Surface Water Impact Assessment
Stockton Sand Quarry Dredging

Report Prepared for: Boral Resources (NSW) Pty Ltd
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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.

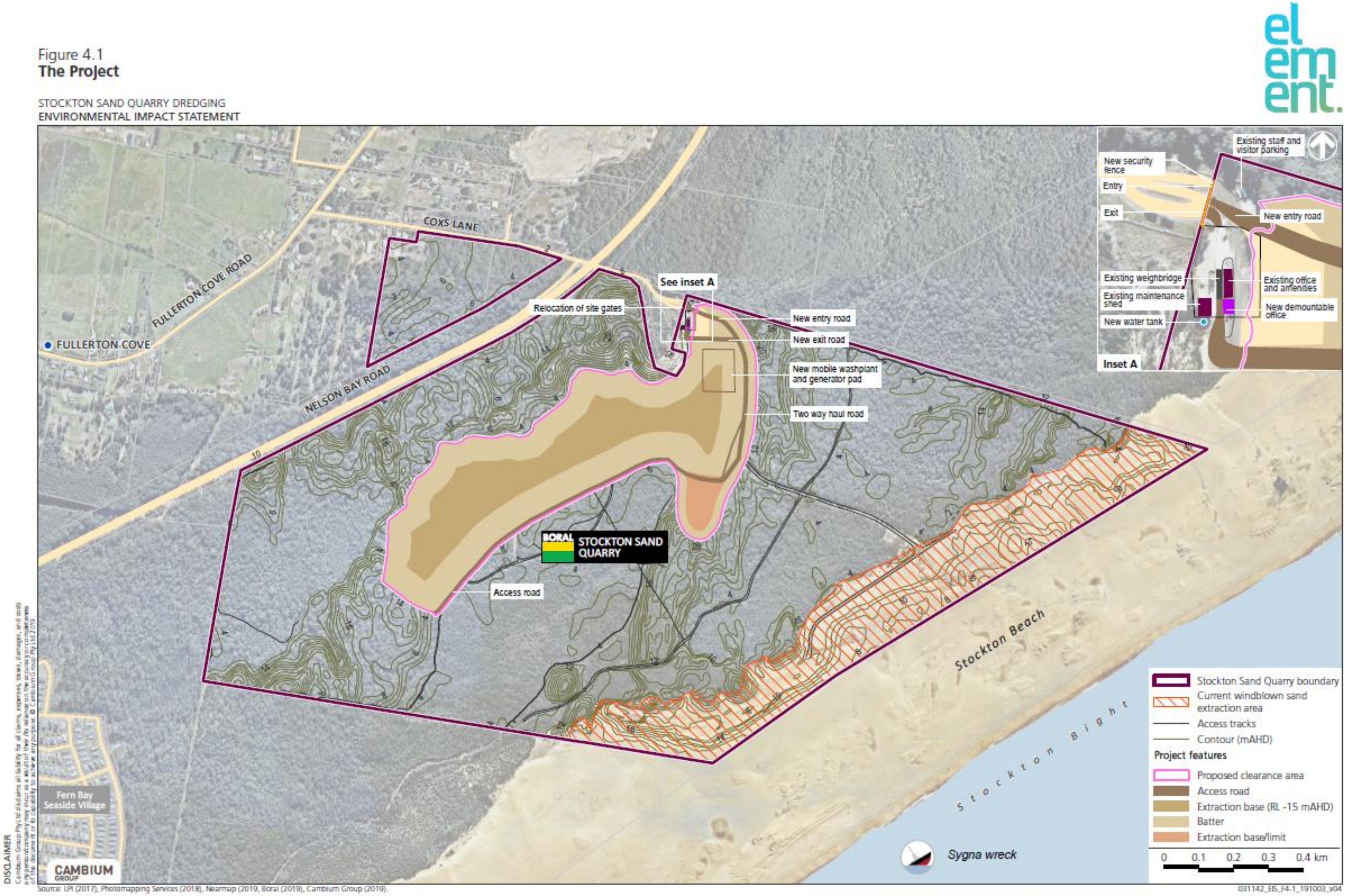


Figure 1.3 Project layout (Element, 2019)

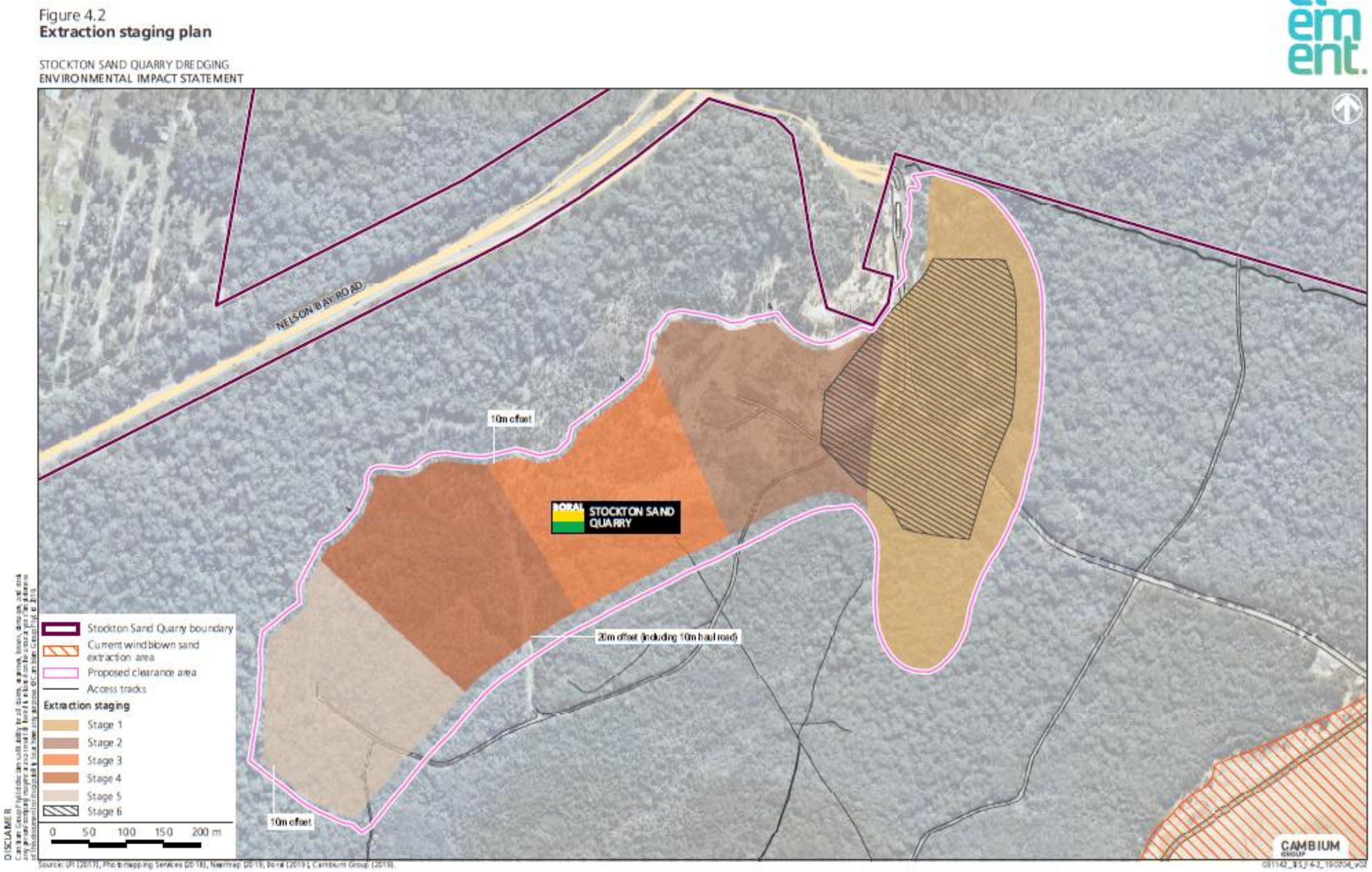


Figure 1.4 Extraction staging plan (Element, 2019)

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.

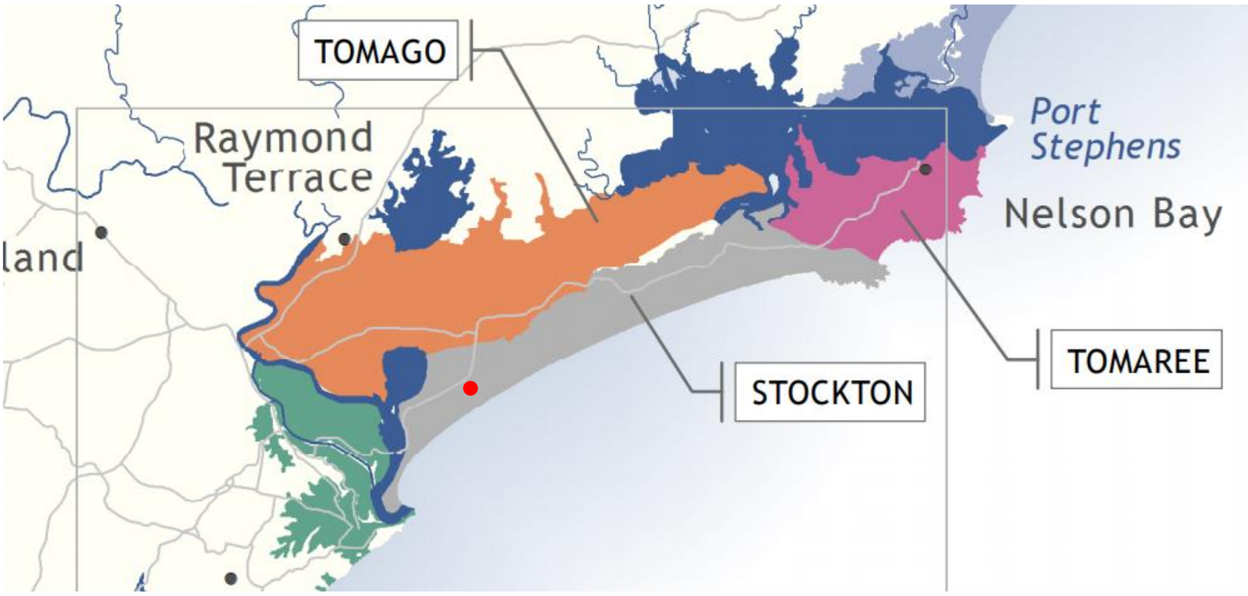


Figure 3.1 Zoomed extraction from WSP Map showing Stockton groundwaters source extents (grey) and project location (red dot)

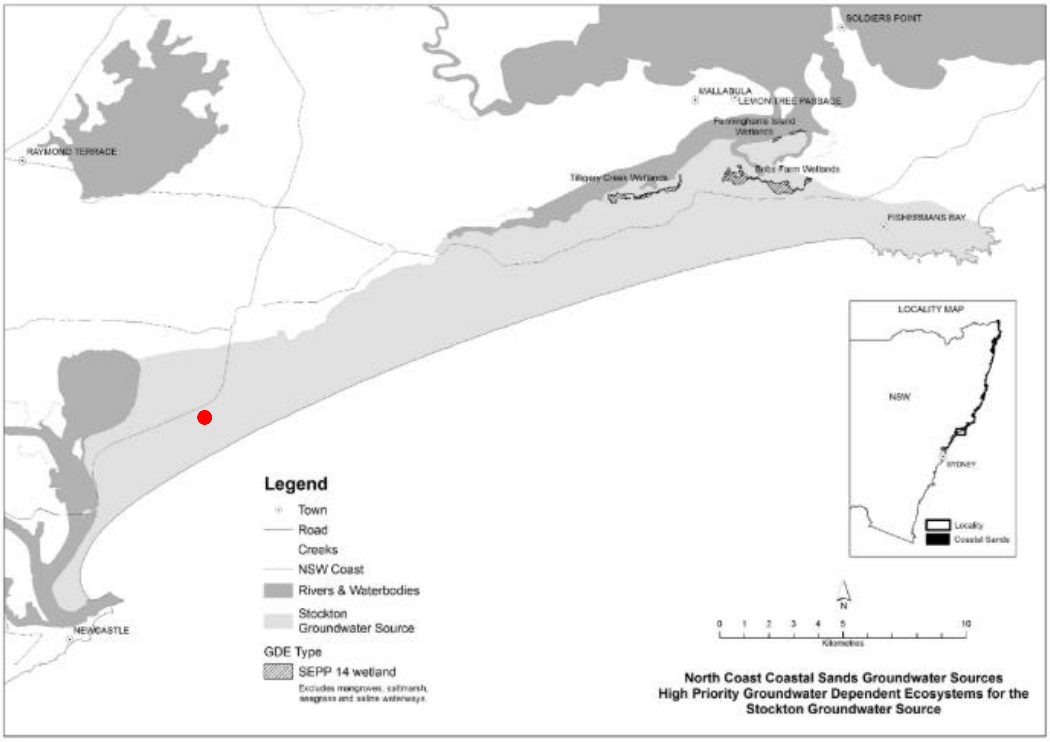


Figure 3.2 Stockton Groundwater Source mapped High Priority GDEs, approximate site location shown in red.

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.

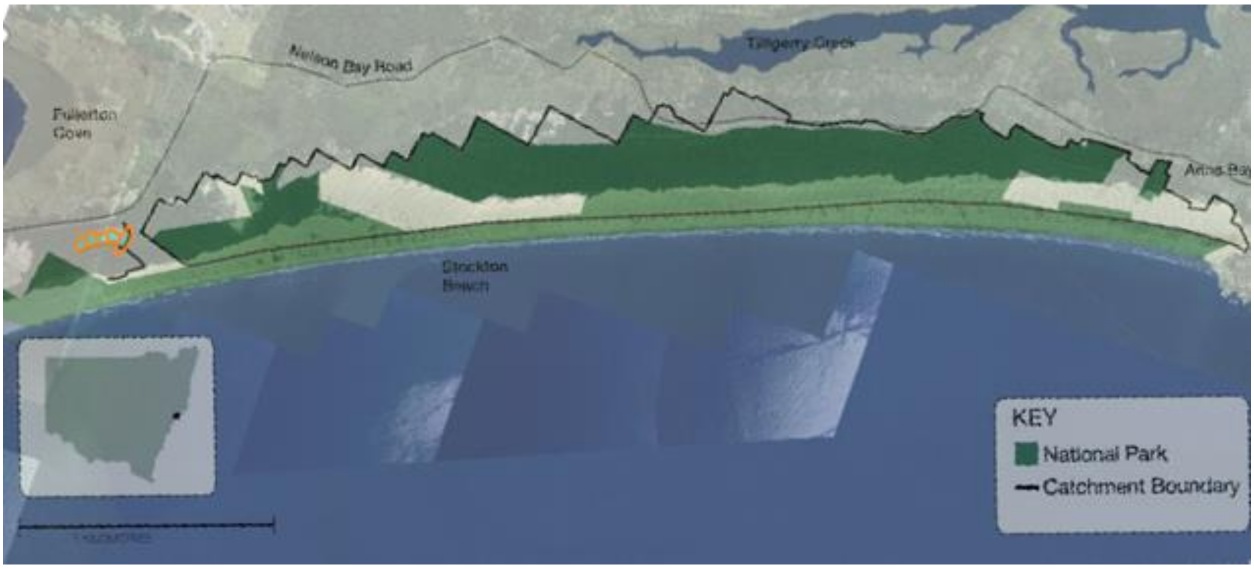


Figure 3.3 Project location (orange) in relation to Stockton Sandbeds aquifer reserve as specified in the Hunter Water (Special Areas) Regulation 2003

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.

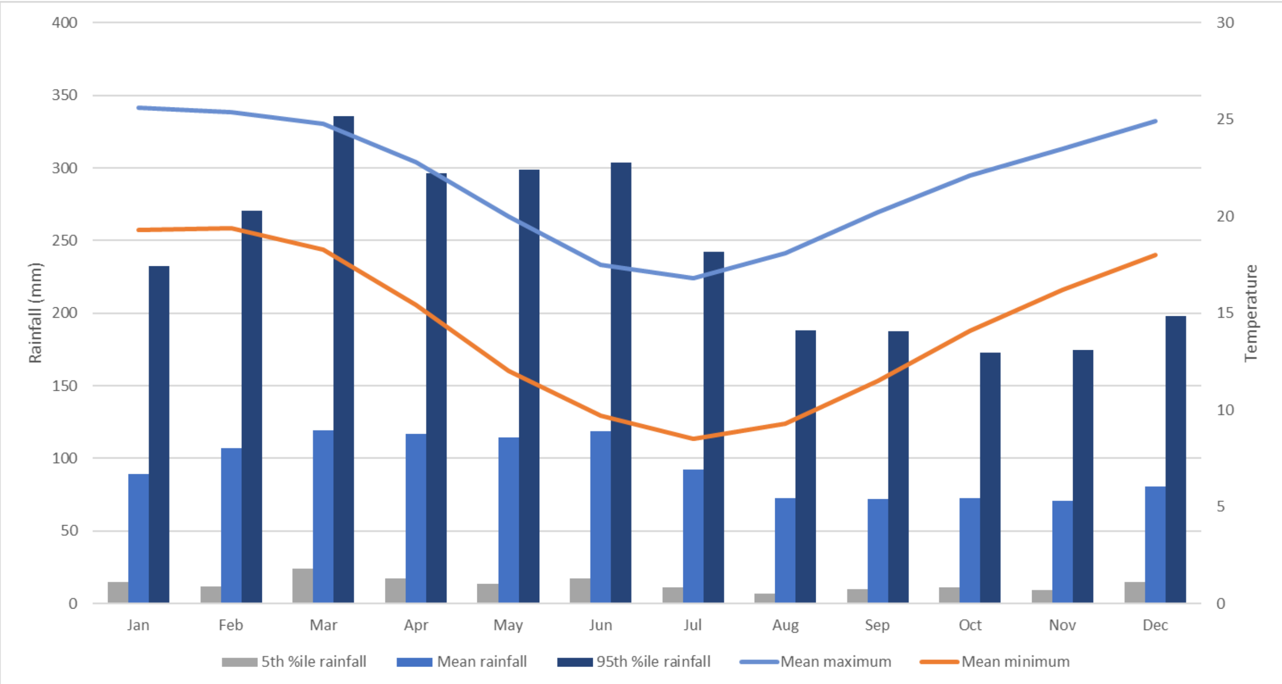


Figure 4.1 Monthly rainfall and temperature

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).

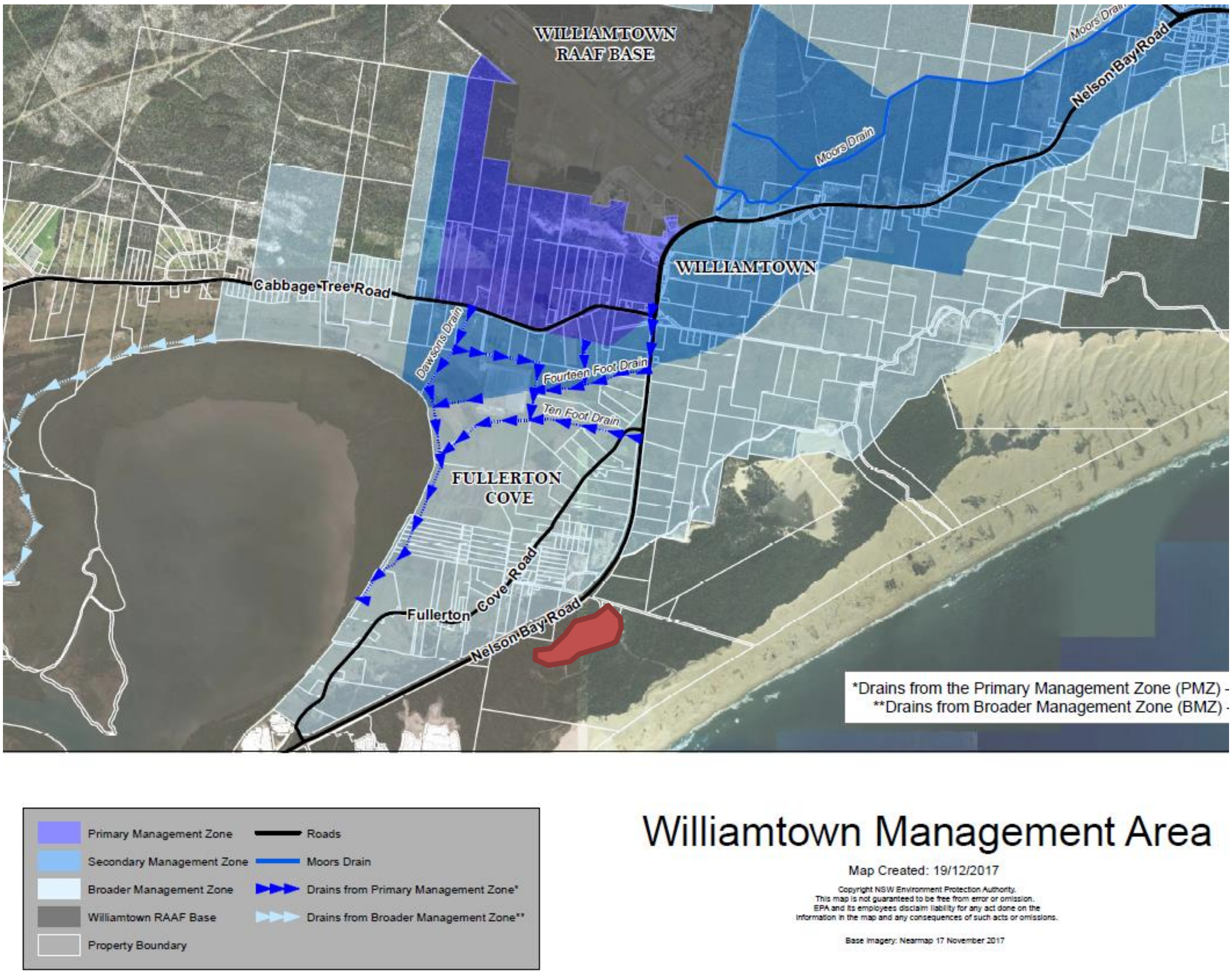


Figure 4.2 Williamtown PFAS management area and Project site (red). (https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/community/williamtownmanagementareamap.pdf, accessed 09/07/2019)

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).

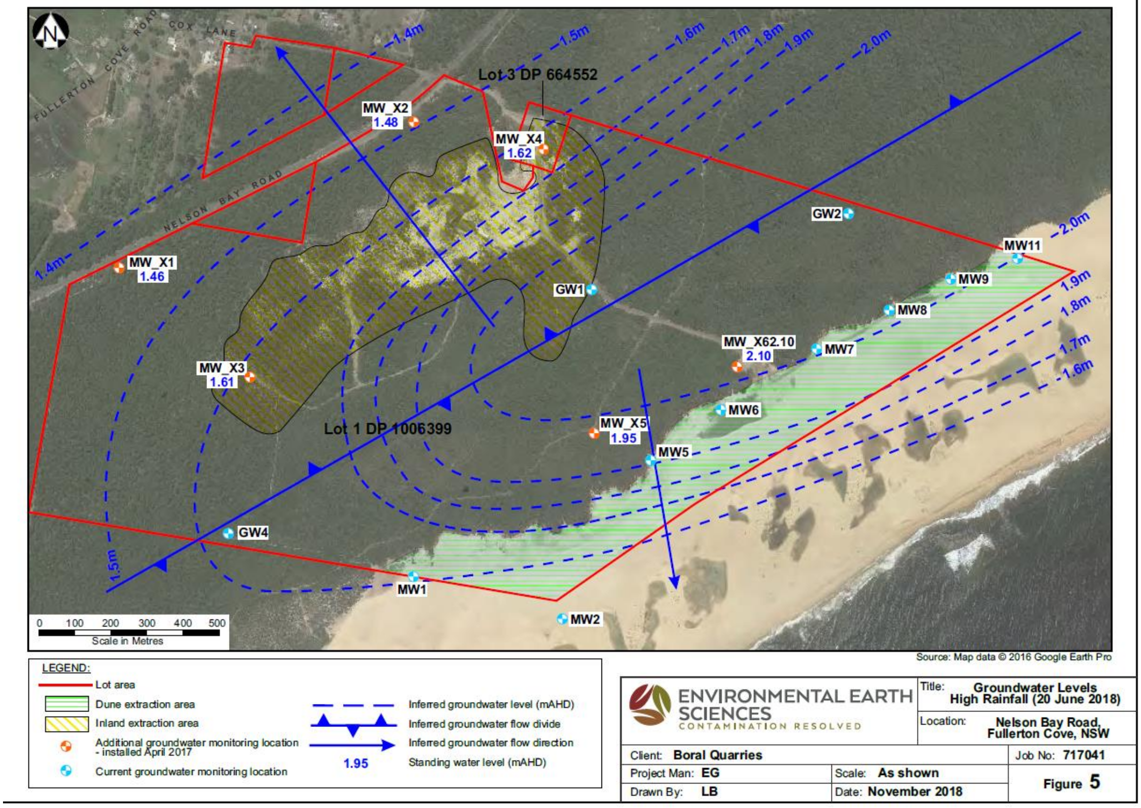


Figure 4.3 Groundwater levels in high rainfall 20 June 2018 (EES, 2019)

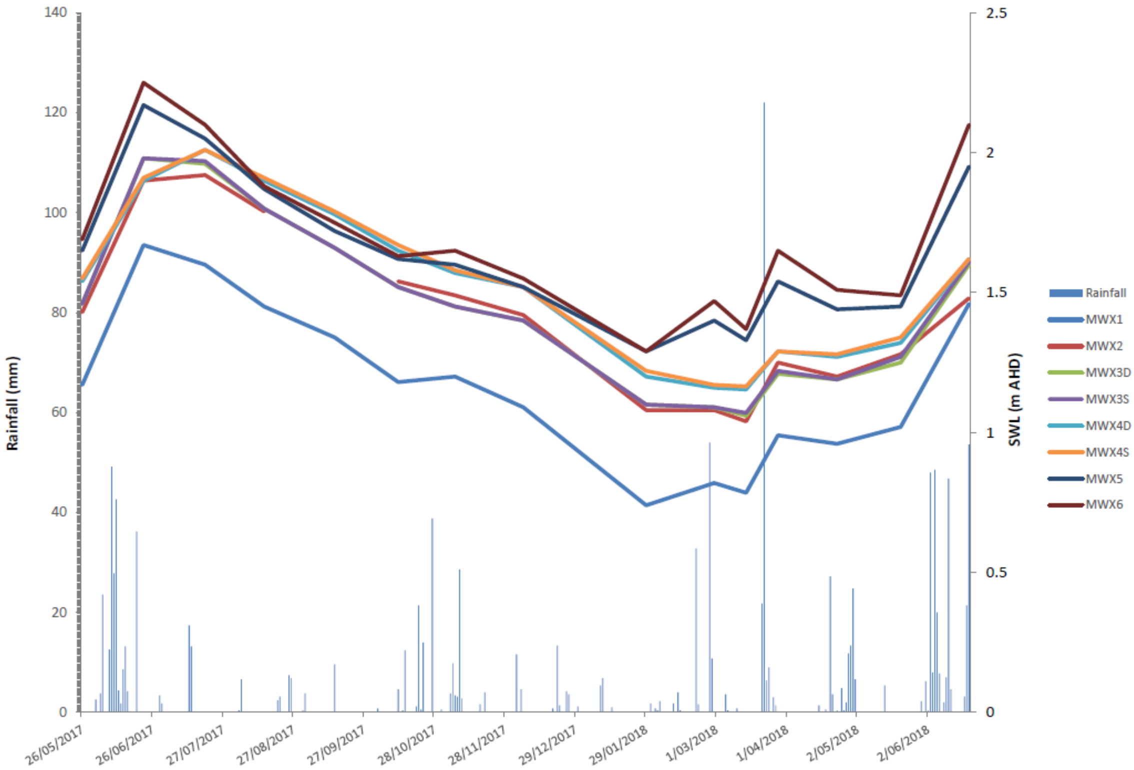


Figure 4.4 Recorded Rainfall and groundwater level (EES, 2019)

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).

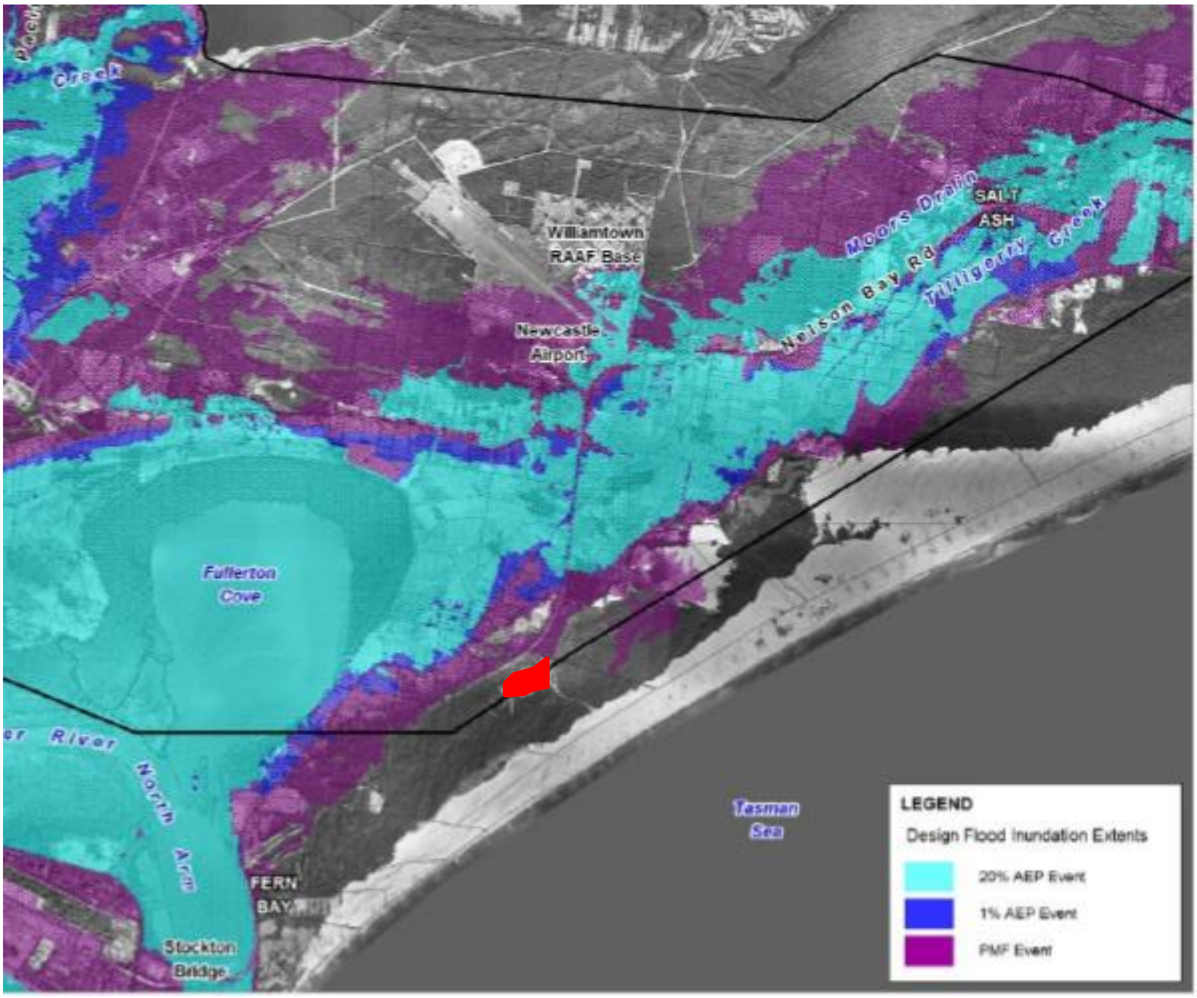


Figure 4.5 Design flood extents and Project site in red - extracted from *Williamstown – Salt Ash Floodplain Risk Management Study & Plan* (Cardno, 2017)

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.

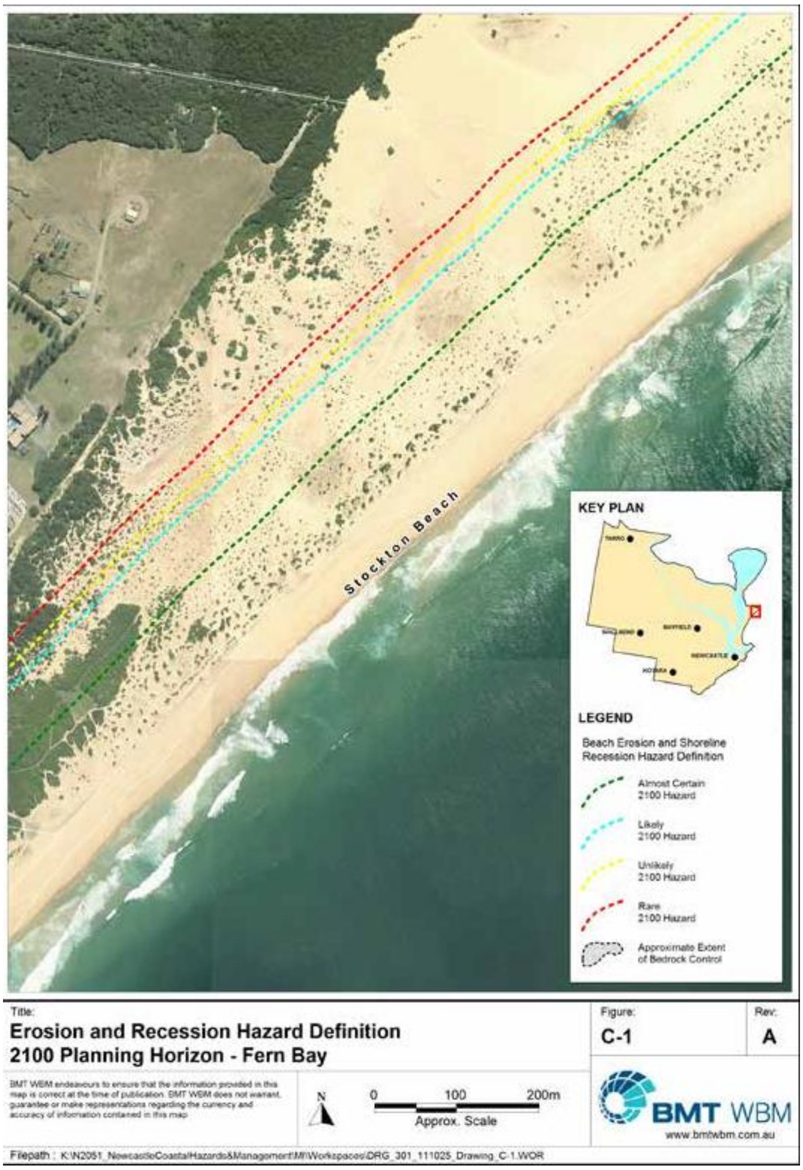


Figure 4.6 Erosion and rececion 2100 year planning horizon (BMT WBM, 2014).

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.

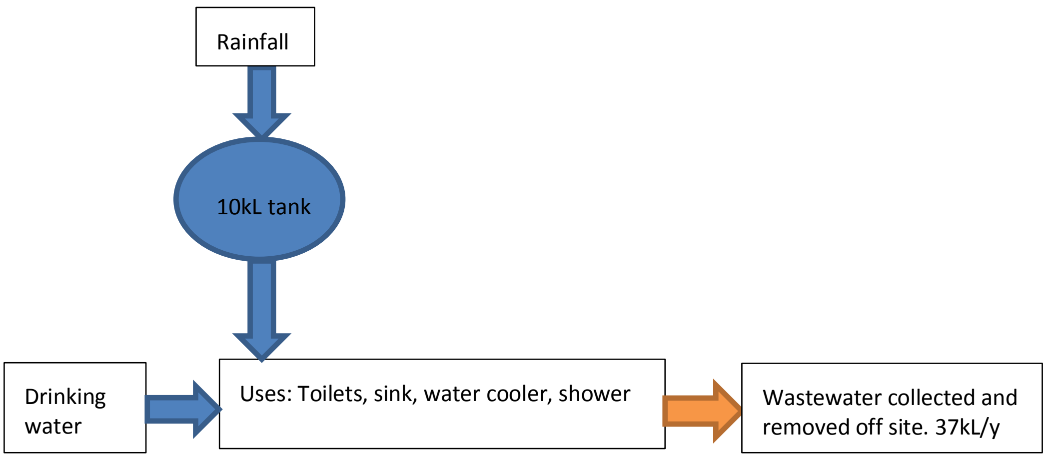


Figure 5.1 Conceptual Site office and weighbridge facility water balance

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.

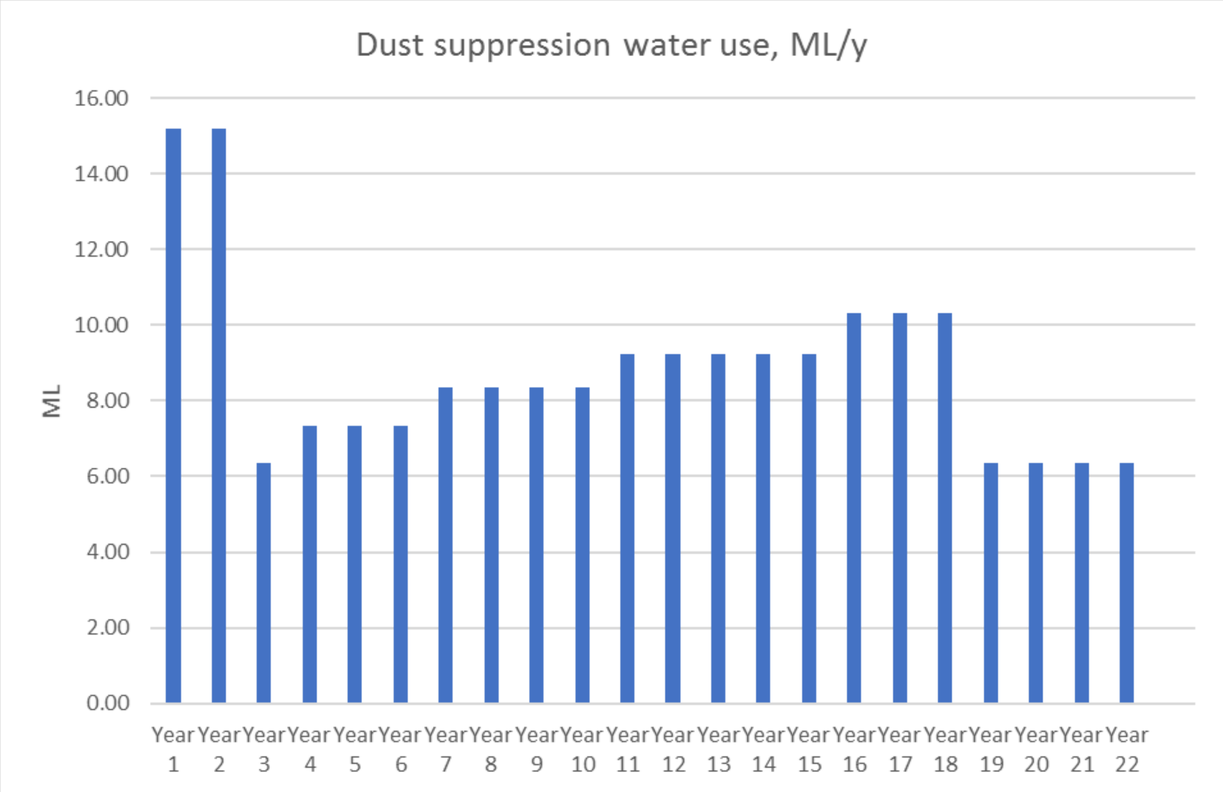


Figure 5.2 Estimated dust suppression water demand

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.

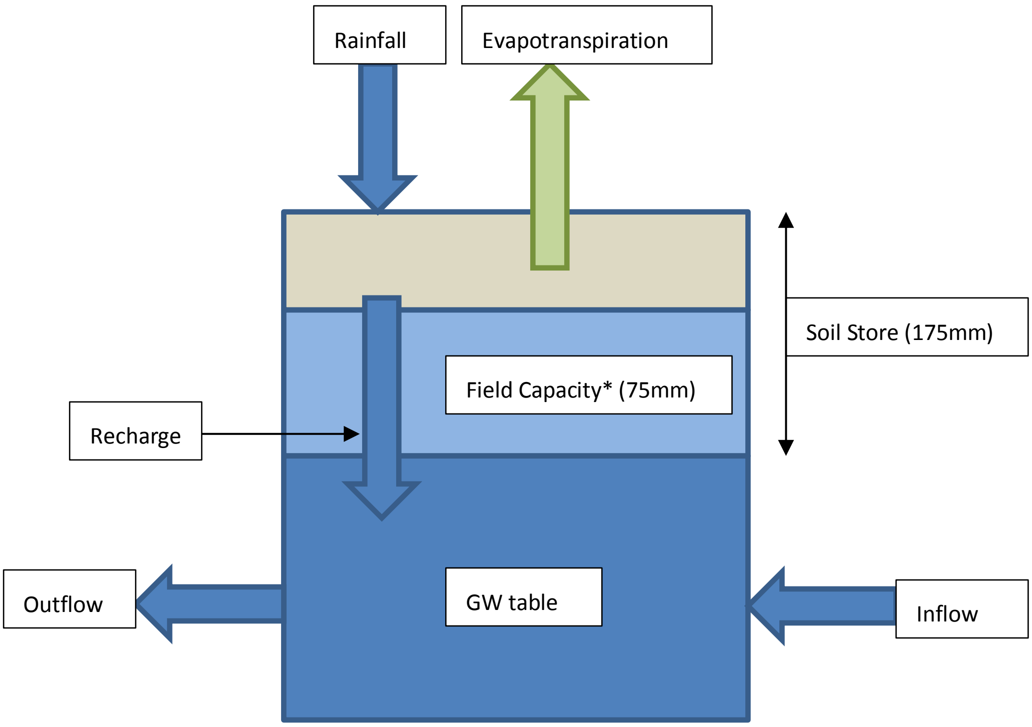


Figure 5.3 Schematic of existing water balance over extraction area.

*Field capacity is the depth of storage within the soil moisture store that must fill before flow to groundwater can occur.

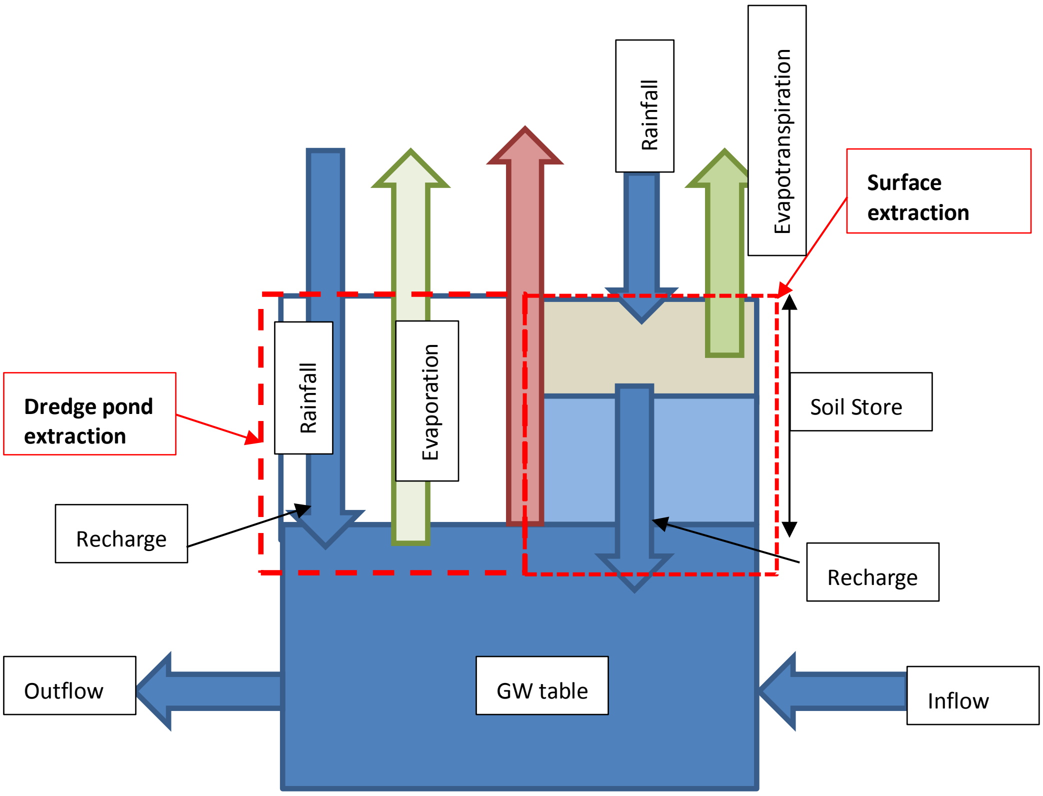


Figure 5.4 Schematic of future surface and groundwater balance

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).

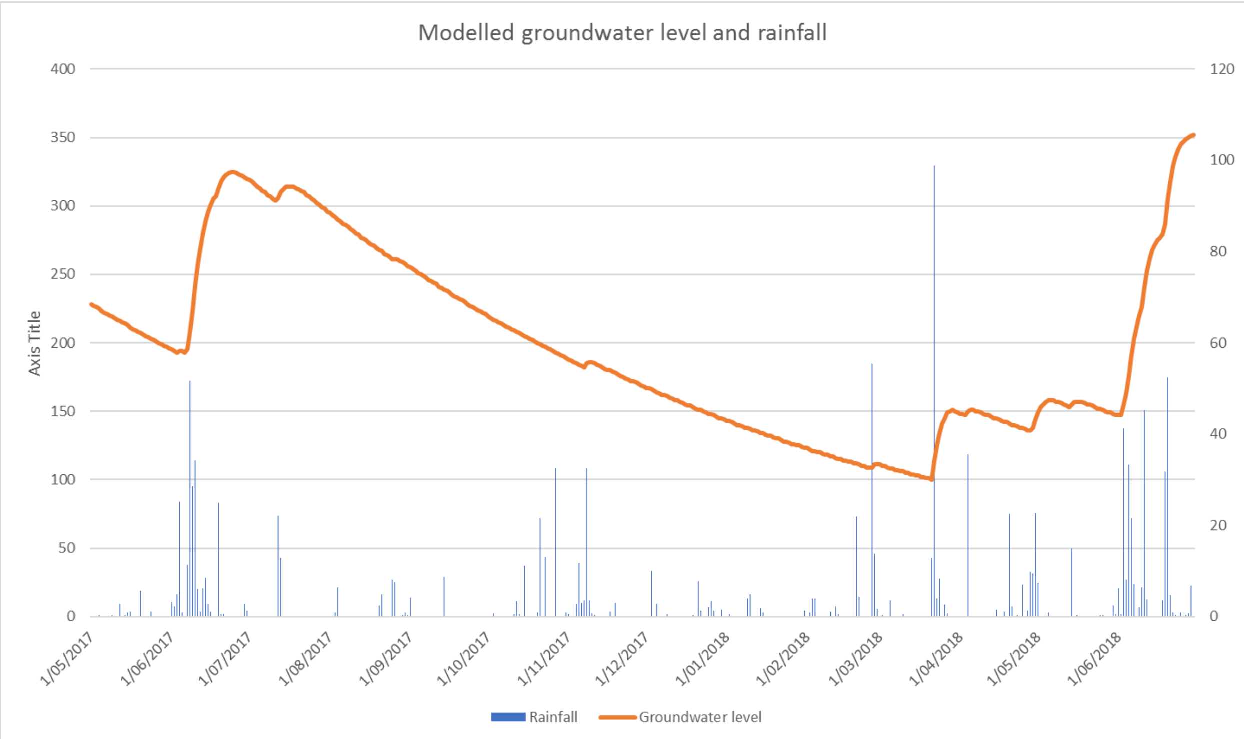


Figure 5.5 Modelled groundwater level and rainfall

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.

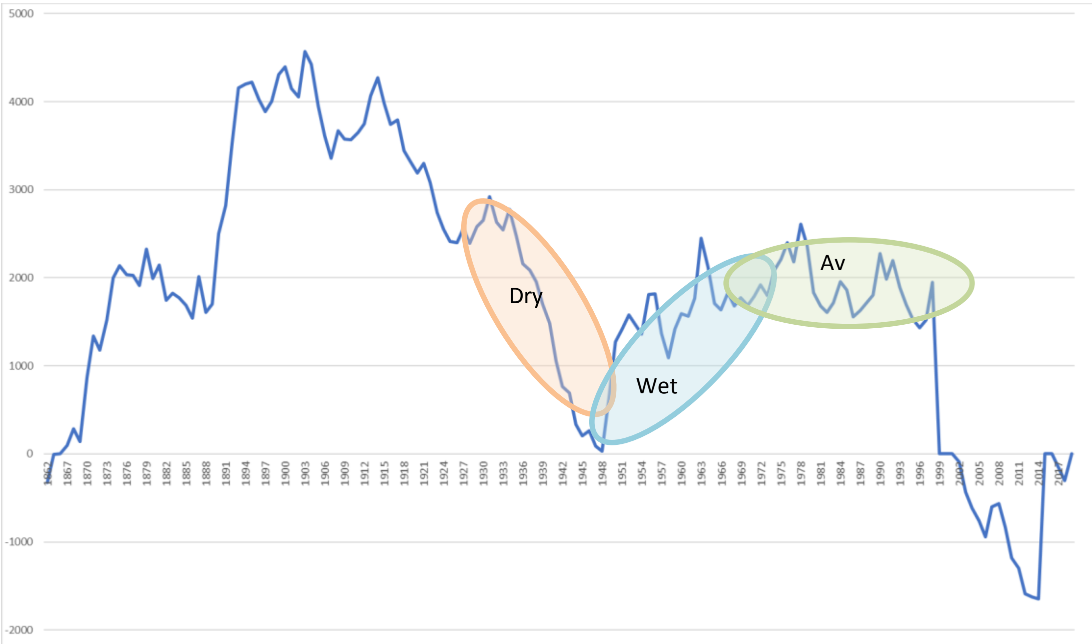


Figure 5.6 Annual rainfall cumulative deviation from the mean, modelled periods.

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 (10^{th} percentile, median and 90^{th} percentile) over the Project life the extraction ranges from 1580 ML for the 10^{th} percentile rainfall, 1067 ML for the median rainfall and 57 ML for the 90^{th} 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 10^{th}, 50^{th} and 90^{th} 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 90^{th} 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.

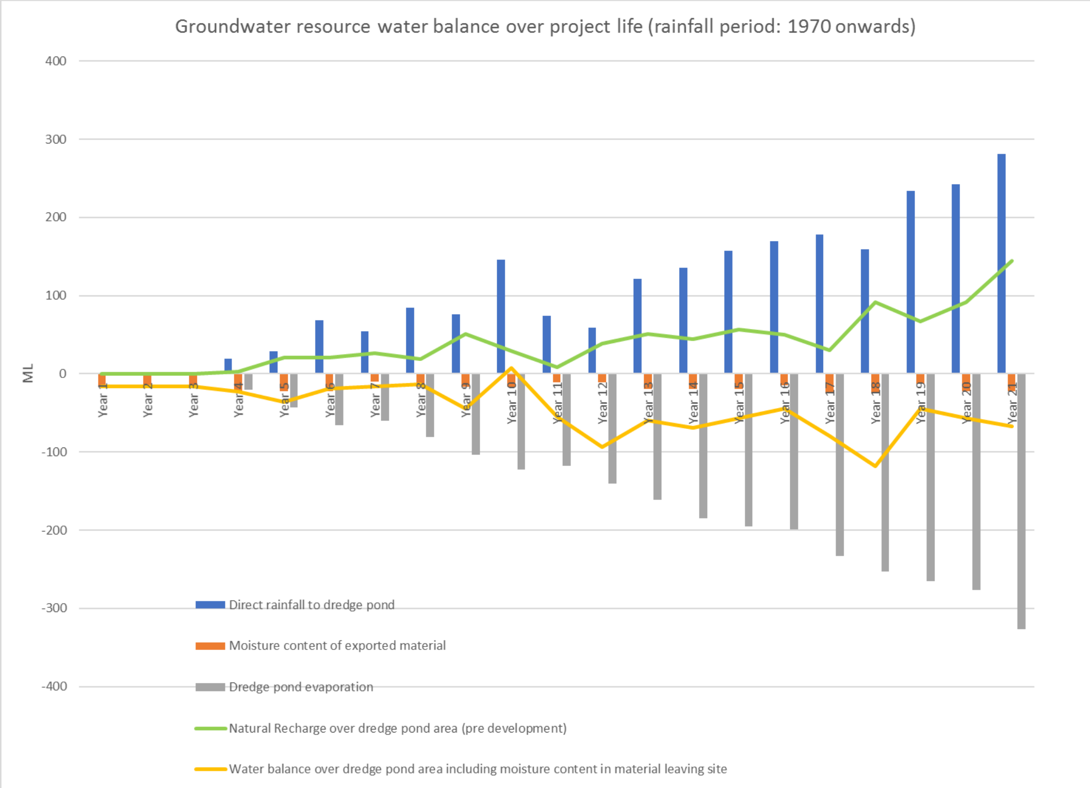


Figure 5.7 Water balance breakdown over the mine operation, and existing recharge over the dredge pond footprint (Average Climate period - 1969 to 1989)

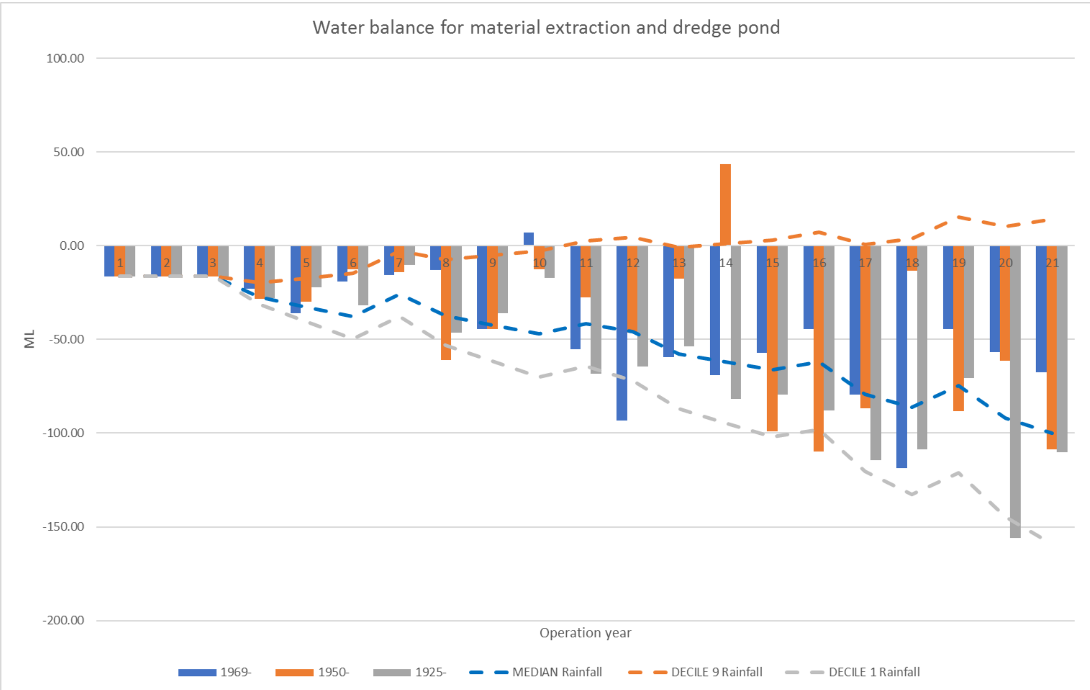


Figure 5.8 Annual water balance for three modelled periods and 10th, 50th and 90th percentile rainfall.

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.

REFERENCES

Australian Government, Bureau of Meteorology (BoM), (2019), *Atlas of groundwater dependent ecosystems*. Accessed June 2019.

BMT WBM (2017 *Williamtown – Salt Ash Floodplain Risk management Study and Plan, Final report.* Port Stephens Council.

BMT WBM (2014) *Newcastle Coastal Zone management Study, Final Report.* Newcastle Council.

Department of Environment and Climate Change, (2008), *Managing Urban Stormwater: soils and construction, Volume 2A: Installation of services, Volume 2C: Unsealed roads Volume 2D: main road construction and Volume 2E Mines and Quarries* (DECC 2008)

Element Environment, (2018), *Stockton Sand Quarry Dredging, Preliminary Environmental Assessment.*

Environmental Earth Sciences (2019), *Hydrogeological impact assessment, Stockton Sand Quarry, Coxs Lane, Fullerton Cove, NSW,* Element Environment.

Jacobs (2017). *Stockton Sand Quarry Groundwater Management Plan*, ref. IA147700_001b/B. Prepared for Boral Pty Ltd.

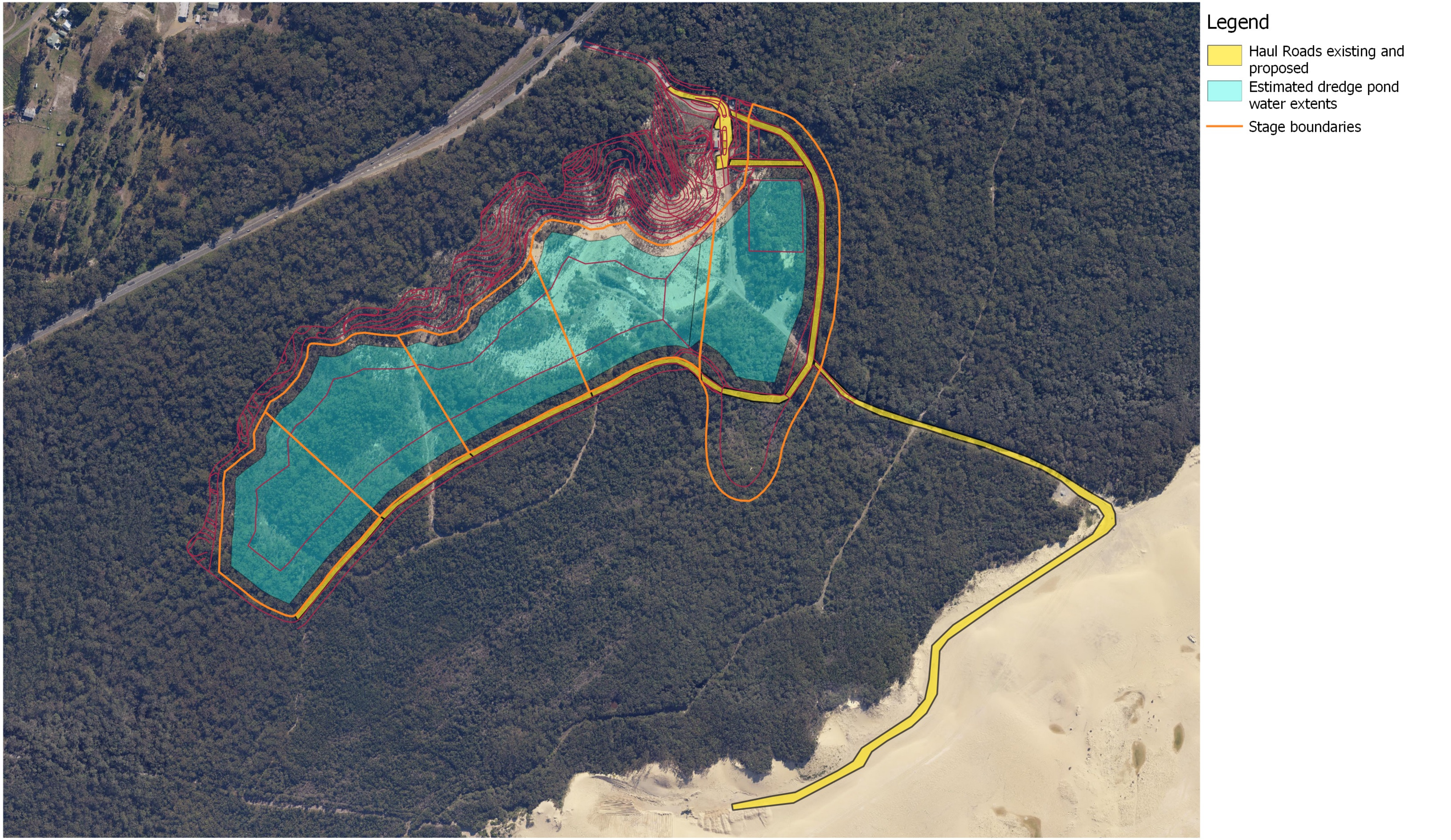
Landcom, (2004), *Managing Urban Stormwater Soils and Construction,* 2004.

NSW Department of Primary Industries (DPI) (2016). *Water sharing plan for the North Coast coastal sands groundwater sources background document.*

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.

RPS (2016). *Boral Stockton Sand Quarry – Groundwater Gap Analysis*, ref. WS00256/003a. Prepared for Boral Quarries.

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

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