



**ENVIRONMENTAL EARTH
SCIENCES**
CONTAMINATION RESOLVED

REHABILITATION STRATEGY FOR STOCKTON SAND QUARRY DREDGING, COXS LANE, FULLERTON COVE, NSW BORAL RESOURCES (NSW) PTY LTD

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VERSION 1

EXECUTIVE SUMMARY

Introduction and objectives

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Sand Quarry (hereafter referred to as the 'site' or the 'quarry'), a long standing operation that currently extracts sand from the windblown (transgressive) sand dunes of Stockton Bight and transports up to 500,000 tonnes of sand product per year for use in the building, landscaping and construction markets.

Due to current and future demand for sand in the Hunter and Sydney regions, Boral is seeking approval for continued and expanded operations at the site through a State Significant Development (SSD) application. The proposed development (hereafter referred to as the 'Project') involves the progressive extraction of sand from the inland vegetated dunes involving dry extraction by front-end loader/excavator to a depth of 4 metres (m) Australian Height Datum (AHD) in stage 1 with all subsequent stages by wet extraction, dredging to 15 m below sea level (-15 m AHD). The Project would seek to permit a site wide increase on the dispatch limit to 750,000 tpa (i.e. the windblown sand extraction area and the Project operations combined) up until 2028 after which the site wide limit would reduce to no more than 500,000 tpa. The Project would be for a period of 25 years.

The objective of this report is to review the current rehabilitation efforts at the site and to formulate a rehabilitation strategy specific to the Project.

Findings

Environmental Earth Sciences undertook a site inspection on 7 June 2019 to assess the progress of previous rehabilitation completed at the site. While rehabilitation has been generally successful, some areas were identified as having slow regeneration. Species selected for rehabilitation have been largely successful.

Potential Impacts

Potential impacts to the environment are likely to arise through the establishment of the Project, extraction of sand, rehabilitation of disturbed areas and final land use as a freshwater pond, over a period of approximately 25 years.

The following limitations to success of rehabilitation were identified:

- High wind exposure on elevated dunes impacting surface stabilisation;
- Nutrient deficiencies limiting plant establishment;
- Lack of soil moisture limiting plant establishment; and
- Weed invasion has previously impacted rehabilitation areas.

Mitigation, Rehabilitation and Monitoring

Established vegetation beyond the Project area will be retained and undisturbed and act as an informal screen or buffer zone between the Project and property boundaries to ensure minimal disruption to the greater community through visual amenity, noise, dust etc.

A buffer zone of 10 m is proposed along the northern perimeter of the dredge pond, and a 20 m buffer zone, including a 10 m haul road, is proposed to the east, south and south west of the pond. The two-way haul road will provide access for routine rehabilitation / maintenance works, and for safety purposes including access for fire services etc. The buffer zones will require routine management and maintenance throughout the life of the Project.

On completion of the Project, the edges of the dredge pond are proposed to be rehabilitated. The objective of the rehabilitation of the Project once all operations cease is to create a wetland (open pit) / freshwater pond.

Erosion and sediment controls are currently implemented at the quarry and will continue throughout the Project until closure. These measures include:

- Diversion of 'clean' overland flow to the site away from 'dirty' areas;
- Vegetation and maintenance of drainage pathways to minimise erosion and sediment accumulation in flowing water;
- Dust suppression on the existing and proposed haul roads; and
- Maintain the exposed sand surface to a minimum to reduce erosion.

The following types of vegetation cover have been used previously and are proposed for rehabilitation of the Project site:

- Trees:
 - Broad leaved Paperbark (*Melaleuca quinquenervia*);
 - Swamp Mahogany (*Eucalyptus robusta*); and
 - Coastal Banksia (*Banksia integrifolia*).
- Shrubs:
 - Coastal Wattle (*Acacia sophorae*); and
 - Coastal Teatree (*Leptospermum laevigatum*).
- Grasses and groundcovers:
 - Pig Face (*Carpobrotus glaucescens*);
 - Beach Fescue (*Austrofestuca littoralis*); and
 - Beach Spinifex (*Spinifex sericeus*).

- Aquatic plants:
 - Common Spike Rush (*Eleocharis acuta*).

Additional rehabilitation species are presented in Table 3 in the report.

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1 INTRODUCTION

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Sand Quarry (hereafter referred to as the 'site' or the 'quarry'), a long standing operation that currently extracts sand from the windblown (transgressive) sand dunes of Stockton Bight and transports up to 500,000 tonnes of sand product per year for use in the building, landscaping and construction markets.

Due to current and future demand for sand in the Hunter and Sydney regions, Boral is seeking approval for continued and expanded operations at the site through a State Significant Development (SSD) application. The proposed development (hereafter referred to as the 'Project') involves the extraction of sand from the inland vegetated dunes by front-end loader/excavator to a depth of 4 metres (m) Australian Height Datum (AHD) and subsequent dredging from 4 m AHD to 15 m below sea level (-15 m AHD).

The Project would seek to permit a site wide increase on the dispatch limit to 750,000 tpa (i.e. the windblown sand extraction area and the Project operations combined) up until 2028 after which the site wide limit would reduce to no more than 500,000 tpa. The Project would be for a period of up to 25 years, subject to demand of sand resources.

After the completion of sand extraction for each area, the Project will require rehabilitation and revegetation. In the initial phases of work, rehabilitation will primarily aim to stabilise the edge of the pond and where necessary to prevent wave action induced erosion at the pond edge. Stabilisation of the pond edge during active sand extraction is to be addressed in the erosion and sediment control plan and is outside the scope of this rehabilitation plan.

On completion, the Project site will be left as a freshwater pond and rehabilitation efforts will generally maintain and manage the pond and the immediate surrounds to minimise the potential for erosion and degradation of areas of exposed soils.

Environmental Earth Sciences was commissioned by Element Environment, on behalf of Boral, to undertake an assessment of the current rehabilitation works and propose a rehabilitation strategy for the Project.

1.1 Objectives

The objective of this report is to review the current rehabilitation efforts at the site and to formulate a rehabilitation strategy specific to the Project.

1.2 Secretary's Environmental Assessment Requirements

This rehabilitation plan addresses the requirements of the Secretary's Environmental Assessment Requirements (SEARs) for land rehabilitation for the project. The SEARs are:

Rehabilitation – including the proposed rehabilitation strategy for the site having regard to the key principles in the Strategic Framework for Mine Closure, including:

- *rehabilitation objectives, methodology, monitoring programs, performance standards and proposed completion criteria;*

- *nominated final land use, having regard to any relevant strategic land use planning or resource management plans or policies; and*
- *the potential for integrating this strategy with any other rehabilitation and/or offset strategies in the region.*

The following Table (**Table 1**) lists the requirements of the SEARs against the locations in the rehabilitation plan.

Table 1: Requirement of the SEARs

SEARs	Location in rehabilitation plan
Rehabilitation objectives	Section 5.1 – Rehabilitation objectives and performance criteria
Rehabilitation methodology	Section 5 – Proposed Rehabilitation Measures
Rehabilitation monitoring programs	Section 5.3 – Rehabilitation Inspection Schedule
Rehabilitation performance standards	Section 4.2 – Rehabilitation Performance Criteria
Proposed completion criteria	Section 5.5 – Proposed Rehabilitation Completion Criteria
Nominated final land use	Section 2.1.4 – Proposed Final Land Use
Integration of rehabilitation strategy	Section 4.2.1 – Integration of Rehabilitation with Previous Works

2 EXISTING ENVIRONMENT

The Stockton Sand Quarry is located in Fullerton Cove, approximately 9.8 kilometres (km) north north-east of the Newcastle Central Business District (CBD), within the Port Stephens Local Government Area (LGA) (**Figure 3**). Access to the site is via Nelson Bay Road and Coxs Lane.

The site owned and operated by Boral covers an approximate area of 246 hectares, comprising of:

- Lot 1 DP 1006399, comprising 234 hectares and located predominantly on the eastern side of Nelson Bay Road;
- Lot 2 DP 1006399 comprising 10.4 hectares and located predominantly on the western side of Nelson Bay Road, with a small portion also positioned on the eastern side of Nelson Bay Road (formerly Part Lot 167, Part Portion 167); and

- Lot 3 DP 664552 comprising 1.619 hectares and located wholly on the eastern side of Nelson Bay Road, and within which the existing depot and weighbridge are located (formerly within Part Lot 3, Part Portion 3).

Under Boral's ownership there have been two primary development consents granted, these include:

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

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

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

A site inspection of rehabilitated areas within the Project site identified that the majority had been revegetated with planted trees. Areas of more recent revegetation had established dense vegetation with young trees and shrubs. Where rehabilitation has been less successful, growth of trees and shrubs remains stunted and areas of open sand remain.

The surrounding natural woodland vegetation was identified to consist predominantly of Swamp Mahogany (*Eucalyptus robusta*) and Coastal Wattle (*Acacia sophorae*), with Beach Fescue (*Austrofestuca littoralis*) and Pig Face (*Carpobrotus glaucescens*) in open areas.

The Project site (identified as 'proposed clearance area' in **Figure 3**) contains all areas to be disturbed by Project operations and covers an area of approximately 37 ha.

The Project site is generally consistent with the same disturbance footprint associated with the former inland extraction area approved and rehabilitated under the 1996 development consent, with the exception of areas to east and south east of Lot 3 and along the southern edge to allow for the construction of new haul roads.

2.1 Background

2.1.1 Sand extraction works

Sand from the former inland extraction area was only extracted to 5 m AHD under the original 1996 development consent. The sand resource above 5 m AHD was exhausted in 2007 and in accordance with the conditions of consent the operations have ceased. Progressive rehabilitation has occurred over the life of operations.

The following reports detail the existing and previous rehabilitation and landscape management plans (RLMP) for the site:

- RW Corkery & Co Pty Ltd (2018) *Rehabilitation and Landscape Management Plan for the Stockton Transgressive Dune Quarry*. Prepared for Boral Resources (NSW) Pty Ltd. September 2018.
- Environmental Compliance Services (2017) *Stockton Transgressive Dune Quarry, Rehabilitation and Landscape Management Plan*. Prepared for Boral Resources (Country) Pty Ltd. March 2017
- Environmental Resources Management Australia (ERM, 2010), *Rehabilitation and Landscape Management Plan, Stockton Transgressive Dune Quarry*, Prepared for Boral Resources (NSW) Pty Ltd. August 2010.

Boral currently extracts sand from the transgressive dunes, referred to as the windblown sand extraction area. Sand extraction on the dunes commenced in 2008 in accordance with development consent DA 140-6-2005. The development consent permits transportation of up to 500,000 tpa of sand products over a 20 year period.

The Project is to be undertaken progressively in six stages, commencing with Stage 1. An overview of the extraction staging plan for the Project is presented in **Figure 4**.

Similar to previous operations of the inland extraction area, sand extraction will involve clearing and grubbing of established vegetation from previous rehabilitation and possible screening of accumulated leaf litter and organic matter. Vegetation will be cleared progressively to limit the exposure of bare sand. Cleared vegetation will either be mulched or stockpiled on-site for later reuse in rehabilitation. Similarly, any stripped topsoil would be retained for use in rehabilitation efforts across the site.

Sand will first be removed via a front-end loader which pushes into the exposed sand face. As the sand is relatively free-flowing, material falls towards the front-end loader at the natural angle of repose.

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

Following initial extraction of sand above the water table to a depth of 4 m AHD in Stage 1, a pond will then be created in stage 2 large enough to float a dredge and accommodate fresh water pumping for the proposed wash plant.

The dredge will move progressively through the extraction area generally following the nominated stages. In most cases, the sand in each extraction stage is fully extracted unless constraints are encountered.

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

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

Sand will be extracted to a maximum depth of approximately 15 m below the sea level (0 m AHD).

2.1.2 Site hydrogeology

A hydrogeological report completed by Environmental Earth Sciences (2019) details the standing water level rises from approximately 1 m AHD during low rainfall events to 2 m AHD at high rainfall events. Refer to the **Figure 4** and **Figure 5** in the following hydrogeological report:

- Environmental Earth Sciences (2019), *Hydrogeological Impact Assessment, Stockton Sand Quarry, Cox's Lane, Fullerton Cove, NSW, Element Environment*, dated April 2019 (reference: 717041_V1).

The Project site consists of an area to be disturbed of approximately 37 hectares. A component of the Project includes sand extraction from to a depth of 15 m below the water table (-15 m AHD).

The site is a groundwater recharge zone, and groundwater in the area is fresh. It is therefore expected that the open water body created from the dredge pond associated with the Project will in time form a freshwater wetland (**Figures 5 and 6**).

2.1.3 Vegetation management

It is proposed that a screen or buffer zone of native trees remains on site between Project site and the quarry property boundaries to ensure minimal disruption to the greater community through visual amenity, noise, dust etc.

A buffer zone of 10 m is proposed along the northern perimeter of the dredge pond and a 20 m buffer zone, including a 10 m haul road, is proposed to the east, south and south west of the pond. The two-way haul road would provide access for routine rehabilitation / maintenance works, and for safety purposes to provide access for fire services etc. The buffer zones will require routine management and maintenance throughout the life of the Project.

2.1.4 Proposed final land use

The proposed final land use of the Project site once all operations cease is to create a wetland (open pit) / freshwater pond surrounded by retained coastal woodland established with endemic species.

The edges of the pond would be adequately stabilised and revegetated with suitable groundcover species to minimise the potential for soil erosion.

Conceptual cross sections are provided in **Figure 5** (north to south) and **Figure 6** (south west to north east) and present approximate schematic drawings of the site following the completion of excavation works.

3 ASSESSMENT OF REHABILITATION WORKS

3.1 Site inspection of rehabilitated areas

Environmental Earth Sciences conducted a site inspection on 7 June 2019 to assess the status of rehabilitation works in the previous inland extraction area. The inspection aimed to assess the efficiency of rehabilitation strategies used to date, with consideration of time since rehabilitation and any localised site conditions which may have influenced vegetation establishment. The findings of the inspection were then used to inform recommendations for rehabilitation of the Project site.

3.1.1 Site observations

Rehabilitation activities have generally been successful at the quarry to date. The degree of vegetation establishment largely depends on the duration since sand extraction activities ceased, with the former Pit 1, 2 and 3 areas of the inland extraction area having well established tree cover, while Pits 4, 5 and 6 of the inland extraction area had smaller trees and shrubs. The following observations were made at the time of the site inspection:

- The successful species in rehabilitated areas consisted predominantly of:
 - Trees – Swamp Mahogany (*Eucalyptus robusta*);
 - Shrubs – Coastal Wattle (*Acacia sophorae*);
 - Grasses – Beach Fescue (*Austrofestuca littoralis*); and
 - Ground cover – Pig Face (*Carpobrotus glaucescens*).
- Poor vegetation establishment has occurred in some areas. This has been attributed to:
 - Areas exposed to high winds which disturb surface soil, particularly on elevated slopes;
 - Areas where nutrient deficiency limits plant growth – this has been observed due to utilisation of coal by-product (chitta) for construction of the haul road resulting in depletion the landscape of nitrogen and other nutrients. Areas of ‘pure’ sand are also subject to nutritional deficiencies; and
 - Limited water availability, observed on high exposed dunes, and potentially the cause of poor vegetation establishment over former haul roads due to soil compaction.

- Environmental Earth Sciences was advised by Boral that weed management has progressed from blanket treatment and now focuses on physical removal of re-grown weeds. The noxious weed Bitou bush was not observed during the site inspection.

A summary of the inspected areas is presented in **Table 2** below. Photographs are presented in Appendix 1.

Table 2: Rehabilitation areas summary

Rehabilitation area Proposed (former)	Observations
Stage 1 Stage 6 (Pit 3)	Photograph 1. Successful revegetation across a large portion of the area, establishment of a variety of tree species and grass understory. Photograph 2. Small area of exposed sand east of haul road. Poor establishment due to windblown sand.
Stage 2 (Pit 6)	Photographs 3 & 4. Areas of poor tree establishment and patchy soil cover. Windblown sand. Rehabilitation more recent in this area.
Stage 3 / 4 (Pit 4)	Photograph 5. Large areas of successful revegetation with young trees and dense shrubs. Photographs 6 & 7. Successful revegetation across the majority of the area. Patchy regrowth in some areas, particularly along a former haul road – attributed to nitrogen deficiency related to use of coal by-product for road construction.
Stage 5 (Pit 2)	Photograph 8. Established trees with shrub understory. Leaf litter layer on ground surface. Photograph 9. Patchy understory and lack of soil cover in small areas within Stage 5.

4 REHABILITATION MANAGEMENT PLAN

4.1 Review of rehabilitation methodology

Based on the findings of the rehabilitation review, and the rehabilitation requirements of the Project, the following recommendations have been made:

- Aspects of the existing rehabilitation process that are considered successful and should continue:
 - Species selection has facilitated establishment of a diverse and robust ecological environment which is representative of local native vegetation; and
 - Weed management has been successful in removing targeted species and preventing infestation.

- Aspects of the existing rehabilitation process that could be improved for future works:
 - Areas subject to high winds, such as elevated dunes, require additional stabilisation to allow vegetation establishment. These areas may also require use of more robust species, such as spinifex to stabilise soil;
 - Areas subject to compaction and heavy impact, such as haul roads, may require deep ripping prior to rehabilitation to improve soil water availability and allow root penetration of soil; and
 - Targeted application of suitable fertilizer, and/or use of nitrogen fixing plant species may improve plant establishment in some areas.
- Aspects where the intended final landform will change the rehabilitation requirements:
 - The final landform is dominated by the dredge pond/s, which will require bank stabilisation;
 - Suitable aquatic species may be required for revegetation within the aquatic zone; and
 - Species selection should facilitate development of understorey vegetation adjacent to retained coastal woodland community, with low ongoing maintenance.

To assist in the preparation of the rehabilitation strategy for the Project, the following guideline has been referred to:

- NSW Department of Trade and Investment (ESG3) *Mining Operations Plan (MOP) Guidelines*, September 2013.

4.2 Rehabilitation performance criteria

The performance criteria for the rehabilitation of the final post sand extraction landform are:

- Stabilisation of the disturbed areas with re-established coverage of endemic species of vegetation; and
- Have a Landscape Function Analysis (LFA) level of natural regeneration greater than 50% of the previously assessed Natural Bushland Control site, located within the quarry property.

4.2.1 Integration of rehabilitation with previous works

The post-quarrying landscapes associated with the previous stages of the Stockton Sand Quarry have been rehabilitated according to their respective rehabilitation plan (ERM 2010b). These rehabilitation works have been assessed and reviewed (Sections 3 and 4 of this report). While the rehabilitation of these areas has been largely successful, some aspects of the rehabilitation indicate areas where improvements and efficiencies can be made. These findings have been incorporated into the development of this rehabilitation strategy.

This rehabilitation strategy therefore aims to integrate the successful aspects of the previous strategies in the ongoing works. This will also provide the benefit of consistency in approach for site operators, consistent use of rehabilitation species, and continuity for site suppliers.

5 PROPOSED REHABILITATION MEASURES

The proposed final land use of the Project site once all operations cease is to create a wetland (open pit) / freshwater pond. The rehabilitation option proposed for the final landform will return the site to a passive environment, whilst maximising the potential for re-equilibration with the surrounding environment (flora and fauna).

To ensure that all rehabilitation (mitigation) measures are sufficiently financed, Boral are currently securing funds for the closure of the site which includes all costs for the final rehabilitation, as well as mitigation measures during works.

The following table (**Table 3**) sets out a summary and timeline for mitigation, rehabilitation, monitoring and maintenance works for the Project site.

Table 3: Proposed rehabilitation and management timeline

Site section	Mitigation/ Rehabilitation measure	Timeframe
Entire site	Topographical survey of current landform levels to inform rehabilitation, vegetation and monitoring.	Prior to site establishment.
Site periphery	Maintain buffer zone of trees to provide a screen between site activities and the site boundaries	Ongoing
	Monitor buffer zone to ensure the screen remains intact and sufficient to provide screening function for operations.	During sand extraction and ongoing
	Removal of undesirable weed species and vegetation not consistent with the local vegetative succession.	Ongoing maintenance
	Revegetation of any disturbed areas by way of selective planting with species native to the locality	Ongoing
Dredge pond / excavation pit	Vegetate dredge pond / excavation pit embankments with native low growing shrubs and grasses to provide bank stability and reduce erosion (including water tolerant and salt tolerant species).	Stabilisation during sand extraction and revegetation at conclusion of site operations in each stage
	Monitor dredge pond / excavation pit embankments to ensure the area remains intact and sufficient for operations.	During sand extraction
	Encouragement of natural reforestation through weed control and reduction.	Ongoing maintenance
Final Landform Option: Wetland / freshwater pond		
Wetland (open pit) / freshwater pond	Conversion of the dredge pond to a wetland (open pit) / freshwater pond.	At conclusion of Stage 6.

Site section	Mitigation/ Rehabilitation measure	Timeframe
	Revegetate excavation pit embankment with native water plant species (including water tolerant and salt tolerant species).	At conclusion of site operations in each stage.
	Encouragement of natural reforestation through weed control and reduction.	At conclusion of site operations in each stage. Ongoing maintenance

5.1 Rehabilitation objectives and performance criteria

The objective of the post-quarrying rehabilitation process is to:

- develop a stable post-quarry landscape, where erosion is controlled and minimised; and
- a vegetation community is established which reflects the endemic ecology of the region and minimises the potential for weed invasion or vegetation community collapse.

The performance criteria for the rehabilitation of the final post sand extraction landform are:

- Stabilisation of the disturbed areas with re-established coverage of endemic species of vegetation; and
- Have a Landscape Function Analysis (LFA) level of natural regeneration greater than 50% of the previously assessed Natural Bushland Control site, located within the quarry property.

5.2 Rehabilitation process

The following steps are proposed to be implemented for progressive rehabilitation of the site, being:

5.2.1 Development of final landform following completion of dredge activities

The final landform should consider:

- the proposed post quarry land use;
- slope steepness and slope length to facilitate erosion control and establishment of slope stability;
- site drainage;
- requirement for soil preparation (i.e. deep ripping haul road corridors); and
- development to of a 'natural' contour profile.

5.2.2 Species selection for landscape position

Within the Project site, species selection should consider landscape position in relation to either the wetland or beach dune vegetation zones (**Figures 1 and 2**). The beach dune vegetation zones are specifically relevant to high exposed dunes, where wind impacts soil stabilisation.

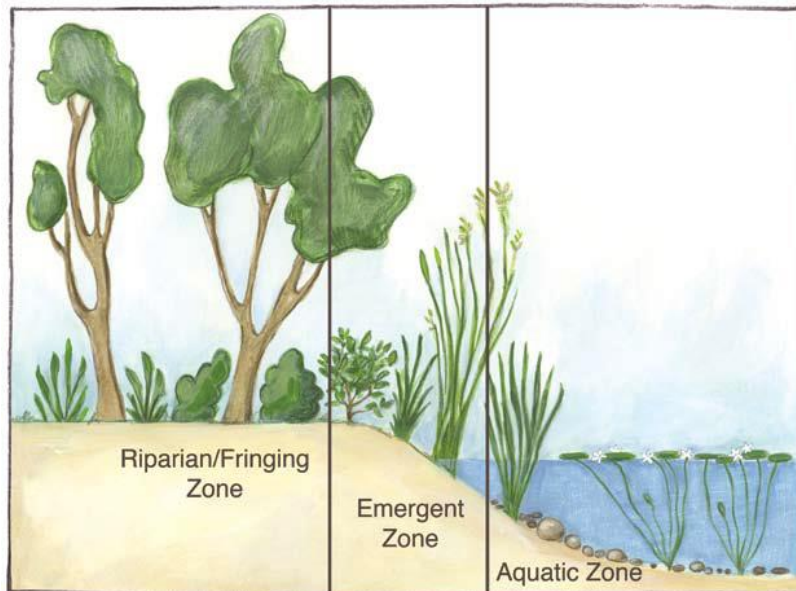


Figure 1: Identification of wetland vegetation zones (Australian Government 2008)

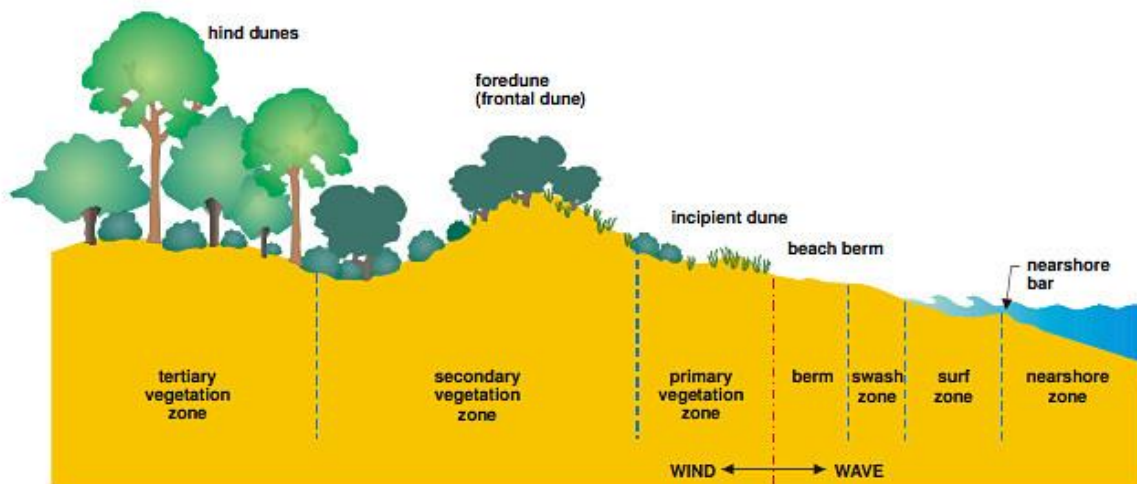


Figure 2: Identification of beach dune vegetation zones (NSW Department of Land and Water Conservation 2001)

A summary of suitable revegetation species is presented in **Table 4**. Note that the list provides a wide range of potential species for use. Use of all species listed is not required.

Table 4: Revegetation species

Species	Vegetation class	Vegetation zone	Suitability notes
Broad leaved Paperbark (<i>Melaleuca quinquenervia</i>)	Tree	Riparian Zone Emergent Zone Hind Dune	Grows in swampy conditions and can regenerate within weeks of a bushfire. Successful previous use on site.
Swamp Mahogany (<i>Eucalyptus robusta</i>)	Tree	Riparian Zone Hind Dune	Grows in swampy sandy conditions and is tolerant of waterlogging. Successful previous use on site.
Smooth-barked Apple (<i>Angophora costata</i>)	Tree	Hind Dune	Large tree, suitable for elevated, but not exposed locations.
Blackbutt (<i>Eucalyptus pilularis</i>)	Tree	Riparian Zone Hind Dune	Large tree common in grassy coastal forests.
Red bloodwood (<i>Corymbia gummifera</i>)	Tree	Riparian Zone Hind Dune	Common to coastal flats and low hills. Tolerant of poorer, sandy soils.
Coastal Wattle (<i>Acacia sophorae</i>)	Shrub	Riparian Zone Hind Dune Foredune	Has the capacity to capture wind blown sands resulting in the formation of hummocks. Beneficial for wind blown and exposed areas. Nitrogen fixing species. Successful previous use on site. Wattles may have relatively short lifespan.
Sydney Golden wattle (<i>Acacia longifolia</i>)	Shrub	Riparian Zone Hind Dune Foredune	Has the capacity to capture wind blown sands resulting in the formation of hummocks. Beneficial for wind blown and exposed areas. Nitrogen fixing species. Subspecies of Coastal wattle. Wattles may have relatively short lifespan.

Species	Vegetation class	Vegetation zone	Suitability notes
Sweet wattle (<i>Acacia suaveolens</i>)	Shrub	Riparian Zone Hind Dune Foredune	Has the capacity to capture wind blown sands resulting in the formation of hummocks. Beneficial for wind blown and exposed areas. Nitrogen fixing species. Wattles may have relatively short lifespan.
Coastal Teatree (<i>Leptospermum laevigatum</i>)	Shrub	Hind Dune Foredune	Salt and drought tolerant. Successful previous use on site.
Coastal Banksia (<i>Banksia integrifolia</i>)	Shrub	Hind Dune Foredune	Thrives in sandy conditions and suitable for the stabilisation of sand and enables the solubilisation of nutrients. Successful previous use on site.
Old Man Banksia (<i>Banksia serrata</i>)	Shrub	Hind Dune Foredune	Thrives in sandy conditions and suitable for the stabilisation of sand and enables the solubilisation of nutrients.
Tree Broom Heath (<i>Monotoca elliptica</i>)	Shrub	Hind Dune Foredune	Long lived and hardy dune species. May be difficult to propagate from seeds – cuttings may perform better.
Common Bush Hop (<i>Dodonaea triquetra</i>)	Shrub	Riparian Zone Hind Dune	Forest understory.
Pig Face (<i>Carpobrotus glaucescens</i>)	Ground cover	Hind Dune Foredune Exposed dune	Has the capacity to capture wind blown sands resulting in the formation of hummocks. Beneficial for wind blown and exposed areas. Successful previous use on site.
Beach Fescue (<i>Austrofestuca littoralis</i>)	Grass	Hind Dune Foredune Exposed dune	Endemic beach grass species. Successful previous use on site.
Blue Flax Lily (<i>Dianella caerulea</i>)	Understory	Riparian Zone Hind Dune Foredune	Hardy and long-lived. Tolerant of a range of moisture conditions.
Kangaroo Grass (<i>Themeda australis</i>)	Grass	Foredune, Exposed dune	Widespread native grass, tolerant of a range of conditions.

Species	Vegetation class	Vegetation zone	Suitability notes
Bracken Fern (<i>Pteridium esculentum</i>)	Understory	Hind Dune Foredune Exposed dune	Quick to colonise disturbed areas. Common in coastal woodlands. May be invasive.
Spiny Headed Mat-Rush (<i>Lomandra longifolia</i>)	Rush	Emergent Zone Riparian Zone	Tolerant of wet and drought conditions.
Cogon Grass (<i>Imperata cylindrica</i>)	Grass	Foredune Exposed dune	Tolerant grass used for ground cover and erosion control. May be invasive and difficult to control. Highly flammable.
Beach Spinifex (<i>Spinifex sericeus</i>)	Grass	Exposed dune	Deep roots to stabilise sand and prevent moisture loss. Recommended for locations where establishment of other vegetation has proven unsuccessful. Successful previous use on site.
Common Spike Rush (<i>Eleocharis acuta</i>)	Rush	Aquatic/emergent zone	Shallow water freshwater wetland rush.

Note(s):

1. Information regarding collection of seed and runners, germination and planting, fertilisation and watering are provided in the Stockton Transgressive Dune Quarry Rehabilitation and Landscape Management Plan (2010).

5.2.3 Stabilisation and revegetation of disturbed areas

It is recommended that the existing Rehabilitation and Landscape Management Plan, Stockton Transgressive Dune Quarry (ERM, 2010) is updated for the Project.

The updated management plan will address:

- the landscape units within each rehabilitation area;
- species and numbers of plants required for each rehabilitation area;
- site preparation requirements – including earthworks and deep ripping;
- soil stabilisation, erosion control and plant protection requirements for each stabilisation area;
- fertilizer requirements; and
- watering and maintenance requirements until plants are established.

Species selection for each area should also address species diversity and succession over time. While some species, such as wattles, may perform well in the short term, they may result in a monoculture which inhibits establishment of other species. Wattles are also relatively short lived and may die out and create a bushfire hazard.

5.2.4 Pest and weed management

Regular inspections should be conducted to assess the presence of pests and weeds. Bitou Bush has previously been a problem at the quarry, however recent management strategies have substantially reduced occurrence. Manual removal has been successful in maintaining control over populations at the quarry. Targeted spraying or removal may be required during the Project.

Potential for animal or insect pest infestation should be monitored and managed as required.

5.3 Rehabilitation inspection schedule

The rehabilitation process should involve regular inspections to monitor the progress of rehabilitation activities, and proactively identify any problems with the remediation process. Monthly and annual inspections are recommended.

5.3.1 Monthly site monitoring

Monthly monitoring of areas relevant to site rehabilitation should continue, as outlined in **Table 5**. Monitoring will focus on identification of any issues relating to plant health or establishment to allow resolution.

Table 5: Monthly monitoring areas

Area	Monitoring requirement
General site	Occurrence of weeds or pests. General health of vegetation.
Trial plantings / Rehabilitation areas	Occurrence of weeds or pests. Health and growth of plants.
Established revegetation areas	Occurrence of weeds or pests. Health and growth of plants. Extent of vegetation cover. Suitability of plant stock for seed or runner collection.

5.3.2 Annual site inspection

An independent inspection of the rehabilitation process should be conducted by a suitably experienced ecologist or environmental restoration consultant. It is recommended that a series of indicator sites are monitored to assess the progress of revegetation, with photographs taken to record site condition. The inspection should assess the site for

compliance with the performance criteria, particularly the 50% LFA target. The inspection should also assess occurrence of any weed species that may be present to facilitate management.

5.3.3 Long term monitoring

It is anticipated that the management and monitoring of the rehabilitation process may extend to a period of up to 10 years from the commencement of rehabilitation of each section of the project area. The point of commencement is considered to be the site preparation and initial planting of those areas. The success of initial site preparation and vegetation establishment is likely to significantly reduce the management requirements for each area over time.

The duration of short to medium term management and monitoring period is estimated to require 1-5 years. This stage involves ensuring landscape stabilisation, vegetation establishment, erosion control and weed management.

If the short to medium term rehabilitation works are successful, monitoring can be substantially reduced over the long term. For the period between 5 and 10 years post rehabilitation monitoring frequency may be reduced. During this period the monitoring would focus on weed management, and species diversity and succession.

Annual site inspections by an ecologist should be maintained for 10 years post rehabilitation, or until the ecologist and administering authority advise that they are no longer required.

5.4 Management and control measures

Erosion and sediment controls are to be implemented and maintained as required through the Project lifespan and until rehabilitated areas have adequately established.

Mechanisms for the control of surface water movement are required and include the following:

- Diversion of 'clean' overland flow to the Project site away from 'dirty' areas;
- Vegetation and maintenance of drainage pathways to minimise erosion and sediment accumulation in flowing water;
- Corrective actions, relating specifically to:
 - maintaining, repairing and cleaning out sediment control structures in order to maintain compliance with the erosion and sediment control plan for the project (i.e. vegetated bund); and
 - repairing eroded areas.

Dust suppression methods are to be used on the existing and proposed haul roads for the Project and with the exception of Stage 1, progressive sand extraction within Stages 2 to 5 will seek to limit exposed ground surfaces to a maximum of 200 - 300 m at any one time to ensure that resource is not lost through exposure to prevailing winds.

5.5 Proposed rehabilitation completion criteria

The completion of the rehabilitation process will be assessed against the performance criteria for the rehabilitation of the final post sand extraction landform. The performance criteria are:

- Stabilisation of the disturbed areas with re-established coverage of endemic species of vegetation; and
- Have a Landscape Function Analysis (LFA) level of natural regeneration greater than 50% of the previously assessed Natural Bushland Control site, located within the quarry property.

The rehabilitation criteria will be deemed to be complete when the criteria have been met, and vegetation communities are mature and stable. It is anticipated that this may occur between 5 and 10 years post rehabilitation for each project area. This will be assessed by the ecologist or environmental restoration consultant completing the annual inspections, who may then provide recommendation that ongoing inspections are no longer required.

6 CONCLUSION

Boral is seeking approval for continued and expanded operations at the Stockton Sand Quarry through a State Significant Development (SSD) application. The Project involves the extraction of sand from the inland vegetated dunes by front-end loader/excavator to a depth of 4 m AHD and subsequent dredging from 4 m AHD to 15 m below sea level (-15 m AHD).

The Project would seek to permit a site wide increase on the dispatch limit to 750,000 tpa (i.e. the windblown sand extraction area and the Project operations combined) up until 2028 after which the site wide limit would reduce to no more than 500,000 tpa.

The Project would be for a period of up to 25 years. Environmental Earth Sciences carried out a site inspection at the quarry on 7 June 2019 to assess the progress of previous rehabilitation efforts at the site. While rehabilitation has been generally successful, the following limitations to success of rehabilitation were identified:

- High wind exposure on elevated dunes impacting surface stabilisation;
- Nutrient deficiencies limiting plant establishment;
- Lack of soil moisture limiting plant establishment; and
- Weed invasion has previously limited establishment of target species.

Potential impacts to the environment are likely to arise through the establishment of the Project, extraction of sand, rehabilitation of the Project site and final land use as a freshwater pond, over a period of approximately 25 years.

Mitigation measures will include:

- a screen or buffer zone of native trees between site activities and the site boundaries
- encouragement of natural reforestation through weed control and reduction.

The proposed final land use of the Project site once all operations cease is to create a wetland (open pit) / freshwater pond surrounded by retained coastal woodland, established with endemic species.

The edges of the pond would be adequately stabilised and revegetated with suitable groundcover species to minimise the potential for soil erosion.

7 LIMITATIONS

This report has been prepared by Environmental Earth Sciences NSW ACN 109 404 006 in response to and subject to the following limitations:

1. The specific instructions received from Element Environment;
2. The specific scope of works set out in PO717059 issued by Environmental Earth Sciences for and on behalf of Element Environment, is included in Section 1.1 (Objectives and Scope) of this report;
3. May not be relied upon by any third party not named in this report for any purpose except with the prior written consent of Environmental Earth Sciences NSW (which consent may or may not be given at the discretion of Environmental Earth Sciences NSW);
4. This report comprises the formal report, documentation sections, tables, figures and appendices as referred to in the index to this report and must not be released to any third party or copied in part without all the material included in this report for any reason;
5. The report only relates to the site referred to in the scope of works being located at Stockton Boral Quarry, Fullerton Cove, NSW ("the site");
6. The report relates to the site as at the date of the report as conditions may change thereafter due to natural processes and/or site activities;
7. No warranty or guarantee is made in regard to any other use than as specified in the scope of works and only applies to the depth tested and reported in this report;
8. Fill, soil, groundwater and rock to the depth tested on the site may be fit for the use specified in this report. Unless it is expressly stated in this report, the fill, soil and/or rock may not be suitable for classification as clean fill, excavated natural material (ENM) or virgin excavated natural material (VENM) if deposited off site;
9. This report is not a geotechnical or planning report suitable for planning or zoning purposes; and
10. Our General Limitations set out at the back of the body of this report.

8 REFERENCES

- Australian Government (2008) Wetland Rehabilitation Guidelines for the Great Barrier Reef catchment. Queensland Wetlands Program.
- Environmental Compliance Services (2017) Stockton Transgressive Dune Quarry, Rehabilitation and Landscape Management Plan. Prepared for Boral Resources (Country) Pty Ltd. March 2017
- Environmental Resources Management Australia (ERM, 2010a), Erosion and Sedimentation Control Plan, Stockton Transgressive Dune Quarry, Boral Resources (NSW) Pty Ltd, dated August 2010 (reference: 0119396 ESCP Final)
- Environmental Resources Management Australia (ERM, 2010b), Rehabilitation and Landscape Management Plan, Stockton Transgressive Dune Quarry, Boral Resources (NSW) Pty Ltd, dated August 2010 (reference: 0119396 RLMP Final).
- Environmental Earth Sciences (2019), Hydrogeological Impact Assessment, Stockton Sand Quarry, Cops Lane, Fullerton Cove, NSW, Element Environment, dated April 2019 (reference: 717041_V1).
- NSW Department of Trade and Investment (ESG3) Mining Operations Plan (MOP) Guidelines, dated September 2013.
- Office of Environment and Heritage (OEH) (2018), Biodiversity Assessment Method Operational Manual – Stage 1, dated May 2018.
- RW Corkery & Co Pty Ltd (2018) Rehabilitation and Landscape Management Plan for the Stockton Transgressive Dune Quarry. Prepared for Boral Resources (NSW) Pty Ltd. September 2018.
- Stehn C1 (2015) A guide to species selection for revegetation projects in the Coffs Harbour Local Government Area, Coffs Harbour City Council, Coffs Harbour, New South Wales, Australia, unpublished draft report.

ENVIRONMENTAL EARTH SCIENCES GENERAL LIMITATIONS

Scope of services

The work presented in this report is Environmental Earth Sciences response to the specific scope of works requested by, planned with and approved by the client. It cannot be relied on by any other third party for any purpose except with our prior written consent. Client may distribute this report to other parties and in doing so warrants that the report is suitable for the purpose it was intended for. However, any party wishing to rely on this report should contact us to determine the suitability of this report for their specific purpose.

Data should not be separated from the report

A report is provided inclusive of all documentation sections, limitations, tables, figures and appendices and should not be provided or copied in part without all supporting documentation for any reason, because misinterpretation may occur.

Subsurface conditions change

Understanding an environmental study will reduce exposure to the risk of the presence of contaminated soil and or groundwater. However, contaminants may be present in areas that were not investigated, or may migrate to other areas. Analysis cannot cover every type of contaminant that could possibly be present. When combined with field observations, field measurements and professional judgement, this approach increases the probability of identifying contaminated soil and or groundwater. Under no circumstances can it be considered that these findings represent the actual condition of the site at all points.

Environmental studies identify actual sub-surface conditions only at those points where samples are taken, when they are taken. Actual conditions between sampling locations differ from those inferred because no professional, no matter how qualified, and no sub-surface exploration program, no matter how comprehensive, can reveal what is hidden below the ground surface. The actual interface between materials may be far more gradual or abrupt than an assessment indicates. Actual conditions in areas not sampled may differ from that predicted. Nothing can be done to prevent the unanticipated. However, steps can be taken to help minimize the impact. For this reason, site owners should retain our services.

Problems with interpretation by others

Advice and interpretation is provided on the basis that subsequent work will be undertaken by Environmental Earth Sciences NSW. This will identify variances, maintain consistency in how data is interpreted, conduct additional tests that may be necessary and recommend solutions to problems encountered on site. Other parties may misinterpret our work and we cannot be responsible for how the information in this report is used. If further data is collected or comes to light we reserve the right to alter their conclusions.

Obtain regulatory approval

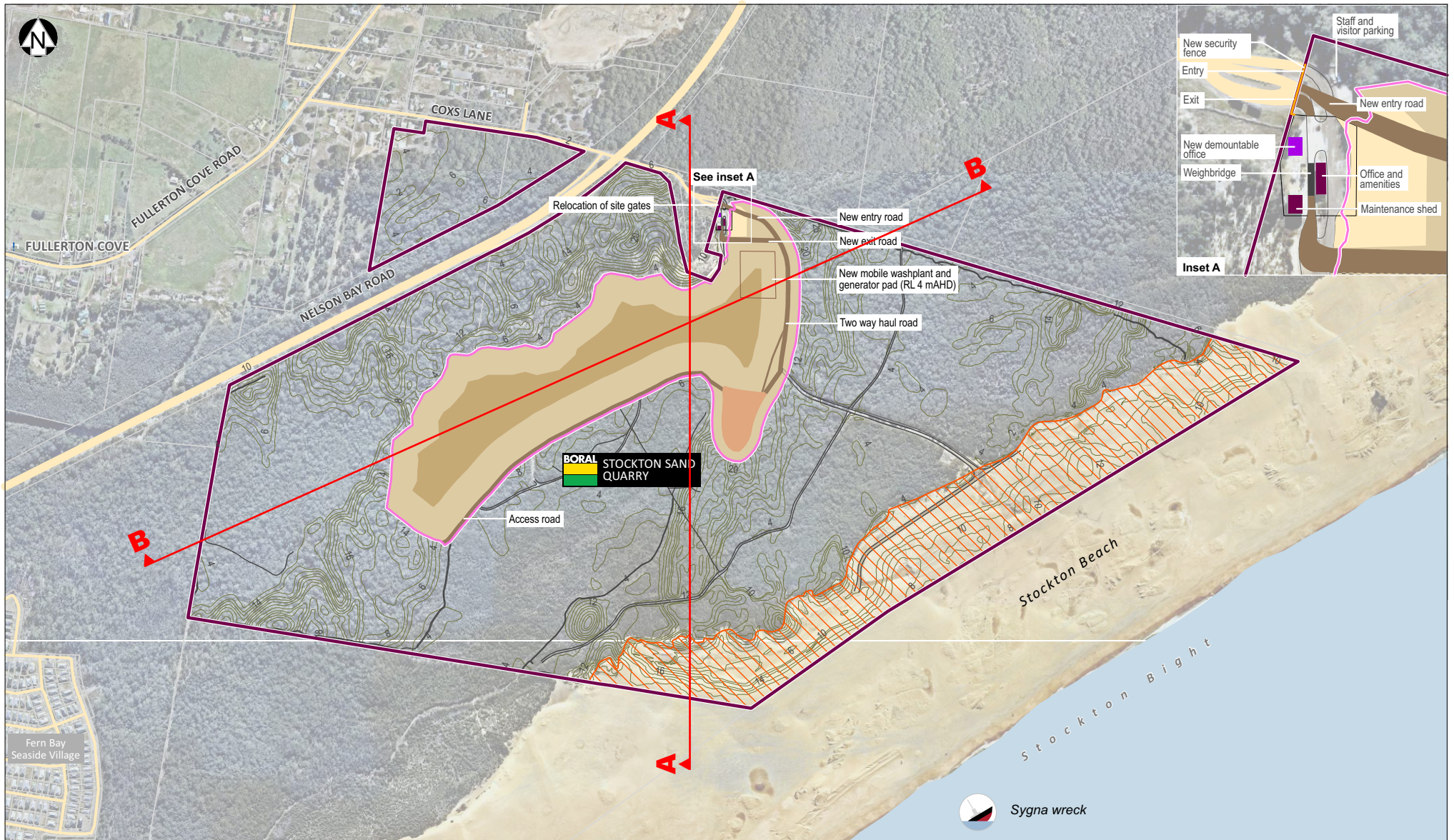
The investigation and remediation of contaminated sites is a field in which legislation and interpretation of legislation is changing rapidly. Our interpretation of the investigation findings should not be taken to be that of any other party. When approval from a statutory authority is required for a project, that approval should be directly sought by the client.

Limit of liability

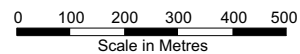
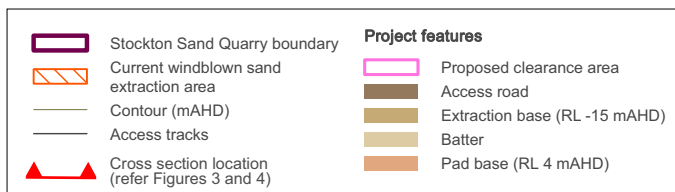
This study has been carried out to a particular scope of works at a specified site and should not be used for any other purpose. This report is provided on the condition that Environmental Earth Sciences NSW disclaims all liability to any person or entity other than the client in respect of anything done or omitted to be done and of the consequence of anything done or omitted to be done by any such person in reliance, whether in whole or in part, on the contents of this report. Furthermore, Environmental Earth Sciences NSW disclaims all liability in respect of anything done or omitted to be done and of the consequence of anything done or omitted to be done by the client, or any such person in reliance, whether in whole or any part of the contents of this report of all matters not stated in the brief outlined in Environmental Earth Sciences NSW's proposal number and according to Environmental Earth Sciences general terms and conditions and special terms and conditions for contaminated sites.

To the maximum extent permitted by law, we exclude all liability of whatever nature, whether in contract, tort or otherwise, for the acts, omissions or default, whether negligent or otherwise for any loss or damage whatsoever that may arise in any way in connection with the supply of services. Under circumstances where liability cannot be excluded, such liability is limited to the value of the purchased service.

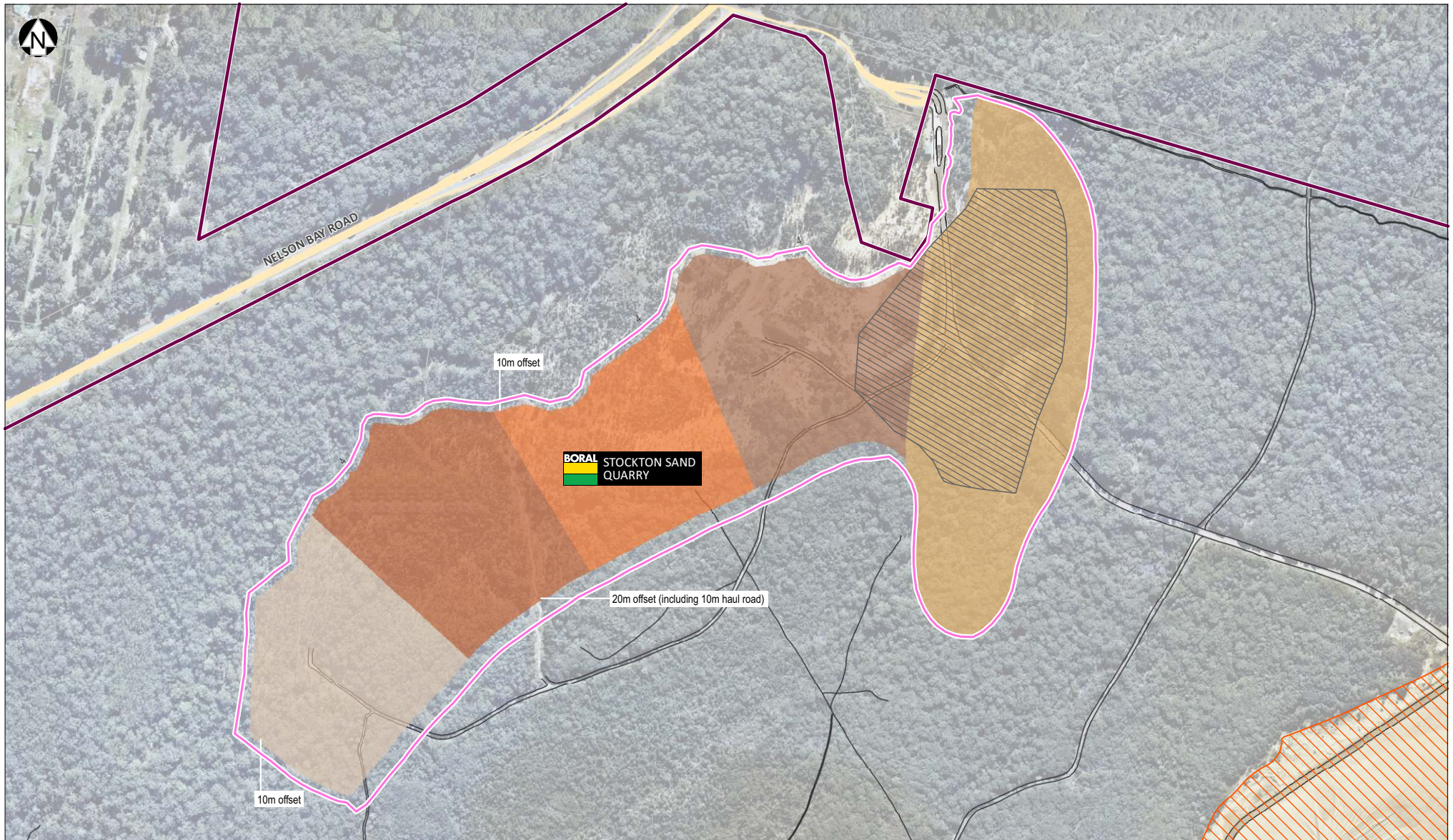
FIGURES



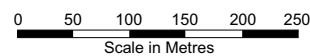
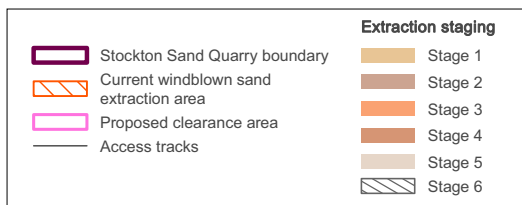
Source: Element Environment



ENVIRONMENTAL EARTH SCIENCES CONTAMINATION RESOLVED		Title: Project Layout
		Location: Nelson Bay Road, Fullerton Cove, NSW
Client: Boral Quarries		Job No: 717041
Project Man: LL/AS	Scale: As shown	Figure 1
Drawn By: LB	Date: July 2019	



Source: Element Environment



Title: **Extraction Staging Plan**

Location: **Nelson Bay Road, Fullerton Cove, NSW**

Client: **Boral Quarries**

Job No: **717041**

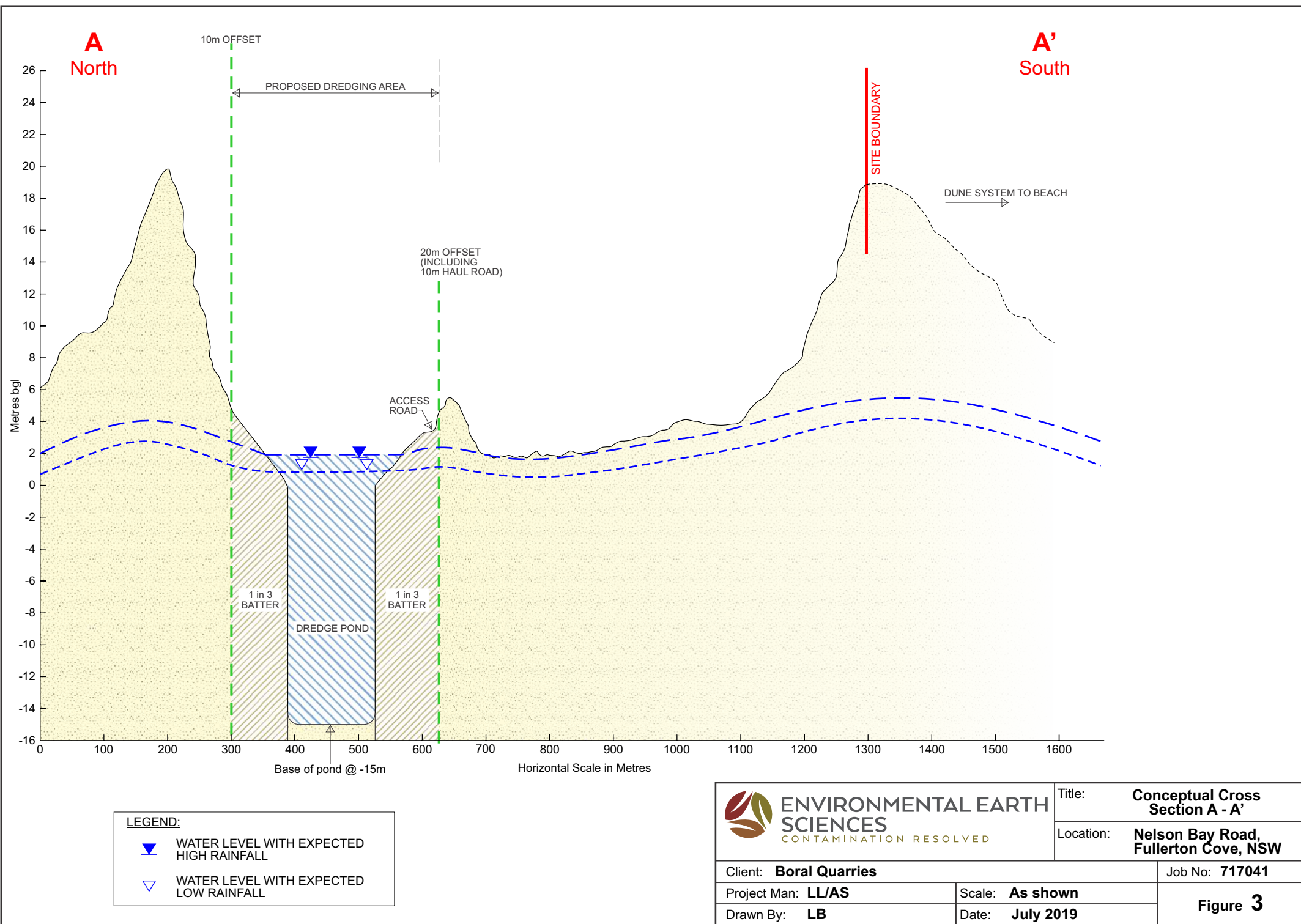
Project Man: **LL/AS**

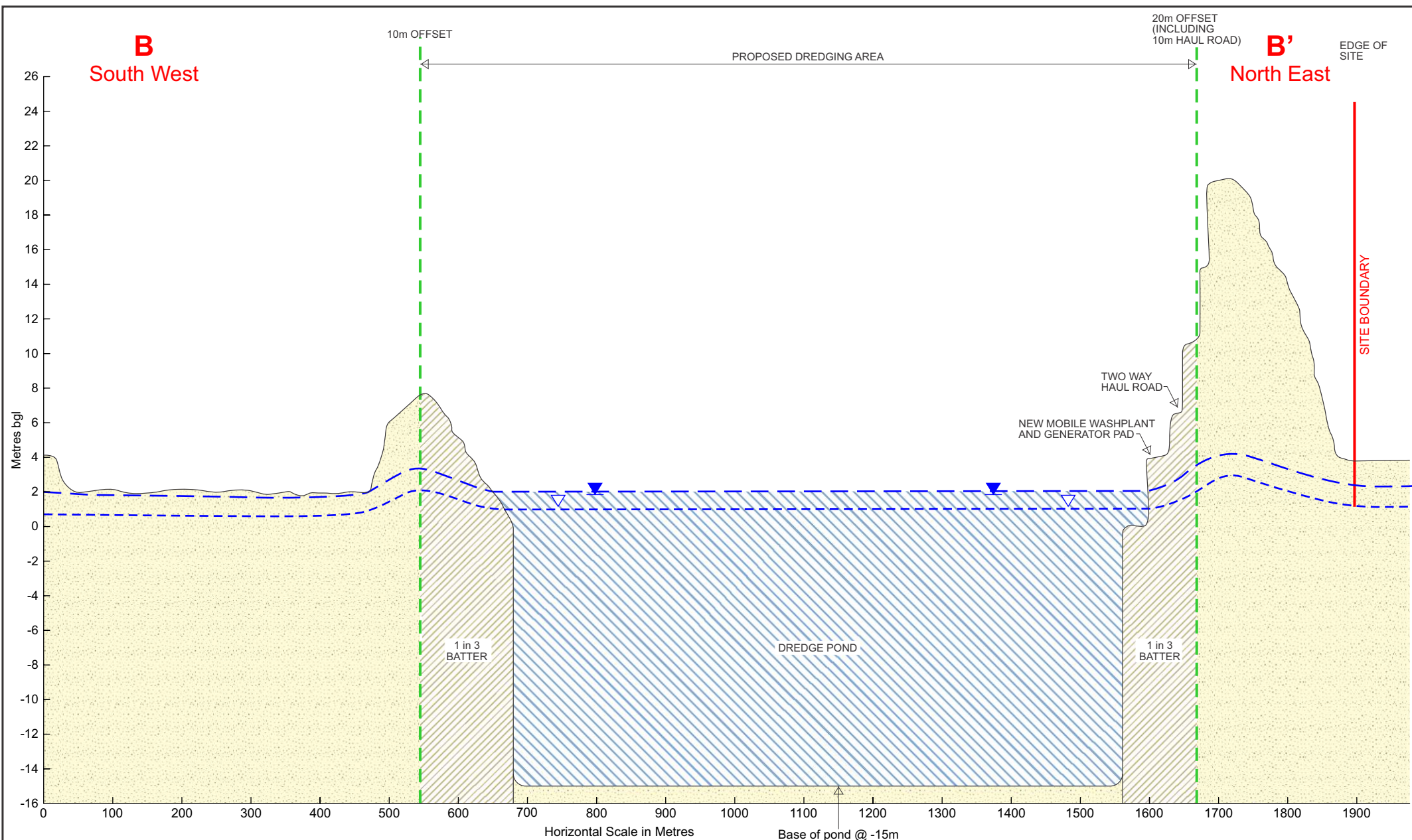
Scale: **As shown**

Drawn By: **LB**

Date: **July 2019**

Figure 2





Title: **Conceptual Cross Section B - B'**

Location: **Stockton Sand Quarry
Coxs Lane, Fullerton Cove, NSW**

Client: **Boral Quarries**

Job No: **717041**

Project Man: **LL/AS**

Scale: **As shown**

Drawn By: **LB**

Date: **July 2019**

Figure 4

APPENDIX A: PHOTOGRAPH PLATES



1. Successful rehabilitation in Stage 1 / Stage 6



2. Stage 1 / Stage 6 rehabilitation poor surface stabilisation in one small area - east of the haul road.



3. Areas of stunted growth in Stage 1 / Stage 6 and Stage 2



4. Areas of stunted growth in Stage 1 / Stage 6 and Stage 2



5. Successful rehabilitation in remaining areas of Stage 4



6. Northern boundary between Stage 3 and Stage 4



7. Northern boundary between Stage 3 and Stage 4



8. Successful rehabilitation of Stage 5



9. Slow growth in small area of Stage 5