). It is "a way to ask questions of a document; a protocol is a list of questions, items, categories or variables that guide data collection from documents" (Altheide 1996, p.26). It is therefore an essential utility of ECA. The protocol itself consists of two tables – Table A and Table B - as shown in the example in Figure 4. Table A, the first of the two tables, has nine columns with the following headers and definitions:

1. case number – a number sequentially allocated to each article analysed (ie number '1' was allocated to the first article analysed, number '2' to the second and so on);
2. search string – the phrase used to search for online news articles, via the search function on the publications webpage;
3. source publication – the title of the newspaper which contained the article. Each article analysed in this ECA exercise was sourced from the *Port Stephens Examiner* website;
4. date of article – the production date of the newspaper article (found on the web page). Note only articles collected from June 2011 to February 2019 were collected;
5. title – the title of the newspaper article;
6. frame – a numeral, corresponding to a particular Frame in Table B which is allocated during the analysis of a *Port Stephens Examiner* article;
7. theme – a numeral, corresponding to a particular Theme in Table B which is allocated during the analysis of a *Port Stephens Examiner* article;
8. discourse - a numeral, corresponding to a particular Discourse in Table B which is allocated during the analysis of a Goulburn Post article; and
9. notes – miscellaneous information specific to an article can be included in the notes column.

TABLE A

Case No.	Search string	Publication	Date of article	Title	Frame	Theme	Discourse	Notes
1	Sand trucks + stockton and Sand tr	Port Stephens Examiner	23/01/2019	Different paths for Port Stephens state election candidates	1	1	1	
2	Sand trucks + stockton and Sand tr	Port Stephens Examiner	3/01/2019	Whale carcass removed from One Mile Beach	DQ			
3	Sand trucks + stockton and Sand tr	Port Stephens Examiner	18/10/2018	No Sand Mining in Bobs Farm action group reformed after pr	2	2	2	
4	Sand trucks + stockton and Sand tr	Port Stephens Examiner	3/10/2018	Bobs Farm sand mine proposal is back on the table	2	2	3	
5	Sand trucks + stockton and Sand tr	Port Stephens Examiner	20/09/2018	Residents turn out to meeting to hear proposal for Anna Bay	3	3	3	

TABLE B

Frames		Themes		Discourses	
Political attention to quarries and	1	Political opposition to road	1	Excessive quarry trucks using public infrastructure	1
Community attention to quarries	2	Community opposition to road impacts	2	Negative impacts on families and schools	2
EIS and infrastructure/traffic plan	3	Infrastructure/traffic studie	3	Additional truck movements (negative sentiment regarding	3
Road maintenance funding	4	Quarry trucks damage road	4	Quarry operators should share road maintenance burden	4
		Quarry benefits outweight	5	Additional truck movements (neutral sentiment regarding r	5
				Negative impacts for community safety	6
				Sand haulage route debate	7

Figure 4 – ECA protocol

A new record containing the above information was added to Table A each time an article containing a narrative about dust or safety (being two social matters identified during the scoping exercise) was read.

The second table (Table B) contained in the protocol lists all the categories (Frames, Themes and Discourses) that emerged from the *Port Stephens Examiner*. Table B is best understood as a 'lookup table' or a 'storage table' which holds the categories that are individually applied to *Port Stephens Examiner* articles during analysis. The three columns in Table B (refer Figure 4) have the following headers and definitions:

1. frames - "very broad thematic emphases or definitions of a report" or "a way of discussing the problem or the kind of discourse that will follow" (Altheide 1996, p.30);
2. themes - "general meanings or even 'miniframes for a report'" or "the recurring typical theses that run through a lot of reports" (Altheide 1996, p.30); and
3. discourses - "a series of representations, practices and performances through which meanings are produced" (Johnston & Gregory, 2000, p. 178).

Each *Port Stephens Examiner* article that mentioned or suggested an association to the target social impact matter was analysed for its relevance to the project. Using Table B, this objective was achieved by developing a Frame, Theme and Discourse for each article. As each article was read, the message it conveyed about the project was considered, and the most appropriate Frame, Theme and Discourse was allocated to it. Articles that did not contain content meeting the definitions of a Frame, Theme and Discourse were disqualified from the ECA. It is important to note that the Frames, Themes and Discourses developed and entered into Table B reflected only the manifest content of the news articles. Manifest content is the descriptive information contained in a media message that is easily recognised and immediately digested by the reader. Manifest content has been described as the information existing 'on the surface' of a text document, and it contrasts with latent content which is characterised by information 'hidden beneath the surface' of a text document which is obtained through deeper analysis (Lombard & Snyder-Dutch, 2002). The Frames, Themes and Discourses were developed, defined in one or two sentences, and added to Table B as they emerged from reading each article. The categories were therefore 'stored' in Table B, and they were assigned a numerical code which was eventually copied into the corresponding cell in Table A.

Rather than being produced at the end of the collection and analysis of newspaper articles, both tables which comprise the protocol are drawn up prior to commencement and entries are gradually and progressively added to it during the execution of ECA. Each time a pertinent article containing a discourse relevant to the target social impact matter was read, a new record was added to Table A. In addition, if no suitable categories (ie Frames, Themes or Discourses) existed in Table B, then new categories were developed and added to that table. The information added to each new record in the protocol corresponds with details sourced from each individual *Port Stephens Examiner* article. The protocol was therefore expanded as the newspaper sample was read.

There were 10 key steps involved in carrying out the ECA method, and whilst being fundamental to the practice of ECA, the Protocol is not utilised until step four. The following section will outline all 10 steps and further illustrate the utility of the Protocol described above.

The ten steps of ECA

The implementation of ECA to *Port Stephens Examiner* articles involved carrying out 10 of the key steps defined by Altheide (1996). Each of these 10 steps is listed below, along with a description of how it was applied in the context of the *Port Stephens Examiner* analysis.

- Step 1: Pursue a specific problem and opportunities to be investigated.

The SIA scoping tool identified social matters that required assessment as part of the SIA. These assessments resemble the problems and opportunities that need to be investigated.

- Step 2: Become familiar with the process and context of the information source. Explore possible sources of information.

Given its position as the most dominant and popular text media publication in the Port Stephens region, the *Port Stephens Examiner* is a unique source of social narratives. The publication broadcasts the views held by society in respect to topical issues and it does so in a standardised process. This process involves the regular and frequent publication of news topics in a uniform format. Articles from the publication are made available online and free of charge. For these reasons it was adopted for the ECA exercise.

- Step 3: Become familiar with several examples of relevant documents and select a unit of analysis.

Familiarity with individual *Port Stephens Examiner* articles was gained by completing a scoping activity. This activity involved conducting an online search for a *Port Stephens Examiner* article, using the search string “Sand trucks + Stockton”. The search was conducted using the search function on the *Port Stephens Examiner* webpage. The search string returned a page of search results, and the five highest ranked articles with Stockton mentioned in the title were read. The process enabled recognition of the layout of the articles and other sections of the page (eg comments section and advertisements) which were not analysed. At this step in the ECA it was revealed that articles returned in the search with the titles “Mega Gallery**:** The week in pictures”, “Photos of the week” and letters to the editor appearing under various titles, gave little value to the ECA. The content was rarely associated with the SIA objectives, reviewing the content was time prohibitive, and the articles were therefore excluded from the ECA (unless their value was immediately discernible in the website search results).

During the initial scoping activity, a decision was made concerning the unit of analysis to be incorporated into the ECA exercise. A ‘unit of analysis’ refers to the portion or segment (eg a particular page, an individual article, a certain paragraph) of relevant articles that will actually be subject to ECA. It was decided that the entire individual articles (including any heading, body text, caption text and/or images) that mentioned or suggested an association to the target social impact matters would be the unit of analysis. This decision was made “because it was clear from the content of the messages [contained in the *Port Stephens Examiner* articles] that they could not be further reduced before analysis without losing valuable contextual information” (Markman & Simons, 2003, p. 16).

- Step 4: List several categories (variables) to guide data collection and draft a protocol (data collection sheet).

Step 4 marked the phase where a protocol (or data collection sheet) was first introduced to the ECA exercise. Categories (ie Frames, Themes and Discourses) that emerged from the articles read during Step 3 were entered into a draft Protocol (refer Figure 4). In terms of discourses, there were initially four observed in the *Port Stephens Examiner* that conveyed specific information regarding the target social impact matters. They included:

1. excessive quarry trucks using public infrastructure;
2. negative impacts on families and schools;
3. additional truck movements (negative sentiment regarding road quality); and
4. quarry operators should share road maintenance burden.

At this step of the ECA, these understandings of the project were derived only from the description immediately recognised within each article. Subsequently, the above four categories only reflected the manifest content of the news articles. These categories were entered into the protocol as they emerged.

- Step 5: Test the protocol by collecting data from several documents.

At Step 5 the additional articles were collected to test the protocol. An additional search was made at this time using the search string "Sand trucks + Nelson Bay Road". During the collection and analysis activities there were additional Frames, Themes and Discourses that emerged from the manifest content of the news articles. An entry was created in the protocol for each article, and the protocol expanded progressively as a consequence.

- Step 6: Revise the protocol and select several additional cases to further refine the protocol.

A revision of the protocol was undertaken when all articles (obtained at the time) that mentioned or suggested an association to the target social impact matter had been tentatively analysed. The revision involved checking the definitions of all categories to ensure that they were succinct and appropriate for the articles that they represented. Modifications to inadequate categories listed in Table B of the protocol were made as needed. The modifications were made in one of four ways; categories were renamed, re-defined, split into two, or merged into one.

- Step 7: Arrive at a sampling rationale and strategy (eg theoretical, purposive, opportunistic, cluster or stratified).

Following the consideration of a range of sampling techniques, theoretical sampling was the technique adopted. Theoretical sampling involves “the selection of material based on emerging understanding of the topic under investigation” (Markman & Simons, 2003, p. 17). The theoretical sampling technique was adopted in order to identify and refine knowledge of narratives about the quarry, over time. At Step 7, other sampling parameters were confirmed such as the publication date range. Articles published between June 2011 and February 2019 were considered for the ECA method. This date range was selected as it commences when the most recent modification to the 2006 development consent was made. The consent was modified to include more appropriate controls to manage interactions with the public in active extraction areas. A logical extension of this scenario is that any social impacts derived from the project may have been reduced as a result of the modification. The date range would therefore capture any new or ongoing impacts, expressed through the media. Any articles published outside of the subject date range were excluded from the study.

- Step 8: Complete data collection for the target social matter.

The relevant search strings were applied and the collection of relevant *Port Stephens Examiner* articles continued in a sustained and rigorous fashion until all articles returned via the online searches had been covered. As articles were collected, they were added to the protocol following the procedure outlined earlier (ie a record of each article was created in Table A of the protocol using its attribute details, and each article was categorised with a Frame, Theme, and Discourse in Table B).

At the completion of Step 8 the sample had been obtained, each article in the sample had been subject to a manifest content analysis, and the results from these analyses had been recorded in the protocol. The results provided a means to understand the implications of the SSD for the target social impact matter, via the discourses being circulated amongst the population.

- Step 9: Consider the content analysis results shown in the ‘discourse’ column. Write summaries or overviews of the key findings.

Once every *Port Stephens Examiner* article listed in Table A of the protocol had been analysed and the results had been entered into the ‘discourse’ column, then the individual results were considered. Summaries were produced of each discourse, and they were the key findings of the ECA exercise.

- Step 10: Integrate the findings including the discourse interpretations and key concepts into the SIA report.

The final step of the ECA involved collating the results contained in the protocol and the discourse summaries into the SIA report. Chapter 6 contains the results.

Participant observation

Participant observation (PO) is a conventional method used in the social sciences. It is "considered a staple in anthropological studies, especially in ethnographic studies, and has been used as a data collection method for over a century" (Kawulich, 2005, p. 25)**.** The method provides a researcher with a means to collect data about cultural phenomena and the social settings in which they arise. In practice, this involves the researcher either openly or covertly examining the daily life of people under study, by "observing things that happen, listening to what is said, and questioning people, over some length of time" (Becker & Geer, 1957, p. 28).

In her thorough analysis its characteristics, Pearsall (1965) explained that PO is at once a role, a means of getting data, and a methodology for understanding human behaviour in natural contexts. Explanations of these three aspects of the method are offered below:

- role: PO implies the roles of a participant and an observer being present in a social setting. On the observer's side, the role is temporary and to a degree 'unnatural'. He [sic] may choose from a limited number of forms along a continuum from that of complete observer to that of complete participant" (Pearsall, 1965, p1). Gold (in Kawulich, 2005) nominates four roles that exist on this continuum (see Figure 5), which specify the degree to which the researcher involves himself/herself in participation in the culture under study:

    1. At one extreme is the *complete participant*, who is a member of the group being studied and who conceals his/her researcher role from the group to avoid disrupting normal activity. The disadvantages of this role are that the researcher may lack objectivity, the group members may feel distrustful of the researcher when the research role is revealed, and the ethics of the situation are questionable, since the group members are being deceived.
    2. In the *participant as observer* role, the researcher is a member of the group being studied, and the group is aware of the research activity. In this role, the researcher is a participant in the group who is observing others and who is interested more in observing than in participating, as his/her participation is a given, since he/she is a member of the group. This role also has disadvantages, in that there is a trade-off between the depth of the data revealed to the researcher and the level of confidentiality provided to the group for the information they provide.
    3. The *observer as participant* role enables the researcher to participate in the group activities as desired, yet the main role of the researcher in this scenario is to collect data, and the group being studied is aware of the researcher's observation activities. In this role, the researcher is an observer who is not a member of the group and who is interested in participating as a means for conducting better observation and, hence, generating more complete understanding of the group's activities. While the researcher may have access to many different people in this situation from whom he/she may obtain information, the group members control the level of information given.
    4. The opposite extreme role from the complete participant is the *complete observer*, in which the researcher is completely hidden from view while observing or when the researcher is in plain sight in a public setting, yet the public being studied is unaware of being observed. In either case, the observation in this role is unobtrusive and unknown to participants.

- means of gathering data: once a role outlined above is selected and the researcher is 'immersed' in the social setting, the researcher can record his/her observations about the person or group being studied. With a "reasonable vantage point, the right tools, and tables for documentation researchers can begin to collect, compare and count the presence, movement and features of individuals, groups and populations in defined spaces" (Laurier, 2010). The researcher can observe and record all aspects of the subject(s) behaviour in relation to the SIA research question(s). These may include nonverbal expression of feelings,

interaction between participants or their natural setting, how participants communicate with each other, and how much time is spent on various activities (Schmuck in Kawulich, 2005); and

- methodology for understanding human behaviour in natural contexts: In its purest methodological form, PO is the process of "establishing rapport within a community and learning to act in such a way as to blend into the community so that its members will act naturally, then removing oneself from the setting or community to immerse oneself in the data to understand what is going on and be able to write about it" (Kawulich, 2005, p. 24). As described above however, the degree to which a researcher intends to 'blend in' is dependent on the role he/she assumes for the activity. Whatever the case, when implemented successfully, the method will yield data from which the researcher will be able to analyse the human behaviour of interest, and ultimately arrive at a conclusion about the SIA research question(s).

Below it is explained how the methodology was applied in the context of the project.

Application of PO to the project

The *Stockton Sand Quarry Dredging Preliminary Environmental Assessment* (Element Environment, 2018) identified unauthorised access to the quarry as a potential community safety risk. Despite mitigation measures (eg security fencing including a gate locked after hours, high visibility line and signage, closed circuit television [CCTV], equipment and safe batter requirements, trespass procedures, and operating hours) being implemented by Boral, there have been safety incidents associated with members of the public accessing the quarry haul road to gain access to and from the beach. A total of nine incidents were recorded during the 2016-2017 reporting period, predominantly associated with recreational vehicles and pedestrians entering the quarry either unintentionally or deliberately to access the beachfront. The SIA scoping phase concluded that further engagement should be undertaken with the prominent recreational dune user groups to adequately assess this community safety matter.

During the EIS preparation phase of the SIA study, it was determined that further engagement with the user groups was not feasible. On the advice of quarry staff, this is due to the fact that members of the public that travel on the public road towards the site and the few that attempt to enter site without authority, are generally unidentified. The few that arrive to the quarry either recognise they are trespassing and leave quickly, or choose an access route that avoids contact with Boral staff. Their visit is fleeting in nature, establishing a dialogue with them is rarely possible, and accordingly, no contact details are possessed by the project team. In summary, there was little prospect of conducting 'further engagement' activities with the individuals concerned.

Due to this scenario, PO was selected for this SIA as an alternate method used to explore instances of potential or actual unauthorised access to the existing quarry, by members of the public. As an alternative to direct engagement with the public, it was an ideal method. This is because it enabled the project team to collect and record data about the behaviour of members of the public (ie the participants) travelling on the public road towards the quarry, including those who actually intended to enter the quarry, despite the difficulties outlined above.

Boral weighbridge staff volunteered their time to make observations about the participants. The weighbridge staff are permanently present at the entry to the quarry during operating hours, and they have visibility of the entry either by direct sight or CCTV footage. Accordingly, they were positioned perfectly to make and record observations. The staff were provided with an overview of the methodology, advice about what observations were required for the SIA, recording instructions, and a template to collect the necessary data. The SIA Lead Author provided this advice. Given the lack of opportunity for the weighbridge staff to be 'immersed' in the social setting, the role they adopted was predominantly that of a 'complete observer' (refer Figure 5).

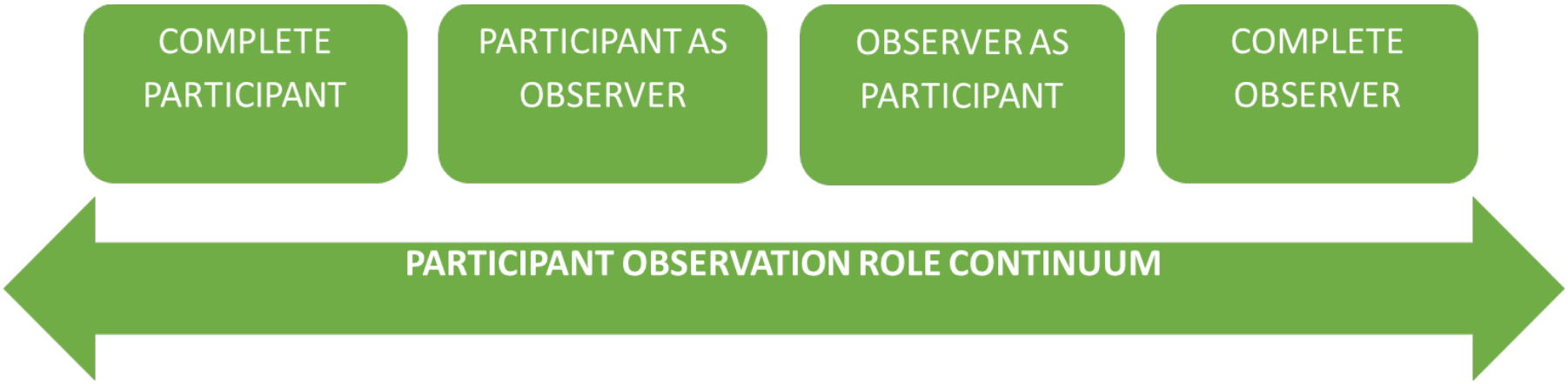


Figure 5 – Participant Observation role continuum (adapted from Gold in Kawulich, 2005)

On the rare occasion where contact was made with the participant, the role adopted was that of an 'observer as participant'. The data sheets were submitted to the SIA Lead Author for analysis at the completion of the exercise.

The PO activity commenced in early January 2019 and ceased in late March 2019. The EIS program was the main driver of the selected date range. The timeframe covered the warmer months of the year which generally attract a relatively larger volume of tourists and other dune users to the beach, so it was assumed to be the most reliable period in terms of capturing observations about the broadest range of participants possible.

The research questions which led the PO activity are:

- do the participants seem to be intentionally or unintentionally accessing site?;
- what is their known or predicted purpose for accessing site?; and
- was their safety put at risk?

Visual impact assessment

A visual impact assessment (VIA) should describe the likely nature and scale of changes in views resulting from a development, and changes to visual amenity experienced by the receptors (Knight & Therivel, 2018). In particular, the VIA conducted as part of the SIA was adopted in response to the possibility (considered during the project scoping phase) that Stockton Beach dune users could see the location of the project site. To investigate the matter, a site visit was conducted to make a visual observation from the dune system, at a location within the quarry boundary that was above the highest point of the publicly accessible area of the dune system adjacent to the quarry. Photographs were taken at the location, and existing photographs were also obtained from the Boral Quarry Manager.

The VIA applied by Andrews et. al. (2012) was adopted for this study. It enables the potential visual impact of the project to be assessed in relation to viewpoints of the dune users. The significance of potential visual impacts was assessed by considering:

1. magnitude - this relates to the magnitude of visual change in the landscape, and its proximity to the viewer. The magnitude of visual change is strongly influenced by the level of visibility of the proposed new work. This results from the combination of scale, extent, distance and duration of the views; and
2. sensitivity - in relation to the quality of the view and how sensitive it is to the proposed change. Visual sensitivity depends on the nature of the existing environment and on the likely response from people viewing the scene. People driving on a busy road and/or at high speeds are likely to be less sensitive to a change in the environment since they are focused on changes in traffic conditions and driving, compared to someone who is enjoying a recreational experience or someone who is viewing the scene from their living room.

The categories of magnitude and sensitivity of visibility are defined in Table 6.

Table 6 - Categories of magnitude and sensitivity (Andrews, Colclough, & Corkery, 2012)

Rank	Description
Negligible	Very minor loss or alteration to one or more key elements/features/characteristics of the baseline visual character (ie pre-SSD approval view) and/or introduction of elements that are consistent with the visual character to the existing landscape character (ie approximating the 'no change' situation).
Low	Minor loss of/or alteration to one or more key elements/features/characteristics of the baseline visual character (ie view pre-SSD approval) and/or introduction of elements that are consistent with the existing landscape character.
Moderate	Partial loss of/or alteration to one or more key elements/features/characteristics of the baseline visual character (ie view pre-SSD approval) and/or introduction of

Rank	Description
	elements that may be prominent but not considered to be substantially uncharacteristic of the existing landscape character.
High	Substantial to total loss of key elements/features/characteristics of the baseline visual character (ie view pre-SSD approval) and/or introduction of elements considered to be totally uncharacteristic of the existing landscape character.

As described above, the magnitude and sensitivity of potential visual impacts to existing views would depend on a combination of scale, extent, distance and duration of the views. Impacts were assessed by applying a consistent set of criteria to the highest dune viewpoint. The criteria are outlined in Table 7.

Table 7 - Visual impact criteria (Andrews, Colclough, & Corkery, 2012)

Criteria	Definition	Rating
Duration of view		
Long term	>1 hour	High
Moderate term	30 minute to 1 hour	Moderate
Short term	<30 minute	Low
Number of viewers		
High	>1,000	High
Moderate	100-999	Moderate
Low	<100	Low
Viewer sensitivity (type)		
Resident	N/A	High
Pedestrian/cyclist		Moderate
Motorist		Low
View sensitivity		
Pristine landscape	N/A	High
Moderately modified landscape		Moderate
Significantly modified landscape		Low
View distance/proximity		
Short	< 100m	High
Medium	100m-500m	Moderate
Long	>500m	Low

Semi-structured interview

Interviewing was selected as a SIA method to further explore the possibility that Stockton Beach dune users could see the location of the project site. An interview was conducted in a semi-structured format using a list of predetermined questions. This format provided a flexible structure which allowed the interviewer to create and ask questions about situations as they emerged, and the interviewee to digress and express views freely (Vilela, 2018).

The work of Bradshaw and Stratford (2005) with regard to qualitative research design and rigour, was helpful in designing the semi-structured interview methodology. The authors provide guidance in relation to participant selection and sampling. Their work explains that in qualitative research, the number of people we interview, communities we observe, or texts we read, is less important than the quality of who or what we involve in our research, and how we conduct that research. Their work emphasises that 'purposive' sampling is typical in this type of research, and that the sample is not intended to be representative given the emphasis is usually on the analysis of meanings. These principles were applied to the SIA interview, and the owner of a dune quad bike adventure business was invited to participate. The business operates daily escorted quad bike tours of the Stockton Beach dunes.

The implementation of the method involved:

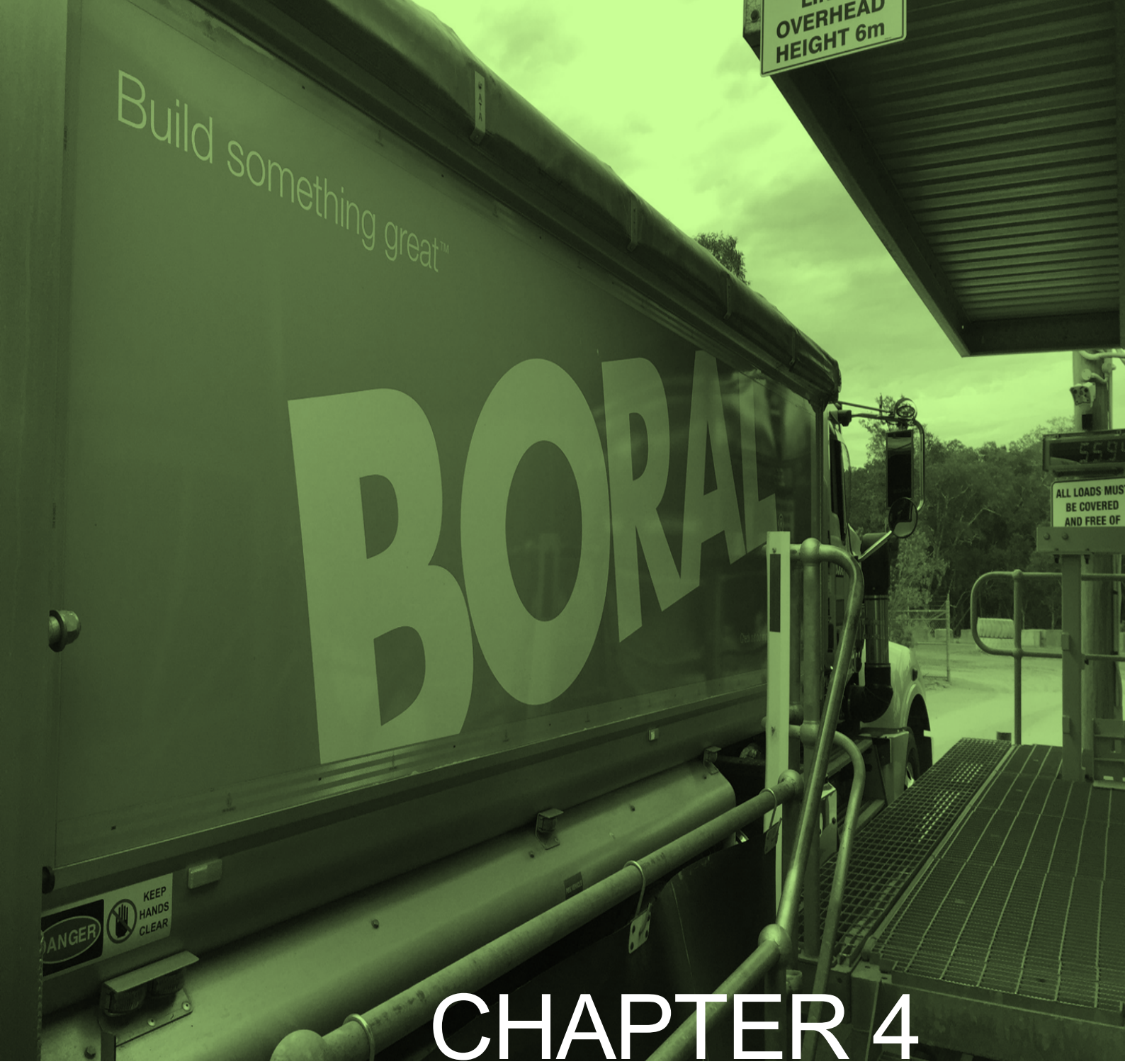
1. developing the pre-determined interview questions, designed to explore the social matters identified in the scoping tool;
2. sending an interview invitation letter to the participant. The letter explained the purpose of the interview, the intention to record it, and provided some frequently asked questions. It explained that consent was required, and sought to obtain it in a "free, prior and informed" (Vanclay, 2015, p. 6) fashion;
3. obtaining participant consent;
4. arranging an interview date;
5. conducting and recording the interview;
6. drafting and conducting a qualitative analysis of the interview transcript; and
7. extracting transcript content for use in the SIA assessment.

3.2.5 Data limitations

Upon reflection of the methods implemented for this SIA, two obvious data limitations are discernible. The first of these relates to the poor attendance at the community information drop-in sessions held during the EIS preparation phase. Despite the sessions being well-advertised, adequate notice being given to the community, and the venue being accessible, attendance at the session was underwhelming (details are provided in Chapter 4). A greater number of attendees would have undoubtedly increased the volume of feedback about the project, which in turn would have strengthened the SIA. Other methods implemented for the study (eg ECA, semi-structured interview and site-tour) would have positively offset the data weakness presented by the level of attendance at the community information drop-in sessions.

A potential data limitation was also evident in the PO methodology adopted for this SIA study. As outlined above, quarry weighbridge staff took responsibility for the data collection aspect of the activity instead of the Lead SIA Author. Data was provided to the author rather than the data being *generated by* the author. If both the weighbridge staff and the author interpreted the behaviour of participants in any given social setting, then there would be potential for variation in those interpretations. It is only possible to speculate on how this scenario might influence the accuracy of observations made about human behaviour at the quarry. However, the instructions and data collection template provided by the author to the weighbridge staff would have mitigated the potential for variation. Furthermore, the decision to place data collection responsibility with the

weighbridge staff was justified in either case, as any alternative which removed that responsibility from weighbridge staff would have been both cost and time prohibitive.



CHAPTER 4

SIA SCOPING AND ENGAGEMENT OUTCOMES

4 SIA SCOPING PHASE AND COMMUNITY ENGAGEMENT OUTCOMES

A SIA scoping exercise was conducted to identify and assess social impacts associated with the project. The purpose of the SIA scoping exercise was to highlight what aspects of the natural or human environment (refer to the social impact categories in Appendix A) are expected to be impacted upon by activities associated with the project, how those impacts should be assessed and to what level of detail. During the scoping phase, early community engagement activities were conducted, the scoping tool (NSW Department of Planning, Industry and Environment, 2017) was used to determine the matters applicable to the project, key stakeholders were identified, and the ASI was developed. Outcomes of these undertakings are provided below.

4.1 Scoping phase outcomes

4.1.1 Early engagement results

The early engagement activities conducted by the project team enabled stakeholders to provide feedback about the project. The feedback was relevant to the SIA scoping phase and was used to consider what social impacts might warrant investigation. The results of the early engagement activities are outlined below, listed by the type of activity.

Letter inviting feedback about Boral's operations

No response or feedback about the project was received by the project team following the distribution of the letter to households nearby to the project site. The survey contained a link to an online survey which invited all recipients to submit their opinions. Nil residents completed the survey.

Emails

In response to emails sent to PSC Councillors separately to inform them about the consultation program for the project (including March 2018 doorknock program), one reply from a Councillor was received by the project team. The reply acknowledged and expressed gratitude to the project team for the update. It contained no specific feedback.

Interviews

Interviews with residents (via the random sample doorknock) living in Fern Bay and Fullerton Cove in early March 2018 generated feedback about traffic and road infrastructure, noise, and access to Stockton Beach, as shown in Table 8. A total of 31 properties were included in the doorknock. No residents were available to be interviewed at eight properties at the time of the doorknock. Note a property with multiple occupancies (such as a gated community) was treated as a single property in Table 8.

Table 8 – Interview results (scoping phase)

Period of residence in area (if disclosed by resident)	Feedback
Fullerton Cove	
Unknown	The quarry and its related traffic is not an issue Traffic movements related to industry are not dissimilar to those at Kooragang Island Raised new entrance to Fern Bay estate under construction – possible effects on through (quarry) traffic.

Period of Residence in Area (if disclosed by resident)	Feedback
3 years	Have had a scare on the Nelson Bay Road off-ramp with a truck looking like it wasn't going to brake Have observed some 'cowboy' behaviour from drivers of non-Boral trucks 'We can't hear your operations from our house'.
37 years	Sometimes get stray trucks using laneway – we contact the quarry and have it corrected Can't hear the operations Interested in purchasing some of the cleared land at back of house (owned by Boral) Would not like to see any of Boral's land turned over to residential development similar to that at Fern Bay Happy for the quarry to continue if resource is available Great to hear of rehabilitation already undertaken and that it is continuing.
19 years	No issues with the operations Per- and poly-fluoroalkyl substances (PFAS) contamination is the major local issue 'If we have a problem, we just call to the quarry Manager' Truck traffic was a significant problem back before construction of on/off ramps to Nelson Bay Road.
18 years	'It's a great business – we don't notice it' Occasionally a stray truck runs down the laneway but the quarry deals with it 'It's really good to be engaged about your business – well done' Nil issues with the possibility of continuing the operations.
43 years	The quarry is not a problem Trucks were a major issue before the on/off ramps.
40 years	Nil problems with the site Before the on/off ramps, trucks were an issue.
Unknown	Notice sand lying on inside of the on-ramp kerb on occasions No issues with the operations at all.
Unknown	No issues with the operations Sometimes there'll be a stray truck on the laneway – just contact the site and they address it Trucks are a problem in regard to the occasional independent quarry (also on Coxs Lane adjoining Nelson Bay Road).
Unknown	Enquired about an easier accessway to beach for horse riders Don't notice the operations 'The truck drivers are great around the horses when they spot us'.
Unknown	'I didn't even know you were there'.
Fern Bay	
Unknown	We've never particularly noticed trucks as part of the Nelson Bay Road traffic flow 'It's a public road, isn't it?'.
Unknown	I have noticed trucks in traffic flow but I have no particular concerns with them 'The trucks are certainly no worse than the buses in terms of presence. They actually slow down for the roundabout, unlike the cars, allowing you to get in'.
Unknown	Trucks do not pose a problem 'Cars queue across the roundabout and make it harder to join the flow, so the trucks don't actually stand out'.

Period of Residence in Area (if disclosed by resident)	Feedback
Unknown	Trucks are not a problem 'They are just another part of the rubbish traffic'.
Unknown	Boral trucks are not noticed beyond others.
Unknown	The main road is probably in need of widening as a general comment A new second entrance is being constructed at the northern end of the estate (left in, left out).
Unknown	Trucks are not a problem.
2 weeks	'We can't hear a thing'.
Unknown	We can't hear your operations from our house.
1 week	We don't notice it [the quarry].
Approx. 3 weeks	I notice absolutely nothing.
2 years	I am used to industrial noises through my employment 'I can't hear anything from your site, even in the early hours when coming home from night shift'.

Newsletter

No response or feedback was received by recipients of the May 2018 newsletter distributed to stakeholders in in Fullerton Cove and Fern Bay via hard copy, to MP offices via email, and online via the project website. The lack of response reduced the amount of data that would have otherwise been available to the SIA.

Meeting invitations

Members of the project team met with Kate Washington MP's staffers and briefed them about the project. The discussion was positive and the staffers were familiar with the issues relating to sand quarrying. The staffers raised one question about the project's implications for the water table. The project team responded that groundwater studies to date had not shown the project having a hydrogeological impact.

PSC meeting

Members of the project team presented a briefing to PSC officers and councillors respectively on 10 May 2018 and 26 July 2018. The material provided by the project team was welcomed by Council and no specific feedback was received.

Meeting invitations to Worimi LALC

Boral's National Indigenous Affairs Manager received no specific project feedback from the Worimi LALC at their meeting in January 2018.

4.1.2 Scoping tool

As outlined in the methodology chapter, the early engagement results presented above were used as DPIE scoping tool (NSW Department of Planning and Environment, 2017) inputs, and therefore assigned a relevant 'social matter' for the purpose of the scoping tool. Each social matter has a number of subcategories. For example, the Amenity matter contains subcategories including acoustic, visual, odour, and microclimate. For the purposes of this SIA, where it was determined that the project would be unlikely to impact a particular subcategory, that subcategory is not discussed below. Only those applicable to the project receive attention herein.

Matter 1: Amenity

The first Amenity sub-category determined to be applicable to the project is 'acoustic' amenity. The preliminary environmental assessment (Element Environment, 2018) determined that the project will introduce additional noise sources from the site, potentially resulting in greater noise levels experienced at residences to the south of the site and west of Nelson Bay Road. Ahead of the quantitative noise assessment which confirms acoustic impacts, early consultation with nearby residents suggested the impacts of the current operations are not significant. Residents did not raise any concerns about acoustic impacts from sources on site or from vehicles utilising the public road network. The following examples of feedback from residents in the residential area closest to the site (ie Fern Bay) highlight the comfort of the community in respect to noise impacts:

- "We can't hear a thing";
- "I can't hear anything from your site, even in the early hours when coming home from night shift"; and
- "We can't hear your operations from our house".

Confidence in the scoping phase that social impacts would arise from the project acoustics was further diminished by the fact that there is a moderate distance (approximately 500 m) between the project site and its nearest receivers.

Taking both the early consultation results and the proximity of receivers into account, the scoping exercise determined that there would be no requirement to conduct a SIA in regard to acoustic amenity, alongside the quantitative noise assessment required for the project.

The second Amenity subcategory determined during the scoping phase to be applicable to the project is 'visual' amenity. The preliminary environmental assessment (Element Environment, 2018) determined there is limited visual exposure of the project to the community, and it nominated Stockton Bight Beach as an isolated viewpoint occasionally visited by recreational dune users. Early consultation activities obtained sentiment that nearby residents hold towards the project and its influence on visual amenity. The statements offered by residents living near the project during the doorknock activity were typical of those collected:

- "We don't notice it [the quarry]"; and
- "I notice absolutely nothing".

According to the above, the scoping exercise determined that a standard SIA would be required in relation to visual amenity. The SIA would focus exclusively on the perception of social impacts created for recreational dune users, in relation to the minor initial Stockton Bight Beach viewpoint.

Matter 2: Access

The scoping exercise determined that 'road and rail network' is a subcategory of Access that is applicable to the project. The additional sand (approximately 250,000 tpa until the windblown sand development consent ceases) transported both north and south on Nelson Bay Road will require the local and regional road network to support a larger quantity of truck movements. It was anticipated that the standalone traffic impact assessment planned to be conducted for the EIS would confirm the likely impacts to the road network and determine the network access and capacity implications, much less the social impacts of increased traffic volumes.

From a social impact perspective, it was considered that road users would likely experience irritation and adverse driving conditions if the volume of heavy vehicle traffic is excessive. The 2016 census data (Australian Bureau of Statistics, 2018) indicates that the majority of inhabitants of Fullerton Cove (64.8%) and Fern Bay (74%) utilised their cars (as the driver) to get to and from their place of employment. This dependency on private vehicular use over public transport, along with the increasing population in the Fern Bay area in particular, has the potential to impact negatively on the capacity of the local road network with the proposed increase in heavy vehicles associated with the quarry. This dependency on private vehicular use will increase the exposure

of Fern Bay and Fullerton Cove residents to traffic along Nelson Bay Road in particular, potentially increasing their awareness of traffic volumes and congestion on the local road network.

Capacity issues and reduced access to the road network (for example, if Fern Bay or Fullerton Cove residents experienced queuing at the Nelson Bay Road and Seaside Boulevard intersection roundabout) would create stress for the travelling public. No traffic impact assessment to confirm such a scenario was available at the time the scoping exercise was conducted however, so comments from local residents collected during early engagement were relied upon to investigate the matter. Those comments highlighted a lack of concern with the current project related traffic situation. Examples of such comments include:

- "the quarry and its related traffic is not an issue";
- "we've never particularly noticed trucks as part of the Nelson Bay Road traffic flow"; and
- "I have noticed trucks in the traffic flow but I have no particular concerns with them".

Based on the fact that a standalone traffic impact assessment would be completed for the EIS and that residents appeared to have minimal concerns with quarry related traffic or the network capacity, the scoping exercise determined that a SIA would not be required to assess this matter. Nevertheless, the project team committed to an adaptive research approach in relation to the results of the traffic impact assessment. If results or ongoing community feedback isolated potential social issues, then more detailed social assessments would be required.

Matter 3: Built environment

The 'public infrastructure' subcategory (as part of the Built Environment) was determined to be applicable to the project during the scoping phase. There are close similarities between this subcategory and the 'road and rail network' subcategory discussed above. The distinction is that the social impact in this case would likely be created by the condition of the road network (ie the road surface quality) rather than the volume of vehicles using it. It was known that the standalone traffic impact assessment would to a degree investigate implications for the quality of public assets, though its scope would potentially exclude social impacts derived from the deterioration of such assets.

Public infrastructure or the condition of local roads was not raised by residents during the early engagement. This could be an indication that the current quality of local roads is satisfactory to the residents or further, that the residents do not consider that project related vehicles substantially influence road quality. It is feasible however to form an alternate view as to why the residents did not raise these topics. Whatever the case, it is obvious that poor quality road infrastructure will cause frustration and annoyance to any road users. Prior to the completion of the traffic impact assessment however, it was premature to predict the project would significantly reduce the quality of public infrastructure. Adopting a precautionary approach, the scoping exercise concluded that a standard SIA was required to assess this matter.

Matter 4: Heritage

As a subset of the Heritage matter, the 'natural' features of the site were identified in the scoping phase as being applicable to the project. A small portion of the dune system adjacent to the project site on Stockton Bight Beach (see the Figure 1) is the natural feature of interest. The Stockton Bight Beach and dune area is used for four-wheel driving, quad bike riding, hiking, horse riding and fishing among other recreational activities. During the scoping phase it was determined that a clear majority of commercial operators advertise four-wheel driving and quad bike riding (see Worimi Local Aboriginal Land Council, 2018) and it was therefore assumed that these activities would be most prominent in the subject dune location. There was no evidence to suggest that the current quarry operations impact the dune system or its recreational values. Ongoing operations were not anticipated to alter this scenario but there was a need to test this perception via further engagement with the community.

Considerations about this matter also included the Aboriginal population and stakeholder group. Fern Bay contains a small Aboriginal and Torres Strait Islander population, which has been established as approximately 3.1% of the community (Australian Bureau of Statistics, 2018). The Worimi LALC manage the Worimi Conservation Lands, which encompass the dune system adjacent to the project.

Despite the fact that Boral had an existing relationship with the Worimi LALC, the scoping phase determined that the views of this organisation and the broader traditional owner community towards the project required further investigation as part of the SIA. The scoping exercise recognised the potential social impact of the project for this stakeholder group and suggested that further focussed engagement was required for the EIS preparation.

Matter 5: Community

During the scoping phase, 'safety' emerged as a Community subcategory applicable to the Project. Table 9 lists the four potential Community safety matters of the project that would be relevant from a social impact perspective and identifies the relevant section of the EIS where these matters will be addressed.

Table 9: Public safety and relevant section of EIS

Environmental Matter	Relevant chapter of EIS
Health risk and nuisance factors from particulate matter (dust)	Air quality
Increased noise associated with extraction activities, including vehicular movements	Noise
Increased traffic volumes	Traffic and transport
Unauthorised access	Hazards and risks

Firstly, the continuation of quarrying activities has the potential to emit dust, primarily from vehicle movements on site. With the implementation of adequate dust control measures, the potential for significant negative air quality impacts from the project was considered to be low, which is commensurate with the fact that no concerns were raised by the public on this matter. Therefore, it was determined that the matter would be assessed in the air quality impact assessment section of the EIS.

Secondly, the site is surrounded by rural and environmental conservation land uses, which are generally characterized by low background noise levels. There is the potential for the project to result in an increase in noise levels within the community with the recommencement of quarrying activities within an area of the site, where extraction activities have not been undertaken since 2008. No feedback was received from residents regarding noise generated by the existing site or the project. Therefore, it was determined that this matter would be assessed in the noise impact assessment section of the EIS.

Thirdly, the increased vehicle movements north and south on Nelson Bay Road have potential road safety implications. Historical safety records do not indicate this as a potential issue. Feedback obtained from residents during early engagement did however raise a safety concern:

> "I have had a scare on the Nelson Bay Road off-ramp with a truck looking like it wasn't going to brake".

This or any similar fear in the community could be exacerbated by the introduction of an increased number of truck movements.

The manner in which potential traffic impacts associated with the project would be assessed from a technical and social perspective are discussed under 'Matter 2: Access' above.

Finally, unauthorised access to the project site by members of the public, whether unintentionally or intentionally, presents a potential safety risk. Historical records indicate that the majority of past incidents relate to recreational vehicles and pedestrians entering the quarry to access the beachfront. Despite the efforts on site to prevent unauthorised access, the scoping exercise acknowledged the potential for the public to attempt to gain access to the property in the future. In this scenario, there is a possibility of potential interaction between members of the public and the project operations, which could cause a safety incident. Therefore, it was determined that a standard SIA is required to assess unauthorised site access as part of this SIA study.

Apart from the standard SIA related to unauthorised site access, the scoping exercise determined that a SIA is not required to assess these community safety matters. It was expected that the air quality, noise, and traffic impact assessments, along with the hazards and risks chapter within the EIS, would adequately address these community safety matters. Further engagement with the prominent recreational dune user groups (in relation to community safety) was planned, but was not possible for the reasons outlined in the methodology chapter. The scoping exercise also acknowledged that the hazards and risks chapter of the EIS would consider the rehabilitated post extraction landform and any new or additional potential community safety implications associated with unauthorised site access.

Matter 6: Economic

Following a consideration of the preliminary environmental assessment (Element Environment, 2018) and Economic matters in the Guideline during the scoping phase, 'natural resource use' was obviously determined to be relevant. Natural fine sand extracted from the quarry is the specific natural resource, and it's use by the project qualified for social impact assessment. The resource is an essential component to construction materials and consequently, to local and regional development projects. The influence of the project on the supply volumes for these development projects is worthy of assessment.

The 'livelihood' of employees at the quarry also emerged in the scoping phase as a subcategory of economic matters that is applicable to the project. During interviews carried out for the ASI development, Boral staff stated that five quarry employees would maintain their employment, and that all are locally based. This impact of the project qualified for further assessment.

The scoping exercise determined that a desktop SIA would be adequate to assess the (likely positive) economic impacts created by the project in relation to natural resource use and its influence on livelihoods.

Summary

A summary of the scoping tool outcomes is provided in Table 10. It lists each social matter from the scoping tool (and relevant subcategory) described above, and the associated scoping tool input. For each social matter, it identifies the relevant social impact category per Section 1.1 of the Guideline (refer Appendix A) which will frame its assessment and discussion in the subsequent chapters of this study. It also identifies which matters will be the subject of a specialist study in the EIS, the level of assessment defined by the scoping tool, and the SIA method selected to address it.

Whilst the full range of social impact categories outlined in Section 1.1 of the Guideline was considered during the scoping phase, four (ie Community, Culture, Decision Making Systems, and Fears and Aspirations) were not recognised in the scoping tool outputs as having potential to cause a social impact. In each of these four cases, there was no material suggestion in the information offered by stakeholders, that any aspect of these social impact categories would be

influenced by the project. Speculation about some possible reasons for this is offered in Chapter 6.

Table 10 - Scoping tool outcomes

Social matter (relevant subcategory) and scoping tool input	Social impact category (Guideline section 1.1)	Will a specialist study be conducted for the EIS?	Level of assessment for the social impact (scoping tool output)	SIA method(s) implemented for the assessment
Amenity (acoustic) Stakeholders did not raise any concerns about acoustic impacts from sources on site or from vehicles utilising the public road network	Health and wellbeing	Yes	No SIA required	Nil
Amenity (visual) Stakeholders did not raise any concerns about visual impacts associated with the project	Surroundings	No	Standard SIA	VIA Semi-structured interview
Access (road and rail network) Residents had minimal concerns with quarry related traffic[2] or the network capacity	Access to and use of infrastructure, services and facilities	Yes	No SIA required	Further engagement and adaptive research approach in relation to the results of the traffic impact assessment
Built environment (public infrastructure) No stakeholder feedback was obtained in relation to the effect of the project on the quality of public infrastructure (ie road surfaces)	Access to and use of infrastructure, services and facilities	Yes	Standard SIA	ECA
Heritage (natural features) There was no evidence to suggest that the sites current operations impact the dune system or its recreational values	Surroundings	Yes	Standard SIA	Further engagement (consultation with Worimi LALC)
Community (safety) Site records confirm unauthorised site access (attempted and actual)	Health and wellbeing	No	Standard SIA	PO
Economic (natural resource use *and* livelihood) The preliminary environmental assessment established that natural fine sand derived from the	Personal and property rights	Yes	Desktop SIA	Desktop research

[2] One resident reported an observation of a truck using the Nelson Bay Road off-ramp in a manner deemed dangerous. It was determined in the scoping phase that an adaptive research approach would be taken in relation to this issue (ie if results or ongoing community feedback isolated traffic incidents as an issue, then more detailed social assessments would be required). Refer to the discussion of "Matter 5".

Social matter (relevant subcategory) and scoping tool input	Social impact category (Guideline section 1.1)	Will a specialist study be conducted for the EIS?	Level of assessment for the social impact (scoping tool output)	SIA method(s) implemented for the assessment
quarry will influence supplies for local and regional development projects				
Economic (livelihood) Boral staff stated that the project would extend the employment of five, locally-based quarry employees and provide additional employment.	Personal and property rights	Yes	Desktop SIA	Desktop research

4.1.3 Key stakeholders

The key stakeholders identified for the project are contained in the stakeholder matrix (Table 11). The matrix contains the key project stakeholders, and the engagement techniques applied to establish and foster a dialogue about the project.

Table 11 – Stakeholder matrix

Project stakeholder	Letter	Phone call	Email	Interview / Informal briefing / 'door knock'	Site visit / tour	Formal presentation	Community drop-in sessions notification	Community drop-in sessions	Newsletter	Meetings	Social media / online	Website / microsite
Host communities and fenceline neighbours												
Cox's Lane neighbours	X			X			X	X	X		X	X
Fern Bay residential area	X			X			X	X	X		X	X
Fullerton Cove residential area	X			X			X	X	X		X	X
Residents in wider region – Stockton/Williamtown							X	X	X		X	X
Indigenous groups												
Worimi LALC	X	X	X				X	X	X	X	X	X
Local government												
PSC Mayor	X		X			X	X	X	X	X	X	X
PSC GM	X		X			X	X	X	X	X	X	X
PSC elected councillors	X		X			X	X	X	X	X	X	X

Project stakeholder	Letter	Phone call	Email	Interview / Informal briefing / 'door knock'	Site visit / tour	Formal presentation	Community drop-in sessions notification	Community drop-in sessions	Newsletter	Meetings	Social media / online	Website / microsite
PSC planning representatives	X	X	X			X	X	X	X	X	X	X
State and federal government												
NSW Member for Port Stephens	X	X	X				X	X	X	X	X	X
NSW Member for Newcastle	X	X	X		X		X	X	X		X	X
NSW Department of Planning, Industry & Environment	X	X	X								X	X
NSW Environment Protection Authority	X		X								X	X
NSW Roads & Maritime Services	X		X								X	X
NSW Office of Environment and Heritage	X		X								X	X
Worimi Conservation Lands	X		X								X	X
Media												
Boral corporate media (ie Facebook and website)		X	X				X	X	X		X	X
Interest / activist groups												
Nil												
Business groups												
Quad bike king	X	X	X	X			X	X			X	X
Sand dune adventures		X	X				X	X		X	X	X
Sid Foggs Coaches			X	X					X			

4.1.4 Area of social influence

The nominated ASI for the project is illustrated in Figure 6. The area is comprised of a polygon containing the project site, the nearest communities including properties in Fern Bay and Fullerton Cove, and a small portion of the sand dune system adjacent to the project site. The polygon is also comprised of linear areas associated with the main transport routes proposed to be used by the project. These linear areas include Coxs Lane, and Nelson Bay Road from its intersection with Seaside Boulevard to its intersection with Cabbage Tree Road. There are no remote locations considered to be indirectly impacted.

The suburb of Fern Bay, at the southernmost extent of the Port Stephens LGA, is north of Stockton (the only suburb of Newcastle situated north of the Hunter River), and east of the north arm of the Hunter River (entrance of Fullerton Cove). In July 2010, the NSW Government approved a land release allowing for the development of approximately 684 homes at Fern Bay. This action paved the way for development associated with increased population growth identified in the *Lower Hunter Regional Strategy 2006 – 2031* (NSW Department of Planning, 2006). The regional significance of Fern Bay as a centre for employment and housing has also been outlined in the *Hunter Regional Plan 2036* (NSW Department of Planning and Environment, 2016).

Fullerton Cove is also a suburb of the Port Stephens LGA and is located to the north of Fern Bay. In the 2011 Census (Australian Bureau of Statistics, 2011), the Fullerton Cove population was just 300 people, whilst Fern Bay had a total population of 1,625. Both suburbs have experienced significant population growth between 2011 and 2016. In the 2016 Census (Australian Bureau of Statistics, 2018), the population of Fullerton Cove was 566 while Fern Bay was 2,763. Residences in Fullerton Cove are predominantly set on larger acreages (unlike the smaller residential lots in Fern Bay) along the Fullerton Road corridor. The properties in Fullerton Cove are older than those in Fern Bay and are physically separated from the project site by Nelson Bay Road and adjacent bushland.

The socio-economic profiles of Fullerton Cove and Fern Bay are outlined below. Insights into the relationships between their respective populations and the project, including social issues and concerns, were gathered during the door knock exercise (scoping phase) and submitted to DPIE.

Rationale for selecting the ASI

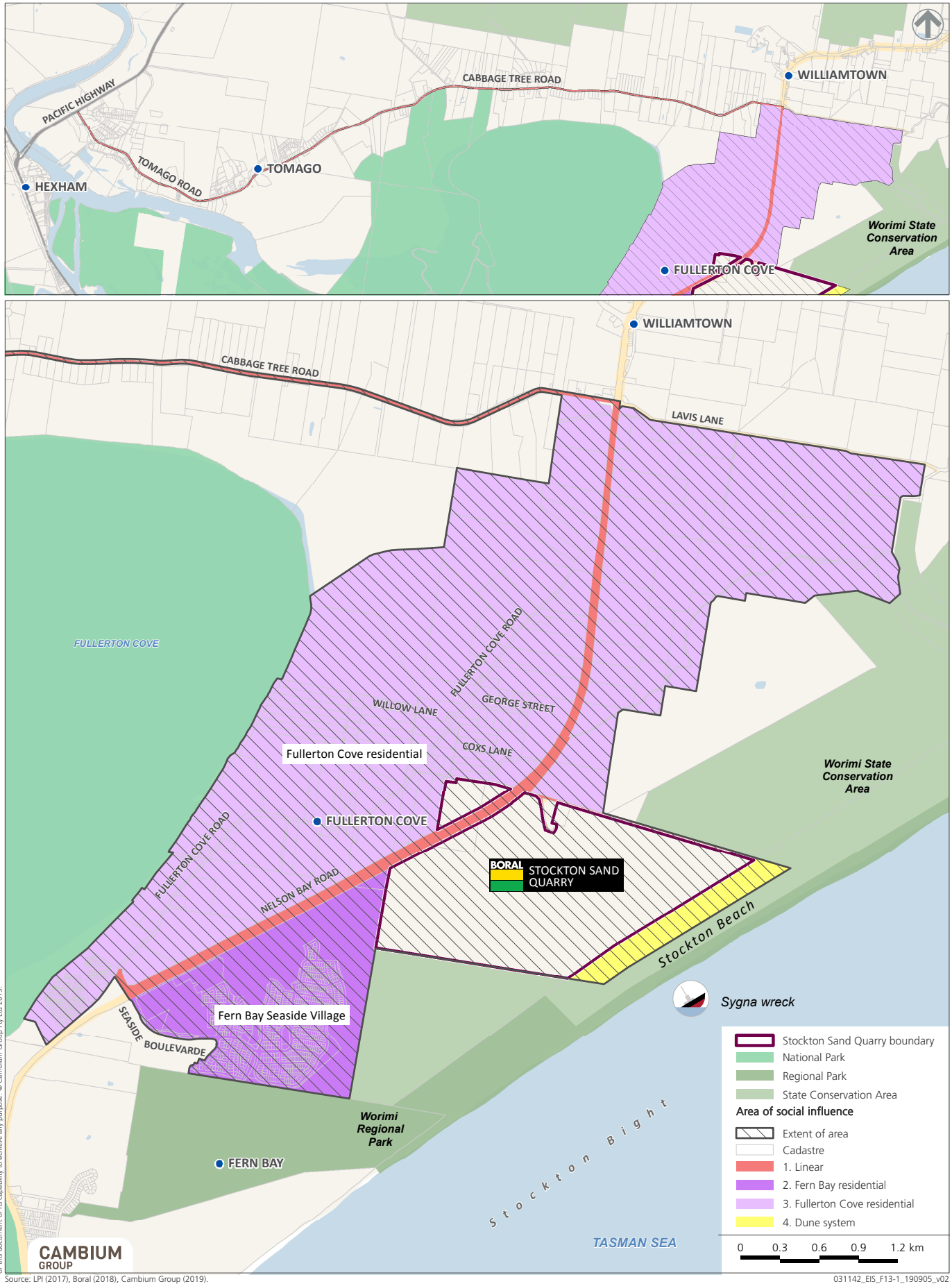
The task of developing the ASI was assisted by the fact that the project has a long-term history. Operations began on the site during the 1970s. Boral acquired the site in 1992 and has developed strong connections with local residents and their Stockton based employees. The influence of the project on social conditions locally is therefore well understood by Boral. This was evident during the semi-structured interviews conducted with Boral staff, which formed a basis for the ASI development. See to Table 12 for a summary of the interview results.

Historical correspondence records maintained by Boral provides evidence of complaints or issues raised by nearby residents and/or business owners. The Annual Environmental Management Reports (AEMR) submitted by Boral to DPIE in accordance with the existing development consent are one source of correspondence records. A review of the AEMRs from recent years indicate that no complaints were received about Boral's operations.

Traffic routes proposed to be used by project vehicles were considered during the ASI development. It was anticipated that most social impacts related to traffic would be experienced at the roundabout (Seaside Boulevard and Nelson Bay Road intersection). Furthermore, Coxs Lane and Nelson Bay Road from its intersection with Seaside Boulevard to its intersection with Cabbage Tree Road were considered the logical parts of the road network where social impacts derived from traffic would occur. On other roads, the volume of non-project related vehicles was expected to reduce the likelihood of a project-related social impact being created.

Figure 6
Area of social influence

STOCKTON SAND QUARRY DREDGING
ENVIRONMENTAL IMPACT STATEMENT



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Source: LPI (2017), Boral (2018), Cambium Group (2019).

Whilst not directly qualifying these assumptions, the project traffic impact assessment (Transport and Urban Planning Pty Ltd, 2019) found traffic impacts of the additional trucks associated with the operation of the project on the adjacent road network, including the principal intersections adjacent the quarry, will be satisfactory.

Aside from the project history and traffic routes, the physical features of the site were also considered as part of the initial ASI development. Due to the natural topography and vegetation surrounding the site, the project is isolated from both a physical (refer to Figure 1) and visual perspective. It is not visible from Nelson Bay Road or surrounding residential areas, and Stockton Bight Beach is the only location where the existing quarry operations have visual exposure. The project will not interfere with public access to Stockton Bight Beach. There are no formal public access points to Stockton Bight through Boral's property. These observations influenced the constrained nature of the ASI.

Table 12 - Summary of interviews with Boral staff

ASI Factor discussed during interview	Feedback obtained
Supply chains	The project would have few linkages with firms at local and regional scales. Expanded operations at the site would require the procurement of specialist equipment at start-up from an overseas supplier. It is expected that operational expenditure following the initial start-up procurement activities would be exclusively for consumables (eg fuel) and maintenance. Manufacturing businesses and local or regional suppliers would not be influenced by the project beyond existing arrangements. The workforce supply chain would not be influenced by the project. The small, locally based workforce would remain to support the project. The workforce would not generate considerable expenditure in any particular locality, or significantly influence the supply of goods to the local area.
Haulage of sand and transport of other goods	The main truck routes that would be used by the project are: ▪ Coxs Lane, Nelson Bay Road (south of Coxs Lane) and Toule Street/Cormorant Road; and ▪ Coxs Lane, Nelson Bay Road between Cabbage Tree Road and Seaside Boulevarde and Cabbage Tree Road/Tomago Road. As the project will increase sand transportation from the site by up to 250,000 tpa, the part of the truck routes most relevant to the creation of social impacts should be included in the ASI. Boral staff anticipate that truck movements would be the only aspect of the project visible to the community.
Materials and equipment	Materials and equipment required by the project would largely be limited to that which would support dredging operations. The dredge, a variety of pipes, and a wash plant would be the major items required. These items should have a minor influence on the extent of the ASI.
The movement of workers (drive-in-drive-out and fly-in-fly-out working arrangements)	Five Boral staff currently work at the site. All are locally based. The project would maintain the employment of the current staff and increase the workforce. Boral also employs truck drivers and associated support personnel. The project would not create links to regional localities via the movement of workers.
Natural features and recreational values (eg dunes at Stockton)	Boral has operated at the site over a long period of time and has not disrupted the natural and recreational values of the adjacent dune system. The project operations would continue to co-exist with natural values and recreational features. Although not disruptive, Boral staff, the local community, and recreational users acknowledge the close proximity of the project to the dune system.
Ancillary infrastructure	The project would be a standalone site. There would be no ancillary infrastructure or secondary sites that would extend its footprint beyond the existing site.
Reputation of other operations in area	There are other extractive industries operating in the area. These operations have generally attracted negative publicity in recent years in

ASI Factor discussed during interview	Feedback obtained
	relation to traffic movements and waste. Community sentiment regarding other extractive operations is generally negative[3].

4.2 Further engagement results

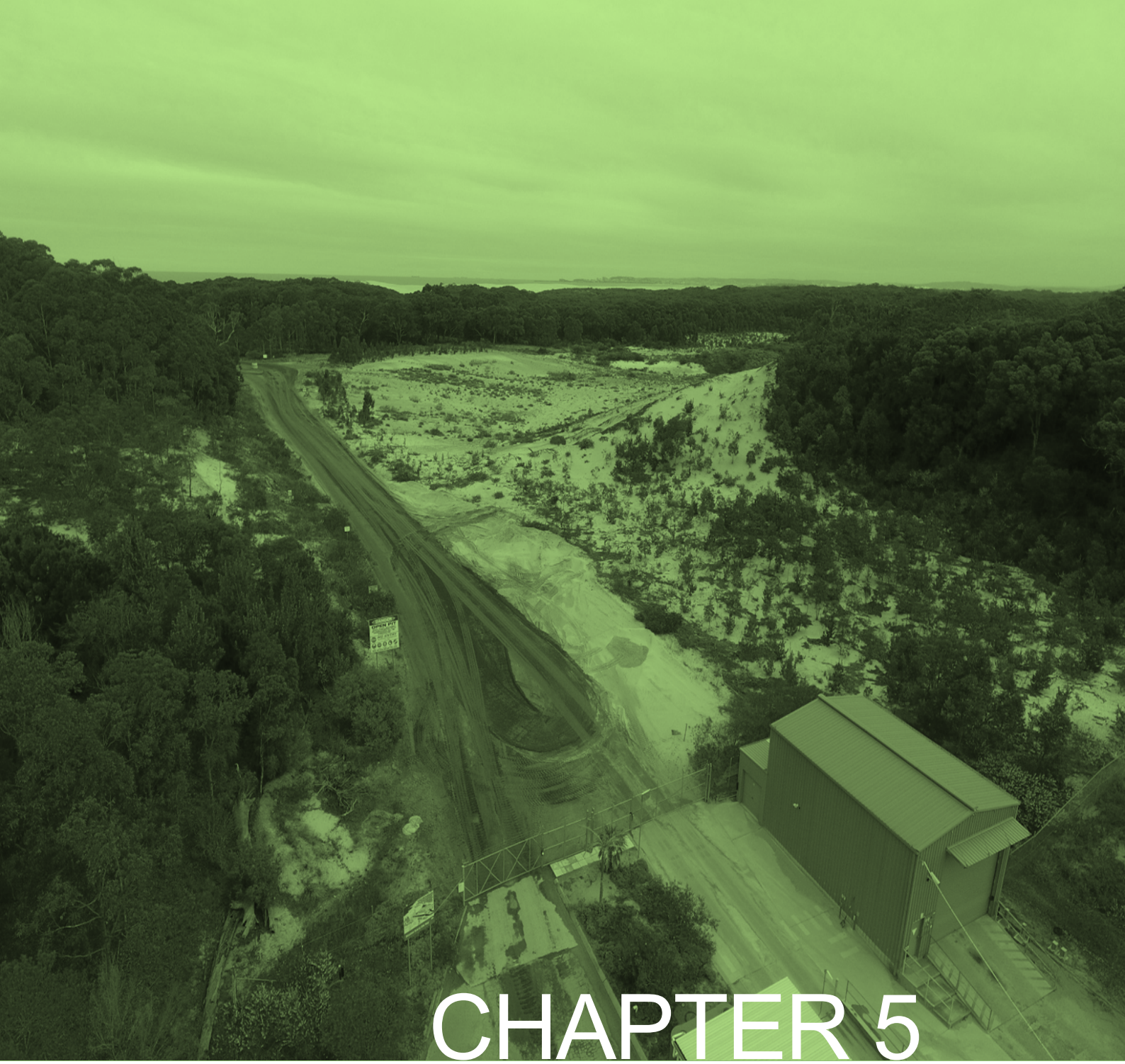
During the EIS preparation phase in early 2019, the project team conducted further stakeholder engagement via the range of stakeholder engagement methods outlined in the methodology chapter. The engagement activities emphasised and sought stakeholder feedback about the project. Table 13 contains the results of the further engagement program.

Table 13 – Further engagement results

Method	Description
Written methods	
Project newsletter and community drop-in sessions notification	Following its distribution, no specific feedback from stakeholders was received. It was concluded that it did not prompt a specific interest in the project. However, one community member who received the newsletter did attend the community drop-in session (see below).
Community drop-in sessions notification	70 notifications were distributed via letter-box drop in Fern Bay, and 60 were distributed in Fullerton Cove on 7 February 2019. The residential block nearest to the project site was included in the distribution area. Following its distribution, no specific feedback from stakeholders was received.
Emails	Emails were sent to project stakeholders including the PSC Mayor and ward councillors regarding the progress of the project. One Councillor replied via email to acknowledge receipt of the project team email. No specific feedback about the project was received.
Phone briefing (informal)	A member of the project team briefed the Port Stephens MP via telephone about the Project during early February 2019. The Port Stephens MP confirmed she would like to meet the project team later in the year. The Port Stephens MP did not raise specific concerns about the project.
In-person interactive methods	
Meeting – CEO Worimi LALC	At the meeting between Boral's Indigenous Affairs Manager and the CEO Worimi LALC, no concerns about the project were raised by the CEO. The CEO made a request for consultation to occur with five stakeholders whom are either neighbours of the project, part of the Indigenous community, representatives of NSW Government agencies, or a combination of these. The CEO also requested ongoing meetings as a means to receive project updates. Boral's Indigenous Affairs Manager agreed to the requests.
Site tour (Newcastle MP)	Members of the project team escorted the Newcastle MP during the visit. Boral staff provided details about the project and addressed questions raised by the Newcastle MP. Nil concerns were formally raised with the project team during or following the site tour.
Community drop-in sessions	The community drop-in sessions advertised locally and held on 14 February 2019 attracted only two community members (a husband and wife couple) from Fullerton Cove, who received the project newsletter and community drop-in sessions notification. Consequently, little data was collected from the sessions. See a summary of the conversation with the couple in Appendix C.

[3] Following the interview, a search was conducted for public commentary about other quarry operators referred to by Boral staff. See media commentary for example; McCarthy (2016) and Environmental Protection Authority (2017).

Method	Description
Consultation with resident	A member of the project team had a conversation with Fern Bay resident, following the traffic query he raised with a project consultant conducting field work adjacent to the project site. The project team member explained the proposal for project related traffic, and confirmed the quantity of proposed traffic movements. The resident was satisfied with the responses. Subsequent to the conversation, the project newsletter and community drop-in sessions notification, and the community drop-in sessions notification was provided to the resident via letter-box drop
Consultation with neighbours via doorknock	See Appendix D for a summary of the consultations
Media methods	
Website	No project related feedback was received via the website feedback form or via the contact phone number listed on the webpage.
Facebook campaign	The project Facebook post (refer Appendix B) received some reply comments. Within three hours of being uploaded, the post attracted 10 'likes', one 'love', one 'share' and one positive comment from a quarry customer who was satisfied with the service he received from quarry staff. Later, it attracted one ‘angry’ emoji and two comments criticising sand extraction generally.



CHAPTER 5

THE SOCIAL BASELINE

5 EXISTING SOCIAL BASELINE

This chapter presents the social baseline for the project. The baseline is the nominated set of social indicators for communities potentially affected by the project. It provides a point of comparison – it can be used as reference data against which to measure the impacts of the project as it develops, and/or to determine the adequacy or otherwise of existing facilities (Vanclay, 2015). All data used in the baseline is derived from the *2016 Australian Census of Population and Housing* (Australian Bureau of Statistics, 2018) unless an alternate source is cited.

The unit of analysis for the regional context is the Hunter region, as defined by the *Hunter Regional Plan 2036* (NSW Department of Planning and Environment, 2016). The equivalent local contexts are the Fern Bay SSC (or State Suburb) and Stockton-Fullerton Cove SA2 (Statistical Area 2) census geographies. A comparison to NSW data is provided where possible.

5.1 Regional context

As a major Australian east coast city, Newcastle is the capital city of the Hunter Region. The city has strong historical links to the extractive industries but over the last two decades has experienced structural economic changes. Newcastle has diversified from its traditional extractive industry base to other economies including defence, education and service industries. Recently the city has benefitted from an urban renewal program led by the NSW Government, with its $650 million investment to the city centre, strengthening connections between the city and waterfront, creating job opportunities, providing new housing, and delivering attractive public spaces connected to better transport (New South Wales Government, 2019). The Port of Newcastle, Newcastle Airport, and heavy rail links facilitate the transport of freight and passengers across the region.

Beyond its capital city, the Hunter Region has unique characteristics which ensure it is one of the strongest regional economies in the country. It has proven premium farming, wine and equine industries, and prominence as a high-quality tourism destination (Deloitte Access Economics, 2013). The region boasts tourist destinations both on its coastline (eg Port Stephens, Forster-Tuncurry) and in its hinterland courtesy of the Hunter being a mature wine making region. Given its diversifying status, future growth and development of the Hunter Region will depend on number of factors including its integration with Asia, changing settlement and migration patterns tied to the greater Sydney population, transitioning to a less carbon intensive economy, digital economic advances, and accessibility in terms or road, rail and freight connectivity (Deloitte Access Economics, 2013).

The prominent socio-economic characteristics associated with the region are identified by NSW Department of Planning and Environment (2016). The Hunter economy accounted for 28% of the entire gross regional product in NSW during 2016. It is one of three best thoroughbred centres in the world, and is the oldest wine making region in Australia. Tourism figures suggest it performs strongly compared to other NSW regions, with over 3.3 million domestic overnight tourists visiting the Hunter Region in 2016. This number accounted for almost 16% of all domestic overnight tourists that visited a destination in regional NSW.

In terms of its population, the region contained 732,400 residents in 2016, and this is expected to increase to 862,250 by 2036, when a quarter of the population will be aged over 65 years of age. Age and sex data (see Table 14) provides a contrast between each Hunter Region LGA population and the NSW population during 2016. An equal number of LGAs (4) had both a lower and higher median age compared to wider NSW. The Muswellbrook LGA population is unique as it contained the lowest proportion of females and had the lowest median age compared to populations in the other geographies.

Table 14 - Age and sex comparison, Hunter LGAs Vs NSW

Council area	Proportion of males	Proportion of females	Median age
Lake Macquarie	48.4	51.2	42
Cessnock	49.7	50.3	38
Singleton	50.9	49.1	36
Muswellbrook	51.3	48.7	35
Upper Hunter	49.4	50.6	41
Dungog	50.1	49.9	45
Maitland	48.8	51.2	36
Port Stephens	49.4	50.6	45
Newcastle	49.3	50.7	37
NSW	49.3	50.7	38

Employment in the Hunter region is marginally weaker compared to the NSW state data. The region has a higher proportion of unemployed people and a smaller proportion of people in full-time work, despite having a larger proportion employed part-time. The employment figures for the region are unsurprising given buoyancy provided by mining activities. Coal mining was the industry that employed most people and accounted for 9% of the regional population during 2016. Other major industries of employment included hospitals (except psychiatric hospitals) (3.2%), aged care residential services (3.0%), supermarket and grocery stores (2.6%) and takeaway food services (2.4%).

5.2 Existing population (local context)

5.2.1 Local government

The project is situated in the Port Stephens LGA which is highlighted in Figure 7. The LGA comprises the coastline from Newcastle in the south to Nelson Bay in the north, and Paterson to the west. The Pacific Highway dissects the LGA.

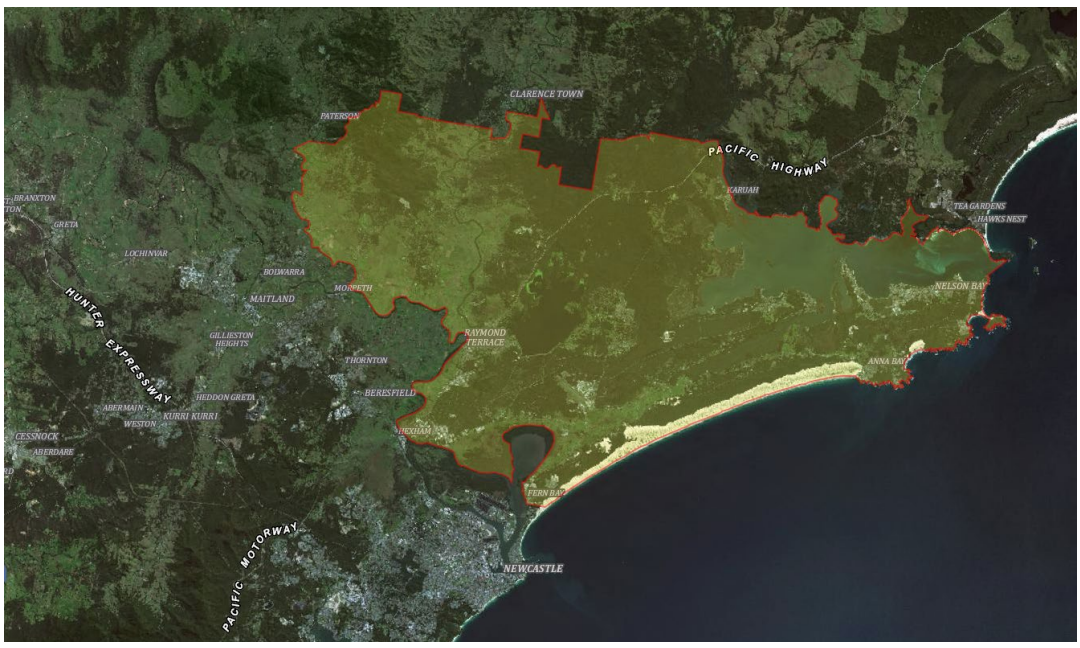


Figure 7 – Port Stephens LGA

5.2.2 Community

Community profile

Socio-economic data from the census provides a snapshot of the community profile in the local area. The data in Table 15 enables a comparison of the Fern Bay, Stockton – Fullerton Cove and NSW populations in respect to a range of socio-economic indicators.

Table 15 – Socio-economic indicators

Socio-economic indicator	Fern Bay	Stockton - Fullerton Cove (SA2)	NSW
Total population	2,763	566	7,467,527
Male	49.50%	49.90%	49.30%
Female	50.50%	50.10%	50.70%
Median age	53	51	38
Average children per family for families with children	1.8	1.7	1.9
Average people per household	2.2	2.3	2.6
Median weekly household income	$1,049	$1,164	$1,486
Median monthly mortgage repayments	$2,167	$2,000	$1,986
Median weekly rent	$430	$330	$380
Average motor vehicles per dwelling	1.6	1.6	1.7

The populations do not differ markedly in terms of gender. It is clear that an older population resides in both Fern Bay and the Stockton – Fullerton Cove areas, in comparison to broader NSW. In the study area, the average number of children per household, people per household, incomes, and motor vehicles per dwelling are smaller when compared to NSW averages.

The median age of 53 for Fern Bay, and 51 for Fullerton Cove suggests that the two are aging suburbs catering to established members of the workforce or retirees. This position is corroborated by the fact that 55% of community members in Fern Bay and 45.8% of community members in Fullerton Cove own their homes outright, and only 23% of homes in Fern Bay and 27.2% of homes in Fullerton Cove are owned with a mortgage. Accordingly, the family structure of Fern Bay favours families without children (58.1%) over families with children (32.1%). This is echoed in Fullerton Cove with the composition of families comprising 50.2% of couples without children compared to 34.0% of couples with children. The aging status of the community is further substantiated by the fact that 41.6% of couple families in Fern Bay and 34.7% in Fullerton Cove are not working.

Population projections

During 2016, the Port Stephens LGA population was 74,100. It is forecast to grow to 92,650 by 2036. Total households and implied dwellings[4] will follow the growth trajectory predicted for the population. The rate of growth in each case is predicted to plateau slightly from 2031. Figure 8 illustrates these projections.

[4] The projection of implied dwelling demand shows how many dwellings are likely to be needed to accommodate the projected population and the households likely to form. It is a demand-driven estimate (NSW Department of Planning and Environment, 2019).

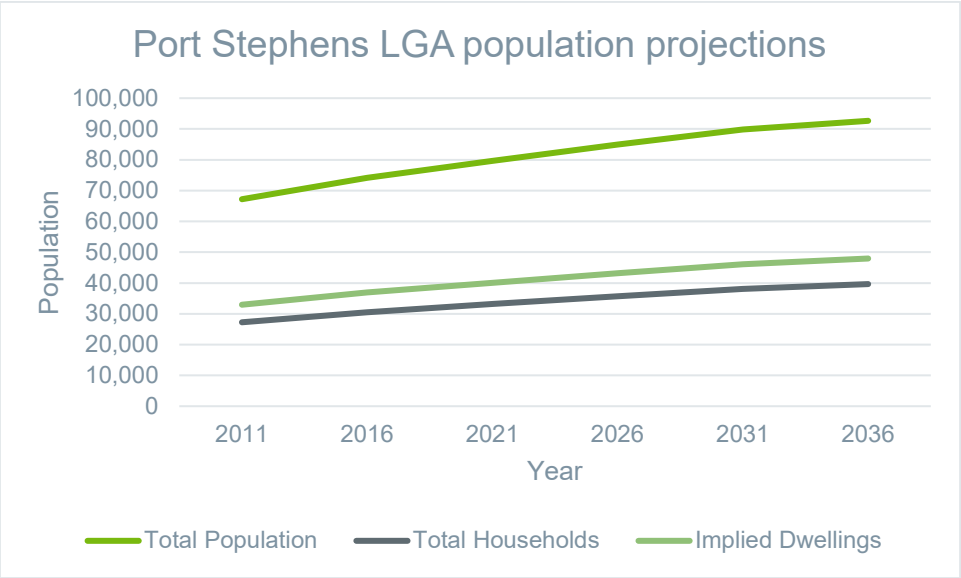


Figure 8 - Local Government Area Population and Household Projections, and Implied Dwelling Requirements (NSW Department of Planning and Environment, 2019)

Family composition

The composition of families in both Stockton – Fullerton Cove and Fern Bay is distinct in comparison to the NSW equivalent (see Table 16). Across NSW there are higher proportions of families (either couples or single parents) with children than in the geographies closest to the project. These statistics underscore the older demograhic and the relatively smaller number of dependent children in the local area.

Table 16 – Family composition

Family composition	Stockton - Fullerton Cove	%	Fern Bay	%	New South Wales	%
Couple family without children	1,010	50.2	465	58.1	709,524	36.6
Couple family with children	683	34	257	32.1	887,358	45.7
One parent family	292	14.5	74	9.2	310,906	16
Other family	25	1.2	4	0.5	32,438	1.7

Indigenous population

The Indigenous populations in the geographies nearest to the project are not drastically different to the proportion of Indigenous people residing in NSW as a whole (see Table 17). As with the non-Indigenous population locally, it is evident that the local geographies contain a comparatively older Indigenous population. This is demonstrated by the median ages in Stockton – Fullerton Cove (27) and Fern Bay (25) being larger than that of the NSW equivalent (22).

Table 17 - Aboriginal and/or Torres Strait Islander peoples

Characteristic	Stockton - Fullerton Cove	%	Fern Bay	%	New South Wales	%
Male	154	51.3	39	47.0	107,368	49.7
Female	146	48.7	44	53.0	108,809	50.3
Median age	27	--	25	-	22	--

Place of birth

In terms of the birthplaces of residents in the communities surrounding the project, England, New Zealand, Scotland, USA, and Germany were reported most frequently at the Census. Excluding those residents born in Australia, the bulk of the local populations were born in Commonwealth nations. The data contained in Table 18 demonstrates there is not a major contrast between the proportions of residents born in these foreign locations, in Stockton - Fullerton Cove, Fern Bay, or NSW more broadly.

Table 18 – Birthplace of residents (excluding Australia)

Birthplace	Stockton - Fullerton Cove	%	Fern Bay	%	New South Wales	%
England	215	2.9	103	3.8	226,564	3
New Zealand	79	1.1	33	1.2	117,136	1.6
Scotland	36	0.5	25	0.9	28,579	0.4
United States of America	30	0.4	21	0.8	30,081	0.4
Germany	35	0.5	18	0.7	29,541	0.4

Multi-culturalism

Non-English languages spoken at home provide an indicator of multi-culturalism in communities. Contrasting language profiles were reported in the Stockton - Fullerton Cove and Fern Bay geographies as shown in Table 19 and Table 20. German and Spanish languages were reported by residents in both local areas as being among the popular non-English languages spoken at home. An obvious departure from the NSW non-English language profile is evident amongst the Stockton - Fullerton Cove population, where only 0.2% spoke Mandarin compared with 3.2% of the NSW population. Other language types were more consistent between the local geographies and NSW.

Table 19 – Language other than English, spoken at home (Stockton - Fullerton Cove)

Language	Stockton - Fullerton Cove	%	New South Wales	%
German	21	0.3	23,033	0.3
Thai	14	0.2	24,839	0.3
Spanish	13	0.2	63,527	0.8
Mandarin	12	0.2	239,945	3.2
Tagalog	11	0.1	45,130	0.6

Table 20 - Language other than English, spoken at home (Fern Bay)

Language	Fern Bay	%	New South Wales	%
German	10	0.4	23,033	0.3
Spanish	9	0.3	63,527	0.8
Khmer	6	0.2	11,694	0.2
Dutch	4	0.1	8,686	0.1
Hindi	4	0.1	67,034	0.9

Employment

Employment status data derived from the Census and reproduced in Table 21, indicates that both Fern Bay and Stockton-Fullerton Cove residents maintain similar working patterns. The main inconsistency between the two resident groups is the proportion of residents that stated both parents in couple families were not working. A greater proportion (41.6%) of Fern Bay residents reported this status, compared to 34.7% of the population in Stockton-Fullerton Cove. Overall, the data illustrates that smaller proportions of the Fern Bay and Stockton-Fullerton Cove residents are working, relative to the collective NSW population.

Table 21 – Employment status

Employment Status of Parents in Couple Families	Fern Bay (%)	Fern Bay (No.)	Stockton-Fullerton Cove SA2 (%)	Stockton-Fullerton Cove SA2 (No.)	NSW (%)	NSW (No.)
Both Employed, Worked full-time	14.8	108	15.9	270	22.6	360,916
Both employed, worked part time	2.1	15	2.7	46	4.0	63,106
One employed full-time, one part time	15.3	112	18.6	315	20.6	329,567
One employed full time, other not working	10.7	78	10.7	181	15.0	240,084
One employed part time, other not working	4.1	30	4.9	84	6.1	96,933
Both not working	41.6	304	34.7	590	21.0	334,742
Other (includes away from work)	4.2	31	4.8	81	5.1	80,905
Labour force not stated (by one or both parents in a couple family)	7.3	53	7.7	131	5.7	90,630

Education

Educational attainment data associated with the local populations is contained in Table 22. It shows that data for the local populations is generally consistent. Conversely, it shows that larger proportions of the local populations attained a school qualification compared to the NSW population, up until the year 10 certificate. This scenario did not hold true for the post-year 10 qualifications however, including university qualifications. The strength of mining and agricultural industries historically in the Hunter region, is perhaps one explanation for this pattern. These

industries would typically require a workforce with practical skills obtained through trade certificates and apprenticeships, rather than through university programs.

Table 22 – Educational attainment

Level of highest educational attainment (People aged 15 years and over)	Stockton - Fullerton Cove	%	Fern Bay	%	New South Wales	%
Bachelor Degree level and above	890	13.8	331	14.2	1,424,716	23.4
Advanced Diploma and Diploma level	506	7.9	187	8	543,142	8.9
Certificate level IV	233	3.6	82	3.5	167,947	2.8
Certificate level III	1,080	16.8	379	16.3	730,498	12
Year 12	589	9.2	215	9.2	930,654	15.3
Year 11	183	2.8	74	3.2	203,574	3.3
Year 10	936	14.6	382	16.4	702,178	11.5
Certificate level II	4	0.1	6	0.3	4,849	0.1
Certificate level I	0	0	0	0	625	0
Year 9 or below	707	11	332	14.2	513,209	8.4
No educational attainment	11	0.2	3	0.1	54,870	0.9
Not stated	1,069	16.6	252	10.8	627,465	10.3

5.2.3 Place

Status of industry

The industries that provide most employment opportunities for the Stockton - Fullerton Cove and Fern Bay workforces are identified in Table 23. It is not surprising that Defence is a strong employment industry for both local populations, given their proximity to the Williamtown RAAF base. The same might be said for State Government Administration data, presuming the base also provides administrative opportunities for the civilian population. The prominence of the Aged Care Residential Services industry is consistent with the older demographic in the area, which promotes a demand for such services.

Table 23 – Employment by industry.

Industry of employment	Stockton - Fullerton Cove	%	Fern Bay	%	New South Wales	%
Defence	126	4.9	82	9.8	21,848	0.6

Industry of employment	Stockton - Fullerton Cove	%	Fern Bay	%	New South Wales	%
Aged Care Residential Services	83	3.2	30	3.6	67,209	2
State Government Administration	66	2.6	25	3	45,546	1.3
Hospitals (except Psychiatric Hospitals)	95	3.7	22	2.6	119,350	3.5

Income

In the Stockton - Fullerton Cove and Fern Bay areas median weekly incomes for people aged 15 years and older, are less than the equivalent NSW measurement. This pattern applies to personal, family and household incomes, as shown in Table 24.

Table 24 - Median weekly income for people aged 15 years and over

Income type	Stockton - Fullerton Cove	Fern Bay	New South Wales
Personal	590	544	664
Family	1,489	1,416	1,780
Household	1,164	1,049	1,486

Council services

Each year in April/May, PSC conducts a survey across the LGA. This survey seeks feedback from residents and visitors on their satisfaction with facilities and services provided by PSC. This annual survey is broadly representative of the population of Port Stephens. The results of the survey are reported to Councillors and staff to inform planning decisions and the allocation of resources.

Table 25 contains survey report (Port Stephens Council, 2018) results regarding the reported satisfaction with a range of Council services. The satisfaction levels can be interpreted as an indication of how attractive Port Stephens is as a 'place', to its residents. In each of the service categories listed, an increase in satisfaction occurred from the time of the first survey in 2012, to the latest survey in 2018, albeit with fluctuations measured during the inter-years. An exception to the trend is evident in children's services which decreased over the sampling period.

Table 25 – Satisfaction with Council services in the Port Stephens LGA (Port Stephens Council, 2018)

All figures in the table below are percentages.

(n= 1287)	2018 Aggregate	2017 Aggregate	2016 Aggregate	2015 Aggregate	2014 Aggregate	2013 Aggregate	2012 Aggregate
Library Services	99.15	98.0	98.6	99.3.	72.4	N/A*	N/A*
Children's Services	99	87.5-100	98.3	98.0	99.6	99.8	N/A**
Ranger Services (e.g. Animal Management)	76.50	70.6	62.6	62.6	63.6	60.4	65.5
Rangers Services (Parking)	74.43	74.3	59.5	61.5	60.1	61.6	56.3
Garbage Collection Services	94.58	93.9	93.5	86.1	93.3	92.7	92.3
Access to waste depots and waste transfer stations	87.38	76.5	81.7	72.2	82.1	76.5	74.3

Safety

Perceptions of safety were also collected as part of the PSC survey. Results in Table 26 illustrate variable perceptions based on the LGA location and time of day. It is not surprising that daylight hours generated a sentiment of safety for a larger number of residents. Daylight hours were not deemed by all to generate feelings of safety however, with three residents indicating they feel unsafe at home and in their neighbourhoods during this time.

Table 26 – Perceptions of safety in the Port Stephens LGA (Port Stephens Council, 2018)

	Very safe	Safe	Moderately safe	Not very safe	Unsafe
At home during the day	672	477	119	13	3
At home at night	532	522	184	36	7
In your neighbourhood during the day	616	508	137	18	3
In your neighbourhood during the night	414	498	279	72	19

Crash and casualty statistics (see Figure 9) collected by Transport for NSW (2019) also provide an insight into safety across the LGA. These figures are also collected annually and will therefore be valuable to baseline monitoring. Between the two datasets presented in the figure, there is an obvious unexplained discrepancy in relation to the number of fatalities in 2016. Nevertheless, the data presents a spike in road deaths at this time.

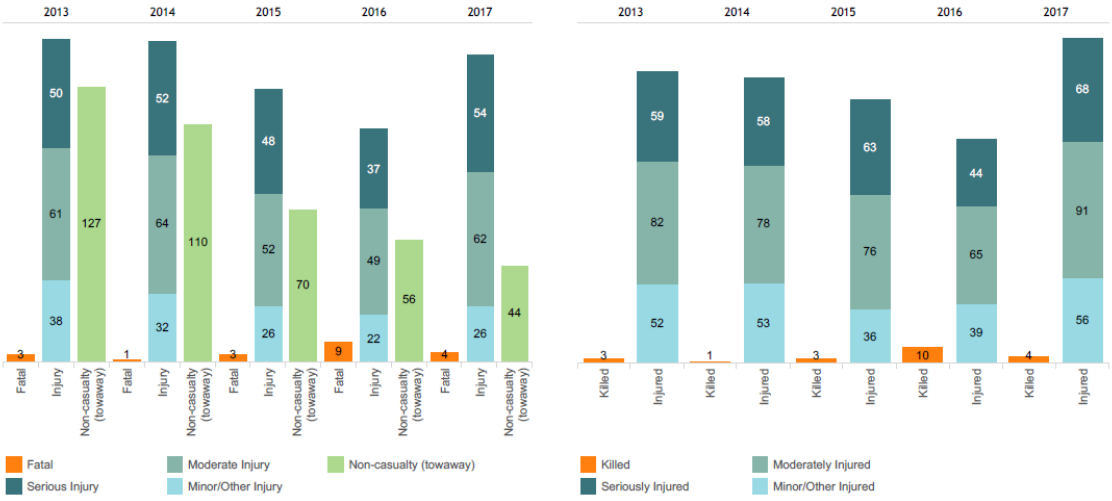


Figure 9 – Crash and casualty statistics, Port Stephens LGA (Transport for NSW, 2019)

Socio-economic index

Socio Economic Indexes for Areas (SEIFA) is a suite of indexes that have been created by the ABS from social and economic Census information.

Each index ranks geographic areas across Australia in terms of their relative socio-economic advantage and disadvantage. Figure 10 presents information from the Index of Relative Socio-economic Disadvantage (IRSD), a general socio-economic index that summarises a range of information about the economic and social conditions of people and households within the Port Stephens LGA. This index includes only measures of relative disadvantage (refer to Compelling Economics Pty Ltd., 2019, for those measures). A low SEIFA score indicates relatively greater disadvantage in general. For example, an area could have a low score if there are (among other

things) many households with low income, many people with no qualifications, or many people in low skill occupations. Conversely, a high SEIFA score indicates a relative lack of disadvantage in general.

The SEIFA score for Port Stephens LGA in 2016 was 980. The scores for the smaller subset geographical areas are slightly higher, with Fern Bay achieving 984, and Fullerton Cove achieving 1035. These scores are relatively high in the range shown in Figure 10 (ie 188-1186).

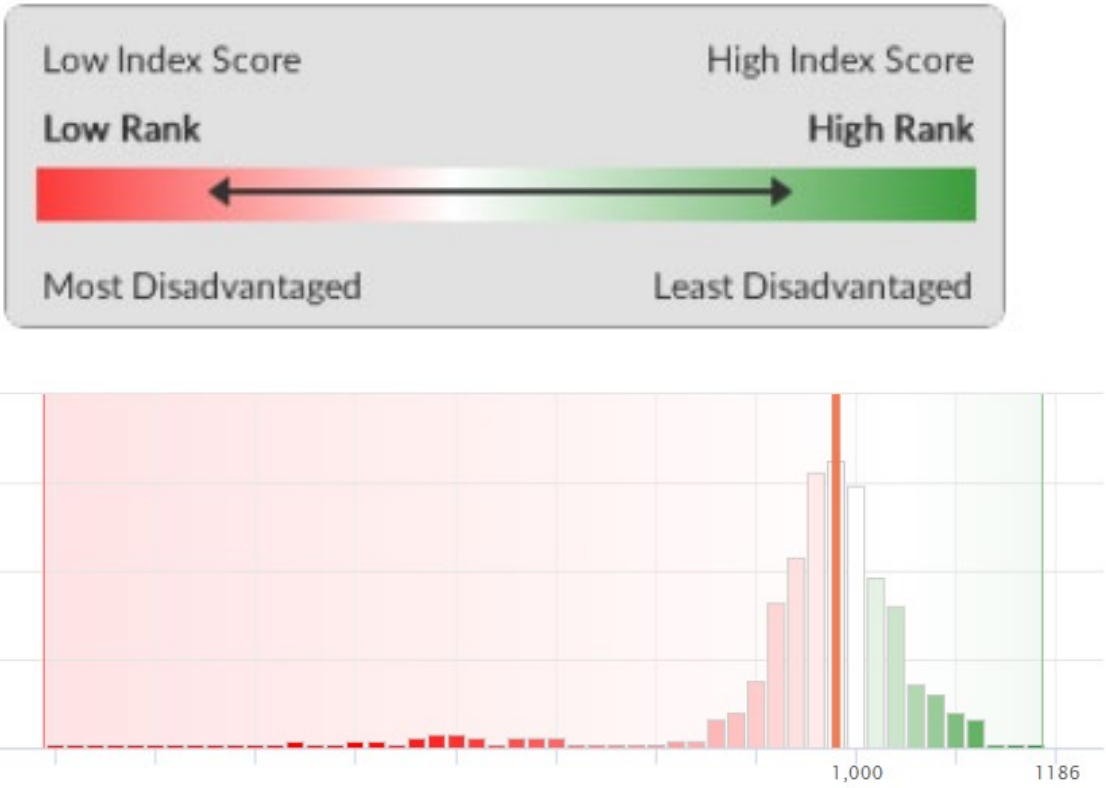


Figure 10 – SEIFA score for Port Stephens LGA (Compelling Economics Pty Ltd., 2019)

5.2.4 Governance

Management of local government resources

Interpreted as a measure of governance in the LGA, PSCs survey (refer Port Stephens Council, 2018) collected feedback about how well the authority manages its resources. The resources in question are its workforce, its assets, and its finances. Figure 11 contains the survey results. In each case approximately 40% of survey respondents were somewhat confident that PSC was managing its resources well. Considering also the proportions of respondents that reported being confident and very confident that PSC was managing their resources well, it can be concluded that the majority of respondents are satisfied about resource management overall.



Figure 11 – Council's management of workforce, assets, and finance (Port Stephens Council, 2018)

5.3 Existing social infrastructure

Social infrastructure refers to facilities and services that enhance the social capacity of communities and may include infrastructure related to health, housing, youth, aged care, leisure, community safety facilities and road safety (Franks, 2012). As with the social indicators presented above, the social infrastructure identified in areas surrounding the project prior to SSD approval will provide a reference point against which social impacts may be measured if the project proceeds. Such impacts can take the form of a decrease in the quantity, diversity, or capacity of the existing social infrastructure, courtesy of demand from an expanded workforce and their relatives relocating to an area. Conversely, an influx of staff and their families, or changes to the

footprint of a project may stimulate new social attributes of the communities, bolster organisational capacities, and contribute to the supply of services.

The analysis conducted for this study identified a range of essential social infrastructure which underpin the social wellbeing of the population. Such infrastructure includes:

- education and child care facilities (five in total);
- community centres and town halls (four);
- art and cultural facilities (four);
- emergency and justice facilities (two);
- health facilities (four);
- aged care facilities (two);
- open space (six);
- sport and recreation facilities (seven); and
- places of worship (two).

The locations of all identified infrastructure are shown in Figure 12.

Figure 12
Social infrastructure

STOCKTON SAND QUARRY DREDGING
ENVIRONMENTAL IMPACT STATEMENT



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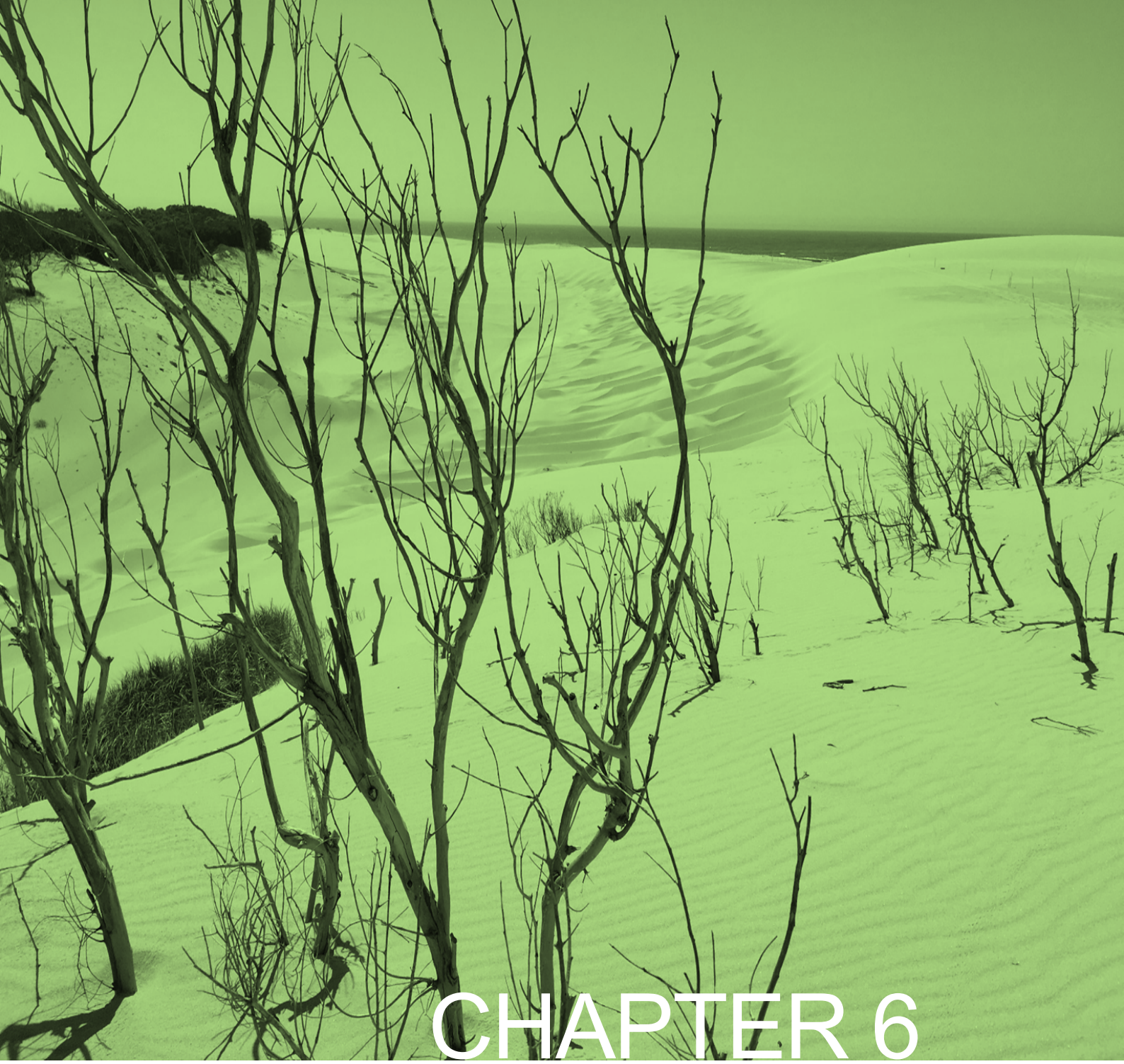
Source: LPI (2018), Boral (2018), Element Environment (2019), Cambium Group (2019).



CHAPTER 6

IMPACT ASSESSMENT

6 ASSESSMENT OF SOCIAL IMPACTS

In this chapter an assessment of the potential negative social impacts associated with the project has been completed on the assumption there is no mitigation. Predicted positive impacts associated with the project are also assessed below. Outcomes of the assessments are discussed according to the Social Risk Matrix contained in Appendix C3 of the Guideline (see Appendix E).

6.1 Way of life

'Way of life' was the first social impact category considered and assessed for the project. It was considered as part of the SIA scoping exercise and determined to be a category not influenced by the project. According to the Guideline, this applies to the influence of the project on how people live, work, play and interact with one another on a daily basis. It was subsequently disqualified from the SIA. Refer to the summary in Section 4.1.2 for an explanation regarding its disqualification from the SIA.

6.2 Community

Consistent with the Guideline, 'Community', including its composition, cohesion, character, how it functions, and sense of place, was considered in the SIA study. The matter was considered as part of the scoping exercise and determined to be a social impact category not affected by the project. Refer to the scoping tool results (the summary in section 4.1.2) for an explanation regarding its disqualification from the SIA.

In the absence of any contrary evidence gathered during the course of this SIA study, a range of explanations might be plausible as to why a community impact did not emerge. The size, scale and location of the project are potentially among the factors. It may be that the project is sufficiently 'hidden' from a visual and acoustic perspective (details about these findings are provided below), and that the small scale ASI does not influence public dialogue about the composition, cohesion, character, functions, or sense of place for neighbouring communities.

6.3 Access to and use of infrastructure, services and facilities

The social impact category related to access and use of infrastructure (per the Guideline), was identified in the SIA as being relevant to the project. The social matter subsets of this category that required assessment include impacts to the 1) Road and rail network and 2) Public infrastructure.

The EIS includes a comprehensive traffic impact assessment (refer Transport and urban Planning Pty Ltd, 2019). It is a specialist study which addresses the two matters above. To supplement the traffic assessment, the ECA methodology was applied for the purpose of the SIA.

6.3.1 Road and rail network

Although the scoping exercise determined that no SIA was required to assess this matter, the project team committed to an adaptive research approach at the completion of the exercise. By adopting this approach, if any EIS results (including those derived from the traffic impact assessment) isolated potential social issues regarding the road network, then detailed social assessments would have been conducted. The same adaptive approach would have been applied if negative feedback was received via further engagement activities during the EIS preparation phase.

No suggestion of social impacts related to the road network emerged from the EIS results. Furthermore, no feedback about these impacts was received via further engagement activities which included the community information sessions, requests for feedback made via emails to the project database, and the further engagement resident consultations made via the doorknock of targeted residences closest to the quarry. Accordingly, the traffic impact assessment (Transport and Urban Planning Pty Ltd, 2019) was relied upon as the leading study into this matter, and further analysis via the implementation of a SIA methodology was not required.

The findings of the traffic impact assessment were favourable to the community in terms of the potential for social impacts to arise from the project, and its influence of the surrounding road network. It found that:

- traffic impacts from the additional trucks associated with the project, on the adjacent road network including the principal intersections adjacent the quarry, will be satisfactory;
- future cumulative traffic impacts associated with the project, on the principal intersections until 2029, will also be satisfactory;
- construction traffic impacts are assessed as satisfactory;
- the project is not expected to have any negative impacts on other road users including pedestrians, cyclists and public transport vehicles (buses), and or on road safety; and
- after 2028, truck numbers generated by the quarry will reduce. When compared to the existing consent (DA 140-5-2006), the additional truck volumes will be 14 truck-loads (28 two-way truck movements) on an average day and 28 truck-loads (56 two way truck movements) on a maximum day. These truck movements will be spread over the road network.

Based on the above findings, the impact for the local community and road users at all stages of the project life-cycle, is predicted to have a **low social risk rating.** It is considered to be immaterial and not requiring the implementation of a mitigation measure.

6.3.2 Public infrastructure

In the scoping phase, public infrastructure (or the condition of local roads) was not identified as a social matter relevant to the SIA. The condition of local roads was not raised by residents during the early or further engagement activities so feedback about this matter was extremely limited. However, acknowledging the increased volume of heavy vehicles proposed for the project and the absence of a traffic impact assessment during the scoping phase, a precautionary approach was adopted. This approach involved the implementation of a standard SIA, via the ECA method. The ECA results supplement the traffic impact assessment which is now available.

Thirty-seven articles were obtained and analysed as part of the ECA (see Appendix F for the ECA protocol and list of articles), to assess the social impacts to public infrastructure. Of those articles, 27 were disqualified as they did not contain a public infrastructure discourse. The following seven discourses emerged from the ECA exercise, each conveying some negative sentiment (excluding item five) towards the social impacts of heavy vehicles using public infrastructure. The discourses listed at items 1,3, and 4 contained a reference to the condition of road pavements:

1. excessive number of quarry trucks using public infrastructure;
2. trucks have negative impacts on families and schools;
3. the introduction of additional truck movements (negative sentiment regarding road quality);
4. quarry operators should share road maintenance burden;
5. the introduction of additional truck movements (neutral sentiment regarding road quality);
6. negative impacts for community safety; and
7. sand haulage route debate.

Whilst heavy vehicles were a feature of each discourse, neither the project, the project location, Fullerton Cove more broadly, or the ASI were their exclusive focus. In other words, the discourses related to truck operations across the Port Stephens LGA, not specifically to truck operations

associated with the project. These observations have implications for the assessment of social impacts under the 'access to and use of infrastructure' social impact category. They suggest that the social impacts in question are cumulative in nature. They are borne from the volume of heavy vehicles from across the region, using public infrastructure. That is, the collection of heavy vehicles sourced from multiple projects both within the ASI and beyond, are producing a negative social impact in relation to public infrastructure. Overall, the results of the ECA exercise illustrate a social unease in relation to the collective volume of heavy vehicles, the introduction of additional truck movements, and the road maintenance burden created by heavy vehicles for public infrastructure across an area much broader than the ASI.

ECA results aside, results of the traffic impact assessment (Transport and Urban Planning Pty Ltd, 2019) and the associated road safety audit are relevant to this matter. The audit examined the existing road pavement and the provision for heavy vehicles. It assessed these against current road practice guidelines and standards, with the objective of identifying any real or potential road safety hazards. The audit identified a number of minor maintenance issues along the haulage route, but did not identify any specific road safety issues that required follow up. These results create a disconnect between the community dialogue about public infrastructure social impacts and the actual impacts predicted to arise from the project. They suggest these impacts are more dominantly perceived or imagined, rather than being material.

Therefore, this social impact was assessed to have a **moderate social risk rating** during the operational project life-cycle stage. This rating was applied on the prediction that the additional heavy vehicle traffic would likely contribute to the cumulative social impact evident in media articles and the ECA results, even if that impact was one perceived by the community.

6.4 Culture

Consistent with the Guideline, 'Culture', including shared beliefs, customs, values and stories, and connections to land, places, and buildings (including Aboriginal culture and connection to country), was considered in the SIA study. The matter was considered as part of the scoping phase and determined to be a social impact category not affected by the project. Refer to the scoping tool results (the summary in Section 4.1.2) for an explanation regarding its disqualification from the SIA.

6.5 Health and wellbeing

The 'Health and Wellbeing' social impact category defined in the Guideline is relevant to the SIA in relation to two social matters. They are: 1) 'acoustic' amenity and 2) 'community safety'. For the acoustic impacts associated with the project, the scoping exercise determined that no SIA would be required alongside the noise impact assessment conducted by Wilkinson Murray (2019). In relation to community safety, the scoping exercise determined that a standard SIA would be required in the absence of any specialist study designed to investigate the matter. The PO method was applied for this purpose.

Assessment results for both social matters are provided below.

6.5.1 Acoustic amenity

The *Stockton Sand Quarry Noise Impact Assessment* (Wilkinson Murray, 2019) conducted for the project involved a detailed assessment of potential operational noise impacts. Acknowledging that the project will generate heavy vehicle movements along Nelson Bay Road, Cabbage Tree Road and Medowie Road, it also involved an assessment road traffic noise (among other noise sources such as plant and equipment). Unattended noise monitoring was conducted to determine the

existing ambient noise levels at the most potentially affected residential receivers in the area surrounding the project.

Results of the noise impact assessment describe that predicted noise levels for the project comply with the established project noise trigger levels and accordingly, no further noise mitigation measures or controls are required to be implemented. In relation to noise impacts derived from heavy vehicle movements on the surrounding road network, the predicted relative increase in noise levels are within the allowable limits, on all designate access routes. In summary, the predicted noise levels for the project are compliant with relevant legislation and standards.

From a social impact perspective, the project is predicted to have a **low social risk rating** in all stages of the project life-cycle. The risk is considered to immaterial and not requiring the implementation of a mitigation measure. This determination was made in consideration of the Wilkinson Murray (2019) findings, and also the fact that no noise concerns or issues were raised by stakeholders in the consultation and engagement activities conducted for the project.

6.5.2 Community safety

Results of the PO exercise show that 17 participant events were observed by the quarry staff. Of these, two events involved actual instances of unauthorised access to the site during the observation period, from early January to late March 2019. For all other instances, members of the public did not enter the quarry and there is every possibility that the participants involved were merely using the public road [5]with no intention of accessing the quarry. They either turned away voluntarily at the quarry entry, some having read the signage (see Figure 13 and Figure 14) on display, or were prompted by quarry staff to turn away. A summary of the other characteristics of the recorded instances are provided in Table 27.

[5] During the PO exercise, quarry staff explained that Google maps currently provides directions to Stockton Bight beach and the Sygna via Cox's Lane. This is likely to draw members of the public to the quarry entrance. Boral have requested that Google correct this and remove the directions from their mapping software. The request was accepted, yet at the time of writing there was no change to this situation. Boral has advised that the matter is being actively followed up.



Figure 13 – Beach access signage



Figure 14 – Warning signage

An analysis of the data in Table 27 was made in respect to the three PO research questions. The questions and analysis results are below.

1. *Do the participants seem to be intentionally or unintentionally accessing site?*

During the observation period, PO results indicate that intentional or unintentional site access did occur, albeit for a small percentage (12%) of the recorded instances.

2. *What was the known or predicted purpose of those people attempting to access the project site?*

The purpose of the persons who accessed the site without authority is known for only one of the two recorded instances. Results indicate that the person involved on this occasion was intending to access the beach. Based on the conversation held with the member of the public, quarry weighbridge staff describe that the person was:

> "in a rush…[I] stopped the car as it was heading through the compound...[the] driver seemed to be late to pick people up from the beach. [I] advised him where the beach access was and he proceeded off site" (quarry weighbridge operator).

The purpose of the second person who accessed site is not known, as quarry staff were not able to have a conversation or determine with certainty what intention that person held.

As shown in Table 27, on five other occasions the travel mode of persons who were potentially interested in site access was travel by foot, horse, and bicycle. The implied purpose in each case was recreation, however there is no evidence to verify this.

3. *Was the safety of those who accessed the project site put at risk?*

In the two instances of unauthorised site access, there was no immediate safety risk to the members of the public. The weighbridge staff were able to alert the people to quarry operations, either by gesture or conversation, and advised them to leave the quarry in a safe manner. Members of the public then departed voluntarily. The cause of risk in these events rests entirely with members of the pubic who choose to undertake their recreational pursuits whilst ignoring the prominent warning signage and/or communications of quarry staff.

After considering and assessing the PO results, **a moderate social risk rating** is considered to be adequate for the project, applicable at all life-cycle stages of the project.

Table 27 – Summary of PO results

Event number	Date	Caucasian or other appearance	Age group (adult or youth)	Number of people	Travel mode	Route	Displayed awareness of site or recognition of warning signage?
1	14/01/2019	Caucasian	Adult	2	Horse	Coxs Lane only	No
2	17/01/2019	Unknown	Adult	1	Walking	Coxs Lane only	No
3	17/01/2019	Unknown	Adult	1	Bicycle	Coxs Lane only	No
4	18/01/2019	Unknown	Unknown	Unknown	Car	Coxs Lane only	Yes, read signage
5	18/01/2019	Not Caucasian	Unknown	Unknown	Car	Coxs Lane only	Yes, read signage
6	22/01/2019	Unknown	Adult	2	Car	Coxs Lane only	Yes
7	22/01/2019	Unknown	Adult	2	Car	Coxs Lane only	Yes, read signage
8	23/01/2019	Unknown	Adult	2	Car	Coxs Lane only	Yes
9	23/01/2019	Unknown	Adult	2	Car	Coxs Lane/Compound access road	Yes
10	24/01/2019	Unknown	Unknown	1	Bicycle	Coxs Lane only	Yes
11	24/01/2019	Unknown	Adult	2	Car	Coxs Lane/Compound access road	Yes, read signage
12	24/01/2019	Unknown	Adult	2	Car	Coxs Lane/Compound access road	Yes, read signage
13	25/01/2019	Unknown	Adult	1	Bicycle	Compound access road	No
14	29/01/2019	Unknown	Adult	2	Car	Coxs Lane/Compound access road	Yes
15	18/02/2019	Caucasian	Adult	1	Car	Through compound	Yes, after alert from staff
16	6/03/2019	Unknown	Unknown	2	Car	Coxs Lane/Compound access road	Yes
17	12/03/2019	Caucasian	Adult	1	Car	Coxs Lane only	Yes

6.6 Surroundings

As subsets of the 'Surroundings' social impact category, two social matters were determined to be relevant to the SIA. They are 1) 'visual amenity' for recreational dune users of Stockton Bight Beach and 2) 'heritage (natural features)'.

No specialist study was conducted as part of the EIS to investigate the potential visual amenity impacts of the project, and the scoping exercise determined a standard SIA was required. Accordingly, a semi-structured interview and the VIA method demonstrated by Andrews et. al. (2012) were applied. In relation to heritage (natural features), the interface between the Indigenous community and the dune areas adjacent the project which encompass the Worimi Conservation Lands, formed a focal point of the scoping exercise. For the purposes of the SIA, it was determined that further engagement with the Worimi WLALC was required in relation to the heritage matter. This was in addition to the Aboriginal cultural heritage assessment of the project.

Assessments of these matters are below.

6.6.1 Visual amenity

At the site visit conducted for the purpose of the VIA, the photograph displayed in Figure 15 was taken at a location within the quarry boundary that was above the highest point of the publicly accessible area of the dune system adjacent to the quarry. Given that recreational dune users are not authorised to breach the boundary rope and access the vantage point depicted in the photograph, there is no option for them to gain a better vantage point of the quarry and proposed project site, unless they access the site without authorisation.

In Figure 15 the project site is not visible. It exists in an area of the quarry that is a substantial distance behind the vegetation visible in the background of the photograph, and that area is characterised by a surface depression. As a result, the project site is completely obscured by the vegetation.

After the visual impact results described above were considered in relation to the receiver (ie the dune user), the Andrews et. al. (2012) visual assessment method was applied. The conclusion reached was that visual impact at the dune vantage point ranks as negligible. This decision was made on the basis that the rating for all criteria is low.



Figure 15 – Highest viewpoint on the dunes with a view towards the proposed dredge pond location

Aside from the VIA outcome, results of the semi-structured interview facilitated an assessment of potential visual amenity issues, and the associated social impacts for recreational dune users at

Stockton Bight. The following extracts from the interview overwhelmingly indicate that the potential for a visual impact to be created by the project is negligible:

> "The only thing we see is the danger tape and I wouldn't describe that as an eyesore".
>
> "To be honest we [quad bike riders] don't stop there…we're running past there and customers don't have a chance [to see the quarry]".
>
> "I don't even know why it's coming up on the radar as a visual impact…you'd need to talk to the pilots from Williamtown airport about that [laughter]".
>
> "We take twenty odd thousand [quad bike] customers along there, and I'm not aware of any concerned by the danger tape [causing] a visual impact" (owner, quad bike adventure company).

On the basis of the VIA, semi-structured interview, and engagement results, the SIA determined that a **low social risk rating** is most suitable for the potential visual amenity impacts predicted for the project. This rating would apply at each of the project life-cycle stages. Furthermore, the risk is considered to be immaterial and would not necessitate the implementation of a mitigation measure.

6.6.2 Heritage (natural features)

Further engagement with Worimi LALC did not yield any specific feedback in relation to potential social impacts likely to be caused by the project. This applies broadly to Aboriginal heritage matters, and more specifically to natural heritage features being the sand dunes where the Worimi LALC operate quad bike tour business, Sand Dune Adventures. In conversation with the CEO Worimi LALC, Boral's Indigenous Affairs Manager agreed to the request to include nominated stakeholders in future communication campaigns. Consultation with Worimi LALC also occurred during Aboriginal cultural heritage assessment process. Consultation with the 19 registered Aboriginal stakeholders identified that the local area has cultural heritage value to the local Aboriginal community. The Aboriginal cultural heritage assessment report (Kelleher Nightingale Consulting, 2019) states that Aboriginal stakeholders expressed the cultural importance and significance of the vegetated hind dune landscape around the study area. Importantly, the report states that no specific Aboriginal cultural values were identified within the study area.

Noting the absence of concerns expressed by the Worimi LALC or other Aboriginal persons during the scoping and EIS preparation phases, the SIA determined a **low social risk rating** was applicable to the heritage aspect of the project, at each of its life-cycle stages. The risk is sufficiently low to be immaterial and not requiring the implementation of a mitigation measure.

6.7 Personal and property rights

Two social matters related to the 'Personal and property rights' social impact category qualified for analysis for the SIA. They are 1) Economic (natural resource use) and 2) Economic (Livelihood). To investigate these two and other potential economic impacts of the Project for the EIS, Gillespie Economics (2019) conducted the *Stockton Sand Quarry Dredging Economic Assessment*. Subsequently, the scoping exercise determined that desktop research would be adequate to assess the above two social matters. Assessment results for each matter are provided below.

6.7.1 Economic (natural resource use)

There is a shortage of natural fine sand supply in the local and regional economy, and it is relevant to the SIA that the project will provide a partial remedy to this situation. Natural fine sand is an essential component to construction materials and consequently, to local and regional development projects. The project presents an opportunity to maintain supply at a cost-effective price.

Gillespie Economics (2019) make further comments about the benefit of the project in relation to its contribution to find sand supply. The assessment states that:

> "demand for sand is dependent on there being a demand for some other product, such as concrete, cement, asphalt and construction materials, which in turn is dependent on demand for construction. With the significant increase in approved infrastructure projects in Sydney and other parts of NSW, the leading suppliers of sand are under pressure to meet this increased demand" (p.7).
>
> "Sand is a high bulk-low cost commodity and hence it is preferable for it to be located close to markets to minimise transport costs. A shortage in the supply of construction sand for the Sydney market has been predicted for many years as access to local onshore sources of construction sand has become increasingly difficult through resource depletion eg Penrith Lakes, and increasing land use constraints surrounding potential alternative sources. In the short term, demand for construction sand can be met by increasing production from existing sources, including Stockton sand quarry" (p.7).
>
> "A CBA [cost benefit analysis] of the Project indicated that it would have net social benefits to Australia of $41M, and net social benefits to NSW of $17M. Hence the Project is desirable and justified from an economic efficiency perspective" (p.7).

According to the analysis above, it is predicted that the project will yield a positive impact from an Economic (natural resource use) perspective. This prediction is made on the basis that the level of interest, scale of benefit, equity in the distribution of the benefit, and likelihood of the benefit is forecast to be **high.**

6.7.2 Economic (livelihood)

An obvious positive impact of the project would be the extension of local employment for the five current quarry employees, and the employment of four additional staff. Interviews with Boral management confirmed the current quarry employees are locally-based. Although this workforce is not large, it must be recognised that the maintenance of employment for a single staff member would enable an income for the household unit of that employee. In this scenario, the number of people benefitting from the project would be larger than the nine individuals employed by the project. Employment for the Project workforce will ensure income for the associated families (or housemates as the case may be).

In a deeper analysis of this matter, Gillespie Economics (2019) found that:

> "The project will provide continued quarry employment for approximately five (four full-time and one casual) employees currently on-site and another four (two full time and two casual). The project is also estimated to provide continued transport employment for 17 people from the local area, plus employment for an additional nine people from the local area.
>
> Economic activity analysis, using IO analysis, estimated that quarry production at 750,000 tonnes per annum (tpa) relative to 500,000 tpa is estimated to make up to

> the following incremental contribution to the regional economy: $5 M in annual direct and indirect regional output or business turnover, $3 M in annual direct and indirect regional value added, $1 M in annual direct and indirect household income, and nine direct and indirect jobs" (p.3).

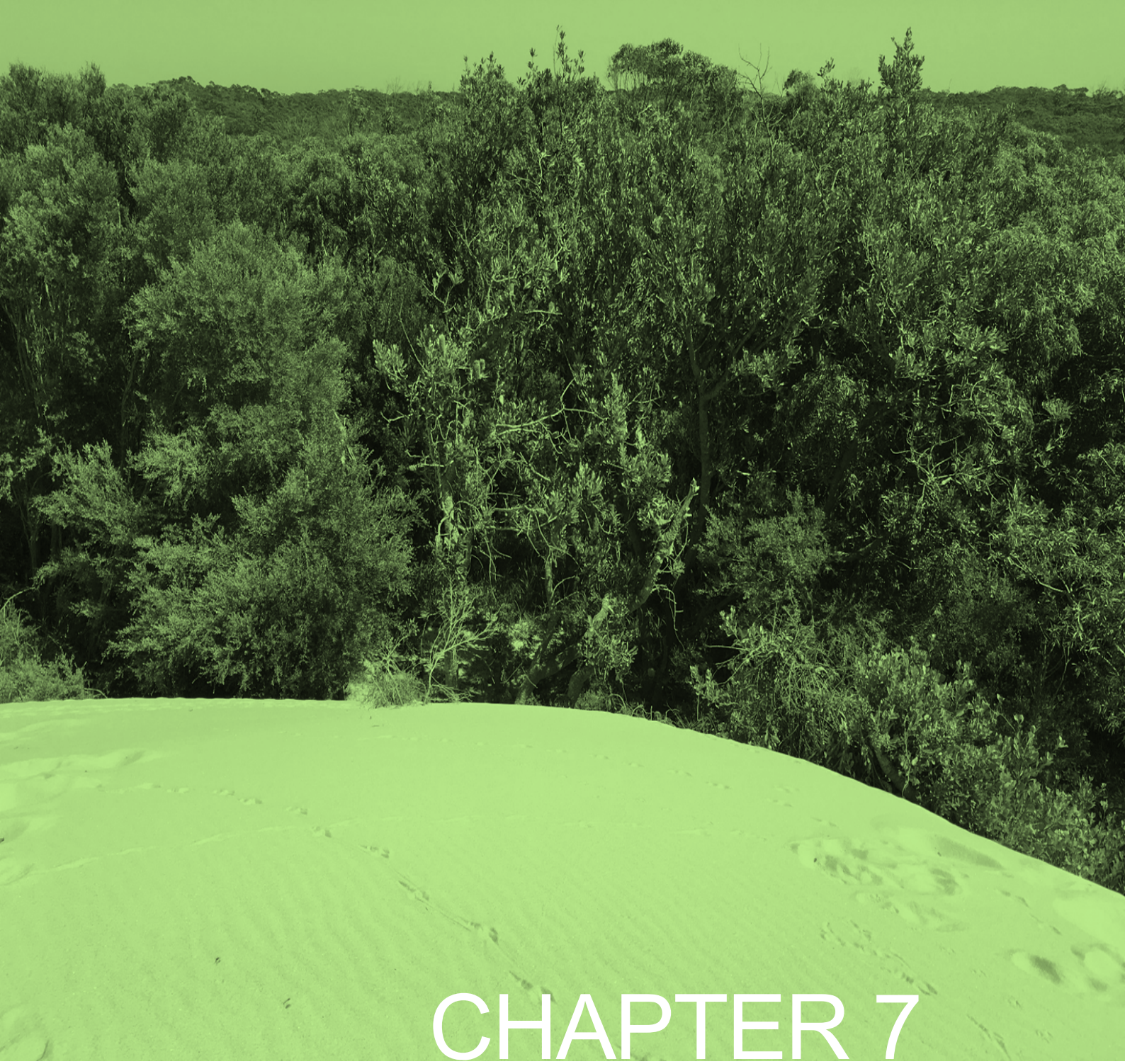
Considering the information obtained for this aspect of the SIA, a positive 'Economic (Livelihood)' social impact for the local population is predicted. The level of interest, scale of benefit, equity in the distribution of the benefit, and likelihood of the benefit is forecast to be **moderate**.

6.8 Decision-making systems

'Decision-making systems' is the social impact category that relates to the influence that individuals have on decisions that affect their lives, and access to complaint, remedy and grievance mechanisms. This category did not emerge in the scoping exercise as one that was potentially affected by the project, or one that required attention in the SIA. It was subsequently disqualified from the SIA for the reasons outlined in the summary in Section 4.1.2.

6.9 Fears and aspirations

According to the Guideline, the final social impact category assessed during the SIA was 'Fears and Aspirations'. The category relates to one or more of the social impact categories discussed previously, or fears about the future of the communities surrounding the project. As per the other social impact categories, 'Fears and Aspirations' of the community was a focus of the scoping exercise, but it did not emerge as a category likely to be influenced by the project. It was treated the same way as other social impact categories deemed to be irrelevant and was disqualified from the SIA. Again, the rationale for its disqualification is provided in Section 4.1.2.



CHAPTER 7

CONCLUSION AND RECOMMENDATIONS

7 SIA CONCLUSION AND RECOMMENDATIONS

This chapter presents the conclusion and recommendations of the SIA. The conclusion identifies the predicted positive social impacts, and only those negative social impacts of the project deemed in the previous chapter to be material. Where material negative impacts are forecast, there are measures available to mitigate them which would improve the social risk ratings allocated in the impact assessment chapter. These measures are identified in the recommendations section below.

7.1 Conclusion

This SIA report outlines the process implemented to identify, predict, evaluate, and develop responses to the social impacts of the project. The report exists as a specialist study developed to support the overall EIS and SSD application.

Boral owns and operates the quarry, a long-standing operation that currently extracts sand from the windblown (transgressive) sand dunes of Stockton Bight, and transports up to 500,000 tonnes of sand product per year for use in the building, landscaping and construction markets. Due to current and predicted future demand for sand in the local Hunter and Sydney regions, Boral is seeking approval for continued and expanded operations at the site through a SSD application. The project involves the extraction of sand from the inland vegetated dunes by front-end loader/excavator in Stage 1 and subsequent dredging. The project would seek to permit a site wide increase on the dispatch limit to 750,000 tpa (ie the windblown sand extraction area and the project operations combined) up until 2028, after which the site wide limit would reduce to no more than 500,000 tpa. The project would be for a period of up to 25 years.

The project's ASI encompasses the nearest communities to the quarry including properties in Fern Bay and Fullerton Cove, and a small portion of the sand dune system adjacent to the project site. Coxs Lane and Nelson Bay Road (from its intersection with Seaside Boulevard to its intersection with Cabbage Tree Road) are the prominent roads associated with the project. Although the project is located in the Port Stephens LGA, Newcastle is the major city nearby. As the regional centre of the Hunter, Newcastle has strong historic links to extractive industries. However, during the last two decades, the region has experienced structural economic changes, diversifying from its traditional extractive industry base to other economies including defence, education and service industries. The Port of Newcastle, Newcastle Airport, and heavy rail links facilitate the transport of freight and passengers across this region of coastal and hinterland tourist destinations.

The social baseline for the project provides a socio-economic description of the Fern Bay and Stockton-Fullerton Cove populations in comparison to the NSW population. It is clear an older population resides in both Fern Bay and the Stockton – Fullerton Cove areas in comparison to broader NSW. In the study area, the average number of children per household, people per household, incomes, and motor vehicles per dwelling are smaller than the NSW averages. Across NSW there are more families (either couples or single parents) with children than in the geographies closest to the project. These statistics underscore the older demographic and relatively smaller number of dependent children in the local area. The Indigenous populations in the geographies nearest the project are not drastically different to the proportion of Indigenous people residing in NSW as a whole. The same cannot be said of a range of other socio-economic indicators however, including multi-culturalism (eg less Mandarin speaking individuals in the study area), employment (eg less people working), and income (less income).

A range of engagement and SIA methods were used to collect and analyse information to determine the potential for social impacts as a consequence of the project. Results of the SIA

analysis were considered according to the social impact categories defined in the Guideline. Of those categories, four were determined to be relevant to the project:

1. access to and use of infrastructure, services and facilities;
2. health and wellbeing;
3. surroundings; and
4. personal and property rights.

The project is predicted to yield limited positive and negative socio-economic impacts for the regional and local populations across these categories, as identified in Table 28. In terms of the predicted positive economic impacts associated with natural resource use, the project would likely have substantial effects (without any enhancement). Ensuring the supply of 'fine' sand will provide security to the building and construction industry both locally and regionally, and mitigate the potential shortage of an essential building product. Without enhancement, there are also positive impacts related to the economic livelihood of quarry employees. Although there are only a small number of employees associated with the project, employment benefits in the form of income will spread to other members of the respective households. Employment is weaker in the study area compared the NSW average, so small employment gains in the local area cannot be understated.

The predicted negative personal safety social impact is localised (ie at property). The other is both cumulative and perceptual in nature. Some mitigation measures are available to address these predicted negative project impacts. The measures are identified in the recommendations below.

Table 28 - Predicted positive and negative social impacts

Social impact type	Social impact category	Predicted social impact
Positive	Personal and property rights	Mitigation of a potential shortage of natural fine sand supply in the local and regional economy
		Employment benefits in the form of income for quarry employees and their households
Negative	Access to and use of infrastructure, services and facilities	Community perception of cumulative impacts to road quality caused by heavy vehicles, per the ECA results
	Health and wellbeing	Personal safety impact to members of the public that access site without authority

7.2 Recommendations

It is recommended that the measures nominated below are implemented to offset the predicted negative social impacts of the project.

7.2.1 Access to and use of infrastructure, services and facilities

An increase in the volume of heavy vehicles using local roads, and the perceived or actual negative influence of those vehicles on road pavement quality, are social risks identified by this SIA through the ECA only (as opposed to direct feedback during engagement activities). These social risks have been thoroughly considered and documented in this SIA, the EIS and associated technical studies. The EIS will be placed on public exhibition and all stakeholders will have the opportunity to view how these social risks have been assessed, and the proposed mitigation and management measures to address them. When the EIS is placed on public exhibition it is recommended that:

- Fullerton Cove residents are notified in writing about the availability of the EIS on exhibition, the increased truck volumes derived from the project, where these matters are addressed in the EIS, SIA and technical studies, how/where they can view the documentation, and an invitation to contact Boral to discuss any residual or additional concerns they may have; and
- Boral places a notice on the project webpage (and sends the web link to the notice via other media channels typically used throughout the SSD stakeholder engagement process) to notify stakeholders about the EIS exhibition process as outlined above.

In both of these EIS exhibition phase notification initiatives, Boral should refer to the increase in truck numbers proposed for roads used by project vehicles, and the high-level results of the road safety audit.

7.2.2 Health and wellbeing

The SIA concluded that potential personal safety risks remain in relation to unauthorised site access. Boral has taken all reasonable and necessary steps to ensure the security of the site and the safety of the public. Staff efforts and quarry features include security fencing and lockable gates, high visibility line and signage, CCTV, safe batter requirements, trespass procedures, and operating hours, yet a small number of people continue to access site without authority.

With other options exhausted, this SIA recommends that the initial request made to Google be repeated with the objective of removing the Stockton Bight beach route (via the quarry) from Google maps. Achieving that objective would potentially dissuade members of the public from attempting to access the quarry without authority.

7.2.3 Summary of negative impacts and recommended mitigation measures

The negative social impacts predicted for the project, their description, and recommendations outlined to address them are summarised in Table 29. Should the recommendations be implemented, lower social risk ratings would be achieved. Some low residual risks would remain. Of these risks, the risk to personal safety would be immaterial.

Table 29 - Summary of negative impacts and recommended mitigation measures

Social Impact Category	Impact Description			Impact without mitigation		Impact with mitigation		
	Impact	Timing	Affected parties	Impact characteristic	Social risk rating	Mitigation	Social risk rating	Residual risk description
Access to and use of infrastructure, services and facilities	Impact to condition of public roads	Operational	Road users (roads surrounding the project)	Cumulative (perceived or actual) risk of additional heavy vehicle traffic affecting road quality	Moderate	Written notification about the availability of the EIS on exhibition, including the dissemination of EIS information about project heavy vehicles	Low	Low
Health and wellbeing	Impact to personal safety	Operational	Unauthorised community members	Personal safety risk from unauthorised site access	Moderate	The initial request made to Google is repeated with the objective of removing the Stockton Bight beach route (via the quarry) from Google maps	Low (if Google maps is corrected)	Low and immaterial (if Google maps is corrected)

7.3 Management and monitoring framework

The mitigation measures summarised in Table 29 should be implemented as part of a broader management and monitoring framework for the quarry. A range of management plans will be developed or updated as part of the project operations, and those addressing safety issues will assist with the management of the negative project impacts identified in Table 29. The management plans may include the:

- environmental management strategy;
- air quality management plan; and
- safety management plan.

Aside from the various management plans, performance measures applicable to the management framework are listed in Table 30, along with the measure type defined in the DPIE assessment and mitigation framework (NSW Department of Planning and Environment, 2017). Community sentiment derived from stakeholder feedback exists as a performance measure and is additional to those listed in Table 30.

Table 30 – Performance measures

Social impact category	Objectives	Affected parties	Actions	Performance measures	Measure type
Access to and use of infrastructure, services and facilities	Counter cumulative and perceptual risk of increased heavy vehicle volumes	Road users (roads surrounding the project)	Written EIS exhibition notification to Fullerton Cove residents	Distribution of notifications to stakeholders during EIS exhibition	Prescriptive[6]
			Provision of notification via web link, to disseminate EIS information about Project heavy vehicles		
Health and wellbeing	Mitigate personal safety risks for people attempting to access the quarry without authority	Unauthorised community members	Repeat the initial request to Google with the objective of removing the Stockton Bight beach route (via the quarry) from Google maps	Google maps is correct	Prescriptive

7.4 Monitoring

A social impact monitoring framework would apply to all phases of the project life-cycle. Monitoring results would be disclosed via the submission of an annual environmental management report (the principal reporting mechanism for the project). The report would be prepared and submitted to DPIE in accordance with conditions of the new SSD approval and would include reporting on all key matters assessed in the EIS.

Table 31 outlines the social issues which will be monitored to ensure compliance and meet the social objectives. In accordance with the Guideline, the table outlines the:

- key social issues to be monitored;
- how and when monitoring data will be collected; and
- community participation.

Although not included in Table 31, the project complaints register is an additional data source that applies to each social issue and provides value to the monitoring framework. The register will continue to operate and provide data in relation to each social issue should a complaint be submitted.

[6] Actions that need to be taken or things that must not be done, for example, adopt a known best-practice technology, design or management approach to mitigate the impact.

Table 31 – Monitoring framework

Social impact category	Social issue	Data source	Data availability / frequency
Access to and use of infrastructure, services and facilities	Road user satisfaction	Council feedback	As available
		Feedback received via Boral corporate communications channels or quarry staff	
Health and wellbeing	Community safety	Quarry staff and CCTV	Constantly during business hours (weighbridge staff) and after hours (CCTV)

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APPENDIX A

Social impact categories from section 1.1. of the Guideline (NSW Department of Planning, Industry and Environment, 2017)

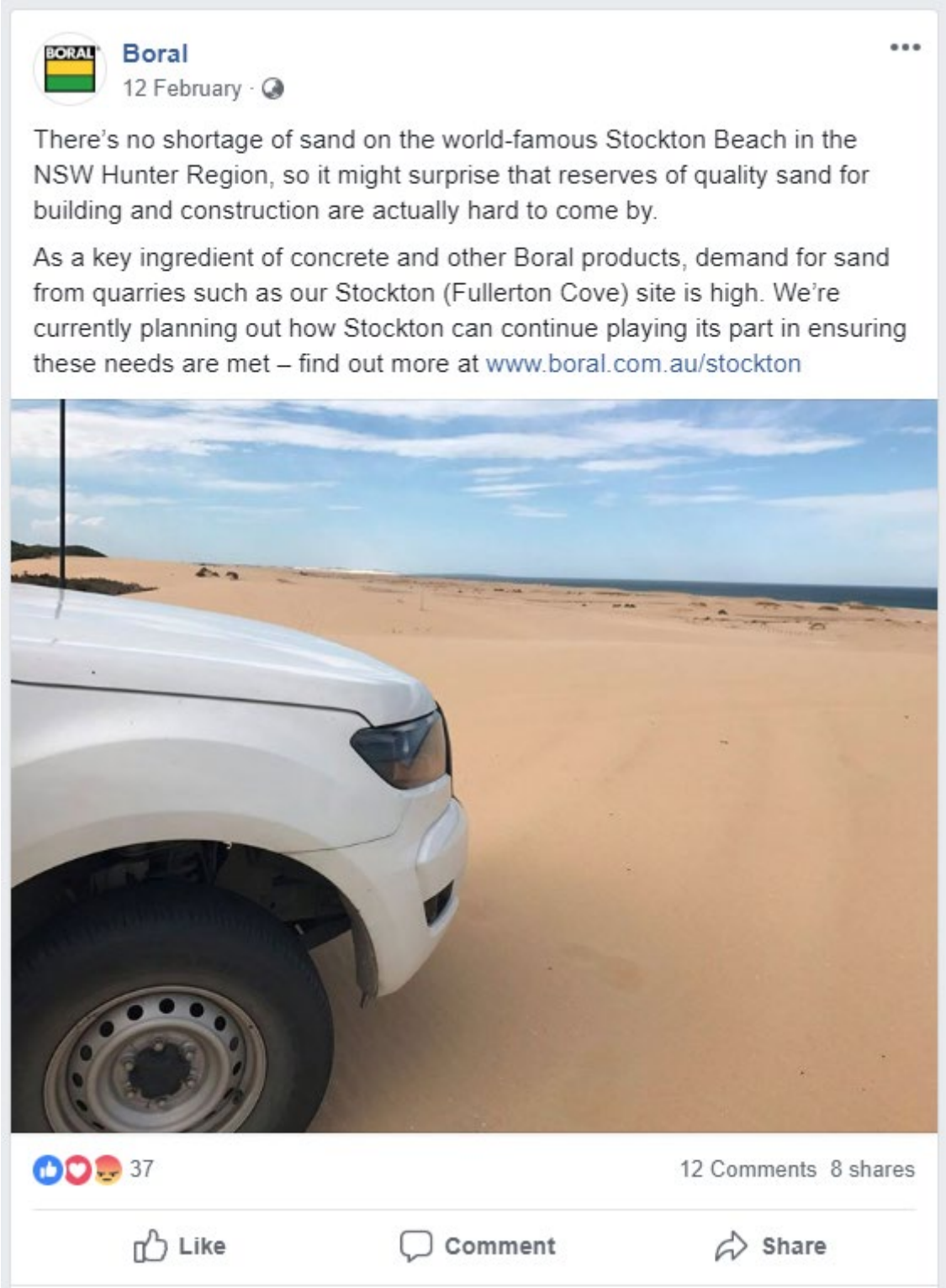
1.1 What are social impacts?

In the context of this guideline, a social impact is a consequence experienced by people[5] due to changes associated with a State significant resource project. As a guide[6], social impacts can involve changes to people's:

- **way of life**, including:
  - how people live, for example, how they get around, access to adequate housing
  - how people work, for example, access to adequate employment, working conditions and/or practices
  - how people play, for example, access to recreation activities
  - how people interact with one another on a daily basis
- **community**, including its composition, cohesion, character, how it functions and sense of place
- **access to and use of infrastructure, services and facilities**, whether provided by local, state, or federal governments, or by for-profit or not-for-profit organisations or volunteer groups
- **culture**, including shared beliefs, customs, values and stories, and connections to land, places, and buildings (including Aboriginal culture and connection to country)
- **health and wellbeing**, including physical and mental health[7]
- **surroundings**, including access to and use of ecosystem services[8], public safety and security, access to and use of the natural and built environment, and its aesthetic value and/or amenity[9]
- **personal and property rights**, including whether their economic livelihoods are affected, and whether they experience personal disadvantage or have their civil liberties affected
- **decision-making systems**, particularly the extent to which they can have a say in decisions that affect their lives, and have access to complaint, remedy and grievance mechanisms
- **fears and aspirations** related to one or a combination of the above, or about the future of their community.

APPENDIX B

Boral Facebook post



APPENDIX C

Community drop-in session summary

Residents question/comments (address: George Street, Fullerton Cove)	Boral project team response
What would be the proposed dredge depth - 1m?	No, 15m
So you complete the dredging and just walk away?	The site is proposed to be rehabilitated post-operation. Rehabilitation process was explained.
Rocla pit was not rehabilitated	Unlike the Rocla operation, the pit would definitely be rehabilitated. project conditions mandate rehabilitation
Where are the boundaries and what is the setback?	A map with boundaries was provided. It was explained that the buffer zone is 15m from the boundary in the windblown dune area
How close can Boral go to the boundary? You must put a batter down it?	The boundary was identified on the map and staff explained that the project would operate inside current boundary
What is the slope of the batters?	20 degrees, planted with native vegetation. It was explained that this environment would counter ripples from dredge operations
How long would the work be done for?	It is a 25-year plan
When will rehabilitation take place?	It would be done concurrently with the operations
How many trucks per day will be operating?	There would be no change to the current permission which allows 150 movements per day. There would be no trucks on local roads (note - this response was accurate at the time of the discussion)
Will the operations change the water table? We are concerned about the water (which we use for irrigation)	Current assessments don't show an impact to the water table
Is the project in the red (PFAS) zone?	No, the site is outside the published PFAS red zone
Will we be notified about the application and determination?	Yes, via letter box drop

APPENDIX D

Summary of consultation with residents via doorknock (August 2019)

Topics discussed	Conversation detail
Coxs Lane	
N/A - resident not at home	
Planning application	Resident asked about the duration of the planning approval being sought. project team advised that the approval would enable the operations to continue for another 25 years post the current consent.
Rehabilitation	Resident asked if there will there be an artificial lake post the dredge operations? project team advised that the site would be rehabilitated (note - this response was accurate at the time of the discussion).
Positive feedback	Resident stated that Boral is a good corporate neighbour.
N/A - resident not at home	
Local employment	Continued operations at the quarry will be positive for local employment. Resident has no issues or concerns about the quarry.
Heavy vehicle on Coxs Lane	Resident observed heavy vehicles using Coxs Lane last week. Up to four heavy vehicles were observed on one day. project team confirmed that the vehicles were working for the CQP quarry (21 Coxs Lane), and Boral had spoken to the quarry manager who in turn counselled the drivers responsible.
PFAS	The resident was curious about results from the PFAS monitoring program associated with the bore on the property adjacent to hers. The project team confirmed that Boral has been monitoring PFAS levels via the bore, and no PFAS had been detected from the samples.
Heavy vehicle on Coxs Lane	Resident observed heavy vehicles using Coxs Lane last week. project team confirmed that the vehicles were working for the CQP quarry (21 Coxs Lane), and Boral had spoken to the quarry manager who in turn counselled the drivers responsible.
Supply of product	Resident enquired about the purchase of sand for use on her property. project team explained product available and purchase process.
George Street	
N/A	Resident stated he had no problem with the quarry operations.
Positive feedback	Resident stated she had no problem with the quarry operations and suggested that the quarry was performing a positive role by preventing the westward movement of windblown sand, and therefore protecting private property.
N/A	Resident stated he had no problem with the quarry operations.
N/A - resident not at home	
N/A - resident not at home	
N/A - resident not at home	
Fullerton Cove Road	
N/A - resident not at home	
Local employment	Continued operations at the quarry will be positive for local employment. Resident has no issues or concerns about the quarry.
N/A	Local business requested an email with current quarry newsletter. project team actioned the request.
N/A	Resident was rushing to an appointment and was too busy to discuss the project.

APPENDIX E

Social risk matrix

			Consequence Level				
			1	2	3	4	5
			Minimal	Minor	Moderate	Major	Catastrophic
Likelihood Level	A	Almost certain	A1	A2	A3	A4	A5
	B	Likely	B1	B2	B3	B4	B5
	C	Possible	C1	C2	C3	C4	C5
	D	Unlikely	D1	D2	D3	D4	D5
	E	Rare	E1	E2	E3	E4	E5
Social Risk Rating							
	Low		Moderate		High		Extreme

SYDNEY NEWCASTLE CENTRAL COAST TOWNSVILLE
elementenvironment.com.au

element.



elementenvironment.com.au



APPENDIX J

ACID SULFATE SOILS ASSESSMENT

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

REPORT NO. **717041_ASS**

ACID SULFATE SOIL IMPACT ASSESSMENT, STOCKTON SAND QUARRY, COXS LANE, FULLERTON COVE, NSW

ENVIRONMENTAL EARTH SCIENCES NSW
REPORT TO ELEMENT ENVIRONMENTAL
8 AUGUST 2019
VERSION 2

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EXECUTIVE SUMMARY

Boral Resources (NSW) Pty Ltd owns and operates the Stockton Sand Quarry (the site), a long-standing operation that extracts and transports up to 500,000 tonnes of sand product per year for use in the building, landscaping and construction markets.

Due to current and future demand for sand in the local Hunter and Sydney regions, Boral is seeking approval for continued operations at the site through a State Significant Development (SSD) application. Boral propose to extract sand from a former sandpit by excavator and dredging (the project). It is understood that approval will be sought for the extraction of a combined maximum of 750,000 tonnes per annum from the two operations for commercial sale until 2028, when the volume will be reduced to 500,000 tonnes per annum.

This project requires an Acid Sulfate Soil (ASS) Impact Assessment to support the Environmental Impact Statement (EIS).

The objective is to identify if actual or potential Acid Sulfate Soils (AASS / PASS) are present within the proposed dredging area and assess the potential impacts of ASS or PASS on sensitive receptors. This includes an assessment of the potential impacts on:

- acid generation from lowering the water table;
- groundwater-dependant ecosystems; and
- extracted sand for commercial sale.

The following scope of works was undertaken to meet the objectives:

- desktop study, including the area's hydrology, geology and ASS risk;
- installation of four representative bores to 16 m below the water table at each location;
- field study including detailed borelogs and field pH and peroxide testing;
- laboratory analysis of selected samples for ASS; and,
- provision of an acid sulfate soil assessment across the area of disturbance.

The likelihood of ASS within the site is considered low due to:

- desktop study of the site reports a low probability for ASS;
- twenty three of the 25 samples analysed reported a risk level of "no risk – no sulfur" and as such are considered Not Acid Sulfate Soils (NASS) and one sample is considered "no risk – non reactive";
- high alkalinity and a high buffering capacity was reported throughout the borehole investigations within the site;
- excavation activities within the site are considered unlikely to change the groundwater level due to high recharge rates and draining water back into the dredge pond; and,
- proposed dredging activities include the sieving of material, so that fines (materials finer than sand) and/or oversize material (outside the appropriate grading envelope) are separated on site and immediately returned below the water table. This reduces potential for acid generation and safeguards the final sand product for commercial sale.

One location reported a moderate risk for potential ASS. This was a localised occurrence.

Regular monitoring as part of an ASS Management Plan is recommended for a proactive monitoring regime so that early indications of localised acid generation could trigger appropriate management. Further testing at the time of extraction is recommended to confirm the assessment.

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C GEOLOGICAL BORELOGS

D LABORATORY TRANSCRIPTS & CHAIN OF CUSTODY FORMS

E QUALITY ASSURANCE AND CONTROL PROCEDURES

1 INTRODUCTION

Boral Resources (NSW) Pty Ltd owns and operates the Stockton Sand Quarry (the site), a long-standing operation that extracts and transports up to 500,000 tonnes of sand product per year for use in the building, landscaping and construction markets.

Due to current and future demand for sand in the Hunter and Sydney, Boral is seeking approval for continued operations at the site through a State Significant Development (SSD) application. Boral propose to extract sand from a former sandpit by excavator and dredging (the project). It is understood that approval will be sought for the extraction of a combined maximum of 750,000 tonnes per annum from the two operations for commercial sale until 2028, when the volume will be reduced to 500,000 tonnes per annum.

This proposal requires an Acid Sulfate Soil (ASS) Impact Assessment to support the Environmental Impact Statement (EIS).

2 OBJECTIVES

To identify if actual or potential ASS (AASS/ PASS) are present within the proposed dredging area, hereto called the 'Inland extraction area (IEA)', an assessment of the potential impacts of AASS or PASS on sensitive receptors is required. This includes an assessment of the potential impacts on:

- acid generation from lowering the water table;
- groundwater-dependant ecosystems;
- extracted sand for commercial sale; and,
- provision of management options for addressing any AASS / PASS.

3 SCOPE OF WORKS

The following scope of works was undertaken to meet the objectives:

- desktop study, including the area's hydrology, geology and ASS risk;
- installation of four representative bores to 16 m below the water table at each location;
- field study including detailed borelogs and field pH and peroxide testing;
- laboratory analysis of selected samples for ASS; and
- provision of an acid sulfate soil assessment across the area of disturbance.

4 SITE IDENTIFICATION AND SETTING

4.1 Location and details

The site is located approximately 10 km north of Newcastle and is currently approved for windblown sand extraction from the Stockton dune fields along their south and eastern site boundary. Table 1 below presents key identification features of the site.

TABLE 1 SITE IDENTIFICATION

Item	Details
Site Owner	Boral
Address	Coxs Lane, Fullerton Cove, NSW 2318
Lot & Plan number	Part Lot 1 DP1006399 Lot 2 DP1006399 Part Lot 3 DP664552 Lot 7300 DP1130730 (Crown Land) NOTE: This application proposes no works on Crown Land
Area	Approx. 246 hectares
Size of IEA	Approx. 37 hectares
Zoning	RU2 – Rural Landscape
Proposed land use	Extractive Industry (sand)
Local Government Authority	Port Stephens Council
Site Location and Layout	Figure 1 and Figure 2

The site location and context is illustrated on Figure 1, while the approximate area proposed for sand extraction (the IEA) is shown in Figure 2.

4.2 Regional Meteorology

Regional meteorological data has been sourced from the Bureau of Meteorology (2018) (*www.bom.gov.au*, verified 28 March 2018) Williamtown RAAF weather station, approximately 5 km from site, and is summarised in Table 2.

Stockton's climate can be described as warm temperate with mild winters and warm summers. The temperature ranges from a mean daily maximum temperature of 17.1 ^{o}C in the coldest month of July, to warm summers with mean daily maximum temperatures of 28.2 ^{o}C in January. Minimum winter daily temperatures range from 6.4 – 8 ^{o}C and the area is rarely subjected to frosts and temperatures below 0 ^{o}C.

Mean annual rainfall recorded at Stockton is 1,124.9 mm and the rainfall pattern has a late summer to autumn dominant trend. Monthly total evaporation rates are less than the average monthly rainfall (Table 2), suggesting strong groundwater recharge rates.

TABLE 2 MONTHLY CLIMATE STATISTICS

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Mean maximum Temperature (ºC)	28.2	27.7	26.3	23.7	20.4	17.7	17.1	18.7	21.5	23.8	25.6	27.3
Mean minimum Temperature (ºC)	18.1	18.1	16.4	13.2	10.1	8.0	6.4	6.9	9.1	12.0	14.4	16.6
Mean rainfall (mm)	99.9	118	120	112	111	123	71.9	73.6	59.7	73.0	82.4	79.0
Mean evaporation (mm)	6.9	6.2	5.0	3.8	2.7	2.5	2.6	3.6	4.7	5.6	6.3	7.2

4.3 Landform and topography

The site is part of the Stockton Sand Dunes; aeolian sand deposits, that span 32 km from Stockton to Anna Bay. The dunes are mobile and as such, topography can alter depending on winds and weather.

The site has historically been used for sand extraction purposes, particularly of the foredunes (Figure 1). The IEA has been subjected to a revegetation initiative, providing a degree of stability to the underlying sands. Elevation within the IEA is generally between 3 – 11 m AHD.

4.4 Soil and geology

The local geology has been described in the Newcastle 1:250 000 Geological series sheet S1 56-2 (1966) as Quaternary gravel, sand, silt, “Waterloo Rock,” with marine and freshwater deposits.

Soil landscape information was sourced from eSPADE v2.0 published by the NSW Office of Environment & Heritage (2018) (espade.environment.nsw.gov.au/, verified 28 March 2018). Two soil landscape groups were identified within the IEA; predominantly Boyces Track with Hawks Nest along the southern Project Area boundary.

Boyces Track are Holocene transgressive aeolian dunes with deep (>300 cm), well-draining and weakly developed podzol soils. Typically, these soils are acid to neutral. Hawks Nest soil landscape are stable low Holocene sand sheets on low transgressive dunes with deep well-draining soils. Typically, they exhibit high water tables and a potential for ASS in low lying swampy swales. These soils may be strongly acid. Refer to Appendix A for Soil Landscape Reports.

4.5 Acid Sulfate Soils

The IEA was reviewed in the Port Stephens 1:50 000 Acid Sulfate Soils Map (1996) produced by NSW Department of Land and Water Conservation. The IEA is considered low probability for ASS in general. The southern boundary of the IEA is considered low probability between 1 - 3 metres below ground surface (m BGS) whilst the remainder and majority of the IEA is considered low probability for ASS >3 m BGS.

Review of the Port Stephens Local Environmental Plan (LEP) 2013 identifies Class 3 and Class 4 ASS in the IEA. While this would usually trigger the requirement for a Development

Consent[1], it is noted that that the area of proposed extraction is already below the natural ground surface (given it is a former sandpit), therefore these clauses may not apply. Furthermore, it is noted as per Clause 7.1 subclause 4(a) and 4(b) of the LEP, the requisite Development Consent can be avoided if:

- a preliminary assessment for the proposed works is prepared in accordance with the ASS Manual indicating no ASS management plan is required; and,
- the preliminary assessment is provided to and approved by the consent authority.

A summary of information regarding the low probability for ASS in the IEA is provided in Table 3 below.

TABLE 3 SUMMARY OF ASS IN IEA

Low Probability for ASS[1]		
ASS MAP Class Description[1]	The environment of deposition has generally not been suitable for the formation of ASS. ASS, if present, is sporadic and may be buried by windblown sediments.	
Environmental Risk[1]	Majority of these landforms are not expected to contain ASS. Land management is generally not affected by ASS. Highly localised occurrences may be found, especially near boundaries with environments with a high probability for ASS. Environmental risk will vary with elevation and depth of disturbance.	
Typical Landform Types[1]	Wa2 - Aeolian sandplain approx 2-4m AHD	Wd4 - Aeolian dunes approx >4m AHD
Depth to sulfidic soil[1]	Between 1 – 3 m BGS	>3 m BGS
Port Stephens LEP (2013) class of land[2]	**Class 3** Development consent required for: Works >1 m BGS. Works by which the water table is likely to be lowered >1 m BGS.	**Class 4** Development consent required for: Works >2 m BGS. Works by which the water table is likely to be lowered >2 m BGS.
Soil Landscape[3]	Hawks Nest	Boyces Track

Notes:

1. Sourced from the Port Stephens 1:50 000 Acid Sulfate Soils Map (1996) produced by NSW Department of Land and Water Conservation.
2. Sourced from Port Stephens Local Environmental Plan 2013; Part 7 Clause 7.1 – Acid Sulfate Soils.
3. Sourced from eSPADE v2.0 published by the NSW Office of Environment & Heritage (2018) (espade.environment.nsw.gov.au/, verified 28 March 2018).

4.6 Hydrogeology and Groundwater Usage

The site is underlain by the Tomago Sandbeds, a shallow, unconfined, rainfed aquifer that runs parallel to the coast. The Tomago Sandbeds contribute to the lower Hunter drinking water supply.

[1] Required for works in Class 3/Class 4 areas proposed at depths of greater than 1 m BGS and 2 m BGS beyond natural ground surface, respectively.

The Report Card for the Stockton Groundwater Source, prepared by the NSW Government's Department of Primary Industries (2016), was reviewed with the following key findings:

- the Stockton Groundwater Source extends from the Hunter River in the south to Murrumburrimbah Swamp in the north. This includes the drainage complexes of Bobs Farm Creek and Fennigans Island Creek;
- the Stockton Groundwater Source spans 32 km in length, 2 – 3 km width, 78m^2 area and has a thickness of 10 – 40 m;
- the rainfall recharge rate is estimated at 20,000 megalitres per year. Rainfall recharges the aquifer via percolation.

The IEA lies within 1.5 km of the Pacific Ocean to the east, and 2.5 km of Fullerton Cove and the Hunter Wetlands National Park to the north and west respectively. The site is surrounded by the Worimi Conservation Area that encompasses a large section of the Stockton dune fields. A groundwater bore network has been established across the perimeter of the site. Several monitoring wells (GW1, MW_x3, MW_x4) are within the IEA or in close proximity (refer to Figure 2 for groundwater bore network).

4.7 Primary industry resources

The IEA is approximately ≥900 m away from any agricultural production, which ensures a buffer distance. The current dominant land uses adjacent to the IEA are sand mining activities and the Worimi State Conservation Area that encompasses the Stockton Sand Dunes adjacent to the site.

As such, there is no current evidence of crop production (irrigated or unirrigated) or intensive horticulture within the immediate surrounds (900 m radius) of the IEA.

5 ACID SULFATE SOIL ASSESSMENT METHODOLOGY

Section 5 outlines the activities undertaken to classify and analyse the main soil types located within the IEA.

5.1 Background information

Before conducting the field assessment, an initial understanding of the different types of soil and landscapes across the IEA was developed. These desktop investigations included:

- review of available topographic, geological, soil and acid sulfate soil maps;
- review of aerial photography for the purpose of delineating landscape features and geomorphic processes within the IEA; and,
- review of climatic data.

This information provided a preliminary understanding of the potential distribution of ASS across the IEA which informed the limited field activities and reporting components of the scope of works. Intrusive field work was then used to validate this information and assess ASS within the IEA and the potential impacts.

5.2 Rationale for sampling locations

The intrusive investigation was advanced within the limitation of heavy vegetation. It was a high priority to retain due to considerable dune revegetation efforts for the stability of the back dunes and the ecosystems they support. Soil sampling locations were selected with the following considerations to:

- obtain representative coverage of the IEA;
- target the lower-lying swales where possible;
- advance boreholes to 16 m below the water table at each location, to assess the full extent (if not more) of the proposed dredging profile.

A summary of soil borehole locations and rationale is provided in Table 4.

TABLE 4 SUMMARY OF LOCATIONS AND RATIONALE

Location	Sampled Media	Rationale
BH1	Soil	IEA coverage; east
BH2	Soil	IEA coverage; north
BH3	Soil	IEA coverage; west
BH4	Soil	IEA coverage; south

5.2.1 Field pH Screening

The following field assessment was undertaken to determine potential impacts of acid sulfate soil and determine sample selection for laboratory analysis:

- soil texture (proportion of sand, silt and clay);
- pH_F and temperature (1:5 soil/water);
- pH_{FOX} and temperature (30% H_2O_2); and
- level of effervescence following H_2O_2 addition.

Field pH screening equipment was calibrated before and after each borehole. For calibration records, refer to Appendix B – Calibration Certificates.

5.2.2 Soil sampling

Investigation works were carried out by Environmental Earth Sciences using a Sonic drill rig. The field team drilled four boreholes within proposed sand extraction area, to depths between 18 - 24 m BGS. A minimum of one soil sample and field pH and peroxide test was undertaken at every change in lithology. Soil samples were collected in a zip-lock bag and placed on ice immediately. Soil sampling locations are shown in Figure 3.

5.2.3 Stratigraphy

The profiles of all bores (BH1 – BH4) consisted entirely of sand. In general, sands encountered were light brown, faun, grey and cream in colour. Typically, they were medium grained and occasionally shell grit was noted.

An organic layer was observed at one location (BH2_2.0) that consisted of dark brown sand and organics from approximately 2.0 – 2.5 m BGS. Groundwater was typically encountered

between 1.5 – 3.5 m BGS except in BH3, where groundwater was encountered approximately between 5.5 – 6.0 m BGS. Refer to Appendix C for the complete borelogs.

5.3 Laboratory soil assessment

A total of 44 samples were collected, of which those whose water to peroxide difference in field pH tests were ≥2 were selected for laboratory analysis. Selected samples (n. 25) were then submitted to a NATA accredited laboratory for the following analytes:

- Chromium Reducible Sulfur (CRS) suite (EA033-A, -B, -C and -E), to determine the on-site potential for the presence of potential, actual or partially oxidised acid sulfate soils including:
    - total actual acidity (TAA) (including pH_{KCl});
    - potential acidity (S_{CR}) using the Chromium Reducible Sulfur (CRS) method;
    - retained acidity as Net Acid Soluble Sulfur (S_{NAS}) when pH_{KCl} ≤4.5;
    - Acid Neutralising Capacity (ANC) –when pH_{KCl} ≥6.5; and
    - Acid Base Accounting (ABA) based on the above results.
- three samples were selected for further testing for Acid Neutralising Capacity (ANC) (EA033-C).

Laboratory transcripts are presented in Appendix D.

Samples were analysed by ALS Environmental (ALS), accredited with the National Association of Testing Authorities (NATA) for the methods used. Intra laboratory duplicates were analysed as part of our standard QA/QC procedures.

5.4 Analytical schedule

The final analytical schedule was chosen in consideration of field observations and the results of the field test for soils. The final analytical schedule is summarised in Table 5. Laboratory transcripts are provided in Appendix D.

TABLE 5 ANALYTICAL SCHEDULE

Soil	No. of samples	No. of intra-lab duplicates	Total
CRS (EA033-A, EA033-B and EA033-E)	25	4	29
ANC (EA033-C)	3	0	3

6 ASSESSMENT CRITERIA

The term acid sulfate soils (ASS) includes both actual and potential acid sulfate soils (AASS and PASS). Actual ASS is defined as soil “containing highly acidic soil horizons” producing “hydrogen ions in excess of the sediments capacity to neutralise the acidity, resulting in soil pH of 4 or less when measured in dry season conditions”. PASS is defined as soil “that contains sulfidic material that has not been oxidised and poses a considerable environmental risk, as they will become extremely acid when exposed to air and oxidised.”

Hazard classes are a means to define material based on impact to the environment and are based on soil sulfide (S) and net acidity (NA) values. Net acidity refers to acid-base accounting (ABA), as it includes assessment of the natural buffering capacity of soil, usually present as carbonates measured as acid neutralising capacity (ANC) in the laboratory. Risk classes normally used to determine the degree of management and remediation required (if any) are no risk - no sulfur, no risk - non-reactive, moderate risk and high risk. An explanation of these classes is presented below and summarised in Table 6.

6.1 No risk-no sulfur and no risk – non-reactive

The no risk – no sulfur classification is based solely on the presence of sulfides measured by the CRS, S_{POS} or TOS methods (Ahern, *et al*. 2004). Soils classified as 'no sulfur' are not acid sulfate soils (NASS), while 'non-reactive' soils are completely self-buffering and do not require management through neutralization if oxidized (although they do require monitoring).

No risk - non-reactive is based on NA and is defined as having S values greater than the no risk – no sulfur threshold but NA values below 3 times that of the no risk – no sulfur values. Thus: for sand, NA <3 kg H_2SO_4/ tonne of soil; for sandy silts and silts, NA <6 kg H_2SO_4/ tonne of soil; and for sandy clays, silty clays and clays, NA <9 kg H_2SO_4/tonne of soil (Table 6).

Note that these levels are based on consideration of buffering agents in the soil, as per the equation:

- NA (kg H_2SO_4/tonne) = sulfur (S) + acidity (TAA) + retained acidity (S_{RAS} at pH_{KCl}<4.5) – buffering (ANC/Ca+Mg)

These levels are also based on Environmental Earth Sciences experience with ASS and require consideration and trialling on a site-specific basis to define the exact value, as soil texture variation can cause deviation by up to 30% from the anticipated value.

6.2 Moderate risk and high-risk ASS

Moderate risk and high-risk sediment and soil could potentially cause a significant adverse risk to the environment. Essentially, moderate risk will generate a small amount of acid slowly while high risk will either generate acid quickly, in large volumes or both. Values for moderate or high-risk sediments have to be derived by either field trials or accelerated weathering experiments, but broad class groups are presented in Table 6. These are the only two classes that are considered ASS from a management point of view.

Table 6 presents soil sulfide hazard classes which rank the net acidity of a soil against its texture. This reflects the buffering capacity of the soil, which is generally lower in coarser (sandier) soils (i.e. sands have limited ability to offset acid generation).

TABLE 6 SOIL SULFIDE HAZARD CLASSES

Risk Class	**No Risk**				**Risk**			
Hazard Class	'No-sulfur'		'Non-reactive'		'Moderate Risk'		'High Risk'	
Texture Group	Sulfur	NA	Sulfur	NA	Sulfur	NA	Sulfur	NA
1	1	N/A	>1 (<10)[4]	<3	>1	>3	>10	>5
2	2	N/A	>2 (<20)[4]	<6	>2	>6	>20	>10

Risk Class	No Risk				Risk			
Hazard Class	'No-sulfur'		'Non-reactive'		'Moderate Risk'		'High Risk'	
Texture Group	Sulfur	NA	Sulfur	NA	Sulfur	NA	Sulfur	NA
3	3	N/A	>3 (<30)[4]	<9	>3	>9	>30	>15

Note(s): 1. all units in kg H_2SO_4 generated per tonne of soil
2. NA net acidity (sulfur + acid – buffering capacity)
3. Texture groups are: 1. Coarse: sand; 2. Medium: loams/silt-light clay; 3. Fine: medium to heavy clay, silty clay
4. [4] sulfur levels exceeding the values in brackets require confirmation through incubation tests or weathering trials
5. shaded values indicate relevant texture group and associated criteria for the IEA

6.3 Procedures for quality control and quality assurance

Quality control is achieved by using NATA registered laboratories using American Society for Testing and Materials (ASTM) standard methods supported by internal duplicates, the checking of high, abnormal or otherwise anomalous results against background and other chemical results for the sample concerned.

Quality assurance is achieved by confirming that field results, or anticipated results based upon comparison with field observations, are consistent with laboratory results. Also, that sampling methods are uniform, and decontamination is thorough. In addition, the laboratory undertakes additional duplicate analysis as part of their internal quality assurance program on the basis of one duplicate analysis for every 20 samples analysed.

Field observations are compared with laboratory results when they are not as expected. Confirmation, re-sampling and re-analysis of a sample are undertaken if the results are not consistent with field observations and/or measurements. In addition, field duplicate sample results have to be within the acceptable range of reproducibility. A discussion of the quality of internal laboratory results and field duplicate relative percentage difference (RPD) calculations are presented in Appendix E.

7 ACID SULFATE SOILS ASSESSMENT RESULTS

7.1 Field pH_F and pH_{FOX} screening

Of the 44 samples field tested, all displayed mild effervescence to peroxide testing with the exception of BH2_2.0 (extreme) where organics were observed and BH3_2.75 (strong) where finer particles were observed in loamy sand.

The pH_F was neutral to mildly acidic across all lithologies, with the most acid reported at pH 5.0 (BH2_2.0) and the most alkaline at pH 8.8 (BH4_20.5). The pH_{FOX} was mildly acid to acid across all lithologies, with the most acid reported at pH 1.3 (BH2_2.0) and the most alkaline at pH 6.6 (BH2_0.5). Refer to Tables 7, 8, 9 and 10 below and overleaf for field screening results.

TABLE 7 FIELD pH SCREENING RESULTS FOR BH1

BH1 Sample (mBGS)	Soil characteristics	pH_F (pH in water)	Water temp (°C)	pH_{FOX} (pH in H_2O_2)	pH_{FOX} temp (°C)	Difference pH_F - pH_{FOX}	Effervescence (none/ mild/ strong/extreme)
0.3	grey / brown SAND w chitter	6.9	31.3	5.7	37.0	1.2	mild
1.0	faun SAND	7.2	28.9	6.1	30.2	1.1	none
1.5	dark brown SAND	6.8	29.1	3.7	31.2	3.1	mild
2.0	faun SAND	6.5	28.9	4.9	29.0	1.6	mild
3.0	brown SAND w chitter	6.5	28.5	3.6	30.2	2.9	mild
4.0	faun / brown SAND	6.2	28.9	3.7	29.6	2.5	mild
7.0	light brown SAND	5.4	35.8	3.2	36.6	2.2	mild
10.5	light grey SAND w shell grit	6.3	33.1	6.1	34.0	0.2	mild
12.0	light brown SAND w shell grit	7.8	30.9	6.1	34.9	1.7	mild
15.0	light grey SAND w shell grit	8.3	30.5	6.1	31.4	2.2	mild

TABLE 8 FIELD pH SCREENING RESULTS FOR BH2

BH2 Sample (mBGS)	Soil characteristics	pH_F (pH in water)	Water temp (°C)	pH_{FOX} (pH in H_2O_2)	pH_{FOX} temp (°C)	Difference pH_F - pH_{FOX}	Effervescence (none/mild/ strong/extreme)
0.25	light brown SAND	6.8	24.5	6.0	26.5	0.8	mild
0.5	cream / light brown SAND w chitter	8.7	24.2	6.6	28.4	2.1	mild
2.0	dark brown / black SAND w organics	5.0	24.0	1.3	93.1	3.7	extreme
2.5	light brown / grey SAND	6.5	24.0	2.8	28.5	3.7	mild
3.0	cream / light brown SAND	6.4	23.9	5.2	25.5	1.2	mild
6.0	cream / light brown SAND w minor organics	6.2	23.9	5.6	25.5	0.6	mild
9.0	light brown SAND	6.4	24.4	3.1	27.4	3.3	mild
12.0	cream SAND	6.9	26.4	5.8	29.1	1.1	none
16.0	light grey SAND	6.5	26.7	5.5	30.6	1.0	mild

BH2 Sample (mBGS)	Soil characteristics	pH_F (pH in water)	Water temp (°C)	pH_{FOX} (pH in H_2O_2)	pH_{FOX} temp (°C)	Difference pH_F - pH_{FOX}	Effervescence (none/mild/ strong/extreme)
19.5	light grey SAND w dark grey mottle	6.0	27.6	6.4	31.0	0.4	mild
24.0	light grey SAND w dark grey mottle	6.6	27.0	6.1	28.6	0.5	mild

TABLE 9 FIELD pH SCREENING RESULTS FOR BH3

BH3 Sample (mBGS)	Soil characteristics	pH_F (pH in water)	Water temp (°C)	pH_{FOX} (pH in H_2O_2)	pH_{FOX} temp (°C)	Difference pH_F - pH_{FOX}	Effervescence (none/mild/ strong/extreme)
0.5	grey SAND	7.2	27.1	6.9	28.8	0.3	mild
2.75	dark brown loamy SAND w chitter	7.4	27.5	6.5	91.1	0.9	strong
3.5	cream SAND w brown mottle	7.7	27.3	5.9	30.5	1.8	mild
4.0	cream SAND	7.4	27.3	5.7	28.2	1.7	mild
6.0	cream SAND	7.0	27.0	5.8	27.2	1.2	mild
8.0	cream SAND	7.1	27.7	5.7	31.0	1.4	mild
9.0	grey / brown SAND	6.9	27.4	2.6	30.5	4.3	mild
12.0	grey SAND w shell grit	7.4	27.5	6.3	31.0	1.1	mild
15.0	grey SAND w shell grit and grey mottle	8.2	27.7	6.2	31.2	2.0	mild
16.0	grey SAND w shell grit	8.6	28.2	6.1	29.7	2.5	mild
18.0	yellow / grey SAND	6.8	29.3	5.9	29.0	0.9	mild

TABLE 10 FIELD pH SCREENING RESULTS FOR BH4

BH4 Sample (mBGS)	Soil characteristics	pH_F (pH in water)	Water temp (°C)	pH_{FOX} (pH in H_2O_2)	pH_{FOX} temp (°C)	Difference pH_F - pH_{FOX}	Effervescence (none/mild/ strong/extreme)
0.5	grey SAND w gravel and organics	7.2	27.9	5.5	28.6	1.7	mild
2.0	grey SAND w gravels and chitter	7.3	27.6	5.1	34.9	2.2	mild
3.5	coffee SAND	7.5	27.6	4.8	28.9	2.7	none
5.0	latte SAND	7.4	27.5	5.0	29.0	2.4	mild

BH4 Sample (mBGS)	Soil characteristics	pH_F (pH in water)	Water temp (°C)	pH_{FOX} (pH in H_2O_2)	pH_{FOX} temp (°C)	Difference pH_F - pH_{FOX}	Effervescence (none/mild/ strong/extreme)
6.0	light brown SAND	7.3	27.5	3.0	29.1	4.3	mild
9.0	light brown SAND	7.0	27.4	2.6	29.4	4.4	mild
12.0	light grey SAND	7.4	27.7	4.6	29.9	2.8	mild
15.0	brown SAND	7.2	29.6	3.9	31.8	3.3	mild
16.0	light grey SAND	7.2	28.8	2.6	31.0	4.6	mild
16.5	dark grey SAND	7.5	28.4	6.1	34.6	1.4	mild
17.0	light brown /grey SAND	8.7	28.0	5.6	31.7	3.1	mild
20.5	white / light grey SAND	8.8	27.7	6.1	29.2	2.7	mild

7.2 Laboratory Results

The pH_{KCl} ranged from 5.1 (BH2_2.0) to 10.2 and overall reported a high amount of alkalinity within the soil profiles of BH1, BH2, BH3 and BH4. Eleven samples were analysed for their buffering capacity (ANC) which ranged from 0.196 kg H_2SO_4 (BH4_9.0) to 80.948 kg H_2SO_4 (BH4_2.0).

All 25 samples except BH2_2.0 and BH4_9.0 reported Potential Acidity (CRS) of <1 kg H_2SO_4 per tonne of soil and NA <1 kg H_2SO_4 per tonne of soil. Sample BH4_9.0 reported NA of 1.016 kg H_2SO_4 per tonne of soil however, due to a CRS of <1 kg H_2SO_4 per tonne of soil there is not enough sulfur present to be considered PASS or AASS. Therefore, all samples except BH2_2.0 have a risk level of "no risk – no sulfur" and as such are considered Not Acid Sulfate Soils (NASS).

Sample BH2_2.0 reported CRS of 3.02 kg H_2SO_4 per tonne of soil and NA of 4.008 kg H_2SO_4 per tonne of soil which is considered as a moderate risk for PASS.

Refer to Table 11 below for a summary of the results and Appendix D for laboratory transcripts.

TABLE 11 SUMMARY OF ACIDITY RESULTS

Sample (depth m BGS)	Texture	pH_{KCl} (1:5)	pH_F (1:5)	pH_{FOX} (H_2O_2)	Potential Acidity (CRS)	Actual Acidity (TAA)	Buffering Capacity (ANC)	Net acidity (NA)	Risk Level
Criteria	-	>5	>5	>2.5	1	1	-	3	-
BH1_1.5	Sand	5.6	6.8	3.7	0.79	0.098	-	0.893	NASS
BH1_3.0	Sand	6	6.5	3.6	0.48	<0.049	-	0.538	NASS
BH1_4.0	Sand	5.5	6.2	3.7	0.73	0.098	-	0.832	NASS
BH1_7.0	Sand	6.1	5.4	3.2	0.55	<0.049	-	0.600	NASS
BH1_15.5	Sand	9.5	8.3	6.1	0.48	<0.049	11.858	-11.320	NASS

Sample (depth m BGS)	Texture	pH_{KCl} (1:5)	pH_F (1:5)	pH_{FOX} (H_2O_2)	Potential Acidity (CRS)	Actual Acidity (TAA)	Buffering Capacity (ANC)	Net acidity (NA)	Risk Level
BH2_0.5	Sand	10	8.7	6.6	0.30	<0.049	32.144	-31.790	NASS
BH2_2.0	Sand	5.1	5.0	1.3	3.02	2.058	1.078	4.008	Moderate Risk
BH2_2.5	Sand	6	6.5	2.8	0.79	<0.049	-	0.844	NASS
BH2_3.0	Sand	6.2	6.4	5.2	0.27	<0.049	-	0.324	NASS
BH2_9.0	Sand	5.8	8.7	6.6	0.61	<0.049	-	0.661	NASS
BH3_3.5	Sand	6.1	7.7	5.9	0.21	<0.049	-	0.263	NASS
BH3_4.0	Sand	6	7.4	5.7	0.24	<0.049	-	0.293	NASS
BH3_9.0	Sand	5.7	6.9	2.6	0.55	<0.049	-	0.600	NASS
BH3_15.0	Sand	9.6	8.2	6.2	0.52	<0.049	47.432	-46.863	NASS
BH3_16.0	Sand	9.5	8.6	6.1	0.36	<0.049	6.37	-5.954	NASS
BH4_2.0	Sand	10.2	7.3	5.1	1.53	<0.049	80.948	-79.370	NRNR
BH4_3.5	Sand	6.6	7.5	4.8	0.21	<0.049	2.646	-2.383	NASS
BH4_5.0	Sand	6.2	7.4	5.0	0.21	<0.049	-	0.263	NASS
BH4_6.0	Sand	5.3	7.3	3.0	0.83	0.196	1.47	-0.448	NASS
BH4_9.0	Sand	5.4	7.0	2.6	0.92	0.294	0.196	1.016	NASS
BH4_12.0	Sand	6	7.4	4.6	0.88	<0.049	-	0.936	NASS
BH4_15.0	Sand	8	7.2	3.9	0.55	<0.049	1.96	-1.360	NASS
BH4_16.0	Sand	5.5	7.2	2.6	0.52	<0.049	-	0.569	NASS
BH4_17.0	Sand	5.9	8.8	6.1	0.55	<0.049	-	0.600	NASS
BH4_20.5	Sand	9.2	7.2	5.5	0.36	<0.049	6.076	-5.660	NASS

Notes:
1. NASS indicates Not Acid Sulfate Soils; NRNR indicates No Risk-Non Reactive
2. Shaded cells indicate exceeds criteria; **shaded and bold cells** indicate High Risk (requires management if disturbed)
3. – indicates no data available

8 CONCLUSIONS AND RECOMMENDATIONS

8.1 General

The objective of this report was to identify if PASS were present within the proposed IEA and if so, assess the potential impacts of PASS on sensitive receptors/uses, as such Environmental Earth Sciences undertook in-situ and laboratory characterisation assessment of soils within the proposed area of sand extraction.

Field tests were generally undertaken at 0.25 m intervals along the soil profile in each of the four boreholes, with laboratory analysis scheduled, based on the field testing results.

Ground conditions assessed in the proposed IEA typically comprised medium-grained sand that extend past the base of the dredging area, to the final depth of investigation (18 to 24 m BGS). No fine sediments such as estuarine muds, clays or silts were observed.

Groundwater was encountered between 1.5 and 3.5 m BGS in the boreholes drilled across the site to depths of between 18 and 24 m BGS, with the exception of BH03 where groundwater was encountered between 5.5 – 6.0 m BGS.

No fine sediments (e.g. clays, silts or estuarine muds) were encountered in shallow profiles at any location during the intrusive assessment. As sulphides typically reside in the finer grained sediments, this observation further reduces the risk for the potential for PASS to be present and, associated oxidisation potential.

Based on the results of the investigation, localised soils in the vicinity of BH2 between 2 and 3 m bgl were identified as a moderate risk acid sulfate soil. However, it is noted that the soil profile in BH02 immediately above and below this medium risk ASS layer can be classified as NASS and, naturally contains a significant buffering capacity (32 kg H_2SO_4 per tonne of soil) lowering the potential for acid generation in this area.

All remaining soils analysed were classified as NASS or NRNR. Given the above, it is reasonable to extrapolate that a natural buffering capacity exists across the IEA due to the presence of shell grit ($CaCO_3$) within sand deposits.

8.2 Mitigation Measures

It is understood that extracted sands will be washed and screened whereby fine-grained material (if present), sands and oversize material not meeting the grading envelope for concrete will be returned to the dredging pond, reducing the risk of any localised finer grained sediments oxidising into PASS.

We recommend all sand be sluiced (or similarly screened) to remove the fines. This would also remove the PASS risk to the final commercial sand product intended for sale. However, it should be noted that the presence of NASS and/or NRNR could still cause iron speckling in any cement render; testing will be required to confirm this. Environmental Earth Sciences assumes removal of finer particles from the sands will reduce any sulphides that may be occurring at low levels.

As the sand extraction activities will see the majority of the water drain back into the dredging pond, there is deemed to be a low risk posed from the oxidation of potentially localised instances of PASS. Furthermore, returning water to the dredging pond also prevents a lowering of the groundwater table, which will ensure in-situ PASS will remain saturated and will not oxidise.

This assessment did not encounter any other specific management considerations in the IEA. However, continual monitoring of pH is required during further works to confirm the classification and ensure that procedures for any treatment and remediation of PASS (as required) is undertaken appropriately.

8.3 Acid Sulfate Soil Management Plan (ASSMP)

Given that a moderate PASS risk was identified within the IEA in the vicinity of BH02, it is recommended, as a precautionary measure, that an Acid Sulfate Soil Management Plan (ASSMP) be prepared in support of the proposed development to properly mitigate any

health and environmental harm during the proposed material extraction/dredging within the EIA.

This plan will cover the entire IEA but will have a particular focus on the area of moderate PASS risk identified (in the vicinity of BH02). This plan will allow a proactive monitoring regime to be established so that early indications of acid generation can trigger appropriate management and/or mitigation strategies before any impact to the environment is realised. Monitoring should commence immediately prior to, during and at the conclusion of the proposed dredging and filling activities.

The ASSMP is recommended to be prepared in accordance with Ahern, C R, Stone, Y, and Blunden, B (1998) – Acid Sulfate Soils Management Guidelines, Acid Sulfate Soil Management Advisory Committee NSW (August 1998).

9 LIMITATIONS

This report has been prepared by Environmental Earth Sciences NSW ABN 109 404 006 in response to and subject to the following limitations:

1. The specific instructions received from client Element Environment;
2. The specific scope of works set out in PO717059 issued by Environmental Earth Sciences for and on behalf of Element Environment;
3. May not be relied upon by any third party not named in this report for any purpose except with the prior written consent of Environmental Earth Sciences NSW (which consent may or may not be given at the discretion of Environmental Earth Sciences NSW);
4. This report comprises the formal report, documentation sections, tables, figures and appendices as referred to in the index to this report and must not be released to any third party or copied in part without all the material included in this report for any reason;
5. The report only relates to the site referred to in the scope of works being located at Stockton Boral Quarry, Fullerton Cove, NSW (“the site”);
6. The report relates to the site as at the date of the report as conditions may change thereafter due to natural processes and/or site activities;
7. No warranty or guarantee is made in regard to any other use than as specified in the scope of works and only applies to the depth tested and reported in this report;
8. Fill, soil, groundwater and rock to the depth tested on the site may be fit for the use specified in this report. Unless it is expressly stated in this report, the fill, soil and/or rock may not be suitable for classification as clean fill if deposited off site; and
9. Our General Limitations set out at the back of the body of this report.

10 REFERENCES

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11 GLOSSARY OF TERMS

The following descriptions are of terms used in the text of this report.

Acid Sulfate Soil (ASS). A soil containing iron sulfides deposited during either the Pleistocene or Holocene geological epochs (Quaternary aged) as sea levels rose and fell.

Alluvial. Describes material deposited by, or in transit in, flowing water.

Anaerobic. Reducing or without oxygen.

Aquifer. A rock or sediment in a formation, group of formations, or part of a formation which is saturated and sufficiently permeable to transmit economic quantities of water to wells and springs.

Aquifer, confined. An aquifer that is overlain by a confining bed with significantly lower hydraulic conductivity than the aquifer.

Aquifer, perched. A region in the unsaturated zone where the soil is locally saturated because it overlies soil or rock of low permeability.

Background. The natural level of a property.

Bore. A hydraulic structure that facilitates the monitoring of groundwater level, collection of groundwater samples, or the extraction (or injection) of groundwater. Also known as a well, monitoring well or piezometer, although piezometers are typically of small diameter and only used for measuring the groundwater elevation or potentiometric surface.

Borehole. An uncased well drill hole.

Cation Exchange Capacity (CEC). The maximum positive charge required to balance the negative charge on colloids (clays and other charged particles). The units are milli-equivalents per 100 grams of material or centimoles of charge per kilogram of exchanger.

Clay. A soil material composed of particles finer than 0.002 mm. When used as a soil texture group such soils contain at least 35% clay.

Confined Aquifer. An aquifer that is confined between two low-permeability aquitards. The groundwater in these aquifers is usually under hydraulic pressure, i.e. its hydraulic head is above the top of the aquifer.

Confining layer. A layer with low vertical hydraulic conductivity that is stratigraphically adjacent to one or more aquifers. A confining layer is an aquitard. It may lie above or below the aquifer.

Dilution. The mixing of a small volume of contaminated leachate with a large volume of uncontaminated water. The concentration of contaminants is reduced by the volume of the lower concentrated water. However, the physical process of dilution often causes chemical disequilibria resulting in the destruction of ligand bonds, the alteration of solubility products and the alteration of water pH. This usually causes precipitation by different chemical means of various species.

Electrical Conductivity (EC). The EC of water is a measure of its ability to conduct an electric current. This property is related to the ionic content of the sample, which is in turn a function of the total dissolved (ionisable) solids (TDS) concentration. An estimate of TDS in fresh water can be obtained by multiplying EC by 0.65.

Fluvial. A material deposited by, or in transit, in streams or watercourses.

Groundwater. The water held in the pores in the ground below the water table.

Groundwater Elevation. The elevation of the groundwater surface measured relative to a specified datum such as the Australian Height Datum (mAHD) or an arbitrary survey datum onsite, or “reduced level” (mRL).

Heavy Metals. All metallic elements whose atomic mass exceeds that of calcium (20) and includes lead (Pb), copper (Cu), Zinc (Zn), cadmium (Cd), and tin (Sn).

Heterogeneous. A condition of having different characteristics in proximate locations. Non-uniform. (Opposite of **homogeneous**).

Horizon. An individual soil layer, based on texture and colour, which differs from those above and below.

Ionic Exchange. Adsorption occurs when a particle with a charge imbalance, neutralises this charge by the attraction (and subsequent adherence of) ions of opposite charge from solution. There are two types of such a charge: pH dependent; and pH independent or crystalline charge. Metal hydroxides and oxy-hydroxides represent examples of the former

type, whilst clay minerals are representative of the latter and are normally associated with cation exchange.

Ions. An ion is a charged element or compound as a result of an excess or deficit of electrons. Positively charged ions are called cations, whilst negatively charged ions are called anions. Cations are written with superscript +, whilst anions use - as the superscript. The major aqueous ions are those that dominate total dissolved solids (TDS). These ions include Cl^-, SO_4^{2-}, HCO_3^-, Na^+, Ca^{2+}, Mg^{2+}, K^+, NH_4^+, NO_3^-, NO_2^-, F^-, PO_4^{3-} and the heavy metals.

Mottled. Masses, blobs or blotches of sub-dominant, varying colours in the soil matrix.

Nodulation. Are hard, usually small, accumulation of precipitated iron and/or manganese in the soil profile, usually a result of past alternating periods of oxidation/reduction.

Oxidation. Was originally referred only to the addition of oxygen to elements. However, oxidation now encompasses the broader concept of the loss of electrons by electron transfer to other ions.

Perched Groundwater. Unconfined groundwater separated from an underlying main body of groundwater by an unsaturated zone. Perched groundwater typically occurs in discontinuous, often ephemeral, lenses, with unsaturated conditions both above and below.

pH. A logarithmic index for the concentration of hydrogen ions in an aqueous solution, which is used as a measure of acidity.

Potential Acid Sulfate Soil (PASS). A soil that has the potential to become acidic if it is exposed to the atmosphere.

Precipitation (chemical). There are two types of precipitation, pH dependent precipitation and solubility-controlled precipitation. As the pH is raised beyond a threshold level the precipitation of metal cations such as oxy-hydroxides and hydroxides occur. As the pH is raised further precipitation continues until there are very few metal cations remaining in solution. This reaction is entirely reversible. Solubility controlled precipitation occurs between two ions when, at a given temperature and pressure, the concentration of one of the ions exceeds a certain level.

Reducing Conditions. Can be simply expressed as the absence of oxygen, though chemically the meaning is more complex. For more details refer to OXIDATION.

Remediation. The restoration of land or groundwater contaminated by pollutants, to a state suitable for other, beneficial uses.

Saturated Zone. A zone in which the rock or soil pores are filled (saturated) with water.

Standing Water Level (SWL). The depth to the groundwater surface in a well or bore measured below a specific reference point – usually recorded as metres below the top of the well casing or below the ground surface.

Stratigraphy. A vertical sequence of geological units.

Texture. The size of particles in the soil. Texture is divided into six groups, depending on the amount of coarse sand, fine sand, silt and clay in the soil.

Topsoil. Part of the soil profile, typically the A1 horizon, containing material which is usually darker, more fertile and better structured than the underlying layers.

Unsaturated Zone. The zone between the land surface and the water table, in which the rock or soil pores contain both air and water (water in the unsaturated zone is present at less than atmospheric pressure). It includes the root zone, intermediate zone and capillary fringe. Saturated bodies such as perched groundwater may exist in the unsaturated zone. Also referred to as the Vadose Zone.

Water table. Interface between the saturated zone and unsaturated zones. The surface in an aquifer at which pore water pressure is equal to atmospheric pressure.

Well. A hydraulic structure that facilitates the monitoring of groundwater level, collection of groundwater samples, or the extraction (or injection) of groundwater. Also known as a Bore.

ENVIRONMENTAL EARTH SCIENCES GENERAL LIMITATIONS

Scope of services

The work presented in this report is Environmental Earth Sciences response to the specific scope of works requested by, planned with and approved by the client. It cannot be relied on by any other third party for any purpose except with our prior written consent. Client may distribute this report to other parties and in doing so warrants that the report is suitable for the purpose it was intended for. However, any party wishing to rely on this report should contact us to determine the suitability of this report for their specific purpose.

Data should not be separated from the report

A report is provided inclusive of all documentation sections, limitations, tables, figures and appendices and should not be provided or copied in part without all supporting documentation for any reason, because misinterpretation may occur.

Subsurface conditions change

Understanding an environmental study will reduce exposure to the risk of the presence of contaminated soil and or groundwater. However, contaminants may be present in areas that were not investigated or may migrate to other areas. Analysis cannot cover every type of contaminant that could possibly be present. When combined with field observations, field measurements and professional judgement, this approach increases the probability of identifying contaminated soil and or groundwater. Under no circumstances can it be considered that these findings represent the actual condition of the site at all points.

Environmental studies identify actual sub-surface conditions only at those points where samples are taken, when they are taken. Actual conditions between sampling locations differ from those inferred because no professional, no matter how qualified, and no sub-surface exploration program, no matter how comprehensive, can reveal what is hidden below the ground surface. The actual interface between materials may be far more gradual or abrupt than an assessment indicates. Actual conditions in areas not sampled may differ from that predicted. Nothing can be done to prevent the unanticipated. However, steps can be taken to help minimize the impact. For this reason, site owners should retain our services.

Problems with interpretation by others

Advice and interpretation is provided on the basis that subsequent work will be undertaken by Environmental Earth Sciences NSW. This will identify variances, maintain consistency in how data is interpreted, conduct additional tests that may be necessary and recommend solutions to problems encountered on site. Other parties may misinterpret our work and we cannot be responsible for how the information in this report is used. If further data is collected or comes to light, we reserve the right to alter their conclusions.

Obtain regulatory approval

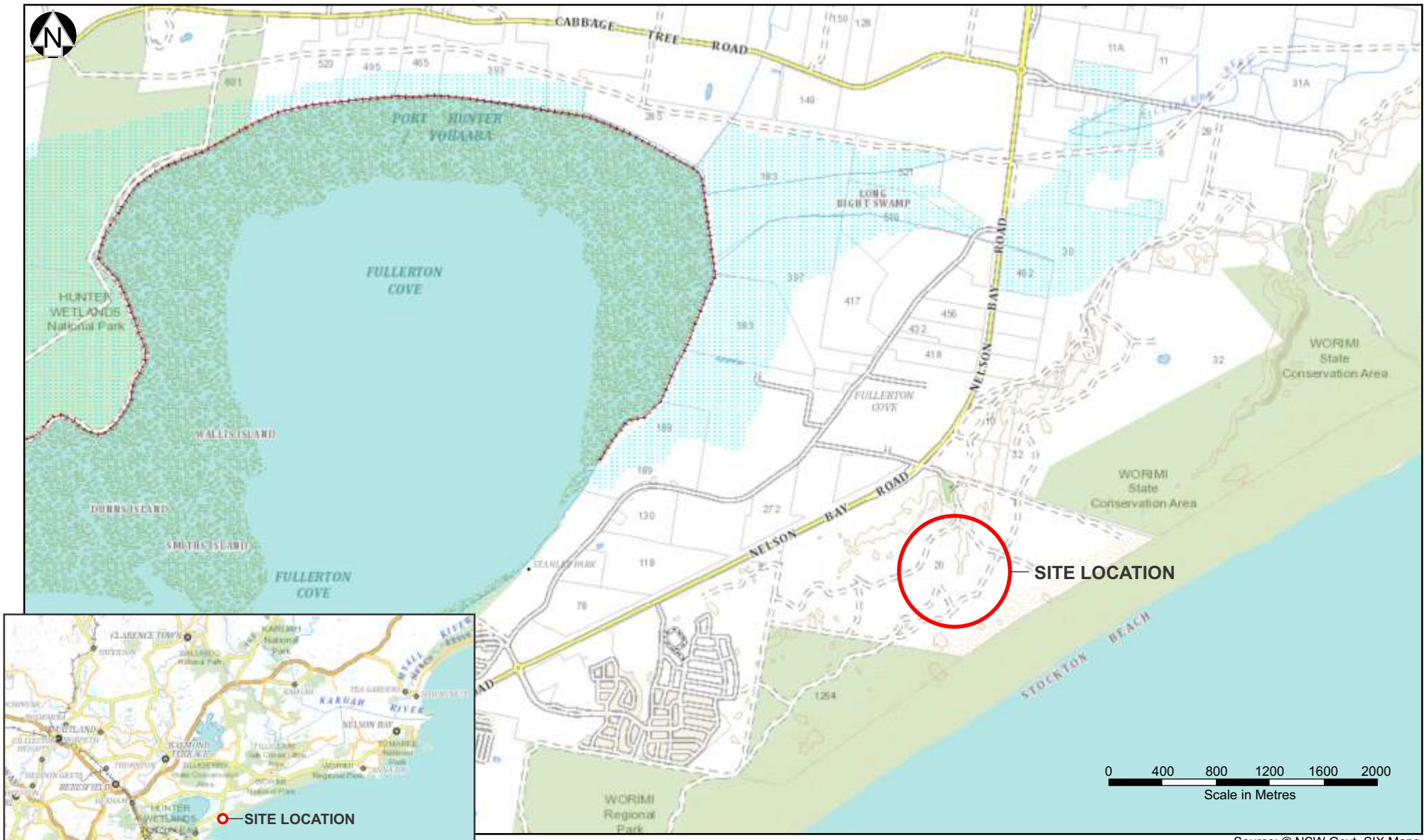
The investigation and remediation of contaminated sites is a field in which legislation and interpretation of legislation is changing rapidly. Our interpretation of the investigation findings should not be taken to be that of any other party. When approval from a statutory authority is required for a project, that approval should be directly sought by the client.

Limit of liability

This study has been carried out to a particular scope of works at a specified site and should not be used for any other purpose. This report is provided on the condition that Environmental Earth Sciences NSW disclaims all liability to any person or entity other than the client in respect of anything done or omitted to be done and of the consequence of anything done or omitted to be done by any such person in reliance, whether in whole or in part, on the contents of this report. Furthermore, Environmental Earth Sciences NSW disclaims all liability in respect of anything done or omitted to be done and of the consequence of anything done or omitted to be done by the client, or any such person in reliance, whether in whole or any part of the contents of this report of all matters not stated in the brief outlined in Environmental Earth Sciences NSW's proposal number and according to Environmental Earth Sciences general terms and conditions and special terms and conditions for contaminated sites.

To the maximum extent permitted by law, we exclude all liability of whatever nature, whether in contract, tort or otherwise, for the acts, omissions or default, whether negligent or otherwise for any loss or damage whatsoever that may arise in any way in connection with the supply of services. Under circumstances where liability cannot be excluded, such liability is limited to the value of the purchased service.

FIGURES

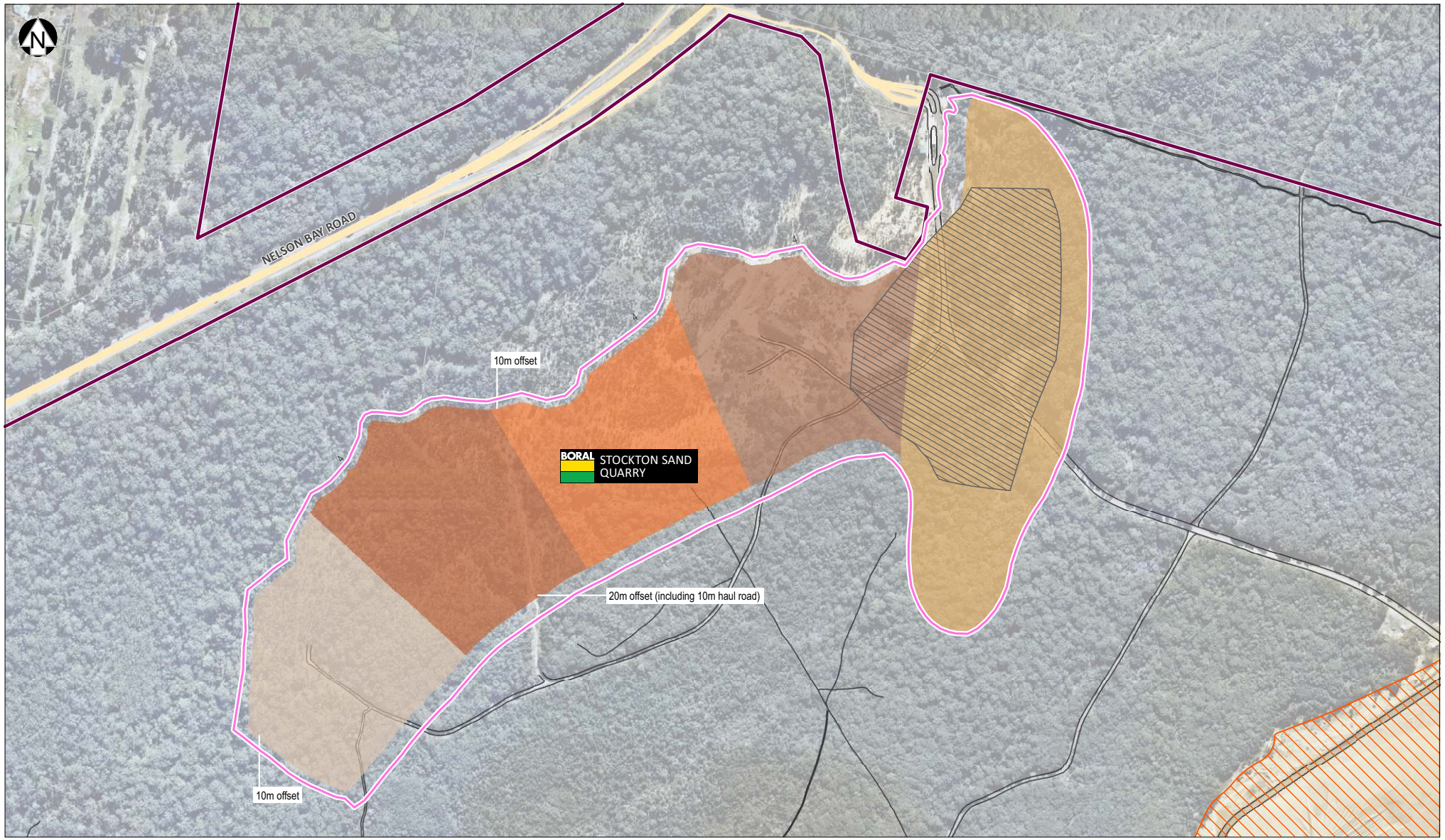


Source: © NSW Govt. SIX Maps

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Title:	**Site Location**
Location:	**Nelson Bay Road, Fullerton Cove, NSW**
Client: **Boral Quarries**	Job No: **717041**
Project Man: **EG**	Scale: **As shown**
Drawn By: **LB**	Date: **November 2018**

Figure 1



Source: Element Environment

Stockton Sand Quarry boundary
Current windblown sand extraction area
Proposed clearance area
Access tracks

Extraction staging
Stage 1
Stage 2
Stage 3
Stage 4
Stage 5
Stage 6

0 50 100 150 200 250
Scale in Metres

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Title: **Extraction Staging Plan**

Location: **Nelson Bay Road, Fullerton Cove, NSW**

Client: **Boral Quarries**

Job No: **717041**

Project Man: **LL/AS**

Scale: **As shown**

Drawn By: **LB**

Date: **July 2019**

Figure 2



LEGEND:

- Lot area
- Dune extraction area
- Approximate inland extraction area
- Borehole location

0 100 200 300 400 500
Scale in Metres

DEPTH TO ACID SULFATE SOIL MATERIALS:

HIGH PROBABILITY :

- Within 1 metre of the ground surface
- Between 1 and 3 metres below the ground surface

LOW PROBABILITY :

- Between 1 and 3 metres below the ground surface
- Greater than 3 metres below the ground surface

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Title: **Acid Sulfate Soil Sampling Locations**

Location: **Nelson Bay Road, Fullerton Cove, NSW**

Client: **Boral Quarries**

Job No: **717041**

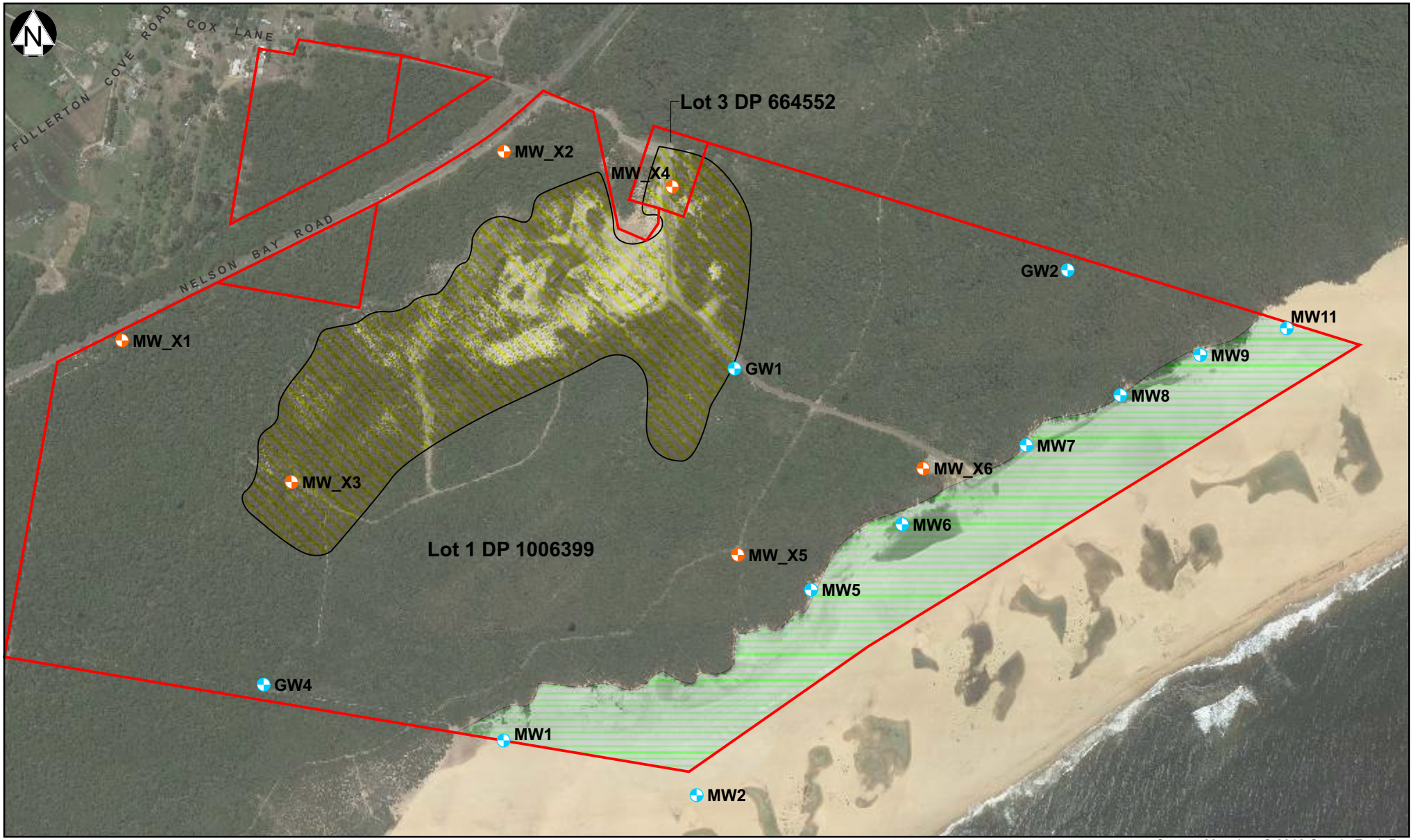
Project Man: **LV**

Scale: **As shown**

Drawn By: **LB**

Date: **April 2018**

Figure 4



Source: Map data © 2016 Google Earth Pro

LEGEND:

- Lot area
- Dune extraction area
- Inland extraction area
- Additional groundwater monitoring location - installed April 2017
- Current groundwater monitoring location

0 100 200 300 400 500

Scale in Metres

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Title:	**Bore location plan**
Location:	**Nelson Bay Road, Fullerton Cove, NSW**
Client: **Boral Quarries**	Job No: **717041**
Project Man: **LV**	Scale: **As shown**
Drawn By: **LB**	Date: **April 2018**

Figure 3

APPENDIX A SOIL LANDSCAPE REPORTS

bt BOYCES TRACK



Landscape—steep Quaternary Holocene sand dunes on the Tomago Coastal Plain. Local relief 10–30 m, slopes >25%, elevation 10–40 m. Uncleared tall open-forest.

Soils—deep (>300 cm), well-drained weakly developed Podzols (Uc2.2).

Qualities and Limitations—wind erosion hazard, steep slopes, mass movement hazard (if disturbed), ground water pollution hazard, non-cohesive acid soils of low fertility.

LOCATION

Steep stable Holocene dunes on the Tomago Coastal Plain between North Stockton and Bobs Farm. Type location is along Boyces Track (Area reference 4**01****E, 63 **70**5**N).

LANDSCAPE

Geology and Regolith

Holocene transgressive aeolian dunes.

Topography

Steep stable Holocene transgressive dunes. Two long walled ridges, parallel to the shoreline, form the major part of this landscape (Thom *et al*. 1992). These ridges are separated by a low relief sand plain (see Hawks Nest **(hn)** soil landscape). Local relief 10–20 m, slope gradients often >30 %, elevation 10–40 m. Windward slopes are generally longer and more gently inclined than leeward slopes which are shorter and steeper, often having formed at the angle of repose of the sand.

Vegetation

Predominantly uncleared tall open-forest containing *Eucalyptus pilularis* (blackbutt), *Angophora costata* (smooth-barked apple), *Banksia serrata* (old man banksia), *Acacia longifolia* (sydney golden wattle) with an understorey of *Persoonia* spp. (geebung), *Pteridium esculentum* (bracken) and *Imperata cylindrica* (blady grass).

Land Use

Predominantly bushland. Some areas are being sand mined.

Existing Land Degradation

This landscape is often being buried on the seaward side by large encroaching unstable transgressive dunes.

SOILS

Dominant Soil Materials

bt1—Speckled loose loamy sand (topsoil—A_1 horizon)

Colour	commonly brownish grey (10YR 4/1)
Texture	coarse loamy sand
Structure	loose
Fabric	sandy
Field pH	moderately to slightly acid (pH 5.0–6.0)
Coarse fragments	few charcoal fragments
Roots	common fine, few coarse
Exposed condition	loose
Permeability	high
Type location	Boyces Track on top of dune 500 m south of Nelson Bay Road (Grid Ref. 4 **01**10*E, 63 **70**40*N). *Soil Landscapes of the Port Stephens 1:100 000 Sheet* Soil Data System card 25, 0–40 cm

bt2—Bleached loose sand (topsoil—A_2 horizon)

Colour	greyish yellow brown (10YR 5/2) to light grey (10YR 7/1, 10YR 8/1). Dry colours usually bleached light grey (10YR 7/1, 10YR8/1)
Texture	sand
Structure	loose

Fabric	sandy
Field pH	slightly acid to neutral (pH 6.0–7.0)
Coarse fragments	few charcoal fragments
Roots	few fine, few coarse
Exposed condition	loose
Permeability	high
Type location	Boyces Track on top of dune 500 m south of Nelson Bay Road (Grid Ref. 4 **01**10*E, 63 **70**40*N). *Soil Landscapes of the Port Stephens 1:100 000 Sheet* Soil Data System card 25, 40–140 cm

bt3—Faintly mottled sand (topsoil—weak Bhs horizon)

Colour	mixture of dark brown (10YR 4/3) or brown (10YR 4/4) mottles in a background colour of dull yellow orange (10YR 6/4)
Texture	sand
Structure	loose
Fabric	sandy
Field pH	slightly acid to neutral (pH 6.0–7.0)
Coarse fragments	absent
Roots	few fine, few coarse
Exposed condition	loose
Permeability	high
Type location	Boyces Track on top of dune 500 m south of Nelson Bay Road (Grid Ref. 4 **01**10*E, 63 **70**40*N). *Soil Landscapes of the Port Stephens 1:100 000 Sheet* Soil Data System card 25, 140–180 cm

bt4—Loose dull yellow orange sand (parent material—C horizon)

Colour	dull yellow orange (10YR 6/4)
Texture	sand
Structure	loose
Fabric	sandy
Field pH	slightly acid to neutral (pH 6.0–7.0)
Coarse fragments	absent
Roots	absent
Exposed condition	loose
Permeability	high
Type location	Boyces Track on top of dune 500 m south of Nelson Bay Road (Grid Ref. 4 **01**10*E, 63 **70**40*N). *Soil Landscapes of the Port Stephens 1:100 000 Sheet* Soil Data System card 25, >180 cm

Occurrence and Relationships

Generally. Up to 40 cm of speckled loose loamy sand **(bt1)** overlies up to 100 cm of bleached loose light grey sand **(bt2)**, which overlies up to a 50 cm of faintly mottled sand **(bt3)** and >500 cm of loose dull yellow orange sand **(bt4)** [well-drained weakly developed Podzols (Uc2.2)]. Boundaries are clear except for **bt3/bt4** which is diffuse. Total soil depth >300 cm.

QUALITIES AND LIMITATIONS

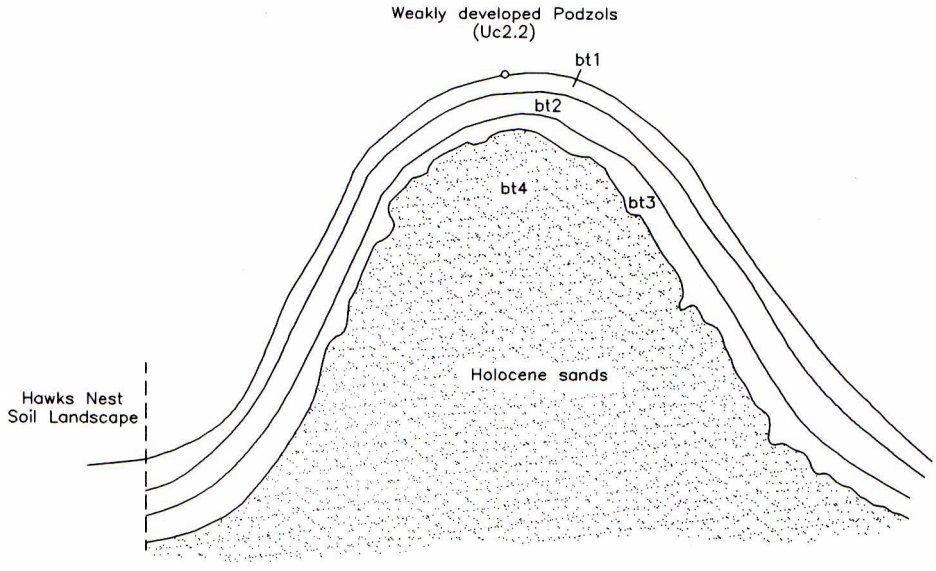
Landscape Limitations

High wind erosion hazard
Mass movement hazard (if disturbed)
Steep slopes (localised)
Non-cohesive soils
Foundation hazard
Ground water pollution hazard

Soil Limitations

bt1 High erodibility
High permeability
Very strong acidity
Low fertility
Low available water-holding capacity

bt2 High erodibility
High permeability
Strong acidity
Very low fertility
Very low available water-holding capacity



■ ***Schematic cross-section of Boyces Track soil landscape illustrating the occurrence and relationship of the dominant soil materials.***

bt3 High erodibility
High permeability
Strong acidity
Very low fertility
Very low available water-holding capacity

bt4 High erodibility
High permeability
Very low fertility
Very low available water-holding capacity

Fertility

Soil Materials as Plant Growth Media. Soil material suitability as growth media is generally low, due to strongly acid soils, high permeability, low fertility and very low available water-holding capacity.

Soil Profile Fertility. Soil profile suitability is generally low to moderate for deep, well-drained Podzols.

Erodibility

	K factor	Non-concentrated flows	Concentrated flows	Wind
bt1	0.000	very low	high	moderate
bt2	0.000	very low	very high	high
bt3	0.000	very low	high	high
bt4	0.000	very low	high	high

Erosion Hazard

	Non-concentrated flows	Concentrated flows	Wind
grazing	slight	high	V high
cultivation	slight	high	extreme
urban	slight	very high	V high

Foundation Hazard

High foundation hazard due to steep slopes and localised mass movement hazard.

Urban Capability

Generally high to severe limitations for urban development.

Rural Capability

Generally severe limitations for cultivation and high limitations for grazing. This landscape is best left undisturbed and retained under native vegetation.

Sustainable Land Management Recommendations

To prevent wind erosion it is important to maintain sufficient ground cover. Fertilisers may be necessary to establish good cover. Protective fences around critical vegetated areas and weed control may also be necessary.

Soil Conservation Earthworks

Not suitable, due to highly pervious soil materials.

hn HAWKS NEST



Landscape—low Holocene sandsheets and low transgressive dunes on the Tomago Coastal Plain. Local relief <3 m, slope gradients <10%, elevation 3–12 m. Dry scrubland, woodland and tall open-forest.

Soils—deep (>300 cm), well-drained Podzols (Uc2.3) and Siliceous Sands/Podzols (Uc2.21) on dunes, deep (>200 cm), poorly drained Humus Podzols (Uc5.1) on sandsheets.

Qualities and Limitations—wind erosion hazard, high watertables (localised), seasonal waterlogging (localised), permanent waterlogging (localised), non-cohesive, potential acid sulphate soils, ground water pollution hazard.

LOCATION

Stable low Holocene sandsheets and low transgressive dunes on the Tomago Coastal Plain from North Stockton to Bobs Farm (Area reference Salt Ash 4 **00**5**E, 63 **70**6**N).

LANDSCAPE

Geology and Regolith

Holocene quartz sandsheets and beach ridges.

Topography

Stable, gently undulating, Holocene, sandsheets and low transgressive dunes. Local relief <3 m, slope gradients <10%, elevation 3–12 m ASL. Low sandy dunes and swales are the dominant landform elements. The area is generally well drained apart from isolated, small, shallow swamps which occur in low lying, poorly drained swales and depressions.

Vegetation

Predominantly uncleared woodland and tall open-forest. Common species include *Angophora costata* (smooth-barked apple), *Eucalyptus pilularis* (blackbutt), *Eucalyptus gummifera* (red bloodwood), *Banksia serrata* (old man banksia), with an understorey of *Pteridium esculentum* (bracken), *Imperata cylindrica* (blady grass), *Actinotus helianthi* (flannel flower), *Persoonia* spp. (geebung), *Acacia longifolia* (sydney golden wattle).

Land Use

The main land use is bushland.

Existing Land Degradation

None identified.

SOILS

Dominant Soil Materials

hn1—Loose speckled grey brown loamy sand (topsoil—A_1 horizon)

Colour	brownish grey (10YR 4/1), occasionally brownish black in moist areas
Texture	loamy sand
Structure	single-grained
Fabric	sandy
Field pH	moderately acid (pH 5.5)
Coarse fragments	few charcoal fragments
Roots	fine common, few to common coarse
Exposed condition	loose
Permeability	very high
Type location	Boyces Track 300 m south of Nelson Bay Road (Grid Ref. 4 **00**850*E, 63 **70**80*N). *Soil Landscapes of the Port Stephens 1: 100 000 Sheet* Soil Data System card 246, 0–45 cm

hn2—Loose bleached sand (subsoil—A_2 horizon)

Colour	dull yellow orange (10YR 7/2), bleached
Texture	sand **Structure** single-grained
Fabric	sandy
Field pH	moderately acid (pH 5.5)

Coarse fragments	absent
Roots	few
Exposed condition	loose
Permeability	very high
Type location	Boyces Track 300 m south of Nelson Bay Road (Grid Ref. 4 **00**850*E, 63 **70**80*N). *Soil Landscapes of the Port Stephens 1:100 000 Sheet* Soil Data System card 246, 45–150 cm

hn3—Coloured mottled sand (subsoil—Bhs horizon)

Colour	organic staining; dark brown (10YR 3/4), brown (10YR 4/4) , organic/iron staining dull yellow orange (10YR 6/4) to dull yellow brown (10YR 5/4) with pale brown mottles
Texture	sand
Structure	single-grained
Fabric	sandy
Field pH	moderately to slightly acid (pH 5.5–6.0)
Coarse fragments	absent
Roots	fine common, few to common coarse
Exposed condition	loose to slightly hardsetting
Permeability	high
Type location	Boyces Track 300 m south of Nelson Bay Road (Grid Ref. 4 **00**850*E, 63 **70**80*N). *Soil Landscapes of the Port Stephens 1:100 000 Sheet* Soil Data System card 246, 150–270 cm

hn4—Greyish yellow brown sand (C horizon)

Colour	commonly greyish yellow brown (10YR 6/2)
Texture	sand
Structure	single-grained
Fabric	sandy
Field pH	moderately acid to neutral (pH 5.5–7.0)
Coarse fragments	absent
Roots	absent
Exposed condition	loose
Permeability	very high
Type location	Boyces Track 300 m south of Nelson Bay Road (Grid Ref. 4 **00**850*E, 63 **70**80*N). *Soil Landscapes of the Port Stephens 1:100 000 Sheet* Soil Data System card 246, 270–>300 cm

Occurrence and Relationships

Soil type is dependent on the age of the sand body. Along the coastal fringe lie the youngest aged dunes, and soil development is very poor apart from some organic matter build-up on the surface and minor development of a Bhs horizon. Further inland the dunes become progressively older and consequently the soils become more strongly developed with increasing age. It must be noted that the poorly developed soils of the seaward dunes very slowly become more developed as one travels landward.

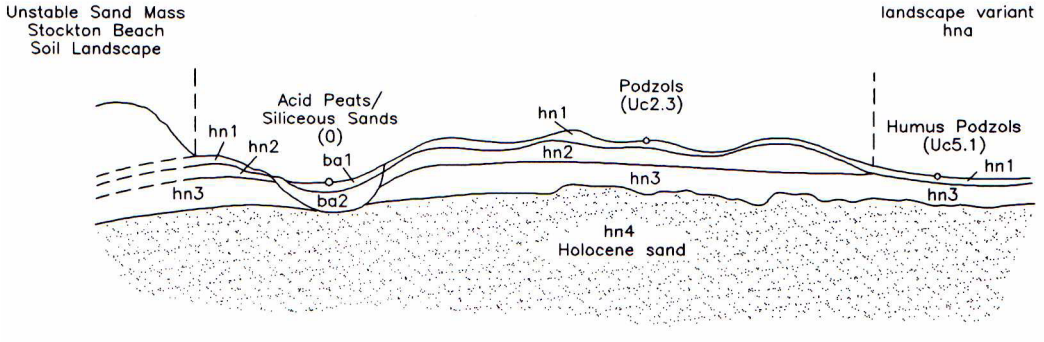
Dunes. Up to 40 cm of **hn1** overlies 10–150 cm of bleached loose sand **(hn2)**. **hn2** overlies 30–>100 cm of coloured mottled sand **(hn3)** and over 300 cm of greyish yellow brown sand **(hn4)** [well-drained Siliceous Sand/Podzol intergrades (Uc2.21) on the seaward fringe, Podzols (Uc2.3) occur landward]. Total soil depth is >300 cm and the boundaries between the soil materials are clear except for the boundary between **hn3** and **hn4** which is often diffuse.

Swampy swales. Small areas Acid Peats (O) occur in low lying, poorly drained swales with up to 10 cm **ba1** overlying >100 cm **ba2** [very poorly drained Acid Peat/Siliceous Sand intergrades]. (See Blind Harrys Swamp **(ba)** soil landscape.)

QUALITIES AND LIMITATIONS

Landscape Limitations

Wind erosion hazard
Non-cohesive soil
High watertables (localised, swales)
Seasonal waterlogging (localised, swales)
Permanent waterlogging (localised, swamps)
Ground water pollution hazard



■ ***Schematic cross-section of Hawks Nest soil landscape illustrating the occurrence and relationship of the dominant soil materials.***

Soil Limitations

hn1 High permeability
Strong acidity
Low fertility
Low available water-holding capacity
hn2 High erodibility
High permeability
Very low fertility
Very low available water-holding capacity
hn3 High erodibility
High permeability
Very low fertility
Very low available water-holding capacity
hn4 High erodibility
High permeability
Strong acidity
Very low fertility
Very low available water-holding capacity
Potential acid sulphate soil (localised)

Fertility

Soil Materials as Plant Growth Media. Soil material suitability is generally low due to very low nutrient and moisture retention capacities, low exchangeable cations and high permeability.

Soil Profile Fertility. Generally low suitability for deep, poorly drained Humus Podzols and deep, well-drained Podzols and Siliceous Sands/Podzols.

Erodibility

	K factor	Non-concentrated flows	Concentrated flows	Wind
hn1	0.000	very low	high	high
hn2	0.000	very low	high	high
hn3	0.000	very low	high	high
hn4	0.000	very low	high	high

Erosion Hazard

	Non-concentrated flows	Concentrated flows	Wind
grazing	slight	high	high
cultivation	slight	high	V high
urban	slight	very high	high

Foundation Hazard

Generally low, except for swampy swales which have a high foundation hazard due to high watertables.

Urban Capability

Exposed areas, swamps, and poorly drained sand flats have high limitations for urban development. Sheltered areas have moderate limitations for urban development.

Rural Capability

Due to the highly sensitive nature of the dunes which are easily predisposed to wind erosion, there is generally a high limitation for both cultivation and grazing. The area is best retained under native timber.

Sustainable Land Management Recommendations

To prevent wind erosion, it is important to maintain sufficient ground cover. Fertilisers may be necessary to establish good cover. Protective fences around critical vegetated areas and weed control may be necessary.

Soil Conservation Earthworks

Not suitable, due to highly pervious soil materials.

APPENDIX B CALIBRATION CERTIFICATES

ENVIRONMENTAL
EARTH SCIENCES
THE KNOW AND THE HOW

Equipment Calibration Record – Hanna pH

This equipment calibration record is to be stored in your job folder

Equipment Type: Hanna pH HI9025

Equipment Number: Eco - Tester pH2

Date Calibrated: 12/3/18 (17:00)

Calibrated By: LJ (name)

Job Number: 717041

Details of Calibration:

Electrode Checked (Condition): _____

pH at 4.01 Reading: 4.0

pH at 7.01 Reading: 7.0

pH at 6.88 Reading: _____

ENVIRONMENTAL EARTH SCIENCES
THE KNOW AND THE HOW

Equipment Calibration Record – Hanna pH

This equipment calibration record is to be stored in your job folder

Equipment Type: Hanna pH HI9025

Equipment Number: 717041

Date Calibrated: 13/3/18 (13:00)

Calibrated By: LV (name)

Job Number: 717041

Details of Calibration:

Electrode Checked (Condition): _____

pH at 4.01 Reading: 4.0

pH at 7.01 Reading: 7.0

pH at 6.88 Reading: _____

ENVIRONMENTAL EARTH SCIENCES
THE KNOW AND THE HOW

Equipment Calibration Record – Hanna pH

This equipment calibration record is to be stored in your job folder

Equipment Type: Hanna pH HI9025

Equipment Number: Eco Tester pH2

Date Calibrated: 14/3/18

Calibrated By: CV (name)

Job Number: 171241

Details of Calibration:

Electrode Checked (Condition): _____

pH at 4.01 Reading: 4.0

pH at 7.01 Reading: 7.0

pH at 6.88 Reading: _____

APPENDIX C GEOLOGICAL BORELOGS

LOCATION:	Fullerton Cove	JOB No.	717041	TRENCH NUMBER:	BH1	LOGGED BY:
EASTING:		DRILL TYPE:	Sonic Drill			LV
NORTHING:		DATE STARTED:	12/03/18	CLIENT:	Element Environment	APPROVED:
ELEVATION:		DATE FINISHED:	12/03/18			LV

Water Level
▼ Water level
▽ Potential water level range
Moisture
D=Dry M=Moist MS=Moist Saturated S=Saturated

PAGE #: 1/1

Depth (metres).	STRATIGRAPHY	GRAPHIC LOG	SAMPLES: Sample Interval	Moisture	pH Field	pH FOX	Water Level	COMMENTS
0	FILL: Loose grey-brown SAND with chitter gravels of mixed lithology and coal.			D	6.9	5.7		
1				M	7.2	6.1		
	FILL: Loose, faun SAND of homogeneous medium grain size.			MS	6.8	3.7	▼	
2	FILL: Loose, dark brown SAND of homogeneous medium grain size.			MS	6.5	4.9		
3	FILL: Loose, faun SAND of medium - coarse grain size.			MS	6.5	3.6		
4	FILL: Loose brown SAND of medium - coarse grain size with chitter.			MS	6.2	3.7		
5	NATURAL: Loose, faun - brown SAND of medium grain size.							
6								
7	NATURAL: Loose, light brown - grey SAND of medium grain size.			MS	5.4	3.2		
8								
9								
10								
11	NATURAL: Loose, light grey SAND with medium - coarse grain size, shell grit present.			MS	6.3	6.1		
12	NATURAL: Loose, grey SAND of medium grain size, minor shell grit present.			MS	7.8	6.1		
13								
14								
15								
16	NATURAL: Loose, grey SAND of medium - coarse grain size, shell grit present.			MS	8.3	6.1		
17								
18								
19	End of core @ 18.0m (> 16m below the water table).							

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

LOCATION:	Fullerton Cove	JOB No.	717041	TRENCH NUMBER:	BH2	LOGGED BY:
EASTING:		DRILL TYPE:	Sonic Drill			LV
NORTHING:		DATE STARTED:	13/03/18	CLIENT:	Element Environment	APPROVED:
ELEVATION:		DATE FINISHED:	13/03/18			LV

Water Level
▼ Water level
▽ Potential water level range
Moisture
D=Dry M=Moist MS=Moist Saturated S=Saturated

PAGE #: 1/1

Depth (metres)	STRATIGRAPHY	GRAPHIC LOG	SAMPLES: Sample Interval	Moisture	pH Field	pH FOX	Water Level	COMMENTS
0	NATURAL: Loose, light brown SAND.			D	8.7	6.6		
1	NATURAL: Loose, cream - light brown SAND of medium grain size. Both chitter gravels and brick present.							
2				M	5.0	1.3	▽	
	NATURAL: Loose, dark brown - black SAND of medium grain size. Organic layer present.			M	6.5	2.8		
3				M	6.4	5.2		
4	NATURAL: Loose, light brown - grey SAND of medium coarse grain size.							
5	NATURAL: Loose cream - light brown SAND of medium - coarse grain size.							
6	Minor presence of organics.			MS	6.2	5.6	▽	
7								
8								
9				MS	6.4	3.1		
10	NATURAL: Loose, light brown - brown SAND of medium grain size.							
11								
12				MS	6.9	5.8		
13	NATURAL: Loose, cream SAND of medium grain size.							
14								
15								
16				MS	6.5	5.5		
17	NATURAL: Loose, light grey SAND of medium grain size.							
18								
19								
20	Grading to grey mottle.			MS	6.0	6.4		
21								
22								
23								
24				MS	6.6	6.1		
	End of core @ 24.0m (> 16m below the water table).							
25								

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

LOCATION:	Fullerton Cove	JOB No.	717041	TRENCH NUMBER:	BH3	LOGGED BY:
EASTING:		DRILL TYPE:	Sonic Drill			LV
NORTHING:		DATE STARTED:	13/03/18	CLIENT:	Element Environment	APPROVED:
ELEVATION:		DATE FINISHED:	13/03/18			LV

Water Level
▼ Water level
▽ Potential water level range
Moisture
D=Dry M=Moist MS=Moist Saturated S=Saturated

PAGE #: 1/1

Depth (metres).	STRATIGRAPHY	GRAPHIC LOG	SAMPLES: Sample Interval	Moisture	pH Field	pH FOX	Water Level	COMMENTS
0	FILL: Loose, grey SAND of medium grain size.			D	7.2	6.9		
3	FILL: Loose, dark brown, loamy SAND of fine - medium grain size. Both chitter gravels and organics present.			DM	7.4	6.5		
				DM	7.7	5.9		
4				DM	7.4	5.7		
5	NATURAL: Loose, cream SAND of medium grain size with brown mottle.							
	NATURAL: Loose, cream SAND of medium grain size.						▽	
6				MS	7.0	5.8	▽	
8	Becoming medium - coarse grain size.			MS	7.1	5.7		
9	NATURAL: Loose, grey- brown SAND of medium grain size.			MS	6.9	2.6		
12	NATURAL: Loose, light grey SAND of medium grain size. Shell grit and fine gravels present.			MS	7.4	6.3		
15	Grading to dark grey mottle.			MS	8.2	6.2		
16	NATURAL: Loose, grey SAND with minor shell grit present.							
18	NATURAL: Loose, yellow - grey SAND of medium grain size.			MS	6.8	5.9		
21	End of core @ 21.0m (> 16m below the water table).							
22								

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

LOCATION:	Stockton	JOB No.	717041	TRENCH NUMBER:	BH4	LOGGED BY:
EASTING:		DRILL TYPE:	Sonic Drill			LV
NORTHING:		DATE STARTED:	14/03/18	CLIENT:	Element Environment	APPROVED:
ELEVATION:		DATE FINISHED:	14/03/18			LV

Water Level
▼ Water level
▽ Potential water level range
Moisture
D=Dry M=Moist MS=Moist Saturated S=Saturated

PAGE #: 1/1

Depth (metres)	STRATIGRAPHY	GRAPHIC LOG	SAMPLES: Sample Interval	Moisture	pH Field	pH FOX	Water Level	COMMENTS
0	FILL: Loose, grey SAND of medium grain size. Gravels and organics present.		—	D	7.2	5.5		
1								
2	FILL: Loose, grey SAND with chitter and gravels present.		—	DM	7.3	5.1		
3								
4	NATURAL: Loose, coffee SAND of medium grain size.		—	MS	7.5	4.8	▽ ▽	
5	NATURAL: Loose, milk - coffee SAND of medium grain size.		—	MS	7.4	5.0		
6	NATURAL: Loose, light brown SAND of medium grain size.		—	MS	7.3	3.0		
7								
8								
9			—	MS	7.0	2.6		
10								
11								
12	NATURAL: Loose, grey SAND of medium grain size.		—	MS	7.4	4.6		
13								
14								
15	NATURAL: Loose, brown SAND of medium grain size.		—	MS	7.2	3.9		
16	NATURAL: Loose, light grey SAND of medium grain size.		—	MS	7.2	2.6		
			—	MS	7.5	6.1		
17	NATURAL: Loose, dark grey SAND of medium - coarse grain size. Shell grit present.		—	MS	8.7	5.6		
18	NATURAL: Loose, light brown - grey SAND of medium grain size.							
19								
20								
21	NATURAL: Loose, white- light grey SAND of fine - medium grain size.		—	MS	8.8	6.1		
22	End of core @ 21.0m (> 16m below the water table).							

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

APPENDIX D LABORATORY TRANSCRIPTS AND CHAIN OF CUSTODY FORMS

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1807945**	Page	: 1 of 8
Client	: **ENVIRONMENTAL EARTH SCIENCES**	Laboratory	: Environmental Division Sydney
Contact	: LORETTA VISINTIN	Contact	: Peter Ravlic
Address	:	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: +61 02 99221777	Telephone	: +61-2-8784 8555
Project	: 717041	Date Samples Received	: 15-Mar-2018 17:30
Order number	:	Date Analysis Commenced	: 24-Mar-2018
C-O-C number	: ----	Issue Date	: 26-Mar-2018 12:44
Sampler	: LV		
Site	: Boral Stockton		
Quote number	: EN/010/17		
No. of samples received	: 48		
No. of samples analysed	: 29		

ilac-MRA NATA
Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ASS: EA033 (CRS Suite):Retained Acidity not required because pH KCl greater than or equal to 4.5
- ASS: EA033 (CRS Suite): Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime (CaCO3) and using a safety factor of 1.5 to allow for non-homogeneous mixing and poor reactivity of lime. For conversion of Liming Rate from 'kg/t dry weight' to 'kg/m3 in-situ soil', multiply 'reported results' x 'wet bulk density of soil in t/m3'.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH1_1.5	BH1_3.0	BH1_4.0	BH1_7.0	BH1_15.5
			Client sampling date / time	12-Mar-2018 00:00	12-Mar-2018 00:00	12-Mar-2018 00:00	12-Mar-2018 00:00	12-Mar-2018 00:00
Compound	CAS Number	LOR	Unit	ES1807945-003	ES1807945-005	ES1807945-006	ES1807945-007	ES1807945-010
				Result	Result	Result	Result	Result
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**5.6**	**6.0**	**5.5**	**6.1**	**9.5**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	**2**	<2	**2**	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	**0.026**	**0.016**	**0.024**	**0.018**	**0.016**
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	**16**	**10**	**15**	**11**	<10
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	**----**	**----**	**----**	**----**	**1.21**
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	**----**	**----**	**----**	**----**	**241**
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	**----**	**----**	**----**	**----**	**0.39**
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	**0.03**	<0.02	**0.03**	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	**18**	**10**	**17**	**11**	<10
Liming Rate	----	1	kg CaCO3/t	**1**	<1	**1**	<1	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	**0.03**	<0.02	**0.03**	<0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	**18**	**10**	**17**	**11**	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t	**1**	<1	**1**	<1	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH2_0.5	BH2_2.0	BH2_2.5	BH2_3.0	BH2_9.0
			Client sampling date / time	13-Mar-2018 00:00	13-Mar-2018 00:00	13-Mar-2018 00:00	13-Mar-2018 00:00	13-Mar-2018 00:00
Compound	CAS Number	LOR	Unit	ES1807945-012	ES1807945-013	ES1807945-014	ES1807945-015	ES1807945-017
				Result	Result	Result	Result	Result
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**10.0**	**5.1**	**6.0**	**6.2**	**5.8**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	**42**	<2	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	**0.07**	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	**0.010**	**0.099**	**0.026**	**0.009**	**0.020**
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	**62**	**16**	<10	**12**
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	**3.28**	**----**	**----**	**----**	**----**
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	**656**	**----**	**----**	**----**	**----**
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	**1.05**	**----**	**----**	**----**	**----**
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	<0.02	**0.17**	**0.03**	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	**104**	**17**	<10	**12**
Liming Rate	----	1	kg CaCO3/t	<1	**8**	**1**	<1	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	**0.17**	**0.03**	<0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	**104**	**17**	<10	**12**
Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	**8**	**1**	<1	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH3_3.5	BH3_4.0	BH3_9.0	BH3_15.0	BH3_16.0
			Client sampling date / time	13-Mar-2018 00:00	13-Mar-2018 00:00	13-Mar-2018 00:00	13-Mar-2018 00:00	13-Mar-2018 00:00
Compound	CAS Number	LOR	Unit	ES1807945-024	ES1807945-025	ES1807945-028	ES1807945-030	ES1807945-031
				Result	Result	Result	Result	Result
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	6.1	6.0	5.7	9.6	9.5
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	0.007	0.008	0.018	0.017	0.012
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	11	10	<10
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	----	----	----	4.84	0.65
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	----	----	----	967	130
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	----	----	----	1.55	0.21
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	12	<10	<10
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	<1	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	12	10	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	<1	<1	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH4_2.0	BH4_3.5	BH4_5.0	BH4_6.0	BH4_9.0
			Client sampling date / time	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00
Compound	CAS Number	LOR	Unit	ES1807945-034	ES1807945-035	ES1807945-036	ES1807945-037	ES1807945-038
				Result	Result	Result	Result	Result
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**10.2**	**6.6**	**6.2**	**5.3**	**5.4**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	**4**	**6**
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	**0.050**	**0.007**	**0.007**	**0.027**	**0.030**
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	**31**	<10	<10	**17**	**18**
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	**8.26**	**0.27**	----	----	----
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	**1650**	**54**	----	----	----
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	**2.65**	**0.09**	----	----	----
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	**0.03**	**0.04**
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	**21**	**24**
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	**2**	**2**
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	**0.05**	<0.02	<0.02	**0.03**	**0.04**
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	**31**	<10	<10	**21**	**24**
Liming Rate excluding ANC	----	1	kg CaCO3/t	**2**	<1	<1	**2**	**2**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	BH4_12.0	BH4_15.0	BH4_16.0	BH4_17.0	BH4_20.5
			Client sampling date / time	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00
Compound	CAS Number	LOR	Unit	ES1807945-039	ES1807945-040	ES1807945-041	ES1807945-043	ES1807945-044
				Result	Result	Result	Result	Result
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**6.0**	**8.0**	**5.5**	**5.9**	**9.2**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	**0.029**	**0.018**	**0.017**	**0.018**	**0.012**
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	**18**	**11**	**11**	**11**	<10
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	**----**	**0.20**	**----**	**----**	**0.62**
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	**----**	**39**	**----**	**----**	**125**
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	**----**	**0.06**	**----**	**----**	**0.20**
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	**0.03**	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	**18**	<10	**12**	**11**	<10
Liming Rate	----	1	kg CaCO3/t	**1**	<1	<1	<1	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	**0.03**	<0.02	<0.02	<0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	**18**	**11**	**12**	**11**	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t	**1**	<1	<1	<1	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	FD1	FD2	FD3	FD4	----
			Client sampling date / time	13-Mar-2018 00:00	12-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	----
Compound	CAS Number	LOR	Unit	ES1807945-045	ES1807945-046	ES1807945-047	ES1807945-048	--------
				Result	Result	Result	Result	----
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**8.6**	**9.3**	**6.3**	**5.6**	**----**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	**----**
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	**----**
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	**0.014**	**0.016**	<0.005	**0.025**	**----**
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	**16**	**----**
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	**0.21**	**1.18**	**----**	**----**	**----**
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	**41**	**235**	**----**	**----**	**----**
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	**0.07**	**0.38**	**----**	**----**	**----**
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**----**
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	**0.03**	**----**
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	**17**	**----**
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	**1**	**----**
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	**0.03**	**----**
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	<10	**17**	**----**
Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	<1	**1**	**----**

CHAIN OF CUSTODY - ANALYSIS REQUEST FORM

Project Manager: Loretta Visintin Sampler: LV Job No: 717041 Site Location: Boral Stockton Laboratory: ALS Sheet: 1 of 1

No. of samples	Sample ID/ Depth	Field pH water	Date sampled	Field Test: Difference pHFOX	Sample Matrix: Soil	Water	Sediment	Analysis Required: EA033 (Cr suite complete)	HOLD												Sample-specific instructions/ notes
1	BH1_0.3	6.9	12/03/2018	1.2	X				x												
2	BH1_1.0	7.2	12/03/2018	1.1	X				x												
3	BH1_1.5	6.8	12/03/2018	3.1	X			x													
4	BH1_2.0	6.2	12/03/2018	1.6	X				x												
5	BH1_3.0	6.5	12/03/2018	2.9	X			x													
6	BH1_4.0	6.2	12/03/2018	2.5	X			x													
7	BH1_7.0	5.4	12/03/2018	2.2	X			x													
8	BH1_10.5	6.3	12/03/2018	0.2	X				x												
9	BH1_12.0	7.8	12/03/2018	1.7	X				x												
10	BH1_15.5	8.3	12/03/2018	2.2	X			x													
11	BH2_0.25	6.8	13/03/2018	0.8	X				x												
12	BH2_0.5	8.7	13/03/2018	2.1	X			x													
13	BH2_2.0	5	13/03/2018	3.7	X			x													
14	BH2_2.5	6.5	13/03/2018	3.7	X			x													
15	BH2_3.0	6.4	13/03/2018	1.2	X			x													
16	BH2_6.0	6.2	13/03/2018	0.6	X				x												
17	BH2_9.0	6.4	13/03/2018	3.3	x			x													
	TOTAL																				

Turn Around *(circle)*: NORMAL / 3 DAYS / 48 HRS / 24 HRS *(confirm with lab in advance if quick turn-around is required)*

Comments/ Instructions:

Lab Quotation No. *(if applicable)*:

Send report to *(email address)*: lvisintin@environmentalearthsciences.com

Cc: report to *(email address)*: mstuckey@eesigroup.com

Cc: invoice to *(email address)*: accounts@eesigroup.com

	Name	Signature	Date	Time
Sent off Site/Office by:	Loretta Visintin	[signature]	15-Mar-18	
Receiving Lab:	Sacy Stephens	Aes	15/3/18	1730 OK
Receiving Lab:				

Phone: (02) 9922 1777
Fax: (02) 9922 1010
PO Box 380 North Sydney NSW 2059
Email: eesnsw@environmentalearthsciences.com

ENVIRONMENTAL EARTH SCIENCES
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Subcon / Forward Lab / Split WO
Lab / Analysis: Brisbane / Cr Suite EA033
Organised By / Date: ----------
Relinquished By / Date: ----------
Connote / Courier: ----------
WO No: ----------
Attach By PO / Internal Sheet: ------

Environmental Division
Sydney
Work Order Reference
ES1807945

Telephone : + 61-2-8784 8555

CHAIN OF CUSTODY - ANALYSIS REQUEST FORM

Project Manager: Loretta Visintin | Sampler: LV | Job No: 717041 | Site Location: Boral Stockton | Laboratory: ALS | Sheet: 1 of 1

No. of samples	Sample ID/ Depth	Field pH water	Date sampled	Field Test: Difference pHFOX	Sample Matrix			Analysis Required												Sample-specific instructions/ notes
					Soil	Water	Sediment	EA033 (Cr suite complete)	HOLD											
18	BH2_12.0	6.9	13/03/2018	1.1	X				x											
19	BH2_16.0	6.5	13/03/2018	1	X				x											
20	BH2_19.5	6	13/03/2018	0.4	X				x											
21	BH2_24.0	6.6	13/03/2018	0.5	X				x											
22	BH3_0.5	7.2	13/03/2018	0.3	X				x											
23	BH3_2.75	7.4	13/03/2018	0.9	X				x											
24	BH3_3.5	7.7	13/03/2018	1.8	X			x												
25	BH3_4.0	7.4	13/03/2018	1.7	X			x												
26	BH3_6.0	7	13/03/2018	1.2	X				x											
27	BH3_8.0	7.1	13/03/2018	1.4	X				x											
28	BH3_9.0	6.9	13/03/2018	4.3	X			x												
29	BH3_12.0	7.4	13/03/2018	1.1	X				x											
30	BH3_15.0	8.2	13/03/2018	2	X			x												
31	BH3_16.0	8.6	13/03/2018	2.5	X			x												
32	BH3_18.0	6.8	13/03/2018	0.9	X				x											
33	BH4_0.5	7.2	14/03/2018	1.7	X				x											
34	BH4_2.0	7.3	14/03/2018	2.2	X			x												
	TOTAL																			

Turn Around *(circle)*: **NORMAL** / **3 DAYS** / **48 HRS** / **24 HRS** *(confirm with lab in advance if quick turn-around is required)*

Comments/ Instructions:

Lab Quotation No. *(if applicable)*:

Send report to *(email address)*: lvisintin@environmentalearthsciences.com

Cc: report to *(email address)*: mstuckey@eesigroup.com

Cc: Invoice to *(email address)*: accounts@eesigroup.com

	Name	Signature	Date	Time
Sent off Site/Office by:	Loretta Visintin		15-Mar-18	
Receiving Lab:	[illegible]		15/3/18	1730 OK
Receiving Lab:				

Phone: (02) 9922 1777
Fax: (02) 9922 1010
PO Box 380 North Sydney NSW 2059
Email: eesnsw@environmentalearthsciences.com

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CHAIN OF CUSTODY - ANALYSIS REQUEST FORM

Job No: 717041 Laboratory: ALS

Project Manager: Loretta Visintin Sampler: LV Site Location: Boral Stockton Sheet: 1 of 1

No. of samples	Sample ID/ Depth	Field pH water	Date sampled	Field Test: Difference pHFOX	Sample Matrix: Soil	Sample Matrix: Water	Sample Matrix: Sediment	Analysis Required: EA033 (Cr suite complete)	Analysis Required: HOLD												Sample-specific instructions/ notes
35	BH4_3.5	7.5	14/03/2018	2.7	X			x													
36	BH4_5.0	7.4	14/03/2018	2.4	X			x													
37	BH4_6.0	7.3	14/03/2018	4.3	X			x													
38	BH4_9.0	7	14/03/2018	4.4	X			x													
39	BH4_12.0	7.4	14/03/2018	2.8	X			x													
40	BH4_15.0	7.2	14/03/2018	3.3	X			x													
41	BH4_16.0	7.2	14/03/2018	4.6	X			x													
42	BH4_16.5	7.5	14/03/2018	1.4	X				x												
43	BH4_17.0	8.7	14/03/2018	3.1	X			x													
44	BH4_20.5	8.8	14/03/2018	2.7	X			x													
45	FD1		13/03/2018		X			x													
46	FD2		12/03/2018		X			x													
47	FD3		14/03/2018		X			x													
48	FD4		14/03/2018		x			x													
	TOTAL		48					29	19												

Turn Around *(circle)*: **NORMAL / 3 DAYS / 48 HRS / 24 HRS** *(confirm with lab in advance if quick turn-around is required)*

Comments/ Instructions:

Lab Quotation No. *(if applicable)*:

Send report to *(email address)*: lvisintin@environmentalearthsciences.com

Cc: report to *(email address)*: mstuckey@eesigroup.com

Cc: invoice to *(email address)*: accounts@eesigroup.com

	Name	Signature	Date	Time
Sent off Site/Office by:	Loretta Visintin	[signature]	15-Mar-18	
Receiving Lab:	Sony Stephen	ALS	15/3/18	1730 O-K
Receiving Lab:				

Phone: (02) 9922 1777
Fax: (02) 9922 1010
PO Box 380 North Sydney NSW 2059
Email: eesnsw@environmentalearthsciences.com

ENVIRONMENTAL EARTH SCIENCES
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CERTIFICATE OF ANALYSIS

Work Order	: **EB1807813**	Page	: 1 of 2
Client	: **ENVIRONMENTAL EARTH SCIENCES**	Laboratory	: Environmental Division Brisbane
Contact	: LORETTA VISINTIN	Contact	: Peter Ravlic
Address	:	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 02 99221777	Telephone	: +61-7-3243 7222
Project	: 717041	Date Samples Received	: 27-Mar-2018 10:19
Order number	:	Date Analysis Commenced	: 29-Mar-2018
C-O-C number	: ----	Issue Date	: 29-Mar-2018 10:54
Sampler	: LORETTA VISINTIN		
Site	: Boral Stockton		
Quote number	: EN/010/17		
No. of samples received	: 3		
No. of samples analysed	: 3		

ilac-MRA NATA
Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- **The samples in this work order have been re-batched from ES1807945.**
- ASS: EA033 (CRS Suite): Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime (CaCO3) and using a safety factor of 1.5 to allow for non-homogeneous mixing and poor reactivity of lime. For conversion of Liming Rate from 'kg/t dry weight' to 'kg/m3 in-situ soil', multiply 'reported results' x 'wet bulk density of soil in t/m3'.

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)				Client sample ID	**BH2_2.0 ES1807945-013**	**BH4_6.0 ES1807945-037**	**BH4_9.0 ES1807945-038**	**----**	**----**
				Client sampling date / time	13-Mar-2018 00:00	14-Mar-2018 00:00	14-Mar-2018 00:00	----	----
Compound	*CAS Number*	*LOR*	*Unit*		**EB1807813-001**	**EB1807813-002**	**EB1807813-003**	**--------**	**--------**
					Result	Result	Result	----	----
EA033-C: Acid Neutralising Capacity									
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3		**0.11**	**0.15**	**0.02**	**----**	**----**
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t		**22**	**30**	<10	**----**	**----**
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S		**0.03**	**0.05**	<0.01	**----**	**----**

SAMPLE RECEIPT NOTIFICATION (SRN)

Work Order : **EB1807813**

Client	: **ENVIRONMENTAL EARTH SCIENCES**	Laboratory	: Environmental Division Brisbane
Contact	: LORETTA VISINTIN	Contact	: Peter Ravlic
Address	:	Address	: 2 Byth Street Stafford QLD Australia 4053
E-mail	: lvisintin@environmentalearthsciences.com	E-mail	: peter.ravlic@alsglobal.com
Telephone	: +61 02 99221777	Telephone	: +61-7-3243 7222
Facsimile	: +61 02 99221010	Facsimile	: +61-7-3243 7218
Project	: 717041	Page	: 1 of 2
Order number	:	Quote number	: ES2015ENVEAR0001 (EN/010/17)
C-O-C number	: ----	QC Level	: NEPM 2013 B3 & ALS QC Standard
Site	: Boral Stockton		
Sampler	: LORETTA VISINTIN		

Dates

Date Samples Received	: 27-Mar-2018 10:19	Issue Date	: 27-Mar-2018
Client Requested Due Date	: 04-Apr-2018	Scheduled Reporting Date	: **04-Apr-2018**

Delivery Details

Mode of Delivery	: Samples On Hand	Security Seal	: Not Available
No. of coolers/boxes	: ----	Temperature	: ----
Receipt Detail	: REBATCH	No. of samples received / analysed	: 3 / 3

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- **The samples in this work order have been re-batched from ES1807945.**
- Discounted Package Prices apply only when specific ALS Group Codes ('W', 'S', 'NT' suites) are referenced on COCs.
- Please direct any turn around / technical queries to the laboratory contact designated above.
- Sample Disposal - Aqueous (3 weeks), Solid (2 months) from receipt of samples.
- Analysis will be conducted by ALS Environmental, Brisbane, NATA accreditation no. 825, Site No. 818 (Micro site no. 18958).
- **Breaches in recommended extraction / analysis holding times (if any) are displayed overleaf in the Proactive Holding Time Report table.**

From: Loretta Visintin [mailto:lvisintin@eesigroup.com]
Sent: Tuesday, 27 March 2018 10:19 AM
To: ALSEnviro Sydney <ALSEnviro.Sydney@ALSGlobal.com>
Cc: Mark Stuckey <mstuckey@eesigroup.com>
Subject: RE: RESULTS & EDD for ALS Workorder : ES1807945 | Your Reference: 717041

Hello,

We have an additional analysis request; we would like to schedule ANC titration (EA033-C) analysis on the following samples:

1 • BH2_2.0
2 • BH4_6.0
3 • BH4_9.0

Standard turnaround will suffice, thanks.

Kind regards, Loretta

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

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APPENDIX E QUALITY ASSURANCE AND QUALITY CONTROL PROCEDURES

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1 DATA QUALITY OBJECTIVES

Development of data quality objectives (DQOs) for each project is a requirement of the National Environment Protection (Assessment of Site Contamination) Amendment Measure (NEPC 2013). Specific discussion in the development of the DQO's has been included in the main report.

Based on the DQOs the following measurement data quality indicators (MDQIs) are provided in Table 1.

TABLE 1 MEASUREMENT DATA QUALITY INDICATORS (MDQIS)

Parameter	Procedure	Minimum Frequency	Criteria	
			(5 to 10x LOR[4])	>10x LOR
Precision	Field Duplicates	1 in 20 - metals	<80 RPD	<50 RPD
		1 in 20 - semi-volatiles	<100 RPD	<80 RPD
		1 in 20 - volatiles	<150 RPD	<130 RPD
	Lab Replicate*	1 in 20	<50 RPD	<30 RPD
Accuracy*	Reference Material	1 in 10	60% to 140%R	80% to 120%R
	Matrix spikes			
	Surrogate spikes			
Representativeness*	Reagent Blanks	1 per batch	No detection	
	Holding Times*	Every sample	-	
Blanks**	Trip Blank	1 per batch	No detection	
	Rinsate Blanks			
Sensitivity	Limit of Reporting	Every sample	LOR < ½ site criteria	

Notes:

1. RPD – relative percentage difference;
2. %R – percent recovery;
3. LOR – limit of reporting;
4. [4] no limit at <5x LOR;
5. * the MDQI is usually specified in the standard method. If not, use the default values set out in this table; and
6. ** only necessary when measuring dissolved metals and volatile organic compounds in water samples.

It should be noted that Standards Australia (i.e. AS4482.1) specify that typical MDQIs for precision should be ≤50% RPD, however it should be noted that low concentrations and organic compounds can be acceptable if reported outside of this range. As the standard suggests, an RPD of >50% has been used as a 'trigger' and values above this level of repeatability have also been noted and explained.

Our adopted MDQIs for precision acknowledge the intrinsic heterogeneity of metal and semi volatile chemical concentrations in disturbed soil that may potentially cause large variations in results between laboratory subsamples (although all efforts are made to homogenise non volatile duplicate samples). Similarly, large variations in volatile chemical concentrations between duplicates may be unavoidable even when using best practice sampling

methodology, especially as we seek to minimise the disturbance to the sample while splitting it which means a high degree of inherent heterogeneity is expected.

As such, our adopted RPD criteria are considered to be a suitable measure for the reproducibility of results within a naturally heterogeneous media such as soil. A ≤50% RPD trigger value will be used, with any exceedance discussed and assessed for acceptability.

2 FIELD QA/QC PROGRAM

2.1 Sample collection, preservation, transportation and storage

Soil samples were collected and placed in appropriate sample containers as supplied by the nominated National Association of Testing Authorities (NATA) laboratory. Samples were labelled with the corresponding field/sample identification number, site reference and date in accordance with Environmental Earth Science sample procedures. Samples were placed in an iced container prior to transport to the nominated laboratory.

Soil samples were supplied to NATA accredited laboratories (ALS Laboratory) under a completed chain of custody (CoC). Copies of the CoC documentation and laboratory transcripts are provided in Appendix D of the main report.

2.2 Calibration of field equipment

The calibration of field equipment (hand held pH reader) was undertaken before and after each bore hole during the soil sampling program. The calibration records can be found within Attachment B.

2.3 Intra (blind) duplicate sampling

2.3.1 Soil

Four intra (blind) samples were collected during collection of soil samples. The relative percentage differences (RPD) calculations of the collected intra duplicate samples are presented in Table 2 below.

Calculated RPDs between the primary sample and their corresponding duplicate samples were all within the acceptable limits (MQDIS), as such, we consider the data set to be reliable.

TABLE 2 SOIL FIELD INTRA DUPLICATE RESULTS

Sample			Primary Sample	Intra duplicate sample	RPD%	Primary Sample	Inter duplicate sample	RPD%	Primary Sample	Inter duplicate sample	RPD%
Analyte	**units**	**LOR**	**BH1_15.5**	**FD2**		**BH4_3.5**	**FD3**		**BH4_6.0**	**FD4**	
Depth (m)			15.5	15.5		3.5	3.5		6.0	6.0	
pH KCl	pH Unit	0.1	9.5	9.3	2.1	6.6	6.3	4.7	5.3	5.6	5.5
Titratable Actual Acidity	mole H+/t	2	nd	nd	nd	nd	nd	-	4	nd	-
sulfidic - Titratable Actual Acidity	% pyrite S	0.02	0.01	0.01	0.0	0.01	0.01	0.0	0.01	0.01	0.0
Chromium Reducible Sulfur	% S	0.005	0.016	0.016	0.0	0.007	nd	-	0.027	0.025	7.7
acidity - Chromium Reducible Sulfur	mole H+/t	10	nd	nd	-	nd	nd	-	17	16	6.1
Acid Neutralising Capacity	% CaCO3	0.01	1.21	1.18	2.5	0.27	-	-	-	-	-
acidity - Acid Neutralising Capacity	mole H+/t	0.5	241	235	2.5	54	-	-	-	-	-
sulfidic - Acid Neutralising Capacity	% pyrite S	0.01	0.39	0.38	2.6	0.09	-	-	-	-	-
ANC Fineness Factor		0.5	1.5	1.5	0.0	1.5	1.5	0.0	1.5	1.5	0.0
Net Acidity	% S	0.02	nd	nd	-	nd	nd	-	0.03	0.03	0.0
Net Acidity	mole H+/t	10	nd	nd	-	nd	nd	-	21	17	21.1
Liming Rate	kg CaCO3/t	1	nd	nd	-	nd	nd	-	2	1	66.7
Net Acidity excluding ANC	% S	0.02	nd	nd	-	nd	nd	-	0.03	0.03	0.0
Net Acidity excluding ANC	mole H+/t	10	nd	nd	-	nd	nd	-	21	17	21.1

Sample			Primary Sample	Intra duplicate sample	RPD%	Primary Sample	Inter duplicate sample	RPD%	Primary Sample	Inter duplicate sample	RPD%
Analyte	**units**	**LOR**	**BH1_15.5**	**FD2**		**BH4_3.5**	**FD3**		**BH4_6.0**	**FD4**	
Liming Rate excluding ANC	kg CaCO3/t	1	nd	nd	-	nd	nd	-	2	1	66.7

Notes:

1. LOR level of reporting
2. RPD relative percentage difference
3. - not analysed, or RPD not calculable
4. nd – not detected above the Laboratory LOR

3 LABORATORY QUALITY CONTROL

3.1 Holding time

Analysed samples were extracted and analysed within acceptable holding times as defined in AS4482.1-2005.

3.2 Laboratories and analytical procedures

Laboratory analysis of primary and intra (blind) duplicate samples for this project was completed by ALS. The laboratory is accredited by NATA for the methods used, details of this accreditation can be viewed at http://www.nata.asn.au/, while details of the samples sent to each laboratory and the analysis requested are contained in the chain of custody documentation held in Appendix D of the main report. The analytical methods are noted on the laboratory transcripts.

3.3 Required limits of reporting

Acceptable limits of reporting (LOR) were provided by the analytical laboratory to allow the results to be compared against the soil investigation levels.

3.4 Laboratory method blanks

Reported results for laboratory method blank samples were acceptable or lower than laboratory LORs.

3.5 Laboratory duplicates

Laboratory duplicate results can be found in the analytical laboratory reports. The RPD between analytical results for primary samples and their corresponding laboratory soil duplicates were within acceptable limits.

4 ASSESSMENT OF DATA QUALITY

Based on information presented above, it can be confidently stated that the MDQO's for this project have been met and the data set is considered to be reliable for interpretative use.

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APPENDIX K

ABORIGINAL CULTURAL HERITAGE ASSESSMENT

STOCKTON SAND QUARRY DREDGING PROJECT (SSD 9490)
FULLERTON COVE, NSW

Aboriginal Cultural Heritage Assessment Report

Prepared for Element Environment Pty Ltd
on behalf of Boral Resources (NSW) Pty Ltd

Port Stephens Local Government Area

November 2019

Ref. 1829

KELLEHER NIGHTINGALE CONSULTING PTY LTD
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Document Information

Project Name	Stockton Sand Quarry Dredging Project (SSD 9490), Fullerton Cove NSW: Aboriginal Cultural Heritage Assessment Report
Project Number	1829
Version	v1
Client Name	Element Environment Pty Ltd for Boral Resources (NSW) Pty Ltd
Recipient	Luke Farrell (Element Environment)
Issue Date	01 November 2019
Prepared by	Dr Matthew Kelleher, Cristany Milicich, Ben Anderson
Approved by	Dr Matthew Kelleher

Executive Summary

Boral Resources (NSW) Pty Ltd ('Boral') owns and operates the Stockton Sand Quarry, a long standing operation that extracts and transports up to 500,000 tonnes of sand product per year for use in the building, landscaping and construction markets. The Stockton Sand Quarry is located behind Stockton Beach at Fullerton Cove, in the Port Stephens Local Government Area (LGA). Due to current and future demand for sand in the Hunter and Sydney regions, Boral is seeking approval for continued and expanded operations at the site through a State Significant Development (SSD) application (SSD 9490) to the NSW Department of Planning, Industry and Environment (DPIE). The proposed development (hereafter referred to as the 'Project') involves the staged extraction of sand from the inland vegetated dunes. Stage 1 will comprise dry extraction by front-end loader/excavator to a depth of 4 metres (m) Australian Height Datum (AHD) and subsequent Stages 2-6 will comprise wet extraction (dredging) from 4 m AHD to 15 m below sea level (-15 m AHD). The Project would seek to permit a site wide increase on the dispatch limit to 750,000 tonnes per annum (tpa) (i.e. the windblown sand extraction area and the Project operations combined) up until 2028 after which the site wide limit would reduce to no more than 500,000 tpa. The Project would be for a period of up to 25 years.

The Project is subject to approval under under Part 4 of the *Environmental Planning & Assessment Act 1979* (EP&A Act). Boral is currently undertaking detailed planning and assessment for the Project, including the preparation of an Environmental Impact Statement (EIS). Boral engaged Element Environment Pty Ltd ('Element') to assist with the preparation of the EIS for the Project. An Aboriginal heritage assessment is required as part of the EIS. Element engaged Kelleher Nightingale Consulting Pty Ltd (KNC) to prepare an Aboriginal cultural heritage assessment report (CHAR) to inform the EIS.

The preparation of the EIS is being undertaken in accordance with the Secretary's environmental assessment requirements (SEARs) issued by the Secretary of the DPIE. (Amended) SEARs for the Project were issued on 16 November 2018. This CHAR addresses the SEARs relating to Aboriginal heritage. The CHAR has been prepared in accordance with the EIS requirements for the Project and DPIE conservation division [formerly Office of Environment and Heritage (OEH)] requirements and guidelines for Aboriginal community consultation and archaeological assessment, including the *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW* and the *Aboriginal cultural heritage consultation requirements for proponents 2010*.

The review of background information revealed there were no known Aboriginal archaeological sites within the study area and proposed extraction area. While sites do occur within the wider Boral property, the study area is generally highly disturbed due to the previous extraction operations and removal of the bulk of the dune mass. Site inspection with the Aboriginal community confirmed the site condition and no Aboriginal objects, archaeological sites or areas of archaeological potential were identified. Subsurface archaeological deposits are considered unlikely to occur given the study area's geomorphological context and the nature and extent of prior extraction disturbance.

Consultation with registered Aboriginal stakeholders was undertaken to identify Aboriginal cultural/social heritage values in the study area, assess impacts of the proposed expansion activities and develop appropriate management recommendations. Consultation with the 19 registered Aboriginal stakeholders identified that the local area has cultural heritage value to the local Aboriginal community. In particular, Aboriginal stakeholders expressed the cultural importance and significance of the vegetated hind dune landscape around the study area. No specific Aboriginal cultural values have been identified within the study area. Boral values Aboriginal community consultation and is committed to ongoing consultation with Aboriginal stakeholders for the Stockton Sand Quarry Dredging Project.

The configuration of the proposed extraction pits has been developed having regard to the constraints of the land, the desire to mitigate and avoid impacts where possible, whilst balancing the commercial viability of the Project and the extent of the known resource. The Project seeks to capitalise on sand availability within the area of existing and previous operations, maximising output from existing production facilities. This results in a smaller disturbance footprint and minimises environmental impacts compared to expansion into un-quarried adjacent areas within the wider property. Impact to intrinsic Aboriginal cultural values of the surrounding landscape is also minimal.

No Aboriginal heritage constraints have been identified for the Project. No avoidance or mitigation measures are required for the Project on Aboriginal heritage grounds.

Management measures should be implemented for adjacent areas (outside of proposed impact area and study area). Aboriginal objects are known to occur in adjacent landforms and these must be avoided by all proposed extraction activities. Management measures to be implemented should include clear delineation of the boundary of the approved impact area and the inclusion of Aboriginal heritage in the existing Environmental Management Strategy (EMS). Documented toolbox talks should also be held to ensure all on-site staff and contractors are aware of obligations and requirements regarding the protection of Aboriginal heritage.

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1 Introduction

1.1 Development Context

Boral Resources (NSW) Pty Ltd ('Boral') owns and operates the Stockton Sand Quarry, a long standing operation that extracts and transports up to 500,000 tonnes of sand product per year for use in the building, landscaping and construction markets. The Stockton Sand Quarry is located behind Stockton Beach at Fullerton Cove, in the Port Stephens Local Government Area (LGA).

Due to current and future demand for sand in the local Hunter and Sydney regions, Boral is seeking approval for continued and expanded operations at the site through a State Significant Development (SSD) application (SSD 9490) to the NSW DPIE. The Project involves the staged extraction of sand from the inland vegetated dunes. Stage 1 will comprise dry extraction by front-end loader/excavator to a depth of 4 metres (m) Australian Height Datum (AHD) and subsequent Stages 2-6 will comprise wet extraction (dredging) from 4 m AHD to 15 m below sea level (-15 m AHD). The Project would seek to permit a site wide increase on the dispatch limit to 750,000 tpa (i.e. the windblown sand extraction area and the Project operations combined) up until 2028 after which the site wide limit would reduce to no more than 500,000 tpa. The Project would be for a period of up to 25 years.

The Project will provide:

- supply of essential natural sand to major infrastructure and associated development projects;
- employment of six full time employees and truck/transportation drivers, with further jobs created through flow-on effects;
- optimal use of a regionally-significant resource; and
- economic benefits to the local community through the purchase of goods and services and local expenditure both directly and indirectly through employee wages.

The Project is subject to approval under under Part 4 of the *Environmental Planning & Assessment Act 1979* (EP&A Act). Boral is currently undertaking detailed planning and assessment for the Project, including the preparation of an Environmental Impact Statement (EIS). Boral engaged Element Environment Pty Ltd ('Element') to assist with the preparation of the EIS for the Project. An Aboriginal heritage assessment is required as part of the EIS. Element engaged Kelleher Nightingale Consulting Pty Ltd (KNC) to prepare an Aboriginal cultural heritage assessment report (CHAR) to inform the EIS.

The preparation of the EIS is being undertaken in accordance with the Secretary's environmental assessment requirements (SEARs) issued by the Secretary of the DPIE. (Amended) SEARs for the Project were issued on 16 November 2018. This CHAR addresses the SEARs relating to Aboriginal heritage. The CHAR has been prepared in accordance with the EIS requirements and DPIE conservation division [formerly Office of Environment and Heritage (OEH)] requirements and guidelines for Aboriginal community consultation and archaeological assessment.

1.2 Project location and description

The Stockton Sand Quarry along located at Stockton Beach, in the suburb of Fullerton Cove, approximately 10.5 kilometres north east of the Newcastle CBD (Figure 1). The site is owned and operated by Boral and covers an approximate area of 246 hectares. Boral's land holding is identified as Lots 1 and 2 DP 1006399 and Lot 3 DP 664552. The site is accessed via a road over an adjacent Crown reserve (Lot 7300 DP1130730) under licence agreement with DPIE Crown Lands.

Under Boral's ownership there have been two primary development consents granted, these include:

- DA 2010/94: The 'inland extraction area' (also known as pits 1 – 6) granted by Port Stephens Council in May 1996; and
- DA 140-6-2005: The 'windblown sand extraction area' (also known as the "windblown project" or pit 7) located on the transgressive dunes adjoining Stockton Beach granted by the Department of Planning in 2006.

The inland extraction operation (DA2010/94) on the vegetated dunes occurred above 5 metres AHD and ceased in 2008 and rehabilitation has been ongoing. This former extraction area is generally consistent with the Project site and is the focus of this Development Application.

The windblown sand extraction area started operations in 2008 and in accordance with condition 5 of the development consent has a 20 year life, due to cease in 2028.

The location of the Project is generally consistent with the same disturbance footprint associated with the former inland extraction area approved under the 1996 development consent, with the exception of areas to east and south east of Lot 3 and along the southern edge to allow for the construction of new haul roads. This area was previously subject to assessment in the *Environmental Impact Statement, For a Sand Extraction Operation on Boral Resources Freehold Property at Fern Bay, Near Newcastle NSW* (ERM Resource Planning Pty Ltd ('ERM') 1994).

The 'study area' for this CHAR comprises the proposed extraction area and impact area for the current Project. The study area is shown in Figures 1 and 2. The study area is substantially the same footprint as the inland extraction area approved under the 1996 development consent and extends over Lot 1 DP 1006399 and partially into Lot 3 DP664552. The study area covers an area of approximately 37 hectares and encompasses all areas to be disturbed by Project operations. The nature of disturbance associated with the Project will occur progressively over six stages and include tree clearing, installation of site infrastructure, access roads, excavation and dredging operations.

As the site is an existing sand quarry, there are minimal site establishment works required, as the Project will predominantly utilise existing infrastructure and services. Where new or augmented infrastructure is required this will be delivered as part of Stage 1 of the Project and will generally include:

- Construction of new entry, exit and associated haul roads to connect with established haul road network;
- Establishment of a pad for the washplant and diesel generator;
- The existing site depot will also be reconfigured to support the Project and will include the following:
    - installation of a new prefabricated office building;
    - relocation of light vehicle parking;
    - relocation of entry gates (inside Boral's boundary); and
    - relocation of onsite of material storage.

Similar to previous operations of the inland extraction area, sand extraction will involve clearing and grubbing of established vegetation from previous rehabilitation and possible sieving of accumulated leaf litter and organic matter. Cleared vegetation will either be mulched or stockpiled on-site for later reuse in rehabilitation. Similarly, any stripped topsoil would be retained for use in rehabilitation efforts across the site.

Stage 1 will involve dry extraction, removing sand via a front-end loader which pushes into the exposed sand face. As the sand is relatively free-flowing, material falls towards the front-end loader at the natural angle of repose. The front-end loader or excavator then loads road trucks in-pit with screened raw sand for transport off-site via the weighbridge.

Following initial dry extraction of sand in Stage 1 above the water table to a depth of 4 m AHD, a pond will be created in the area of Stage 2. The pond will be made large enough to float a dredge and accommodate fresh water pumping for the proposed wash plant. The dredge will move progressively through the extraction area generally following the nominated stages. In most cases, the sand in each extraction stage is fully extracted unless constraints are encountered.

The dredge will move backwards and forwards across the active dredge pond, suctioning away against the underwater sand face. The sand / water mix will be pumped directly from the dredge via a pontoon-mounted pipeline to the wash plant in the processing area. The dredge manoeuvres around the pond and its position is stabilised by tie ropes connected to the banks around the active pond.

The dredge will then progressively extract sand in a south westerly direction in a staged process. Extraction will then move to the east and culminate with relocation of the proposed processing and stockpile area to a confined area in Stage 1 and subsequent dredging of the majority of the Stage 1 extraction area (to be known as Stage 6). Sand will be extracted to a maximum depth of approximately 15 m below the sea level (0 m AHD).

Project features are shown in Figure 3.

1.3 Purpose of this report

The Project is subject to assessment by the DPIE and approval under the EP&A Act which requires preparation of an EIS. This CHAR is one of a number of technical papers that forms part of the EIS. The purpose of this technical paper is to identify and assess the Aboriginal heritage impacts of the Project. In doing so it responds directly to the SEARs as outlined in section 1.4. This report has also been prepared in accordance with the DPIE requirements and guidelines relating to the assessment of Aboriginal heritage in NSW. These include:

- *Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW* (OEH 2010a);
- *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW* (OEH 2011);
- *Aboriginal cultural heritage consultation requirements for proponents 2010* (OEH 2010b); and
- *NSW Skeletal Remains: Guidelines for Management of Human Remains* (Heritage Office 1998).

1.4 Secretary's environmental assessment requirements

This CHAR has been prepared to address the SEARs for the Project for the purpose of seeking project approval under the EP&A Act. The CHAR addresses the Standard Environmental Assessment Requirements provided for the Project. Table 1 outlines the requirements relevant to this assessment and where they are addressed in the report.

Table 1. SEARs: Aboriginal Heritage

General requirements	Where addressed in this document
An assessment of the potential impacts on Aboriginal heritage (cultural and archaeological), including evidence of appropriate consultation with relevant Aboriginal communities/parties and documentation of the views of these stakeholders regarding the likely impact of the development on their cultural heritage	Section 2 Section 5 Appendices A-C
Specific requirements	**Where addressed in this document**
5. The Environmental Impact Assessment (EIS) must identify and describe the Aboriginal cultural heritage values that exist across the whole area that will be affected by the development and document these in the Aboriginal Cultural Heritage Assessment Report (ACHAR). This may include the need for surface survey and test excavation. The identification of cultural heritage values should be guided by the *Guide to investigating, assessing and reporting on Aboriginal Cultural Heritage in NSW* (DECCW, 2011) and consultation with OEH regional branch officers.	Section 2 Section 5 Section 6 Section 7
6. Consultation with Aboriginal people must be undertaken and documented in accordance with the *Aboriginal cultural heritage consultation requirements for proponents 2010* (DECCW). The significance of cultural heritage values for Aboriginal people who have a cultural association with the land must be documented in the ACHAR.	Section 2 Section 7 Appendices A-C
7. Impacts on Aboriginal cultural heritage values are to be assessed and documented in the ACHAR. The ACHAR must demonstrate attempts to avoid impact upon cultural heritage values and identify any conservation outcomes. Where impacts are unavoidable, the ACHAR must outline measures proposed to mitigate impacts. Any objects recorded as part of the assessment must be documented and notified to OEH.	Section 8

1.5 CHAR objectives

The objectives of the CHAR are to:

- Undertake background research and primary investigations, including ethnohistorical, landscape/environmental, archaeological and cultural, to identify Aboriginal cultural heritage places and values within the study area – addressed in Chapters 2-6;
- Involve Aboriginal stakeholders in all stages of Aboriginal heritage assessment and development of management recommendations – addressed in Chapter 2;
- Identify and assess Aboriginal archaeological and cultural heritage places and values within the study area including an assessment of significance – addressed in Chapters 2-6, Chapter 7;
- Identify and assess the actual or likely harm to Aboriginal objects or Aboriginal places from the proposed activities of the project – addressed in Chapter 8; and
- Identify any practical measures that may be taken to protect and conserve Aboriginal objects or Aboriginal places and any practical measures that may be taken to avoid or mitigate any actual or likely harm to Aboriginal objects or Aboriginal places – addressed in Chapters 8-9 (no harm identified).

The DPIE *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW* provides further guidance on the preparation of a CHAR. This report has been prepared in accordance with the requirements of the Regulation and the DPIE guide.



Figure 1. Location of the Stockton Sand Quarry and study area

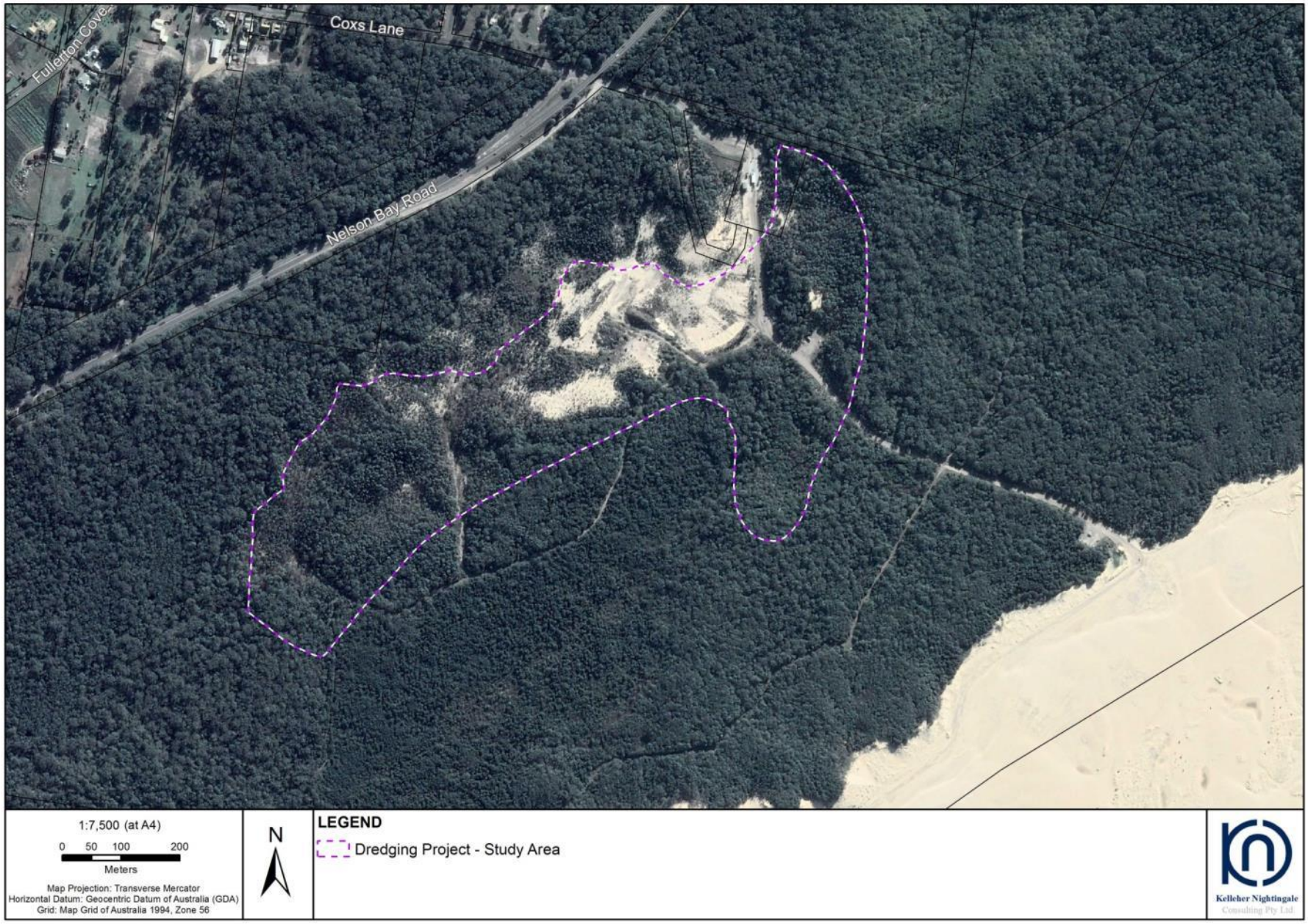

Figure 2. Detail of the study area

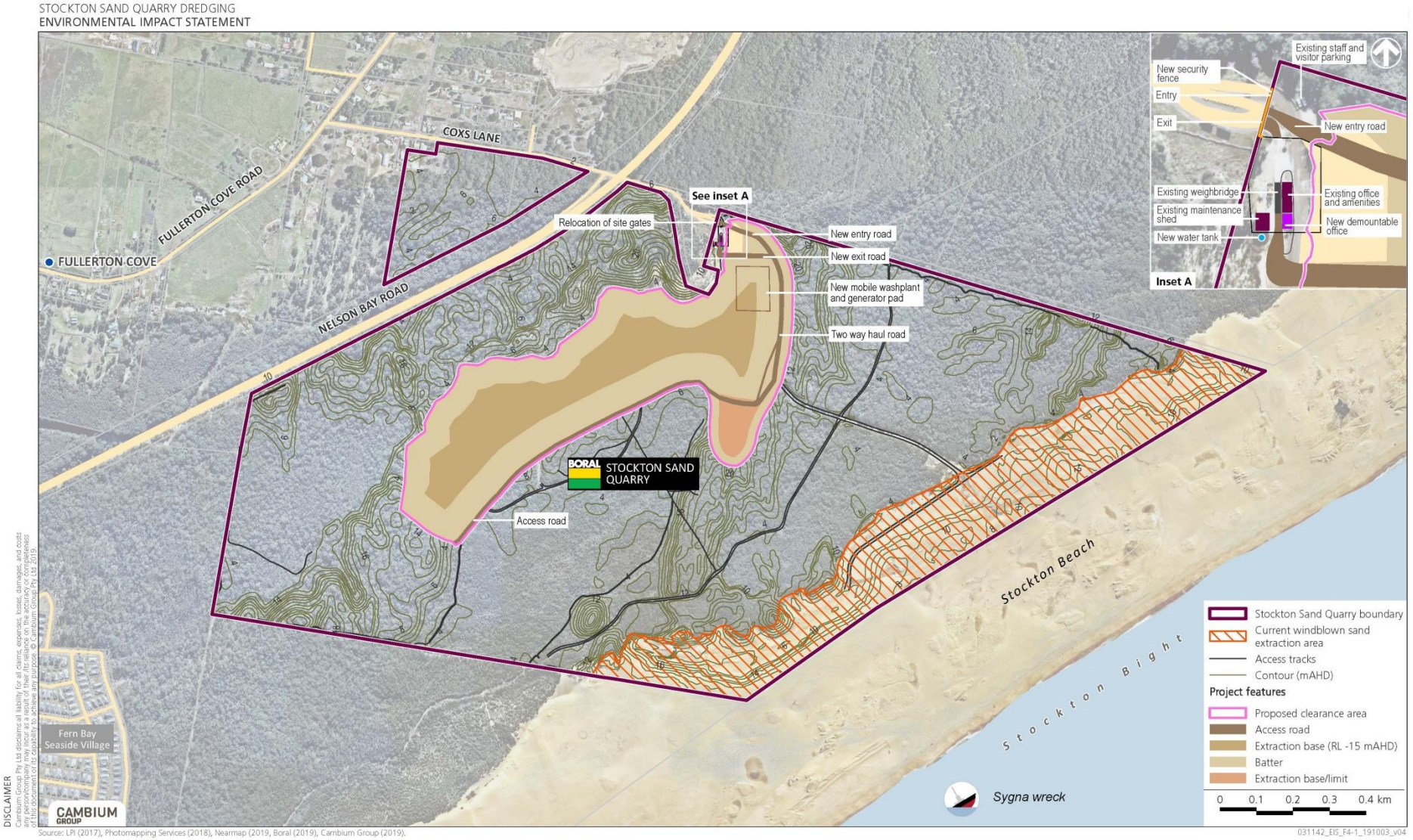

Figure 3. Key features of the Project (Element 2019:Figure 4.1)

2 Aboriginal Community Consultation

The aim of Aboriginal community consultation is to integrate cultural and archaeological knowledge and ensure registered stakeholders have information to make decisions on Aboriginal cultural heritage. For the preparation of this CHAR, consultation with Aboriginal people has been undertaken in accordance with the *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (OEH 2010b) and the requirements of Clause 80C of the *National Parks and Wildlife Regulation 2009*. The formal consultation process has included:

- government agency notification letters (letters dated 15 February 2019);
- advertising for registered stakeholders in local media (*Port Stephens Examiner* 7 March 2018: refer Appendix A);
- notification of closing date for registration (21 March 2019);
- ongoing compilation of registrants list, through continuing to register individuals and groups for consultation on the project;
- provision of project information and proposed cultural heritage assessment methodology (letters dated 3 April 2019) allowing for a 28 day review period;
- provision of draft CHAR (letters dated 9 September 2019) allowing for a 28 day review period; and
- ongoing consultation with the local Aboriginal community.

Aboriginal stakeholders were consulted throughout all stages of the assessment process. A full log of consultation is attached as Appendix B. Boral is committed to ongoing consultation with the Aboriginal community.

2.1 Registration of interest

Aboriginal people who hold knowledge relevant to determining the cultural heritage significance of Aboriginal objects and Aboriginal places in the area were invited to register an interest in a process of community consultation. Sixteen groups or individuals registered an interest in the Project. Investigations included consultation with Aboriginal community individuals and groups as listed in Table 2.

Table 2. Registered Aboriginal stakeholders

Registered Aboriginal Stakeholder	Representative and/or Contact Person
Worimi Local Aboriginal Land Council (LALC)	Jamie Merrick
Murra Bidgee Mullangari Aboriginal Corporation	Ryan Johnson
Didge Ngunawal Clan	Paul Boyd and Lilly Carroll
Merrigarn Indigenous Corporation	Shaun Carroll
Muragadi Heritage Indigenous Corporation	Anthony Johnson
Nur-Run-Gee Pty Ltd	Leonard Anderson OAM
Lower Hunter Wonnarua Cultural Services	Tom Miller
Worimi Traditional Owners Indigenous Corporation	Candy Towers
A1 Indigenous Services	Carolyn Hickey
Murrooma Incorporated	Anthony Anderson
Karuah Indigenous Corporation	David Feeney
Widescope Indigenous Group	Steven Hickey
Worimi Conservation Lands (WCL Board of Management c/o Graeme Russell)	Graeme Russell
Amanda Hickey Cultural Services	Amanda Hickey
Aboriginal stakeholder (details withheld)	Aboriginal stakeholder (details withheld)
Aboriginal stakeholder (details withheld)	Aboriginal stakeholder (details withheld)

*Two stakeholders specified they did not want their details released in accordance with item 4.1.5 of the *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010*

2.2 Consultation regarding the land and proposed activity

Following on from Stage 1 of the consultation process undertaken by KNC (stakeholder identification and registration), project-specific consultation was undertaken. Information regarding the proposed extraction project was provided to registered Aboriginal stakeholder groups in a letter dated 3 April 2019. Information included an outline of the Project, location of the study area, development approval context and an invitation to consult during the assessment.

Stakeholders were also provided with the proposed assessment methodology for the Cultural Heritage Assessment Report, and invited to review and provide feedback (review period of 28 days, closing on 1 May 2019). An invitation was extended for Aboriginal cultural knowledge holders and stakeholders to provide comments on the proposed cultural heritage assessment methodology, including any protocols regarding the gathering of information and any matters such as issues/areas of cultural significance that might affect, inform or refine the assessment methodology.

Stakeholders were invited to attend a site inspection of the study area with the proponent and project archaeologist. All stakeholders were invited to attend (invitations sent 18 June 2019) or provide a representative. The site inspection took place on 27 June 2019.

2.3 Stakeholder responses to the proposed assessment methodology for the Cultural Heritage Assessment Report

Responses to the proposed assessment methodology were received from A1 Indigenous Services (A1), Murra Bidgee Mullangari Aboriginal Corporation (MBMAC), Muragadi Heritage Indigenous Corporation (MHIC), Murrooma Incorporated (Murrooma), Merrigarn Indigenous Corporation (Merrigarn), Widescope Indigenous Group (WIG), and Worimi Traditional Owners Indigenous Corporation (WTOIC).

A1 stated that they supported the proposed CHAR methodology and expressed interest in being involved in any potential fieldwork associated with the project (email dated 13 April 2019).

MBMAC stated they had read the project information and proposed assessment methodology and endorsed the proposed approach (email dated 3 April 2019).

MHIC stated that they endorsed KNC's assessment recommendations and had reviewed the project information and methodology (email dated 3 April 2019).

Murrooma responded via email (9 April 2019) and requested some additional information prior to making comment, including a map of the proposed dredging area. KNC responded on 9 April 2019 and provided a map. Further comment was then provided by Murrooma on 23 April 2019. Murrooma stated that they agreed with the proposed assessment methodology and consultation process for the Project, and noted their involvement with previous assessments in the area. In particular, Murrooma identified the dune ridges as traditional transit routes along the coast, and noted the presence of culturally significant Worimi sites in the surrounding area. Murrooma also stressed the importance of having local knowledge holders involved in the consultation process.

Merrigarn stated that they had read the project information and proposed assessment methodology and supported the recommendations made by KNC (email dated 3 April 2019).

WIG expressed support for the proposed methodology (email dated 19 April 2019).

WTOIC expressed that the Project area held cultural significance for the Worimi people (email dated 6 May 2019) and recommended further assessment of the area due to the potential to find artefacts. WTOIC affirmed that it was "extremely important to our Worimi people to gain the best outcome for protection and preservation of our local sites/objects".

2.4 Site inspection

A site inspection was undertaken with Aboriginal stakeholder representatives on 27 June 2019. Stakeholders attended across two sessions in the morning and afternoon. Representatives from Worimi LALC, Didge Ngunawal Clan, Nur-Run-Gee Pty Ltd, Murrooma, Worimi Conservation Lands, Karuah Indigenous Corporation, Widescope Indigenous Group and Amanda Hickey Cultural Services attended the inspection and Worimi LALC, Didge Ngunawal Clan, Nur-Run-Gee Pty Ltd, Murrooma, Worimi Conservation Lands and Karuah Indigenous Corporation representatives took part in the site walkover. Representatives were accompanied by project archaeologist Dr Matthew Kelleher (KNC) and Neil Gascoyne (Quarry Manager, Boral).

The site inspection included a discussion of the site history and existing quarrying disturbance, further discussion of the Project, proposed extraction staging, remediation and archaeological context of the local area including location of nearby previously recorded sites. A site walkover was undertaken of the study area.

No Aboriginal objects were identified and representatives concurred with the assessment of existing severe disturbance within the study area and proposed extraction area.

2.5 Review of draft CHAR

The draft CHAR was provided to stakeholders with an invitation to review and provide comment (draft CHAR review package sent 9 September 2019). Stakeholders were invited to provide further comment on the Aboriginal cultural significance of the study area and the management recommendations presented in the report. A 28 day review and comment period was provided.

Two responses were received from stakeholders. Comments are attached in full in Appendix C and summarised below.

2.6 Stakeholder responses to draft CHAR

MBMAC stated that they had received and reviewed the draft CHAR, and endorsed the recommendations made in the document (email dated 12 September 2019).

Muragadi stated that they agreed with the recommendations made in the report (email dated 13 September 2019).

2.7 Ongoing consultation

Boral values Aboriginal community consultation and is committed to ongoing consultation with Registered Aboriginal Stakeholders for the Stockton Sand Quarry Dredging Project.

2.8 Aboriginal cultural values

It has been identified during the consultation process to date that the wider study area has cultural heritage value to the local Aboriginal community. Some of the Aboriginal cultural heritage values expressed by stakeholders include:

- strong association with the land;
- responsibility to look after the land, including the heritage sites, plants and animals, waterways, beaches, ocean and the land itself;
- scarred trees;
- artefact sites and middens;
- water sources, wetlands, creek lines and rivers, especially major landscape features such as the Hunter River and Fullerton Cove;
- indigenous plants and animals; and
- general concern for burials, as their locations are not always known and they can be found anywhere.

Numerous stakeholders have expressed close familial and traditional connections with the area, and stakeholders retain oral histories and cultural knowledge of the area. Stakeholders expressed the importance of education and protection of Aboriginal cultural heritage, and consideration of the landscape as a whole when assessing archaeological sites and their connections across Country. Aboriginal cultural values and knowledge of the area have been provided by registered stakeholders throughout the consultation process to date and are summarised below.

Murrooma highlighted the importance of the general area, stating that “there are many places within this area that have significant cultural value to Worimi people and are in close proximity to the proposed project. These places of social, spiritual and cultural value are traditional areas with direct linkage to our ancestors and storylines” (letter dated 23 April 2019). Murrooma noted that traditional uses of the area included transit routes across the dune fingers and stressed that local knowledge holders and Traditional Owners from the area should be the source of specific cultural information for the study area.

WTOIC noted that the area was culturally significant to Worimi people (email dated 6 May 2019).

3 Environmental Context

3.1 Geology and geomorphology

The Stockton Sand Quarry is located within the Hunter subregion of the Sydney Basin, bordering the Pacific Ocean. The Sydney Basin is a large geological feature stretching from Batemans Bay in the south to Newcastle in the north and Lithgow in the west. The formation of the basin began between 250 to 300 million years ago when river deltas gradually replaced the ocean that had extended as far west as Lithgow (Pickett and Alder 1997). Fluctuating marine advances and regressions deposited sediment onto older basement rocks of the Lachlan Fold Belt and Late Carboniferous volcanoclastic sediments.

The Hunter subregion comprises a complex of Permian shales, sandstones, conglomerates, volcanics and coal measures, and is bounded on the north by the Hunter Thrust fault and on the south by cliffs of Narrabeen Sandstone. A Quaternary coastal barrier system is present in the Newcastle/Stockton Bight (National Parks and Wildlife Service (NPWS) 2003:191). The quarry is located within this coastal barrier system in the Stockton Bight. Stockton Bight (also known as Newcastle Bight) is a wide south facing coastal embayment bordered by Nobbys Head at Newcastle in the south and Birubi Point at Anna Bay in the north. The bedrock of Nobbys Head and the higher relief of Newcastle border the southern side of Stockton Bight, comprising the various Permian age subgroups of the Newcastle Coal Measures (coal, tuff, conglomerate, sandstone and shale) (Gorbert and Chesnut 1975).

The Hunter River has been deflected to the south by the Stockton Bight barrier system and enters the sea against Nobbys Head. The Bight sediments abut the sedimentary Permian rocks of the Tomago coal measures (shale, mudstone, sandstone, coal, tuff and clay) and Mulbring siltstone (siltstone, claystone, sandstone, conglomerate and limestone) between Raymond Terrace and Big Swan Bay, and at the northern end of the Bight abut the older Carboniferous Nerong Volcanics at Birubi Point (toscanite, dacite, andesite, ignimbrite, agglomerate, conglomerate, sandstone and siltstone). Between the Stockton training wall of the Hunter River and Birubi Point is the Stockton sand barrier system. The coastal barrier system consists of a gently curving Quaternary sand dune barrier system that comprises four major components (ERM 2005a:42):

- an inner (Pleistocene) barrier extending from the Hunter River to Lemon Tree Passage which was deposited as a series of parallel beach ridges and transgressive dunes approximately 120,000 years ago;
- a back-barrier depression backs the inner barrier and is occupied by the Hunter River - Raymond Terrace - Grahamstown Reservoir and Port Stephens;
- an interbarrier depression occupied by Fullerton Cove - Salt Ash – Tilligerry Creek; and
- an outer (Holocene) barrier that was deposited after the last post-glacial sea level rise, approximately 6,000-6,500 years ago.

Aeolian erosion and redeposition have reworked the surfaces of both barriers and in addition the morphology of the beach ridges has been modified by fluvial denudation. The Stockton Sand Quarry is located in the Holocene outer barrier system. The outer barrier includes the present beach and dune system and was initiated by waves and wind once post-glacial sea levels stabilised. The outer barrier has been through four periods of development (Short 2017:6):

1. 6,500-5,000 BP: Development of the Holocene foredune ridge plain. Waves delivered sand that progressively built the shoreline seaward by 3km, leaving a series of undulating foredune ridges. These extended the length of the bight and were fully vegetated. The only ridges visible today are located at the northeastern end of the bight, the majority having been exhumed, reworked and buried by subsequent dune movement;
2. 5,200-4,000 BP: Phase 1 dune transgression. The initial development and subsequent inland migration of the Phase 1 transgressive dune system buried the old land surface. Phase 1 dunes were then vegetated and stabilised up to 3km inland;
3. 2,000 BP: Phase 2 dune transgression. Second dune transgression moved up to 2km inland, reworking and burying earlier Phase 1 dunes. Phase 2 dunes were then vegetated and stabilised; and
4. 500 BP-ongoing: Phase 3 dune transgression. Phase 3 dunes have started moving inland as bare sand, excavating the outer foredune ridges and burying Phase 2 dunes. The Phase 3 dunes have moved several hundred metres inland since the commencement of transgression, and currently form an active, unstable and unvegetated transverse dune system along the bight.

The study area for the current Project is located atop a series of stable, vegetated dune ridges associated with the Phase 1 and 2 dune transgressions. ERM (1994) examined the age of the dune system within the previous extraction area. The study identified that the majority of the extraction area was positioned within the dune system estimated to be between 1200 and 2300 years old (Phase 2 transgression), with a small portion of the extraction area along the northern boundary of the site adjacent to Nelson Bay Road identified to be around 4500 years old (Phase 1 transgression) (Element 2019:64).

This accords with more recent coastal geomorphology assessment undertaken for the current Project (Short 2019), which confirmed that the Project area was located within the Phase 1 and 2 dunes. These are located atop the former Holocene foredune ridge plain (6,500-5,000 BP). During the initial development of the outer barrier, the prograding shoreline was capped by this series of well vegetated undulating foredune ridges and swales with an elevation between 5 and 10 metres (Short 2019:2). The foredune ridges would have provided a suitable sheltered area close to the ocean shore for Aboriginal occupation sites, albeit within a changing geomorphological system. Archaeological material located on the surface of these 5-10 metre high landforms would likely have been retained at or near the surface given the stabilising effect of vegetation but would have been vulnerable to erosion and displacement in areas of disturbance.

Old land surfaces associated with this phase of barrier development area known to contain midden sites where exposed by the ongoing Phase 3 dune transgression closer to the current shoreline (see Section 5). Further inland, successive periods of exhumation, reworking and reburial of the foredune ridges have taken place associated with the Phase 1-2 dune transgressions. Excavation to 5 metres AHD during previous extraction work associated with the inland extraction area is expected to have removed material to below the depth at which Aboriginal occupation evidence associated with either the Holocene foredune ridge plain or Phase 1-2 dunes would be expected to occur. It is therefore unlikely that the study area retains Aboriginal occupation evidence.

The remaining Phase 1-2 relict series of vegetated beach parallel dunes and intervening low profile sand sheets forms a distinct geomorphological unit within the outer barrier system, and contrasts with the active, mobile Phase 3 dune transgression currently taking place to the east along the margin of the sand quarry property boundary.

Recent Quaternary coastal geology mapping (Figure 4; Hashimoto and Troedson 2008) shows the geological units which underlie the Boral property at Stockton. The eastern extent of the Boral property is located atop Holocene age mobile dunes comprised of marine sand (Qhbdm), corresponding to the geomorphological unit of existing beach and unstable high dunes. The majority of the property (including the entirety of the study area) is located atop Holocene dunes of marine sand (Qhbd), corresponding to the older stable, vegetated beach parallel dunes and intervening sand sheets. Small areas to the west and north are mapped as Holocene beach ridge swales and dune deflation hollows (Qhbw) comprising marine sand, organic mud and peat. Some small areas of Holocene freshwater swamp (Qhs) have developed in these low-lying areas, comprising organic mud, peat, clay and silt with a marine sand component. Almost the entirety of the current study area has been modified by previous sand mining activity.

3.2 Topography and hydrology

The majority of Boral's property comprises relatively stable and vegetated hind dune and inter dune environments, while the south eastern property boundary encompasses the un-vegetated and mobile foredune environment. An existing and ongoing windblown sand extraction program is located along the sheltered side of this un-vegetated mobile dune. Elevations of the dunes in the vicinity of the quarry typically range from 8 to 16 metres AHD with some in excess of 20 metres AHD, while the lowest interdunal areas are approximately 4 metres AHD (RPS 2016 in Element 2019:8).

Originally, two parallel dune ridges were present on the property but large portions of these (the current study area) have been subject to previous sand quarrying and rehabilitation and do not retain a natural topography. The rehabilitated surface is undulating with steep cut slopes. Prior to previous sand extraction, the 1994 EIS described the original natural topography of the ridges. The westernmost ridge had a northeast-southwest orientation and a maximum height of 36 metres AHD along the northern Boral property boundary. The ridge comprised a series of steep-sided conical sand knolls connected by more gentle undulating areas. Slopes were variable but localised gradients were as high as 40%. The lower ridge to the east was described as diverging in a north-south direction and ranging from 20-34 metres AHD. The intervening low sand sheet separating the two ridges had an elevation of approximately 5 metres AHD. The removal of substantial sand mass is evident when comparing this to the current site topography.

No springs or permanent streams are present within the study area or the larger Boral property. Several small semi-permanent waterholes are present around the stable, vegetated dunes and shallow water pools form in the inter-dunal swales of the active transgressive dunes to the east after periods of rain, persisting when deflation reaches the water table. Shallow ponding across the sand sheets separating the older dunes also occurs as a result of naturally low lying interdunal swales where there is interaction with shallow groundwater. It is also possible that some surface runoff which does not infiltrate through the sand may accumulate in these swale areas contributing to the ponding (Element 2019:8). Previous assessments indicate the water table within the current study area fluctuates between 1.5-4 metres AHD (ERM 1994:5.10-5.11).

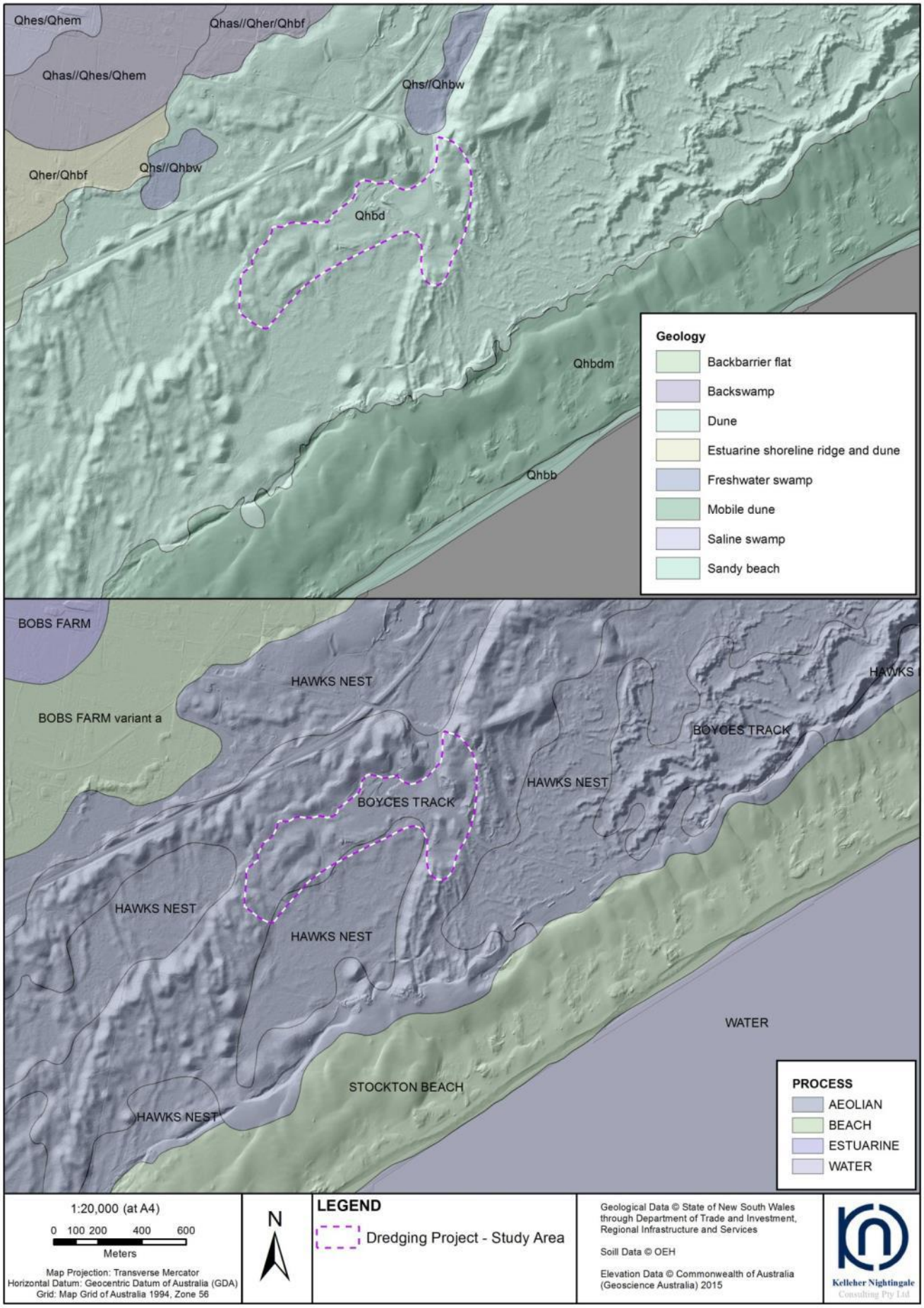

Figure 4. Geology and soils of the study area

3.3 Soil landscapes

The study area intersects two soil landscapes. The majority of the area is located atop the aeolian Boyces Track soil landscape. Boyces Track soils occur on the steep, stable Holocene transgressive aeolian dunes of the Tomago Coastal Plain, primarily arranged as two long walled ridges parallel to the shoreline between Stockton and Bobs Farm. Local relief is between 10-30 metres with slope gradient <30%. Windward dune slopes are generally longer and gentler than leeward slopes. Soils comprise deep (>300 cm), well-drained weakly developed Podzols under native vegetation with loose, loamy sand topsoils. Occurrence and relationship of soil material is generally up to 40 cm of speckled loose loamy sand (A1 horizon) overlying up to 100 cm of bleached loose light grey sand (A2 horizon), which overlies up to a 50 cm of faintly mottled sand (weak Bhs horizon) and >500 cm of loose dull yellow orange sand (C horizon (parent material).

The long ridges occupied by the Boyces Track soils are separated by a low relief sand sheet where the Hawks Nest soil landscape occurs and intersects the eastern margins of the current study area. Hawks Nest soils occur on the low Holocene sandsheets, swales and low transgressive dunes, comprising deep (>300 cm), well-drained Podzols and Siliceous Sands/Podzols on dunes and deep (>200 cm), poorly drained Humus Podzols on sandsheets (Matthei 1995:215). Local relief is <3 metres with slope gradients <10%. Low sandy dunes and swales are the dominant landform elements. Soil type is dependent on the age of the sand body (Matthei 1995). Along the coastal fringe, soil development is very poor on the younger dunes apart from some organic matter build-up on the surface and minor development of a Bhs horizon. Typical occurrences and relationship of soil materials is as follows: up to 40 cm of loose speckled grey-brown loamy sand (A1) overlies 10–150 cm of bleached loose sand (A2). This overlies 30–>100 cm of coloured mottled sand (B horizon) and over 300 cm of greyish yellow brown sand (C horizon). There are well-drained Siliceous Sand/Podzol intergrades on the seaward fringe, while Podzols occur landward.

Both soil landscapes are highly susceptible to wind erosion and mass movement if disturbed, being non-cohesive, and locally steep slopes also occur. The Boyces Track and Hawks Nest soil landscapes (which occur on the stable Phase 1 and 2 dune systems and intervening sand sheets) are gradually being engulfed by the Stockton Beach soil landscape associated with the active transgressive Phase 3 dune to the east. The stabilised dunes within the study area have previously been assessed by various mining companies for their heavy mineral content. The drilling and logging data from these assessments was considered by Boral in the 1994 EIS (ERM 1994:5.4-5.7). This included 74 holes drilled by Mineral Deposits Ltd (MDL) in 1989 and a further 175 holes by RZM Pty Ltd in 1990. In both explorations, holes were arranged along parallel lines across the Boral property. Two cross sections were prepared for the EIS based on the results. Both cross sections cover the current study area. The cross sections demonstrated fine to medium-grained, light brown to buff coloured sand to approximately 3-6 metres below sea level. Below this was a substrate of fine to coarse-grained grey sand with shell and lithic fragments. Within the paler sand (Phase 1/2 dunes) were lenses of fine to coarse-grained grey sand with a higher organic content and lithic fragments but no shell material. Areas of darker grey or brown staining were evident in association with these, and below the organic rich horizon in the low-lying sand sheet between ridgelines. These areas may be reworked remnants of the vegetated Holocene foredune ridge plain (6,000-5,000 BP). The higher dunes also displayed an organic-rich upper horizon. Quality and grading analysis determined that the sand was fine to medium-grained, generally well sorted and free of shells, shell fragments, pebbles and clay lumps.

3.4 Site history and land use

The study area and wider Boral property has a history of sand quarrying and landscape disturbance over at least the last 60 years. G. Hawkins and Sons acquired the site in the 1950s although, prior to that time, sand had already been removed from the site. Further extraction activities took place across the site from the late 1970s under a consent granted by Port Stephens Council in 1976, with sand transported along internal haul roads. Previous areas of disturbance identified in the 1994 EIS included a large portion of the eastern Phase 1-2 dune, the Crown Land at Lot 7300 DP1130730, areas around the site office, the southern part of the western Phase 1-2 dune, a large part of the sand sheet between the Phase 1-2 dunes and the active Phase 3 dune, and former haul roads and tracks (ERM 1994: Figure 5.12). In addition, the eastern section of Boral's landholding along the active Phase 3 transverse dunes was previously dredged for mineral sands by MDL between late 2000 and 2003.

Boral acquired the site in 1992 and extraction of sand on the vegetated dunes in the inland extraction area commenced in 1996 under a development consent issued by Port Stephens Council. The consent was for sand extraction above 5 metres AHD and road transport of up to 500,000 tpa for a period of 13 years. The development involved clearance of native vegetation and sand extraction by front end loader. Excavated material was then dry-screened in order to remove roots and minor naturally occurring coal fragments. Recycled road base from Boral's Kooragang Island recycling facility was imported to provide an inert stable base for haul roads and the floor of the operating extraction area. A front-end loader or excavator loaded road trucks in-pit with screened raw sand for transport off-site via the weighbridge, or was moved to the stockpile area. As each area of extraction was exhausted, topsoil and previously felled vegetation was re-spread over finished areas. The extraction areas were thus progressively rehabilitated until the approved resource was exhausted in 2008. The approved extraction area predominantly occupies the same footprint as the current study area and comprises large areas of evident disturbance despite rehabilitation (cf. Figures 2 and 5).



Figure 5. Aerial imagery from 2004 showing extent of disturbance from previous extraction (Google Earth)

4 Ethnohistoric context

Although the specific Project area is not recorded directly in ethnographical accounts, historical accounts were made of the Aboriginal people living in the region at the time of initial European exploration and settlement in the late eighteenth and early nineteenth centuries. (cf. Brayshaw 1987; Maynard 2015). These historical accounts describe a landscape which was important to and intensively used by Aboriginal people. Contact with Europeans introduced diseases that drastically altered the size and structure of the Aboriginal population, whilst the establishment of a penal colony and later settlement at Newcastle subsumed the traditional areas used to meet subsistence needs and displaced the Aboriginal people inhabiting these areas.

Early historical observations described several Aboriginal groups within the wider Hunter region associated with particular areas of land. The study area and the wider Port Stephens area is located within the traditional lands of the Worimi. The area inhabited by the Worimi is traditionally described as bounded by the Hunter River to the south, Manning River to the north, and the Allyn and Patterson Rivers to the west (WCL 2019). Language group boundaries described by Tindale (1974) give the Worimi area as from the "Hunter River to Forster near Cape Hawke along coast; at Port Stephens; inland to near Gresford; about Glendon Brook, Dungog, head of Myall Creek and south to Maitland". Aboriginal people appear to have been organised into small groups of families or 'bands' who participated in communal subsistence gathering activities and formed part of a larger clan or descendant group that held ties to that area of Country. The Worimi around the immediate Port Stephens area were traditionally divided into four groups or *ngurras:* the Maiangal, Gamaipingal, Garuagal/Garuegal and Buraigal/Baraigal. The study area is located within the Maiangal area south of Port Stephens along the Stockton Bight to the Hunter River. To the south of the Hunter River were the Awabakal and inland, the Wonarua and Gringai.

Early European accounts indicate that the Worimi lived a mobile lifestyle, primarily in small territorial clans and local clans of extended family groups, forming larger bands through social and cultural links including marriage and communal participation in subsistence activities. Interactions with neighbouring language groups such as the Awabakal were also common. The Port Stephens area offered many lakes, estuaries, sandy beaches and intertidal zones with a diversity and abundance of resources for the local people to use. In the Port Stephens region, local Aboriginal people were identified as inland or salt water people due to their occupation of particular marine or estuarine landscapes and their use of the natural resources found in these environments. The salt water Maiangal occupied the vicinity of the study area. They would have had access to a wide range of avian, terrestrial and marine fauna along the shore while repeated firing of vegetation would have opened up foliage allowing ease of access through and between different eco zones as they moved through Country.

The shelters used by Aboriginal people at camp locations around Port Stephens were depicted in a 1826 painting by Augustus Earle (Plate 1). In the painting, the shelters can be seen as being constructed of bark sheeting while Aboriginal people are depicted gathered around fires which are situated at the entrances to the shelters. The construction was supported by three forked sticks brought together at the top to form a triangle. Dawson (1830:171 in Brayshaw 1987) recorded that "the two sides towards the wind are covered by long sheets of bark, the third is left open…When the wind shifts the gunyer is shifted also".



Plate 1. "A native camp of Australian savages near Port Stevens, [i.e. Stephens] New South Wales", by Augustus Earle. 1826. National Library of Australia; Rex Nan Kivell Collection NK12/28. http://nla.gov.au/nla.obj-134497417/view

Thomas Skottowe, while Commandant of the Newcastle penal settlement from 1811 to 1814, collected several Aboriginal items from the region which were drawn by T.R. Browne (Plate 2). The items include spears, a shield, a spear-thrower, clubs, an axe with a European iron blade, a boomerang, a basket, a water-carrier, a twined dilly bag, and a fishing line with shell hook. The depicted items illustrate the use of various perishable materials including bark, wood and grasses that are rarely preserved in the archaeological record and would have constituted a large portion of the items used by past Aboriginal people.

Historical sources also recorded some of the uses that artefacts which are found within archaeological contexts would have had. Hatchets were constructed from hard stone which was chipped and then ground to an edge before being hafted while stone knives were documented as being used for cutting up meat and stone chips or shells used for skinning animals (Miller 1886: 353). Brayshaw (1987) provides a list of recorded material culture from the area, including forked poles for climbing trees, eucalypt bark canoes, bark string and netted bags, shell fish hooks, spears made with *Xanthorrhea* shafts, spear-throwers, shield, clubs, and shaped sticks for digging yams and tubers.



Plate 2. Native Arms from Select Specimens From Nature of the / Birds Animals &c &c of New South Wales, Collected and Arranged by Thomas Skottowe Esqr. The Drawings By T.R. Browne. Image from the State Library of New South Wales: http://www.sl.nsw.gov.au/collection-items/native-arms-select-specimens-nature-birds-animals-c-c-new-south-wales-collected-and

Early historical sources also note that an abundant supply of fresh water and marine resources were available in the region from the Hunter River, the estuary towards the mouth of the Hunter River and the coast of the South Pacific Ocean (cf. Grant 1803). Aboriginal people were observed exploiting marine resources of the coast and Hunter River by fishing and gathering shell fish while terrestrial resources such as kangaroos, bandicoots, snakes and lizards were hunted in the hinterland areas (Grant 1803: 55; Fawcett 1898: 152; Threlkeld in Gunson 1974:54-55). Consumption of shellfish was particularly important along the coast, and historical sources also record lobster-diving around the Port Stephens area with William Scott noting that "lobsters were caught by the women who, in the sea dived amongst the rocks for them". Various fishing techniques were used and canoes were used for both line and spear fishing. At Port Stephens in the mid 1800s, Scott recorded that women used the hook and line and men used spears. However, one method of fishing he observed included both men and women: "the women would be on the lookout for the shining, shimmering mass of fish to come round some wooded headland, and when their shrill outcries told of the approach of the finny prey, the men would rush to the shore. Hissing into the water would hurtle the heavy spears…." (Newcastle Morning Herald Supplement 1993 in AMBS 2005). Another technique included the use of a hand net, "forming a circle in shallow waters and enclosing the fish" (Threlkeld in Gunson 1974:190). Threlkeld also noted fish traps made from twigs and poles in streams (Threlkeld in Gunson 1974:190).

The Port Stephens region remains important to local Aboriginal people, who have maintained their traditional ties to the area through the sharing of knowledge and lore down generations. The consultation process to date has identified a number of people who have indicated their interest in the area, demonstrating the tangible link that members of the contemporary Aboriginal community retain to the land.

5 Archaeological Context

5.1 AHIMS web services

The Aboriginal Heritage Information Management System (AHIMS) is a heritage database and regulated under section 90Q of the *National Parks and Wildlife Act 1974*. AHIMS contains information and records pertaining to registered Aboriginal archaeological sites (Aboriginal objects, as defined under the Act) and declared Aboriginal places in NSW.

A search of AHIMS was conducted on 25 July 2019 to identify registered (known) Aboriginal sites or declared Aboriginal places within or adjacent to the study area (Appendix D).

The AHIMS Web Service database search was conducted within the following coordinates (GDA, Zone 56):

Eastings:	388850 - 393800
Northings:	6363000 - 6366500
Buffer:	0 metres (search coordinates included a buffer around the study area)

The AHIMS search results showed 75 Aboriginal sites recorded in or near the above location. No Aboriginal places had been declared in or near the above location. The locations of registered Aboriginal sites in the search area are shown on Figure 6. The frequencies of site types ('site features') are listed in Table 3.

Table 3. Frequency of site features from AHIMS database search

Site Context	Site Features	Frequency	(%)
Open Site	Aboriginal Resource and Gathering; Artefact	2	*2.7*
	Artefact	18	*24.0*
	Artefact; Shell	24	*32.0*
	Shell	24	*32.0*
	Restricted*	7	*9.6*
Total		*75*	*100*

*Seven restricted sites were present within the AHIMS search area, meaning no further information is available regarding site type, location or condition. Consultation with the AHIMS registrar confirmed that none of these were located within the study area and would not be impacted by any works within the Project area.

As well as determining if there are any registered (known) sites within a given area, an AHIMS search also helps to characterise local archaeology by illustrating the distribution of known sites within the local landscape. Search results for the current project indicated the predominance of open context occurrences of artefacts and shell (middens) around the study area. According to the data retrieved from AHIMS, these are the most common manifestations of archaeological material in the local area. Sites displaying solely shell (n=24) or solely artefacts (n=18) have also been recorded. Artefacts may be identified in isolation ('isolated finds') or in association with others in an artefact scatter (open camp site). Two artefact sites have also been recorded in associated with areas of Aboriginal Resource and Gathering.

The presence of numerous recorded sites in the vicinity of the study area demonstrates physically that the local landscape was used by Aboriginal people in the past and that material traces of this landscape use have survived in the form of Aboriginal objects and archaeological deposit. No previously registered AHIMS sites are located within the study area although several are present on the wider Boral property. The wider property also contains one unregistered site (BFB 1) identified during a previous survey. These recordings are discussed further in section 5.3.

5.2 Other heritage registers and databases

A search was also undertaken of the following statutory and non-statutory heritage registers for Aboriginal heritage items within or adjacent to the study area:

- Port Stephens Local Environmental Plan (LEP) 2013;
- State Heritage Register and State Heritage Inventory;
- Section 170 Heritage and Conservation Registers;
- Commonwealth Heritage List;
- National Heritage List;
- Australian Heritage Database;
- Australian Heritage Places Inventory; and
- Register of the National Estate (N.B. the Register was closed in 2007 and is no longer a statutory list. It is maintained on a non-statutory basis as a publicly available archive and educational resource).



Figure 6. Registered Aboriginal sites near the study area (AHIMS results)

Three heritage items were identified on these registers. The Port Stephens LEP 2013 lists the 'Stockton Beach Dune System' within Lots 224–227 and 230 DP 1097995, Lots 216 and 218 DP 1044608, Lot 592 DP 1097992 and Lot 7033 DP 1053720. The item borders the wider Boral property to the east and north. The item is listed as a natural landscape. The listing includes 'Aboriginal site and shell middens, ship wrecks, WWII ramparts, tank traps, proofing range, rifle range and tin huts' within the Stockton Beach Dune System. The item is listed as 'I34' on Schedule 5 of the Port Stephens LEP 2013 as displaying local heritage significance. The item is located outside of the current study area.

The Register of the National Estate, a non-statutory archive which closed in 2007, lists two further recordings in the Fern Bay area. 'Newcastle Bight Coastal Area' is listed as an Indicative Place (i.e. was not accessioned onto the register prior to its closing) and was nominated for its Natural value. The statement of significance includes Aboriginal heritage values in its description, particularly "some of the largest Midden sites in NSW as well as burial and educational sites". The recording is not a listed heritage item and has no legal status as a statutory heritage item.

A second Indicative Place described only as 'Indigenous Place' is listed for the suburb of Fern Bay, with no further information available. This recording is also not a listed heritage item and has no legal status as a statutory heritage item.

No other Aboriginal heritage items or items of Aboriginal heritage significance were listed on these databases within or in the vicinity of the study area.

5.3 Previous investigations around the study area

The study area and adjacent areas have been subject to a number of detailed archaeological investigations conducted as part of the planning and approval process for previous sand extraction activities, as well as larger scale regional studies of the Newcastle Bight.

Newcastle Bight Aboriginal Sites Study

The Newcastle Bight Aboriginal Sites Study was a comprehensive and large scale assessment undertaken in the late 1980s to inform the region's future development planning (Dean-Jones 1990). The assessment area encompassed the whole of the Bight and a range of environmental and geomorphological contexts. A detailed analysis of environmental change and landscape processes through the Late Pleistocene and Holocene was formulated in order to better understand the Aboriginal archaeological record. The study also included a review of previously recorded sites and relevant ethnographical data. Prior to this study, approximately 70 Aboriginal archaeological sites had been formally recorded within the Bight's dual barrier system, primarily midden sites. While some of these were spatially extensive, including dense concentrations of stone artefacts and packed, stratified shell, the majority of middens were smaller deposits exhibiting high levels of disturbance from a combination of natural (aeolian, fluvial) factors and modern landscape use. The dynamic geomorphic context of the Bight was highlighted as a particular factor in site taphonomy, detection and distribution patterning.

A field survey was undertaken as part of the assessment and recorded over 100 archaeological sites, with a further 40-50 additional middens noted in the modern foredune/swale but not recorded in detail. Midden sites predominated, with three quarters (74%) of the newly recorded sites including at least a sparse scatter of estuarine or marine shell material. Most of these were thin and disturbed deposits, with only 12% displaying dense concentrations or lenses of packed shell. Stone artefacts were relatively rare, with fewer than five recorded at most sites where these were present. Denser concentrations of stone artefacts were associated with two particular types of site: midden complexes associated with late Holocene stable dune surfaces overlooking the deflation basin at the rear of the beach, and open campsites on Pleistocene dunes associated with Pleistocene freshwater wetlands or Holocene estuarine wetlands. It was noted that despite the presence of sites on Pleistocene dune surfaces of the inner barrier, there was no evidence that these were of an age with the substrate, and were generally similar in stone tool technology to more recent sites from the Holocene barrier. Site differences appeared to relate to differing environmental contexts and exploitation of the attendant resource zones rather than differences in site age.

An analysis of site distribution patterning was undertaken based on the results of the background research and the field survey. For the most part, newly identified sites recorded during the survey were located on the deflation basin and outer margin of active transgressive dunes. Almost all were middens. This was considered to represent intensive occupation of the deflation basin/dune area over the last 1000 years but with several caveats; namely, very active geomorphological processes. In particular, dune cycling and the movement of transgressive dunes leads to constant exposure, deflation and reburial of archaeological material. Freshwater pools in the swales and deflation basin also deflate and rework middens around their margins. Large and complex middens may only be exposed as discontinuous, disturbed scatters or recorded as several smaller sites and archaeological context was hard to ascertain where no direct association with a recognisable land surface existed.

A total of 18 sites were recorded on the stable, vegetated Phase 1 and 2 hind dunes. Most were in locations associated with modern freshwater and estuarine environments along the interbarrier depression, although eight were located in

the body of the transgressive dune field. Sites were situated on weakly to moderately podzolised sands with a light grey A1 horizon incorporating organic material and charcoal and a slightly bleached A2 horizon. Shell content of the sand was low. Sites were found on both the Phase 1 and Phase 2 dunes and it was noted that although sites were not located on the highest points or on every longitudinal dune ridge, "they conspicuously avoid the swales" (Dean-Jones 1990:97). Sites comprised thin scatters of fragmented shell, with no stone artefacts observed. Species were predominantly pipi, with a smaller component of cockle and mud whelk.

Sites located further to the west, on Phase 1 dunes bordering the interbarrier depression, tended to have a higher representation of estuarine species, especially oyster, and had larger and denser middens with stone artefacts much more frequently recorded. Archaeological sites on the seaward side of the outer barrier were located either at the interface between the deflation basin and the seaward base of the transgressive dune, or in close association with linear exposures of the older Holocene land surface (wherever this occurred). The Fern Bay sites recorded during this assessment near the current study area are located within these contexts, further to the east of the study area in the active transgressive Phase 3 dune field. Disturbed shell scatters around the margins of the freshwater soaks were considered to be lag deposits in the deflating floor of the swales and blowouts. Given the high number of sites recorded within these areas, the active transgressive dune/deflation basin margin was ascribed with high archaeological sensitivity, although it was noted that apart from the current beach/foredune, this was also the area with the greatest geomorphic instability. It was also noted that 4WD activity was impacting on numerous sites. It was recommended that this activity be better managed to minimise archaeological impact, and that the NPWS explore the possibility of increasing their landholdings in the Bight in order to capture a sample of the aeolian surfaces which dominate its complex geomorphology.

Stockton Rifle Range

An Aboriginal cultural heritage and archaeological assessment was undertaken for a proposed residential development at the Stockton Rifle Range approximately 3.4 kilometres to the south west of the current study area (Umwelt 2017). The assessment comprised a review of background information including landscape factors and archaeological context, an Aboriginal community consultation process and a field survey. The assessment focused on the proposed development lands within the vegetated stable dune system east of Fern Bay. The part of the property containing the active transgressive (unvegetated) dune field and beach front was to be rezoned as E2 Environmental Conservation land and not developed.

A review of landscape factors identified the complex geomorphology of the Stockton Bight dual barrier system and dune transgression sequence as a key factor in understanding archaeological site occurrence, visibility and preservation. In particular, it was noted that the Holocene beach ridge, strand plain and dune sequence present along the outer barrier had a maximum age of approximately 6000 BP. Within this sequence, the three phases of dune transgression have been dated to 4500 - 4000BP for Phase 1, 2300 - 1200BP for Phase 2, and the currently active Phase 3 approximately 300BP.

The environmental context of the local area was identified as having provided a wide range of resources to Aboriginal people. Flora and fauna from terrestrial, saltmarsh, estuarine and marine environments would have provided raw materials for food, medicine, and material culture. Stone resources suitable for tool-making do not occur in the immediate area but were available from outcrops at Nobbys Head to the south and various coal measures at Shortland and Tomago to the west and northwest. Coastal woodland would have been present across the earlier Phase 1 and Phase 2 stable transgressive dunes, supporting a range of mammal, reptile and bird species that provided food and other resources for Aboriginal people.

Review of archaeological context confirmed that shell middens were the most commonly recorded site type in the area. A previous analysis of archaeological patterning by Umwelt (2003) identified that sites recorded within the vegetated dune field (stable Phase 1 and 2 transgressive dunes) were primarily small scatters of stone artefacts or small (likely single event) pipi middens. Sites within the vegetated dunes tended to be buried and only visible in disturbed areas, resulting from a combination of bioturbation, occupation processes (e.g. trampling) and natural slope movement processes. This exposure of material that previously would have been in a subsurface context suggested that deposits were not deep within the dune profile (<1 metre). However, it was also noted that stabilised dunes are still subject to erosion moving sands downslope (degrading) or the addition of new wind-blown sand or ongoing podsol formation (aggrading). The stable Phase 1/2 dunes may therefore have both aggrading and degrading surfaces through time, which may affect the location and integrity of any archaeological deposits they contain.

Sites within the deflation basin between the foredune and the active, un-vegetated Phase 3 dunes included both small scatters and middens along with more complex sites, with identification and exposure of archaeological material "at least partially dictated by the history of deposition and deflation in the location and the destructive forces of aeolian abrasion" (Umwelt 2003). It was also noted that most sites in the Outer Barrier had not been subject to dating, and that while sites were known to occur on the buried soil surfaces of the Holocene foredune ridge plain, the archaeological material was not necessarily of the same age.

Field survey was undertaken of the proposed residential development area located within the western vegetated area. Eleven previously unrecorded sites were identified and the locations of two previously recorded sites within the area were revisited. Sites comprised disturbed, low density artefact scatters with shell midden material. Artefact raw material was primarily Nobbys tuff with occasional silcrete. Shell material was generally in poor condition, weathered and highly fragmented. The archaeological sensitivity and potential of the remainder of the vegetated dunes was linked to disturbance factors.

Sites were identified in areas of exposure and disturbance associated with the decommissioning and remediation of the former rifle range and Defence lands, or along recreational vehicle tracks. The location of four further registered sites (presumed but unconfirmed burials registered as a result of anomalous results on a Ground Penetrating Radar survey) were confirmed to be outside the proposed development area, along the Popplewell Road reserve to the west. In general, the recorded middens displayed low integrity and low research potential due to previous disturbance. The cultural values assessment conducted by the Aboriginal community identified that the more intact, vegetated stable dunes north of the access road, known site locations and the potential burials displayed high significance.

Stockton Sandpit Sand Extraction – Archaeological Assessment (1994)

In 1994, Resource Planning Pty Ltd undertook an archaeological assessment and survey to inform the EIS being prepared for the proposed sand extraction area in the centre of the Boral property. The study area for this assessment is the same as the previous sand extraction area and the current study area. The assessment included a review of background archaeological and environmental context, review of previous investigations both in and around the study area, development of site predictions, archaeological field survey and an impact assessment/recommendations for the sand extraction proposal. The assessment was undertaken with the Worimi LALC.

The study area was confirmed to be located on the Phase 1/2 stable hind dunes, across an area of low, stabilised sandy swamp and an area of higher stable dunes. Several vegetation species in the area were identified as having being used by Aboriginal people as food and medicinal resources, as well as for material culture such as string, baskets and containers. Stone resources were found to be scarce on the outer barrier, only known to be present at Nobbys Head (fine cherty tuffs) and Tomago (silicified crystalline tuffs). It was suggested that Aboriginal people living around the study area would have accessed these via water craft. A review of previous investigations and recorded sites identified that the majority of known archaeological sites in the local area sites were middens and were mostly located within the active Phase 3 dune system, deflation basin and foredune along the current beach. Middens were also known to occur on the landward side of the stabilised Phase 1 dunes facing the interbarrier depression. Based on background information review, these two landscape contexts appeared to be the most archaeologically sensitive, with fewer recordings known from the Phase 2 dune field. Stone artefacts were found to be generally rare in small midden sites but were common at the larger, stratified sites.

Previous assessments undertaken in the Phase 1/2 dune field immediately to the south of Boral's holdings indicated that midden material was primarily identified in areas of disturbance. In particular, Koettig (1987) stated that midden material was present 10-20cm below the present ground surface and thus would only be identified in areas where ground disturbance extended to at least this depth. A shovel testing program was also undertaken by Dean-Jones in the area, which concluded that midden material was consistently identified on ridges between 30-50cm below the present ground surface (ERM 1994:5.30).

It was established that two previously recorded AHIMS sites were present on the wider Boral property. Both were recorded during a previous survey assessment of the Boral property in 1992 (Resource Planning 1992). 38-4-0321 comprised an open artefact scatter recorded on the edge of the Phase 1 stabilised dune along the Boral property boundary along Nelson Bay Road. Eight tuff flakes were identified along the southern side of the road, with a further 40 located along the northern side of the road. The second site (38-4-0322) was identified within the former deflation basin landward of the active transgressive dune field. The site comprised a small, disturbed shell midden of crushed pipi fragments in the vicinity of three waterholes. Neither site was located in the proposed extraction area (current study area) and neither was to be affected by the proposed quarrying. Two further locations of potential were identified during the 1992 survey. The first of these was a sparse scatter of fragmented rock oyster and whelk located on the dune face of the Phase 2 dune, and the second was scattered fragments of oyster shell on the dune slope near Nelson Bay Road. Neither of these locations were recorded as archaeological sites.

Archaeological field survey was undertaken of the proposed extraction area with the Worimi LALC, with a particular focus on areas of exposure and ground disturbance that could be expected to reveal archaeological material (e.g. vehicle and animal tracks, areas of natural exposure). No archaeological material was identified within the study area and it was confirmed that previously recorded sites would not be affected by the proposal. The potential for subsurface midden sites was assessed as low and it was noted that previous drilling programs across the property did not detect any subsurface shell deposits or archaeological material. Given the indications from previous studies that midden material occurred within the top ~50cm of the profile in the Phase 1/2 dune field, the study area was considered unlikely to contain any buried deposits. It was concluded that there was low site potential in the Phase 2 dunes where the extraction was proposed.

The fragmented material previously identified on the Phase 2 dune in 1992 was considered to display low to no archaeological value and was not considered to be a constraint. The report provided by the Worimi LALC confirmed that no archaeological material was found within the study area despite an intensive field survey. Overall, it was recommended that the sand extraction could proceed with no objection on Aboriginal archaeological grounds. Port Stephens Council subsequently gave development consent for the project in 1996 and extraction was undertaken until the approved resource was exhausted in 2008. Extraction activities completed under this development consent have impacted the majority of the current study area (cf. Figures 2 and 5).

Stockton Sandpit Windblown Sand Extraction - Archaeological Assessment (2005)

Aboriginal heritage assessment also formed part of the EIS prepared for the subsequent Windblown Project to the east of the current study area (ERM 2005b). This assessment included the overall Boral property but focussed on the proposed Windblown extraction area, primarily the active transgressive dune previously dredged for mineral sands by MDL. The assessment included background research to provide an assessment of the potential for the study area to contain cultural material, a site inspection to assess Aboriginal cultural heritage and areas of potential cultural heritage, and consultation with the Aboriginal community (Worimi LALC and Maaiangal Aboriginal Heritage Incorporation).

Environmental assessment confirmed that the proposed windblown sand extraction area was located in a geomorphically complex and dynamic context. Three periods of dune transgression were noted for the outer barrier, described by ERM as follows: the first occurred approximately 4000 years ago, the second approximately 1200 years ago and the third, which is still active and is overriding the 1200 year old outer transgressive dune, began approximately 300 years ago. The entirety of the Windblown Project was located on the active, 300 year old transgressive dune. Analysis and discussion of the previous MDL mineral sand extraction operation concluded that the entirety of the previously dredged area had been subject to severe disturbance to a level several metres below the water table. It was noted that shell and gravel material occurred throughout the processed sands and were occasionally left as lag deposits on the 'dune' surfaces. Ongoing disturbance from recreational 4WD activity along the active dunes was also considered likely to have impacted on cultural material.

Review of background archaeological information indicated that the majority of the sites recorded along the Stockton Bight were located on or near the deflation basin between the frontal dune and the main transgressive dune mass; however it was noted that this patterning may have been the result of better visibility and exposure in comparison to the stable, vegetated Phase 1 and 2 dunes. This accorded with the findings of the Newcastle Bight Aboriginal Sites Study, which identified this as a particularly archaeologically sensitive part of the outer barrier. Previous assessment had recorded few sites on the active Phase 3 transgressive dune mass landward of the deflation basin.

It was identified during background information review that several previously recorded AHIMS sites near Boral's property boundary were likely located slightly further seaward than their registered coordinates. There were no recorded sites within the proposed Windblown extraction area, and recent dredging meant there was considered to be almost no archaeological potential (ERM 2005a:82). There was considered to be low to moderate archaeological potential in the corridor between the dredge path and native vegetation on the Phase 1/2 dunes, and one new site (named BFB 1) was recorded here during the subsequent field survey. The site comprised a shell midden of moderate density, highly fragmented pipi on an exposure of the darker old Holocene land surface. No artefacts were recorded. The proposed windblown sand project impact area was changed in order to avoid the site, which has not been registered on AHIMS.

The Aboriginal cultural assessment found that the overall landscape, native vegetation, waterholes, and archaeological sites were all significant to the Aboriginal community. Significance assessment for BFB 1 found the site to have low archaeological significance. Following modification of the proposed extraction area to avoid BFB 1, impact assessment considered that the Windblown project would not impact on any Aboriginal cultural heritage. In particular, the potential for Aboriginal cultural material to occur in the area previously subject to dredging was assessed as minimal given the severe levels of disturbance. No further archaeological work was recommended and the project was granted consent from the then Minister for Planning in 2006.

Summary

The review of background information revealed there were no known Aboriginal archaeological sites within the study area and proposed extraction area associated with the Project. Previous assessment for the original extraction EIS (1994) in consultation with the Worimi LALC did not identify any Aboriginal archaeological sites or project constraints within the study area. The potential for subsurface Aboriginal archaeological material in the current study area is low and has not been indicated by previous investigations including an extensive drill sampling program. The current study area is generally highly disturbed due to the existing extraction operation.

6 Site Inspection

A site inspection was carried out as part of the Aboriginal heritage assessment of the study area. The visual inspection included a pedestrian walkover and assessment of the study area. Inspection was undertaken by Dr Matthew Kelleher (KNC) accompanied by Neil Gascoyne (Boral) and Registered Aboriginal Stakeholders for the Stockton Sand Quarry property. Aboriginal community participation in the site inspection is detailed in Section 2.

The site inspection aimed to identify Aboriginal objects or sites (if present), assess the archaeological potential and sensitivity of the study area, and confirm the nature and extent of previous disturbance.

The majority of the study area was confirmed to be severely disturbed following the previous sand extraction program. Large sections of the former dunes are absent, with the expansion of the central low-lying basin landform following extraction. The adjoining slopes to the west have also been modified as part of the rehabilitation program, which included shaping and contouring of the finished batters to merge more harmoniously with the remaining portion of the adjacent unworked dune body. A revegetation program has also been undertaken and the reinstated higher elevation slopes and crests to the south and west are heavily vegetated with native regrowth, primarily from the Coastal Sand Apple – Blackbutt open forest vegetation community. Ferns, grasses and stripped saplings provide ground cover and leaf litter is abundant. The aerial imagery from 2004 (Figure 5) indicates the widespread nature of extraction disturbance in this area despite current rehabilitated conditions.



Plate 3. Typical regrowth vegetation cover in south western part of study area



Plate 4.Patchy exposures in vegetated south western part of study area

Topsoil has been reintroduced to a number of areas in order to support the vegetation. Ground surface exposures were infrequent, and where present the visibility was generally low. Exposures were primarily of clean, cream- to buff-coloured sand with little podzol development or organic A horizon evident. No shell midden material or Aboriginal objects were observed in these areas. Scattered introduced fill and other rubble (used onsite to construct haul roads) was present on the surface in some of the larger exposures.



Plate 5. Typical cleared area with scattered fill material on surface in former extraction area



Plate 6.View to north east from south western elevation showing central basin extraction area

The central basin formed by the previous extraction program is undulating and vegetated with a mixture of cereal grasses (stabiliser crop introduced to protect against immediate aeolian erosion) and scattered spinifex, as well as regrowth shrubs and smaller native saplings around the margins of the basin. Ground disturbance from tracks and the former haul roads was evident. Areas of lower apparent disturbance along the southern margin of the study area where the future haul road is proposed were closely inspected but no archaeological sites or areas of potential were identified.



Plate 7. View to south west from edge of central basin looking towards vegetated higher dunes to the south



Plate 8.View to north across central basin

The eastern portion of the study area was also closely inspected due to the presence of small areas of remnant landform with low apparent disturbance and larger mature regrowth trees. These were present in between larger areas of disturbance associated with previous extraction activities and vegetation clearance (cf. Figure 5). Ground surface visibility was generally low due to thick vegetation cover, restricted to small areas around trees and on the slopes where downhill sand movement had created exposures. No shell material or archaeological sites were identified.



Plate 9. View up slope north of current haul road showing exposures



Plate 10. View to south from crest above current haul road showing vegetation coverage and landform

Summary

Visual inspection confirmed the extent and nature of previous extraction disturbance within the study area. These areas have little to no archaeological potential given the previous removal of the dune mass to 5 metres AHD. Ground surface exposure within the study area varied from high to low, with archaeological visibility obscured by vegetation and disturbed sands.

Areas of lower apparent disturbance (i.e. apparent remnant slope/crest landforms on the edges of the former extraction area) were closely inspected but no archaeological material was identified despite frequent exposure and localised disturbance of the ground surface.

No archaeological sites, Aboriginal objects or areas of Aboriginal archaeological potential were identified. No shell material was identified. Archaeological potential for subsurface archaeological deposits was assessed as very low to nil given the extent of previous disturbance and the findings of previous assessments.

7 Cultural heritage values and statement of significance

7.1 Significance assessment criteria

One of the primary steps in the process of cultural heritage management is the assessment of significance. Not all sites are equally significant and not all are worthy of equal consideration and management (Sullivan and Bowdler 1984, Pearson and Sullivan 1995:7). The determination of significance can be a difficult process as the social and scientific context within which these decisions are made is subject to change (Sullivan and Bowdler 1984). This does not lessen the value of the heritage approach, but enriches both the process and the long-term outcomes for future generations, as the nature of what is conserved and why, also changes over time.

Significance assessments can generally be described under three broad headings (Pearson and Sullivan 1995:7):

- value to groups such as Aboriginal communities;
- value to scientists and other information gatherers; and
- value to the general public in the context of regional, state and national heritage.

The assessment of significance is a key step in the process of impact assessment for a proposed activity as the significance or value of an object, site or place will be reflected in resultant recommendations for conservation, management or mitigation.

The *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* (OEH 2010a) requires significance assessment according to criteria established in the *Australia ICOMOS Burra Charter* (Australia ICOMOS 2013). The *Burra Charter* and its accompanying guidelines are considered best practice standard for cultural heritage management, specifically conservation, in Australia. Guidelines to the *Burra Charter* set out four criteria for the assessment of cultural significance:

- Aesthetic value - relates to the sense of the beauty of a place, object, site or item;
- Historic value - relates to the association of a place, object, site or item with historical events, people, activities or periods;
- Scientific value - scientific (or research) value relates to the importance of the data available for a place, object, site or item, based on its rarity, quality or representativeness, as well as on the degree to which the place (object, site or item) may contribute further substantial information; and
- Social value - relates to the qualities for which a place, object, site or item has become a focus of spiritual, political, national or other cultural sentiment to a group of people. In accordance with the *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW*, the social or cultural value of a place (object, site or item) may be related to spiritual, traditional, historical or contemporary associations. "Social or cultural value can only be identified though consultation with Aboriginal people" (OEH 2011:8).

Significance assessment focusses on the social/cultural, historic, scientific and aesthetic significance of Aboriginal heritage values as identified in *The Burra Charter* (Australia ICOMOS 2013). The identification of significance is developed in consultation with the registered Aboriginal stakeholders. Assessed values for the study area are detailed below.

Cultural / social significance

This area of assessment concerns the value(s) of a place, feature or site to a particular community group, in this case the local Aboriginal community. Aspects of social significance are relevant to sites, objects and landscapes that are important or have become important to the local Aboriginal community. This importance involves both traditional links with specific areas as well as an overall concern by Aboriginal people for sites generally and their continued protection. Aboriginal cultural significance may include social, spiritual, historic and archaeological values and is determined by the Aboriginal community.

It has been identified during the consultation process that the general area has high cultural heritage value (social value) to the local Aboriginal community. Cultural or social values provided by the registered Aboriginal stakeholders are discussed in Section 2. No specific cultural values for the study area have been identified to date.

Historic significance

Community consultation and historical research has not identified any information regarding specific historical significance of the study area. No specific historical significance for the project area has been provided by the registered Aboriginal stakeholders to date. Archaeologically, the study area does not contain these values in relation to Aboriginal heritage.

Scientific / archaeological significance

For archaeologists, scientific significance refers to the potential of a site to contribute to current research questions. Alternately, a site may be an in situ repository of demonstrably important information, for example rare artefacts of unusually high antiquity.

Scientific significance is assessed using criteria to evaluate the contents of a site, state of preservation, integrity of deposits, representativeness of the site type, rarity/uniqueness and potential to answer research questions on past human behaviour. Recommended criteria for assessing archaeological significance include:

- Archaeological Research Potential - significance may be based on the potential of a site or landscape to explain past human behaviour and can incorporate the intactness, stratigraphic integrity or state of preservation of a site, the association of the site to other sites in the region (connectivity), or a datable chronology;

- Representativeness - all sites are representative of those in their class (site type/subtype) however the issue here relates to whether particular sites should be conserved to ensure a representative sample of the archaeological record is retained. Representativeness is based on an understanding of the regional archaeological context in terms of site variability in and around the study area, the resources already conserved and the relationship of sites across the landscape; and

- Rarity – which defines how distinctive a site may be, based on an understanding of what is unique in the archaeological record and consideration of key archaeological research questions (i.e. some sites are considered more important due to their ability to provide certain information). It may be assessed at local, regional, state and national levels.

High significance is usually attributed to sites which are so rare or unique that the loss of the site would affect our ability to understand an aspect of past Aboriginal use/occupation of an area. In some cases a site may be considered highly significant because it is now rare due to destruction of the archaeological record through development. Moderate (medium) significance is attributed to sites which provide information on an established research question. Sites with moderate significance are those that offer the potential to yield information that will contribute to the growing holistic understanding of the Aboriginal cultural landscape of the project area. Archaeological investigation of moderately significant sites will contribute knowledge regarding site type interrelationships, cultural use of landscape features and occupation patterns. Low significance is attributed to sites which cannot contribute new information about past Aboriginal use/occupation of an area. This may be due to site disturbance or the nature of the site's contents.

The study area does not display any scientific/archaeological significance as it does not contain any identified Aboriginal archaeological sites or areas of potential. The area displays no archaeological research potential and is not representative of the wider Phase 1-2 Holocene dune landscape bordering the Stockton Bight due to the extent of previous disturbance.

Aesthetic Values

Aesthetic values are often closely related to the social values of a site or broader cultural landscape. Aspects may include scenic sights, smells and sounds, architectural fabric and creative aspects of a place. No specific aesthetic values for the study area have been identified by registered Aboriginal stakeholders to date. Archaeologically, the study area does not contain these values in relation to Aboriginal heritage due to the extent of previous disturbance. Neighbouring landforms (outside the study area) retain aesthetic values representative of the Phase 1-2 Holocene dune landscape along the Stockton Bight.

7.2 Statement of significance

The wider local area has cultural value for the local Aboriginal community. The identified cultural value is a feeling of attachment and responsibility for the land. Registered Aboriginal stakeholders have expressed that traditional knowledge indicates significant areas in the surrounding dune field (outside of the Boral property and proposed impact area).

To date, no areas of Aboriginal cultural significance have been identified within the study area. Stakeholders concurred with the assessment of existing severe disturbance within the study area and proposed extraction area. The study area does not display any identified archaeological, historic or aesthetic significance in relation to Aboriginal heritage values.

8 Discussion and impact assessment

Boral is seeking approval for continued operations at the site through an SSD application (SSD 9490) to the DPIE. Boral propose to extract sand from the former sandpit by excavator and dredging. This assessment has considered the impact to Aboriginal heritage values within the study area as a result of the proposed surface disturbance and sand extraction activities.

The review of background information revealed there were no known Aboriginal archaeological sites within the study area and proposed extraction area. Previous assessment for the original extraction EIS (1994) in consultation with the Worimi LALC did not identify any Aboriginal archaeological sites or project constraints within the study area. The potential for Aboriginal archaeological material in the current study area is low and has not been indicated by previous investigations.

The potential for subsurface midden sites has consistently been assessed as low to minimal and it was noted that extensive previous drilling programs across the property did not detect any subsurface shell deposits or archaeological material.

The previous extraction program removed the dune bodies within the extraction area to a depth of 5 metres AHD. Extraction to this depth is likely to have removed any once present archaeological material associated with the earlier Holocene foredune ridge plain at 5-10 metres AHD. Given the indications from previous studies that midden material within the Phase 1-2 dune field occurs within the top ～50cm of the profile, potential for deposit associated with these geomorphological elements has also been removed. The Project area is therefore considered unlikely to contain any buried deposits associated with Aboriginal occupation.

The study area is generally highly disturbed due to the previous operations associated with the inland extraction area. Site inspection confirmed the extent and nature of previous disturbance and no Aboriginal objects, archaeological sites or areas of archaeological potential were identified. Areas of lower apparent disturbance (i.e. apparent remnant slope/crest landforms on the edges of the former extraction area) were closely inspected but no archaeological material was identified despite frequent exposure and localised disturbance of the ground surface.

The study area does not display any scientific/archaeological significance as it does not contain any identified Aboriginal archaeological sites or areas of potential. The wider landscape encompassing the Boral property retains Aboriginal cultural value and significance, including nearby traditional areas, movement routes, flora and fauna communities, natural landscape values and the linkages the landscape provides to ancestors and storylines.

The configuration of the Project has been developed having regard to the constraints of the land, the desire to mitigate and avoid impacts where possible, whilst balancing the commercial viability of the Project and the extent of the known resource. The Project seeks to capitalise on sand availability within the area of existing and previous operations, maximising output from existing production facilities. This results in a smaller disturbance footprint and minimises environmental impacts compared to expansion into un-quarried adjacent areas within the wider property. Impact to intrinsic Aboriginal cultural values of the surrounding landscape is also minimal.

No Aboriginal heritage constraints have been identified for the Project. No avoidance or mitigation measures are required for the Project on Aboriginal heritage grounds.

Management measures should be implemented for adjacent areas (outside of proposed impact area and study area). Aboriginal objects are known to occur in adjacent landforms and these must be avoided by all proposed extraction activities. Management measures to be implemented should include clear delineation of the boundary of the approved impact area and the inclusion of Aboriginal heritage in the existing Environmental Management Strategy (EMS) for the quarry. Documented toolbox talks should also be held to ensure all on-site staff and contractors are aware of obligations and requirements regarding the protection of Aboriginal heritage.

9 Management and Recommendations

The following management recommendations have been made for the Project, based on the findings of the CHAR assessment and in consultation with Registered Aboriginal Stakeholders.

No impact to Aboriginal heritage was identified for the Project.

The management measures detailed below provide an additional process to manage Aboriginal cultural heritage through the operation lifetime of the extraction area.

9.1 Heritage Training and Induction Process

- **Aboriginal heritage management procedures will be included in quarry personnel training and induction processes.**

Aboriginal heritage management procedures and responsibilities for compliance will form part of the project induction for quarry personnel (employees, contractors, subcontractors and/or agents). This will include site identification (including heritage site map) to ensure all personnel are aware of Aboriginal heritage management responsibilities, issues affecting their activities and procedures for dealing with unexpected finds including human remains.

9.2 Avoiding Impact to Adjacent Areas

The CHAR and recommendations made herein are specific to the area assessed for the Project as described in this report and referred to as the 'study area' (refer Figures 1 and 2). All works associated with the Project should be contained within the study area. Additional archaeological or Aboriginal heritage assessment would be required for any proposed impacts outside the current study area.

Aboriginal objects are known to occur in adjacent landforms and these must be avoided by all proposed extraction activities. Management measures to be implemented should include clear delineation of the boundary of the approved impact zone and the inclusion of Aboriginal heritage in the existing Environmental Management Strategy (EMS) for the quarry. Documented toolbox talks will also be held to ensure all on-site staff and contractors are aware of obligations and requirements regarding the protection of Aboriginal heritage.

9.3 Unexpected Finds Procedure

- **Any unexpected Aboriginal heritage items (Aboriginal objects) will be managed appropriately.**

In the event that an unexpected find (Aboriginal object) is encountered the following procedure will apply:

1. Stop work and protect find area and report to environmental manager;
2. Contact heritage advisor for identification;
    a. No further action if the find is not an Aboriginal object; and
    b. If the find is an Aboriginal object proceed to next step;
3. Undertake relevant regulatory requirements and contact with DPIE where required;
4. Implement conservation or mitigation strategy;
5. Obtain approval if required and comply with conditions; and
6. Recommence work.

9.4 Procedures for Handling Human Remains

- **Note that Project Approvals do not include the destruction of human remains**
- **Any potential human remains encountered will be protected and managed appropriately.**

This section outlines the procedure for handling human remains in accordance with the Skeletal Remains – Guidelines for the Management of Human Skeletal Remains under the *Heritage Act 1977* (NSW Heritage Office 1998) and the Aboriginal Cultural Heritage Standards and Guidelines Kit (NPWS 1997). In the event that quarry operations reveal possible human skeletal material (remains), the following procedure is to be followed:

1. as soon as remains are exposed, all work is to halt at that location immediately and the Quarry Manager on site is to be immediately notified to allow assessment and management;
    i. stop all activities;
    ii. secure the site; and
    iii. not further harm the remains.

2. contact police: the discovery of human remains triggers a process which assumes that they are associated with a crime. The NSW Police retain carriage of the process until such time as the remains are confirmed to be Aboriginal or historic;
3. DPIE, as the approval authority, will be notified when human remains are found;
4. once the police process is complete and if remains are not associated with a contemporary crime, DPIE will determine the process:
    i. if the remains are identified as Aboriginal, the site is to be secured and all Aboriginal stakeholders are to be notified in writing; or
    ii. if the remains are identified as non-Aboriginal (historical) remains then DPIE heritage division will be contacted as appropriate;
5. once the police process is complete and if the remains are identified as not being human work can recommence once the appropriate clearances have been given.

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Appendix A Advertisement for registration of interest

Notice for Registration of Interest

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Sand Quarry, a long standing operation that extracts and transports sand product for use in the building, landscaping and construction markets. The current operation extracts sand from the windblown dunes and has consent to transport up to 500,000 tonnes of sand product per year.

Due to current and future demand for sand in the Hunter and Sydney regions, Boral is seeking approval for continued and expanded operations at the site through a State Significant Development (SSD) application under Part 4 of the NSW Environmental Planning & Assessment Act 1979. The proposal will seek to extract sand from a former sandpit, located in the central portion of the site, by excavator and dredge (the project). Boral is seeking approval to excavate and dredge an estimated 8 million tonnes of sand at a rate of up to 500,000 tonnes per annum (tpa) from the former extraction area.

The proposal will seek approval to increase transportation of product by 250,000 tpa allowing for a total of 750,000 tpa of product to be transported from the site under two development consents. When extraction from the windblown dunes ceases, transportation limits will be reduced to 500,000 tpa.

The project is located at Coxs Lane, Fullerton Cove, NSW in the Port Stephens Local Government Area. The proponent is Boral Resources (NSW) Pty Ltd (Rachael Snape, Planning & Development Manager (NSW /ACT) – PO Box 6041, North Ryde NSW 2113).

Boral proposes to carry out consultation with Aboriginal people in accordance with the Office of Environment and Heritage Aboriginal cultural heritage consultation requirements for proponents 2010. The purpose of this consultation process is to inform the preparation of environmental assessment documentation and to assist the Department of Planning and Environment in its consideration of the project.

Boral invites Aboriginal groups and/or Aboriginal people who hold cultural knowledge relevant to determining the significance of Aboriginal objects and/or places within the vicinity of Stockton, NSW to register interest in a process of community consultation with the contact shown below (on behalf of Boral):

Boral Resources (NSW) Pty Ltd c/o Kelleher Nightingale Consulting
Level 10, 25 Bligh Street
Sydney NSW 2000
Phone: 9232 5373
Fax: 9223 0680

The closing date for registration is **21 March 2019.**

Please be advised that in accordance with OEH requirements, we are required to record the names and contact details of each Aboriginal person who has registered an interest in this project and provide a copy of that record to the relevant OEH office and Local Aboriginal Land Council (LALC). If you are registering your interest, please let us know if you do not want your details forwarded to these organisations.

Appeared in: *Port Stephens Examiner* (Thursday 7 March 2019, p.34)

Appendix B Aboriginal community consultation log

RECORD OF ABORIGINAL COMMUNITY CONSULTATION AND CONSULTATION LOG
Aboriginal cultural heritage consultation requirements for proponents 2010 (OEH)
STOCKTON SAND QUARRY DREDGING PROJECT (SSD 9490)

Step	Task Requirement	Action	Outcome
4.1.1	Identify if native title exists in relation to the project area.	Conducted National Native TitleVision (NNTV) search on 15/02/2019. Wrote to National Native Title Tribunal (NNTT) for a list of registered native title claimants, native title holders and registered Indigenous Land Use Agreements (letter dated 15/02/2019).	NNTV search showed no native title holders or registered Indigenous Land Use Agreements in the project area. 19/02/2019 NNTT: Provided data for the Port Stephens LGA. No native title holders or registered Indigenous Land Use Agreements for the project area.
4.1.2	Ascertain, from reasonable sources of information, the names of Aboriginal people who may hold cultural knowledge relevant to determining the significance of Aboriginal objects and/or places. Compile a list of Aboriginal people who may have an interest for the proposed project area and hold knowledge relevant to determining the cultural significance of Aboriginal objects and/or places	Wrote to various government agencies to obtain names and contact details of parties that may have an interest or hold cultural knowledge for the project area (letters dated 15/02/2019): Port Stephens Council (PSC); Hunter Central Coast ROG, Office of Environment and Heritage (OEH); Worimi Local Aboriginal Land Council (WLALC); The Registrar, *Aboriginal Land Rights Act 1983* for a list of Aboriginal owners (ORALRA); The National Native Title Tribunal (NNTT) for a list of registered native title claimants, native title holders and registered Indigenous Land Use Agreements; Native Title Services Corporation (NTSCORP Limited); and Local Land Services (LLS). (Letters dated15/02/2019).	Responses received from: 19/02/2019 NNTT: Provided data for the Port Stephens LGA. No native title holders or registered Indigenous Land Use Agreements for the project area. 25/02/2019 OEH: Provided a list of Aboriginal stakeholders known to OEH that may have an interest in the project. Notes that consultation must be carried out before making an application for an AHIP and that consultation does not equal employment. Advises consultants must still advertise for interested parties. 07/03/2019 ORALRA: Advised that a search of the Register of Aboriginal Owners returned no results for the project area. Noted proximity of Worimi Conservation Lands (WCL). Suggested contacting WCL and WLALC for further assistance. 21/02/2019 PSC: Suggested contacting WLALC for further assistance.
4.1.3	Written notification and advertisement: Write to the Aboriginal people whose names were obtained in step 4.1.2 and the relevant LALC(s) to notify them of the proposed project. Place a notice in the local newspaper circulating in the general location of the proposed project, explaining the project and its exact	Notification letters (dated 05/03/2019) and invitation to register interest sent to people and groups identified in step 4.1.2. A1 Indigenous Services AGA Services Carol Ridgeway-Bissett Cacatua Culture Consultants Crimson-Rosie Divine Diggers Aboriginal Cultural Consultants Didge Ngunawal Clan Hunters and Collectors	Responses for registration of interest from written notification and advertisement were received from: Worimi LALC (via email 06/03/2019) Murra Bidgee Mullangari Aboriginal Corporation (via email 05/03/2019) Didge Ngunawal Clan (via email 05/03/2019) Merrigarn Indigenous Corporation (via email 05/03/2019) Muragadi Heritage Indigenous

Step	Task Requirement	Action	Outcome
4.1.3 contd.	location. Notification by letter and newspaper must include: (a) the name and contact details of the proponent (b) a brief overview of the proposed project that may be the subject of an application for an AHIP, including the location of the proposed project (c) a statement that the purpose of community consultation with Aboriginal people is to assist the proposed applicant in the preparation of an application for an AHIP and to assist the Director-General of OEH in his or her consideration and determination of the application (d) an invitation for Aboriginal people who hold cultural knowledge relevant to determining the significance of Aboriginal object(s) and/or place(s) in the area of the proposed project to register an interest in a process of community consultation with the proposed applicant regarding the proposed activity (e) a closing date for the registration of interests.	Kawul Pty Ltd T/A Wonn1 Sites Karuah Indigenous Corporation Karuah LALC Lower Hunter Aboriginal Incorporated Lower Hunter Wonnarua Cultural Services Lakkari NTCG Murra Bidgee Mullangari Aboriginal Corporation Mindaribba LALC Mur-Roo-Ma Inc Nur-Run-Gee Pty Ltd Roger Matthews Consultancy Steve Talbott Worimi Conservation Lands Wonnarua Elders Council Widescope Indigenous Group Worimi LALC Worimi Traditional Owners Indigenous Corporation Wattaka Wonnarua CC Service Advertisement inviting people to register interest in consultation published in the *Port Stephens Examiner* on 07/03/2019. Advertisement attached as Appendix A. Closing date for registration of interest was 21/03/2019.	Corporation (via email 05/03/2019) Nur-Run-Gee Pty Ltd (via email 07/03/2019) Lower Hunter Wonnarua Cultural Services (via email 07/03/2019) Worimi Traditional Owners Indigenous Corporation (via email 07/03/2019) A1 Indigenous Services (via email 09/03/2019) Murrooma Incorporated (via email 11/03/2019) Karuah Indigenous Corporation (via email 11/03/2019) Widescope Indigenous Group (via email 12/03/2019) Worimi Conservation Lands (Board of Management) (via phone 13/03/2019) Amanda Hickey Cultural Services (via email 14/03/2019) Two additional stakeholders registered for consultation but specified they did not want their details released, in accordance with Step 4.1.5. A total of 16 stakeholders registered for the project.
4.1.4	A minimum of 14 days from the date the letter was sent or notice published in the newspaper to register an interest.	Closing date for registration of interest included in the notification letters and notice in the newspaper was at least 14 days from the date the letters were sent and notice appeared in the newspaper. Closing date for registration of interest was 21/03/2019.	A minimum of 14 days was provided. Letters were sent on 05/03/2019, advertisement was published on 07/03/2019, and the closing date for registration of interest was 21/03/2019.

Step	Task Requirement	Action	Outcome
4.1.5	Must advise Aboriginal people who are registering an interest that their details will be forwarded to OEH and the LALC unless they specify that they do not want their details released.	Groups informed by letters (dated 05/03/2019) or verbally over the phone if they registered by phone.	Two registered Aboriginal stakeholder groups specified that they did not want their details to be released.
4.1.6	Make a record of the names of each Aboriginal person who registered an interest. Provide a copy of that record and copy of the notification from step 4.1.3 to the relevant OEH EPRG regional office and LALC	List of registered stakeholders compiled. A total of 16 stakeholders registered for the project. Two registered Aboriginal stakeholder group specified that they did not want their details to be released.	Letters sent to OEH and Worimi LALC with list of registered Aboriginal stakeholders (letters dated 03/04/2019). Two registered Aboriginal stakeholder group specified that they did not want their details to be released.
4.1.7	LALCs holding cultural knowledge relevant to determining the significance of Aboriginal objects and places in the proposed project area who wish to register an interest to be involved in consultation must register their interest as an Aboriginal organisation rather than individuals.	Worimi LALC registered interest to be involved in consultation.	Worimi LALC registered interest as an organisation. Provided contact details for the LALC and the name of a LALC representative to act as contact person (Jamie Merrick).
4.1.8	Where an Aboriginal organisation representing Aboriginal people who hold cultural knowledge has registered an interest, a contact person for that organisation must be nominated. Aboriginal cultural knowledge holders who have registered an interest may indicate they have appointed a representative to act on their behalf. Where this occurs, the registered Aboriginal party must provide written confirmation and contact details of those individuals to act on their behalf.	Responses received from organisations and individuals registering interest in the project. Contact details and names of representatives were also provided.	Aboriginal stakeholders have registered as an organisation name or as individuals. Contact details and names of representatives for the organisations were provided and confirmed during the registration of interest process.
4.2	Presentation of information about the proposed project	Information regarding the proposed project provided throughout the consultation process including letters sent on 05/03/2019 and 03/04/2019. Information included an outline of the Project, location of the study area, development approval context and an invitation to consult during the assessment. Informal discussions also held during the registration of interest period.	No responses to the provision of project information. Outcome of site visit is discussed below.

Step	Task Requirement	Action	Outcome
4.2 contd.		Stakeholders were also invited to attend a site inspection to discuss the project and Aboriginal cultural heritage.	
4.3.1-4.3.2	Notification of proposed assessment methodology	Copy of the proposed assessment methodology sent to all registered stakeholders with an invitation to provide comment (letters dated 03/04/2019). A 28 day review period was provided.	Responses to the proposed assessment methodology were received from A1 Indigenous Services (A1), Murra Bidgee Mullangari Aboriginal Corporation (MBMAC), Muragadi Heritage Indigenous Corporation (MHIC), Murrooma Incorporated (Murrooma), Merrigarn Indigenous Corporation (Merrigarn), Widescope Indigenous Group (WIG), and Worimi Traditional Owners Indigenous Corporation (WTOIC). A1 stated that they supported the proposed CHAR methodology and expressed interest in being involved in any potential fieldwork associated with the project (email dated 13/04/2019). MBMAC stated they had read the project information and proposed assessment methodology and endorsed the proposed approach (email dated 03/04/2019). MHIC stated that they endorsed KNC's assessment recommendations and had reviewed the project information and methodology (email dated 03/04/2019). Murrooma responded via email (09/04/2019) and requested some additional information prior to making comment, including a map of the proposed dredging area. KNC responded on 09/04/2019and provided a map. Further comment was then provided by Murrooma on 23/04/2019. Murrooma stated that they agreed with the proposed assessment methodology and consultation process for the Project, and noted their involvement with previous assessments in the area. In particular, Murrooma identified the dune ridges as traditional transit routes along the coast, and noted the presence of culturally significant Worimi sites in the surrounding area. Murrooma also stressed the importance of having local knowledge holders involved in the consultation process. Merrigarn stated that they had read the project information and proposed assessment methodology and supported the recommendations made by KNC (email dated

Step	Task Requirement	Action	Outcome
4.3.1-4.3.2 contd.			03/04/2019). WIG expressed support for the proposed methodology (email dated 19/04/2019). WTOIC expressed that the Project area held cultural significance for the Worimi people (email dated 06/05/2019) and recommended further assessment of the area due to the potential to find artefacts. WTOIC affirmed that it was "extremely important to our Worimi people to gain the best outcome for protection and preservation of our local sites/objects".
4.3.3	Gathering information about cultural significance	Aboriginal stakeholders invited to provide information about cultural significance of the area (letters dated 05/03/2019, 03/04/2019 and 09/09/2019)). Previous comments recognised and additional comments sought. Stakeholders also invited to attend a site visit.	Throughout the assessment process, cultural knowledge regarding the Aboriginal cultural/social values of the study area and identified archaeological sites was sought from registered stakeholders.Stakeholders also invited to attend a site visit. Numerous stakeholders have expressed close familial and traditional connections with the area, and stakeholders retain oral histories and cultural knowledge of the area. Stakeholders expressed the importance of education and protection of Aboriginal cultural heritage, and consideration of the landscape as a whole when assessing archaeological sites and their connections across Country. Aboriginal cultural values and knowledge of the area have been provided by registered stakeholders throughout the consultation process to date and are summarised below. Murrooma highlighted the importance of the general area, stating that "there are many places within this area that have significant cultural value to Worimi people and are in close proximity to the proposed project. These places of social, spiritual and cultural value are traditional areas with direct linkage to our ancestors and storylines" (letter dated 23 April 2019). Murrooma noted that traditional uses of the area included transit routes across the dune fingers and stressed that local knowledge holders and Traditional Owners from the area should be the source of specific cultural information for the study area. WTOIC noted that the area was culturally significant to Worimi people (email dated 06/05/2019).

Step	Task Requirement	Action	Outcome
-	Site inspection.	Stakeholders were invited to attend a site inspection of the study area with the proponent and project archaeologist. All stakeholders were invited to attend (invitations sent 18 June 2019) or provide a representative. The site inspection took place on 27 June 2019.	Stakeholders attended across two sessions in the morning and afternoon. Representatives from Worimi LALC, Didge Ngunawal Clan, Nur-Run-Gee Pty Ltd, Murrooma, Worimi Conservation Lands, Karuah Indigenous Corporation, Widescope Indigenous Group and Amanda Hickey Cultural Services attended the inspection and Worimi LALC, Didge Ngunawal Clan, Nur-Run-Gee Pty Ltd, Murrooma, Worimi Conservation Lands and Karuah Indigenous Corporation representatives took part in the site walkover. Representatives were accompanied by project archaeologist Dr Matthew Kelleher (KNC) and Neil Gascoyne (Quarry Manager, Boral). The site inspection included a discussion of the site history and existing quarrying disturbance, further discussion of the Project, proposed extraction staging, remediation and archaeological context of the local area including location of nearby previously recorded sites. A site walkover was undertaken of the study area. No Aboriginal objects were identified and representatives concurred with the assessment of existing severe disturbance within the study area and proposed extraction area.
4.4	Review of draft cultural heritage assessment report	Stakeholders were provided with a copy of the draft CHAR and invited to review and provide comments/feedback (review package sent 23/08/2019). A 28 day review period was provided, ending on 23/09/2019.	Two responses to the draft CHAR were received from stakeholders (Appendix C). MBMAC stated that they had received and reviewed the draft CHAR, and endorsed the recommendations made in the document (email dated 12 September 2019). Muragadi stated that they agreed with the recommendations made in the report (email dated 13 September 2019).

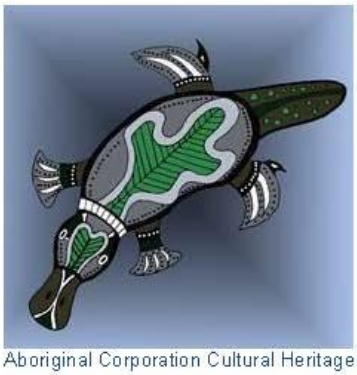
Appendix C Aboriginal stakeholder comments on draft CHAR

Zac Thomas

From: Ryan Johnson <murrabidgeemullangari@yahoo.com.au>
Sent: Thursday, 12 September 2019 3:22 PM
To: Zac Thomas
Subject: RE: 1828 Draft CHAR Review - Stockton Sand Quarry Dredging Project - MBMAC

Hi Zac,
I have read the Draft Char review for the above project, I endorse the recommendations made by Kelleher Nightingale.
Kind regards
Darleen Carroll Johnson

Ryan Johnson | **Murra Bidgee Mullangari**



Aboriginal Corporation Cultural Heritage

A: PO Box 246, Seven Hills, NSW, 2147
E: murrabidgeemullangari@yahoo.com.au
ICN: 8112

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From: Zac Thomas [mailto:zac.thomas@knconsult.com.au]
Sent: Monday, 9 September 2019 4:25 PM
To: Ryan Johnson <murrabidgeemullangari@yahoo.com.au>
Subject: 1828 Draft CHAR Review - Stockton Sand Quarry Dredging Project - MBMAC

Dear Registered Aboriginal Stakeholder,

Please find attached a cover letter and a copy of the draft Aboriginal Cultural Heritage Assessment Report for the proposed Stockton Sand Quarry Dredging Project at Stockton, NSW.

1

Zac Thomas

From: Muragadi <muragadi@yahoo.com.au>
Sent: Friday, 13 September 2019 4:19 PM
To: Zac Thomas
Subject: RE: 1828 Draft CHAR Review - Stockton Sand Quarry Dredging Project - MHIC

Hi Zac,
I agree with the recommendations made by Kelleher Nightingale for the above project.
Thanks
Anthony
0418970389

From: Zac Thomas [mailto:zac.thomas@knconsult.com.au]
Sent: Monday, 9 September 2019 4:26 PM
To: Muragadi <muragadi@yahoo.com.au>
Subject: 1828 Draft CHAR Review - Stockton Sand Quarry Dredging Project - MHIC

Dear Registered Aboriginal Stakeholder,

Please find attached a cover letter and a copy of the draft Aboriginal Cultural Heritage Assessment Report for the proposed Stockton Sand Quarry Dredging Project at Stockton, NSW.

No impact to Aboriginal heritage was identified for the project. While sites do occur within the wider Boral property, the proposed extraction area is highly disturbed due to the previous quarrying operations and removal of the bulk of the dune mass.

Aboriginal objects that are known to occur in adjacent landforms must be avoided by all proposed extraction activities. We have included management measures for protecting these areas (outside of proposed impact area) and an Unexpected Finds Procedure for the project has also been included.

As a registered Aboriginal stakeholder for this project, we would like to invite you to review the report and provide us with any comments or feedback you may have.

Please forward any comments to myself or the office by **7 October 2019**. Thank you and we look forward to receiving your comments.

Kind regards,

Zac Thomas
Heritage Administration Assistant
Kelleher Nightingale Consulting Pty Ltd
Level 10, 25 Bligh St
Sydney NSW 2000
p 02 9232 5373

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Appendix D Extensive AHIMS search results

Office of Environment & Heritage NSW GOVERNMENT

AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : 1828 Stockton

Client Service ID : 437444

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
	Contact	Recorders	Umwelt (Australia) Pty Limited					Permits		
38-4-0644	Fullerton Site 36	AGD	56	391496	6363762	Open site	Valid	Artefact : 1		
	Contact	Recorders	Umwelt (Australia) Pty Limited					Permits		
38-4-0262	Fern Bay_6;	AGD	56	391500	6363900	Open site	Valid	Shell : -, Artefact : -	Midden	1845
	Contact	Recorders	Pam Dean-Jones,Mr.Luke Godwin,M Heath					Permits		
38-4-0263	Fern Bay_7;	AGD	56	391600	6364000	Open site	Valid	Shell : -, Artefact : -	Midden	1845
	Contact	Recorders	Pam Dean-Jones,Mr.Luke Godwin,M Heath					Permits		
38-4-0322	Newcastle Bight 1;	AGD	56	391670	6364600	Open site	Valid	Shell : -, Artefact : -	Midden	2250
	Contact	Recorders	Mr.Matthew Barber					Permits		
38-4-0264	Fern Bay_8;	AGD	56	391800	6364100	Open site	Valid	Shell : -, Artefact : -	Midden	1845
	Contact	Recorders	Pam Dean-Jones,Mr.Luke Godwin,M Heath					Permits		
38-4-0564	Fullerton 3	AGD	56	391828	6364079	Open site	Valid	Shell : 1		
	Contact	Recorders	Umwelt (Australia) Pty Limited					Permits		
38-4-0265	Fern Bay_9;	AGD	56	391900	6364200	Open site	Valid	Shell : -, Artefact : -	Midden	1845
	Contact	Recorders	Pam Dean-Jones,Mr.Luke Godwin,M Heath					Permits		
38-4-0565	Fullerton 4	AGD	56	391904	6364081	Open site	Valid	Shell : 1		
	Contact	Recorders	Umwelt (Australia) Pty Limited					Permits		
38-4-0566	Fullerton 5	AGD	56	392065	6364201	Open site	Valid	Shell : 1		
	Contact	Recorders	Umwelt (Australia) Pty Limited					Permits		
38-4-0266	Fern Bay_10;	AGD	56	392100	6364200	Open site	Valid	Shell : -, Artefact : -	Midden	1845
	Contact	Recorders	Pam Dean-Jones,Mr.Luke Godwin,M Heath					Permits		
38-4-0267	Fern Bay_11;	AGD	56	392200	6364300	Open site	Valid	Shell : -, Artefact : -	Midden	1845
	Contact	Recorders	Pam Dean-Jones,Mr.Luke Godwin,M Heath					Permits		
38-4-0567	Fullerton 7	AGD	56	392285	6364371	Open site	Valid	Shell : 1		
	Contact	Recorders	Umwelt (Australia) Pty Limited					Permits		
38-4-0268	Fern Bay_12;	AGD	56	392300	6364400	Open site	Valid	Shell : -, Artefact : -	Midden	1845
	Contact	Recorders	Pam Dean-Jones,Mr.Luke Godwin,M Heath					Permits		
38-4-0054	Newcastle Bight;	AGD	56	392377	6364161	Open site	Valid	Artefact : -	Open Camp Site	
	Contact	Recorders	J.A Starling					Permits		
38-4-0269	Fern Bay_13;	AGD	56	392400	6364400	Open site	Valid	Shell : -, Artefact : -	Midden	1845
	Contact	Recorders	Pam Dean-Jones,Mr.Luke Godwin,M Heath					Permits		
38-4-0568	Fullerton 8	AGD	56	392465	6364420	Open site	Valid	Shell : 1		
	Contact	Recorders	Umwelt (Australia) Pty Limited					Permits		
38-4-0569	Fullerton 9	AGD	56	392710	6364583	Open site	Valid	Artefact : 19, Shell : 1		

Report generated by AHIMS Web Service on 25/07/2019 for Cristany Milicich for the following area at Datum :GDA, Zone : 56, Eastings : 388850 - 393800, Northings : 6363000 - 6366500 with a Buffer of 0 meters. Additional Info : Archaeological assessment. Number of Aboriginal sites and Aboriginal objects found is 75

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Office of Environment & Heritage NSW GOVERNMENT

AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : 1828 Stockton

Client Service ID : 437444

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
38-4-0950	Fern Bay Estate 17	AGD	56	389785	6364535	Open site	Valid	Artefact : -, Shell : -		
	Contact T Russell	**Recorders**	ERM Australia Pty Ltd- Sydney CBD					**Permits**		
38-4-0948	Fern Bay Estate 15	AGD	56	389847	6364460	Open site	Valid	Artefact : 1		
	Contact T Russell	**Recorders**	ERM Australia Pty Ltd- Sydney CBD					**Permits**		
38-4-0129	NBR7;	AGD	56	389850	6364380	Open site	Valid	Artefact : -	Open Camp Site	1269,101086
	Contact	**Recorders**	Margrit Koettig,Rex Silcox					**Permits**		
38-5-0157	Fullerton Site 1;Newcastle Bight;	AGD	56	389930	6362840	Open site	Valid	Shell : -, Artefact : -	Midden,Open Camp Site	
	Contact	**Recorders**	Liam Dagg					**Permits**	845,916	
38-4-0321	Newcastle Bight 2;	AGD	56	390050	6364760	Open site	Valid	Artefact : -	Open Camp Site	2250,101086
	Contact	**Recorders**	Mr.Matthew Barber					**Permits**		
38-5-0161	Fullerton Site 5;Newcastle Bight;	AGD	56	390090	6363090	Open site	Valid	Shell : -, Artefact : -	Midden,Open Camp Site	
	Contact	**Recorders**	Liam Dagg					**Permits**	916	
38-5-0158	Fullerton Site 2;Newcastle Bight;	AGD	56	390260	6363040	Open site	Valid	Shell : -, Artefact : -	Midden,Open Camp Site	
	Contact	**Recorders**	Liam Dagg,Liam Dagg					**Permits**	845,916	
38-4-0706	FC 1	AGD	56	390580	6365650	Open site	Valid	Artefact : 9		
	Contact	**Recorders**	Mary Dallas Consulting Archaeologists (MDCA)					**Permits**		
38-5-0159	Fullerton Site 3;Newcastle Bight;	AGD	56	390640	6363260	Open site	Valid	Shell : -, Artefact : -	Midden,Open Camp Site	
	Contact	**Recorders**	Liam Dagg,Liam Dagg					**Permits**	845,916	
38-5-0160	Fullerton Site 4;Newcastle Bight;	AGD	56	390960	6363500	Open site	Valid	Shell : -, Artefact : -	Midden,Open Camp Site	
	Contact	**Recorders**	Liam Dagg					**Permits**	916	
38-4-0260	Fern Bay_4;	AGD	56	391000	6363500	Open site	Valid	Artefact : -	Open Camp Site	1845
	Contact	**Recorders**	Pam Dean-Jones,Mr.Luke Godwin,M Heath					**Permits**		
38-5-0162	Fullerton Site 6;Newcastle Bight;	AGD	56	391040	6363460	Open site	Valid	Shell : -, Artefact : -	Midden	
	Contact	**Recorders**	Liam Dagg					**Permits**	916	
38-4-0340	Williamtown 1;WT-1;	AGD	56	391100	6365500	Open site	Valid	Artefact : -	Open Camp Site	
	Contact	**Recorders**	Giles Hamm Archaeology					**Permits**		
38-4-1035	Fullerton Cove Extraction 1	AGD	56	391149	6366046	Open site	Valid	Artefact : 100		
	Contact Searle	**Recorders**	Ms.Penny Mccardle					**Permits**	3033	
38-4-0261	Fern Bay_5;	AGD	56	391200	6363700	Open site	Valid	Shell : -, Artefact : -	Midden	1845
	Contact	**Recorders**	Pam Dean-Jones,Mr.Luke Godwin,M Heath					**Permits**		
38-4-0563	Fullerton 1	AGD	56	391352	6363717	Open site	Valid	Shell : -		

Report generated by AHIMS Web Service on 25/07/2019 for Cristany Milicich for the following area at Datum :GDA, Zone : 56, Eastings : 388850 - 393800, Northings : 6363000 - 6366500 with a Buffer of 0 meters. Additional Info : Archaeological assessment. Number of Aboriginal sites and Aboriginal objects found is 75

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AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : 1828 Stockton

Client Service ID : 437444

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1856	Restriction applied. Please contact ahims@environment.nsw.gov.au.					Open site	Valid			
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1859	Restriction applied. Please contact ahims@environment.nsw.gov.au.					Open site	Valid			
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1855	Restriction applied. Please contact ahims@environment.nsw.gov.au.					Open site	Valid			
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1854	Restriction applied. Please contact ahims@environment.nsw.gov.au.					Open site	Valid			
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1853	Restriction applied. Please contact ahims@environment.nsw.gov.au.					Open site	Valid			
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-0791	Fern Bay Estate 8	AGD	56	388750	6363700	Open site	Valid	Artefact : -, Shell : -		
	Contact	Recorders	Pam Dean-Jones					Permits		
38-4-0787	Fern Bay Estate 9	AGD	56	388790	6363344	Open site	Valid	Artefact : -		
	Contact	Recorders	Jim Wheeler					Permits	2026	
38-4-0861	Fern Bay Estaet 9	AGD	56	388790	6363440	Open site	Valid	Shell : 1		
	Contact T Russell	Recorders	Jim Wheeler					Permits		
38-4-0789	Fern bay Estate 11	AGD	56	388850	6363850	Open site	Valid	Artefact : -		
	Contact	Recorders	Pam Dean-Jones					Permits		
38-4-0131	NBR5;	AGD	56	388920	6364080	Open site	Valid	Artefact : -	Open Camp Site	1269
	Contact	Recorders	Margrit Koettig,Rex Silcox					Permits		
38-4-0788	Fern Bay Estate 10	AGD	56	388950	6363900	Open site	Valid	Shell : -		
	Contact	Recorders	Pam Dean-Jones					Permits	2355	
38-4-0951	Fern Bay Estate 18	AGD	56	389035	6364110	Open site	Valid	Shell : 2, Artefact : 81		
	Contact T Russell	Recorders	ERM Australia Pty Ltd- Sydney CBD					Permits		
38-4-0130	NBR6;	AGD	56	389260	6364220	Open site	Valid	Shell : -, Artefact : -	Midden	1269,101086
	Contact	Recorders	Margrit Koettig,Rex Silcox					Permits		
38-4-0127	NBR9;	AGD	56	389360	6364400	Open site	Valid	Shell : -, Artefact : -	Midden	1269,101086
	Contact	Recorders	Margrit Koettig,Rex Silcox					Permits		
38-4-0949	Fern Bay Estate 16	AGD	56	389772	6364185	Open site	Valid	Artefact : 4		
	Contact T Russell	Recorders	ERM Australia Pty Ltd- Sydney CBD					Permits		

Report generated by AHIMS Web Service on 25/07/2019 for Cristany Milicich for the following area at Datum :GDA, Zone : 56, Eastings : 388850 - 393800, Northings : 6363000 - 6366500 with a Buffer of 0 meters. Additional Info : Archaeological assessment. Number of Aboriginal sites and Aboriginal objects found is 75

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AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : 1828 Stockton

Client Service ID : 437444

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
38-4-1645	Fullerton Cove Midden 2	GDA	56	390179	6365560	Open site	Valid	Artefact : -, Shell : -		
	Contact	Recorders	Ms.Erin Mein					Permits	4398	
38-4-2011	George St 1	GDA	56	390796	6366074	Open site	Valid	Artefact : -		
	Contact	Recorders	Umwelt (Australia) Pty Limited,Miss.Nicola Roche					Permits	4398	
38-4-1872	Worimi RVA 032	GDA	56	391356	6363899	Open site	Valid	Shell : 1		
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1871	Worimi RVA 031	GDA	56	391731	6364059	Open site	Valid	Shell : 1		
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1869	Worimi RVA 029	GDA	56	391857	6364253	Open site	Valid	Shell : 1		
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1870	Worimi RVA 030	GDA	56	391926	6364193	Open site	Valid	Shell : 1		
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1867	Worimi RVA027	GDA	56	391965	6364382	Open site	Valid	Shell : 1		
	Contact	Recorders	Mr.Warren Mayers,Mr.Matthew Kelleher,Kelleher Nightingale Consulting Pty Ltd ((					Permits		
38-4-1868	Worimi RVA 028	GDA	56	391971	6364367	Open site	Valid	Shell : 1		
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1864	Worimi RVA 024	GDA	56	392464	6364646	Open site	Valid	Shell : 1		
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1865	Worimi RVA 025	GDA	56	392464	6364646	Open site	Valid	Shell : 1		
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1873	Worimi RVA 033	GDA	56	392600	6364679	Open site	Valid	Shell : 1		
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1863	Worimi RVA 023	GDA	56	392876	6364757	Open site	Valid	Shell : 1		
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1807	RVA site 1	GDA	56	393021	6364846	Open site	Valid	Shell : -, Artefact : -		
	Contact	Recorders	NPWS - Hunter District					Permits		
38-4-1861	Worimi RVA 021	GDA	56	393027	6364869	Open site	Valid	Shell : 1		
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1860	Worimi RVA 020	GDA	56	393069	6365020	Open site	Valid	Shell : 1		
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1858	Restriction applied. Please contact ahims@environment.nsw.gov.au.					Open site	Valid			
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1857	Restriction applied. Please contact ahims@environment.nsw.gov.au.					Open site	Valid			

Report generated by AHIMS Web Service on 25/07/2019 for Cristany Milicich for the following area at Datum :GDA, Zone : 56, Eastings : 388850 - 393800, Northings : 6363000 - 6366500 with a Buffer of 0 meters. Additional Info : Archaeological assessment. Number of Aboriginal sites and Aboriginal objects found is 75

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SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
	Contact	Recorders	Umwelt (Australia) Pty Limited					Permits		
38-4-0068	Newcastle Bight;3;	AGD	56	392795	6366181	Open site	Valid	Artefact : -	Open Camp Site	
	Contact	Recorders	M Dodkin					Permits		
38-4-0570	Fullerton 10	AGD	56	393049	6364716	Open site	Valid	Shell : 1		
	Contact	Recorders	Umwelt (Australia) Pty Limited					Permits		
38-4-0645	Fullerton Site 37	AGD	56	393117	6364880	Open site	Valid	Shell : 1		
	Contact	Recorders	Umwelt (Australia) Pty Limited					Permits		
38-4-0571	Fullerton 11	AGD	56	393188	6364916	Open site	Valid	Shell : 1		
	Contact	Recorders	Umwelt (Australia) Pty Limited					Permits		
38-4-1030	Lagoons 4	AGD	56	393233	6366293	Open site	Valid	Aboriginal Resource and Gathering : 1, Artefact : 3000		
	Contact Searle	Recorders	Mr.Peter Anderson					Permits		
38-4-1032	Lagoons 3	AGD	56	393250	6366153	Open site	Valid	Artefact : 2		
	Contact Searle	Recorders	Mr.Peter Anderson					Permits		
38-4-1034	Lagoons 2	AGD	56	393271	6365983	Open site	Valid	Artefact : 3		
	Contact Searle	Recorders	Mr.Peter Anderson					Permits		
38-4-1033	Lagoons 1	AGD	56	393272	6365983	Open site	Valid	Artefact : 2100, Aboriginal Resource and Gathering : 1		
	Contact Searle	Recorders	Mr.Peter Anderson					Permits		
38-4-0056	Freshwater Lagoons;	AGD	56	393351	6365825	Open site	Valid	Artefact : -	Open Camp Site	315,703
	Contact	Recorders	ASRSYS					Permits		
38-4-0572	Fullerton 12	AGD	56	393525	6366116	Open site	Valid	Shell : 1		
	Contact	Recorders	Umwelt (Australia) Pty Limited					Permits		

Report generated by AHIMS Web Service on 25/07/2019 for Cristany Milicich for the following area at Datum :GDA, Zone : 56, Eastings : 388850 - 393800, Northings : 6363000 - 6366500 with a Buffer of 0 meters. Additional Info : Archaeological assessment. Number of Aboriginal sites and Aboriginal objects found is 75

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APPENDIX L

SURFACE WATER ASSESSMENT

Surface Water Impact Assessment
Stockton Sand Quarry Dredging



Report Prepared for: Boral Resources (NSW) Pty Ltd
August 2019

Prepared by

southeast
engineering+environmental

a: PO Box 96 Moruya NSW 2537
p: 02 4474 4439
e: lachlan@south-east.com.au

Document Verification

Document title: Surface Water Impact Assessment - Stockton Sand Quarry Dredging

Project number: 463

Prepare by: Lachlan Bain

Issue and date: B 10/12/2019

Issue to: Element Environment

Document history: A 16/08/2019

Commercial in Confidence

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1.0 INTRODUCTION

1.1. Background and document purpose

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Sand Quarry (hereafter referred to as the 'site' or the 'quarry'), a long standing operation that currently extracts sand from the windblown (transgressive) sand dunes of Stockton Bight and transports up to 500,000 tonnes per annum (tpa) of sand product for use in the building, landscaping and construction markets.

Due to current and future demand for sand in the Hunter and Sydney regions, Boral is seeking approval for continued and expanded operations at the site through a State significant development (SSD) application. The proposed development (hereafter referred to as the 'Project') involves the extraction of sand from the inland vegetated dunes by front-end loader/excavator to a depth of 4 metres (m) Australian Height Datum (AHD) and subsequent dredging from 4 m AHD to 15 m below sea level (-15 m AHD). The SSD application seeks a site wide increase on the dispatch limit to 750,000 tpa (i.e. the windblown sand extraction area and the Project operations combined) to 2028 after which the site wide limit would reduce to a maximum 500,000 tpa. The Project would be for a period of up to 25 years..

This Surface water assessment considers the existing surface water and groundwater interactions at the site, and the potential impacts associated with the Project on surface water. A *Hydrogeological impact assessment* (EES, 2019) has been prepared which covers potential groundwater impacts in detail. There is some overlap between the hydrogeological assessment and this surface water assessment due to the close interaction between surface waters and groundwater at this site. In particular, the preparation of a water balance for the Project, required as part of this assessment, needs to account for all water sources and demands including rainfall inflows as well as evaporation associated with the exposure of the groundwater table to the atmosphere.

1.2. Site Description

1.2.1. Locality

The site is at Fullerton Cove, between Nelson Bay Road and Stockton Beach, about 4.3 km south of Williamtown. The entrance to the quarry is off Coxs Lane. The Worimi State Conservation Area bounds the site to the northeast and southwest, along with several private properties. Nelson Bay Road forms the northern site boundary. Towards the east is Stockton Beach which is part of the Worimi Regional Park, and beyond is Stockton Bight and the South Pacific Ocean.

1.2.2. Landscape

The Project area is located generally over a previous inland extraction area which followed a northeast to southwest orientated dune ridge. The area now consists of an undulating landscape with a well-defined low area within the dunes down to about 2.5 m AHD in places where the proposed extraction will take place (Figure 1.3). Levels over the proposed Project area range from a dune peak at the eastern end of up to 27 m AHD and other high points of around 10 to 16 m AHD at the south western end, with the majority of the project area at about 5 to 6 m AHD. The lowest point along the project area is about 6 m AHD along the southern and western edge.

The Project area has been rehabilitated since completion of the previous inland extraction, and vegetation is well established in the older parts (Figure 1.2) of the extraction area, and less so where extraction was more recently completed (Figure 1.1).



Figure 1.1 Proposed extraction areas (i.e. the project area) looking over Stage 1



Figure 1.2 proposed extraction area (i.e. the project area) looking south-west over stages 2-5

1.2.1. Land use and ownership

Boral's land holding is identified as:

- Lot 1 DP 1006399, comprising 234 hectares (ha) on the eastern side of Nelson Bay Road;
- Lot 2 DP 1006399 comprising 10.4 ha and predominantly on the western side of Nelson Bay Road, with a small portion on the eastern side of Nelson Bay Road (formerly Part Lot 167, Part Portion 167); and
- Lot 3 DP 664552 comprising 1.619 ha wholly on the eastern side of Nelson Bay Road, and within which the existing depot and weighbridge are located (formerly within Part Lot 3, Part Portion 3).

The site is accessed via Crown land (Lot 7300 DP1130730) under licence agreement with the NSW Department of Planning, Industry and Environment, Crown Lands).

1.3. Project Description

1.3.1. Previous and current operations

Sand extraction has taken place in various locations on the site since 1976 when G. Hawkins and Sons was initially granted consent.

Under Boral's ownership there have been two primary development consents granted, these include:

- DA 2010/94: The 'inland extraction area' (also known as pits 1 – 6) granted by Port Stephens Council in May 1996; and
- DA 140-6-2005: The 'windblown sand extraction area' (also known as the "windblown project" or pit 7) located on the transgressive dunes adjoining Stockton Beach granted by the Department of Planning in 2006.

The inland extraction operation on the vegetated dunes occurred above 5m AHD and ceased in 2008 and rehabilitation has been ongoing. This former extraction area is generally consistent with the Project site and is the focus of this development application.

The windblown sand extraction area started operations in 2008 and in accordance with the conditions of the development consent has 20 year life, due to cease in 2028.

The windblown sand extraction area is approximately 375 m south east of the Project site, and is approved to operate until 2028 and dispatch up to 500,000 tpa. .

Sand from the former inland extraction area was only extracted to 5 m AHD under the original 1996 development consent. The sand resource above 5 m AHD was exhausted in 2008 and in accordance with the conditions of consent the operations have ceased.

1.3.2. Proposed operations

The Project involves the extraction of sand from within the former inland extraction area (inclusive of pits 1 – 6) from the existing ground level to a depth of 15 m below sea level (-15 m AHD). As extraction will intercept the groundwater table (at approximately 1 m AHD) the primary method of sand extraction will involve dredging.

There is an estimated 9 million tonnes of sand resource within the Project extraction area. The application seeks a site wide increase on the dispatch limit to 750,000 tpa (i.e. the windblown sand extraction area and the Project operations combined) up until 2028 after which the site wide limit would reduce to no more than 500,000 tpa. The increase in the site wide dispatch limit is sought to permit maximum flexibility across the two projects areas (located on the same site).

Mobile plant and equipment utilised at the site would operate across both project areas and a docket system at the weighbridge would monitor outgoing product as a site total.

To account for market fluctuations in demand, Boral is seeking a development consent period of 25 years for the SSD approval.

The Project is to be undertaken progressively in six stages, commencing with Stage 1.

Sand extraction will involve clearing and grubbing of established vegetation from previous rehabilitation and possible screening of accumulated leaf litter and organic matter. Cleared vegetation will either be mulched or stockpiled on-site for later reuse in rehabilitation. Similarly, any stripped topsoil would be retained for use in rehabilitation efforts across the site.

Progressive extraction of sand from the inland vegetated dunes will generally involve dry extraction by front-end loader/excavator to a depth of 4 metres (m) Australian Height Datum (AHD) in stage 1 with all subsequent stages by wet extraction, dredging to 15 m below sea level (-15 m AHD). The dredge will move progressively through the extraction area generally following the nominated stages (stages 2 - 6).

The sand / water mix will be pumped directly from the dredge via a pontoon-mounted pipeline to the wash plant in the processing area. The dredge manoeuvres around the pond and its position is stabilised by tie ropes connected to the banks around the active pond.

The estimated sand extraction program is outlined in Table 1.1. The Project layout is shown in Figure 1.3 and Figure 1.4.

Figure 4.1
The Project

STOCKTON SAND QUARRY DREDGING
ENVIRONMENTAL IMPACT STATEMENT

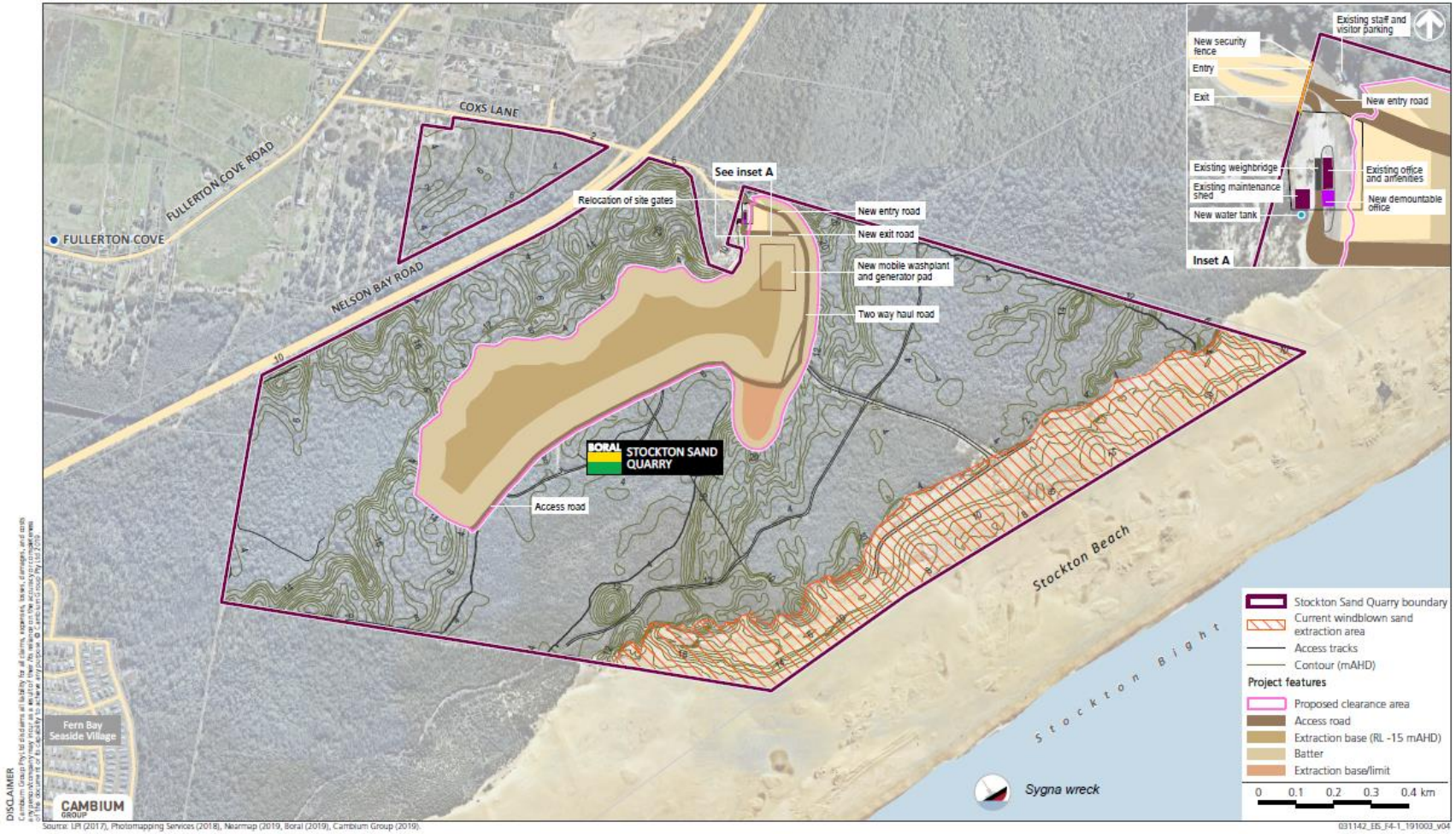


Figure 1.3 Project layout (Element, 2019)

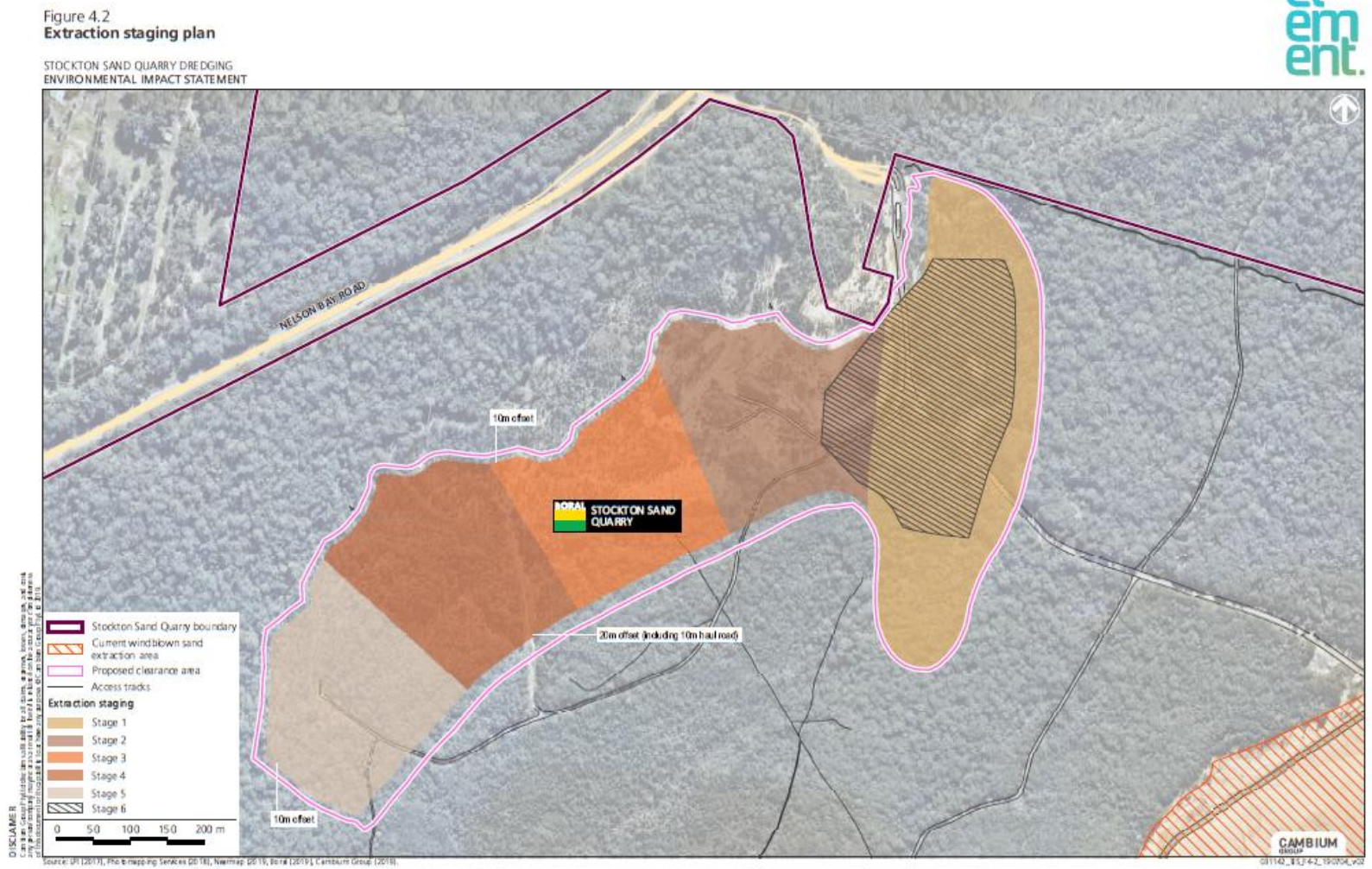


Figure 1.4 Extraction staging plan (Element, 2019)

Table 1.1 Proposed program for sand extraction

Stage	Reserve (tonnes)	Duration (years)	Approximate dates
Existing windblown sand consent	1.5 million tonnes (Mt) (max.)	3 – 9 years	2019 - 2028
1	1,640,000	2 - 3	2020 - 2022
2	1,327,138	2 - 3 years	2022 - 2025
3	1,354,000	2 - 3 years	2025/2026 – 2028/2029
4	1,901,000	3 – 4 years	2030 – 2034
5	1,483,000	3 years	2037
6	1,326,000	3 years	2039/40
Total	*9,032,138*	*19 -20 years*	

1.4. Current water use and management

1.4.1. Water Access Licence and allocation

Boral has obtained a zero share water access licence (WAL 37223). Water share allocations will be obtained prior to the commencement of operations.

1.4.2. Haul Roads

Dust suppression using water carts is carried out on the existing unpaved haul roads from the site office through to Stockton Beach. Water is purchased directly from a water cart contractor, drawing water from mains supply. Dust suppression water use over the 2018 year was 15.2 megalitres (ML) over an area of approximately 1.82ha, equating to 8.3 megalitres per hectare (ML/ha) over the year. The historical average water usage for dust suppression is approximately 12ML per annum (*Pers comm, Neil Gascoyne, quarry manager*), varying according to adjustments to haul roads, and climatic variations.

Table 1.2 Dust suppression water use over 2018.

Month	Water use (ML)
Jan	1.60
Feb	1.65
Mar	1.56
Apr	1.54
May	1.46
Jun	0.14
Jul	1.06
Aug	1.48
Sep	0.90
Oct	1.15
Nov	1.73
Dec	0.93
Total	*15.20*

1.4.3. Office facilities and water management.

Apart from drinking water, which is supplied in 20 litre containers from a bottled water contractor, the remainder of water use for the office buildings and toilet facilities is supplied from a 10 kilolitre (kL) rainwater tank, collecting office and shed roof water. Since installation in 2017, the tank has not required supplementary filling from a water contractor, although this is possible, if required.

Wastewater is treated via a septic system and collected in pump out tanks which are regularly emptied by a contractor and disposed off-site. Approximately 5000 litres are collected every 7 weeks. Typically, the septic system accommodates about four to five people on site.

1.5. Proposed water management

1.5.1. Stormwater

Stormwater runoff will generally be confined to roof areas, hardstand areas, paved roads and constructed haul roads. The sandy soils over the remainder of the site, including disturbed areas where extraction occurs and along the banks dredge pond will generate little surface runoff, except for exposed slopes in heavy rain.

The existing office will continue to drain to the rainwater tank. Where possible any new roof areas should also be plumbed to the tank. The entrance area will continue to drain to the pervious landscape adjacent to this part of the site.

A new rainwater tank will be installed adjacent to the existing maintenance shed, and roof water from the shed directed to it. This will provide a minimum 20kL of static firefighting supply.

Haul roads will be constructed from imported material to support the necessary traffic loads. Road design, including longitudinal and crossfall grading will divert stormwater runoff from the road surface to the adjoining landscape sheet runoff, or into shallow table drains. Runoff from haul roads will either infiltrate directly in areas adjacent or flow to low points within the landscape where it will infiltrate. Haul roads adjacent to the dredge pond should be graded away from the pond where possible to separate sediment in runoff from the dredge pond into low points adjacent to the road.

1.5.2. Extraction area

The extraction area is shown in Figure 1.4, removal of vegetation will occur progressively both within stages and stage by stage. This will minimise habitat impacts, help reduce water losses by maintaining surface cover and shading as long as possible and limit sand product losses though wind erosion.

As the groundwater table is intercepted and the dredge pond is created, areas previously losing water to the atmosphere via evapotranspiration associated with vegetation over this area, will transition to direct evaporation and direct recharge from rainfall. The dredge pond will progressively increase in size up to the completion of stage 6 after which the pond will be retained as a feature of the rehabilitated site.

1.5.3. Processing

Sand extracted by excavator will either be screened prior to stockpiling, of stockpiled directly. Dry excavated sand will leave the site with a moisture content of around 3% based on laboratory testing of extracted material undertaken by Coffey Partners and provided by Boral.

The sand/water pumped from the dredge will pass through a screen and floatation tank for fines removal, prior to being pumped through a cyclone for dewatering and then stockpiled. Dewatered sand leaving the site will have a moisture content of approximately 5% (*Pers comm. Neil Gascoyne, Quarry Manager).*

Water and removed fines will be recycled back to the dredge pond away from dredge operations, and in an area isolated with a silt boom.

1.5.4. Haul Road dust suppression

The existing haul road accessing the wind blown area will be adjusted to divert around the Stage 1 area to allow for extraction. Adjustments will also be made to the entrance and exit alignments to the weigh bridge. The haul roads require intermittent dust suppression, depending on climatic conditions (temperature/soil surface moisture and wind) and vehicle movements. Haul roads associated with the will be 10m wide and will run on the southern side of the extraction pond. Haul roads will be progressively constructed to avoid soil/vegetation disturbance and loss of sand to wind erosion. Refer to Appendix A for a figure showing site haul roads and haul road staging.

2.0 PLANNING SECRETARY'S ENVIRONMENTAL ASSESSMENT REQUIREMENTS

Table 2.1 Issued SEARS and relevant report section.

SEAR	Relevant section
A detailed site water balance, including a description of site water demands and intakes, water disposal methods (inclusive of volume and frequency of any water discharges), water supply infrastructure and, water storage structures;	Refer to Section 6 which covers a range of water balances on the site based on demand and supply source.
Identification of any licensing requirements or other approvals under the Water Act 1912 and/or Water Management Act 2000;	Refer to Section 3.1, legislation
Demonstration that water for the construction and operation of the development can be obtained from an appropriately authorised and reliable supply in accordance with the operating rules of any relevant Water Sharing Plan (WSP);	Refer to Section **Error! Reference source not found.** for a discussion on the available water within the relevant WSP.
A description of the measures proposed to ensure the development can operate in accordance with the requirements of any relevant WSP or water source embargo;	Refer to both Section 3.1 for discussions around the legislative requirements as well as Sections 7.4 and 8.1 for discussions on allocations required and monitoring necessary to estimate extractions over the site.
An assessment of any likely flooding impacts of the development, having regard to the relevant requirements provided by OEH in Attachment 2;	Refer to Section 4.0
An assessment of the likely impacts on the quality and quantity of existing surface and groundwater resources (including consideration of the Williamtown RAAF Base Contamination Broader Management Zone, any nearby drinking water catchments and other water users);	Refer to Section 7.0 as well as the Hydrogeological Impact Assessment.
A detailed description of the proposed water management system (including sewage), water monitoring program and other measures to mitigate potential surface and groundwater impacts;	Refer to Section 6 for a description of the water management systems on site as well as Section 8 which outlines management and mitigation measures.

3.0 RELEVANT LEGISLATION, POLICY AND GUIDELINES

Approval is sought as a State Significant Development (SSD) under part 4 of the NSW *Environmental Planning & Assessment Act 1979* (EP&A Act). Legislation, policy and guidelines applicable to the surface water impacts and management associated with the Project are outlined below.

3.1. Legislation

3.1.1. Environmental Planning and Assessment Act 1979

The proposed development is categorised as State Significant Development in accordance with section 4.36 of the EP&A Act 1979. Section 4.41 of the EP&A Act 1979 does not require certain authorisations for State Significant Developments including a water use approval under section 89, a water management work approval under section 90 or an activity approval (**other than an aquifer interference approval)** under section 91 of the Water Management Act 2000 (WM Act). As the proposed dredging activities will intercept and expose the groundwater table, the proposed development would, for the purpose of the WM Act, trigger section 91 of the WM Act. This is addressed in section 3.1.3.

There is no provision within the EP&A Act 1979 to limit the provisions of the *Water Act 1912* with respect to licensing. However, it is noted that pursuant to the provisions of section 129A the Water Act 1912 does not apply as the site is located within a part of the State to which Part 3 of Chapter 3 applies.

3.1.1.1. Port Stephens Local Environmental Plan

The site is located in LGA of Port Stephens, a review of the Port Stephens Local Environmental Plan 2013 has identified the following planning control maps that can be used to determine the likelihood of impact on surface water management and quality:

- The site is located outside any flood planning area;
- No wetlands are located on or within proximity to the site;
- The site is not located within the drinking water catchment; and
- The site is not located in the Williams River Catchment.

3.1.2. Water Management Act (WM Act) 2000

The Project involves dredging activities that will intercept and expose the groundwater table defined under the WM Act as an “aquifer interference activity” requiring an aquifer interference approval under section 91.

The Project is located within the Stockton Groundwater Source as mapped within the Water Sharing Plan (WSP) for the North Coast Coastal Sands Groundwater Sources 2016 which is adopted under section 50 of the WM Act. The WSP is discussed in section 3.1.2.3.

Boral has a Water Access Licence (WAL) for the location, however no allocations. Prior to commencement of any works that would expose the water table Boral will need to obtain sufficient water allocations to account for losses or extractions associated with the Project. Allocations can be obtained either through access to existing water allocations through trading, or by obtaining additional, unallocated water through the controlled allocations process under section 65 of the WM Act. Water availability for the Stockton Groundwater Source is discussed in section 3.1.2.3 below. .

3.1.2.1. Basic landholder rights

Under Part 1, Basic landholder rights, the WM Act allows for landholders to construct water supply works and extract water for domestic consumption and stock watering as outlined in Division 1. Under Division 2, harvestable rights, landholders may construct water supply works to collect surface flows, and extract certain amounts based on specified calculations on maximum harvestable rights.

As no stock or domestic consumption is proposed for the site Division 1 does not apply. Under Division 2, no surface flows (runoff) are proposed to be collected at the site (as site geology is predominantly sand), therefore harvestable rights are not able to be practically implemented.

3.1.2.2. Water Management (General) Regulation 2018

The Water Management (General) Regulations 2018 (the WM Regulations) support the implementation of the WM Act 2000. Part 3 specifically addresses the requirements for aquifer interference approvals.

Section 24 (a) of the Water Management (General) Regulation 2018 specifically defines the extraction of sand as an *aquifer interference activity* as such it is taken that the provisions of Part 3 Apply.

Section 28 sets out the matters affecting the consideration of applications for approvals and states the following.

> *For the purposes of section 96 (a) of the Act, the matters to be taken into consideration by the Minister in considering whether or not to grant an aquifer interference approval include whether the amount of water taken in the course of carrying out the aquifer interference activity to which the approval relates will exceed the total extraction limit for the aquifer set out in any relevant management plan.*

The provisions of the relevant plan are addressed in section 3.1.2.3 of this report. The assessment of potential impacts is set out in sections 5.3 and 6.3.

A Water Supply Works (WSW) approval, or construction or use of a water supply work is not required, as sections 36 and 39 of the Regulation exempts those carrying out an aquifer interference activity associated with mining or extractive industry from being guilty of an offence if operating without a WSW or water use approval (section 91B and 91A of the WM Act).

3.1.2.3. Water Sharing Plan for the North Coast Coastal Sands Groundwater Sources 2016.

The site is located over the Stockton Groundwater Source which is regulated by the Water Sharing Plan (WSP) for the North Coast Coastal Sands Groundwater Sources 2016 (Figure 3.2).

Water sharing plans are adopted under section 50 of the WM Act and operate as a statutory instrument. The relevant provisions of the plan include:

- Section 24 (j) that indicates 1008.5 unit shares are authorized to be taken from the Stockton groundwater source;
- Section 26 (11) that permits a long term annual extraction limit of 14,000ML/year from the Stockton groundwater source;
- Section 28 states that average annual extractions measured against long term average extraction limits in the Stockton groundwater source will include the preceding three water years;
- Section 36 outlines a range of rules around accounting for water use including:
    - (2) extracted volume must not exceed water allocations (either held, traded or carried over)
    - (3) a maximum of 20% of the previous years allocation to be carried over
- Section 41 that outlines rules relating to the proximity of water supply works to Groundwater Dependent Ecosystems (GDEs), in particular:
    - (c) that a water supply works approval must not be granted within 800m of a high priority GDE.

Water shares and allocations

The WSP specifies the planned environmental water provisions, water for basic landholder rights, share components of existing aquifer access licenses and long term average annual extraction limits for this water source (Table 3.1). Approximately 12,709 megalitres per year (ML/y) is unassigned and may be made available under Section 65 of the WM Act as controlled allocations.

Table 3.1 Stockton Groundwater Source summary

Groundwater component	Annual volume (ML/y)
Total recharge[1]	21000
Planned Environmental Water[2]	7000
Long Term Average Annual Extraction Limit (LTAAEL)	14,000
Basic Landholder Rights	254
Aquifer Access Licence[3]	1037.5 shares at 1ML/share

[1]22% of average annual rainfall as per *Water Sharing Plan for the North Coast Coastal Sands Groundwater Sources (DPI, 2016).*
[2]33% of long term recharge *(DPI, 2016).*
[3]NSW Water Register as of 02/07/2019

Groundwater Dependent Ecosystems

Section 10 (a) of the WSP states an objective of the Plan is to:

> *protect, preserve, maintain and enhance the important high priority Groundwater Dependent Ecosystems (GDEs) within these groundwater sources.*

Known high priority GDEs have been mapped and included in the WSP (Figure 3.2), The Project does not require a WSW approval under section 39 of the WM Regulation, as such Section 41 (2) proximity requirements to GDEs do not necessarily apply. Nevertheless, the location of the aquifer interference activity relative to the mapped high priority GDEs is in well in excess of the proximity distance of up to 800m that preclude approval (Figure 3.2). Notably the nearest mapped high priority GDE is located approximately 15 km east, northeast of the project site.

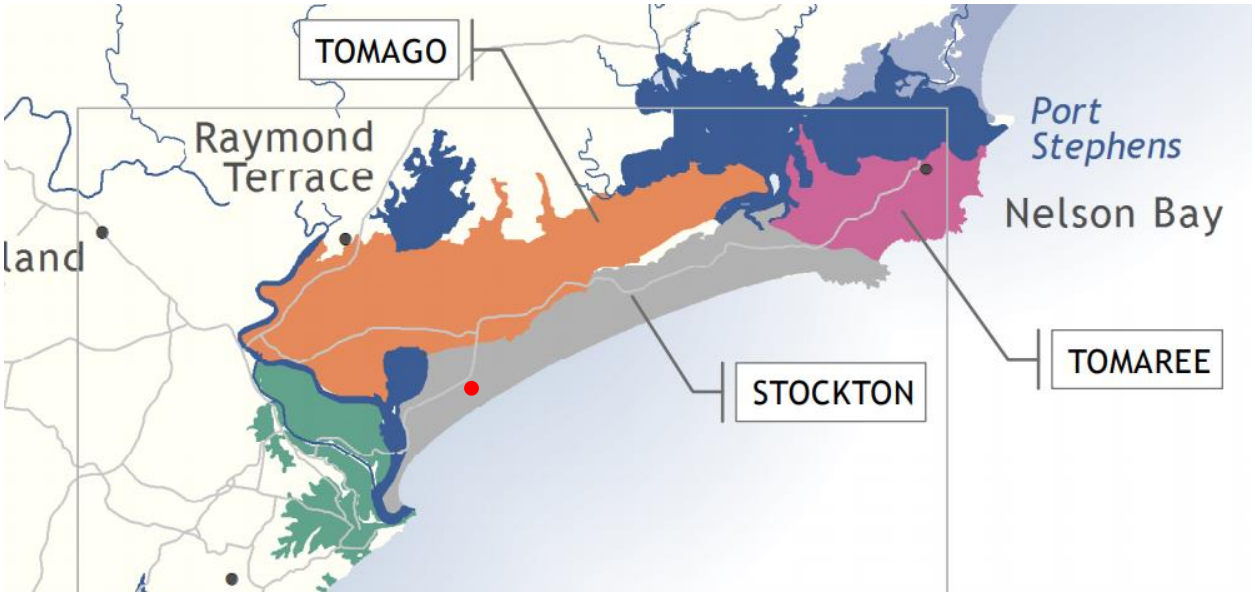


Figure 3.1 Zoomed extraction from WSP Map showing Stockton groundwaters source extents (grey) and project location (red dot)

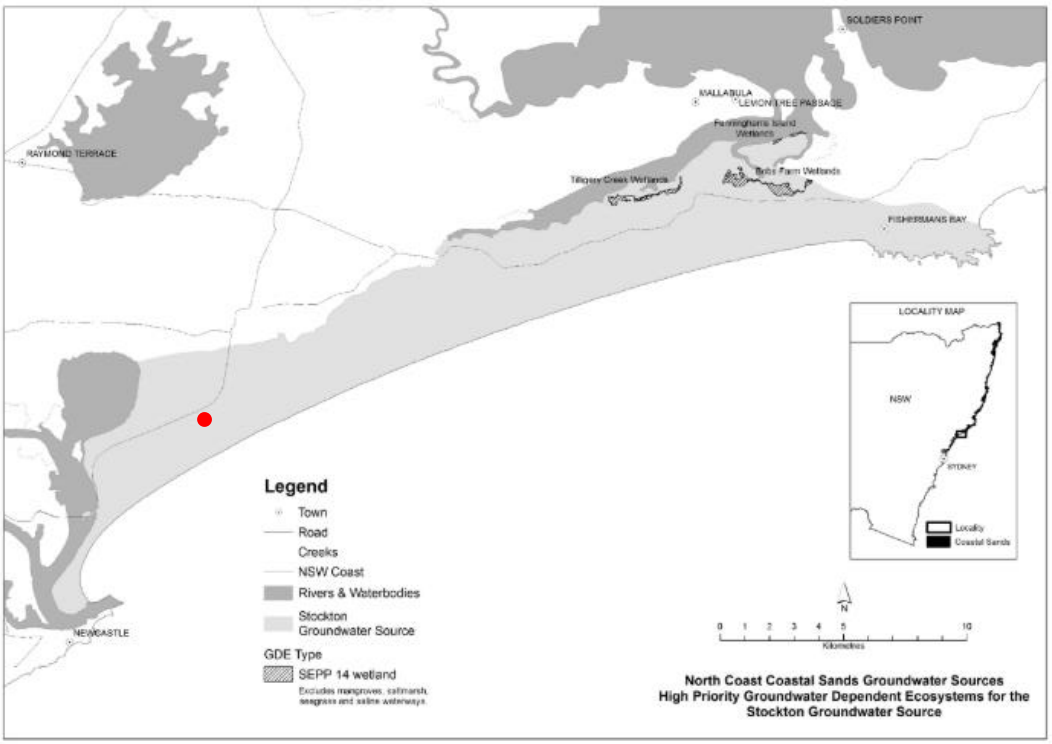


Figure 3.2 Stockton Groundwater Source mapped High Priority GDEs, approximate site location shown in red.

3.1.3. Hunter Water Act 1991 No 53

The Hunter Water Act establishes the Hunter Water Corporation (HWC) and outlines a range of activities and controls related to the extraction and provision of water. These include the requirement for a consent authority to notify the HWC of applications of developments that have the potential to impact water quality. Specifically, Section 51:

> (*2) If a consent authority within the area of operations or a special area receives a development application or building application in relation to any matter that, in the opinion of the consent authority, may:*
>
> *(a) significantly damage or interfere with the Corporation's works, or*
>
> *(b) significantly adversely affect the Corporation's operations, or*
>
> *(c) significantly adversely affect the quality of the water from which the Corporation draws its supply of water in a special area,*
>
> *the consent authority must, within 7 days of the receipt of the application, give the Corporation notice of the application.*

In this case, although the Project is not itself located within a 'special area', see section 3.1.3.1 below, the works are within the HWC area of operations.

3.1.3.1. Hunter Water (Special Areas) Regulation 2003

The Hunter Water (Special Areas) regulation specifies catchment area boundaries within which specific development referrals and pollution controls apply to protect drinking water sources. The Project is located beyond the catchment area boundaries specified for the Stockton Sandbeds aquifer reserve. As such the Hunter Waters (Special Areas) regulation does not apply to this Project.

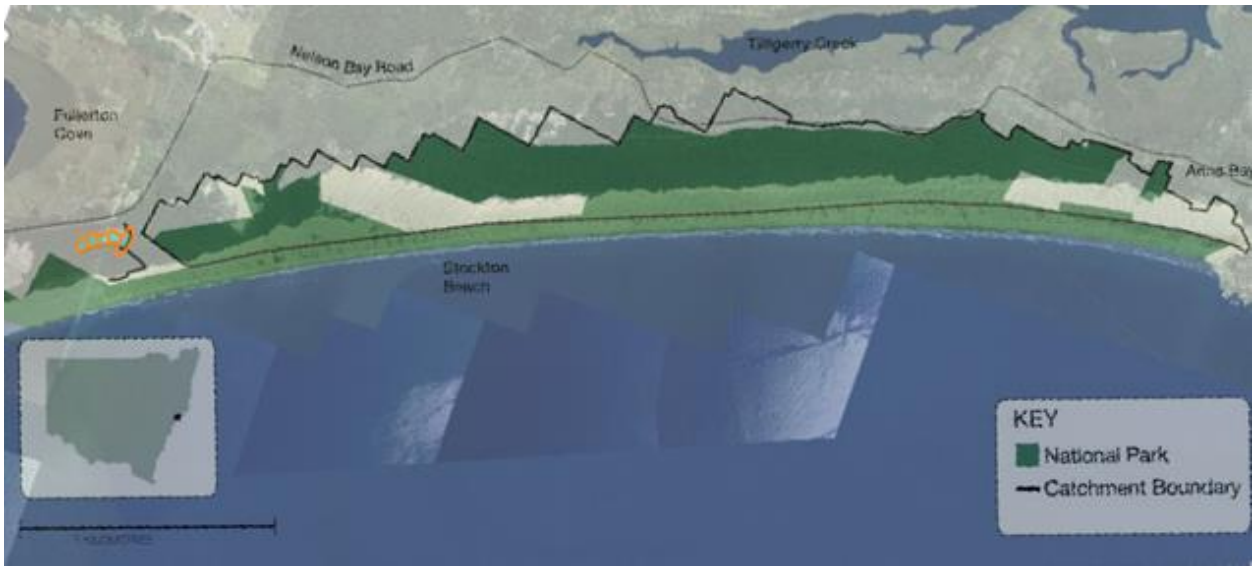


Figure 3.3 Project location (orange) in relation to Stockton Sandbeds aquifer reserve as specified in the Hunter Water (Special Areas) Regulation 2003

3.1.4. Protection of the Environment Operations Act 1997

The NSW *Protection of the Environment Operations Act 1997* (PoEO Act) and the NSW Protection of the Environment Operations (General) Regulation 2009 set out the general obligations for environmental protection. In relation to surface and groundwater management, Section 120 prohibits the pollution of waters.

The existing operation has an Environment Protection Licence (EPL), however there are no aspects of the current EPL relating to surface water management or discharge.

An EPL for surface water discharge will not be required for the Project as it is confined within the dune landscape and due to the high infiltration rates there is no surface water discharge from the site, refer to Sections 4.3 and 4.4

3.2. Guidelines and Policies

3.2.1. NSW Water Extraction Monitoring Policy

The NSW Water Extraction Monitoring Policy outlines the procedures necessary to ensure that accurate measurement of water extractions is undertaken and that licence conditions and the objectives of Water Sharing Plans are being met.

Monitoring is undertaken at the source level, as well as an individual licence level. At the individual level monitoring is generally undertaken using a variety of flow metering approaches or through secondary measures such as electricity consumption or as a pumping diary. In this case, should monitoring be required, a specific negotiation will be required to design a monitoring system given the idiosyncrasies of the Project.

3.2.2. NSW State Rivers and Estuaries Policy

The *NSW State Rivers and Estuaries Policy* (NSW Water Resources Council, 1993) contains state-wide objectives for the protection and enhancement of watercourses. The proposed surface water management should be consistent with the *NSW State Rivers and Estuaries Policy* objectives which are to:

- *manage the rivers and estuaries of NSW in ways which slow, halt or reverse the overall rate of degradation in their systems*
- *ensure the long term sustainability of their essential biophysical functions and*
- *maintain the beneficial use of these resources.*

The Project has no direct impacts on nearby rivers or estuaries. There is a broader connection via the groundwater table to local estuaries. Impacts on the groundwater resource are managed through the Water Act and WM Act, and any approvals through these acts would meet the objectives of the *NSW State Rivers and Estuaries Policy*.

3.2.3. National Water Quality Management Strategy, Water Quality Objectives and ANZECC guidelines.

The National Water Quality Management Strategy (NWQMS) provides guidance on water quality planning and management at a federal level. From that framework, the NSW government has set out policies and objectives for water quality management over the state. Water Quality Objectives (WQOs) have been established for catchments throughout NSW, using the ANZECC guidelines to set trigger values for a range of parameters, based on the water use, for example; protecting aquatic ecosystems or providing drinking water. These trigger values may be refined based on local catchment conditions, monitoring and research.

In this case, direct discharge to surface waters will not occur as part of the Project, however a connection to the Stockton groundwater source will occur. Many of the WQOs for aquatic ecosystems set out for the Hunter River catchment for surface waters will also be relevant for the protection of groundwater quality. This is discussed further within Section 7.7.

3.2.4. NSW Aquifer Interference Policy (DPI, 2012)

The NSW Aquifer Interference Policy (DPI, 2012) explains the requirements for obtaining licences for aquifer interference activities and defines the considerations for assessing whether the interference is considered a minimal impact.

The policy outlines the framework for assessing the impacts and the key tests that the Project should meet when the approval for aquifer interference is being assessed, including:

- Demonstrating the ability to obtain necessary licences;
- Demonstrating that the minimal impact considerations can be met; and
- Proposing remedial actions should the impacts of the approval be greater than predicted.

There are significant unallocated annual volumes available within the Stockton Groundwater Source as outlined in the relevant WSP, suggesting that obtaining the necessary water allocations and associated supply works for the Project is possible through new allocations. Boral is currently investigating all possible options, including obtaining and transferring and applying for new allocations.

The *Hydrogeological impact assessment* (EES, 2019) addresses the minimal impacts considerations.

3.2.5. Erosion and sediment control guidelines

The following erosion and sediment control guidelines provide guidance for preventing erosion and protecting surface waters from suspended sediment:

- Managing Stormwater: Soils and Construction, Volume 2E – Mines and Quarries (DECC, 2008) provides guidelines to specifically address requirements for erosion and sediment

control on mines and quarries based on the principles set out in Managing Stormwater: Soils and Construction, Volume 1 (Landcom 2004); and

- Managing Urban Stormwater: soils and construction, Volume 1 and Volume 2C: Unsealed roads and 2D: main road construction (DECC 2008) provide guidance on road design and design of erosion and sediment control measures for the construction of the proposed access and haul roads over the site.

3.3. Summary of licensing/entitlement requirements

The Project will require an aquifer interference approval under section 91 of the WM Act as defined under section 24 of the WM Regulation. The primary consideration for the aquifer interference approval, as outlined in the WM Regulation under section 28 is whether the extraction associated with the aquifer interference approval is less than the total water available for extraction as outlined in the relevant water management plan.

The Project is located within the Stockton groundwater source as mapped in the Water Sharing Plan (WSP) for the North Coast Coastal Sands Groundwater Sources 2016, which is adopted under section 50 of the WM Act. The WSP identifies the water available for extraction from the Stockton Groundwater source at 14,000Mega Litres (ML)/year, of which approximately 1,300ML is allocated. The ultimate extraction associated with the interference is estimated around 100ML/y, reflecting a total demand of less than 1 per cent of the potential allocation available. This allocation would not be required until late in the project life when the dredge pond has reached stage 6. The necessary entitlement is well within the amount available within the aquifer and consistent with the stated objective of the water sharing plan to support "viable and sustainable water-dependent industries".

Boral has a WAL for the project site, and will require sufficient allocations to account for the projected water extractions. These allocations can be obtained either through the trading of existing allocations, or through application for new allocations under section 65 of the WM Act that have been identified as available in the WSP.

Water allocations may be acquired progressively as extraction progresses, the dredge pond increases in size and water demands increase.

4.0 SURFACE WATER ENVIRONMENT

4.1. Climate

A review of climatic data from Bureau of Meteorology (BOM) Newcastle Nobbys Signal Station (061055) indicates that the climate over the site is temperate with annual average rainfall of 1123 millimetres per year (mm/y) skewed towards late summer and autumn (Figure 4.1). Annual areal actual evapotranspiration is estimated at between 811mm/y from the BOM (1961-1990) to 966mm/y from the Scientific Information for Land Owners (SILO) climate database (1900-2019). Average annual evaporation, as estimated using a Class A Evaporation pan measurements, is 1474mm/y (BOM), and the Morton's lake evaporation is 1369mm/y (SILO database).

As can be seen from the spread between the 5th and 95th percentile rainfall data, rainfall distribution is skewed towards the drier end, with infrequent large rainfall events leading to the larger difference between the average and 95% percentile.

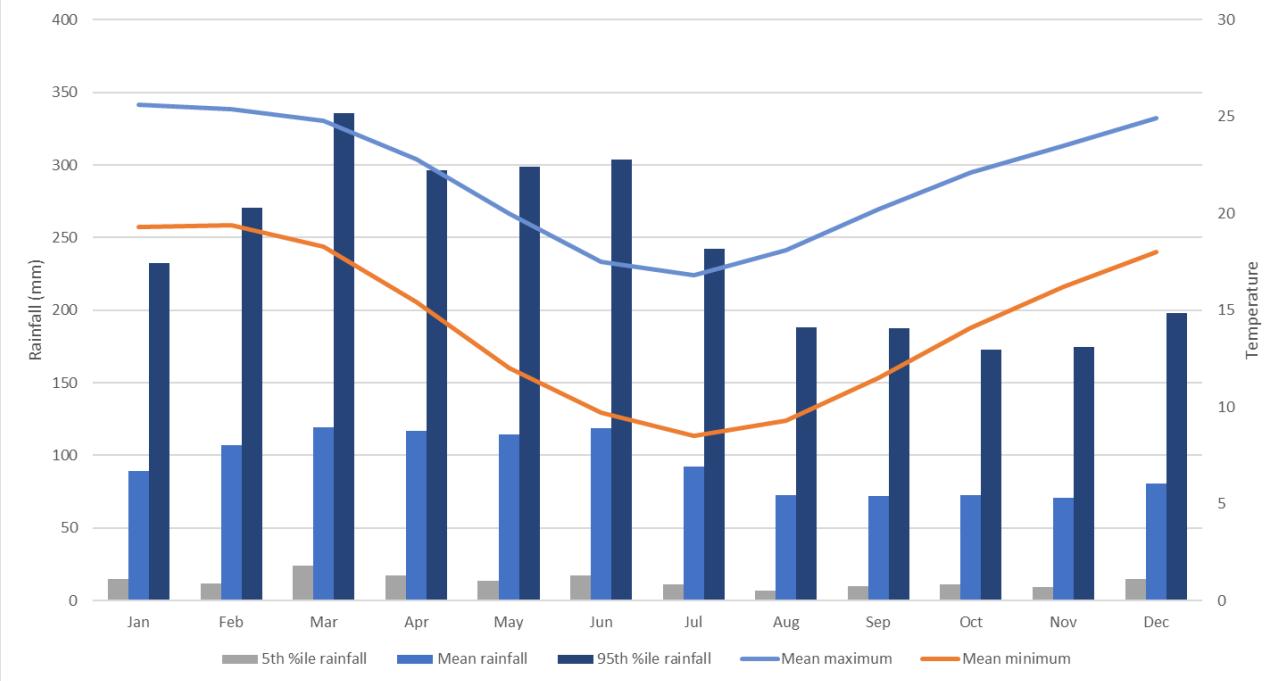


Figure 4.1 Monthly rainfall and temperature

Average annual rainfall exceeds evapotranspiration for the site for both the Morton's Areal Actual evapotranspiration for the BOM period of estimation from 1961 to 1990, as well as a longer period estimation from 1900 to 2019 as taken from the SILO database, suggesting that the Project site is likely to be a net importer of water to the groundwater table on average.

For areas of open water, which will be generated as part of the Project, Class A pan evaporation, and Morton's lake evaporation estimates exceed average annual rainfall.

4.2. Regional hydrology and hydrogeology

The *Water Sharing Plan for the North Coast Coastal Sands Groundwater Sources – Background document* (DPI, 2016) describes the Stockton Groundwater Source (Figure 3.2) as follows:

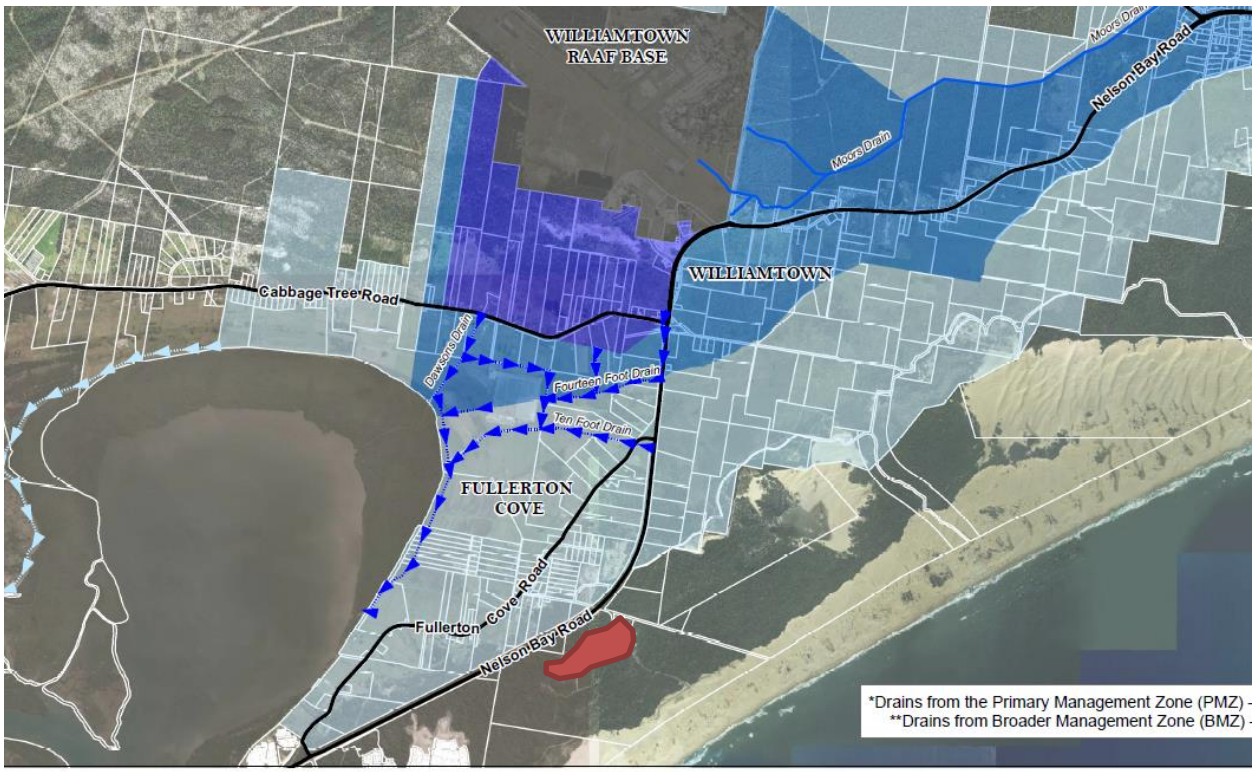
> *The Stockton Groundwater Source is located on the Lower North Coast between the villages of Stockton and Anna Bay. It consists of a series of parallel small dune ridges with intervening lowland swales tending to swamps. The Stockton Groundwater Source is located between the coastline and Tilligerry Creek. It extends from the Hunter River at Stockton in the south, to the drainage complex of Bobs Farm Creek, Fenninghams Island Creek, and Murrumburrimbah Swamp near Anna Bay in the north. The area of the Stockton Groundwater Source has been updated since the plan was first developed as a result of improved mapping methods. The area now totals approximately 113 km².*
>
> *Groundwater is used predominantly for domestic purposes accessed through basic spear point extraction systems. Some entitlement is also used for irrigation and commercial purposes.*
>
> *Located within the groundwater source are the Worimi Conservation Lands which cover the Worimi National Park, Worimi State Conservation Area, and Worimi Regional Park.*

Recharge of the groundwater source is from direct rainfall over the area. Recharge calculations assume an infiltration rate of 0.22 (22% of rainfall) for the sand aquifer components of the resource and an infiltration rate of 0.02 (2% of rainfall) for the residual aquifer component, which is about one third of the area, and is separated from the sand aquifer for a range of reasons. Table 3.1 summarises total recharge and available water for extraction. Recharge estimates are based on site specific recharge studies undertaken on the adjacent Tomago and Tomaree groundwater sources (DPI, 2016).

The Stockton Groundwater Source is bounded to the south by the influence of the Tasman Sea, and to the north by the Tomago groundwater source (183 km^2). The Tomago groundwater source is an exposed sand body of accumulated sand and shelly sands overlaying clay. This groundwater source is an important source of municipal water supply for Hunter Water Corporation, which has an extensive extraction bore field in the eastern part of the groundwater source within the Tilligerry State Conservation Area.

From the locality of Salt Ash heading west to Fullerton Cove is an area identified as the Williamtown management area, as an area either contaminated or potentially contaminated with by Per – and Poly Fluoroalkyl Substances (PFAS) from previous operations at the Williamtown RAAF Base. The NSW EPA has identified Primary, Secondary and Broader Management Zones in which there are recommendations to not use groundwater, bore water of surface water for any purpose in the Primary management zone, and to not use groundwater, bore water of surface water for drinking or cooking in the Secondary and Broader management zones.

The Project site is located approximately 250 m from the Broader Management Zone in the separate Stockton groundwater source (Figure 4.2).



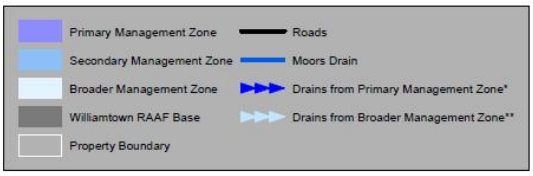




Figure 4.2 Williamtown PFAS management area and Project site (red). (https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/community/williamtownmanagementareamap.pdf, accessed 09/07/2019)

4.3. Surface drainage and groundwater interaction

Surface runoff, surface ponding and exposure of the groundwater table at the surface is a function of rainfall intensity, groundwater table depth and ocean influences. Infiltration rates are a function of surface condition and previous rainfall (ie. soil moisture).

The existing Project site is a basin, with no surface flow connection to adjacent areas and the lowest surface level located around the edge of the Project site to the south east, towards Stockton Beach at about 6m AHD. There are no springs or permanent streams within the proposed extraction area. Local hydrology is driven by the high infiltration rates associated with the sands over the site, the confined nature of the landscape and the interaction with the groundwater table and underground geology.

Surface runoff is limited to periods where the groundwater table reaches surface levels, the soil moisture store is fully saturated, where rainfall intensity exceeds infiltration rates, or a combination of the three. Ocean conditions, including storm surge, large tides and the wave climate also influence groundwater levels. During what is known as the 'Pasha Bulker storm' of June 2007, the associated storm surge and rainfall caused inundation up to about 3.5m AHD over the current Project site (*Pers comm. Neil Gascoyne, quarry manager)* where excavation depths had extended down to about 2.5m AHD.

A range of investigations have been carried out over and surrounding the Project site to establish groundwater depths and movement as part of this assessment process, as well as previous approvals and investigations for other purposes.

The Environmental Impact Statement (EIS) for the original sand extraction proposal, which approximately covers the footprint of this Project, compiled previous groundwater modelling and assumptions undertaken by Coffee Partners International and Mackie Martin International into groundwater behaviour. The results of these investigations showed that during dry periods groundwater levels of 1.0 to 1.5m AHD could be expected, under normal periods levels of 2.0 to 2.5m AHD and up to 3.5 to 4.0m AHD during wet periods (Umwelt, 1995). Recharge rates of 30% and hydraulic conductivity of 20 metres per day (m/d) were assumed in these model estimates.

Groundwater monitoring records identify two primary flow directions for groundwater, either to the north west towards Fullerton Cove, and the Tomago Groundwater Source, or to the south east towards Stockton Beach (EES, 2019), with the divide running approximately parallel to the beach edge and moving landward during periods of high rainfall. During wetter periods the flow divide intercepts the proposed extraction area (Figure 4.3). The flow through the proposed extraction area is predominantly to the north west, towards Fullerton Cove.

The 'special area' as mapped for Stockton water supply aquifer under the Hunter Water (Special Areas) Regulation 2003, is approximately 150m to the north east of the site. The groundwater flow direction is to the southwest towards the site, or to the northwest or southeast. Water movement is from the water supply aquifer area towards the Project site.

Recorded groundwater levels during low rainfall (March 2018) and high rainfall (June 2018) periods record groundwater levels of between 1.0 to 1.4m AHD and 1.6 to 2.0m AHD respectively. Measured hydraulic conductivity is 25m/d (EES, 2019). As the 2018 groundwater records outlined above show, the aquifer responds rapidly to rainfall. Records over the period of 2016 to June 2018 show that several rainfall events ≥40 mm occurring within a fortnight can raise standing water levels across all bores at the quarry by approximately 0.5m (Figure 4.4).

In line with the strong connectivity between the groundwater table and surface rainfall, estimated permeability over the site based on testing and literature reviews is high, between 6-55m/d (EES, 2019), although the hydraulic gradient is low, resulting in groundwater velocities of between 12.6 to 116m/y (EES, 2019). Based on these hydraulic parameters, groundwater flow through the proposed extraction area and towards Fullerton Cove is estimated at about 300m^3/d (EES, 2019).

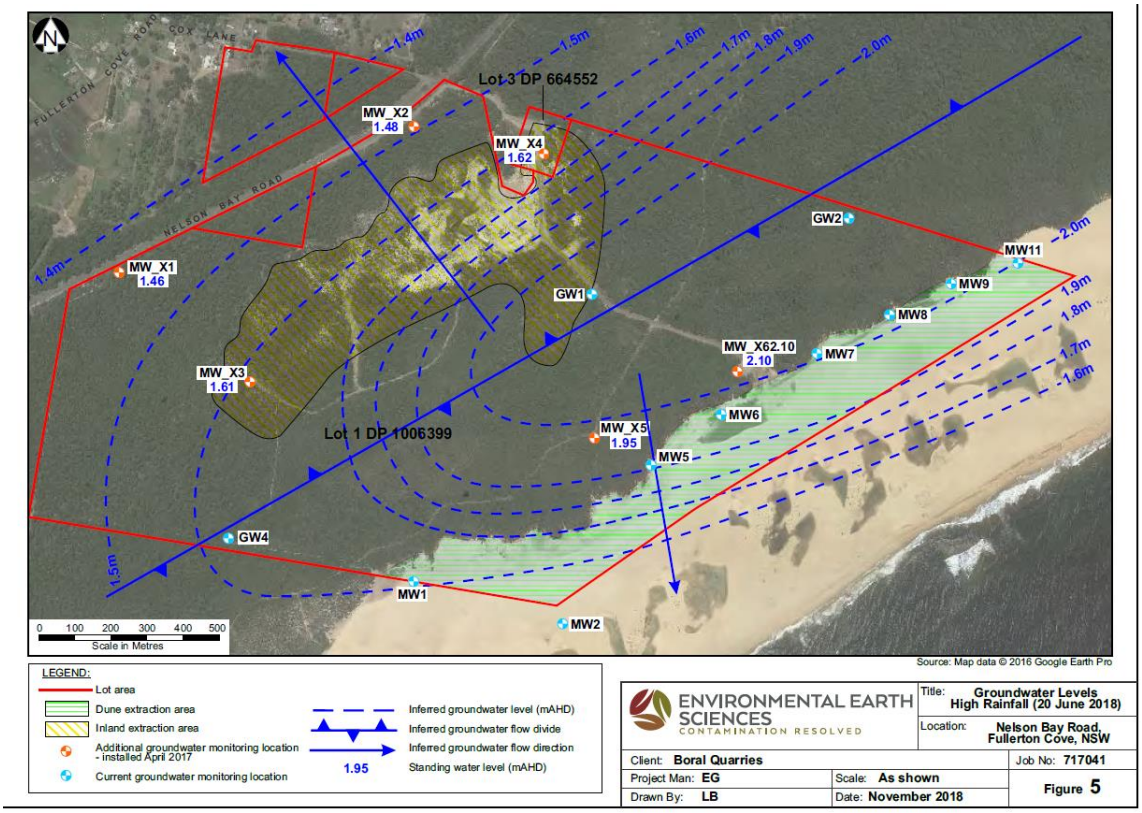


Figure 4.3 Groundwater levels in high rainfall 20 June 2018 (EES, 2019)

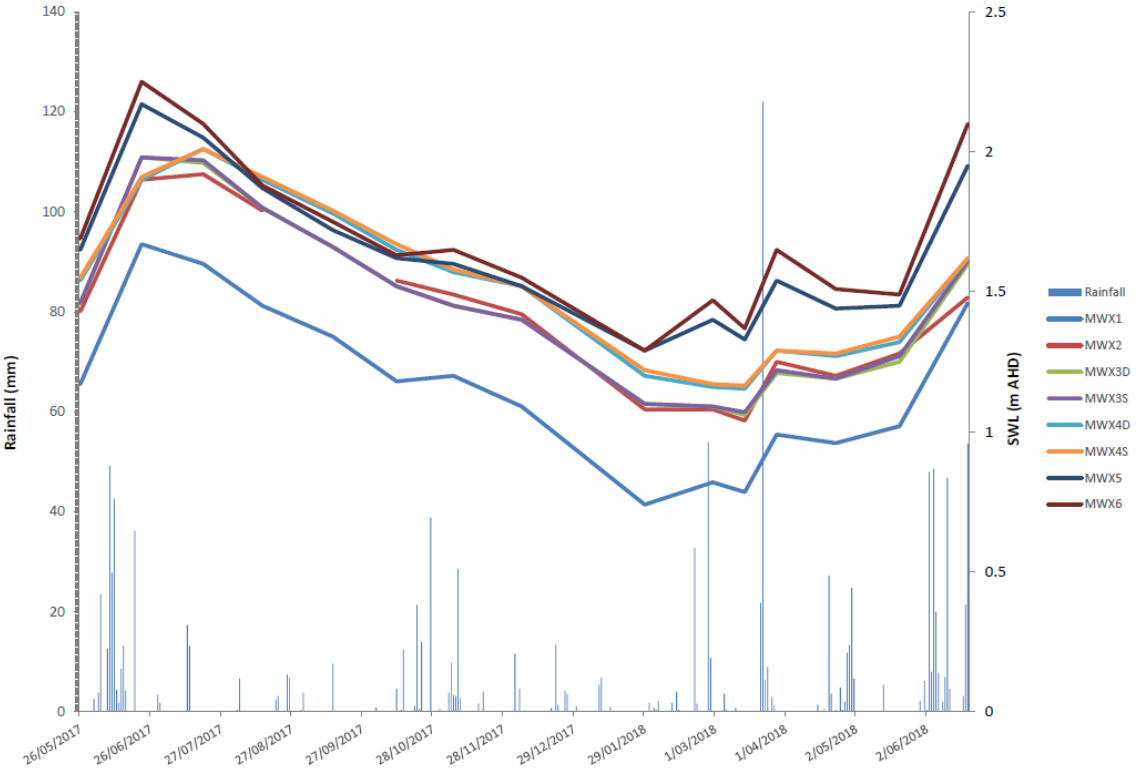


Figure 4.4 Recorded Rainfall and groundwater level (EES, 2019)

4.4. Flooding and coastal hazards

4.4.1. Flooding and inundation

The *Williamtown – Salt Ash Floodplain Risk Management Study & Plan* (BMT WBM Pty Ltd, 2017) consolidates previous flood studies and reviews over the Williamtown and Salt Ash districts and covers the Project site. The *Williamtown – Salt Ash Floodplain Risk Management Study & Plan* also considers impacts associated with climate change, including increased ocean inundation levels and increased rainfall intensity.

Flooding in the vicinity of the Project site area is driven primarily by floodwaters from the Hunter River that overtop the Fullerton Cove levee, and the severity is a function of the magnitude of flooding within the Hunter River, which in turn is a combination of sea level impacts and catchment runoff. For the purposes of floodplain risk management, Port Stephens Council have decided the 1% AEP design flood is assumed to be a 50% AEP sea level and 10% AEP local catchment runoff event (BMT WBM, 2017).

The Project site is located beyond the Williamtown - Salt Ash floodplain Probable Maximum Flood (PMF) extents, and therefore smaller flood smaller events, and is located beyond Port Stephens Council's flood hazard mapping extents (Figure 4.5). These estimates include allowances for climate change impacts. Estimates of the 1% AEP flood level and PMF flood level in the vicinity of the site are 1.5m, and 5.2m AHD respectively. Direct surface flood impacts from the Hunter River on the Project site for the PMF or more frequent events such as the 1%AEP are not expected and the Projects site itself is not at risk of flooding from the Hunter River. Surface floodwaters for the PMF event would impact on access to and from the site, however the return interval of such an event, and the operating life make this highly unlikely..

As outlined in section 4.3 above, potential water ponding within the site is primarily due to raised groundwater levels which can be exacerbated by ocean inundation and localised heavy rainfall.

Historically, groundwater levels up to 3.5 to 4.0m AHD are experienced at the site during wet periods (Umwelt, 1995).

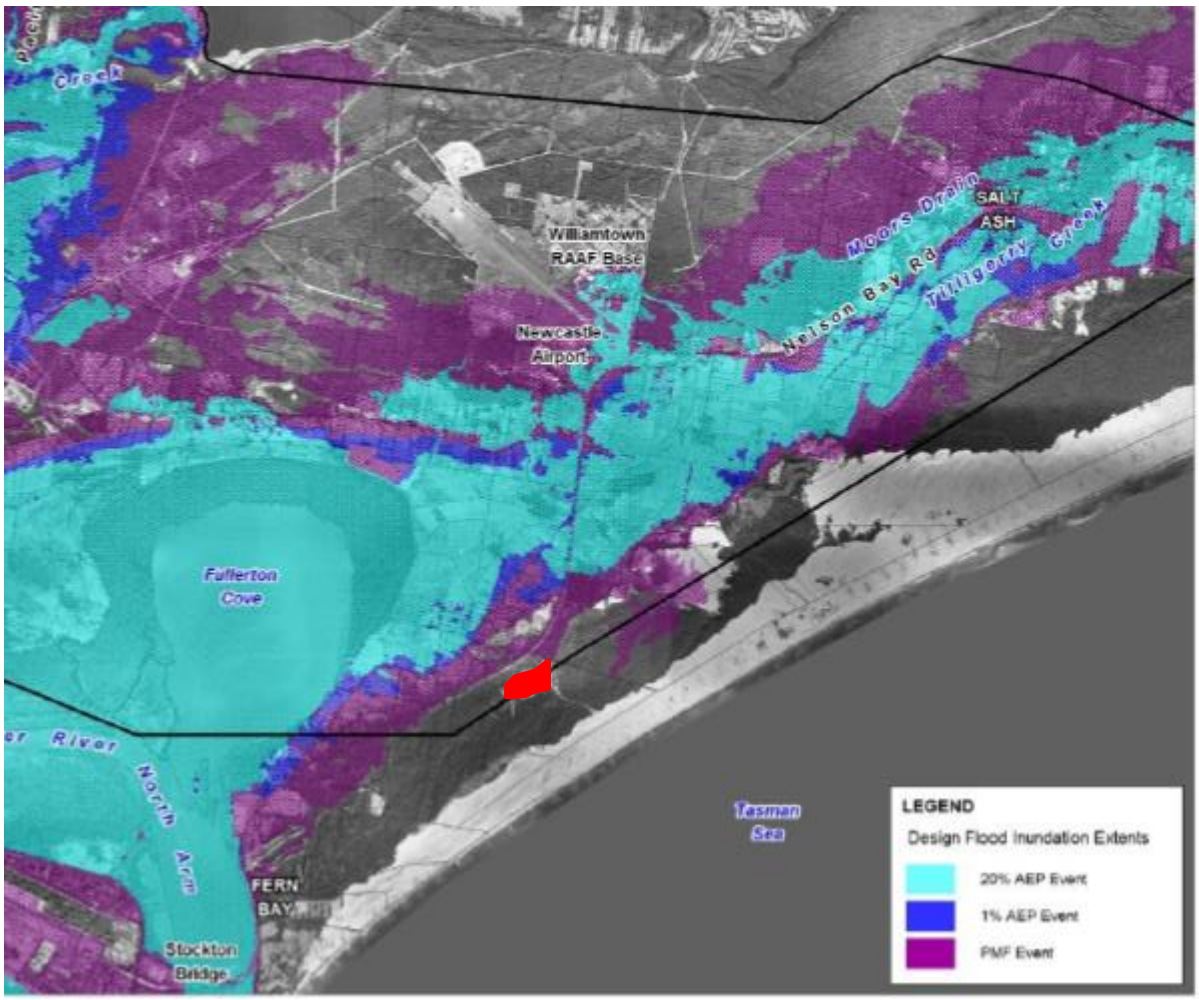


Figure 4.5 Design flood extents and Project site in red - extracted from *Williamstown – Salt Ash Floodplain Risk Management Study & Plan* (Cardno, 2017)

4.4.2. Coastal Hazards

Coastal hazards consist of erosion and wave runup along Stockton Beach. Coastal erosion and recession estimates out to the year 2100 have been estimated as part of Coastal zone management planning by Newcastle Council (BMT WBM, 2014). These estimates extend up to the Council boundary at Fern Bay about 3km to the southwest of the Project site, and represent a similar aspect and coastal exposure to that of the Project site. Likely beach erosion and recession in a large ocean inundation event by 2100 is about 250m (Figure 4.6). The Project site is well beyond projected coastal erosion extents, and is expected to be completed before 2050. Coastal hazards are not an issue at the site.

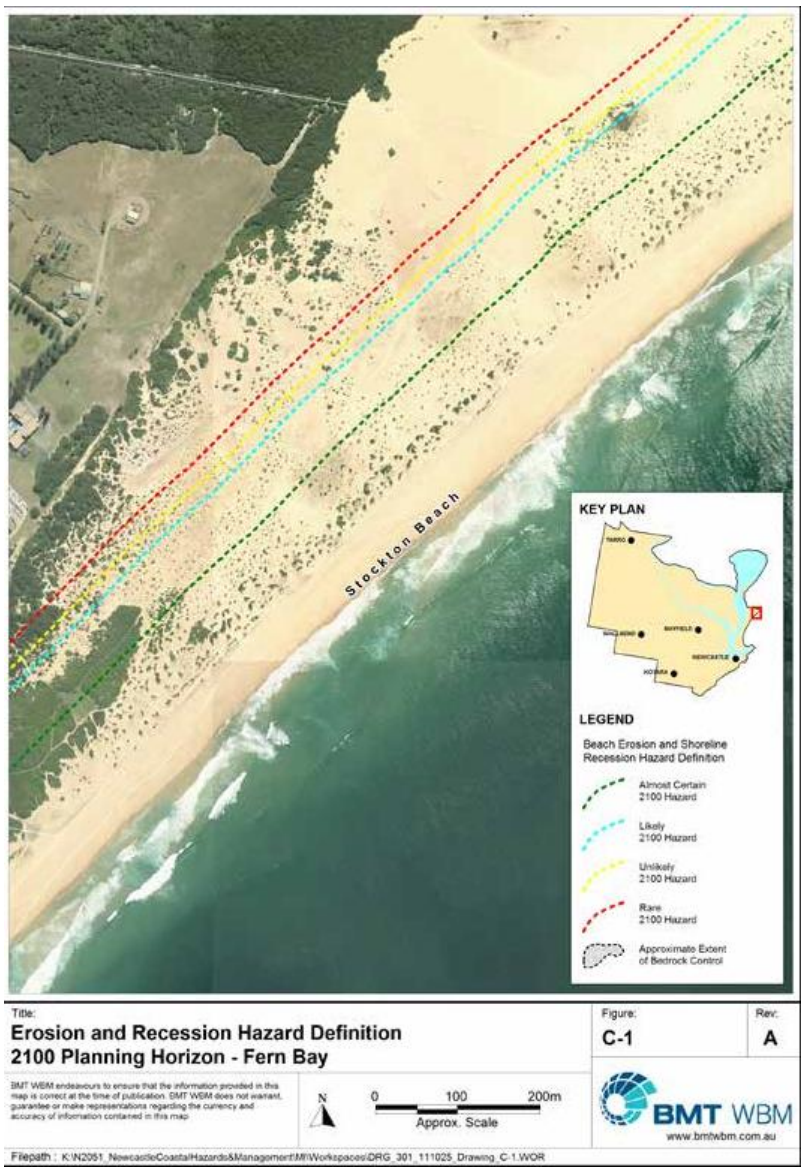


Figure 4.6 Erosion and rececion 2100 year planning horizon (BMT WBM, 2014).

4.5. Water quality

The *Hydrogeological Impact Assessment Stockton Sand Quarry, Coxs Lane, Fullerton Cove (EES, 2019)* summarises a range of water quality parameters analysed within the groundwater table, including a range of heavy metals and PFAS compounds. A brief summary of findings from this report is outlined below:

- On Stockton beach side of the groundwater divide, acidic pH that exceeds guideline values and is attributed to the result of natural occurring acidic soil groups;
- Arsenic (As) exceeded guidelines for drinking in bore MWx6, however this is considered a natural occurrence. Dissolved metals including aluminium, copper, zinc, arsenic and lead exceed guideline values for ecosystem protection (freshwater and marine); and
- No PFAS was detected in any groundwater samples analysed, in line with the investigations undertaken by the NSW EPA in the identification of PFAS management zones.

Given the general

5.0 SITE WATER BALANCE

5.1. Background

The water balance for the site has three separate components:

1. Water use and wastewater generation associated with the office and weighbridge facility;
2. Water use associated with dust suppression as required over the site; and
3. Changes to landscape conditions, primarily comprising removal of vegetation and transformation of dune areas to a dredge pond, and losses associated with the moisture content of extracted material leaving the site.

5.2. Direct demands

5.2.1. Office and weighbridge facility

Water demand at the office and weigh bridge facility are not expected to change significantly over the Project, and employment levels will remain similar to existing conditions. Any changes to water demand or wastewater generation associated with the office and weighbridge area can be managed through purchase of additional mains water from water contractors if required and additional wastewater removal contractors. Currently, rainfall is sufficient for site demands and approximately 37kL of collected wastewater is removed each year.

The Project will increase staff numbers to up to six full time staff and three casual staff. The existing wastewater system can accommodate this additional load, and pump out frequency can be increased when required.

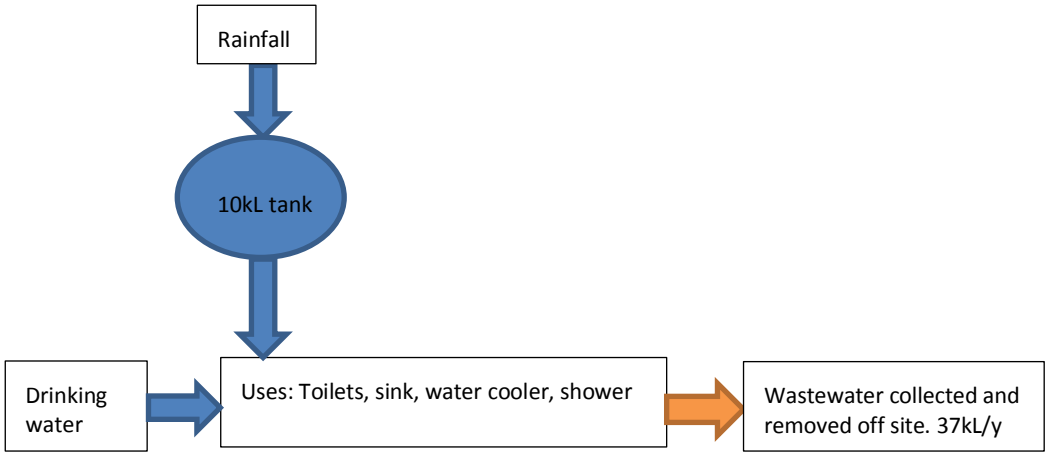


Figure 5.1 Conceptual Site office and weighbridge facility water balance

5.2.2. Fire fighting

In order to accommodate firefighting demands at the site, 20kL of static storage in a rainwater tank is proposed adjacent to the existing maintenance shed. Roof water from the maintenance shed will be diverted into the storage tank, and retained for firefighting purposes.

5.2.3. Dust Suppression

Water is purchased from a water cart contractor and sourced from mains supply. Water use for dust suppression is a function of rainfall, wind and truck and other vehicle movements and the quarry currently uses approximately 15.2ML/y to manage dust suppression on around 3 ha of unsealed haul roads within the site. Refer to Appendix A for a schematic showing existing and future haul road areas.

As the proposed Stage 1 is brought online, the existing extraction at the windblown sand extraction area will begin to reduce. After an estimated two years, the windblown sand extraction area (pit 7) will be exhausted and supply will be from the Project as per the staging timeline outlined in Section 1.3.

It is expected that water demand for dust suppression is approximately proportional to the amount of haul road area under use. The 2018 water demand has been applied over the future staging haul road areas to estimate water demand over the life of the Project. As Figure 5.2 shows, as pit 7 winds down, dust suppression water demand significantly reduces, then ramps up again as future stages are brought on line, peaking when the dredge pond is at full extent, and then reducing as the pond area is rehabilitated and Stage 6 is brought on line at the end of the Project.

It is expected that water use for dust suppression will continue to be supplied from water contractors that source water from the mains supply.

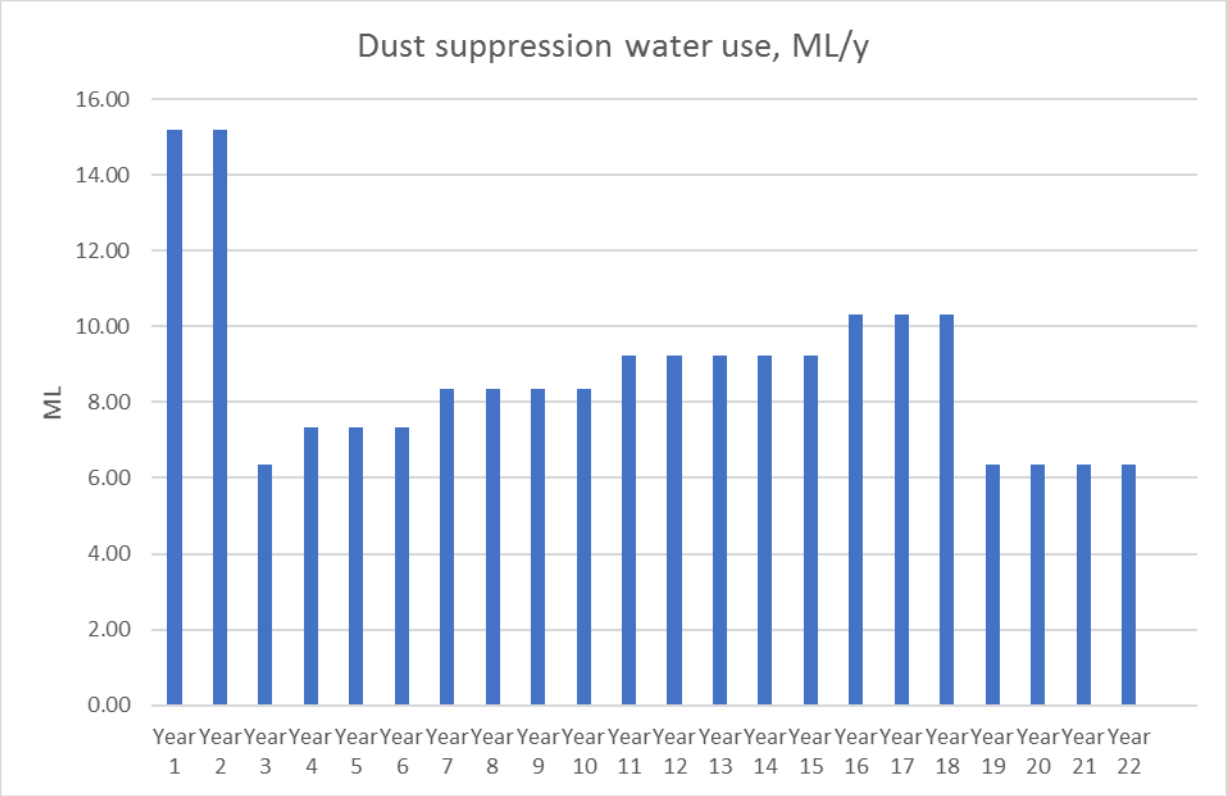


Figure 5.2 Estimated dust suppression water demand

5.3. Landscape changes and sand extraction

5.3.1. Background

Landscape changes and extraction associated with the Project will interact with the Stockton Groundwater Source. Groundwater mapping undertaken by EES suggests that the recharge boundary for the source runs roughly parallel to Stockton Beach, about 400m from the dune vegetation edge and ranges in depth from about 1.4m AHD to 1.0m AHD across the site, depending on recent rainfall. The boundary varies slightly depending on rainfall, extending closer to the ocean during periods of low rainfall and recharge, and then landward in higher rainfall periods (EES, 2019).

The water balance over the proposed extraction area in its current state consists of inflow from rainfall and groundwater movement through the extraction area (transmission) of about 300m^3/d and outflows in the form of evapotranspiration. Recharge to groundwater is a function of rainfall depth, evapotranspiration and the condition of the soil moisture store.

The proposed extraction area will be excavated to a depth of approximately 4m AHD with no interaction with the groundwater table itself. Water extracted from the site during dry extraction activities is limited to the moisture content associated with the sand soil profile.

Once sand extraction in each stage extends to the groundwater table, a 'window' to the groundwater table will be created when the dredge pond is created, and extraction using a dredge will commence. This will then generate losses from the groundwater resource associated with the moisture content of the material leaving the site, plus losses associated with direct evaporation through the 'window' to the groundwater table. The dredge pond will also create a direct connection between the groundwater table and rainfall. This will continue through Stages 2 to 6.

Advice from DPIE NRAR is that the exposure of the groundwater table to the atmosphere and subsequent direct evaporation from the groundwater resource needs to be accounted for as an extraction.

Refer to Appendix A for a schematic showing the assumed surface water extents and stage boundaries.

A conceptual model of both the existing condition and future condition over the footprint of the proposed extraction area have been used to establish how the water balance will change from existing conditions, and then forward over time as the sand extraction process expands (Figure 5.3 and

Figure 5.4). The model is used to estimate likely water extraction from the groundwater source over the life of the Project.

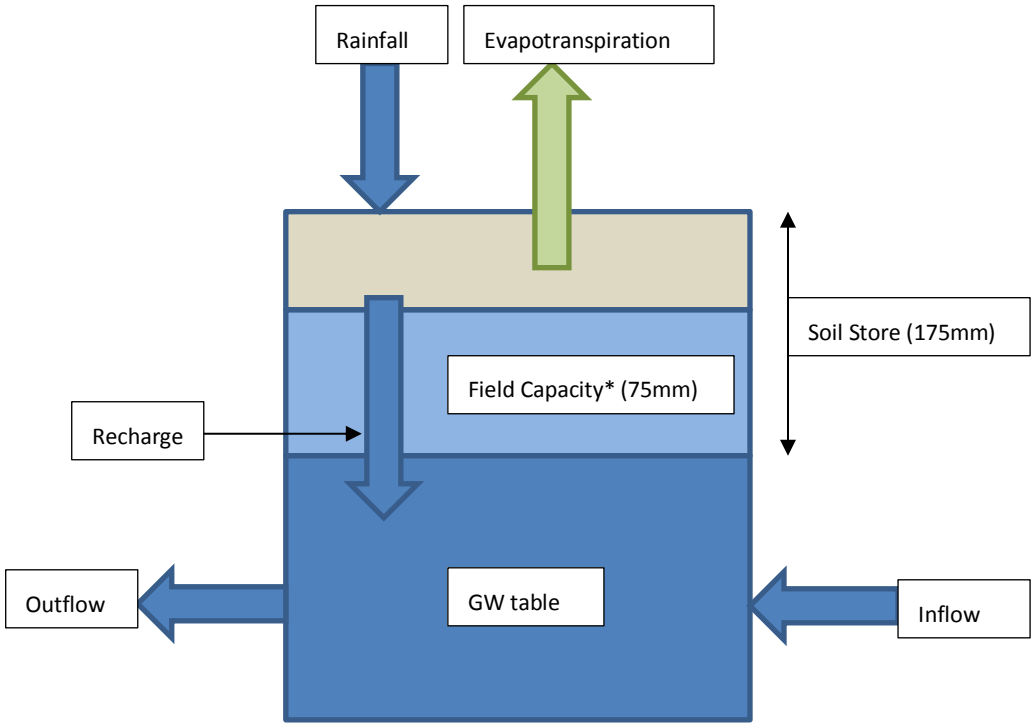


Figure 5.3 Schematic of existing water balance over extraction area.

*Field capacity is the depth of storage within the soil moisture store that must fill before flow to groundwater can occur.

Moisture content in product

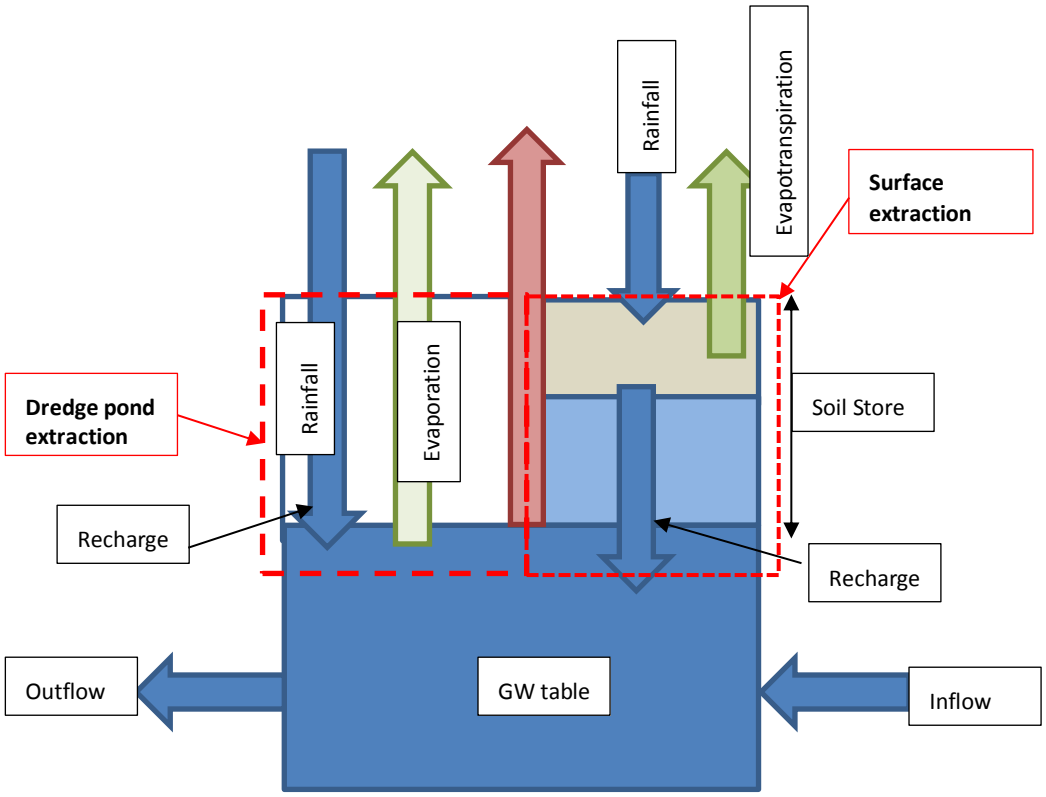


Figure 5.4 Schematic of future surface and groundwater balance

5.3.2. Model assumptions and setup

Climate information

The climate data required to model site surface and groundwater behaviour was extracted from the SILO gridded data sets available on 'The Long Paddock' website. Daily climate data from 1900 to present was collected, including rainfall, evaporation and a range of Morton's evaporation estimates, including evaporation over shallow lakes and actual evapotranspiration over land.

Soil store and groundwater

The primary consideration for this component of the assessment is the impact of the Project on the Stockton groundwater source. In order to establish this, an estimate of recharge making its way to the groundwater table is necessary.

For the purposes of this modelling, the groundwater transmissions, shown as inflows and outflows (groundwater flux) for both the existing and proposed conditions are assumed to be unchanged, given the size of the disturbance in relation to the surrounding water table extents, and are therefore ignored (Figure 5.3 and Figure 5.4).

A variation of the Australia Water Balance Model (AWBM) incorporated in the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) was used to emulate the behaviour of the soil moisture store and groundwater table and from that estimate recharge to the groundwater table. The following model assumptions were used:

- Soil storage capacity: 175mm (Macleod, 2008);

- Field capacity: 75mm (Macleod, 2008);
- Infiltration rate: 360mm/d (typical for sandy soils);
- Percentage of soil store in excess of field capacity to GW table: 22%; and
- Time step: daily.

Existing conditions

Groundwater storage variation was compared with field bore hole depth records collected as part of the *Hydrogeological impact assessment, Stockton Sand Quarry, Coxs Lane* (EES, 2019). Modelled response of groundwater storage approximates recorded results over the period from May 2017 to June 2018, with slightly smaller variation in level (Figure 5.5). The *Hydrogeological impact assessment, Stockton Sand Quarry, Coxs Lane* (EES, 2019) estimated annual recharge for the site at 350mm/y for average annual rainfall of 1100mm based on Podosolic soil type. The average annual recharge as estimated in the soil-groundwater model used for this study is 390mm/y with an average annual rainfall for the period of 1120mm, suggesting modelled recharge estimates are reasonable. The WSP for the Stockton Groundwater Source assumes 22% recharge, or 262mm/y (DPI, 2016).

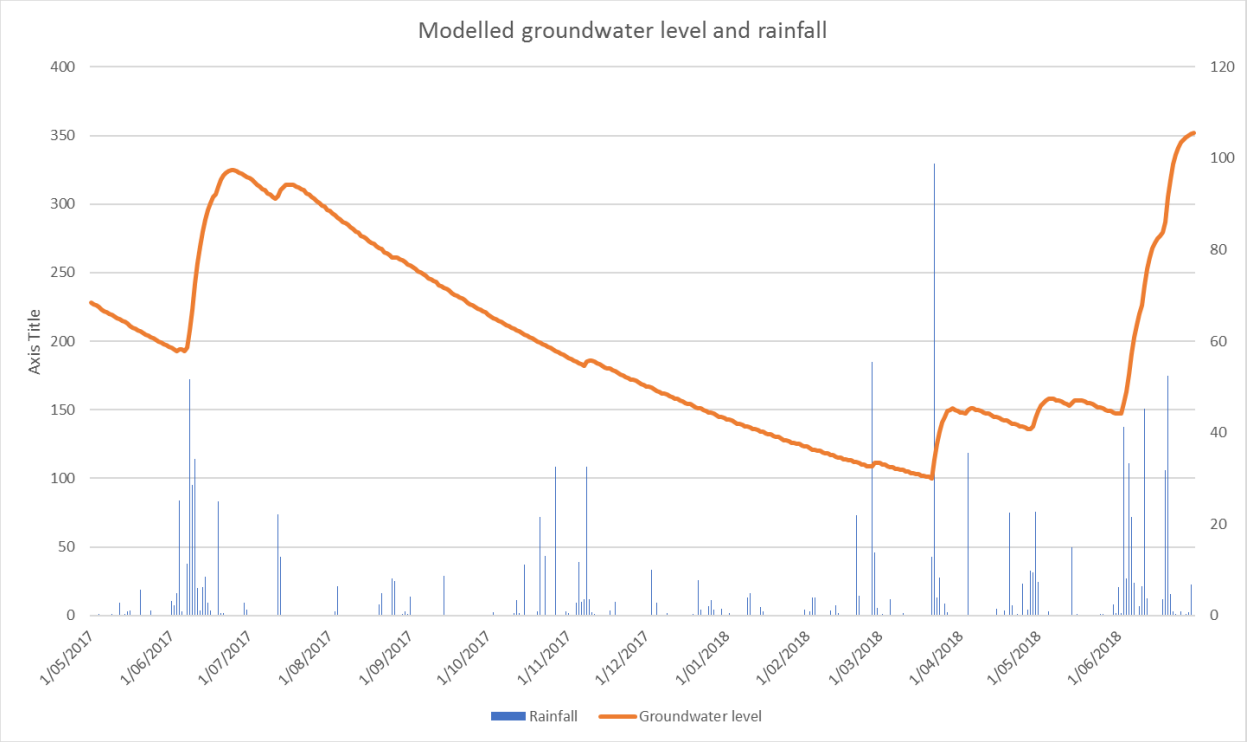


Figure 5.5 Modelled groundwater level and rainfall

Modelled conditions

A model of the proposed conditions considers the losses associated with the moisture content of sand material leaving the site, along with the impact of the areal change in the landscape from dunes to a dredge pond, and the associated change from evapotranspiration over the vegetated and partially vegetated surface to direct evaporation from the dredge pond surface itself.

For the extracted material, moisture content is estimated to be 3% for material excavated from above the water table, based on laboratory testing carried out by Coffey Partners and provided by Boral. For material extracted from below the water table, a moisture content of 5% is assumed, based on experience from the Quarry Manager and data from Boral's other dredging operations at Dunmore, NSW. In areas where sand extraction is occurring above the groundwater table, the interaction between rainfall, the soil moisture store and infiltration is assumed to be the same as for the undisturbed landscape, with a similar recharge to groundwater occurring. Where the extraction area exposes the groundwater table, rainfall is considered to be directly added to groundwater, and direct evaporation to the atmosphere directly from groundwater surface (Morton's lake evaporation) is assumed.

The extraction associated with evaporation is the balance between direct rainfall entering the dredge pond, and evaporation from the dredge pond surface.

Three climate periods were selected to model the impact of the Project to gain an appreciation of system behaviour over different rainfall conditions; a 'wet' period, from 1950 to 1970, an 'average' period, from 1969 to 1989, and a 'dry' period, from 1925 to 1945 covering the life of the Project (Figure 5.6). The model was also run with the same rainfall over the project life for the median, 10th percentile and 90th percentile rainfall.

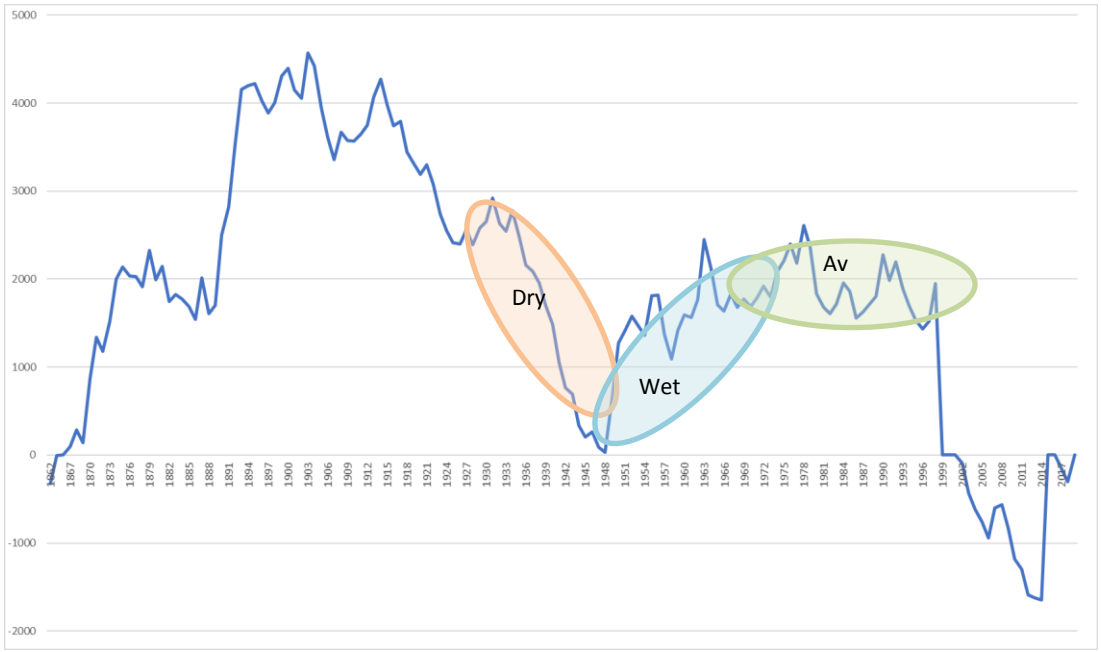


Figure 5.6 Annual rainfall cumulative deviation from the mean, modelled periods.

5.3.1. Results

There is significant variation in annual water extraction volumes over the three periods modelled due to rainfall variability (Table 5.1). Variation in extraction over the Project life for the periods modelled ranges from 867 ML to 1237 ML (Table 5.2). For continuous set rainfall (10th percentile, median and 90th percentile) over the Project life the extraction ranges from 1580 ML for the 10th percentile rainfall, 1067 ML for the median rainfall and 57 ML for the 90th percentile rainfall.

Extractions generally increase over time as the dredge pond expands, peaking at an average close to 100ML/y in the last years of the Project.

For the purpose of the assessment, a 21 year period has been modelled based on the most realistic projections for sand demands and operational constraints. The consent period applied for is 25 years. Should operations extend beyond the 21 years, the extractions are still relevant, and relate primarily to the size of the dredge pond. The model is a tool that provides an indication of water demands over time, monitoring will be required to accurately estimate demands and compare with water allocations whilst the aquifer is exposed.

Table 5.1 Annual water balance results for a range of climatic periods and rainfall percentiles.

Stage	Operation year	Average annual extraction for the three periods modelled (ML/y)	Minimum annual extraction for the periods modelled	Maximum annual extraction for the periods modelled	Extraction based on median rainfall (ML/y)	Extraction based on 10th percentile rainfall (ML/y)
1	1	-16.40	-16.40	-16.40	-16.40	-16.40
	2	-16.40	-16.40	-16.40	-16.40	-16.40
2	3	-16.40	-16.40	-16.40	-16.40	-16.40
	4	-26.38	-22.81	-28.34	-27.36	-31.32
	5	-29.34	-22.32	-35.89	-32.60	-40.52
3	6	-21.24	-12.62	-31.82	-37.83	-49.72
	7	-13.38	-10.44	-15.72	-25.87	-37.75
	8	-40.07	-13.00	-60.83	-37.47	-53.00
	9	-41.67	-35.87	-44.59	-42.29	-61.48
	10	-7.65	7.08	-17.34	-47.12	-69.95
4	11	-50.35	-27.51	-68.46	-41.60	-64.43
	12	-68.07	-46.38	-93.29	-45.88	-71.95
	13	-43.56	-17.41	-59.44	-57.76	-87.07
	14	-35.71	43.63	-81.69	-62.04	-94.58
	15	-78.49	-57.15	-99.00	-66.32	-102.10
5	16	-80.68	-44.34	-109.86	-62.14	-97.92
	17	-93.50	-79.37	-114.53	-79.10	-120.23
	18	-80.24	-13.31	-118.60	-86.17	-132.65
6	19	-67.80	-44.59	-88.16	-74.72	-121.19
	20	-91.39	-56.72	-156.02	-91.82	-144.53
	21	-95.36	-67.44	-110.09	-100.07	-159.04
Total		**-1041.08**	**-569.80**	**-1382.00**	**-1067.00**	**-1588.00**

Table 5.2 Water balance Project totals

Demand/Supply Location	Dry (1900-1920)	Average (1969-1989)	Wet (1950-1970)
	ML	ML	ML
Rainfall	2010	2290	2314
Moisture content in material	378	378	378
Evaporation (dredge pond)	2869	2851	2802
Balance	**-1237**	**-938**	**-867**

5.3.2. Discussion

Existing recharge into groundwater over the quarry is on average 390mm/y based on the AWBM and about 262mm/y based on the WSP. As the dredge pond is created, direct rainfall to the groundwater table increases, as does evaporation and moisture losses associated with removed material.

The balance between rainfall addition through direct rainfall into the groundwater table and evaporation from the dredge pond surface area is generally negative, although there are infrequent years of high rainfall when this is positive. A generally negative balance is to be expected given the average Morton's lake evaporation of 1368mm/y exceeds the average annual rainfall of 1120mm/y. Losses associated with material leaving the site vary by a small amount based on assumptions around production. As the Project expands past Stage 1 and the dredge pond increases in size, losses associated with evaporation increase, as do the gains associated with direct rainfall, depending on the rainfall variation. Figure 5.7 presents the various water balance supplies and demands and losses for the 'average' climate period, showing the changes over time as the dredge pond expands.

Figure 5.8 shows the variability in the total water balance over the life of the Project for the range of climactic periods modelled. Figure 5.8 also shows the results of the water balance model when using constant 10th, 50th and 90th percentile rainfall, showing that net extraction is more likely than net imports to the groundwater table from above average rainfall. Generally, the site will be a net water importer to the groundwater table in only in years when rainfall is at or above the 90th percentile.

The water balance model of the dredge pond and extraction shows that there could be significant variability in extractions from the groundwater source due to variability in rainfall and the associated changes direct rainfall inputs into the groundwater table.

To accurately estimate extractions, detailed record keeping of dredge pond area, evaporation and rainfall are recommended.

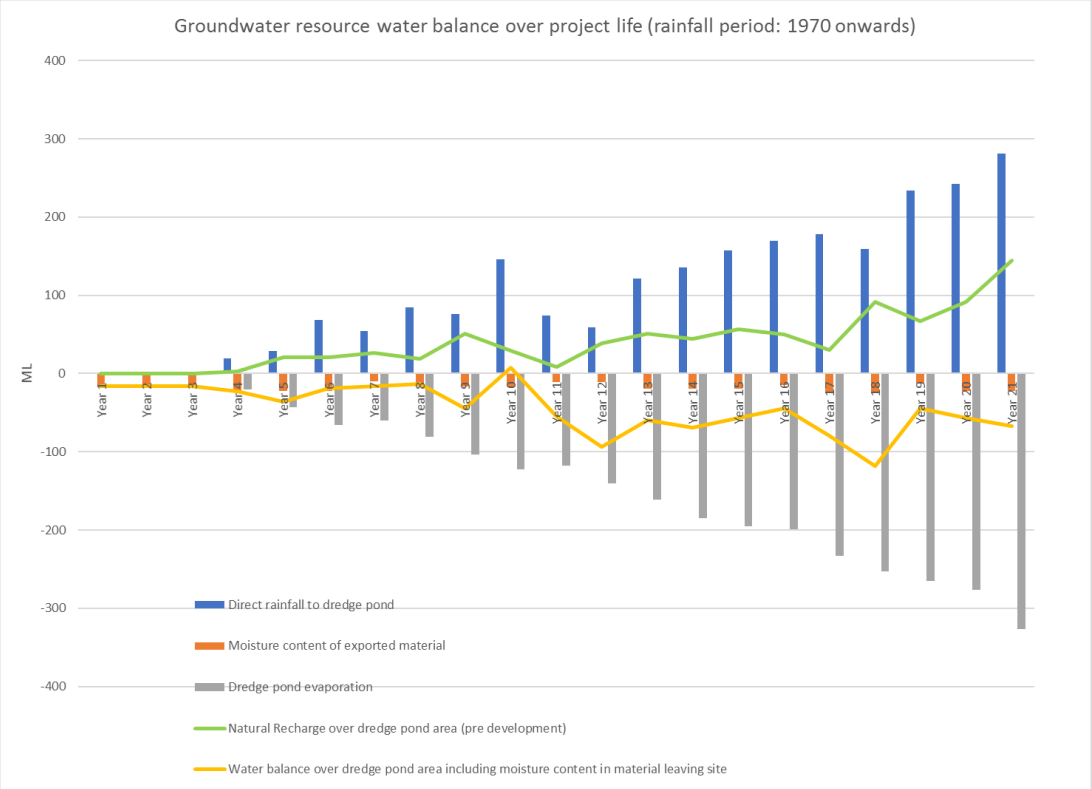


Figure 5.7 Water balance breakdown over the mine operation, and existing recharge over the dredge pond footprint (Average Climate period - 1969 to 1989)

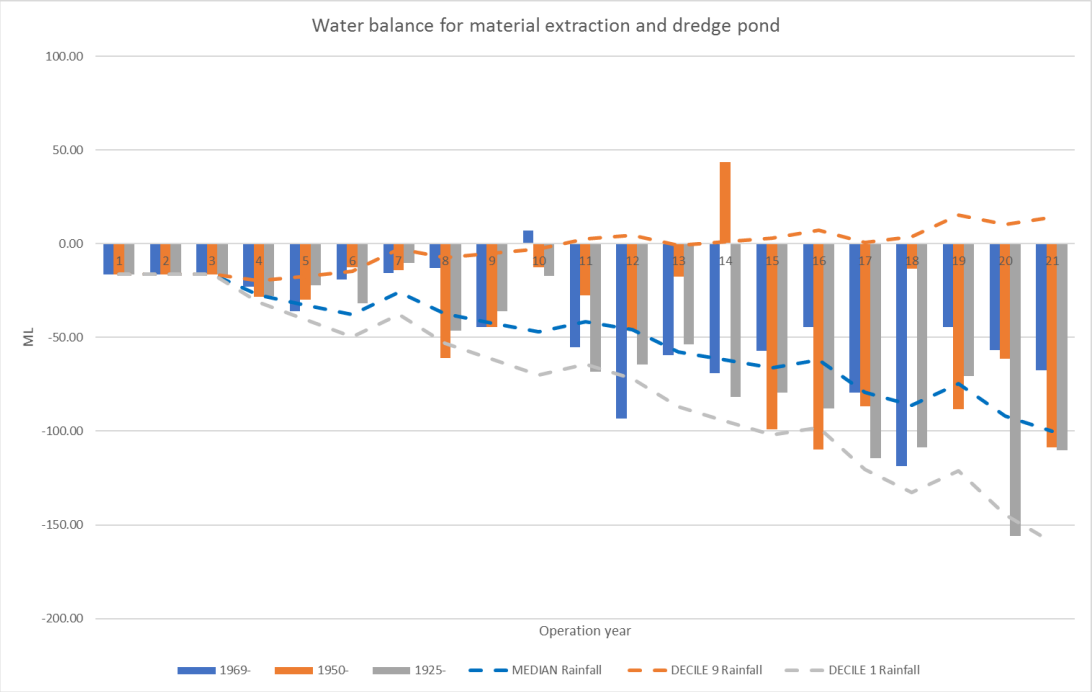


Figure 5.8 Annual water balance for three modelled periods and 10th, 50th and 90th percentile rainfall.

6.0 IMPACT ASSESSMENT

6.1. Evaluation

In order to evaluate potential surface water impacts associated with the Project, the risk of impact has been assessed. In this case, risk is a combination of the likelihood of an impact and the consequences of that impact occurring based on the matrix outlined in Table 6.1. Where the risk is estimated to be medium or higher, mitigation and management measures are discussed. Surface water impact assessment is summarised in Table 6.2.

Table 6.1 Risk assessment matrix

Likelihood	Consequence				
	Negligible	Minor	Moderate	Major	Catastrophic
Remote	Low	Low	Low	Medium	Medium
Unlikely	Low	Low	Medium	High	High
Possible	Low	Medium	High	Very High	Very High
Likely	Medium	High	Very High	Very High	Extreme
Almost certain/Inevitable	Medium	High	Very High	Extreme	Extreme

6.2. Surface water impacts

6.2.1. Construction

The site is predominantly sand with high infiltration rates, and additionally the quarry operations are self-contained with no surface discharge. Given the confined nature of the extraction area erosion of the sand landscape in the Project area during heavy rainfall is unlikely to be an issue. However, haul roads, and some areas of stabilisation may require virgin excavated natural material (VENM) or other road base material for construction that will contain clays and other soil types of smaller particle sizes that are more erodible than existing sand material on site. Although surface runoff is contained within the site, erosion and sediment controls for areas where VENM or other material have been brought into the site for foundations, haul roads and stabilisation are necessary to limit sediment movement onto the adjoining landscape, where exotic vegetation can establish, or into the dredge pond.

6.2.2. Operation

Haul roads present a continuing source of sediment in periods of high rainfall. The nature of the site landscape means that any eroded material from the haul road surface is contained in close proximity to the road. There are no surface water connections from the site to watercourses off site.

The Project includes construction of a new processing area that includes a diesel generator as well as continuing use of the existing maintenance shed. There are potential impacts from the areas associated with refueling or chemical spills reaching surface or groundwater, particularly during rainfall events.

Once the dredge becomes operational the dredge will extract sand from the base of the pond. Dredge extraction involves a caged impeller which disturbs the sand profile creating a slurry for extraction. Minimal material is suspended in this part of the operation, as fines are extracted within the slurry.

Once extracted, the slurry will pass through a wash plant to remove any fines or other unwanted materials . Given the nature of the deposited sand, fines content is expected to be low.

Materials filtered out in the wash plant, predominantly fines will be pumped back to the dredge pond, away from the operating dredge to encourage settlement. , and limit fines movement back though the dredge The entire operation is isolated from surface water interaction beyond the site.

As discussed in Section 4.4, there is no direct connection from the site to surface floodwaters. However, inundation of the proposed extraction area has occurred previously due to increased groundwater levels associated with heavy rainfall, adjacent flooding and possibly ocean inundation. Levels of up to 3.5m to 4.0m AHD have been experienced. Permanent (existing and proposed) infrastructure on the site is located at 4.0m and above.

6.3. Water balance and groundwater impacts

Groundwater impacts are covered in detail within the *Hydrogeological impact assessment* (EES, 2019).

As previously mentioned there is a close interaction between rainfall, surface water and the groundwater table, and as such the water balance has prepared to examine impacts over the life of the project.

Prior to construction of the dredge pond, moisture content within extracted material is the largest extraction. After completion of the Stage 2 dredge pond, the balance of direct rainfall and evaporation then becomes the largest extraction, growing as the pond surface area expands.

Towards the end of the Project life when the dredge pond is at its largest and extraction is still occurring, total water extraction is close to 100 ML/y assuming median rainfall and up to 156 ML/y assuming 10th percentile rainfall.

In terms of impact on the groundwater source the Project extraction is minimal. The available water within the Stockton groundwater source, known as the Long Term Average Annual Extraction Limit (LTAAEL) is 14000 ML/y (DPI, 2016), after existing landholder rights and allocations are accounted for, approximately 12,000 ML/y remains. Estimated annual extraction is approximately 1% of the available allocations from the Stockton groundwater source.

The mapped boundary to the Stockton aquifer as specified in the Hunter Water (Special Areas) Regulation 2003, is approximately 150m to the north east at its closest point. Groundwater monitoring shows that groundwater flow direction is away from the aquifer spreading towards the site and to the north west ands south west. Movement of groundwater and any potential contaminants from the site to the Stockton aquifer is highly unlikely. This is discussed in more detail within the *Hydrogeological impact assessment* (EES, 2019).

Table 6.2 Surface water environmental impact assessment

Project component		Potential surface water impacts	Likelihood of impact	Consequence of impact	Risk rating	Comment
Site establishment	Changes to entry road and parking relocation	Localised change to surface runoff.	Possible	Negligible	Low	Negligible impact, local stormwater discharge to adjacent sand landscape.
	Construction of pad for wash plant and diesel generators	Localised change to surface runoff.	Possible	Negligible	Low	Negligible impact, local stormwater discharge to adjacent sand landscape.
Internal access roads	Modification of existing haul road for stage 1	Localised change to surface runoff, erosion and sedimentation during construction of haul road.	Possible	Negligible	Low	Haul road construction will require road base material from off site. Potential for erosion of this material, however if not controlled, confined to extraction area and dredge pond.
	Construction of perimeter haul road alongside dredge pond	Localised change to surface runoff, erosion and sedimentation during construction of haul road.	Possible	Negligible	Low	Haul road construction will require road base material from off site. Potential for erosion of this material, however if not controlled, confined to extraction area and dredge pond.
		Water use for dust suppression on the haul roads.	Unlikely	Negligible	Low	Water supply for dust suppression to be sourced from a licenced water contractor.
Sand extraction	Progressive vegetation removal and extraction associated with Stage 1, and establishment of wash plant and diesel generators	Changes to surface hydrology associated with vegetation removal. Localised erosion depending on surface slope.	Possible	Negligible	Low	Small changes to hydrology in context of larger groundwater source. Site clearing to be limited, should erosion occur, confined to extraction area.
		Potential water quality impacts associated with fuel and oil spills associated with wash plant and generators.	Unlikely	Moderate	Medium	Potential for fuel spills during refueling, or through failure of fuel storage.
		Water extraction associated with moisture content lost in material.	Likley	Negligible	Medium	Water losses from the site associated with moisture content of material leaving the site is considered an extraction from the groundwater resource. Although a small amount in comparison with the LTAAEL, a WAL and allocation is required for this water extraction.

		Increase in groundwater table due to ocean inundation, heavy rainfall and/or local flooding.	Possible	Minor	Medium	Increased groundwater levels associated with flooding may require temporary stoppage of extraction and movement of plant and equipment.
	Stage 2 to 6 progressive vegetation removal and surface material extraction. Creation of dredge pond as window to groundwater table.	Changes to surface hydrology associated with vegetation removal. Localised erosion depending on surface slope.	Possible	Negligible	Low	Small changes to hydrology in context of larger groundwater source. Site clearing to be limited, should erosion occur, confined to extraction area.
		Water extraction associated with moisture content lost in material and direct evaporation from dredge pond 'window' to the groundwater table.	Likely	Minor	High	Water losses from the site associated with moisture content of material leaving the site and the balance of evaporation and direct rainfall to the dredge pond is considered an extraction from the groundwater resource. Although a small amount in comparison with the LTAAEL, a WAL and allocation is required for this water extraction.
Sand processing	Transfer from dredge pond to wash tank and floating of fines (<75µm). Wash tank water and fines the returned to dredge pond.	Accumulation of fines within the dredge pond, increasing turbidity within the pond.	Possible	Minor	Medium	Fines returned to dredge pond will increase turbidity within the pond. As dredge pond size increases, the discharge point for returned wash tank water can be located away from the dredge extraction point to allow for fines to settle. The pond is isolated from water bodies, fines will be retained within the dredge pond as such environmental risk is minimal.
Stabilisation	Constructed batter slopes along the dredge pond edge	Erosion along dredge pond edge due to operations and wave action.	Likely	Minor	High	Dredge pond banks to be progressively stabilised using revegetation, rock riprap and imported virgin excavated natural material.

7.0 MANAGEMENT AND MITIGATION OF SURFACE WATER RISKS

Table 7.1 Management and Mitigation measures

Project component		Potential surface water impacts	Management and Mitigation
Site establishment	Changes to entry road and parking relocation	Localised change to surface runoff.	Refer 7.2
	Construction of pad for wash plant and diesel generators	Localised change to surface runoff.	Refer 7.1, 7.3
Internal access roads	Modification of existing haul road for stage 1	Localised change to surface runoff, erosion and sedimentation during construction of haul road.	Refer 7.2
	Construction of perimeter haul road alongside dredge pond	Localised change to surface runoff, erosion and sedimentation during construction of haul road.	Refer 7.2
		Water use for dust suppression on the haul roads.	Refer 7.2
Sand extraction	Progressive vegetation removal and extraction associated with Stage 1, and establishment of wash plant and diesel generators	Changes to surface hydrology associated with vegetation removal. Localised erosion depending on surface slope.	Refer 7.2
		Potential water quality impacts associated with fuel and oil spills associated with wash plant and generators.	Refer 7.1
		Water extraction associated with moisture content lost in material.	Refer 7.4
		Increase in groundwater table due to ocean inundation, heavy rainfall and/or local flooding.	Refer 7.3,
	Stage 2 to 6 progressive vegetation removal and surface material extraction. Creation of dredge pond as window to groundwater table.	Changes to surface hydrology associated with vegetation removal. Localised erosion depending on surface slope.	Refer 7.4, 7.5, 7.6
		Water extraction associated with moisture content lost in material and direct evaporation from dredge pond 'window' to the groundwater table.	Refer 7.4, 7.5, 7.6, 7.7
Sand processing	Transfer from dredge pond to wash tank and floating of fines (<75µm). Wash tank water and fines the returned to dredge pond.	Accumulation of fines within the dredge pond, increasing turbidity within the pond.	Refer 7.5
Stabilisation	Constructed batter slopes along the dredge pond edge	Erosion along dredge pond edge due to operations and wave action.	Refer 7.6

7.1. Refueling, hydrocarbon and chemical spills

Standard hydrocarbon and chemical storage, handling and management techniques should be implemented for the proposed diesel generator and wash plant areas, along with the existing maintenance shed. The existing Environmental Management Strategy for the site should be updated to accommodate these changes to operations on the site.

7.2. Sediment and erosion control

Constructed areas such as haul roads and hardstand areas present the larges risk for erosion and sediment generation given the potential small particle sizes associated with the imported material necessary for these areas. Erosion prevention and sediment controls should be implemented through the design of the haul roads and hardstand areas to limit concentrated flow paths and through the use of erosion and sediment controls during construction and operation. Refer to the following guidelines when preparing haul road designs and undertaking construction at the site:

- Managing Stormwater: Soils and Construction, Volume 2E – Mines and Quarries (DECC, 2008) provides guidelines to specifically address requirements for erosion and sediment control on mines and quarries based on the principles set out in Managing Stormwater: Soils and Construction, Volume 1 (Landcom 2004); and
- Managing Urban Stormwater: soils and construction, Volume 1 and Volume 2C: Unsealed roads and 2D: main road construction (DECC 2008) provide guidance on road design and design of erosion and sediment control measures for the construction of the proposed access and haul roads over the site.

7.3. Flooding and inundation

Modelled maximum groundwater levels and reported maximum groundwater levels for the Project site are 3.5 to 4.0m AHD. All fixed infrastructure such as the weighbridge, offices, diesel generators and wash plant are located well above these levels.

During surface extraction processes, machinery and portable screens can be moved prior to increased groundwater levels. To predict these periods, rainfall and ocean level conditions should be monitored through the BoM, including storm warnings for heavy rain and high seas. In conjunction, groundwater levels should be monitored and rates of movement noted. Based on this information the Quarry Manager should decide on precautionary measures to remove machinery from areas where groundwater flooding may occur. Currently the procedure is to store all plant and equipment in the maintenance shed, above groundwater inundation levels.

For the dredge pond processing area, allowances should be made for the dredge to move to a higher level through adjustments in mooring lines and transfer pipes. Management of this risk should include a groundwater inundation management plan that includes monitoring of existing bores, flood and storm warnings as well as specific triggers for the movement of machinery and equipment and temporary storage locations.

7.4. Extractions, licensing and evaporation mitigation

The exposure of the groundwater table through excavation will necessitate an aquifer interference approval under section 91 of the WM Act. Sufficient water allocations will be required to account for extractions from the Stockton Groundwater Source through moisture content in sand material leaving the site, and through the creation of a 'window' to the groundwater table which will allow direct evaporation, along with direct rainfall input.

The proponent may consider implementing measures to reduce extractions, particularly evaporation from the dredge pond surface.

Evaporation from the pond surface is primarily a function of the energy added to the pond water surface through radiation and convection, as well as the moisture content of the atmosphere at the pond surface and how quickly this is replaced through air movement (wind). Limiting these factors can help reduce evaporation.

There are a range of technologies available to reduce evaporation through techniques which limit exposure of surface water to atmosphere by providing shade and reducing air flow (wind), and the use of direct barriers, such as covers or floating materials. These may reduce evaporation up to 80 to 90%.

Although chemical barriers are available, only physical barriers should be considered to limit water quality risks.

If evaporation reduction techniques are applied, at some point the 'window' to the groundwater table may become a net importer rather than exporter to the gro1undwater table if annual rainfall begins to exceed annual evaporation over the pond surface.

7.5. Fines management

Limited fines are expected within the extracted material due to the nature of the sand deposit. Any fines collected within the wash plant will be returned to the dredge pond. The water and fines return point will be located as far as possible from the dredge operation to limit reprocessing. Fines management is less a water quality issue, and more a production issue, given the isolation of the dredge pond from the surrounding environment.

Should fines settlement become an issue, a silt curtain is an appropriate method to restrict fines movement between the dredge operation area and fines return point. Operations should be monitored to determine whether installation of a silt curtain is required.

7.6. Stabilisation of dredge pond batters

Geotechnical investigations into site slope stability and angles of repose have been undertaken by Pells Sullivan Meynink (PSM) and the following batter designs have been developed (PSM, 2019):

- A batter slope of 2H:1V (Horizontal:Vertical) above 4 m AHD;
- A batter slope of 3H:1V from 4 m AHD on the sides of the dredge pond to 15 m below the water table at the base. The batter slope of 3H:1V will range from 3-9 m AHD on

the southern and eastern perimeters of the dredge pond and also extend to 15 m below the water table at the base.

- On the southern and eastern sides of the proposed dredge pond the perimeter haul road will follow existing topography and may require some earthworks as required to achieve 10H:1V and facilitate safe access for heavy vehicles.

The stabilisation of the edges of the dredge pond will rely on batters at an angle of natural repose. Preliminary geotechnical advice has been provided by Pells Sullivan Meynick Pty Ltd, which recommended regular inspection of the batters to ensure management responses are taken. Where necessary, a protective layer of appropriate VENM may be used to stabilise the embankments.

Management options for stabilisation and embankment erosion will be:

- progressive rehabilitation using planted edges; and/or
- VENM emplacement, including application of 450 mm rock

In the initial phases of work, the aim will be to stabilise the edge of the pond and where necessary to prevent wave action induced erosion at the pond edge.

7.7. Water quality and quantity monitoring

7.7.1. Water quality

Surface water monitoring within the dredge pond should follow the recommendations outlined in the Hydrogeological Impact Assessment report (EES, 2019) for monitoring and testing of existing bores on a monthly basis as well as after periods of heavy rainfall in excess of 20mm in 24 hours, where testing should be carried out daily on the heavy rainfall days and the subsequent 3 days. Surface water testing within the dredge pond should include:

- Field measurement within the dredge pond of:
  - pH, electrolytic conductivity (EC), oxidation-reduction potential (ORP), static water levels (SWL), dissolved oxygen (DO) and temperature;
- Laboratory analysis for:
  - full ionic balance suite – pH, TDS, cations (Na, Ca, Mg, K), anions (Cl, SO4, HCO3, PO4, F) and nutrients (NH3, NO3 and NO2); and
  - dissolved metals / metalloids including aluminium (Al), arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), manganese (Mn), mercury (Hg), nickel (Ni) and zinc (Zn).

After 12 months of regular testing, monthly sampling may be extended to bi-monthly should no exceedances or significant variations overtime occur. Monitoring during rainfall events should be maintained.

7.7.2. Water quantity

To gather an accurate understanding of extractions from the groundwater source and accurately estimate evaporation losses detailed measurements of the pond area, moisture content of sand material, and sand material export are required. The following monitoring is recommended:

- Six monthly measurements of dredge pond area either through site survey or aerial survey;
- Fortnightly measurements of moisture content in exported material through stockpile measurements; and
- Record of material leaving site and whether from excavations above groundwater table, of from dredge pond.

8.0 SUMMARY AND RECOMMENDATIONS

8.1. Water supply and licensing

Water demands and supplies for the Project include:

- Water for office toilets showers and drinking, supplied from a rainwater tank and bottled water;
- Water for dust suppression on haul roads is supplied from a water contractor; and
- Water leaving with material as moisture content, and the balance of direct rainfall and evaporation over the dredge pond are considered extractions from the groundwater source.

A site water balance that incorporates moisture lost in sand material and the net extractions from the dredge pond has been prepared. Initially, prior to the dredge pond creation, extraction sits at a maximum of around 16.4ML/y. After Stage 1, as the dredge pond expands, evaporative losses increase even though direct rainfall is added to the groundwater table.

It is recommended that water allocations via a WAL be obtained based on the median rainfall water balance (Table 5.1). Boral may choose to purchase allocations in a staggered fashion to cover demand as required. For example, obtain allocations of 50ML/y to cover the first three stages, then increase to 100ML/y to cover the remainder of the project, or source the 100ML/y up front.

In conjunction with obtaining water allocations to cover extractions, detailed measurements of pond surface area should be maintained to allow for accurate estimations of extractions based on local rainfall and evaporation.

Given that evaporation from the pond surface represents the largest extraction from the site, investigations into evaporation prevention technologies and testing of these technologies is recommended.

8.2. Management and mitigation

Beyond ensuring that correct licencing and sufficient water allocations are available for the Project, a number of other management and mitigation measures are recommended to provide protection of groundwater and surface water, including:

- Updating existing Environmental Management Strategy to provide protection of surface waters for the new diesel generators, wash plant and cyclone;
- Preparing a groundwater inundation management plan to deal with raised groundwater levels during periods of high ocean level and high rainfall. This should include:
    - Monitoring systems (BOM, bore groundwater levels); and
    - Triggers for the movement of machinery and equipment and temporary storage locations;
- Monitoring fines movement and potential reprocessing to establish whether a silt curtain is required;
- Undertaking water quality monitoring of the dredge pond as outlined in Section 8.6.1;
- Undertaking monitoring and measurements to enable estimation of water extractions including:
    - Six monthly measurements of pond area;
    - Fortnightly measurements of moisture content in exported material through stockpile measurements; and
    - Recording quantities of material leaving site and whether these area sourced from excavations above the groundwater table, of from dredge pond.

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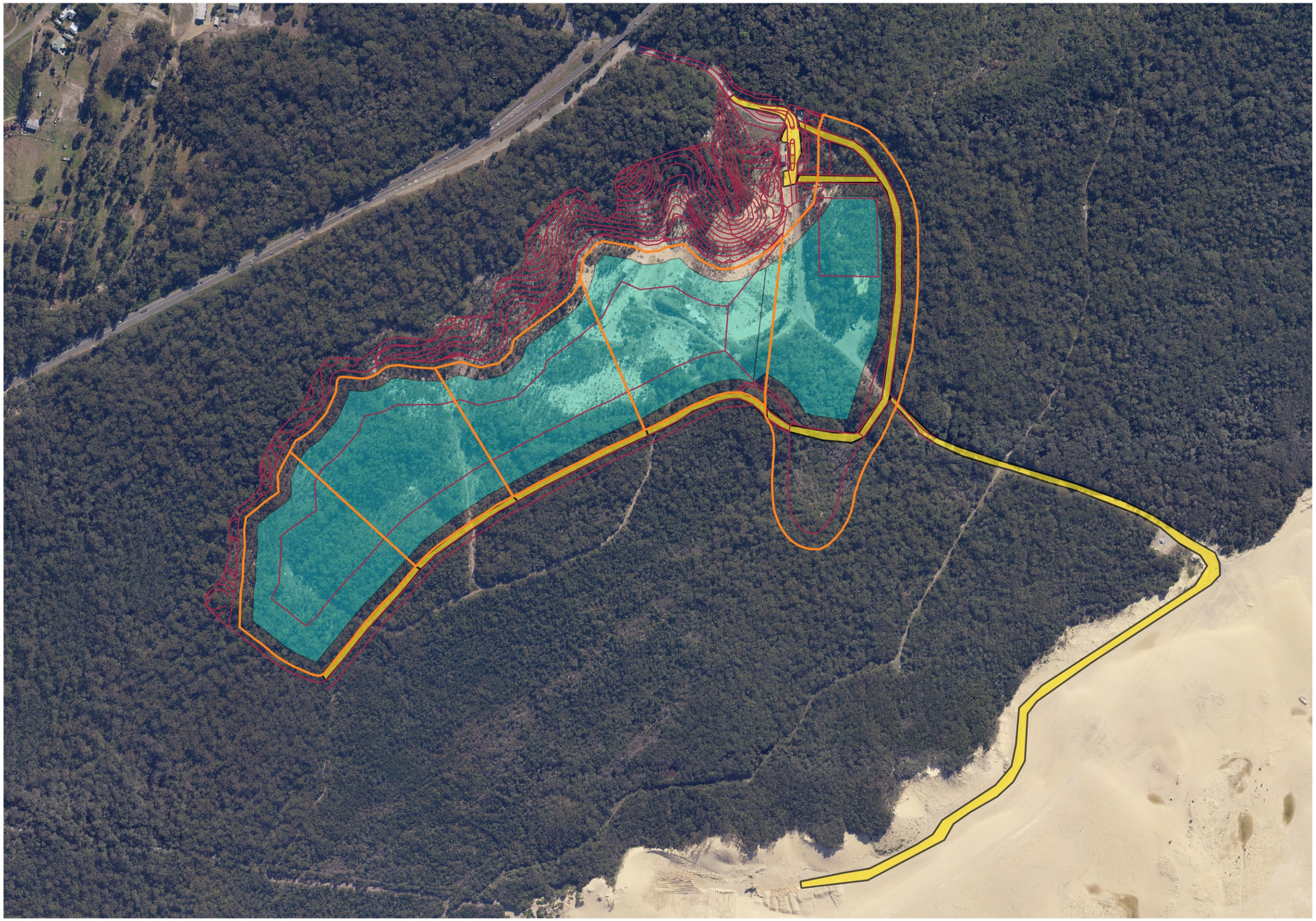
APPENDIX A – WATER EXTENTS HAUL ROAD AND STAGE BOUNDARIES USED IN WATER BALANCE



Water extents, haul road and stage boundaries used in water balance

0 25 50 75 100 m

Client: Elkement Environment
DATE: 01/08/2019

southeast
engineering+environmental
14 Mirrabooka Avenue. Moruya 2537 - Tel. 02 4474 4439



APPENDIX M

BUSHFIRE HAZARD ASSESSMENT

BUSHFIRE ASSESSMENT REPORT

STOCKTON SAND QUARRY DREDGING

LOT 3 DP 664552, Lots 1 and 2 DP 1006399
Coxs Lane, Fullerton Cove

Date: **14/10/2019**

Prepared for: **Boral**

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2	17/08/2019	Final	M. Hamilton	P.Couch
3	18/08/2019	Final – incorporating Boral's comments	M. Hamilton	P.Couch
4	14/10/2019	Updated Site Plan and Staging Plan	M. Hamilton	P.Couch

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1.0 EXECUTIVE SUMMARY AND COMPLIANCE TABLES

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Sand Quarry (hereafter referred to as the 'site' or the 'quarry'), a long standing operation that currently extracts sand from the windblown (transgressive) sand dunes of Stockton Bight and transports up to 500,000 tonnes of sand product per year for use in the building, landscaping and construction markets.

Due to current and future demand for sand in the Hunter and Sydney regions, Boral is seeking approval for continued and expanded operations at the site through a State Significant Development (SSD) application. The proposed development (hereafter referred to as the 'Project') involves the extraction of sand from the inland vegetated dunes by front-end loader/excavator to a depth of 4 metres (m) Australian Height Datum (AHD) and subsequent dredging from 4 m AHD to 15 m below sea level (-15 m AHD). The Project would seek to permit a site wide increase on the dispatch limit to 750,000 tonnes per annum (i.e. the windblown sand extraction area and the Project operations combined) up until 2028 after which the site wide limit would reduce to no more than 500,000 tonnes per annum. The Project would be for a period of up to 25 years, subject to demand of sand resources.

This report has assessed the project against the requirements of section 4.14 of the NSW E*nvironmental Planning and Assessment Act 1979*, AS3959 (2009) Building in Bushfire-Prone Areas and Planning for Bush Fire Protection (2006).

This report establishes that the project is capable of complying with the acceptable solutions of Planning for Bush Fire Protection (2006).

TABLE 1 – PROPERTY DETAILS AND TYPE OF PROPOSAL

Applicant Name	Boral Resources (NSW) Pty Ltd		
Site Address	Coxs Lane, Fullerton Cove	**Lot/Sec/DP**	Lot 3 DP664552, Lots 1 and 2 DP 1006399
Local Government Area	Port Stephens	**FDI**	100
Bushfire Prone Land	Yes, mapped bushfire prone land		
Type of development	Extractive Industry	**Type of Area**	Existing sand quarry within forest
Special Fire Protection Purpose	No	**Flame Temperature**	1090K
Application Complies with DTS Provisions	Yes. Relevant specifications and requirements are satisfied	**Referral to RFS required**	No

TABLE 2 – BUSHFIRE THREAT ASSESSMENT PORTABLE OFFICE BUILDING

	North	East	South	West
AS3959 (2009) Vegetation Structure	Forest	Forest	Forest	Scrub
Asset Protection Zone	65 metres	25 metres	25 metres	25 metres
Accurate Slope Measure	8 degrees downslope	12 degrees upslope	12 degrees upslope	12 degrees upslope
Slope Range	6 to 10 degrees downslope	Level/Upslope	Level/Upslope	Level/Upslope
AS3959 (2009) Bushfire Attack Level (BAL)	BAL-19	BAL-29	BAL-29	BAL-19

TABLE 3 – PLANNING FOR BUSHFIRE PROTECTION (2006) 4.3.5 COMPLIANCE

Performance Criteria	Proposed Development Determinations	Method of Assessment
Asset Protection Zone	Asset Protection Zones have been determined in accordance with AS 3959 (2009) Method 1 Simplified Procedure and Planning for Bush Fire Protection (2006). The Asset Protection Zone will be maintained for the life of development and defendable space is provided onsite.	Acceptable Solution
Siting and Design	Buildings have been designed to minimise the risk of bushfire attack.	Acceptable Solution
Construction Standards **AS3959 – 2009**	Bushfire Attack Levels have been determined in accordance with AS 3959 (2009) Method 1 Simplified Procedure and Planning for Bush Fire Protection (2006). The highest Bushfire Attack Level to the proposed building was determined to be BAL-29. Non-residential Class 5 to 8 buildings require no specific level of construction in accordance with AS3959 (2009) and National Construction Code 2019. Structural fire protection measures are deemed adequate if located outside the flame zone.	Acceptable Solution
Private and or Public Road Infrastructure	The public road system is not affected or changed as part of this application.	Acceptable Solution
Property Access	Property access complies with Planning for Bushfire Protection (2006) S4.1.3.	Acceptable Solution

Water and Utility Services	Water, electricity and gas services offer compliance with Planning for Bush Fire Protection (2006) section 4.1.3.	Acceptable Solution
Landscaping	Landscaping to comply with Planning for Bush Fire Protection (2006), appendix 5.	Acceptable Solution

TABLE 4 – REVIEW OF SECRETARY'S ENVIRONMENTAL ASSESSMENT REQUIREMENTS (SEARS) FOR BUSHFIRE

Assessment Criteria	Compliance
The aims and objectives of Planning for Bushfire Protection (2006)	The aims and objectives are addressed in section 3.4 of this report.
Identification of potential ignition sources during construction and operation of the development	Potential ignition sources are detailed in section 7.0 of this report.
Storage of fuels and other hazardous materials (e.g. explosives for blasting)	The storage of fuels and hazardous materials are detailed in section 7.0 of this report.
Proposed bushfire protection measures for the development including vegetation management and fire suppression capabilities	Asset protection zones are based on AS3959 (2009) and have the buildings located outside BAL-FZ. Fire response procedures from staff have been included in section 8.0 of this report.
Operational access for firefighting appliances to the site	Property access to the buildings complies with Planning for Bush Fire Protection (2006) S4.1.3. Recommendations have been made on the safe access and egress of workers and firefighters along the haul road with adequate road widths and turning bays provided.
Emergency and evacuation planning	An existing emergency management plan has been prepared for the site which considers bushfire.

2.0 INTRODUCTION

2.1 PROJECT DESCRIPTION

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Sand Quarry (hereafter referred to as the 'site' or the 'quarry'), a long standing operation that currently extracts sand from the windblown (transgressive) sand dunes of Stockton Bight and transports up to 500,000 tonnes of sand product per year for use in the building, landscaping and construction markets.

Due to current and future demand for sand in the local Hunter and Sydney regions, Boral is seeking approval for continued and expanded operations at the site through a State Significant Development (SSD) application. The proposed development (hereafter referred to as the 'Project') involves the extraction of sand from the inland vegetated dunes by front-end loader/excavator to a depth of 4 metres (m) Australian Height Datum (AHD) and subsequent dredging from 4 m AHD to 15 m below sea level (-15 m AHD). The Project would seek to permit a site wide increase on the dispatch limit to 750,000 tonnes per annum (i.e. the windblown sand extraction area and the Project operations combined) up until 2028 after which the site wide limit would reduce to no more than 500,000 tonnes per annum. The Project would be for a period of up to 25 years.

The site contains an existing operation located approximately 375 m south east of the Project site, referred to as the windblown sand extraction area (or pit 7). The windblown sand extraction area is approved to operate until 2028 and dispatch up to 500,000 tonnes per annum from the site (refer to condition 6 of DA 140-6-2005).

Sand from the former inland extraction area was only extracted to 5 m AHD under the original 1996 development consent. The sand resource above 5 m AHD was exhausted in 2007 and in accordance with the conditions of consent the operations have ceased. The Project involves the extraction of sand from within the former inland extraction area (inclusive of pits 1 – 6) from the existing ground level to a depth of 15 m below sea level (-15 m AHD). As extraction will intercept the groundwater table (at approximately 1 m AHD) the primary method of sand extraction will involve dredging.

There is an estimated 9 million tonnes of sand resource within the Project extraction area.

Mobile plant and equipment utilised at the site would operate across both project areas and a docket system at the weighbridge would monitor outgoing product as a site total.

The Project is to be undertaken progressively in six stages, commencing with Stage 1. Similar to previous operations of the inland extraction area, sand extraction will involve clearing and grubbing of established vegetation from previous rehabilitation and possible screening of accumulated leaf litter and organic matter. Cleared

vegetation will either be mulched or stockpiled on-site for later reuse in rehabilitation. Similarly, any stripped topsoil would be retained for use in rehabilitation efforts across the site.

Sand will first be removed via a front-end loader which pushes into the exposed sand face. As the sand is relatively free-flowing, material falls towards the front-end loader at the natural angle of repose.

The sand will then be screened and stockpiled before a front-end loader then loads road trucks in-pit with screened raw sand for transport off-site via the weighbridge.

Following initial extraction of sand above the water table to a depth of 4 m AHD, a pond will then be created and will be made large enough to float a dredge and accommodate fresh water pumping for the proposed wash plant.

The dredge will move progressively through the extraction area generally following the nominated stages. In most cases, the sand in each extraction stage is fully extracted unless constraints are encountered.

The dredge will move backwards and forwards across the active dredge pond. The sand / water mix will be pumped directly from the dredge via a pontoon-mounted pipeline to the wash plant in the processing area. The dredge manoeuvres around the pond and its position is stabilised tie ropes connected to the banks around the active pond.

The dredge will then progressively extract sand in a south westerly direction in a staged process. Extraction will then move to the east and culminate with relocation of the proposed processing and stockpile area to a confined area in Stage 1 and subsequent dredging of the majority of the Stage 1 extraction area (to be known as Stage 6).

2.2 PURPOSE OF REPORT

The purpose of this report is to establish suitable bushfire mitigation measures for the proposed continued sand quarry operations on lands identified as Lot 3 DP664552, Lots 1 and 2 DP 1006399, Coxs Lane, Fullerton Cove, in order for the approval authority to make determination of the proposed development pursuant to the requirements of section 4.14 of the *NSW Environmental Planning and Assessment Act 1979*.

Development on Bush Fire Prone Land must satisfy the aim and objectives of Planning for Bush Fire Protection (2006). The aim of Planning for Bush Fire Protection is to use the NSW development assessment system to provide for the protection of human life (including firefighters) and to minimise impacts on property from the threat of bush fire, while having due regard to development potential, onsite amenity and protection of the environment.

More specifically, the objectives are to:

(i) Afford occupants of any building adequate protection from exposure to a bush fire;
(ii) Provide for a defendable space to be located around buildings;
(iii) Provide appropriate separation between a hazard and buildings which, in combination with other measures, prevent direct flame contact and material ignition;
(iv) Ensure that safe operational access and egress for emergency service personnel and residents is available;
(v) Provide for ongoing management and maintenance of bush fire protection measures, including fuel loads in the asset protection zone (APZ); and
(vi) Ensure that utility services are adequate to meet the needs of firefighters (and others assisting in bush fire fighting).

This report addresses the matters identified in A4.1 of appendix 4 of Planning for Bush Fire Protection (2006) and demonstrates that the proposal satisfies the aims and objectives of Planning for Bush Fire Protection (2006) by satisfying the performance criteria within section 4.3 of the document. The specific objectives for infill development are as follows:

- Ensure that the bushfire risk to adjoining lands is not increased;
- Provide minimum defendable space;
- Provide better bushfire protection, on a re-development site, than the existing situation. This should not result in new works being exposed to greater risk than an existing building;
- Ensure that the footprint of the proposed building does not extend towards the hazard beyond existing building lines on neighbouring land;
- Not result in an increased bushfire management and maintenance responsibility on adjoining landowners, unless they have agreed to the development; and
- Ensure building design and construction enhances the chances of occupant and building survival.

The recommendations within this report address the aims and objectives of Planning for Bush Fire Protection (2006) to reduce the risk of ignition of the buildings in a bushfire event and provide a safe working environment.

2.2 EXISTING INFRASTRUCTURE

Boral established a fenced depot as part of the previous inland extraction area project, this compound has been maintained as part of the ongoing operation. The fenced depot contains the following infrastructure:

- an amenities/office building providing an office, lunchroom, toilet and shower;
- weighbridge;
- designated parking area for employees and visitors; and
- maintenance shed for the front-end loader and a 4,200 litre above ground bunded fuel tank.

The existing site depot will be reconfigured to support the Project and will include the following:

- installation of a new prefabricated office building;
- relocation of light vehicle parking;
- relocation of entry gates (inside Boral's boundary); and
- relocation of onsite of storage facilities.

The Project will also include the following new or augmented infrastructure:

- construction of a new entry road. The new haul road will link to the existing haul road in the south eastern extent of Stage 1 and enable continued access to the windblown sand extraction area. The road will be two way configuration (i.e. trucks moving in and out) and a separated exit road will be constructed to allow exiting vehicles to cross the weighbridge (refer to Figure 3);
- a pad for the wash plant and diesel generators will be constructed as soon as practicable after vegetation removal and sand extraction in the northern portion of the Stage 1 extraction area; and
- relocation of the parking area to the south and relocation of the security gates northward across the entry road which will enclose the parking area and the new entry road. The docketing kiosk registering vehicles entering the site will also be relocated.



PHOTOGRAPH 1 – SITE PHOTO

View of the existing site office, amenities, workshop and weighbridge looking south. A processing plant will be located south of the cluster of buildings within the Stage 1 extraction area.



PHOTOGRAPH 2 – WESTERN VEGETATIVE THREAT

View of coastal scrub located west of the workshop with coastal dune forest located further west. The forest is dominated by eucalypts and banksias with an understorey of native shrubs and grasses.

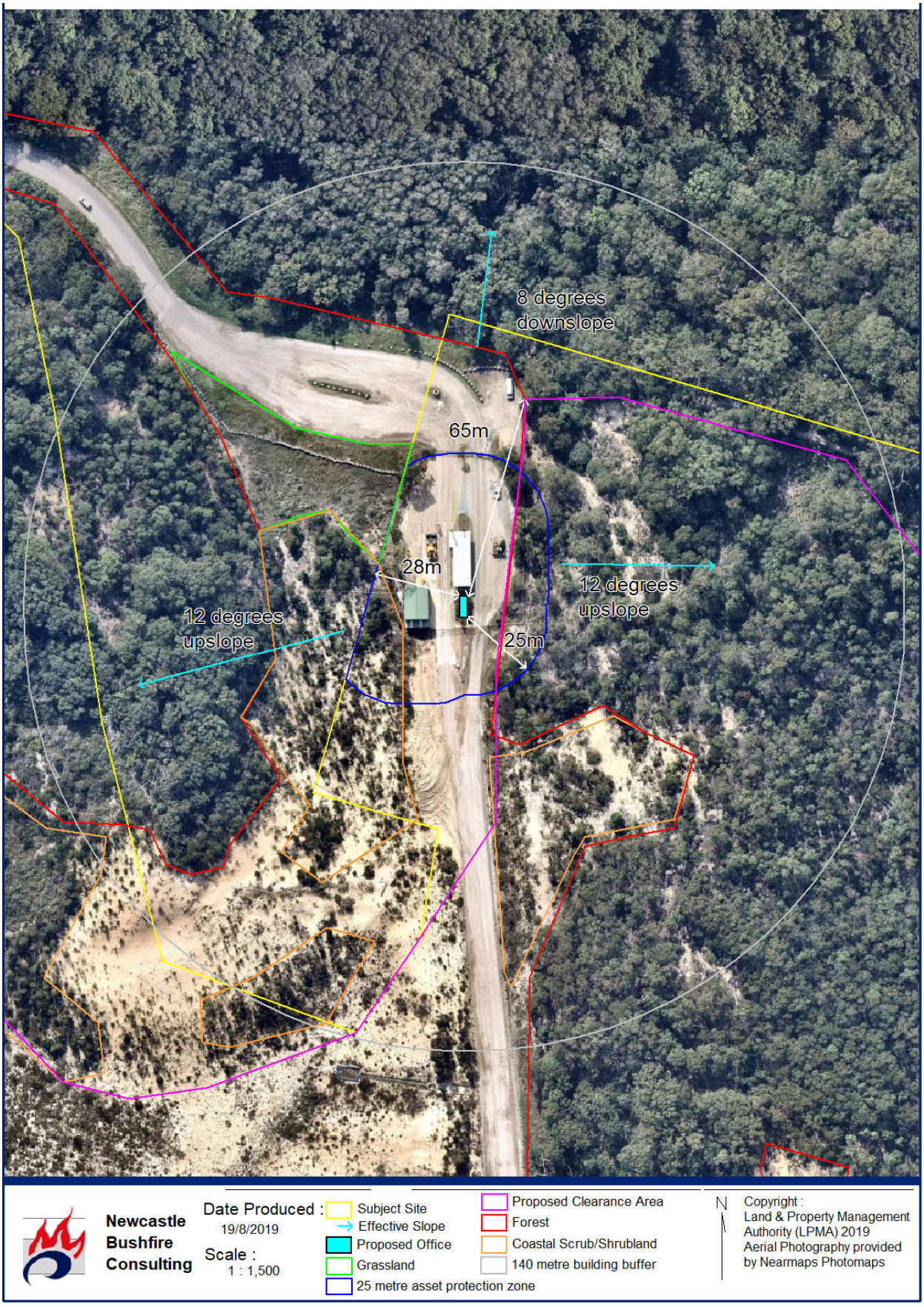

FIGURE 1 – SITE CONSTRAINTS MAP

3.0 BUSHFIRE ATTACK ASSESSMENT

3.1 VEGETATION CLASSIFICATION

Potential bushfire hazards were identified from Port Stephens Council's Bushfire Prone Mapping as occurring within the investigation area. Aerial mapping and inspection of the site reveals that the bushfire prone land map is reasonably accurate in respect to the current bushfire hazard.

The major vegetative threats have been determined using Keith (2004) to derive vegetation structures listed in Planning for Bush Fire Protection (2006). General vegetation structures have been translated to AS3959 (2009) groupings.

Primary Vegetation Structures have been identified in Figure 1 – Site Constraints Map and separation distances shown in Table 2 – Bushfire Attack Assessment.

3.2 EFFECTIVE SLOPE

Effective slope was measured using 2 metre contour data obtained from NSW Spatial Services and verified by a laser hypsometer on site. The laser hypsometer verified slope within the vegetation calculating effective fire run slope from 5 separate measurements in each dominant direction.

Effective Slopes have been identified in Figure 1 – Site Constraints Map and slope ranges are shown in Table 2 – Bushfire Threat Assessment.

3.3 BUSHFIRE ATTACK LEVELS

Bushfire attack levels and relevant construction levels in accordance with AS3959 (2009) have been demonstrated in Section 1 Executive Summary and Compliance Tables.

<u>Features on or adjoining the site that may mitigate the impact of a high intensity bushfire on the proposed development</u>
The bushland in close proximity to the buildings, is located upslope, which will result in reduced fire intensity and rate of spread. A large portion of the site near the buildings has been mined previously, with a significantly reduced fuel load.

<u>Likely environmental impact of any proposed bushfire protection measures</u>
Significant clearing is required for the proposed sand mine expansion with environmental studies to be completed.



FIGURE 2 – LOCALITY MAP
Courtesy of OpenStreetMap



PHOTOGRAPH 3 – SITE ACCESS

View of property access to Coxs Lane which provides good access and egress to the site. The current and future access is designed for trucks larger than a medium rigid vehicle with good access to fight fire.

3.4 COMPLIANCE WITH AIMS AND OBJECTIVES OF PLANNING FOR BUSHFIRE PROTECTION

The aims and objectives of Planning for Bushfire Protection (2006) are addressed below for a non-combustible industrial building.

Afford occupants of any building adequate protection from exposure to a bush fire
Following the establishment of an asset protection zone, the buildings within the existing site depot will have a reduced exposure to bushfire. Evacuation planning in the event of bushfire should clearly indicate to workers to evacuate early in a direction away from the fire.

Provide for a defendable space to be located around buildings
Defendable space is available around the buildings in the existing site depot. In the event of bush fire, firefighters will have direct access to the bushland via the internal road network of the quarry which will support firefighting efforts. In the event a fire front impacts on the buildings, defendable space is available surrounding the buildings from where the fire would be fought. A 25 metre asset protection zone is recommended around the buildings.

Provide appropriate separation between a hazard and buildings which, in combination with other measures, prevent direct flame contact and material ignition
Following establishment of the asset protection zones the buildings in the existing site depot will be outside of BAL-FZ and exposed to BAL-29. The buildings excepting the relocatable office building are existing with the primary vulnerability being the subfloor.

Ensure that safe operational access and egress for emergency service personnel and building users is available
The property access to the buildings offers compliance with Planning for Bush Fire Protection access requirements. The road will be designed for the movements of large vehicles which exceeds the minimum widths of Planning for Bush Fire Protection.

Provide for ongoing management and maintenance of bush fire protection measures, including fuel loads in the asset protection zone (APZ)
The Quarry Manager shall maintain landscaping and fuel management in accordance with Appendix 5 of Planning for Bush Fire Protection 2006 and the NSW Rural Fire Service's document Standards for Asset Protection Zones.

Ensure that utility services are adequate to meet the needs of firefighters (and others assisting in bush fire fighting)
A 20,000 litre static water supply is required for the Project and should be equipped with firefighting fittings. Electrical supplies are located underground.

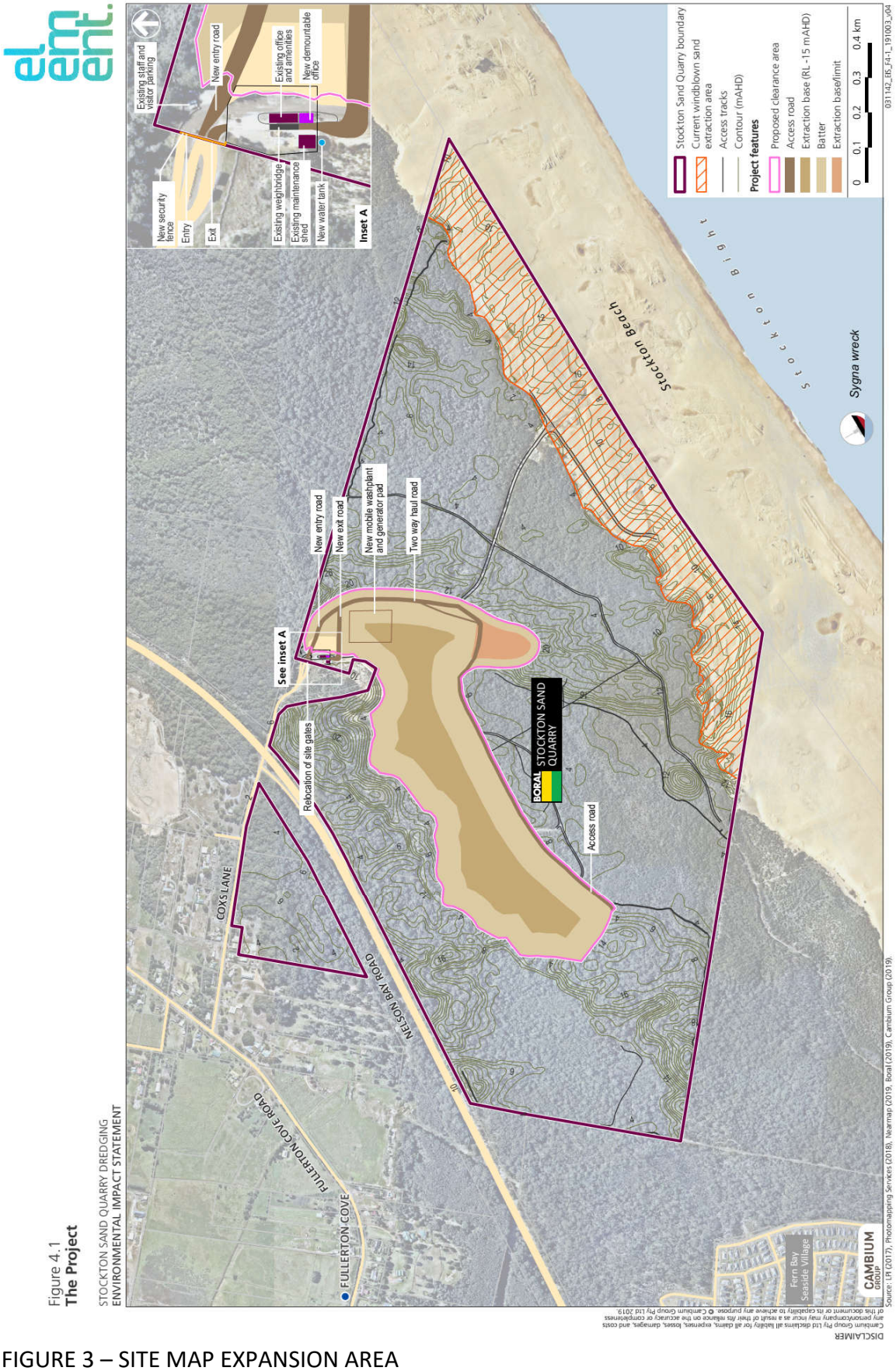

FIGURE 3 – SITE MAP EXPANSION AREA

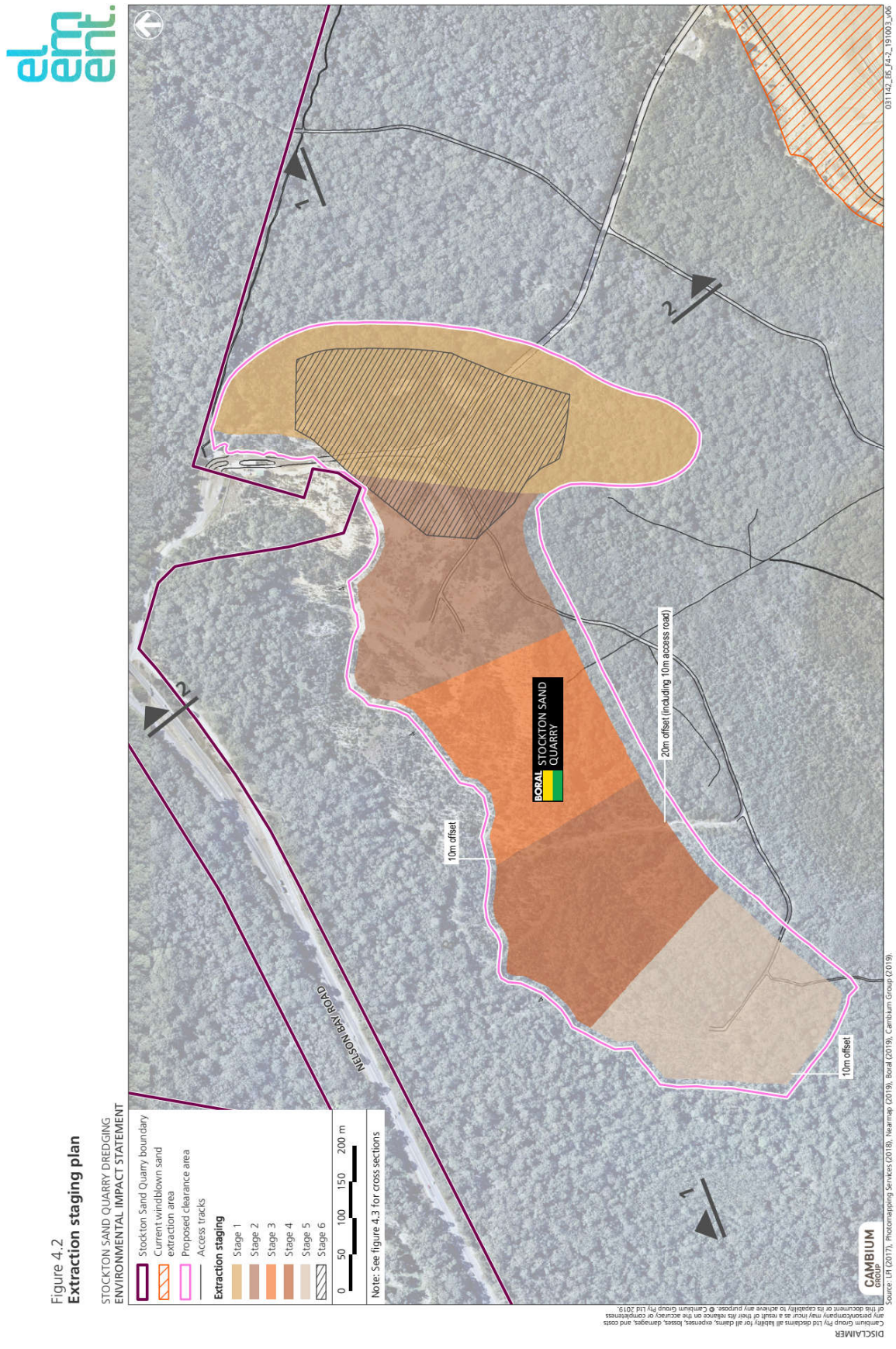

FIGURE 4 – STAGING PLAN

4.0 UTILITY SERVICES AND INFRASTRUCTURE

4.1 WATER SERVICES

The quarry is greater than a hectare in size with no hydrant access. A static water supply with provision for a minimum 20,000 litres shall be provided for the Project.

The following requirements should be adhered to for the water supply:

- The water source shall be made available or located within the inner protection area (IPA) and away from the structure.
- A hardened ground surface for truck access is to be supplied up to and within 4 metres of the water source.
- A 65mm metal Storz outlet with a gate or ball valve shall be provided.
- The water tank if located above ground shall be of a non-combustible material.
- Tanks and associated fittings on the hazard side of the building shall be provided with adequate shielding to mitigate the impact of flame contact and radiant heat and provide safe access for fire fighters.
- The gate or ball valve, pipes and tank penetration are adequate for full 50mm inner diameter water flow through the Storz fitting and are metal.
- All associated fittings to the tank shall be non-combustible.
- An 'SWS' marker shall be obtained from the local NSW Rural Fire Service and positioned for ease of identification by brigade personnel and other users of the SWS. In this regard:
  a) Markers must be fixed in a suitable location so as to be highly visible; and
  b) Markers should be positioned adjacent to the most appropriate access for the static water supply.

4.2 ELECTRICITY SERVICES

The existing electrical transmission lines are located underground and require no additional protection measures.

4.3 GAS SERVICES

- Reticulated or bottled gas to be installed and maintained in accordance with AS 1596 (2002) and the requirements of the relevant authorities. Metal piping is to be used.
- Fixed gas cylinders to be kept clear of flammable material by a distance of 10 metres and shielded on the hazard side of the installation.

- Gas cylinders close to the dwelling are to have the release valves directed away from the building and at least 2 metres from flammable material with connections to and from the gas cylinder being of metal.
- Polymer-sheathed, flexible gas supply lines to gas meters adjacent to the buildings are not to be used.

5.0 PROPERTY ACCESS

Property access is by way of Coxs Lane, providing access from the public road system to the quarry via a right of way on crown land.

The existing property access roads onsite shall comply with section 4.1.3 of Planning for Bush Fire Protection (2006). The new property access shall comply with the following:

- a minimum carriageway width of four metres
- a minimum vertical clearance of four metres to any overhanging obstructions, including tree branches.
- internal roads for rural properties provide a loop road around any dwelling or incorporate a turning circle with a minimum 12 metre outer radius.
- curves have a minimum inner radius of six metres and are minimal in number to allow for rapid access and egress.
- the minimum distance between inner and outer curves is six metres.
- the crossfall is not more than 10 degrees.
- maximum grades for sealed roads do not exceed 15 degrees and not more than 10 degrees for unsealed roads.
- the property access road should be upgraded to have passing bays every 200 metres that are 20 metres long by two metres wide, making a minimum trafficable width of six metres at the passing bay.

There will be a new haul road constructed around the east of Stage 1 and a perimeter road constructed progressively along the southern edge of the Project area as dredging progresses.

The perimeter haul road will be up to 10 metres wide and when complete (at the end of Stage 5) the road will support movement of vehicles around the southern perimeter of the dredge pond and be used to support access for rehabilitation works and future site management.

6.0 LANDSCAPING MAINTENANCE

It is recommended that landscaping is undertaken for the site depot in accordance with Appendix 5 of Planning for Bush Fire Protection (2006) and maintained for the life of the development.

Trees should be located greater than 2 metres from any part of the roofline of a building. Garden beds of flammable shrubs are not to be located under trees and should be no closer than 10 metres from an exposed window or door. Trees should have lower limbs removed up to a height of 2 metres above the ground.

The landscaped area should be maintained free of leaf litter and debris. The gutter and roof should be maintained free of leaf litter and debris. Landscaping should be managed so that flammable vegetation is not located directly under windows.

Ground fuels such as fallen leaves, twigs (less than 6mm in diameter) and branches should be removed on a regular basis, and grass needs to be kept closely mown and, where possible, green.

7.0 POTENTIAL IGNITION SOURCES DURING CONSTRUCTION AND OPERATION

The following potential ignition sources are identified that could affect the occurrence and growth of a fire:

- Equipment faults, such as electrical short circuit or fuel leak on a machine;
- Lightning strike;
- Hazard reduction burn;
- Intentional arson; and
- Lit cigarettes or matches being carelessly thrown on the ground.

It is noted that there is a designated smoking area onsite within the site depot that should reduce the chances of a bushfire starting.

The proposed development includes the quarrying of sand which is an inert material. The varying stages of the development will involve clearing of bushland with limited opportunity for fire to start if machinery is maintained and the bushland is not burned.

Storage of Hazardous Materials
The existing workshop within the site depot holds a number of hazardous and flammable materials, with the building locked up when no workers are onsite. The following flammable items and mitigation strategies have been utilised onsite:

- 4,500 litre diesel storage tank. Additional metal cowling provided between the shed wall and the tank;
- the site has an approved flammables cabinet for flammable items to be stored in;
- Spray cans are located in a ventilated cupboard off the ground. This is an approved cabinet for pressurised spray cans; and
- The fuel ute has a 400 litre diesel tank with a quick hitch connector that will reduce fuel spillage.

There are no explosives stored onsite. The fuel ute is recommended to be stored in the workshop or offsite, when the site is unmanned.

Recommended Upgrade. The workshop is recommended to have the polycarbonate roofing to be replaced with metal roof sheeting.

8.0 FIRE RESPONSE PROCEDURE FROM STAFF

The following procedure shall be detailed in the Bushfire Evacuation Plan however should be used for initial response to a fire:

- Ensure the safety and wellbeing of oneself.
- Removing where possible any further danger(s).
- Ensuring the safety of uninjured people and preventing where possible further injury to victims.
- Informing the fire warden and any firefighters of the nature and the location of the emergency.
- Administer or organise first aid care for the injured if trained.
- Search area if practicable.
- Keep doors and windows closed to minimise fire spread.
- Close window shutters.
- Consider the risk of further fire, explosions or of the fire spreading.

The fire warden shall be contacted in the first instance, where possible, due to having greater experience of the site and specific fire training.

Mechanical tools, or plant machinery may be used to extinguish a small fire. The existing water cart may assist firefighters in extinguishing small fires.

Any fires shall be responded to as quickly as possible if they are deemed safe to extinguish.

Employees are not trained as firefighters and any larger fires which may place the health of staff in danger, shall not be fought. NSW Fire and Rescue or NSW Rural Fire Service may respond to the site. Employees may assist the firefighters through the use of heavy machinery.

9.0 RECOMMENDATIONS

Based upon an assessment of the plans and information received for the Project, it is recommended that development consent be granted subject to the following conditions:

1. Following the approval of the development and for the life of the development, the property around the building, shall be maintained to a distance of 25 metres where onsite as an inner protection area (IPA) as outlined within section 4.1.3 and Appendix 5 of Planning for Bush Fire Protection 2006 and the NSW Rural Fire Service's document Standards for Asset Protection Zones.
2. The workshop is recommended to have the polycarbonate roofing to be replaced with metal roof sheeting.
3. The new haul roads shall comply with section 4.1.3 and Appendix 5 of Planning for Bush Fire Protection 2006 with the roads being a minimum 6.5 metres in width with a turning bay at the termination of the road, having a minimum 12 metre outer radius.
4. Water, electricity and gas are to comply with section 4.1.3 of Planning for Bush Fire Protection (2006).
   Water Services
   a. A 20,000 litre static water supply with firefighting fittings is required.
5. Landscaping for the site depot is to be undertaken in accordance with Appendix 5 of Planning for Bush Fire Protection (2006) and managed and maintained in perpetuity.
6. It is recommended that the Quarry Manager incorporate the new building into the existing emergency evacuation plans prepared for the workplace with specific consideration of bushfire evacuation planning.

10.0 CONCLUSION

The final recommendation is that the Project offers compliance with Planning for Bush Fire Protection (2006). There is potential for bushfire attack at the quarry and a list of recommendations has been included in the above assessment to reduce that risk.

11.0 APPENDIX 1.0 – ASSET PROTECTION ZONES SUMMARY

Below is a summary of Asset Protection Zones outlined in appendix 5 of Planning for Bush Fire Protection (2006) and the NSW Rural Fire Services "Standards for Asset Protection Zones." The property owner(s) should obtain these two documents and familiarise themselves with their content.

Generally
Asset Protection Zones (APZ) refer to the area between the bushfire threat and the asset (i.e. building). The APZ may contain two areas; the Inner Protection Area (IPA) and the Outer Protection Area (OPA). Some areas should be managed entirely as an Inner Protection Area (IPA). Refer to the plans for locations of APZ and distances from Assets.

Inner Protection Area (IPA)
The inner protection area is located adjacent to the asset and is identified as a fuel-free zone.

A. Shrubs (consisting of plants that are not considered to be trees)

1. Shrubs must be located away from a building's glazing and vent openings.
2. Avoid planting around entry-ways if the vegetation is flammable.
3. A maximum 20% of the Inner Protection Area may contain shrubs.
4. A minimum 1.5 metre separation of shrubby vegetation from the building shall be maintained.
5. Shrubs must not have a connection with the tree canopy layer; remove/trim shrubs or underprune trees.
6. Ensure turf is suitably mown and/or grasslands are continually slashed to restrict to max 100mm high.

B. Trees: Maintain a minimum 2-5 metre canopy separation.

1. Trees are allowed in the inner protection area however they should not touch or overhang buildings. No tree should be within 2 metres of the roofline.
2. Underprune branches between the shrub layer and the canopy layer.
3. Ensure branches do not overhang buildings.
4. Ensure all trees in the IPA within 3 metres of buildings do not provide a serious fire threat.
5. Trees should have lower limbs removed up to a height of 2 metres above the ground.

Outer Protection Area (OPA)
The Outer Protection Area (OPA) is located adjoining the vegetation. The OPA should be maintained as a fuel-reduced area. This assumes trees may remain but with a significantly reduced shrub, grass, and leaf litter layer. In many situations leaf litter and the shrub layer may not require maintenance at all.

A. Shrubs:

1. Reduce or trim large stands of shrubs

B. Trees:

1. Existing trees can be retained.
2. Ensure a separation is available between shrubs and tree canopy.
3. Reduce tree canopy so there is no interlocking canopy.

12.0 REFERENCES AND DISCLAIMER

References

Standards Australia (2009) AS3959 Construction of Buildings in Bushfire-Prone Areas

Keith D. (2004) "Ocean Shores to Desert Dunes," Department of Environment and Conservation, Sydney.

Environmental Planning and Assessment Act (1979)

New South Wales Rural Fire Service (2006) Planning for Bush Fire Protection

New South Wales Rural Fire Service (2010) Planning for Bush Fire Protection Appendix 3 Amendment

Disclaimer

Despite the recommendations in this report, it is impossible to remove the risk of fire damage to the building entirely. This report assesses and provides recommendations to reduce that risk to a manageable level. It is of paramount importance that the recommendations are adhered to for the life of the structure and that all maintenance is performed, to ensure a level of protection is provided to the building, occupants and firefighters.

Planning for Bush Fire Protection (2006) states that notwithstanding the precautions adopted, it should always be remembered that bushfires burn under a wide range of conditions and an element of risk, no matter how small, always remains.

AS3959 (2009) Building in Bushfire-Prone Areas states that the standard is designed to lessen the risk of damage to buildings occurring in the event of the onslaught of bushfire. There can be no guarantee, because of the variable nature of bushfires, that any one building will withstand bushfire attack on every occasion.



APPENDIX N

ECONOMICS ASSESSMENT

Stockton Sand Quarry Dredging

Economic Assessment

Prepared for

Boral Resources (NSW) Pty Ltd
C/- Element Environment Pty Ltd

By



Gillespie Economics
Email: gillecon@bigpond.net.au

September 2019

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BOXES

Box 1 Steps in CBA

EXECUTIVE SUMMARY

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Sand Quarry (hereafter referred to as the 'site' or the 'quarry'), a long standing operation that currently extracts sand from the windblown (transgressive) sand dunes of Stockton Bight and transports up to 500,000 tonnes per annum (tpa) of sand product for use in the building, landscaping and construction markets.

Due to current and future demand for sand in the local Hunter and Sydney regions, Boral is seeking approval for continued and expanded operations at the site through a State Significant Development (SSD), development application. The proposed development (hereafter referred to as the 'Project') involves the extraction of sand from the inland vegetated dunes by front-end loader/excavator to a depth of 4 metres (m) Australian Height Datum (AHD) in stage 1 and subsequent dredging to 15 m below sea level (-15 m AHD). The Project would seek to permit a site wide increase on the dispatch limit to 750,000 tpa (i.e. the windblown sand extraction area and the Project operations combined) up until 2028 after which the site wide limit would reduce to no more than 500,000 tpa. The Project would be for a period of up to 25 years.

Gillespie Economics has been engaged by Element Environment Pty Ltd (Element) on behalf of Boral Resources (NSW) Pty Ltd to complete an Economic Assessment of the Project.

This Economic Assessment relates to the preparation of each of the following types of analyses:

- A Cost Benefit Analysis (CBA) of the Project;
- A Local Effects Analysis (LEA), including using input-output (IO) analysis, for the Local Area regional economy of the combined Port Stephens, Maitland and Newcastle Local Government Areas (LGAs).

CBA

A CBA of the Project indicated that it would have net social benefits to Australia of $41 million (M), and net social benefits to NSW of $17M. Hence the Project is desirable and justified from an economic efficiency perspective. Environmental, social and cultural impacts of the Project have been minimised through Project design and mitigation, offset and compensation measures. In particular, Boral will purchase the required Water Access Licence, provide required biodiversity offsets or fund payments and establish required bushfire hazard reduction measures. The costs of these actions are included in the estimate of the net social benefits of the Project. The economic value of residual impacts are considered to be immaterial from an aggregated economic efficiency perspective.

While the main environmental, cultural and social impacts have been quantified and included in the Project CBA, any other residual environmental, cultural or social impacts that remain unquantified would need to be valued at greater than $41M for the Project to be questionable from an Australian economic efficiency perspective, and greater than between $17M for the Project to be questionable from NSW economic efficiency perspective.

LEA

The Project will provided continued quarry employment for approximately five (four full-time and one casual) employees currently on-site and another four (two full time and two casual). The Project is also estimated to provide continued transport employment for 17 people from the Local Area, plus employment for an additional 9 people from the Local Area.

Economic activity analysis, using IO analysis, estimated that quarry production at 750,000 tonnes per annum (tpa) relative to 500,000 tpa is estimated to make up to the following incremental contribution to the regional economy:

- $5M in annual direct and indirect regional output or business turnover;
- $3M in annual direct and indirect regional value added;
- $1M in annual direct and indirect household income; and
- 9 direct and indirect jobs.

This is a minimum incremental impact. Based on the available sand resource and likely production profiles without the Project, sand extraction will decline significantly below approved levels. Consequently, incremental impacts will likely to be closer to the levels identified in the report for 750,000 tpa and 500,000 tpa.

Transportation of quarry product at 750,000 tpa relative to 500,000 tpa is estimated to make up to the following incremental contribution to the regional economy:

- $4M in annual direct and indirect regional output or business turnover;
- $2M in annual direct and indirect regional value added;
- $1M in annual direct and indirect household income; and
- 16 direct and indirect jobs.

This is also a minimum incremental impact given that without the Project sand extraction will decline significantly below approved levels.

1 INTRODUCTION

1.1 Introduction

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Sand Quarry (hereafter referred to as the 'site' or the 'quarry'), a long standing operation that currently extracts sand from the windblown (transgressive) sand dunes of Stockton Bight and transports up to 500,000 tonnes per annum (tpa) of sand product for use in the building, landscaping and construction markets.

Due to current and future demand for sand in the local Hunter and Sydney regions, Boral is seeking approval for continued and expanded operations at the site through a State Significant Development (SSD), development application. The proposed development (hereafter referred to as the 'Project') involves the extraction of sand from the inland vegetated dunes, initial extraction in stage 1 will be by front-end loader/excavator to a depth of 4 metres (m) Australian Height Datum (AHD) all subsequent stages will be dredged to 15 m below sea level (-15 m AHD). The Project would seek to permit a site wide increase on the dispatch limit to 750,000 tpa (i.e. the windblown sand extraction area and the Project operations combined) up until 2028 after which the site wide limit would reduce to no more than 500,000 tpa. The Project would be for a period of up to 25 years.

Gillespie Economics has been engaged by Element Environment Pty Ltd (Element) on behalf of Boral Boral to complete an Economic Assessment of the the Project. The purpose of the Economic Assessment is to form part of an Environmental Impact Statement (EIS) being prepared by Element to support an application for State Significant Development, Development Application under Division 4.1 of Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) for the Project.

1.2 Legislative Context and Guidelines[1]

This Economic Assessment has been carried out in accordance with:

- the amended Secretary's Environmental Assessment Requirements (SEARs), issued by the then NSW Department of Planning and Environment on 16 November 2018 that required:
  - a detailed assessment of the likely economic impacts of the development, paying particular attention to:
    - the significance of the resource;
    - the costs and benefits of the project; identifying whether the development as a whole would result in net benefits to NSW, including consideration of fluctuation in commodity markets and exchange rates; and
    - the demand on local infrastructure and services.
  - the reasons why the development should be approved having regard to biophysical, **economic** and social **impacts** of the project, including the principles of ecologically sustainable development.
- Section 4.15 (1) of the EP&A Act which requires the following two matters to be taken into consideration by the consent authority in determining a development application:
  - the likely impacts of that development, including environmental impacts on both the natural and built environments, and social and ***economic impacts in the locality***; and
  - the public interest (taken as the collective public interest of households in NSW).

[1] Refer to Attachment 1 for the legislative context for economic methods in Environmental Impact Assessment (EIA) in NSW.

- Clause 7(1)(f) of Schedule 2 of the *Environmental Planning and Assessment Regulation 2000* which requires environmental assessments to provide "*the reasons justifying the carrying out of the development, activity or infrastructure in the manner proposed, having regard to biophysical, economic and social considerations…"* Note to Clause 7 (1) (f) states that "*A cost benefit analysis may be submitted or referred to in the reasons justifying the carrying out of the development, activity or infrastructure."*

- the following standards, guidelines and policies:

  - NSW Government (2015) *Guideline for the economic assessment of mining and coal seam gas proposals*;
  - NSW Government (2018) *Technical Notes Supporting the Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals*;
  - NSW Treasury (2017) *NSW Government Guide to Cost-Benefit Analysis*

To meet the above requirements two types of analysis are needed[2]:

- a cost benefit analysis (CBA) which is the primary way that economists evaluate the net benefits of projects and policies, provide economic justification for a project and addresses the public interest;

- a local effects analysis (LEA) to assess the impacts of the Project in the locality, specifically:

  - effects relating to local employment;
  - effects relating to non-labour project expenditure; and
  - environmental and social impacts on the local community.[3]

Economic analysis tools of CBA and LEA are not mechanised decision-making tools, but rather a means of analysis that provides useful information for decision-makers to consider alongside the performance of a project in meeting other, often conflicting, government goals and objectives.

1.3 Report Outline

Section 2 outlines the scope of the project, as assessed in the EIS[4]. This is the information on which the Economic Assessment is based. Section 3 provides an overview of the CBA and LEA approach used in this study. Section 4 and 5 document the CBA and LEA of the Project, respectively. Section 6 provides a supplementary LEA using input-output (IO) analysis. Conclusions are provided in Section 7.

Table 1.1 lists the matters identified in the SEARs and where they are addressed in this report.

Table 1.1 Relevant matters raised in SEARs

Requirement	Section addressed
The significance of the resource	2.1

2 While specifically relevant to mining, rather than extractive industry, the following guidelines provide relevant information on how to address the public interest and economic impacts in the locality.

- NSW Government (2015) Guideline for the economic assessment of mining and coal seam gas proposals;
- NSW Government (2018) Technical Notes Supporting the Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals;

NSW Treasury (2017) NSW Government Guide to Cost-Benefit Analysis also provides guidance on how to undertake a cost benefit analysis.

[3] Refer to Attachment 2 for an introduction to economic methods.

[4] The reader should refer to the EIS for more detailed qualitative consideration of the scope of the Project, Project impacts and mitigation measures.

The costs and benefits of the project; identifying whether the development as a whole would result in net benefits to NSW, including consideration of fluctuations in the commodity markets and exchange rates	4
The demand on local infrastructure and services	4.4
the reasons why the development should be approved having regard to biophysical, economic and social impacts of the project, including the principles of ecologically sustainable development	4

2 PROJECT DESCRIPTION

2.1 Economic Context and Significance of the Resource

Demand for sand is a derived demand. That is, demand for sand is dependent on there being a demand for some other product, such as concrete, cement, asphalt and construction materials, which in turn is dependent on demand for construction. With the significant increase in approved infrastructure projects in Sydney and other parts of NSW, the leading suppliers of sand are under pressure to meet this increased demand.

Supply of sand is constrained by geology and geomorphology as well as distance to the location of construction. Sand is a high bulk-low cost commodity and hence it is preferable for it to be located close to markets to minimise transport costs. A shortage in the supply of construction sand for the Sydney market has been predicted for many years as access to local onshore sources of construction sand has become increasingly difficult through resource depletion e.g. Penrith Lakes, and increasing land use constraints surrounding potential alternative sources. In the short term, demand for construction sand can be met by increasing production from existing sources, including Stockton Sand Quarry (NSW Department of Trade and Investment, 2016).

As Stockton Sand Quarry is one of Boral's few remaining natural sand quarries, Boral propose to meet part of this increased demand in natural sand by extracting sand from within the same general area as the inland extraction quarry pit approved under the 1996 development consent. The available resource from this Project is estimated at around 9 million tonnes.

2.2 Overview

Sand extraction has taken place in various locations on the site since 1976 when G. Hawkins and Sons was initially granted consent.

Boral acquired the site in 1992. Under Boral's ownership there have been two primary development consents granted, these include:

- DA 2010/94: The 'inland extraction area' (also known as pits 1 – 6) granted by Port Stephens Council in May 1996; and
- DA 140-6-2005: The 'windblown sand extraction area' (also known as the "windblown project" or pit 7) located on the transgressive dunes adjoining Stockton Beach granted by the Department of Planning in 2006.

The inland extraction operation (DA2010/94) on the vegetated dunes occurred above 5 metres AHD and ceased in 2008 and rehabilitation has been ongoing. This former extraction area is generally consistent with the Project site and is the focus of this Development Application.

The site contains an existing operation located approximately 375 m south east of the Project site, referred to as the windblown sand extraction area (or pit 7). The windblown sand extraction area is approved to operate until 2028 and dispatch up to 500,000 tpa from the site.

The Project involves the extraction of sand from within the former inland extraction area (inclusive of pits 1 – 6) from the existing ground level to a depth of 15 m below sea level (-15 m AHD). As extraction will intercept the groundwater table (at approximately 1 m AHD) the primary method of sand extraction will involve dredging.

There is an estimated 9 million tonnes of sand resource within the Project extraction area. The Project would seek to permit a site wide increase on the dispatch limit to 750,000 tpa (i.e. the windblown sand extraction area and the Project operations combined) up until 2028 after which the site wide limit would reduce to no more than 500,000 tpa. The increase in the site wide dispatch limit is sought to

permit maximum flexibility across the two projects areas (located on the same site). A concurrent administrative amendment to DA 140-5-2006 to allow for the site wide dispatch limit increase would be lodged with the Department of Planning, Industry and Environment (DPIE).

Mobile plant and equipment utilised at the site would operate across both project areas and a docket system at the weighbridge would monitor outgoing product as a site total.

The Project is to be undertaken progressively in six stages, commencing with Stage 1.

Similar to previous operations of the inland extraction area, sand extraction will involve clearing and grubbing of established vegetation from previous rehabilitation and possible screening of accumulated leaf litter and organic matter. Cleared vegetation will either be mulched or stockpiled on-site for later reuse in rehabilitation. Similarly, any stripped topsoil would be retained for use in rehabilitation efforts across the site.

Dray extraction of sand will occur only in stage 1. Dry extraction will be undertaken by front-end loader which pushes into the exposed sand face. As the sand is relatively free-flowing, material falls towards the front-end loader at the natural angle of repose.

The sand will then be screened and stockpiled before a front-end loader then loads road trucks in-pit with screened raw sand for transport off-site via the weighbridge.

Following initial extraction of sand above the water table to a depth of 4 m AHD in stage 1 only, a pond will be created large enough to float a dredge and accommodate fresh water pumping for the proposed wash plant.

The dredge will move progressively through the extraction area generally following the nominated stages. In most cases, the sand in each extraction stage is fully extracted unless constraints are encountered.

The dredge will move backwards and forwards across the active dredge pond, suctioning away the underwater sand face. The sand / water mix will be pumped directly from the dredge via a pontoon-mounted pipeline to the wash plant in the processing area. The dredge manoeuvres around the pond and its position is stabilised by wire tie ropes connected to the banks around the pond.

The dredge will then progressively extract sand in a south westerly direction in a staged process. Extraction will then move to the east and culminate with relocation of the proposed processing and stockpile area to a confined area in Stage 1 and subsequent dredging of the majority of the Stage 1 extraction area (to be known as Stage 6).

Sand will be extracted to a maximum depth of approximately 15 m below the sea level (0 m AHD).

There are minimal site establishment works required, as the Project will predominantly utilise existing infrastructure and services. New or augmented infrastructure includes:

- construction of a new entry road. The new haul road will link to the existing haul road in the south eastern extent of Stage 1 and enable continued access to the windblown sand extraction area. The road will be two way configuration (i.e. trucks moving in and out) and a separated exit road will be constructed to allow exiting vehicles to cross the weighbridge;
- a pad for the wash plant and diesel generators will be constructed as soon as practicable after vegetation removal and sand extraction in the northern portion of Stage 1; and

The existing site depot will also be reconfigured to support the Project and will include the following:

- installation of a new prefabricated office building;
- relocation of light vehicle parking;

- relocation of entry gates (inside Boral's boundary);
- relocation of onsite of storage facilities;
- replacement of workshop roofing; and
- and installation of a 30,000 L water storage tank for potential firefighting efforts.

The Project would provide employment opportunity for an additional two full time personnel and two casual employees, bringing the total employment for the quarry to six full time and three casual employees. The quarry would continue to also provide flow on employment opportunities for numerous Boral and customer truck drivers and associated service personnel.

2.3 Mitigation Measures

Boral aims to maximise the benefits of the Project to the region while minimising adverse impacts, as far as possible.

In this respect, a range of general and specific economic impact mitigation and management measures are proposed and would include:

Potential Environmental, Cultural and Social Impacts

- A range of measures to mitigate, offset and compensate for potential environmental, cultural and social impacts of the Project. A full outline of these is provided in the EIS.

Potential Workforce Impacts

- Provision of ongoing employment for the existing workforce which would be made redundant if the Project is not approved;
- Employment of regional residents preferentially where they have the required skills and experience and demonstrate a cultural fit with the organisation;
- Participating, as appropriate, in business group meetings, events or programs in the regional community.

Potential Business Impacts

- Purchasing local non-labour inputs to production preferentially where local producers can be cost and quality competitive, to support local industries.

3 ECONOMIC ASSESSMENT METHODS

3.1 Introduction

The economic methods used to assess the Project and its impacts are outlined below.

3.2 Cost Benefit Analysis

3.2.1 Background

Economic assessment is primarily concerned with identifying changes in aggregate wealth, from a national perspective, associated with alternative resource use patterns. CBA is the standard technique applied to estimate these wealth changes.

CBA has its theoretical underpinnings in neoclassical welfare economics. CBA applications in NSW are guided by these theoretical foundations as well as the NSW Treasury (2017). CBA applications within the NSW EIA framework are further guided by the NSW Government (2015) *Guidelines for the economic assessment of mining and coal seam gas proposals* and NSW Government (2018) *Technical Notes Supporting the Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals.*

CBA is concerned with a single objective of the EP&A Act and governments, i.e. economic efficiency. It provides a comparison of the present value of aggregate benefits to society, as a result of a project, policy or program, with the present value of the aggregate costs. These benefits and costs are defined and valued based on the microeconomic underpinnings of CBA. In particular, it is the values held by individuals in the society that are relevant, including both financial and non-financial values. Provided the present value of aggregate benefits to society exceed the present value of aggregate costs (i.e. a net present value of greater than zero), the project is considered to improve the well-being of society and hence is desirable from an economic efficiency perspective.

3.2.2 Definition of society

CBA includes the consideration of costs and benefits to all members of society i.e. consumers, producers and the broader society as represented by the government.

The most inclusive definition of society includes all people, no matter where they live or to which government they owe allegiance to (Boardman et al. 2001). However, in practice most analysts define society at the national level based on the notion that the citizens of a country share a common constitution that sets out fundamental values and rules for making collective choices and that the citizens of other countries have their own constitutions that make them distinct societies (Boardman et al. 2001).

While most applications of CBA are performed at the national level, "to incorporate national distinctions in a CBA is far easier said than done. Thus many CBAs end up estimating the net benefits for global society, if only implicitly" (Bureau of Transport Economics 1999, p. 2).

With respect to the application of CBA in relation to mining and coal seam gas proposals, NSW Government (2015) guidelines define the public interest, and hence society, as the households of NSW.

CBA undertaken at a sub-national perspective requires attribution of primary costs and benefits to different geographic scales and results in a number of costs and benefits that accrue to people outside the region of analysis being excluded (Boardman *et al.* 2001). It may also result in additional costs and benefits, such as secondary net benefits, that are normally omitted from CBA, being included.

For this study, the CBA is initially undertaken from a global perspective i.e. including all the costs and benefits of a project, no matter who they accrue to, and then truncated to assess whether there are net benefits to Australia and NSW.

3.2.3 Definition of the project scope

The definition of the project for which approval is being sought has important implications for the identification of the costs and benefits of a project. Even when a CBA is undertaken from a global perspective, and includes costs and benefits of a project that accrue outside the national border, only the costs and benefits associated with the defined project are relevant. For extractive industry projects, typically only the costs and benefits from resource extraction and delivery to domestic customers, are relevant.

Sand quarry products are intermediate goods i.e. are inputs to other production processes such as production of cement. However, these other production processes themselves require approval and, in CBA, would be assessed as separate projects (NSW Treasury, 2007). The Project definition, including mitigation measures, are summarised in Section 2.

3.2.4 Net production benefits

CBA of quarry proposals invariably involves a trade-off between:

- The net production benefits of a project; and
- The environmental, social and cultural impacts (most of which are costs of quarrying but some of which may be benefits) including economic benefits to existing landholders, economic benefits to workers, net public infrastructure costs and economic benefits to suppliers (NSW Government, 2015).

Net production benefits can be estimated based on market data on the projected financial[5] value of the resource less the capital and operating costs of projects, including opportunity costs of capital and land already in the ownership of proponents. This is normally commercial-in-confidence data provided by the proponent. Production costs and benefits over time are discounted to a present value.

3.2.5 Environmental, social and cultural impacts

The consideration of non-market impacts in CBA relies on the assessment of other experts contributing information on the biophysical impacts. The EIS process results in detailed (non-monetary) consideration of the environmental, social and cultural impacts of a project and the proposed means of mitigating the impacts. Only where some physical impacts are identified by other experts can economists attempt to consider the economic consequences of these impacts.

At its simplest level, CBA may summarise the consequences of the environmental, social and cultural impacts of a project (based on the assessments in the EIS), for people's well-being. These qualitatively described impacts can then be considered alongside the quantified net production benefits, providing important information to the decision-maker about the economic efficiency trade-offs involved with a project.

At the next level of analysis, attempts may be made to value some of the environmental, social and cultural impacts. These environmental, social and cultural impacts generally fall into three categories, those which:

- can be readily identified, measured in physical terms and valued in monetary terms;

[5] In limited cases the financial value may not reflect the economic value and therefore it is necessary to determine a shadow price for the resource.

- can be identified and measured in physical terms but cannot easily be valued in money terms; and
- are known to exist but cannot be precisely identified, measured or valued (NSW Treasury, 2007).

Impacts in the first and second category can potentially be valued in monetary terms using benefit transfer or, subject to available resources, primary non-market valuation methods. Benefit transfer involves using information on the physical magnitude of impacts and applying per unit value estimates obtained from non-market valuation studies undertaken in other contexts.

Primary non-market valuation methods include choice modelling and the contingent valuation method where a sample of the community is surveyed to ascertain their willingness to pay to avoid a unit change in the level of a biophysical attribute. Other methods include the property valuation approach where changes in environmental quality may result in changes in property value.

In addition to biophysical externalities, payments to landholders or workers over and above their opportunity cost can represent an economic benefit to landholders and workers, respectively. Where this occurs it can be estimated using market data on payments to be made and opportunity costs.

Where a project imposes a cost on public infrastructure in excess of payments made for that infrastructure there is an additional social costs for inclusion in CBA. These costs can potentially be estimated based on analysis of infrastructure costs and payments.

In attempting to value the impacts of a project on the well-being of people, there is also the practical principle of materiality. Only those impacts which are likely to have a material bearing on the decision need to be considered in CBA (NSW Government, 2012). NSW Government (2012) suggests that values that are less than 5% of the quantified net present value of a project are unlikely to be material. Where benefits and costs cannot be quantified these items should be included in the analysis in a qualitative manner (NSW Treasury, 2007; NSW Government, 2015).

3.2.6 Consideration of net social benefits

The consideration of the net social benefits of a project combines the value estimate of net production benefits and the qualitative and quantitative estimates of the environmental, social and cultural impacts.

In combining these considerations, it should be noted that the estimates of net production benefits of a project generally includes accounting for costs aimed at mitigating, offsetting or compensating for the main environmental, social and cultural impacts. This includes the costs of providing ecological offsets and the cost of purchasing groundwater and surface water entitlements in the water market. Including these costs in the capital and operating costs of a project effectively internalises the environmental, social and cultural costs of a project. To avoid double counting of impacts, only residual impacts, after mitigation, offset and compensation, require additional consideration.

Even when no quantitative valuation is undertaken of the environmental, social and cultural impacts of a project, the threshold value approach can be utilised to inform the decision-maker of the economic efficiency trade-offs. The estimated net production benefits of a project provides the threshold value that the non-quantified environmental, social and cultural impacts of a project (based on the assessments in the EIS), after mitigation, offset and compensation by the proponent, would need to exceed for them to outweigh the net production benefits.

Where the main environmental, social and cultural impacts of a project are valued in monetary terms, stronger conclusions can be drawn about the economic efficiency of a project i.e. the well-being of society.

Any other residual environmental, cultural or social costs that remain unquantified in the analysis[6] can also be considered using the threshold value approach. The costs of these unquantified environmental, cultural and social impacts would need to be valued by society at greater than the quantified net social benefit of a project to make it questionable from an economic efficiency perspective.

3.2.7 Consideration of the distribution of costs and benefits

While CBA, undertaken at different scales, can provide qualitative and quantitative information on how costs and benefits are distributed, welfare economics and CBA are explicitly neutral on intra and intergenerational distribution of costs and benefits. There is no welfare criterion in economics for determining what constitutes a fair and equitable distribution of costs and benefits. Judgements about intra and intergenerational equity are subjective and are therefore left to decision-makers.

Nevertheless, it should be noted that the costs and benefits in CBA are defined and valued based on the values held by individuals in the current generation. There is no way to measure the value that future generations hold for impacts of current day projects as they are not here to express it. However, as identified by Boardman et al., (2001), this is not considered a serious problem for CBA because:

- Few policies involve impacts that only appear in the far future. Consequently, the willingness to pay of people alive today can be used to predict how future generations will value them;
- Most people alive today care about the well-being of their children, grandchildren and great grandchildren, whether or not they have yet been born. They are therefore likely to include the interests of these generations to some extent in their own valuations of impacts. Because people cannot predict with certainty the place that their future offspring will hold in society, they are likely to take a very broad view of future impacts; and
- Discounting used in CBA also reduces the influence of costs and benefits that occur a long way into the future.

Furthermore, increased wealth (e.g. royalties and taxes) generated by projects that have a net benefit to the current community can be used to improve the services (e.g. health, school and community services) and environment (e.g. protected areas) that are passed on to future generations.

As identified by the Productivity Commission (2006), a policy option that provides the highest net benefit, as indicated by CBA, would also be consistent with the principles of ecologically sustainable development.

3.2.8 Consideration of other objectives of Government

CBA does not address other objectives of the EP&A Act and governments. Decision-makers therefore need to consider the economic efficiency implications of a project, as indicated by CBA, alongside the performance of a project in meeting other conflicting goals and objectives of the EP&A Act and government.

[6] Including potential impacts that were unknown at the time of the preparation of the EIS or arise during the EIA process due to differences in technical opinions.

3.2.9 Key steps in Cost Benefit Analysis

The key steps in CBA are summarised in Box 1.

Box 1: Key steps in a CBA
Step 1: Establish the base case against which to assess the potential economic, social and environmental impacts of changes due to the project.
Step 2: Define the project including all significant inputs required to achieve the project's objectives.
Step 3: Quantify the changes from the base case resulting from the project. This will focus on the incremental changes to a range of factors (for example, environmental, economic, social) resulting from the project.
Step 4: Estimate the monetary value of these changes and aggregate these values in a consistent manner to assess the outcomes. Where market prices exist, they are a starting point for valuations of both outputs and of inputs used for production. For non-market goods, as for many environmental impacts and some social impacts, the aim is to value them as they would be valued in money terms by the individuals who experience them.
Step 5: Estimate the Net Present Value (NPV) of the project's future net benefits, using an appropriate discount rate.
Step 6: Undertake sensitivity analysis on the key range of variables, particularly given the uncertainties related to specific benefits and costs.
Step 7: Assess the distribution of costs and benefits across different groups.
Step 8: Report CBA results, including all major unquantified impacts so the appraisal addresses and incorporates all material relevant to the decision maker**.**

Source: NSW Government (2015)

Section 4 reports on the CBA of the Project at different geographic scales based on the financial, technical and environmental advice provided by Boral and its' specialist consultants.

3.3 Local Effects Analysis

3.3.1 Introduction

LEA aims to address the consequences of the proposal in its "locality" as required by Section 4.15 of the EP&A Act. It is intended to complement CBA by translating effects at the NSW level to impacts on the communities located near the project site. It also provides additional information to describe changes that are anticipated within a locality, such as employment changes. LEA is intended to inform the scale of change rather than being representative of costs and benefits to the local community.

NSW Government (2015) identifies that for the purpose of a LEA the locality is defined as the Statistical Area Level 3[7] (SA3) that contains the proposed project. The relevant population group is defined as those people ordinarily resident in the locality at the time of the proposal.

The local effects required to be analysed in a LEA are:

- local employment and income effects
- other local industry effects, for example on suppliers; and
- environmental and social change in the local community.

[7] In this case the Port Stephens, Maitland and Newcastle LGAs have been chosen to represent the locality.

3.3.2 Direct effects relating to local employment

The *Guidelines for the economic assessment of mining and coal seam gas proposals* (NSW Government 2015) identify that only employment of people ordinarily resident in the region at the time of the proposal can be included in the initial estimation of direct local employment increases.[8]

The guidelines assume that these people would otherwise be employed in the region and so the increased disposable wages for the region as a result of a project is the difference between the average net income of these people in the project industry and the average net income in other industries.[9]

The incremental full-time equivalent direct employment from a project to the locality is estimated as the increase in net income divided by the average net income in the project sector.

The aim of this approach is to gauge the incremental impacts for existing residents of the locality. However, as a direct measure of regional employment and wages for existing residents it is likely to understate effects because it assumes that:

- existing local residents employed by a project are already employed in the region i.e. they are not unemployed or coming from new participants in the labour force;
- jobs vacancies in the region created by those filling the positions in a project remain unfilled for the duration of the project i.e. it essentially assumes that the regional economy and the wider Australian economy is at full employment. Refer to Attachment 3 for a discussion of the job chain effect and a comparison to input-output (IO) analysis.

From a regional economy perspective (rather than focused on existing residents), it is also likely to understate effects since it does not take into account the income spending of those who may migrate into the region to live during the life of a project.

3.3.3 Estimating effects related to non-labour project expenditure

In addition to the incremental direct regional employment and wages generated by a project, the other major economic effect will be expenditure in the region on other, non-labour, inputs. These can be estimated for construction and operation phases of a project. Identified local expenditure may not all accrue to the region, particularly for margin sectors such as wholesale and retail trade purchases where only the margin would accrue to the regional business entities unless products are also manufactured locally.

3.3.4 Second round/flow-on effects

The Guidelines (NSW Government 2015) identify that flow-on effects can also be extremely important for local communities and should therefore also be considered either qualitatively or using techniques such as IO analysis and for larger projects computable general equilibrium (CGE) modelling, provided the assumptions and limitations of the methods are identified.

3.3.5 Effects on other local industries

The LEA should also give consideration to potential impacts such as:

[8] Employment filled by those migrating into a region to live are excluded, as are jobs filled by those who reside outside the region.
[9] Wages paid to those migrating into a region to live are excluded as a wages benefit to the region.

- displacement of other land uses, where the project uses land that would otherwise be used for other purposes;
- where the project affects choices of external parties, particularly tourism and business travel; and
- where the project creates temporary effects on other industries that cause short run market adjustments in the cost of living for local residents, particularly food and housing markets.

3.3.6 Environmental and social impacts on the local community (Externalities)

Finally, every LEA should assess positive and negative externalities created by the proposed project on the locality, with a focus on material, unmitigated effects. This information is available from the CBA.

3.3.7 Input-output analysis

Section 5 undertakes a LEA as identified above and consistent with the NSW Government Guidelines (2015). In addition, an IO analysis (refer to Attachment 4) of the Project is undertaken to identify the gross regional economic activity that the Project will provide to the region. As identified in Attachment 3, incorporation of consideration of the "job chain" effect means that the direct incremental employment and income to a region approximates the total income of those employed in the region who already reside in the region or migrate into the region to live i.e. the gross footprint of economic activity estimated using IO analysis is also an indicator of the net effect.

IO analysis essentially involves two steps:

- construction of an appropriate IO table (regional transaction table) that can be used to identify the economic structure of the region and multipliers for each sector of the economy; and
- identification of the initial impact or stimulus of the project (construction and/or operation) in a form that is compatible with the IO equations so that the IO multipliers and flow-on effects can then be estimated (West, 1993).

The IO method is based on a number of assumptions that are outlined in Attachment 5. Most notably IO analysis assumes that the regional economy has access to sufficient labour and capital resources (from both inside and outside the region) so that an individual project does not result in any regional price changes e.g. wages in other industries or house rentals, which would lead to contractions (“crowding out”) of economic activity in other sectors in the same region. Any "crowding" out is assumed to occur outside the region where the Project is concentrated and the regional impact analysis is focused. A dynamic CGE approach may overcome the limitation of IO analysis but is unlikely to be warranted at local or regional scale or with small scale impacts.

The consequence of the assumptions of IO analysis, is that IO modelling results provide an upper bound economic activity impact estimate.

IO analysis identifies the economic activity of a project on the economy in terms of four main indicators:

- ***Gross regional output*** – the gross value of business turnover;
- ***Value-added*** – the difference between the gross value of business turnover and the costs of the inputs of raw materials, components and services bought in to produce the gross regional output. These costs exclude income costs;
- ***Income*** – the wages paid to employees including imputed wages for self employed and business owners; and
- ***Employment*** – the number of people employed (including self-employed, full-time and part-time).

These indicators of economic activity are not equivalent to the economic measures of consumer and producer surplus that are relevant in the CBA framework.

Gross regional output is a measure of total revenue or turnover. All costs of production would need to be subtracted from total revenue to make it approximate the measure of producer surplus. Value-added is an indicator of net value to producers, but unlike the producer surplus measure, it does not take account of all production costs – only non-labour costs are subtracted from revenue. Income or wages paid to employees is a cost to the producer in the CBA framework and is one of the costs subtracted from revenue or output to calculate the producer surplus or net benefit to producers. Employment is a non-financial indicator identifying the physical number of jobs associated with an activity.

Unlike CBA there are no decision rules to identify whether an increase or decrease in economic activity is desirable, although it is often implicitly assumed that more economic activity is good and less economic activity is bad. However, not all economic activity is desirable from a community welfare perspective since it may be associated with say environmental degradation, crime, etc.

As well as providing an indication of gross economic activity in a region, economic activity analysis can have important links to social impact assessment since changes in income and employment levels can impact population levels and their ability to maintain community infrastructure (schools, hospitals, housing etc), broader community and cultural value systems and inter-relationships.

4 COST BENEFIT ANALYSIS OF THE PROJECT

4.1 Introduction

This Section reports on a CBA of the Project based on financial, technical and environmental advice provided by Boral and its' specialist consultants.

4.2 Identification of the Base Case and the Project

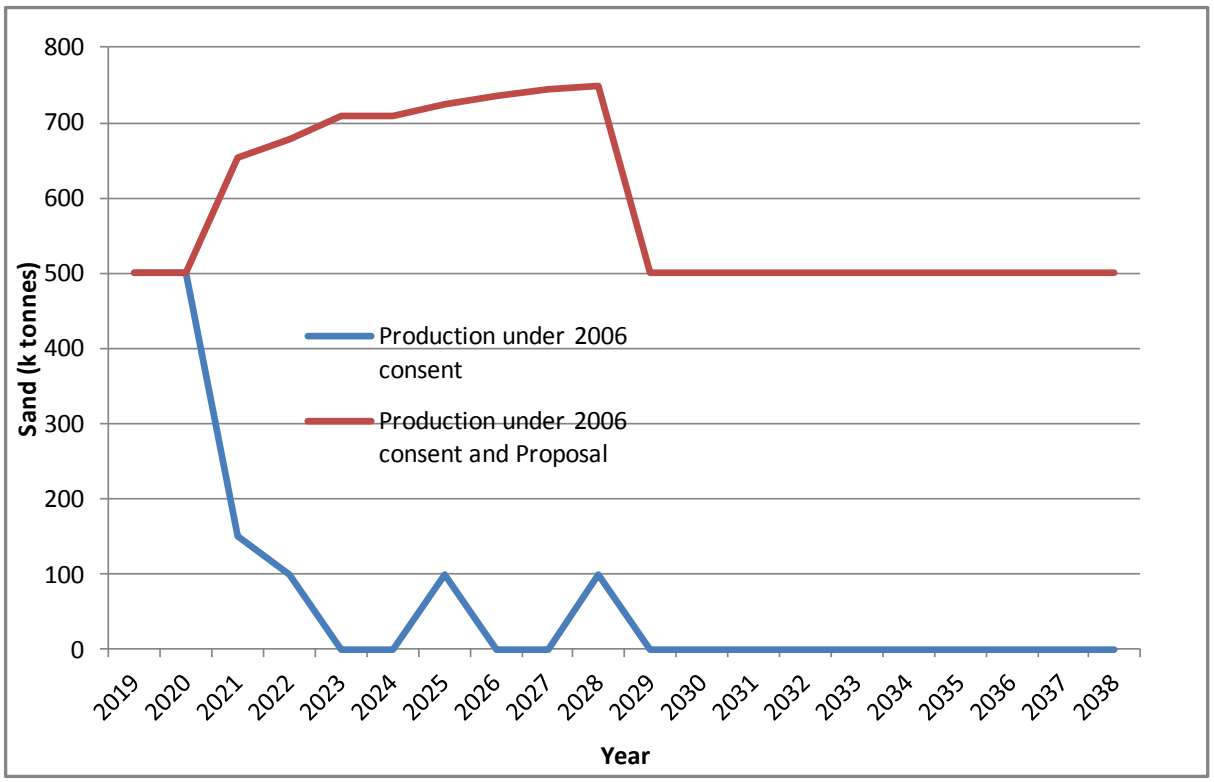
Identification of the "base case" or "without" Project scenario is required in order to facilitate the identification and estimation of the incremental economic benefits and costs of the Project.

Under the base case, Boral would operate under the current approval for a period to 2028, extracting and dry screening a total of 1.45 million tonnes (Mt) of saleable product from the transgressive windblown sand dunes adjoining the beach, with annual production up to 500,000 tpa of saleable product. On expiry of this consent some final rehabilitation of the windblown extraction area will occur.

In contrast, the Project is as described in Section 2 would seek to permit a site wide increase on the dispatch limit to 750,000 tpa (i.e. the windblown sand extraction area and the Project operations combined) up until 2028 after which the site wide limit would reduce to no more than 500,000 tpa.

An indicative comparison of the production profile "with" and "without" the extension project is provided in Figure 4.1

Figure 4.1 - Indicative Production Schedule With and Without the Project



The Project assessed in the EIS and evaluated in the CBA is considered by Boral to be the most feasible alternative required for minimising environmental, cultural and social impacts whilst maximising resource recovery, operational efficiency and ensuring ongoing employment for the existing workforce. It is therefore this option that is proposed by Boral and was subject to detailed economic analysis.

4.3 Identification of Benefits and Costs

Relative to the base case or "without" Project scenario, the Project may have the potential incremental economic benefits and costs shown in Table 4.1. The main potential economic benefit is the producer surplus (net production benefits) generated from sand extraction, producer surplus generated from ex-quarry transportation to customers, and any wage benefits to employment. The main potential economic costs relate to any environmental, social and cultural costs of quarrying and product transportation.

Table 4.1 – Potential Incremental Economic Benefits and Costs of the Project

Category	Costs	Benefits
Net production benefits from quarrying	Opportunity costs of capital equipment in 2028 Opportunity cost of land[1] in 2028 Development costs including labour, capital equipment and any acquisition costs for impacted properties and biodiversity offsets Operating costs of quarry including labour and mitigation, offsetting and compensation measures Rehabilitation and decommissioning costs at end of the Project life	Avoided decommissioning and rehabilitation costs in 2028 Value of additional sand supply Residual value of capital equipment and land at end of Project life
Net production benefits from ex-quarry transport	Capital and operating costs	Revenues
Potential environmental, social and cultural impacts of extraction, processing and transportation, after mitigation, offsetting and compensation	Noise impacts Air quality impacts Surface water and groundwater impacts Ecological impacts Transport impacts Aboriginal heritage impacts Economic benefits to existing landholders Net public infrastructure costs Loss of surplus to other industries	Wage benefits to employment

It should be noted that the potential environmental, social and cultural costs listed in Table 4.1 are only economic costs to the extent that they affect individual and community well-being through direct use of resources by individuals or non-use. If the potential impacts do not occur or are mitigated, compensated or offset to the extent where community wellbeing is insignificantly affected (i.e. costs are borne by the proponent), then no environmental, social or cultural economic costs should be included in the Project CBA apart from the mitigation, compensation or offsetting costs.

4.4 Quantification/Valuation of Benefits and Costs

Consistent with NSW Treasury (2017) and NSW Government (2015), the analysis was undertaken in real values with discounting at 7 percent (%) and sensitivity testing at 4%, 7% and 10%.

The analysis period is 25 years, coinciding with the period from the present until the end of the Project life. Any impacts that occur after this period are included in the final year of the analysis as a terminal value.

Where competitive market prices are available, they have generally been used as an indicator of economic values. Environmental, cultural and social impacts have initially been left unquantified and interpreted using the threshold value method.

An attempt has also been made to estimate environmental, cultural and social impacts using market data and benefit transfer[10] and incorporate them into an estimate of the net social benefit of the Project. However, even with the inclusion of these values, the estimated net social benefits of the Project provides another threshold value that any residual or non-quantified economic costs would need to exceed to make the Project questionable from an economic efficiency perspective.

4.4.1 Production costs and benefits of quarrying[11]

Production Costs

Opportunity Cost of Land and Capital in 2028

The majority of land required for the existing consent and the Project is owned by Boral with a small area leased from the Crown for access to the quarry. Under the base case, the current consent for extraction from the transgressive windblown sand dunes adjoining the beach, would lapse in 2028 with mandated rehabilitation under the consent occurring. At this stage i.e. in 2028, the land would be essentially vegetated coastal land zoned RU2 - Rural Landscape. There is an opportunity cost in 2028 associated with the Project of continuing to use this land for sand extraction instead of its next best use. This opportunity cost is equivalent to its undeveloped land value, which according to NSWGlobe is in the order of $2.5M

Similarly, there is an opportunity cost in 2028 of continuing to use any capital equipment for the Project that has some residual market value. For the purpose of the analysis the residual value of the capital equipment in 2028 is assumed to be zero.

Development Cost of the Project

The incremental development costs of the Project are largely associated with site infrastructure and the purchase of a dredge. These costs are estimated at $6M and occur between 2020 and 2023.

Additional one-off costs of $2.5M have been included for:

- acquisition of biodiversity offsets ($2M);
- purchase of groundwater water access licences (WALs) ($0.5M); and
- provision of water tank and equipment for bushfire management ($20,000).

Capital costs and one-off costs are included in the economic analysis in the years of the Project in which they are expected to occur.

Annual Operating Costs of the Project

The annual incremental operating costs of the Project (average annual incremental operating costs of $3M) include those associated with dredging, stockpiling, progressive rehabilitation and administration and environmental monitoring. These costs include labour costs, which reflect the value of labour resources in their next best use.

Depreciation has been omitted from the estimation of operating costs since depreciation is an accounting means of allocating the cost of a capital asset over the years of its estimated useful life. The economic capital costs are included in the development costs of the Project in the years in which they occur.

[10] Benefit transfer refers to borrowing economic values that have been determined for other study sites.
[11] All values reported in this section are undiscounted Australian dollars unless otherwise specified.

Rehabilitation and Decommissioning Costs

At the end of the Project life, the quarry site will be decommissioned and rehabilitated at an estimated cost of $100,000. Other annual rehabilitation costs are included in the annual operating costs of the Project.

Production Benefits

Avoided Rehabilitation and Decommissioning Costs in 2028

By undertaking the Project there are no avoided or delayed rehabilitation costs associated with the existing consent. This is because the existing consent relates to extraction in a different location to that proposed for the Project. Final rehabilitation under the existing consent will occur at the end of that consent i.e. 2028, regardless of the Project.

The site has minimal infrastructure, comprising a site office with amenities, workshop and weighbridge. Minimal decommissioning costs are assumed.

Value of Sand

The main economic benefit of the Project is the market value of additional sand production. Most of the sand produced is sold internally with the remainder sold in the market. All sales are at market prices. An average unit price has been applied to the output of the quarry based on advice from Boral. It has not been reported for reasons of commercial confidentiality.

There is uncertainty around future sand prices and hence assumed values have been subjected to sensitivity testing (see Section 4.6).

Residual Value at End of the Evaluation Period

At the end of the Project, capital equipment and land (excluding offsets which are required to be protected in perpetuity) may have some residual value that could be realised by sale or alternative use.

It is assumed that rehabilitated land (not including the biodiversity offsets) has a residual value of $2.5M in accordance with its current land value, and that capital equipment has no residual value.

4.4.2 Production costs and benefits of product transport

The costs and benefits of quarrying considered in Section 4.4.1 include costs and revenues/benefits of activities up to the quarry gate. Since product transport externalities are a consideration of the EIS, economic benefits associated with transportation of quarry product to customers also needs to be considered. These net production benefits essentially relate to the net revenue that accrues to transport provider.

The annual net production benefits of product transport has been estimated based on assumed incremental sand production, an average per tonne transport cost ($15), and the percentage of total revenue that is net revenue (11%[12]).

[12] Based on the ratio of gross operating surplus to revenue for the road transport sector in the 2016-17 National Input-Output Table, adjusting for mixed income.

4.4.3 Environmental, social and cultural costs and benefits

The environmental, social and cultural impacts of the Project are assessed in the EIS. This Section considers these impacts from an economic perspective. Attachment 6 summarises the treatment of the environmental, social and cultural impacts of the Project in the CBA.

Noise

The impact of the Project noise on nearby properties can potentially be valued using the property value method, where the change in property value as a result of the noise impacts are estimated, or the defensive expenditure method and damage cost method where the costs of mitigation are estimated.

The Noise Impact Assessment identified that the predicted noise levels at sensitive receptors comply with the established project noise trigger levels and hence in accordance with the Noise Policy for Industry, no further noise mitigation measures or controls are warranted. It also found that the predicted relative increase in noise levels due to heavy vehicle movements are within the allowable limits outlined in the Road Noise Policy on all designate access routes.

Hence, impacts are considered to be immaterial from an aggregate economic efficiency perspective. No economic costs are included in the CBA.

Air Quality

The impact of the Project dust emissions can potentially be valued using the property value method, where the change in property value as a result of the air quality impacts are estimated, the cost of illness method where changes in health episodes as a result of emissions are estimated and/or the defensive expenditure method and damage cost method where the costs of mitigation are estimated.

The Air Quality Impact Assessment undertook air dispersion modelling to predict the potential for offsite dust and nitrogen dioxide (NO_2) impacts in the surround area due to the operation of the Project. Using conservative assumptions that are likely to overstate impacts, the Assessment predicted that the Project would have a negligible incremental impact at the surrounding residential receptor locations. Nevertheless, the site would apply appropriate dust management measures to ensure it minimises the potential occurrence of excessive air emissions from the site. Consequently, impacts are considered to be immaterial from an aggregate economic efficiency perspective and no economic costs are included in the CBA apart from the costs of proposed general mitigation and monitoring measures.

Surface Water and Groundwater

Surface water and groundwater are potential inputs into numerous alternative production processes and so its use for extractive industry has an opportunity cost, i.e. its value in the next best alternative use. In NSW the government has established a market framework to facilitate the allocation of surface water. Water access and use is only permissible with possession of a WAL (except in the case of harvestable rights, native title rights and some stock and domestic rights). Water Sharing Plans that are prepared under the *Water Management Act 2000* set the rules by which water is shared between all users, including the environment, in each water management area in NSW. These plans also set rules for water trading, that is, the buying and selling of water licences and also annual water allocations (Montoya 2010). Consequently, the market value for surface water can be considered to give a reasonable indication of its economic value in alternative uses such as agriculture, i.e. its opportunity cost

The Surface Water Impact Assessment identifies that with respect to surface water the site is self contained. The Project will result in some localised changes to surface runoff, erosion and

sedimentation during construction and operation requiring implementation of sedimentation and erosion control measures.

The Project will also extract water from the Stockton Groundwater Source through moisture content in sand material leaving the site, and through the creation of a 'window' to the groundwater table which will allow direct evaporation, along with direct rainfall input. WALs of up to 100 megalitres per year (ML/yr) will be required from the Stockton Groundwater Source.

The opportunity cost of 100 ML/year extracted from Stockton Groundwater Source has been included in the CBA by applying an assumed market value of water of $5,000/ML. This is a use value of the water. Assuming that the WAL water would otherwise be allocated to other uses, there are no incremental non-use impacts e.g. aquatic ecology impacts, of using this water for extractive instead of alternative uses.

Ecology

The main ecological impact of the Project is associated with the clearing of an estimated 38.14 ha of native vegetation and habitat, which is predominately rehabilitation land from the former quarry pit. No threatened flora are likely to be impacted by the Project. However, some threatened fauna that are mostly likely to ulitise the foraging habitat of the Project area on an intermittent basis will be impacted.

The impacted vegetation, and associated fauna, is likely to have non-use values to the community that would be lost as a result of the Project. These values could potentially be estimated using non-market valuation methods. However, it is government policy that biodiversity offsets are provided that improve or at least maintain biodiversity values. The provision of offsets is also likely to have non-use values to the community that would be gained as a result of the Project. Provided the values held by the community for the offsets are equal or greater than values that would be lost then no additional economic costs warrant inclusion in the CBA apart from the costs of providing offsets. These costs are estimated are estimated at up to $2M and included in the capital costs of the Project.

Road Transport

The Traffic Impact Assessment found that the impacts of the additional truck movements during on the adjoining road network and intersections during construction and operation would be satisfactory and there will be minimal changes to the Level of Service and vehicle delays on the road network, including at all key intersections. It also found that the Project is not expected to have any negative impacts on the other road users and or on road safety. Consequently, there are no additional economic costs that warrant inclusion in the CBA.

Aboriginal Heritage

Impacts on Aboriginal cultural heritage can have use and non-use values to both Aboriginal and non-Aboriginal people that can be potentially estimated used nonmarket valuation methods such as choice modelling.

A review of background information undertaken for the Aboriginal Cultural Heritage Assessment Report revealed there were no known Aboriginal archaeological sites within the study area and proposed extraction area. While sites do occur within the wider Boral property, the study area is generally highly disturbed due to the previous extraction operations and removal of the bulk of the dune mass. Site inspection with the Aboriginal community confirmed the site condition and no Aboriginal objects, archaeological sites or areas of archaeological potential were identified. Subsurface archaeological deposits are considered unlikely to occur given the study area's geomorphological context and the nature and extent of prior extraction disturbance. No specific Aboriginal cultural values have been identified within the study area.

Hence, there are no material economic costs for inclusion in the CBA.

Bushfire Hazard Assessment

The Bushfire Hazard Assessment establishes that the project is capable of complying with the acceptable solutions of Planning for Bush Fire Protection (2006). However, Boral would need to install a 20,000 litre static water supply with firefighting fittings. For the purpose of the analysis this is assumed to come at a cost of $20,000. It is arguable whether this cost is attributable to the Project or would be required anyway for the existing operation. However, conservatively this cost has been attributed to the Project.

Other Potential Impacts

The Project is not considered likely to have any material historic heritage, visual or greenhouse gas impacts for inclusion in the CBA.

Market Benefits to Workers

The Project will result in all five existing jobs at the quarry being retained together with an additional two new full-time jobs and two casual jobs at the quarry. In addition, jobs associated with the transportation of quarry material will also be retained and additional transport jobs generated.

In standard CBA, the wages associated with employment are considered an economic cost of production with this cost included in the calculation of net production benefits (producer surplus). This approach assumes labour markets clear, with no involuntary unemployment i.e. full employment, and no other distortions (Bartik, 2012). Conservatively, this approach is adopted in this analysis.

Economic Benefits to Existing Landholders

All land required for the Project is owned by the proponent. No benefits to other landholders via land prices in excess of the opportunity cost of the land will occur.

Economic Benefits to Suppliers

The focus of CBA is generally on primary costs and benefits i.e. first round impacts. Secondary net benefits that accrue to firms that sell to or buy from a project are ignored. Conservatively, this convention is adopted and hence no secondary benefits to the economic are included.

Net Public Infrastructure Impacts

No net infrastructure costs to government are envisaged as a result of the Project. Given that additional employment will likely be sourced from existing residents of NSW no additional demand for community infrastructure is envisaged.

Loss of Surplus to Other Industries

No loss of surplus to other industries is envisaged as a result of the Project.

4.5 Consolidation of Value Estimates

The present value of costs and benefits, using a 7% discount rate, is provided in Table 4.2. The top half of the Table identifies production costs and benefits of the Project associated with quarrying and product transportation. Quarrying production costs includes capital and operating costs associated with the mitigation, offset and compensation of environmental, social and cultural impacts. The bottom

of the Table summarises the residual environmental, social and cultural impacts of the Project after mitigation, offset and compensation.

The Project is estimated to have total net production benefits (quarrying and product transportation) of $48M. Assuming 75% Australian ownership of Boral and 100% Australian ownership of transport providers, $41M of these net production benefits would accrue to Australia[13]. The estimated net production benefits that accrue to Australia can be used as a threshold value or reference value against which the relative value of the residual environmental impacts of the Project, after mitigation, compensation and offset, may be assessed. This threshold value is the opportunity cost to society of not proceeding with the Project. The threshold value indicates the price i.e. $41M, that the Australian community must value any residual environmental impacts of the Project (be willing to pay) to justify in economic efficiency terms the no development option.

However, from Table 4.2 it can be seen that there are few external environmental, social or cultural impacts of the Project, and those that do exist e.g. ecological impacts and groundwater impacts, are internalised into the capital costs of the proponent via payment for ecological offsets and WALs, and hence are incorporated into the estimate of net production benefits. Residual impacts would be immaterial.

Consequently, the Project is estimated to have net social benefits to Australia of $41M and hence is desirable and justified from an economic efficiency perspective.

[13] This is the net production benefits of the Project minus the residual producer surplus accruing overseas.

Table 4.2 - Global and National Cost Benefit Analysis Results of the Project (Present Values @7% discount rate)

	Costs		Benefits	
	Description	**Value ($M)**	**Description**	**Value ($M)**
Net production benefits from quarrying	Opportunity cost of land	$1	Avoided decommissioning and rehabilitation costs	$0
	Opportunity cost of capital	$0	Value of sand	$72
	Development costs	$7	Residual value of land	$1
	Operating costs	$27	Residual value of capital	$0
	Decommissioning and rehabilitation costs	$0		***$73***
	Sub-total	***$34***	***Sub-total***	***$73***
	Net Production Benefits			**$39 ($32)**
Net production benefits from ex-quarry transport	Transport costs	$72	Transport revenue	$81
	Net Production Benefits			**$9 ($9)**
	Total Net Production Benefits			**$48M ($41M)**
Environmental, social and cultural impacts	Noise impacts	No properties impacted by exceedances	Market values of employment	NA
	Air quality impacts	No properties impacted by exceedances	Economic benefits to existing landholders	NA
	Surface water and groundwater	Cost of WALs included in capital costs	Economic benefits to suppliers	NA
	Ecology	Some loss of values but offset. Cost of biodiversity offset included in capital costs		
	Road transport impacts	No material network, level of service or safety impacts.		
	Aboriginal heritage	No material impacts		
	Bushfire hazard	Additional cost of water storage and fire fighting equipment included in capital costs		
	Historic heritage	No material impacts		
	Visual	No material impacts		
	Greenhouse gas	No material impacts		
	Net public infrastructure costs	No material impacts		
	Loss of surplus to other industries	No material impacts		
	Residual non-market impacts sub-total	**$0**		**$0**
NET SOCIAL BENEFITS				**$48 ($41)**

Note: totals may have minor discrepancies due to rounding. When impacts accrue globally, the numbers in brackets relates to the level of impact estimated to accrue to Australia

Residual net producer surplus to Boral Shareholders i.e. producer surplus less company tax, is apportioned by 75% in accordance with the estimated level of Australian shareholdings.

Road transport providers are assumed to be 100% Australian owned.

No material impacts does not mean that there will be no impacts but that aggregated immaterial impacts are not likely to amount in aggregate to more than 5% of the quantified net production benefits of the Project.

4.6 NSW Costs and Benefits

The NSW Government (2015) guidelines have a particular focus on the costs and benefits to NSW. Table 4.3 identifies the costs and benefits to NSW. Impacts that have a national dimension are apportioned to NSW, in particular:

- 32% of the estimated company tax generated from the Project (quarrying and product transport) is attributed to NSW (NSW Guidelines 2015);
- 32% of the residual net producer surplus from the quarry is apportioned to NSW i.e. share ownership assumed to be distributed in line with the population;
- 100% of residual net producer surplus of transport provision is apportioned to NSW i.e. ownership is NSW based;
- all other potential environmental, social and cultural impacts would accrue to NSW households. However, in accordance with Government policy and regulation these impacts are largely mitigated, compensated or offset by the proponent.

On this basis, the costs and the benefits of the Project to NSW are summarised in Table 4.3. The estimated Net Social Benefits of the Project to NSW are estimated at $17M, present value at 7% discount rate (the latter including employment benefits). Consequently, as well as resulting in net benefits to Australia, the Project would also result in net benefits to NSW.

Any unquantified residual impacts of the Project after mitigation, offset and compensation would need to be valued at greater than $17M, present value for the Project to be questionable from an NSW economic efficiency perspective.

Table 4.3 - Cost Benefit Analysis Results of the Project - NSW (Present Values @7% discount rate)

COSTS	VALUE ($M)	BENEFITS	VALUE ($M)
Environmental, social and cultural impacts		***Net Production Benefits of Quarrying***	
Noise impacts	No properties impacted by exceedances	Direct company tax	$4
Air quality impacts	No properties impacted by exceedances	Residual net production benefits	$7
Surface water and groundwater	Cost of WALs included in capital costs	***Sub-total***	**$10**
Ecology	Some loss of values but offset. Cost of biodiversity offset included in capital costs	***Net Production Benefits of Product Transport***	
Road transport impacts	No material network, level of service or safety impacts.	Direct company tax	$1
Aboriginal heritage	No material impacts	Residual net production benefits	$6
Bushfire hazard	Additional cost of water storage and fire fighting equipment included in capital costs	***Sub-total***	**$7**
Historic heritage	No material impacts	Market values of employment	NA
Visual	No material impacts	Economic benefits to existing landholders	NA
Greenhouse gas	No material impacts	Economic benefits to suppliers	NA
Net public infrastructure costs	No material impacts	Market values of employment	NA
Loss of surplus to other industries	No material impacts	***Sub-total***	***$0***
Sub-total	***$0***		
NET SOCIAL BENEFITS to NSW			**$17**

The approach used in this section is that where impacts do not exist, are offset or compensated for, it is assumed that they are immaterial. Immaterial does not mean that there will be no impacts but aggregate immaterial impacts are not likely to amount to more than 5% in aggregate of the quantified net production benefits of the Project

It should be noted that this is residual net production benefit is not equivalent to profit and hence should not be used to infer profitability of the Project.

4.7 Distribution of NSW Costs and Benefits

As identified in Section 3, CBA is only concerned with the single objective of economic efficiency. CBA and welfare economics provide no guidance on what is a fair, equitable or preferable distribution of costs and benefits. Nevertheless, CBA can provide qualitative and quantitative information for the decision-maker on how economic efficiency costs and benefits are distributed.

The costs and benefits of the Project to NSW are potentially distributed among a range of stakeholders as identified in Table 4.4.

Table 4.4 - Incidence of NSW Costs and Benefits

BENEFITS AND COSTS	INCIDENCE OF COSTS AND BENEFITS	MAGNITUDE OF IMPACT ($M)
Net Production Benefits of Quarrying		
Direct company tax	NSW Government and NSW households	$4
Residual net production benefits	Boral and its NSW shareholders	$7
Net Production Benefits of Product Transport		
Direct company tax	NSW Government and NSW households	$1
Residual net production benefits	Transport providers and their owners/shareholders	$6
Additional benefits		
Wage benefits to employment	Employees of the Project who reside in NSW	NA
Economic benefits to existing landholders	Local landholders who sell land required for Project including buffer land	NA
Economic benefits to suppliers	Regional and State suppliers of inputs to production	NA
Environmental, social and cultural costs*		
Noise impacts	Adjoining landholders	No properties impacted by exceedances
Air quality impacts	Adjoining landholders	No properties impacted by exceedances
Surface water and groundwater	Local surface water users	$0.5M Cost of WALs included in capital costs
Ecology	Local and NSW households	$2M Some loss of values but offset. Cost of costs
Road transport impacts	Local residents	No material network, level of service or safety impacts.
Aboriginal heritage	Aboriginal people and other local and NSW households who value Aboriginal heritage	No material impacts
Historic heritage impacts	Local and NSW households who value heritage	No material impacts*
Visual impacts	Adjoining landholders and those travelling past the site	No material impacts*
Greenhouse gas	Local and NSW households	No material impacts*
Net public infrastructure costs	NSW Government and NSW households	No material impacts*
Loss of surplus to other industries	Local industries adversely impacted by the Project	No material impacts*

* NSW regulations require many impacts to be borne by the proponent via mitigation, offset and compensation. Where these measures perfectly mitigate, offset or compensate then no residual impacts occur and all impacts are borne by the proponent. This table identifies who bears residual impacts if they did occur as a result of the Project and mitigation, offset and compensation was imperfect.

4.8 Risk and sensitivity analysis

The main areas of environmental risks associated with quarry projects relate to:

- the financial viability of a project from unexpected downturns in prices and any consequent environmental impacts from premature cessation of operations;
- ecological risk associated with whether the biodiversity offsets will adequately compensate for the direct ecological impacts; and
- other environmental, social and cultural impacts estimations and required mitigation measures.

The Independent Planning Commission has previously identified that the financial viability of projects is a risk assumed by the project proponents. Nevertheless, it should be noted that the Project is the continuation of an existing financially viable operation. Boral is willing to invest in the Project and has a fiduciary responsibility to its shareholders. It is highly unlikely Boral's investment would take place and then operations would cease, leaving residual environmental impacts at the site. Strong current and foreseeable demand for sand is also likely to underpin the financial viability of the Project.

The provision of biodiversity offsets can be associated with a number of risks, including in relation to the biodiversity benefits of additional management of offsets, success in reconstruction of ecological communities, time-lags between impacts and provision of offsets as well as between management actions and achievement of ecological outcomes. These risks are mitigated through offset ratio

requirements in the calculation of offsets requirements or fund payments, and commitment to the provision/payment for offset actions prior to the commencement of works under approval.

There is some risk associated with the estimation of environmental, social and cultural impacts of the Project and the level of mitigation measures proposed. However, it should be noted that impacts have generally been assessed based on the maximum annual levels of production and hence are likely to be overstated. Ongoing monitoring will ensure that appropriate mitigation measures are implemented as required.

The net present values (NPVs)[14] of the Project presented in Table 4.2 and Table 4.3 are based on a range of assumptions around which there is some level of uncertainty. Uncertainty in a CBA can be dealt with through changing the values of critical variables in the analysis (James and Gillespie, 2002) to determine the effect on the NPV[15].

In this sensitivity analysis, the CBA results for NSW were tested for changes to the following variables at a 4%, 7% and 10% discount rate:

- Opportunity costs of land;
- Quarry capital costs including offsets, WALs and fire fighting requirements;
- Quarry operating costs;
- Quarry decommissioning costs;
- Value of sand;
- Quarry production levels;
- Residual value of quarry land; and
- Net transport revenue.

Results are reported in Table 4.5. What this analysis indicates, is that CBA results at the NSW level are most sensitive to increases in operating costs, reductions in the value of sand and reductions in production volume.

The Project is the continuation of an existing quarrying operation and hence operating costs in this location and geological environment are known. Estimates of operating costs of the Project are therefore likely to be reasonably accurate and a 20% increase that is maintained each and every year of the analysis as reported in the sensitivity analysis is highly unlikely.

The strong demand for sand that underpins the Project suggests that sustained reductions in sand value and annual production levels is highly unlikely

The sensitivity analysis also indicated that the CBA results are not sensitive to changes in capital costs, opportunity costs of land or environmental costs that have not already been internalised into production costs, such as WALs and offsets. Since mitigation, offset and compensation costs are small components of the capital and operating costs of the Project, it is unlikely that large changes in these cost levels would have any significant impact on the CBA results.

Under all scenarios examined, the Project has net social benefits to NSW.

[14] NPV is the present value of benefits less the present value of costs. Present values are calculated using a discount rate that reflects peoples time preferences.

[15] Quantitative risk analysis could also potentially be undertaken. However, this requires information on the probability distributions for input variables in the analysis. This information is not available and so the sensitivity testing is limited to uncertainty analysis.

Table 4.5 - NSW CBA Results Sensitivity Testing (Present Value $Millions)

	4% Discount Rate	7% Discount Rate	10% Discount Rate
CENTRAL ANALYSIS	**$23**	**$17**	**$13**
INCREASE 20%			
Opportunity cost of quarry land	$23	$17	$13
Quarry development costs	$23	$17	$13
Quarry operating costs	$21	$16	$12
Quarry decommissioning costs	$23	$17	$13
Value of sand	$28	$21	$16
Volume of quarry production	$28	$21	$16
Residual value of land	$23	$17	$13
Transport net revenue	$25	$19	$15

	4% Discount Rate	7% Discount Rate	10% Discount Rate
DECREASE 20%			
Opportunity cost of quarry land	$23	$17	$13
Quarry development costs	$23	$18	$14
Quarry operating costs	$25	$19	$15
Quarry decommissioning costs	$23	$17	$13
Value of sand	$18	$14	$11
Volume of quarry production	$18	$14	$10
Residual value of land	$23	$17	$13
Transport net revenue	$21	$16	$12

5 LOCAL EFFECTS ANALYSIS

5.1 Introduction

The CBA in Section 4 is concerned with whether the incremental benefits of the Project exceed the incremental costs and therefore whether the community would, in aggregate, be better off 'with' the Project compared to 'without' it. This Section and Section 6 examines local effects using two different methods.

The Local Area is defined as the LGA of Port Stephens (within which the Project is located) as well as the adjoining LGAs of Maitland and Newcastle. This is the local region that primarily benefits from and supplies inputs to the Project.

5.2 Direct Effects Related to Employment

All current and prospective quarry employment is likely to be sourced from the Local Area while 64% of transport employment is estimated to be sourced from the Local Area.

The Project will provide continued quarry employment for approximately five (four full time and one casual) employees currently on-site and another four (two full time and two casual). In the absence of the Project employment would reduce generally in line with reduced production and in 2028 would be zero.

The Project is estimated to provide continued transport employment for 17 people from the Local Area, plus employment for an additional 9 people from the Local Area.[16] Based on estimated wages for quarry workers and average wage from the input-output table for the road transport sector, the Project is estimated to provide initial incremental net income to the local area of $0.6M increasing to around $1M when production levels reduce to 500,000 tpa. The increased disposable net income in the region may be as high as $1.6M if current production levels could not be maintained under the base case due to shortages of sand.

The above level of benefit to the Local Area economy, may be reduced if people employed by the Project would otherwise have been employed elsewhere in the Local Area and the increased demand for labour as a result of the Project has no job chain effects i.e. it is assumed that employment in the quarry and transport, simply substitutes for other jobs in the region.

Table 5.1 - Analysis of Income and Job Effects

	Current Employment	Project Employment	Increment
a) Direct employment during operations phase sourced from Local Area			
Quarry	5	9	4
Road Transport	17	26	9
Total	***22***	***35***	***13***
b) Net income in quarrying and transport sector			
Quarry	$290,480	$502,184	$211,704
Road Transport	$747,197	$1,120,796	$373,599
Total	***$1,037,677***	***$1,622,979***	***$585,302***

5.3 Direct Effects Related to Non-labour Expenditure

The total annual non-labour expenditure (after subtraction of wages to quarry workers) is estimated at $2.4M per annum when production is at 750,000 tpa and $1.6M per annum when the production is at

[16] Transport employment estimates are based on the estimated expenditure on transport and ratios in the regional input-output table for the road transport sector. See Section 6. Additional employment in transport is provided to people located outside the region.

500,000 tpa. This was estimated based on the ratio of local expenditure to total (non-labour) expenditure in the regional input-output table for the *non metallic mineral mining sector*. Refer to Section 6.

5.4 Second Round and Flow-on Effects

The incremental expenditure by employees and non-labour expenditure that is captured by the local area provides flow-on economic activity to the local economy, which can be estimated in terms of economic activity indicators of output, value-added, income and employment. Section 6 provides a full assessment of flow-on effects arising from both labour expenditure and non-labour expenditure.

5.5 Effects on Other Industries

5.5.1 Wage impacts

In the short-run, increased regional demand for labour as a result of the Project (relative to the situation of no Project) could potentially result in some increased pressure on wages in other sectors of the economy. The magnitude and duration of this upward wages pressure would depend on the level of demand for labour, the availability of labour resources in the region and the availability and mobility of labour from outside the region. However, the level of labour demand is low, there are substantial labour resources available in the Local Area and from outside the local area. Wage impacts are therefore not likely to be significant. Where upward pressure on regional wages occurs, it represents an economic transfer between employers and owners of skills and would attract skilled labour to the region leading to downward pressure on wages.

5.5.2 Housing impacts

The Project is a continuation and extension of an existing quarry operation. All quarry employment is anticipated to be sourced from the Local Area with 64% of transport employment sourced from the Local Area. No substantial migration of labour is anticipated and hence there will be no additional demand for housing or community infrastructure.

5.5.3 Displacement of other land uses

The Project will not displace any other land uses and will have no significant impact on tourism or recreation.

5.6 Environmental, Cultural and Social Impacts on the Local Community (Externalities)

The main externalities that potentially accrue from the Project and the magnitude of these to the local area are summarised in Table 5.2.

Table 5.2 - Environmental and Social Impacts on the Local Community ($M)

Environmental, social and cultural costs	Incidence of Impacts	Magnitude of Local Impact
Noise impacts	Adjoining landholders	No properties impacted by exceedances
Air quality impacts	Adjoining landholders	No properties impacted by exceedances
Surface water and groundwater	Local surface water users	$0.5M Cost of WALs included in capital costs
Ecology	Local and NSW households	$2M Some loss of values but offset. Cost of costs
Road transport impacts	Local residents	No material network, level of service or safety impacts.
Aboriginal heritage	Aboriginal people and other local and NSW households who value Aboriginal heritage	No material impacts
Historic heritage impacts	Local and NSW households who value heritage	No material impacts*
Visual impacts	Adjoining landholders and those travelling past the site	No material impacts*
Greenhouse gas	Local and NSW households	No material impacts*
Net public infrastructure costs	NSW Government and NSW households	No material impacts*
Loss of surplus to other industries	Local industries adversely impacted by the Project	No material impacts*

5.7 Summary of Local Effects

A summary of local effects of the Project is provided in Table 5.3.

Table 5.3 - Summary of Local Effects

	Current Employment	Project Employment	Increment
Direct employment during operations phase sourced from Local Area			
Quarry	5	9	4
Road Transport	17	26	9
Total	***22***	***35***	***13***
Net income in quarrying and transport sector			
Quarry	$290,480	$502,184	$211,704
Road Transport	$747,197	$1,120,796	$373,599
Total	***$1,037,677***	***$1,622,979***	***$585,302***
Second round and flow-on effects	Refer to Section 6		
Contraction in other sectors	No material impact		
Displaced activities	Not applicable		
Wage price impacts	No material impact		
Housing price impacts	No material impact		
Externality impacts	**Incidence of Impacts**	**Magnitude of Impact**	
Noise impacts	Adjoining landholders	No properties impacted by exceedances	
Air quality impacts	Adjoining landholders	No properties impacted by exceedances	
Surface water and groundwater	Local surface water users	$0.5M Cost of WALs included in capital costs	
Ecology	Local and NSW households	$2M Some loss of values but offset. Cost of costs	
Road transport impacts	Local residents	No material network, level of service or safety impacts.	
Aboriginal heritage	Aboriginal people and other local and NSW households who value Aboriginal heritage	No material impacts	
Historic heritage impacts	Local and NSW households who value heritage	No material impacts*	
Visual impacts	Adjoining landholders and those travelling past the site	No material impacts*	
Greenhouse gas	Local and NSW households	No material impacts*	
Net public infrastructure costs	NSW Government and NSW households	No material impacts*	
Loss of surplus to other industries	Local industries adversely impacted by the Project	No material impacts*	

6 SUPPLEMENTARY LOCAL EFFECTS ANALYSIS

6.1 Introduction

This Section uses IO analysis to identify the gross economic activity footprint associated with the Project on the Local Area economy.

6.2 Structure of the Local Area Economy

For the purpose of the analysis the Local Area is defined as the Port Stephens, Maitland and Newcastle LGA.

A 2016-17 IO table of the regional economy was developed using the Generation of Input-Output Tables (GRIT) procedure (Attachment 7) using a 2016-17 IO table of the National economy as the parent table and 2016 Census employment by industry data for NSW and the region. The 114 sector IO table of the regional economy was aggregated to 50 sectors and 8 sectors for the purpose of describing the economy.

A highly aggregated 2016-17 IO table for the regional economy is provided in Table 6.1. The rows of this table indicate how the gross regional output of an industry is allocated as sales to other industries, to households, to exports and other final demands (OFD) (which includes stock changes, capital expenditure and government expenditure). The corresponding column shows the sources of inputs to produce that gross regional output. These include purchases of intermediate inputs from other industries, the use of labour (household income), the returns to capital or other value-added (OVA) (which includes gross operating surplus and net indirect taxes and subsidies) and goods and services imported from outside the region. The number of people employed in each industry is also indicated in the final row.

Output for the regional economy is estimated at $83,220M. Value-added for the regional economy is estimated at $24,440M, comprising $12,702M to households as wages and salaries (including payments to self employed persons and employees) and $11,737M in OVA.

The employment total working in the regional economy was 149,733.

The economic structure of the regional economy can be compared with that for NSW through a comparison of results from the respective IO models (Figures 6.1 and 6.2). This reveals that the mining, manufacturing and utilities sectors in the regional economy are of greater relative importance than they are to the NSW economy, while the business services sectors and public personal services sectors are of less relative importance than they are to the NSW economy.

Figures 6.3 to 6.5 provide a more expansive sectoral distribution of gross regional output, employment, household income, value-added, exports and imports, and can be used to provide some more detail in the description of the economic structure of the regional economy.

In terms of output, the metal manufacturing, public administration and professional/scientific/technical services are the most significant sectors to the regional economy. In terms of value-added the public administration, finance, education and health sectors are the most significant sectors. The public administration, education, health and professional/scientific/technical services sectors are the most significant sector for income while the health, retail and education sectors are the most significant sectors for employment. The metal manufacturing sector is the most significant sector for both imports and exports, with the coal mining sector being the second most significant sector for exports.

Table 6.1 - Aggregated Transactions Table: Regional Economy 2016-17 ($M)

	Ag, forestry, fishing	Mining	Manuf.	Utilities	Building	Trade/ Accom	Bus. Srvcs	Public/ Pers. Srvcs	TOTAL	Household Expenditure	OFD	Exports	Total
Ag, forestry, fishing	16	0	105	0	1	31	5	5	**165**	31	184	143	**522**
Mining	0	93	283	8	22	4	13	6	**430**	5	147	1,738	**2,321**
Manuf.	18	68	487	21	470	166	166	165	**1,561**	399	921	3,719	**6,601**
Utilities	9	18	149	559	39	58	143	103	**1,079**	232	781	46	**2,138**
Building	13	55	35	59	1,276	61	392	294	**2,184**	18	3,334	25	**5,560**
Trade/Accom	14	47	193	22	156	163	254	247	**1,095**	2,146	361	825	**4,428**
Bus.Srvcs	40	225	632	237	599	811	3,044	1,052	**6,638**	4,049	1,963	1,958	**14,608**
Public/Pers Srvcs	3	48	70	24	71	43	306	276	**840**	1,836	6,042	493	**9,211**
TOTAL	**114**	**555**	**1,953**	**930**	**2,635**	**1,337**	**4,322**	**2,148**	**13,993**	**8,717**	**13,732**	**8,947**	**45,389**
Household Income	73	267	1,057	261	1,124	1,639	3,469	4,812	**12,702**	-	-	-	**12,702**
OVA	222	1,181	664	669	716	798	4,908	992	**10,150**	869	712	7	**11,737**
Imports	114	318	2,927	278	1,085	655	1,909	1,259	**8,544**	3,153	1,456	239	**13,392**
TOTAL	**522**	**2,321**	**6,601**	**2,138**	**5,560**	**4,428**	**14,608**	**9,211**	**45,389**	**12,739**	**15,900**	**9,192**	**83,220**
Employment (no.)	**1,238**	**2,166**	**10,624**	**2,356**	**11,624**	**30,580**	**31,104**	**60,042**	**149,733**				

Figure 6.1 - Summary of Aggregated Sectors: Regional Economy (2016-17)

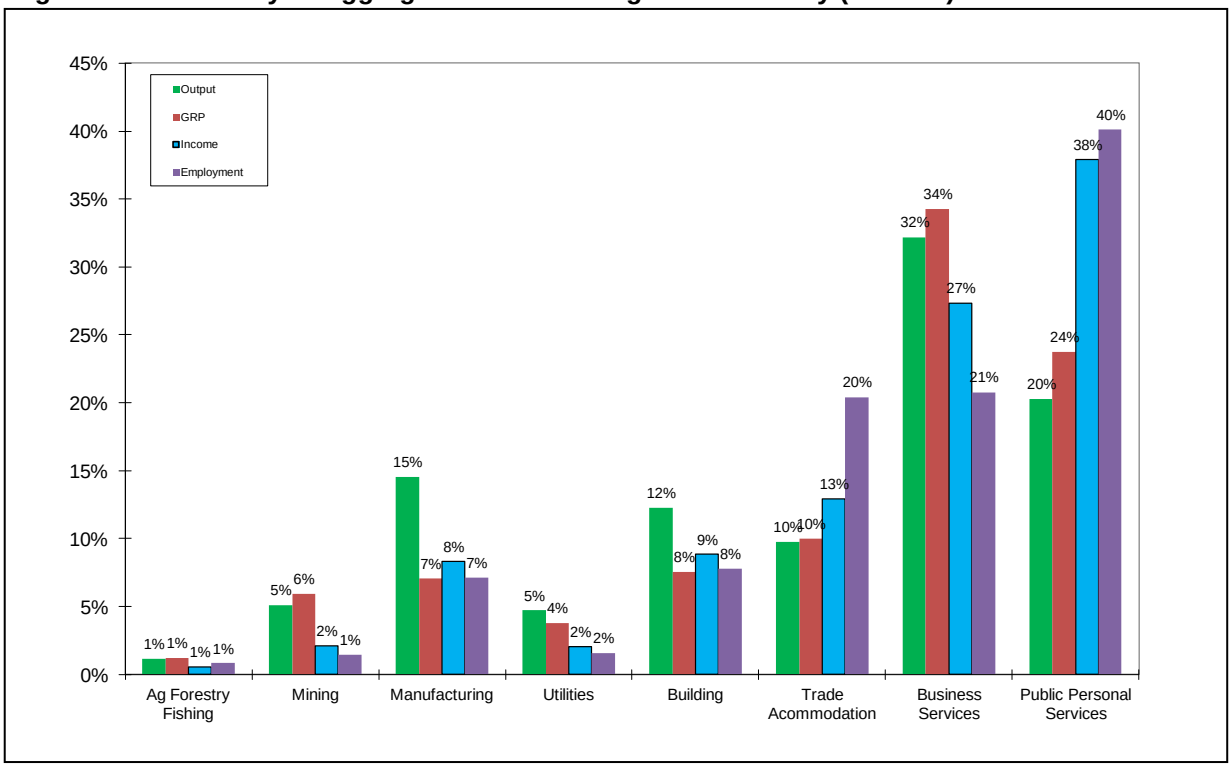


Figure 6.2 - Summary of Aggregated Sectors: NSW Economy (2016-17)

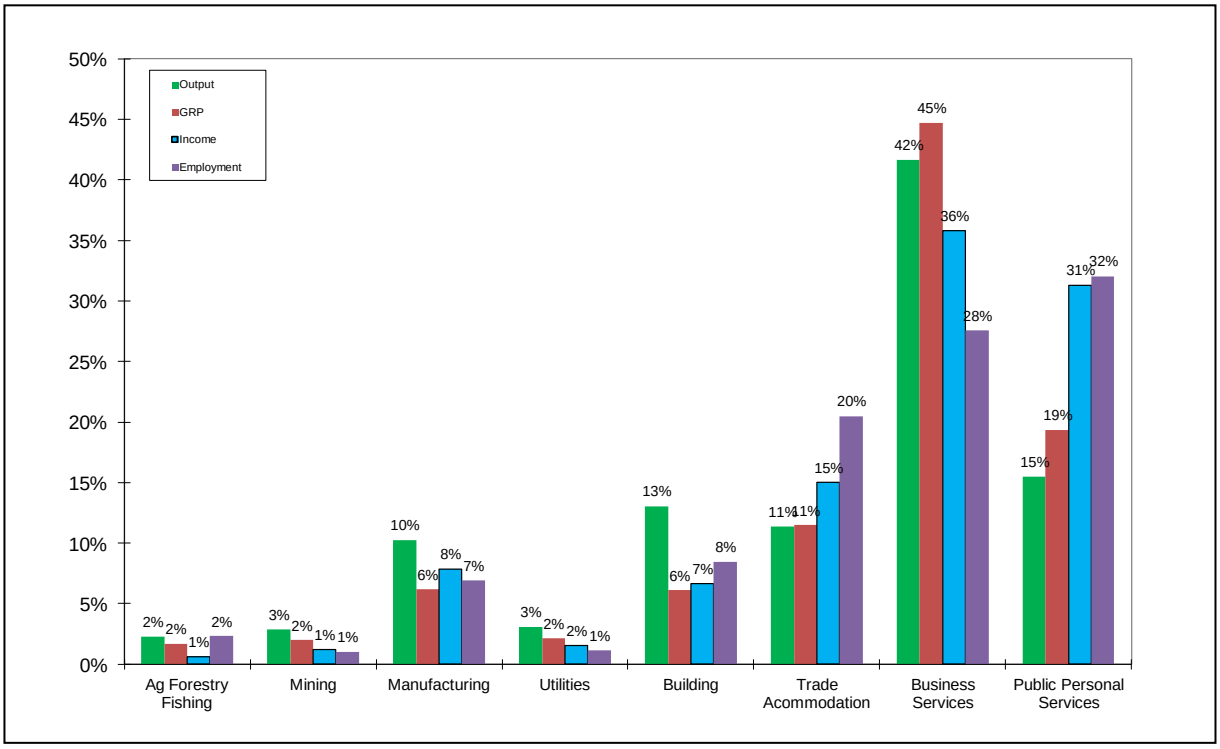


Figure 6.3 Sectoral Distribution of Gross Regional Output and Value Added ($M)

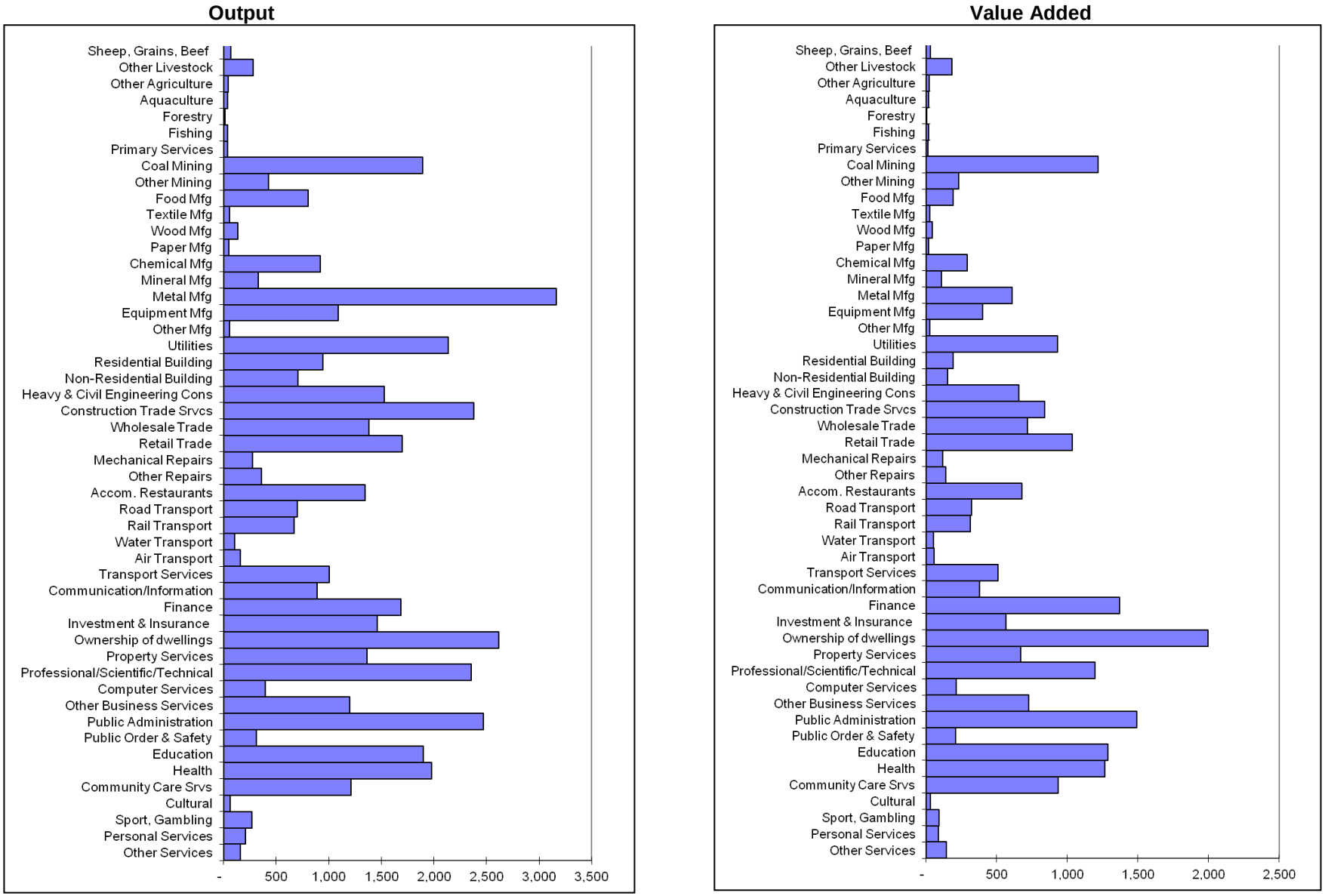


Figure 6.4 Sectoral Distribution of Income ($M) and Employment (No.)

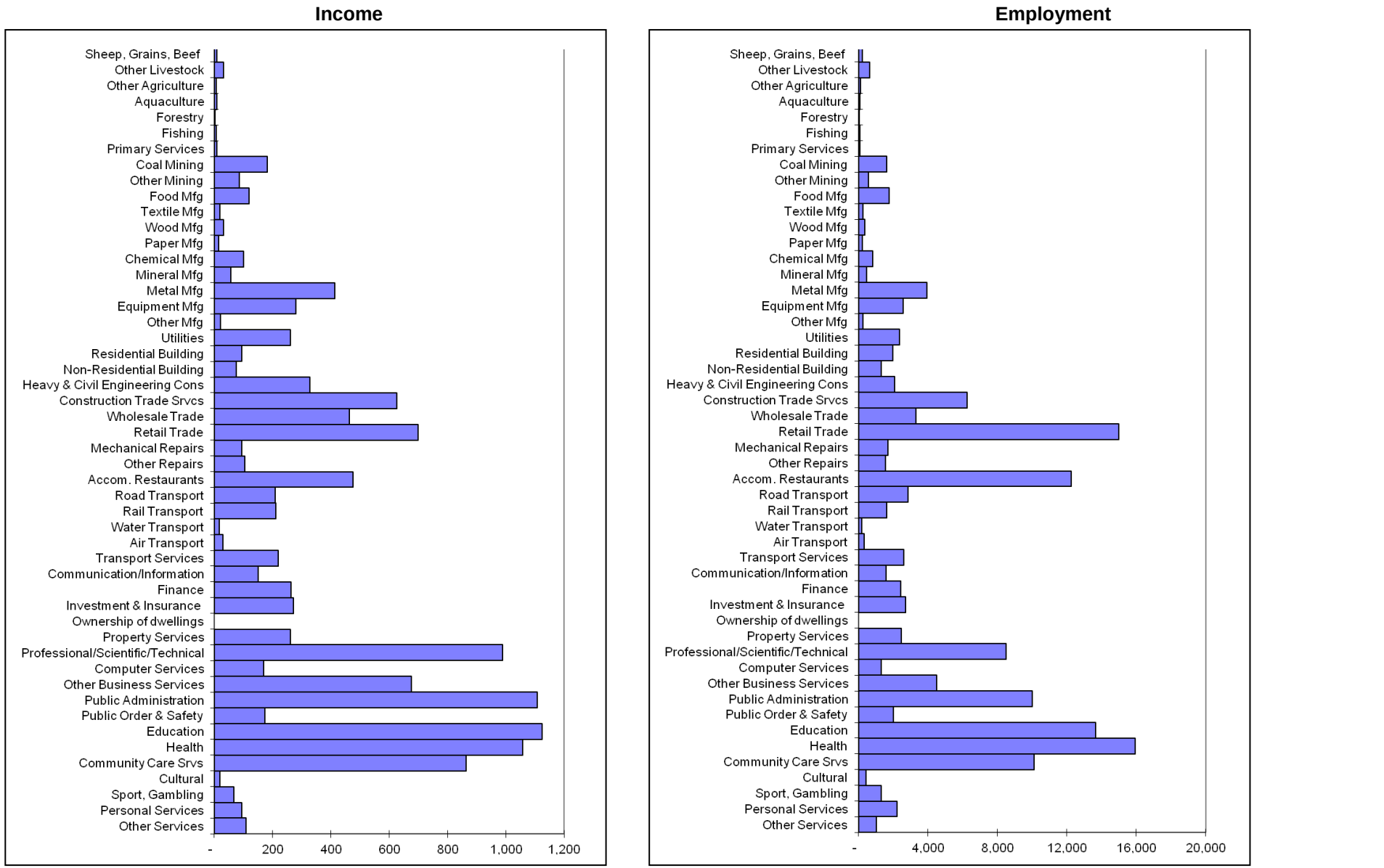
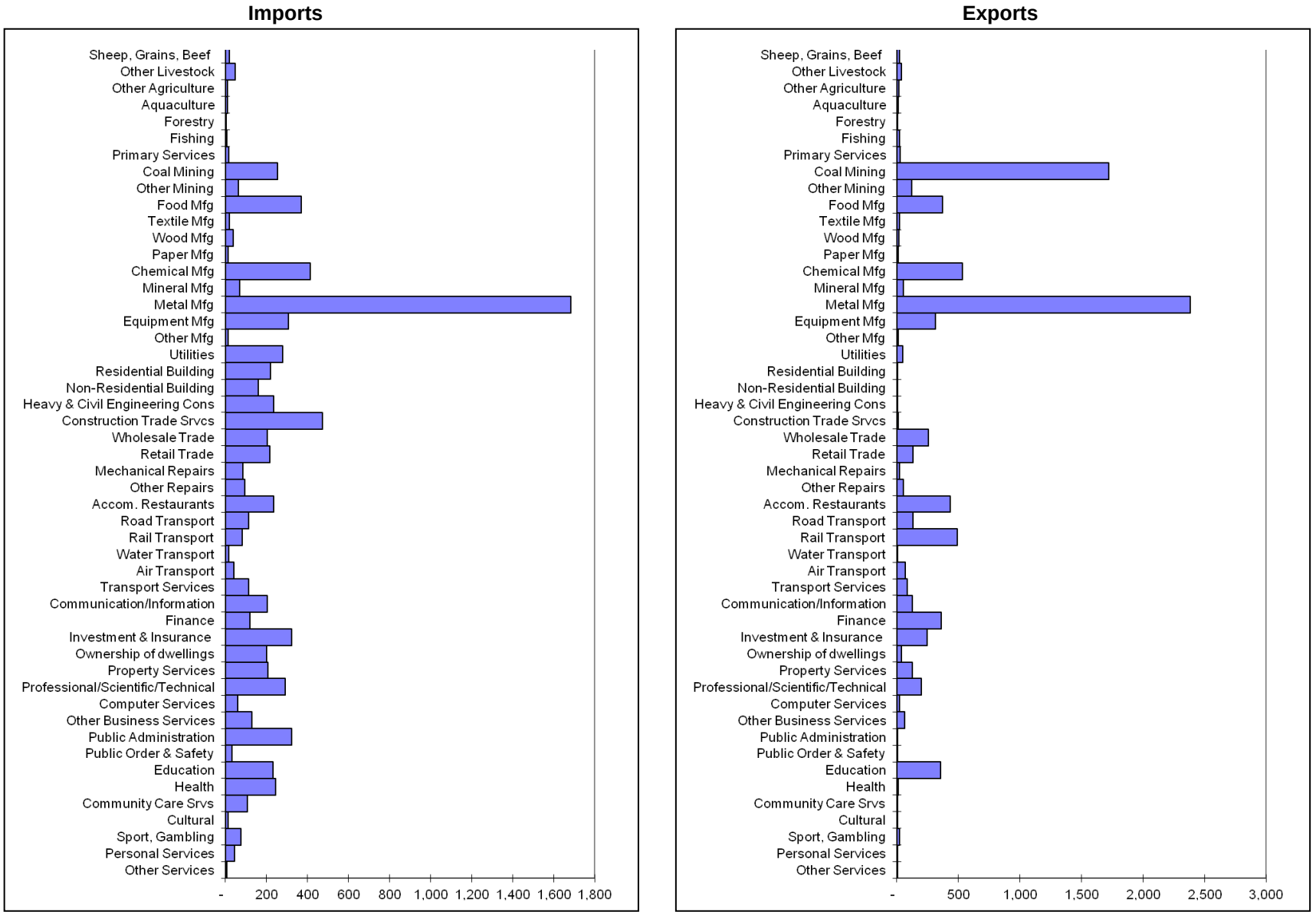


Figure 6.5 Sectoral Distribution of Imports and Exports ($M)



6.3 Local Area Impacts of the Project

6.3.1 Introduction

There is no substantive construction phase associated with the Project and hence this assessment focuses on the economic activity to the Local Area economy i.e. the output, value-added, income and employment associated with the quarrying operation and delivery of quarry products. All other things being equal, the economic activity arising from the Project will depend on:

- the expenditure profile in the regional economy that is associated with the quarry and transport;
- the expenditure profile and residential location of the quarry and transport workforce; and
- the size of the regional economy and the ability of local businesses to supply inputs to production demanded by quarry and transport operators and the workforce.

Impacts are reported separately for quarrying and transport components of the Project

6.3.2 Quarry Operation

Introduction

For the analysis of the quarry operation, new Project sectors were inserted into the regional IO table reflecting operations at 500,000 tpa and 750,000 tpa. The annual revenue, operating costs, and gross profit for the new sectors were obtained from financial information provided by Boral. For these new sectors:

- the estimated gross annual revenue from the region was allocated to the *Output* row;
- gross profit was allocated to the *Other Value Added* row;
- the estimated wage bill of employees residing in the region was allocated to the *household wages* row (100% live in the region);
- non-wage expenditure was allocated between *intermediate* sectors in the regional economy and *imports* based on expenditure profile in the *non metallic mineral mining sector*[17] of the regional input-output table; and
- direct employment by the Project in the region was allocated to the *employment* row.

Impacts

The total and disaggregated annual impacts of the quarry operation on the regional economy (in 2019 dollars) at two different levels of production i.e. 500,000 tpa and 750,000 tpa are shown in Table 6.2. Incremental impacts are also provided.

[17] This the industry sector that sand quarrying is located.

Table 6.2 - Economic Impacts of Quarry Operation on the Regional Economy ($2019)

	Direct Effect	Production Induced	Consumption Induced	Total Flow-on	TOTAL EFFECT
500,000 tpa					
OUTPUT ($M)	7.0	2.5	0.9	3.4	10.4
Type 11A Ratio	1.00	0.36	0.13	0.49	1.49
VALUE ADDED ($M)	4.4	1.2	0.5	1.7	6.1
Type 11A Ratio	1.00	0.28	0.12	0.40	1.40
INCOME ($M)	0.4	0.4	0.2	0.6	1.0
Type 11A Ratio	1.00	1.17	0.44	1.61	2.61
EMPL. (No.)	5	6	3	9	14
Type 11A Ratio	1.00	1.23	0.65	1.88	2.88
750,000 tpa					
OUTPUT ($M)	10.5	3.5	1.4	4.9	15.4
Type 11A Ratio	1.00	0.33	0.14	0.47	1.47
VALUE ADDED ($M)	6.8	1.6	0.8	2.5	9.2
Type 11A Ratio	1.00	0.24	0.12	0.36	1.36
INCOME ($M)	0.7	0.6	0.3	0.9	1.5
Type 11A Ratio	1.00	0.95	0.40	1.35	2.35
EMPL. (No.)	9	9	5	14	23
Type 11A Ratio	1.00	0.96	0.56	1.52	2.52
Incremental Impact					
OUTPUT ($M)	3.5	1.0	0.5	1.5	5.0
Type 11A Ratio	1.00	0.27	0.15	0.42	1.42
VALUE ADDED ($M)	2.4	0.4	0.3	0.7	3.1
Type 11A Ratio	1.00	0.17	0.13	0.30	1.30
INCOME ($M)	0	0	0	0	1
Type 11A Ratio	1.00	0.68	0.36	1.00	2.00
EMPL. (No.)	4	3	2	5	9
Type 11A Ratio	1.00	0.64	0.45	1.10	2.09

Quarry production at 750,000 tpa relative to 500,000 tpa is estimated to make up to the following incremental contribution to the regional economy:

- $5M in annual direct and indirect regional output or business turnover;
- $3M in annual direct and indirect regional value added;
- $1M in annual direct and indirect household income; and
- 9 direct and indirect jobs.

This is a minimum incremental impact. Based on the available sand resource and production profiles identified in Figure 4.1, without the Project, sand extraction will decline significantly below approved levels. Consequently, incremental impacts will likely to be closer to the levels identified above for 750,000 tpa and 500,000 tpa.

Main Sectors Affected

Production induced and consumption induced flow-on impacts from the Project are likely to affect a number of different sectors of the regional economy. The sectors most impacted by output, value-added and income flow-ons are likely to be the:

- Professional, Scientific and Technical Services;
- Construction Services;

- Coal Mining;
- Exploration and Mining Support Services;
- Retail Trade sector;
- Wholesale Trade sector; and
- Employment, Travel Agency and Other Administrative Services.

Businesses that can provide the inputs to the quarrying process required by the Project and/or the products and services required by employees would directly benefit from the Project by way of economic activity. However, because of the inter-linkages between sectors, many indirect businesses also benefit.

6.3.3 Transportation of Quarry Products

Introduction

For the analysis of the transportation of quarry products, the revenue accruing to transport operators from the transport of 500,000 tpa and 750,000 tpa was estimated. This was then adjusted by 64% on the advice of Boral that 36% of transport operators are located outside the region. The impact of this level of final demand on the regional economy was then calculated using the IO7 program.

Impacts

The total and disaggregated annual impacts of the transportation of quarry products on the regional economy (in 2019 dollars) at two different levels of production i.e. 500,000 tpa and 750,000 tpa are shown in Table 6.3. Incremental impacts are also provided.

Table 6.3 - Economic Impacts of the Quarry Product Transport on the Regional Economy ($2019)

	Direct Effect	Production Induced	Consumption Induced	Total Flow-on	TOTAL EFFECT
500,000 tpa					
OUTPUT ($M)	4.45	2.50	1.61	4.11	8.56
Type 11A Ratio	1.00	0.56	0.36	0.92	1.92
VALUE ADDED ($M)	2.04	1.22	0.93	2.16	4.20
Type 11A Ratio	1.00	0.60	0.46	1.06	2.06
INCOME ($M)	0.89	0.53	0.29	0.83	1.72
Type 11A Ratio	1.00	0.60	0.33	0.93	1.93
EMPL. (No.)	17.36	9.00	5.85	14.85	32.21
Type 11A Ratio	1.00	0.52	0.34	0.86	1.86
750,000 tpa					
OUTPUT ($M)	6.67	3.75	2.41	6.16	12.84
Type 11A Ratio	1.00	0.56	0.36	0.92	1.92
VALUE ADDED ($M)	3.06	1.83	1.40	3.24	6.30
Type 11A Ratio	1.00	0.60	0.46	1.06	2.06
INCOME ($M)	1.33	0.80	0.44	1.24	2.57
Type 11A Ratio	1.00	0.60	0.33	0.93	1.93
EMPL. (No.)	26.04	13.51	8.77	22.28	48.32
Type 11A Ratio	1.00	0.52	0.34	0.86	1.86
Incremental Impact					
OUTPUT ($M)	2.22	1.25	0.80	2.05	4.28
Type 11A Ratio	1.00	0.56	0.36	0.92	1.92
VALUE ADDED ($M)	1.02	0.61	0.47	1.08	2.10
Type 11A Ratio	1.00	0.60	0.46	1.06	2.06
INCOME ($M)	0.44	0.27	0.15	0.41	0.86
Type 11A Ratio	1.00	0.60	0.33	0.93	1.93
EMPL. (No.)	8.68	4.50	2.92	7.43	16.11
Type 11A Ratio	1.00	0.52	0.34	0.86	1.86

Transportation of quarry product at 750,000 tpa relative to 500,000 tpa is estimated to make up to the following incremental contribution to the regional economy:

- $4M in annual direct and indirect regional output or business turnover;
- 2M in annual direct and indirect regional value added;
- $1M in annual direct and indirect household income; and
- 16 direct and indirect jobs.

This is a minimum incremental impact. Based on the available sand resource and production profiles identified in Figure 4.1, without the Project, sand extraction will decline significantly below approved levels. Consequently, incremental impacts will likely to be closer to the levels identified above for 750,000 tpa and 500,000 tpa.

Main Sectors Affected

Production induced and consumption induced flow-on impacts from the Project are likely to affect a number of different sectors of the regional economy. The sectors most impacted by output, value-added and income flow-ons are likely to be the:

- Professional, Scientific and Technical Services;

- Retail Trade sector;
- Wholesale Trade sector.
- Automotive Repairs and Maintenance sector;
- Road Transport sector;
- Transport Support Services and Storage; and
- Employment, Travel Agency and Other Administrative Services.

Businesses that can provide the inputs to the road transport sector and/or the products and services required by employees would directly benefit from the Project by way of economic activity. However, because of the inter-linkages between sectors, many indirect businesses also benefit.

6.4 Potential Contraction in Other Sectors

Economic impacts for the Local Area economic modelled using IO analysis represent only the gross or positive economic activity associated with the Project. Where employed and unemployed labour resources in the region are limited and the mobility of in-migrating or commuting labour from outside the region is restricted there may be competition for regional labour resources, as a result of the individual project, that drives up regional wages. In these situations, there may be some 'crowding out' of economic activity in other sectors of the regional economy.

'Crowding out' would be most prevalent if the regional economy was at full employment and it was a closed economy with no potential to use labour and other resources that currently reside outside the region. However, the regional economy is not at full employment and has access to external labour resources. Consequently, 'crowding out' of economic activity in other sectors as a result of the Project would not be expected to be significant at the regional level.

However, even where there is some 'crowding out' of other economic activities this does not indicate losses of jobs but the shifting of labour resources to higher valued economic activities. This reflects the operation of the market system where scarce resources are reallocated to where they are most highly valued and where society would benefit the most from them. This reallocation of resources is therefore considered a positive outcome for the economy not a negative.

7 CONCLUSION

A CBA of the Project indicated that it would have net social benefits to Australia of $41M, and net social benefits to NSW of $17M. Hence the Project is desirable and justified from an economic efficiency perspective. Environmental, social and cultural impacts of the Project have been minimised through Project design and mitigation, offset and compensation measures. In particular, Boral will purchase required Water Access Licences, provide required biodiversity offsets and establish required bushfire hazard reduction measures. The costs of these actions are included in the estimate of the net social benefits of the Project. The economic value of residual impacts are considered to be immaterial from an aggregated economic efficiency perspective.

While the main environmental, cultural and social impacts have been quantified and included in the Project CBA, any other residual environmental, cultural or social impacts that remain unquantified would need to be valued at greater than $41M for the Project to be questionable from an Australian economic efficiency perspective, and greater than between $17M for the Project to be questionable from NSW economic efficiency perspective.

The Project will provide continued quarry employment for approximately five (four full time and one casual) employees currently on-site and another four (two full time and two casual). The Project is also estimated to provide continued transport employment for 17 people from the Local Area, plus employment for an additional 9 people from the Local Area.

Economic activity analysis, using IO analysis, estimated that quarry production at 750,000 tpa relative to 500,000 tpa is estimated to make up to the following incremental contribution to the regional economy:

- $5M in annual direct and indirect regional output or business turnover;
- $3M in annual direct and indirect regional value added;
- $1M in annual direct and indirect household income; and
- 9 direct and indirect jobs.

This is a minimum incremental impact. Based on the available sand resource and likely production profiles without the Project, sand extraction will decline significantly below approved levels. Consequently, incremental impacts will likely to be closer to the levels identified in the report for 750,000 tpa and 500,000 tpa.

Transportation of quarry product at 750,000 tpa relative to 500,000 tpa is estimated to make up to the following incremental contribution to the regional economy:

- $4M in annual direct and indirect regional output or business turnover;
- $2M in annual direct and indirect regional value added;
- $1M in annual direct and indirect household income; and
- 16 direct and indirect jobs.

This is also a minimum incremental impact given that without the Project sand extraction will decline significantly below approved levels.

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ATTACHMENT 1 – LEGISLATIVE CONTEXT FOR ECONOMIC ANALYSIS IN EIA

Environmental Planning and Assessment Act 1979 and Environmental Planning and Assessment Regulation

- The basis for economic analysis under the *Environmental Planning and Assessment* (EP&A) *Act 1979* emanates from:
  - the definition of the term "environment" in the EP&A Act which is broad and includes the social and **economic** environment, as well as the biophysical environment;
  - the "objects" of the EP&A Act which includes *"promoting the social and **economic welfare** of the community"*; and
  - Clause 7(1)(f) of Schedule 2 of the EP&A Regulations which requires environmental assessment to provide "*the reasons **justifying** the carrying out of the development, activity or infrastructure in the manner proposed, having regard to biophysical, **economic** and social considerations…"*
  - *Section 4.15 of the EP&A Act requires the following two matters to be taken into consideration by the consent authority in determining a development application:*
    - the public interest (taken as the collective public interest of households in NSW); and
    - the likely impacts of that development, including environmental impacts on both the natural and built environments, and social and ***economic impacts in the locality***.
- Objects of promoting economic welfare and requirements to justify a project having regard to economic considerations are consistent with the use of CBA. A Note to Clause 7 (1) (f) states that "A cost benefit analysis may be submitted or referred to in the reasons justifying the carrying out of the development, activity or infrastructure."
- A cost benefit analysis is consistent with the consideration of the public interest, although the limitation of public interest to NSW households requires consideration of the costs and benefits to NSW households, whereas CBA would normally be undertaken at the National level.
- Elements of CBA can provide information on the economic impacts in the locality, although CBA should not be undertaken at the local level. This can be supplemented by other forms of analysis to examine economic impacts in the locality such as the consideration of:
  - effects relating to local employment;
  - effects relating to non-labour project expenditure; and
  - environmental and social impacts on the local community.

Secretary's Environmental Assessment Requirements

- The Project SEARs include a requirement for:
  - an assessment of the likely economic impacts of the development, paying particular attention to:
    - the significance of the resource;

- the economic benefits of the project for the State and region; and
- the demand for the provision of local infrastructure and services.

- the reasons why the development should be approved having regard to biophysical, **economic** and social **considerations**, including the principles of ecologically sustainable development.

Other Economic Guidelines

- In 2015 the NSW Government prepared *Guidelines for the economic assessment of mining and coal seam gas proposals*. This provides an outline of how to undertake a CBA and local effects analysis of mining and coal seam gas proposals.

- NSW Treasury (2007) *NSW Government Guideline for Economic Appraisal*, provides guidance for Government agencies on how to undertake CBA of significant spending proposals, including proposed capital works, projects and new programs across all public sector agencies. However, many of the principles have broader application.

ATTACHMENT 2 – INTRODUCTION TO ECONOMIC METHODS

Benefit Cost Analysis

- Cost Benefit Analysis (CBA) is the primary way that economists evaluate projects and policies.

- CBA evaluates whether the well-being (**economic welfare**) of the community is in aggregate improved by a project. It does this by comparing the costs and benefits of a project to the community.

- The community whose welfare is included is broadly defined as anyone who bears significant costs and benefits of a project. However, in practice most CBA is undertaken at a national level. CBA at a sub-national level is not recommended however if undertaken at this level should provide decision-makers with estimates of all significant effects, including those to non-residents of the sub-national region.

- It is not possible to justify a project on economic grounds without doing a CBA.

Economic Activity Analysis

- Economists also often provide information to decision-makers on the **economic activity** that a project will provide to the regional, state or national economy. This is particularly relevant at the regional level since many regions and towns are experiencing long term decline as a result of structural change in the economy. Additional economic activity can help the prosperity of these regions.

- **Direct** economic activity provided by a project can be estimated from financial and labour estimates for a project. Methods that can be used to estimate **direct** and **indirect** economic activity include IO analysis and CGE modelling. Refer to Attachment 3 for a comparison of these methods and their assumptions.

- While economic activity measures from IO analysis and CGE modelling e.g. direct and indirect output, value-added and income, are generally not measures of benefits and costs relevant to a CBA this information can be of interest to decision-makers[18].

Economic Analysis and Decision-Making

- CBA and local effects analysis (including IO/CGE analysis) are not mechanised decision-making tools, but rather means of analysis that provide useful information to decision-makers.

- Decision-making is multi-dimensional. CBA is concerned with the single objective of **economic efficiency** (economic welfare) while IO analysis and CGE are concerned with the objective of **economic activity** (growth). They do not address equity and other objectives of government. Decision-makers therefore need to consider the economic efficiency and economic activity implications of a project, as indicated by CBA and IO/CGE analysis respectively, alongside the performance of a project in meeting other, often conflicting, government goals and objectives.

[18] It should be noted that it is possible to analyse industry benefits and costs within a general equilibrium framework where impacts are of a sufficient scale that they flow through into multiple sectors in the economy. However, for individual projects a partial equilibrium framework is the preferred approach for the estimation of costs and benefits (US EPA (2010) Guidelines for Preparing Economic Analyses, US EPA).

ATTACHMENT 3 – COMPARISON OF INPUT-OUTPUT ANALYSIS AND THE LEA METHOD

IO analysis begins with identification of the direct gross regional economic activity footprint of a project for the region. If a project provides 100 jobs then all these jobs are counted in IO analysis as a direct effect i.e. direct employment in the region, because the jobs are located in the region. However, in IO analysis only the income of employees living in the region are counted as direct income effects since it is only wages expenditure of those living in the region that flows through the regional economy. In IO analysis, if 40% of a projects jobs are filled by people who already reside in the region then the **total** wages of these people is counted as a direct regional income effect of the project. Similarly, if 40% of the new jobs are taken by people who migrate into the region this is also counted as direct income for the region, as it is income that will accrue to people living in the region even though they are new residents. In IO analysis, the income of those residing outside the region is excluded as most of their income will be taken home after shift and spent where they live or elsewhere.

These direct employment and income effects for the region are those **associated** with the project i.e. the gross footprint, rather than specifically an assessment of **incremental** effects. This is partly because assessment of incremental effects becomes highly contentious and difficult. However, as will be shown below, these gross direct effects associated with a project can also be a reasonable approximation of incremental effects when "trickle down" or "job chain" effects are considered.

However, first is a comparison between how IO analysis treats direct employment and income effects (as explained above) and that in the NSW (2015) guideline.

The guideline splits labour into those ordinarily resident in the region and those not ordinarily resident in the locality. For those ordinarily resident in the region the guideline suggests calculation of incremental income as the difference between a mining (including quarrying) income and the average level of income in other industries in the region. Incremental direct employment is then calculated by dividing this incremental income by the average wage in mining.

The guideline ignores workers who migrate into the region to work. However, using the rationale of the guideline, workers who migrate into the region to take jobs in a project provide a greater level of incremental income and spending in the region than those to take jobs in a project and who already reside in the region. The entire wage of those migrating into the region is additive to regional income in comparison to wage increments for those already residing in the region.

Table 1 provides an example of incremental wages using the guideline method and when income from those migrating into the region is counted. If only the incremental wages of those who already reside in the region are counted the incremental impact is $1.4M in annual wages. However, if the incremental wages to the region from those who migrate into the region are included, this increases to $5.4M.

Table 1 - Incremental Income when Immigrating Workforce is Included

Categories of Workers	Direct Empl	Current Wages @$65k	New Wages @$100k	Incremental New Wages for Workers	Incremental New Wages to the Region
Already Live in Region	40	2,600,000	4,000,000	1,400,000	1,400,000
Migrate into Region to Live	40	2,600,000	4,000,000	1,400,000	4,000,000
Commute from outside	20	1,300,000	2,000,000	700,000	0
Total Direct Empl	**100**	**6,500,000**	**10,000,000**	**3,500,000**	**5,400,000**

Even for those already living in the region who are already employed, the incremental income estimated using the guideline will substantially understate additional regional income effects. This is because new jobs in a region create a chain of job opportunities (referred to in the literature as the "trickle down" effect or "job chain" - see Persky et al, 2004 What are jobs worth?, Employment Research Vol. 11 , p. 3).

An already employed person in the region moving into a mining (including quarrying) job, creates a job vacancy, which can be filled by those in the region (already employed, unemployed or attracted into the labour force) or by in-migration. Where this job is filled by those already employed in the region this in turn creates another vacancy etc. Following the entire chain through, the cumulative increase in wages to a region would approach the wages of the total direct jobs. It would only be discounted if the chain ends with employment of those from local residents in the unemployment pool (who are receiving an allowance and hence already are spending income in the region) or if jobs remain unfilled. In periods of higher unemployment rates, jobs along the job chain remaining unfilled is unlikely. If the chain ends with in-migrating employment or employment of those in the region that are new to the workforce then the incremental wages is equal to the total wages of the new jobs.

Table 2 demonstrates the "trickle down" effect in relation to 40 new mining jobs filled by already employed local workers. It shows that the total annual wages of the new mining jobs is $4M. Under the trickle down approach where all jobs are backfilled including ultimately by 40 local residents from the unemployment pool the incremental wages to the region are $3.5M. If some of these jobs filled from the unemployment pool are ultimately filled by in-migration the difference between the incremental wages to the region and the total annual mining jobs wages will lessen.

The guideline does not take account of the "trickle down" effect and essentially assumes that the previous jobs of "job movers" in the region remain vacant for the life of the Project.

Incorporation of consideration of the "trickle down" effect means that the direct incremental income to a region approximates that assumed in IO analysis (i.e. the gross footprint of economic activity estimated using IO analysis is also an indicator of the net effect).

Table 2 - Demonstration of the Trickle Down Effect for 40 Jobs Filled by Locals Who are Already Employed in the Region

	Total wages	Increment Wages Gain to Region
1. New mining wage for 40 workers @$100k	$4,000,000	$1,400,000 (1-2)
2. Current Wages for 40 workers @$65k	$2,600,000	$1,000,000 (2-3)
3. Wage of people filling above 40 positions @$40k	$1,600,000	$800,000 (3-4)
4. Wage of people filling above 40 positions @$20k	$800,000	$ 255,664 (4-5)
5. Wages of the unemployed filling above 40 positions (Newstart - single no children)	$544,336	
Total		**$3,455,664**

ATTACHMENT 4 – INPUT-OUTPUT ANALYSIS AND COMPUTABLE GENERAL EQUILIBRIUM ANALYSIS

Input-Output Analysis

- IO analysis is a cost effective and simple method for estimating the gross market economic activity i.e. financial transactions and employment, in a specified region that is associated with a project.
- IO analysis is the most widely used model for regional impact assessment (West and Jackson 2005).
- IO analysis can be undertaken at the LGA or aggregation of LGAs level.
- IO analysis can provide disaggregation of economic activity impacts across many sectors – 111 sectors based on current National IO tables.
- IO analysis was developed by Wassily Leontief for which he received the Nobel Prize in Economics.
- IO analysis is a static analysis that looks at economic activity impacts in a particular year e.g. a typical year of a projects operation.
- IO analysis has historically been applied at the regional level to assess the economic activity impacts of individual projects.
- IO analysis involves the development of an IO table representing the buying and selling of goods and services in the economy. These fixed average ratios are used to estimate the direct and indirect impacts of a change in expenditure in a region.
- IO analysis identifies the gross direct and indirect additional (positive) regional economic activity associated with a project in terms of a number of indicators of economic activity – output, income, value-added[19] and employment.
- Economic activity measures used in IO are not measures of benefits and costs relevant to a CBA.
- IO analysis does not attempt to examine non-market environmental, social or cultural impacts.
- IO analysis does not depend on the assumption *"that there is a ghost pool of highly skilled yet unemployed people"* in a region as suggested by a Land and Environment Court Judgement.
- The estimation of economic activity impacts in IO analysis are based on a number of simplifying assumptions – most notable is that the regional economy has **access to** sufficient labour and capital resources (from both **inside** and **outside** the region) so that an individual project does not result in any regional price changes e.g. wages in other industries or house rentals, which would lead to contractions ("crowding out") of economic activity in other sectors in the region.
- For the assessment of the impacts of individual projects on small open regional economies, this is a reasonable assumption.
- Nevertheless, the results of IO modelling can be seen as representing an upper bound for the net economic activity associated with a project.

Computable General Equilibrium Modelling

- CGE modelling is an alternative more expensive, complicated but theoretically more sophisticated method for estimating the economic activity associated with a project.

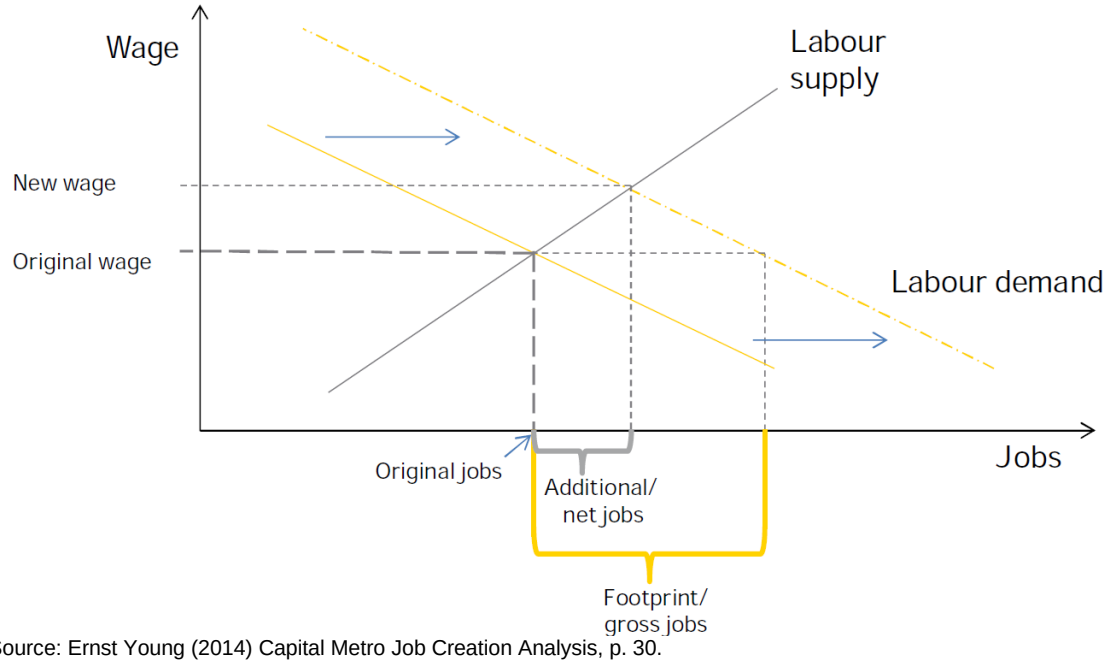
[19] Value-added is the difference between the gross value of business turnover and the costs of the inputs of raw materials, components and services bought in to produce the gross regional output.

- CGE modelling can be dynamic or comparative static[20] and has historically been applied at the State and National level for determining the potential economic activity associated with the introduction of major government policy changes and investment in large infrastructure projects.
- CGE modelling can also be undertaken at a regional level but normally at no finer scale than the Statistical Subdivision level.
- CGE modelling estimates the additional net (positive and negative) economic activity associated with a project in terms of a number of economic indicators – including value-added and employment – but also real income, government tax revenue and components of value-added.
- Economic activity measures used in CGE modelling are not generally measures of benefits and costs relevant to a CBA, although CGE modelling can also be used to estimate market costs or market benefits, as part of a CBA, where the magnitude of a project will affect a large number of sectors and the effects will be spread more broadly throughout the economy.
- Economic activity impacts can be disaggregated by sector but this is not normally as disaggregated as in IO analysis.
- CGE modelling does not attempt to examine non-market environmental, social or cultural impacts.
- CGE modelling is underpinned by an IO database as well as a system of interdependent behaviour and accounting equations which are based on economic theory (but mostly without econometric backing at the regional level).
- The equations in CGE models ensure that any change in demand in a region, no matter how small, translates into some change in prices and hence there is always some 'crowding out' of other economic activity in the region.
- At the regional level, CGE results can be very sensitive to changes in these behavioural assumptions.
- 'Crowding out' of other economic activities estimated via CGE modelling does not reflect losses of jobs but the shifting of labour resources to higher valued economic activities.

[20] Comparative static models compare one equilibrium point with another but do not trace the impact path along the way. Dynamic models give year by year impacts of a shock.

Comparison of IO Analysis and CGE Modelling

Figure A4.1 – Comparison of Employment Estimates in IO Analysis and CGE Modelling



Source: Ernst Young (2014) Capital Metro Job Creation Analysis, p. 30.

- Figure A4.1 illustrates the difference between the output of IO analysis and the output of CGE with respect to employment. IO analysis estimates the employment footprint or gross jobs from a project. It can also be taken as an indicator of net jobs from a project where there is no or little upward pressure on wages for the region in question as a result of the individual project and hence no or little crowding out of other economic activity[21]. CGE modelling assumes upward pressure on wages and hence some crowding out of other economic activity in the region. Under this assumption CGE estimates additional net jobs as being less than the employment footprint/gross jobs.
- Which modelling approach best represents the true situation depends on whether and to what extent price changes occur at a regional level as a result of individual projects. This is an empirical issue and would depend on the migration of labour into the region, commuting of labour and timely management of land releases by Councils. Few studies exist that examine this issue.
- IO analysis provides decision-makers with information on the relative employment footprint/gross jobs of different projects, without going to the second and more complicated stage of trying to model wage rises and "crowding out" across all other sectors in the economy.
- Regional economic activity, estimated by IO analysis or CGE modelling, is just one piece of information that decision-makers may take into account in considering a project.

Guidelines

- Both IO analysis and CGE modelling are identified in the DP&I's *draft Guideline for Economic Effects and Evaluation in EIA* (James and Gillespie 2002) as appropriate methods for examining regional economic impacts i.e. impacts on economic activity – the size and structure of an economy.
- NSW Treasury (2009) *Guidelines for estimating employment supported by the actions, programs and policies of the NSW Government,* supports the use of IO for deriving estimates for

[21] This is akin to the marginal assumption in CBA.

employment supported by NSW Government actions, programs and policies, and clarifies the interpretation of such estimates.

- Other guidelines to recognise the role of IO analysis include:
  - US Environment Protection Agency (2010) *Guidelines for Preparing Economic Analyses*;
  - Australian Bureau of Rural Science (2005) *Socio-economic Impact Assessment Toolkit: A guide to assessing the socio-economic impacts of Marine Protected Areas in Australia*.
- NSW Treasury (2007) identify that IO analysis is commonly used to assess the regional impacts of a project. However, IO analysis is concerned with measuring economic activity, and is not a tool for the evaluation of projects (in the way that CBA is).
- World Bank economist Mustafa Dinc (2015) Introduction to Regional Economic Development: Major Theories and Basic Analytical Tools, Edward Elgar, UK, identifies IO as one of the most widely used models around the world for undertaking regional economic impact analysis and a solid framework to analyse the interdependence of industries in an economy.

Government Applications of IO Analysis

- Applications of IO analysis commissioned by Government agencies include:
  - Department of Sustainability, Environment, Water, Population and Communities (2011) *Assessing the Socio-Economic Impacts of Sustainable Diversion Limits and Water for the Future Investments: An Assessment of the Short-Term Impacts at a Local Scale*
  - NSW Natural Resources Commission (2009) *River Red Gum Assessment: Socio-economic impact assessment*;
  - Victorian Environmental Assessment Council (2007) *River Red Gum Forests Investigation – Socio-Economic Assessment.*
  - Resource and Conservation Division of the NSW Department of Urban Affairs and Planning (1999) Regional Impact Assessments as part of the NSW Comprehensive Regional Assessments under the National Forestry Policy.
  - Reserve Bank of Australia (2012) *Industry Dimensions of the Resource Boom: An Input-Output Analysis.*
  - DECCW (2009) Economic benefits of national parks and other reserves in New South Wales - Summary report, reports the results of numerous studies it and its' predecessors have commissioned on the regional economic impacts of national parks and protected areas.
  - DECCW (2006) *Socio Economic Assessment of the Batemans Bay Marine National Park*
  - DECCW (2006) *Socio Economic Assessment of the Port Stephens – Great Lakes Marine Park*
  - National Parks Service, US Department of the Interior (2014) *2012 National Parks Visitor Spending Effects: Economic Contribution to Local Communities, States and the Nation*.

Criticisms Misrepresented

- The main concern that economists e.g. the Productivity Commission, NSW Treasury and ABS (as quoted by The Australia Institute in numerous submissions to mining projects in NSW) have with IO is its use as a substitute for CBA, not its use for estimating direct and indirect regional economic activity impacts.
  - NSW Treasury (2009) "*Model based economic impact assessment [such as IO analysis] is not a substitute for a thorough economic analysis of a policy. The appropriate method for analysing policy alternatives is benefit cost analysis (CBA)".*

- The main "abuse" reported by the Productivity Commission is using IO analysis to *"make the case for government intervention"* when CBA is the appropriate method for doing this.

- ABS's concerns with IO being "*biased*" refer to it being a "*biased estimator of the benefits or costs of a project"*. IO does not estimate benefits and costs but economic activity.

- Concerns of the Warkworth Judgement with IO analysis being "deficient" related to the data (industry data from surveys undertaken in 2001 and assumptions used (see next dot point)), but more fundamentally for not *"assisting in weighing the economic factors relative to the various environmental and social factors, or in balancing economic, social and environmental factors".* This is an inappropriate criticism of the IO method, since it does not pretend to do this.

- IO analysis does not depend on the assumption *"that there is a ghost pool of highly skilled yet unemployed people"* in a region as suggested in the Warkworth Judgement. It allows for labour to come from within or outside the region.

Latest Use of IO Analysis

- BAEconomics (2014) in its Economic Impact Assessment for Warkworth Continuation 2014 and Mt Thorley Operations 2014 justifies the use of IO analysis to estimate economic activity associated with the Project.

- Dr Brian Fisher, the Managing Director of BAEconomics is a highly respected resource economist who previously held the positions of Executive Director of the Australian Bureau of Agricultural and Resource Economics (ABARE) and Associate Commissioner of the Productivity Commission. He received an Order of Australia in the Queen's Birthday Honours List in 2007.

ATTACHMENT 5 – UNDERLYING ASSUMPTIONS AND INTERPRETATIONS OF INPUT-OUTPUT ANALYSIS AND MULTIPLIERS

1. "The *basic assumptions* in IO analysis include the following:

   - there is a fixed input structure in each industry, described by fixed technological coefficients (evidence from comparisons between IO tables for the same country over time have indicated that material input requirements tend to be stable and change but slowly; however, requirements for primary factors of production, that is labour and capital, are probably less constant);
   - all products of an industry are identical or are made in fixed proportions to each other;
   - each industry exhibits constant returns to scale in production;
   - unlimited labour and capital are available at fixed prices; that is, any change in the demand for productive factors will not induce any change in their cost (in reality, constraints such as limited skilled labour or investment funds lead to competition for resources among industries, which in turn raises the prices of these scarce factors of production and of industry output generally in the face of strong demand); and
   - there are no other constraints, such as the balance of payments or the actions of government, on the response of each industry to a stimulus.

2. The multipliers therefore describe *average effects, not marginal effects*, and thus do not take account of economies of scale, unused capacity or technological change. Generally, average effects are expected to be higher than the marginal effects.

3. The IO tables underlying multiplier analysis only take account of one form of *interdependence,* namely the sales and purchase links between industries. Other interdependence such as collective competition for factors of production, changes in commodity prices which induce producers and consumers to alter the mix of their purchases and other constraints which operate on the economy as a whole are not generally taken into account.

4. The combination of the assumptions used and the excluded interdependence means that IO multipliers are higher than would realistically be the case. In other words, they tend to *overstate* the potential impact of final demand stimulus. The overstatement is potentially more serious when large changes in demand and production are considered.

5. The multipliers also do not account for some important pre-existing conditions. This is especially true of Type II multipliers, in which employment generated and income earned induce further increases in demand. The implicit assumption is that those taken into employment were previously unemployed and were previously consuming nothing. In reality, however, not all 'new' employment would be drawn from the ranks of the unemployed; and to the extent that it was, those previously unemployed would presumably have consumed out of income support measures and personal savings. Employment, output and income responses are therefore overstated by the multipliers for these additional reasons.

6. The most *appropriate interpretation* of multipliers is that they provide a relative measure (to be compared with other industries) of the interdependence between one industry and the rest of the economy which arises solely from purchases and sales of industry output based on estimates of transactions occurring over a (recent) historical period. Progressive departure from these conditions would progressively reduce the precision of multipliers as predictive device" (ABS 1995, p.24).

Multipliers indicate the total impact of changes in demand for the output of any one industry on all industries in an economy (ABS, 1995). Conventional output, employment, value-added and income multipliers show the output, employment, value-added and income responses to an initial output stimulus (Jensen and West, 1986).

Components of the conventional output multiplier are as follows:

Initial effect - which is the initial output stimulus, usually a $1 change in output from a particular industry (Powell and Chalmers, 1995; ABS, 1995).

First round effects - the amount of output from all intermediate sectors of the economy required to produce the initial $1 change in output from the particular industry (Powell and Chalmers, 1995; ABS, 1995).

Industrial support effects - the subsequent or induced extra output from intermediate sectors arising from the first round effects (Powell and Chalmers, 1995; ABS, 1995).

Production induced effects - the sum of the first round effects and industrial support effects (i.e. the total amount of output from all industries in the economy required to produce the initial $1 change in output) (Powell and Chalmers, 1995; ABS, 1995).

Consumption induced effects - the spending by households of the extra income they derive from the production of the extra $1 of output and production induced effects. This spending in turn generates further production by industries (Powell and Chalmers, 1995; ABS, 1995).

The *simple multiplier* is the initial effect plus the production induced effects.

The *total multiplier* is the sum of the initial effect plus the production-induced effect and consumption-induced effect.

Conventional employment, value-added and income multipliers have similar components to the output multiplier, however, through conversion using the respective coefficients show the employment, value-added and income responses to an initial output stimulus (Jensen and West, 1986).

For employment, value-added and income, it is also possible to derive relationships between the initial or own sector effect and flow-on effects. For example, the flow-on income effects from an initial income effect or the flow-on employment effects from an initial employment effect, etc. These own sector relationships are referred to as ratio multipliers, although they are not technically multipliers because there is no direct line of causation between the elements of the multiplier. For instance, it is not the initial change in income that leads to income flow-on effects, both are the result of an output stimulus (Jensen and West, 1986).

A description of the different ratio multipliers is given below.

$$\text{Type 1A Ratio Multiplier} = \frac{\text{Initial + First Round Effects}}{\text{Initial Effects}}$$

$$\text{Type 1B Ratio Multiplier} = \frac{\text{Initial + Production Induced Effects}}{\text{Initial Effects}}$$

Type 11A Ratio Multiplier = $\frac{\text{Initial + Production Induced + Consumption Induced Effects}}{\text{Initial Effects}}$

Type 11B Ratio Multiplier = $\frac{\text{Flow-on Effects}}{\text{Initial Effects}}$

Source: Centre for Farm Planning and Land Management (1989).

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ATTACHMENT 6 – CBA AND ASSESSMENT OF EXTERNALITIES

Consideration of Externalities in the Economic Assessment

Introduction

- The "perfect" CBA is an ideal. Different situations call for different styles and depths of analysis.
- Valuation of all environmental impacts is neither practical nor necessary.
- In attempting to value impacts, there is the practical principle of materiality. Only those impacts which are likely to have a material bearing on the decision need to be considered in CBA (NSW Government 2012). The guideline gives an example of impacts of less than $1M being immaterial for a project with an estimated net present value of $20M.
- The CBA of the Project took three approaches to the consideration of environmental costs:
  - Threshold value analysis;
  - Qualitative consideration of impacts and valuation of the main impacts based on market data and benefit transfer; and
  - Additional threshold value analysis to recognise that some impacts may not have been fully valued and incorporated into the analysis.

Threshold Value Analysis

- The first approach used to consider the environmental impacts of the Project was the threshold value method.
- Threshold value analysis is a recognised approach to CBA where it is not possible or pragmatic to attempt to value potential external impacts.
- Threshold value analysis was developed by Krutilla and Fisher (1975)[22]. It is specifically referred to as an appropriate approach in the DP&I's (2002) *Draft Guideline for Economic Effects and Evaluation in EIA,* and is a widely recognised approach.
- Threshold value analysis avoids the sometimes contentious matter of physically quantifying environmental impacts and then placing dollar values on them.
- Threshold value analysis leaves the trade-off between quantified economic benefits and unquantified environmental costs for the decision-maker.
- In the Economic Assessment of the Project, the estimated net production benefits provides a threshold value or reference value against which the relative value of the residual environmental, social and cultural impacts of the Project, after mitigation, offset and compensation, may be assessed. The threshold value indicates the price that the community must value any residual environmental impacts of the Project (be willing to pay) to justify in economic efficiency terms the 'no development' option.

[22] Krutilla, J.V. and A.C. Fisher (1975) *The Economics of Natural Environments*, Johns Hopkins University Press, Baltimore.

Qualitative consideration of impacts and valuation of the main impacts based on market data and benefit transfer

- The second approach used was to qualitatively consider, and where possible value, the main environmental, cultural and social impacts of the Project for the well-being of people.

- Qualitative consideration of potential impacts and any subsequent valuation of impacts relied on the assessment of biophysical impacts provided in the Project EIS by technical specialists.

- The approach to valuing environmental impacts in the Economic Assessment of the Project is summarised in Table A6.1.

Table A6.1 – Method for Valuing Environmental Impacts in the Economic Assessment of the Project

Impact	Potential Valuation Method	Comment
Greenhouse gas emissions	Damage cost method	No significant GHG emissions
Noise impacts		
Significant	Property valuation method	Cost of acquiring properties encompasses property value impacts due to noise - but no impacts of the Project and hence no acquisitions required.
Moderate and low	Defensive expenditure	Noise mitigation costs at properties - but no impacts of the Project.
Significant air quality impacts	Property valuation method	Cost of acquiring properties encompasses property value impacts due to air quality impacts. However, no properties impacted by exceedances.
Use of surface water	Market value of water	Cost of Water Access Licences reflects marginal value product of water. However, no surface WALs required.
Use of groundwater	Market value of water	Cost of Water Access Licences reflects marginal value product of water. Cost of acquisitions included in the capital costs of the Project.
Groundwater drawdown	Defensive expenditure	No material impacts on private bores predicted.
Water discharges		Regulated under the Protection of Environment Operations Act 1997.
Ecology	Replacement cost	Costs of offsets have been included in capital costs. Assumes that offsets levels are sufficient to compensate the community for values lost. This is a requirement of Govt. Policy.
Road transport impacts	Defensive expenditure	Cost of road investment required as a result of the Project. However, no material impacts and hence no road investment required.
Aboriginal heritage	Defensive expenditure	Costs of actions to mitigate impacts. However, no material Aboriginal heritage impacts predicted.
Historic heritage	Defensive expenditure Benefit transfer of CM data	Costs of mitigation or values from community willingness to pay studies. However, no historic heritage impacts predicted.
Visual	Defensive expenditure	Costs of mitigation measures. However, no material impacts predicted.

Additional Threshold Value Analysis

- To the extent that there may be some disagreement about the estimated economic values of the environmental impacts of the Project, the estimated net benefits of the Project provides another threshold value that the residual environmental impacts of the Project after mitigation, compensation and offset would need to exceed to make the Project questionable form and economic efficiency perspective. This again allows the decision-maker to consider any material impacts that it identifies in the course of its consideration that were not valued in the Economic Assessment.

ATTACHMENT 7 – THE GRIT SYSTEM FOR GENERATING INPUT-OUTPUT TABLES

The Generation of Regional Input-Output Tables (GRIT) system was designed to:

- combine the benefits of survey based tables (accuracy and understanding of the economic structure) with those of non-survey tables (speed and low cost);
- enable the tables to be compiled from other recently compiled tables;
- allow tables to be constructed for any region for which certain minimum amounts of data were available;
- develop regional tables from national tables using available region-specific data;
- produce tables consistent with the national tables in terms of sector classification and accounting conventions;
- proceed in a number of clearly defined stages; and
- provide for the possibility of ready updates of the tables.

The resultant GRIT procedure has a number of well-defined steps. Of particular significance are those that involve the analyst incorporating region-specific data and information specific to the objectives of the study. The analyst has to be satisfied about the accuracy of the information used for the important sectors; in this case the other mining sector. The method allows the analyst to allocate available research resources to improving the data for those sectors of the economy that are most important for the study.

An important characteristic of GRIT-produced tables relates to their accuracy. In the past, survey-based tables involved gathering data for every cell in the table, thereby building up a table with considerable accuracy. A fundamental principle of the GRIT method is that not all cells in the table are equally important. Some are not important because they are of very small value and, therefore, have no possibility of having a significant effect on the estimates of multipliers and economic impacts. Others are not important because of the lack of linkages that relate to the particular sectors that are being studied. Therefore, the GRIT procedure involves determining those sectors and, in some cases, cells that are of particular significance for the analysis. These represent the main targets for the allocation of research resources in data gathering. For the remainder of the table, the aim is for it to be 'holistically' accurate (Jensen, 1980). This means a generally accurate representation of the economy is provided by the table, but does not guarantee the accuracy of any particular cell. A summary of the steps involved in the GRIT process is shown in Table A7.1 (Powell and Chalmers, 1995).

Table A7.1
The GRIT Method

Phase	Step	Action
PHASE I		ADJUSTMENTS TO NATIONAL TABLE
	1	Selection of national input-output table (106-sector table with direct allocation of all imports, in basic values).
	2	Adjustment of national table for updating.
	3	Adjustment for international trade.
PHASE II		ADJUSTMENTS FOR REGIONAL IMPORTS
		(*Steps 4-14 apply to each region for which input-output tables are required*)
	4	Calculation of 'non-existent' sectors.
	5	Calculation of remaining imports.
PHASE III		DEFINITION OF REGIONAL SECTORS
	6	Insertion of disaggregated superior data.
	7	Aggregation of sectors.
	8	Insertion of aggregated superior data.
PHASE IV		DERIVATION OF PROTOTYPE TRANSACTIONS TABLES
	9	Derivation of transactions values.
	10	Adjustments to complete the prototype tables.
	11	Derivation of inverses and multipliers for prototype tables.
PHASE V		DERIVATION OF FINAL TRANSACTIONS TABLES
	12	Final superior data insertions and other adjustments.
	13	Derivation of final transactions tables.
	14	Derivation of inverses and multipliers for final tables.

Source: Bayne and West (1988).

REFERENCES

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APPENDIX O

REHABILITATION STRATEGY

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

REHABILITATION STRATEGY FOR STOCKTON SAND QUARRY DREDGING, COXS LANE, FULLERTON COVE, NSW

BORAL RESOURCES (NSW) PTY LTD

2 SEPTEMBER 2019
717041
VERSION 1

EXECUTIVE SUMMARY

Introduction and objectives

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Sand Quarry (hereafter referred to as the 'site' or the 'quarry'), a long standing operation that currently extracts sand from the windblown (transgressive) sand dunes of Stockton Bight and transports up to 500,000 tonnes of sand product per year for use in the building, landscaping and construction markets.

Due to current and future demand for sand in the Hunter and Sydney regions, Boral is seeking approval for continued and expanded operations at the site through a State Significant Development (SSD) application. The proposed development (hereafter referred to as the 'Project') involves the progressive extraction of sand from the inland vegetated dunes involving dry extraction by front-end loader/excavator to a depth of 4 metres (m) Australian Height Datum (AHD) in stage 1 with all subsequent stages by wet extraction, dredging to 15 m below sea level (-15 m AHD). The Project would seek to permit a site wide increase on the dispatch limit to 750,000 tpa (i.e. the windblown sand extraction area and the Project operations combined) up until 2028 after which the site wide limit would reduce to no more than 500,000 tpa. The Project would be for a period of 25 years.

The objective of this report is to review the current rehabilitation efforts at the site and to formulate a rehabilitation strategy specific to the Project.

Findings

Environmental Earth Sciences undertook a site inspection on 7 June 2019 to assess the progress of previous rehabilitation completed at the site. While rehabilitation has been generally successful, some areas were identified as having slow regeneration. Species selected for rehabilitation have been largely successful.

Potential Impacts

Potential impacts to the environment are likely to arise through the establishment of the Project, extraction of sand, rehabilitation of disturbed areas and final land use as a freshwater pond, over a period of approximately 25 years.

The following limitations to success of rehabilitation were identified:

- High wind exposure on elevated dunes impacting surface stabilisation;
- Nutrient deficiencies limiting plant establishment;
- Lack of soil moisture limiting plant establishment; and
- Weed invasion has previously impacted rehabilitation areas.

Mitigation, Rehabilitation and Monitoring

Established vegetation beyond the Project area will be retained and undisturbed and act as an informal screen or buffer zone between the Project and property boundaries to ensure minimal disruption to the greater community through visual amenity, noise, dust etc.

A buffer zone of 10 m is proposed along the northern perimeter of the dredge pond, and a 20 m buffer zone, including a 10 m haul road, is proposed to the east, south and south west of the pond. The two-way haul road will provide access for routine rehabilitation / maintenance works, and for safety purposes including access for fire services etc. The buffer zones will require routine management and maintenance throughout the life of the Project.

On completion of the Project, the edges of the dredge pond are proposed to be rehabilitated. The objective of the rehabilitation of the Project once all operations cease is to create a wetland (open pit) / freshwater pond.

Erosion and sediment controls are currently implemented at the quarry and will continue throughout the Project until closure. These measures include:

- Diversion of 'clean' overland flow to the site away from 'dirty' areas;
- Vegetation and maintenance of drainage pathways to minimise erosion and sediment accumulation in flowing water;
- Dust suppression on the existing and proposed haul roads; and
- Maintain the exposed sand surface to a minimum to reduce erosion.

The following types of vegetation cover have been used previously and are proposed for rehabilitation of the Project site:

- Trees:
    - Broad leaved Paperbark (*Melaleuca quinquenervia*);
    - Swamp Mahogany (*Eucalyptus robusta*); and
    - Coastal Banksia (*Banksia integrifolia*).
- Shrubs:
    - Coastal Wattle (*Acacia sophorae*); and
    - Coastal Teatree (*Leptospermum laevigatum*).
- Grasses and groundcovers:
    - Pig Face (*Carpobrotus glaucescens*);
    - Beach Fescue (*Austrofestuca littoralis*); and
    - Beach Spinifex (*Spinifex sericeus*).

- Aquatic plants:
    - Common Spike Rush (*Eleocharis acuta*).

Additional rehabilitation species are presented in Table 3 in the report.

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

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1 INTRODUCTION

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Sand Quarry (hereafter referred to as the 'site' or the 'quarry'), a long standing operation that currently extracts sand from the windblown (transgressive) sand dunes of Stockton Bight and transports up to 500,000 tonnes of sand product per year for use in the building, landscaping and construction markets.

Due to current and future demand for sand in the Hunter and Sydney regions, Boral is seeking approval for continued and expanded operations at the site through a State Significant Development (SSD) application. The proposed development (hereafter referred to as the 'Project') involves the extraction of sand from the inland vegetated dunes by front-end loader/excavator to a depth of 4 metres (m) Australian Height Datum (AHD) and subsequent dredging from 4 m AHD to 15 m below sea level (-15 m AHD).

The Project would seek to permit a site wide increase on the dispatch limit to 750,000 tpa (i.e. the windblown sand extraction area and the Project operations combined) up until 2028 after which the site wide limit would reduce to no more than 500,000 tpa. The Project would be for a period of up to 25 years, subject to demand of sand resources.

After the completion of sand extraction for each area, the Project will require rehabilitation and revegetation. In the initial phases of work, rehabilitation will primarily aim to stabilise the edge of the pond and where necessary to prevent wave action induced erosion at the pond edge. Stabilisation of the pond edge during active sand extraction is to be addressed in the erosion and sediment control plan and is outside the scope of this rehabilitation plan.

On completion, the Project site will be left as a freshwater pond and rehabilitation efforts will generally maintain and manage the pond and the immediate surrounds to minimise the potential for erosion and degradation of areas of exposed soils.

Environmental Earth Sciences was commissioned by Element Environment, on behalf of Boral, to undertake an assessment of the current rehabilitation works and propose a rehabilitation strategy for the Project.

1.1 Objectives

The objective of this report is to review the current rehabilitation efforts at the site and to formulate a rehabilitation strategy specific to the Project.

1.2 Secretary's Environmental Assessment Requirements

This rehabilitation plan addresses the requirements of the Secretary's Environmental Assessment Requirements (SEARs) for land rehabilitation for the project. The SEARs are:

Rehabilitation – including the proposed rehabilitation strategy for the site having regard to the key principles in the Strategic Framework for Mine Closure, including:

- *rehabilitation objectives, methodology, monitoring programs, performance standards and proposed completion criteria;*

- *nominated final land use, having regard to any relevant strategic land use planning or resource management plans or policies; and*
- *the potential for integrating this strategy with any other rehabilitation and/or offset strategies in the region.*

The following Table (**Table 1**) lists the requirements of the SEARs against the locations in the rehabilitation plan.

Table 1: Requirement of the SEARs

SEARs	Location in rehabilitation plan
Rehabilitation objectives	Section 5.1 – Rehabilitation objectives and performance criteria
Rehabilitation methodology	Section 5 – Proposed Rehabilitation Measures
Rehabilitation monitoring programs	Section 5.3 – Rehabilitation Inspection Schedule
Rehabilitation performance standards	Section 4.2 – Rehabilitation Performance Criteria
Proposed completion criteria	Section 5.5 – Proposed Rehabilitation Completion Criteria
Nominated final land use	Section 2.1.4 – Proposed Final Land Use
Integration of rehabilitation strategy	Section 4.2.1 – Integration of Rehabilitation with Previous Works

2 EXISITING ENVIRONMENT

The Stockton Sand Quarry is located in Fullerton Cove, approximately 9.8 kilometres (km) north north-east of the Newcastle Central Business District (CBD), within the Port Stephens Local Government Area (LGA) (**Figure 3**). Access to the site is via Nelson Bay Road and Coxs Lane.

The site owned and operated by Boral covers an approximate area of 246 hectares, comprising of:

- Lot 1 DP 1006399, comprising 234 hectares and located predominantly on the eastern side of Nelson Bay Road;
- Lot 2 DP 1006399 comprising 10.4 hectares and located predominantly on the western side of Nelson Bay Road, with a small portion also positioned on the eastern side of Nelson Bay Road (formerly Part Lot 167, Part Portion 167); and

- Lot 3 DP 664552 comprising 1.619 hectares and located wholly on the eastern side of Nelson Bay Road, and within which the existing depot and weighbridge are located (formerly within Part Lot 3, Part Portion 3).

Under Boral's ownership there have been two primary development consents granted, these include:

- DA 2010/94: The 'inland extraction area' (also known as pits 1 – 6) granted by Port Stephens Council in May 1996; and

- DA 140-6-2005: The 'windblown sand extraction area' (also known as the "windblown project" or pit 7) located on the transgressive dunes adjoining Stockton Beach granted by the Department of Planning in 2006.

The inland extraction operation on the vegetated dunes occurred above 5 metres AHD and ceased in 2008 and rehabilitation has been ongoing. This former extraction area is generally consistent with the Project site and is the focus of this Development Application.

The windblown sand extraction area started operations in 2008 and in accordance with condition 5 of the development consent has a 20 year life, due to cease in 2028.

A site inspection of rehabilitated areas within the Project site identified that the majority had been revegetated with planted trees. Areas of more recent revegetation had established dense vegetation with young trees and shrubs. Where rehabilitation has been less successful, growth of trees and shrubs remains stunted and areas of open sand remain.

The surrounding natural woodland vegetation was identified to consist predominantly of Swamp Mahogany (*Eucalyptus robusta*) and Coastal Wattle (*Acacia sophorae),* with Beach Fescue (*Austrofestuca littoralis)* and Pig Face (*Carpobrotus glaucescens*) in open areas.

The Project site (identified as 'proposed clearance area' in **Figure 3**) contains all areas to be disturbed by Project operations and covers an area of approximately 37 ha.

The Project site is generally consistent with the same disturbance footprint associated with the former inland extraction area approved and rehabilitated under the 1996 development consent, with the exception of areas to east and south east of Lot 3 and along the southern edge to allow for the construction of new haul roads.

2.1 Background

2.1.1 Sand extraction works

Sand from the former inland extraction area was only extracted to 5 m AHD under the original 1996 development consent. The sand resource above 5 m AHD was exhausted in 2007 and in accordance with the conditions of consent the operations have ceased. Progressive rehabilitation has occurred over the life of operations.

The following reports detail the existing and previous rehabilitation and landscape management plans (RLMP) for the site:

- RW Corkery & Co Pty Ltd (2018) *Rehabilitation and Landscape Management Plan for the Stockton Transgressive Dune Quarry*. Prepared for Boral Resources (NSW) Pty Ltd. September 2018.

- Environmental Compliance Services (2017) *Stockton Transgressive Dune Quarry, Rehabilitation and Landscape Management Plan.* Prepared for Boral Resources (Country) Pty Ltd. March 2017

- Environmental Resources Management Australia (ERM, 2010), *Rehabilitation and Landscape Management Plan, Stockton Transgressive Dune Quarry*, Prepared for Boral Resources (NSW) Pty Ltd. August 2010.

Boral currently extracts sand from the transgressive dunes, referred to as the windblown sand extraction area. Sand extraction on the dunes commenced in 2008 in accordance with development consent DA 140-6-2005. The development consent permits transportation of up to 500,000 tpa of sand products over a 20 year period.

The Project is to be undertaken progressively in six stages, commencing with Stage 1. An overview of the extraction staging plan for the Project is presented in **Figure 4**.

Similar to previous operations of the inland extraction area, sand extraction will involve clearing and grubbing of established vegetation from previous rehabilitation and possible screening of accumulated leaf litter and organic matter. Vegetation will be cleared progressively to limit the exposure of bare sand. Cleared vegetation will either be mulched or stockpiled on-site for later reuse in rehabilitation. Similarly, any stripped topsoil would be retained for use in rehabilitation efforts across the site.

Sand will first be removed via a front-end loader which pushes into the exposed sand face. As the sand is relatively free-flowing, material falls towards the front-end loader at the natural angle of repose.

The sand will then be screened and stockpiled before a front-end loader then loads road trucks in-pit with screened raw sand for transport off-site via the weighbridge.

Following initial extraction of sand above the water table to a depth of 4 m AHD in Stage 1, a pond will then be created in stage 2 large enough to float a dredge and accommodate fresh water pumping for the proposed wash plant.

The dredge will move progressively through the extraction area generally following the nominated stages. In most cases, the sand in each extraction stage is fully extracted unless constraints are encountered.

The dredge will move backwards and forwards across the active dredge pond.. The sand / water mix will be pumped directly from the dredge via a pontoon-mounted pipeline to the wash plant in the processing area. The dredge manoeuvres around the pond and its position is stabilised by ‘tie ropes connected to the banks around the active pond.

The dredge will then progressively extract sand in a south westerly direction in a staged process. Extraction will then move to the east and culminate with relocation of the proposed processing and stockpile area to a confined area in Stage 1 and subsequent dredging of the majority of the Stage 1 extraction area (to be known as Stage 6).

Sand will be extracted to a maximum depth of approximately 15 m below the sea level (0 m AHD).

2.1.2 Site hydrogeology

A hydrogeological report completed by Environmental Earth Sciences (2019) details the standing water level rises from approximately 1 m AHD during low rainfall events to 2 m AHD at high rainfall events. Refer to the **Figure 4** and **Figure 5** in the following hydrogeological report:

- Environmental Earth Sciences (2019), *Hydrogeological Impact Assessment*, *Stockton Sand Quarry, Cox's Lane, Fullerton Cove, NSW, Element Environment*, dated April 2019 (reference: 717041_V1).

The Project site consists of an area to be disturbed of approximately 37 hectares. A component of the Project includes sand extraction from to a depth of 15 m below the water table (-15 m AHD).

The site is a groundwater recharge zone, and groundwater in the area is fresh. It is therefore expected that the open water body created from the dredge pond associated with the Project will in time form a freshwater wetland (**Figures 5** and **6**).

2.1.3 Vegetation management

It is proposed that a screen or buffer zone of native trees remains on site between Project site and the quarry property boundaries to ensure minimal disruption to the greater community through visual amenity, noise, dust etc.

A buffer zone of 10 m is proposed along the northern perimeter of the dredge pond and a 20 m buffer zone, including a 10 m haul road, is proposed to the east, south and south west of the pond. The two-way haul road would provide access for routine rehabilitation / maintenance works, and for safety purposes to provide access for fire services etc. The buffer zones will require routine management and maintenance throughout the life of the Project.

2.1.4 Proposed final land use

The proposed final land use of the Project site once all operations cease is to create a wetland (open pit) / freshwater pond surrounded by retained coastal woodland established with endemic species.

The edges of the pond would be adequately stabilised and revegetated with suitable groundcover species to minimise the potential for soil erosion.

Conceptual cross sections are provided in **Figure 5** (north to south) and **Figure 6** (south west to north east) and present approximate schematic drawings of the site following the completion of excavation works.

3 ASSESSMENT OF REHABILITATION WORKS

3.1 Site inspection of rehabilitated areas

Environmental Earth Sciences conducted a site inspection on 7 June 2019 to assess the status of rehabilitation works in the previous inland extraction area. The inspection aimed to assess the efficiency of rehabilitation strategies used to date, with consideration of time since rehabilitation and any localised site conditions which may have influenced vegetation establishment. The findings of the inspection were then used to inform recommendations for rehabilitation of the Project site.

3.1.1 Site observations

Rehabilitation activities have generally been successful at the quarry to date. The degree of vegetation establishment largely depends on the duration since sand extraction activities ceased, with the former Pit 1, 2 and 3 areas of the inland extraction area having well established tree cover, while Pits 4, 5 and 6 of the inland extraction area had smaller trees and shrubs. The following observations were made at the time of the site inspection:

- The successful species in rehabilitated areas consisted predominantly of:
    - Trees – Swamp Mahogany (*Eucalyptus robusta*);
    - Shrubs – Coastal Wattle (*Acacia sophorae*);
    - Grasses – Beach Fescue (*Austrofestuca littoralis*); and
    - Ground cover – Pig Face (*Carpobrotus glaucescens*).
- Poor vegetation establishment has occurred in some areas. This has been attributed to:
    - Areas exposed to high winds which disturb surface soil, particularly on elevated slopes;
    - Areas where nutrient deficiency limits plant growth – this has been observed due to utilisation of coal by-product (chitta) for construction of the haul road resulting in depletion the landscape of nitrogen and other nutrients. Areas of ‘pure’ sand are also subject to nutritional deficiencies; and
    - Limited water availability, observed on high exposed dunes, and potentially the cause of poor vegetation establishment over former haul roads due to soil compaction.

- Environmental Earth Sciences was advised by Boral that weed management has progressed from blanket treatment and now focuses on physical removal of re-grown weeds. The noxious weed Bitou bush was not observed during the site inspection.

A summary of the inspected areas is presented in **Table 2** below. Photographs are presented in Appendix 1.

Table 2: Rehabilitation areas summary

Rehabilitation area Proposed (former)	Observations
Stage 1 | Stage 6 (Pit 3)	Photograph 1. Successful revegetation across a large portion of the area, establishment of a variety of tree species and grass understory. Photograph 2. Small area of exposed sand east of haul road. Poor establishment due to windblown sand.
Stage 2 (Pit 6)	Photographs 3 & 4. Areas of poor tree establishment and patchy soil cover. Windblown sand. Rehabilitation more recent in this area.
Stage 3 / 4 (Pit 4)	Photograph 5. Large areas of successful revegetation with young trees and dense shrubs. Photographs 6 & 7. Successful revegetation across the majority of the area. Patchy regrowth in some areas, particularly along a former haul road – attributed to nitrogen deficiency related to use of coal by-product for road construction.
Stage 5 (Pit 2)	Photograph 8. Established trees with shrub understory. Leaf litter layer on ground surface. Photograph 9. Patchy understory and lack of soil cover in small areas within Stage 5.

4 REHABILITATION MANAGEMENT PLAN

4.1 Review of rehabilitation methodology

Based on the findings of the rehabilitation review, and the rehabilitation requirements of the Project, the following recommendations have been made:

- Aspects of the existing rehabilitation process that are considered successful and should continue:
    - Species selection has facilitated establishment of a diverse and robust ecological environment which is representative of local native vegetation; and
    - Weed management has been successful in removing targeted species and preventing infestation.

- Aspects of the existing rehabilitation process that could be improved for future works:
    - Areas subject to high winds, such as elevated dunes, require additional stabilisation to allow vegetation establishment. These areas may also require use of more robust species, such as spinifex to stabilise soil;
    - Areas subject to compaction and heavy impact, such as haul roads, may require deep ripping prior to rehabilitation to improve soil water availability and allow root penetration of soil; and
    - Targeted application of suitable fertilizer, and/or use of nitrogen fixing plant species may improve plant establishment in some areas.
- Aspects where the intended final landform will change the rehabilitation requirements:
    - The final landform is dominated by the dredge pond/s, which will require bank stabilisation;
    - Suitable aquatic species may be required for revegetation within the aquatic zone; and
    - Species selection should facilitate development of understorey vegetation adjacent to retained coastal woodland community, with low ongoing maintenance.

To assist in the preparation of the rehabilitation strategy for the Project, the following guideline has been referred to:

- NSW Department of Trade and Investment (ESG3) *Mining Operations Plan (MOP) Guidelines*, September 2013.

4.2 Rehabilitation performance criteria

The performance criteria for the rehabilitation of the final post sand extraction landform are:

- Stabilisation of the disturbed areas with re-established coverage of endemic species of vegetation; and
- Have a Landscape Function Analysis (LFA) level of natural regeneration greater than 50% of the previously assessed Natural Bushland Control site, located within the quarry property.

4.2.1 Integration of rehabilitation with previous works

The post-quarrying landscapes associated with the previous stages of the Stockton Sand Quarry have been rehabilitated according to their respective rehabilitation plan (ERM 2010b). These rehabilitation works have been assessed and reviewed (Sections 3 and 4 of this report). While the rehabilitation of these areas has been largely successful, some aspects of the rehabilitation indicate areas where improvements and efficiencies can be made. These findings have been incorporated into the development of this rehabilitation strategy.

This rehabilitation strategy therefore aims to integrate the successful aspects of the previous strategies in the ongoing works. This will also provide the benefit of consistency in approach for site operators, consistent use of rehabilitation species, and continuity for site suppliers.

5 PROPOSED REHABILITATION MEASURES

The proposed final land use of the Project site once all operations cease is to create a wetland (open pit) / freshwater pond. The rehabilitation option proposed for the final landform will return the site to a passive environment, whilst maximising the potential for re-equilibration with the surrounding environment (flora and fauna).

To ensure that all rehabilitation (mitigation) measures are sufficiently financed, Boral are currently securing funds for the closure of the site which includes all costs for the final rehabilitation, as well as mitigation measures during works.

The following table (**Table 3**) sets out a summary and timeline for mitigation, rehabilitation, monitoring and maintenance works for the Project site.

Table 3: Proposed rehabilitation and management timeline

Site section	Mitigation/ Rehabilitation measure	Timeframe
Entire site	Topographical survey of current landform levels to inform rehabilitation, vegetation and monitoring.	Prior to site establishment.
Site periphery	Maintain buffer zone of trees to provide a screen between site activities and the site boundaries	Ongoing
	Monitor buffer zone to ensure the screen remains intact and sufficient to provide screening function for operations.	During sand extraction and ongoing
	Removal of undesirable weed species and vegetation not consistent with the local vegetative succession.	Ongoing maintenance
	Revegetation of any disturbed areas by way of selective planting with species native to the locality	Ongoing
Dredge pond / excavation pit	Vegetate dredge pond / excavation pit embankments with native low growing shrubs and grasses to provide bank stability and reduce erosion (including water tolerant and salt tolerant species).	Stabilisation during sand extraction and revegetation at conclusion of site operations in each stage
	Monitor dredge pond / excavation pit embankments to ensure the area remains intact and sufficient for operations.	During sand extraction
	Encouragement of natural reafforestation through weed control and reduction.	Ongoing maintenance
Final Landform Option: Wetland / freshwater pond		
Wetland (open pit) / freshwater pond	Conversion of the dredge pond to a wetland (open pit) / freshwater pond.	At conclusion of Stage 6.

Site section	Mitigation/ Rehabilitation measure	Timeframe
	Revegetate excavation pit embankment with native water plant species (including water tolerant and salt tolerant species).	At conclusion of site operations in each stage.
	Encouragement of natural reafforestation through weed control and reduction.	At conclusion of site operations in each stage. Ongoing maintenance

5.1 Rehabilitation objectives and performance criteria

The objective of the post-quarrying rehabilitation process is to:

- develop a stable post-quarry landscape, where erosion is controlled and minimised; and
- a vegetation community is established which reflects the endemic ecology of the region and minimises the potential for weed invasion or vegetation community collapse.

The performance criteria for the rehabilitation of the final post sand extraction landform are:

- Stabilisation of the disturbed areas with re-established coverage of endemic species of vegetation; and
- Have a Landscape Function Analysis (LFA) level of natural regeneration greater than 50% of the previously assessed Natural Bushland Control site, located within the quarry property.

5.2 Rehabilitation process

The following steps are proposed to be implemented for progressive rehabilitation of the site, being:

5.2.1 Development of final landform following completion of dredge activities

The final landform should consider:

- the proposed post quarry land use;
- slope steepness and slope length to facilitate erosion control and establishment of slope stability;
- site drainage;
- requirement for soil preparation (i.e. deep ripping haul road corridors); and
- development to of a ‘natural’ contour profile.

5.2.2 Species selection for landscape position

Within the Project site, species selection should consider landscape position in relation to either the wetland or beach dune vegetation zones (**Figures 1 and 2**). The beach dune vegetation zones are specifically relevant to high exposed dunes, where wind impacts soil stabilisation.

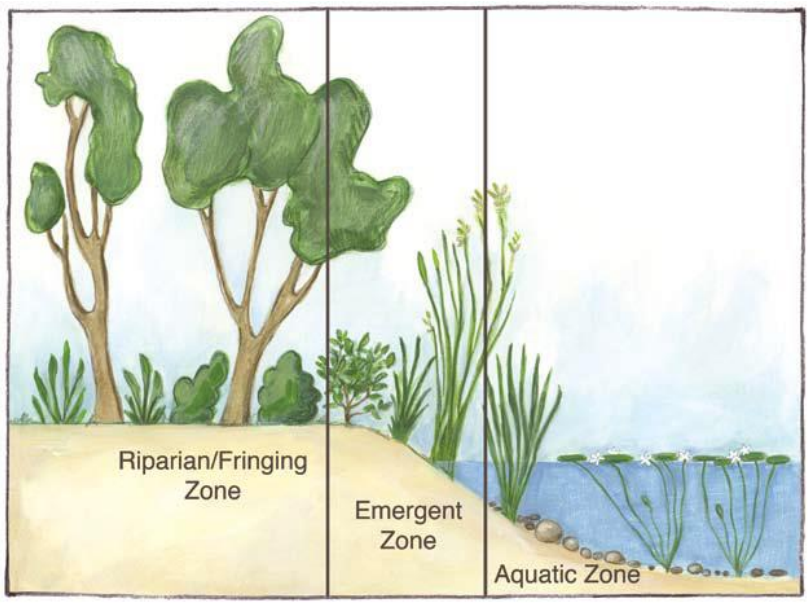

Figure 1: Identification of wetland vegetation zones (Australian Government 2008)

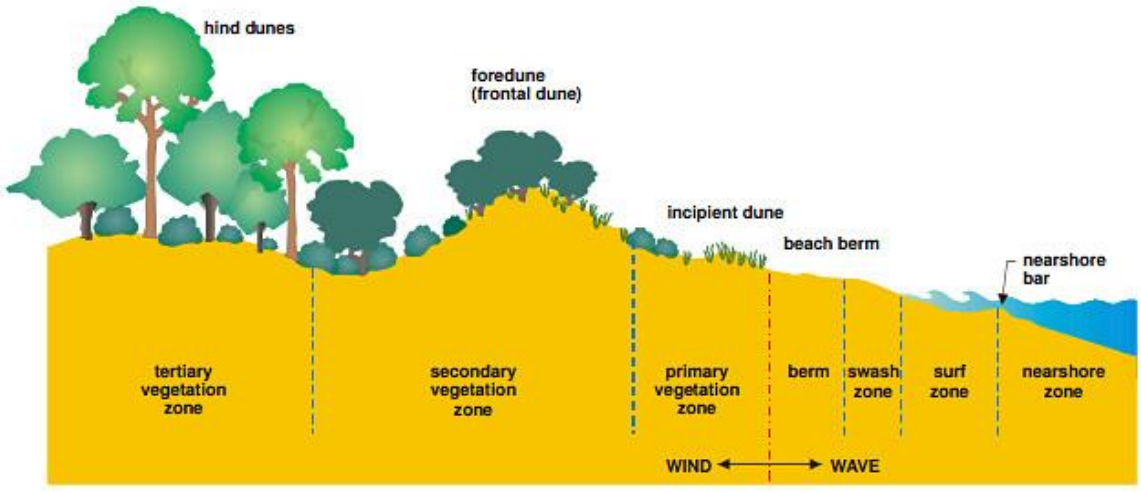

Figure 2: Identification of beach dune vegetation zones (NSW Department of Land and Water Conservation 2001)

A summary of suitable revegetation species is presented in **Table 4**. Note that the list provides a wide range of potential species for use. Use of all species listed is not required.

Table 4: Revegetation species

Species	Vegetation class	Vegetation zone	Suitability notes
Broad leaved Paperbark (*Melaleuca quinquenervia*)	Tree	Riparian Zone Emergent Zone Hind Dune	Grows in swampy conditions and can regenerate within weeks of a bushfire. Successful previous use on site.
Swamp Mahogany (*Eucalyptus robusta*)	Tree	Riparian Zone Hind Dune	Grows in swampy sandy conditions and is tolerant of waterlogging. Successful previous use on site.
Smooth-barked Apple (*Angophora costata*)	Tree	Hind Dune	Large tree, suitable for elevated, but not exposed locations.
Blackbutt (*Eucalyptus pilularis*)	Tree	Riparian Zone Hind Dune	Large tree common in grassy coastal forests.
Red bloodwood (*Corymbia gummifera*)	Tree	Riparian Zone Hind Dune	Common to coastal flats and low hills. Tolerant of poorer, sandy soils.
Coastal Wattle (*Acacia sophorae*)	Shrub	Riparian Zone Hind Dune Foredune	Has the capacity to capture wind blown sands resulting in the formation of hummocks. Beneficial for wind blown and exposed areas. Nitrogen fixing species. Successful previous use on site. Wattles may have relatively short lifespan.
Sydney Golden wattle (*Acacia longifolia*)	Shrub	Riparian Zone Hind Dune Foredune	Has the capacity to capture wind blown sands resulting in the formation of hummocks. Beneficial for wind blown and exposed areas. Nitrogen fixing species. Subspecies of Coastal wattle. Wattles may have relatively short lifespan.

Species	Vegetation class	Vegetation zone	Suitability notes
Sweet wattle (*Acacia suaveolens*)	Shrub	Riparian Zone Hind Dune Foredune	Has the capacity to capture wind blown sands resulting in the formation of hummocks. Beneficial for wind blown and exposed areas. Nitrogen fixing species. Wattles may have relatively short lifespan.
Coastal Teatree (*Leptospermum laevigatum*)	Shrub	Hind Dune Foredune	Salt and drought tolerant. Successful previous use on site.
Coastal Banksia (*Banksia integrifolia*)	Shrub	Hind Dune Foredune	Thrives in sandy conditions and suitable for the stabilisation of sand and enables the solubilisation of nutrients. Successful previous use on site.
Old Man Banksia (*Banksia serrata*)	Shrub	Hind Dune Foredune	Thrives in sandy conditions and suitable for the stabilisation of sand and enables the solubilisation of nutrients.
Tree Broom Heath (*Monotoca elliptica*)	Shrub	Hind Dune Foredune	Long lived and hardy dune species. May be difficult to propagate from seeds – cuttings may perform better.
Common Bush Hop (*Dodonaea triquetra*)	Shrub	Riparian Zone Hind Dune	Forest understory.
Pig Face (*Carpobrotus glaucescens*)	Ground cover	Hind Dune Foredune Exposed dune	Has the capacity to capture wind blown sands resulting in the formation of hummocks. Beneficial for wind blown and exposed areas. Successful previous use on site.
Beach Fescue (*Austrofestuca littoralis*)	Grass	Hind Dune Foredune Exposed dune	Endemic beach grass species. Successful previous use on site.
Blue Flax Lily (*Dianella caerulea*)	Understory	Riparian Zone Hind Dune Foredune	Hardy and long-lived. Tolerant of a range of moisture conditions.
Kangaroo Grass (*Themeda australis*)	Grass	Foredune, Exposed dune	Widespread native grass, tolerant of a range of conditions.

Species	Vegetation class	Vegetation zone	Suitability notes
Bracken Fern (*Pteridium esculentum*)	Understory	Hind Dune Foredune Exposed dune	Quick to colonise disturbed areas. Common in coastal woodlands. May be invasive.
Spiny Headed Mat-Rush (*Lomandra longifolia*)	Rush	Emergent Zone Riparian Zone	Tolerant of wet and drought conditions.
Cogon Grass (*Imperata cylindrica*)	Grass	Foredune Exposed dune	Tolerant grass used for ground cover and erosion control. May be invasive and difficult to control. Highly flammable.
Beach Spinifex (*Spinifex sericeus*)	Grass	Exposed dune	Deep roots to stabilise sand and prevent moisture loss. Recommended for locations where establishment of other vegetation has proven unsuccessful. Successful previous use on site.
Common Spike Rush (*Eleocharis acuta*)	Rush	Aquatic/emergent zone	Shallow water freshwater wetland rush.

Note(s):

1. Information regarding collection of seed and runners, germination and planting, fertilisation and watering are provided in the Stockton Transgressive Dune Quarry Rehabilitation and Landscape Management Plan (2010).

5.2.3 Stabilisation and revegetation of disturbed areas

It is recommended that the existing Rehabilitation and Landscape Management Plan, Stockton Transgressive Dune Quarry (ERM, 2010) is updated for the Project.

The updated management plan will address:

- the landscape units within each rehabilitation area;
- species and numbers of plants required for each rehabilitation area;
- site preparation requirements – including earthworks and deep ripping;
- soil stabilisation, erosion control and plant protection requirements for each stabilisation area;
- fertilizer requirements; and
- watering and maintenance requirements until plants are established.

Species selection for each area should also address species diversity and succession over time. While some species, such as wattles, may perform well in the short term, they may result in a monoculture which inhibits establishment of other species. Wattles are also relatively short lived and may die out and create a bushfire hazard.

5.2.4 Pest and weed management

Regular inspections should be conducted to assess the presence of pests and weeds. Bitou Bush has previously been a problem at the quarry, however recent management strategies have substantially reduced occurrence. Manual removal has been successful in maintaining control over populations at the quarry. Targeted spraying or removal may be required during the Project.

Potential for animal or insect pest infestation should be monitored and managed as required.

5.3 Rehabilitation inspection schedule

The rehabilitation process should involve regular inspections to monitor the progress of rehabilitation activities, and proactively identify any problems with the remediation process. Monthly and annual inspections are recommended.

5.3.1 Monthly site monitoring

Monthly monitoring of areas relevant to site rehabilitation should continue, as outlined in **Table 5**. Monitoring will focus on identification of any issues relating to plant health or establishment to allow resolution.

Table 5: Monthly monitoring areas

Area	Monitoring requirement
General site	Occurrence of weeds or pests. General health of vegetation.
Trial plantings / Rehabilitation areas	Occurrence of weeds or pests. Health and growth of plants.
Established revegetation areas	Occurrence of weeds or pests. Health and growth of plants. Extent of vegetation cover. Suitability of plant stock for seed or runner collection.

5.3.2 Annual site inspection

An independent inspection of the rehabilitation process should be conducted by a suitably experienced ecologist or environmental restoration consultant. It is recommended that a series of indicator sites are monitored to assess the progress of revegetation, with photographs taken to record site condition. The inspection should assess the site for

compliance with the performance criteria, particularly the 50% LFA target. The inspection should also assess occurrence of any weed species that may be present to facilitate management.

5.3.3 Long term monitoring

It is anticipated that the management and monitoring of the rehabilitation process may extend to a period of up to 10 years from the commencement of rehabilitation of each section of the project area. The point of commencement is considered to be the site preparation and initial planting of those areas. The success of initial site preparation and vegetation establishment is likely to significantly reduce the management requirements for each area over time.

The duration of short to medium term management and monitoring period is estimated to require 1-5 years. This stage involves ensuring landscape stabilisation, vegetation establishment, erosion control and weed management.

If the short to medium term rehabilitation works are successful, monitoring can be substantially reduced over the long term. For the period between 5 and 10 years post rehabilitation monitoring frequency may be reduced. During this period the monitoring would focus on weed management, and species diversity and succession.

Annual site inspections by an ecologist should be maintained for 10 years post rehabilitation, or until the ecologist and administering authority advise that they are no longer required.

5.4 Management and control measures

Erosion and sediment controls are to be implemented and maintained as required through the Project lifespan and until rehabilitated areas have adequately established.

Mechanisms for the control of surface water movement are required and include the following:

- Diversion of ‘clean’ overland flow to the Project site away from ‘dirty’ areas;
- Vegetation and maintenance of drainage pathways to minimise erosion and sediment accumulation in flowing water;
- Corrective actions, relating specifically to:
    - maintaining, repairing and cleaning out sediment control structures in order to maintain compliance with the erosion and sediment control plan for the project (i.e. vegetated bund); and
    - repairing eroded areas.

Dust suppression methods are to be used on the existing and proposed haul roads for the Project and with the exception of Stage 1, progressive sand extraction within Stages 2 to 5 will seek to limit exposed ground surfaces to a maximum of 200 - 300 m at any one time to ensure that resource is not lost through exposure to prevailing winds.

5.5 Proposed rehabilitation completion criteria

The completion of the rehabilitation process will be assessed against the performance criteria for the rehabilitation of the final post sand extraction landform. The performance criteria are:

- Stabilisation of the disturbed areas with re-established coverage of endemic species of vegetation; and
- Have a Landscape Function Analysis (LFA) level of natural regeneration greater than 50% of the previously assessed Natural Bushland Control site, located within the quarry property.

The rehabilitation criteria will be deemed to be complete when the criteria have been met, and vegetation communities are mature and stable. It is anticipated that this may occur between 5 and 10 years post rehabilitation for each project area. This will be assessed by the ecologist or environmental restoration consultant completing the annual inspections, who may then provide recommendation that ongoing inspections are no longer required.

6 CONCLUSION

Boral is seeking approval for continued and expanded operations at the Stockton Sand Quarry through a State Significant Development (SSD) application. The Project involves the extraction of sand from the inland vegetated dunes by front-end loader/excavator to a depth of 4 m AHD and subsequent dredging from 4 m AHD to 15 m below sea level (-15 m AHD).

The Project would seek to permit a site wide increase on the dispatch limit to 750,000 tpa (i.e. the windblown sand extraction area and the Project operations combined) up until 2028 after which the site wide limit would reduce to no more than 500,000 tpa.

The Project would be for a period of up to 25 years. Environmental Earth Sciences carried out a site inspection at the quarry on 7 June 2019 to assess the progress of previous rehabilitation efforts at the site. While rehabilitation has been generally successful, the following limitations to success of rehabilitation were identified:

- High wind exposure on elevated dunes impacting surface stabilisation;
- Nutrient deficiencies limiting plant establishment;
- Lack of soil moisture limiting plant establishment; and
- Weed invasion has previously limited establishment of target species.

Potential impacts to the environment are likely to arise through the establishment of the Project, extraction of sand, rehabilitation of the Project site and final land use as a freshwater pond, over a period of approximately 25 years.

Mitigation measures will include:

- a screen or buffer zone of native trees between site activities and the site boundaries
- encouragement of natural reafforestation through weed control and reduction.

The proposed final land use of the Project site once all operations cease is to create a wetland (open pit) / freshwater pond surrounded by retained coastal woodland, established with endemic species.

The edges of the pond would be adequately stabilised and revegetated with suitable groundcover species to minimise the potential for soil erosion.

7 LIMITATIONS

This report has been prepared by Environmental Earth Sciences NSW ACN 109 404 006 in response to and subject to the following limitations:

1. The specific instructions received from Element Environment;
2. The specific scope of works set out in PO717059 issued by Environmental Earth Sciences for and on behalf of Element Environment, is included in Section 1.1 (Objectives and Scope) of this report;
3. May not be relied upon by any third party not named in this report for any purpose except with the prior written consent of Environmental Earth Sciences NSW (which consent may or may not be given at the discretion of Environmental Earth Sciences NSW);
4. This report comprises the formal report, documentation sections, tables, figures and appendices as referred to in the index to this report and must not be released to any third party or copied in part without all the material included in this report for any reason;
5. The report only relates to the site referred to in the scope of works being located at Stockton Boral Quarry, Fullerton Cove, NSW (“the site”);
6. The report relates to the site as at the date of the report as conditions may change thereafter due to natural processes and/or site activities;
7. No warranty or guarantee is made in regard to any other use than as specified in the scope of works and only applies to the depth tested and reported in this report;
8. Fill, soil, groundwater and rock to the depth tested on the site may be fit for the use specified in this report. Unless it is expressly stated in this report, the fill, soil and/or rock may not be suitable for classification as clean fill, excavated natural material (ENM) or virgin excavated natural material (VENM) if deposited off site;
9. This report is not a geotechnical or planning report suitable for planning or zoning purposes; and
10. Our General Limitations set out at the back of the body of this report.

8 REFERENCES

Australian Government (2008) Wetland Rehabilitation Guidelines for the Great Barrier Reef catchment. Queensland Wetlands Program.

Environmental Compliance Services (2017) Stockton Transgressive Dune Quarry, Rehabilitation and Landscape Management Plan. Prepared for Boral Resources (Country) Pty Ltd. March 2017

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NSW Department of Trade and Investment (ESG3) Mining Operations Plan (MOP) Guidelines, dated September 2013.

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RW Corkery & Co Pty Ltd (2018) Rehabilitation and Landscape Management Plan for the Stockton Transgressive Dune Quarry. Prepared for Boral Resources (NSW) Pty Ltd. September 2018.

Stehn C1 (2015) A guide to species selection for revegetation projects in the Coffs Harbour Local Government Area, Coffs Harbour City Council, Coffs Harbour, New South Wales, Australia, unpublished draft report.

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

ENVIRONMENTAL EARTH SCIENCES GENERAL LIMITATIONS

Scope of services
The work presented in this report is Environmental Earth Sciences response to the specific scope of works requested by, planned with and approved by the client. It cannot be relied on by any other third party for any purpose except with our prior written consent. Client may distribute this report to other parties and in doing so warrants that the report is suitable for the purpose it was intended for. However, any party wishing to rely on this report should contact us to determine the suitability of this report for their specific purpose.

Data should not be separated from the report
A report is provided inclusive of all documentation sections, limitations, tables, figures and appendices and should not be provided or copied in part without all supporting documentation for any reason, because misinterpretation may occur.

Subsurface conditions change
Understanding an environmental study will reduce exposure to the risk of the presence of contaminated soil and or groundwater. However, contaminants may be present in areas that were not investigated, or may migrate to other areas. Analysis cannot cover every type of contaminant that could possibly be present. When combined with field observations, field measurements and professional judgement, this approach increases the probability of identifying contaminated soil and or groundwater. Under no circumstances can it be considered that these findings represent the actual condition of the site at all points.

Environmental studies identify actual sub-surface conditions only at those points where samples are taken, when they are taken. Actual conditions between sampling locations differ from those inferred because no professional, no matter how qualified, and no sub-surface exploration program, no matter how comprehensive, can reveal what is hidden below the ground surface. The actual interface between materials may be far more gradual or abrupt than an assessment indicates. Actual conditions in areas not sampled may differ from that predicted. Nothing can be done to prevent the unanticipated. However, steps can be taken to help minimize the impact. For this reason, site owners should retain our services.

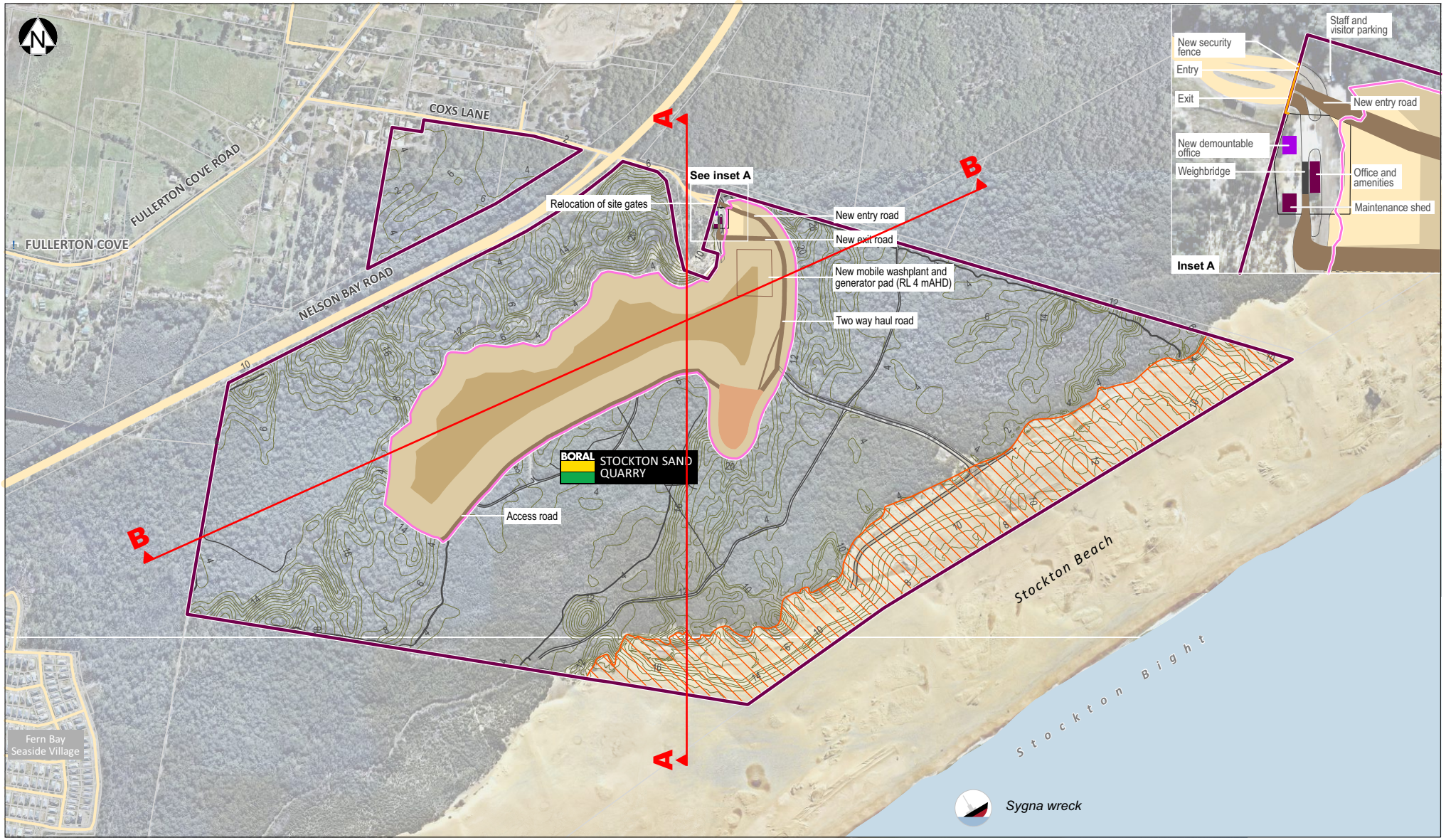
Problems with interpretation by others
Advice and interpretation is provided on the basis that subsequent work will be undertaken by Environmental Earth Sciences NSW. This will identify variances, maintain consistency in how data is interpreted, conduct additional tests that may be necessary and recommend solutions to problems encountered on site. Other parties may misinterpret our work and we cannot be responsible for how the information in this report is used. If further data is collected or comes to light we reserve the right to alter their conclusions.

Obtain regulatory approval
The investigation and remediation of contaminated sites is a field in which legislation and interpretation of legislation is changing rapidly. Our interpretation of the investigation findings should not be taken to be that of any other party. When approval from a statutory authority is required for a project, that approval should be directly sought by the client.

Limit of liability
This study has been carried out to a particular scope of works at a specified site and should not be used for any other purpose. This report is provided on the condition that Environmental Earth Sciences NSW disclaims all liability to any person or entity other than the client in respect of anything done or omitted to be done and of the consequence of anything done or omitted to be done by any such person in reliance, whether in whole or in part, on the contents of this report. Furthermore, Environmental Earth Sciences NSW disclaims all liability in respect of anything done or omitted to be done and of the consequence of anything done or omitted to be done by the client, or any such person in reliance, whether in whole or any part of the contents of this report of all matters not stated in the brief outlined in Environmental Earth Sciences NSW's proposal number and according to Environmental Earth Sciences general terms and conditions and special terms and conditions for contaminated sites.

To the maximum extent permitted by law, we exclude all liability of whatever nature, whether in contract, tort or otherwise, for the acts, omissions or default, whether negligent or otherwise for any loss or damage whatsoever that may arise in any way in connection with the supply of services. Under circumstances where liability cannot be excluded, such liability is limited to the value of the purchased service.

FIGURES



Source: Element Environment

Stockton Sand Quarry boundary
Current windblown sand extraction area
Contour (mAHD)
Access tracks
Cross section location (refer Figures 3 and 4)

Project features

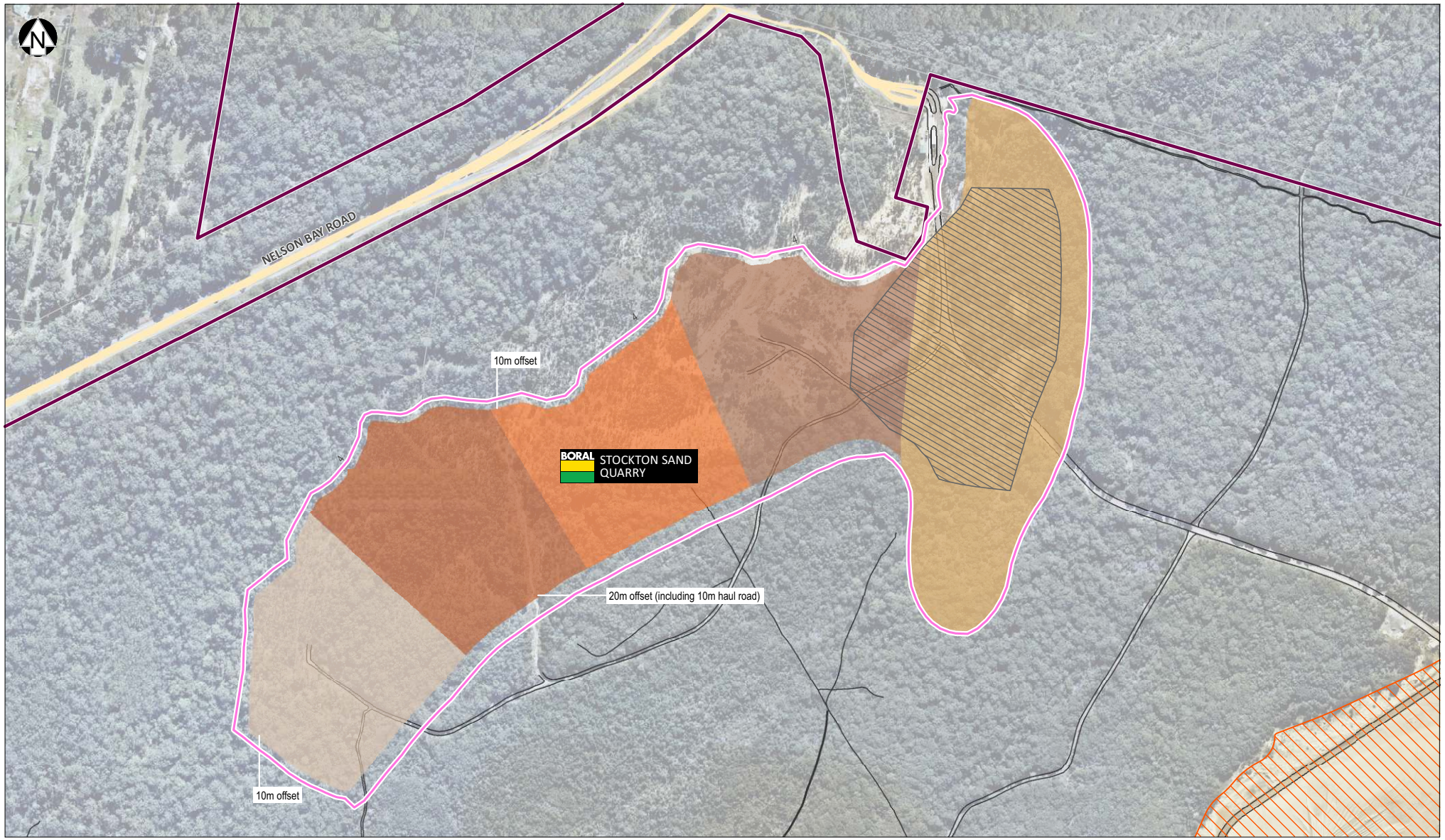
Proposed clearance area
Access road
Extraction base (RL -15 mAHD)
Batter
Pad base (RL 4 mAHD)

0 100 200 300 400 500
Scale in Metres

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Title:	**Project Layout**
Location:	**Nelson Bay Road, Fullerton Cove, NSW**
Client: **Boral Quarries**	Job No: **717041**
Project Man: **LL/AS**	Scale: **As shown**
Drawn By: **LB**	Date: **July 2019**

Figure 1



Source: Element Environment

Stockton Sand Quarry boundary
Current windblown sand extraction area
Proposed clearance area
Access tracks

Extraction staging
Stage 1
Stage 2
Stage 3
Stage 4
Stage 5
Stage 6

0 50 100 150 200 250
Scale in Metres

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Title: **Extraction Staging Plan**

Location: **Nelson Bay Road, Fullerton Cove, NSW**

Client: **Boral Quarries**

Job No: **717041**

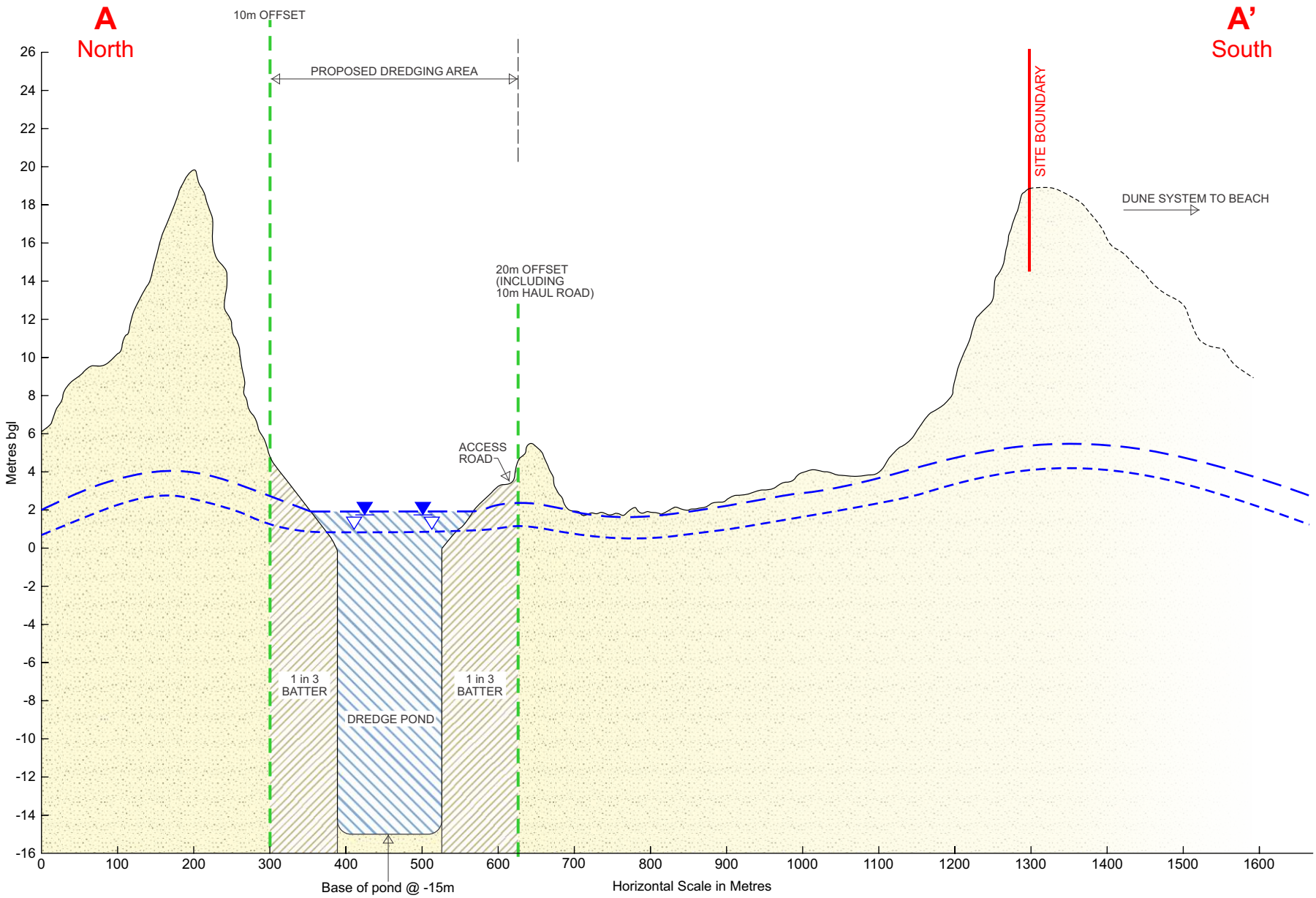
Project Man: **LL/AS**

Scale: **As shown**

Drawn By: **LB**

Date: **July 2019**

Figure 2



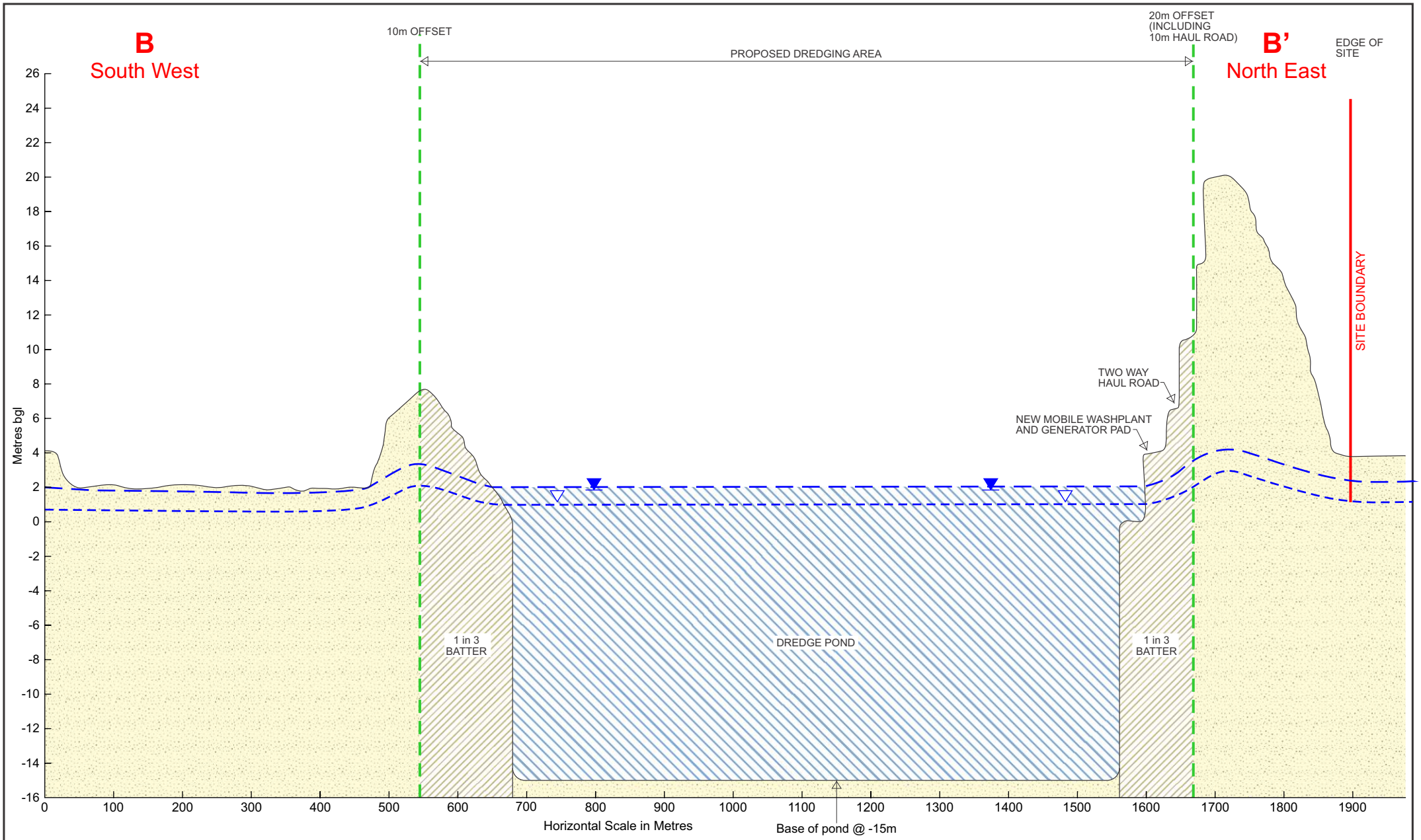
LEGEND:

- WATER LEVEL WITH EXPECTED HIGH RAINFALL
- WATER LEVEL WITH EXPECTED LOW RAINFALL

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Title:	**Conceptual Cross Section A - A'**
Location:	**Nelson Bay Road, Fullerton Cove, NSW**
Client: **Boral Quarries**	Job No: **717041**
Project Man: **LL/AS**	Scale: **As shown**
Drawn By: **LB**	Date: **July 2019**

Figure 3



LEGEND:

- WATER LEVEL WITH EXPECTED HIGH RAINFALL
- WATER LEVEL WITH EXPECTED LOW RAINFALL

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

Title:	**Conceptual Cross Section B - B'**
Location:	**Stockton Sand Quarry Coxs Lane, Fullerton Cove, NSW**
Client: **Boral Quarries**	Job No: **717041**
Project Man: **LL/AS**	Scale: **As shown**
Drawn By: **LB**	Date: **July 2019**

Figure 4

APPENDIX A: PHOTOGRAPH PLATES



1. Successful rehabilitation in Stage 1 / Stage 6



2. Stage 1 / Stage 6 rehabilitation poor surface stabilisation in one small area - east of the haul road.



3. Areas of stunted growth in Stage 1 / Stage 6 and Stage 2



4. Areas of stunted growth in Stage 1 / Stage 6 and Stage 2



5. Successful rehabilitation in remaining areas of Stage 4



6. Northern boundary between Stage 3 and Stage 4



7. Northern boundary between Stage 3 and Stage 4



8. Successful rehabilitation of Stage 5



9. Slow growth in small area of Stage 5