

25 June 2019

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Re: Submissions for proposed Modification 2 of the Dunmore lakes Sand Project

Background

Public and Government authorities have provided submissions regarding the proposed Modification 2 of the Dunmore Lakes Sand Project. A number of these submissions relate to water quality and flooding issues addressed in the Surface Water Assessment prepared by Southeast Engineering and Environmental.

The surface Water Assessment has been updated to address many of the submissions, particularly issues relating to flooding.

This letter summarises the submissions provided by agencies and local government as well as a response to each submission that also references the sections of the updated Surface Water Assessment where that issue has been addressed (Table 1).

Table 1 Summary of submission issues and response.

Party	Issue outlined in submission.	Response
DPE	Please provide further flooding information, including flood extent maps and a flood impact assessment (including an assessment of a range of floods up to the probable maximum flood (PMF)).	The 5, 20, 100 year ARI and PMF events have been modelled for the existing and proposed conditions for both Stage 5A and 5B. Key impacts are: - For 5A, a 16mm increase over Riverside Drive in the 5 year ARI event and smaller increases in other events. - For 5B, no impacts beyond the site boundary. Approximately 45mm increase in flood height for the 100 year ARI event at the southern end of the bunded dredge pond. A large (1.6m/s) increase in flood velocity over the dredge pond spillway will occur in a PMF event. Refer to sections 3 and 4 of the Surface Water Assessment for more detail.
	Please provide further information on potential cumulative impacts to adjoining and downstream environments, in accordance with relevant coastal management and regional planning policy frameworks.	The Surface Water Assessment has been updated to consider the cumulative impacts associated with the land use change over the site, in the context of the broader catchment. Over the short term pollutant loads should not increase conditional on appropriate EMPs being implemented. Additionally, no increase to the current annual extraction is proposed, limiting environmental risk associated with processing operations to close to the current situation. In the long term Stage 5B will be converted to a rehabilitated pond and surrounding native vegetation, an improvement on the previous grazing land use in terms of pollutant load. Refer to section 4.8 in the updated Surface Water Assessment.
EPA	WATER Surface Water & Groundwater Given the potential for acid to be a pollutant of concern at the operations, a review of management and mitigation practices is required, particularly in relation to the local lowering of pH levels should acidification occur. The proponent has advised that an Acid Sulphate Soil Management Plan (ASSMP) will be prepared to incorporate the new extraction areas. The proposed ASSMP (incorporating both stage 5 extraction areas) should be prepared in discussions with EPA and the Office of Environment and Heritage.	An ASSMP will be prepared.

OEH	<i>Floodplain Risk Management & Water Quality</i> The flood information provided in the Surface Water Assessment Report (2019) is limited, and no flood extents maps have been provided nor have flood impacts been assessed. Furthermore, and in contrast to current operations, the proposed modification will result in a loss of floodplain storage during operation due to the proposed bunding of excavation pits. We therefore recommend that an assessment for the full range of floods up to the probable maximum flood (PMF) be undertaken in both Stages 5A and 5B. This assessment should address existing and developed scenarios, flood impacts and trafficability, including implications for accessibility for emergency services and isolation.	Updated flood modelling has been undertaken to consider the impacts of the proposed bunded dredge ponds on floodplain storage and associated flood levels. Refer to sections 3.0 and 4.0 of the updated Surface Water Assessment for detail.
	<i>Floodplain Risk Management & Water Quality</i> Whilst the environmental assessment describes the existing environmental setting and assesses the potential direct impacts associated with the modification, it does not conclusively address potential cumulative impacts to adjoining and downstream environments. It is therefore recommended that further information be provided to characterise potential adverse cumulative impacts on adjoining coastal wetlands, including the proposal's influence on the environmental health of the Minnamurra River estuary, in accordance with the relevant coastal management and regional planning policy frameworks.	The Surface Water Assessment has been amended to consider the cumulative impacts associated with the land use change over the site, in the context of the broader catchment. Over the short term pollutant loads should not increase conditional on appropriate EMPs being implemented. Additionally, no increase to the current annual extraction is proposed, limiting environmental risk In the long term Stage 5B will be converted to a rehabilitated pond and surrounding native vegetation, an improvement on the previous grazing land use in terms of pollutant load. Refer to section 4.8 in the updated report.

DPI, (NRAR	Estimate the volume of aquifer material to be removed from the excavations, and the effect of this on groundwater inflow during sand extraction. The aquifer material volume/removal rate must to be accounted for, and water balances updated and presented for both extraction and non-extraction scenarios.	With respect to water balances, a water balance accounting for losses associated with material extraction and water use associated with dust suppression have been included in the Surface Water Assessment. Water leaving the ponds as part of the sand slurry will be returned to the dredge ponds in the return pipeline. Additional water balance information accounting for changes to the site water balance associated with the creation of dredge ponds and associated direct rainfall and evaporation from the groundwater table has been included. Refer to section 4.6 in the Surface Water Assessment.
Kiama Municipal Council	The Environment Assessment indicates that the Stage 5A extraction area lies within flood prone land associated with the Rocklow Creek catchment, while the Stage 5B extraction area lies within the floodplain of Minnamurra River. The proposed modification would result in ground disturbance which has the potential to expose ground surfaces to erosion and result in sedimentation of local watercourses and ultimately Rocklow Creek and Minnamurra River, and associated coastal wetland. Area 5B is very low-lying and council is concerned that the extraction will impact on natural groundwater and surface water (flood) flows with resultant impacts on the adjoining coastal wetland ecosystems.	The proposed extraction areas will be isolated from flood events up to the 100 year ARI flood to reduce the risk of water quality impacts. A range of water quality management measures have been outlined in the Surface Water Assessment for the construction, operation and rehabilitation phases of the development. Updated flood modelling has been undertaken to consider the impacts of the proposed banded dredge ponds on floodplain storage and associated flood levels. Refer to sections 3.0 and 4.0 of the updated Surface Water Assessment for detail
Shellharbour City Council	i. Potential impact on water quality to Rocklow Creek and the Minnamurra River are from sedimentation resulting from soil disturbance as well as groundwater contamination as discussed above. ii. With regard to sedimentation management, adequate measures must be implemented to ensure material cannot move from the site and contaminate downstream	Refer to the comments outlined above for Kiama Municipal Council. Updated flood modelling has been undertaken making use of a hydrologic and hydraulic model commissioned by Kiama Municipal Council for the proposed Minnamurra River shared user pathway. The model assumes 100% blockage at Riverside Drive. Model background and assumptions used can be found in <i>Flood and Coastal Study, Stage 2 Report, Minnamurra River Boardwalk</i> (Cardno, 2019). Regarding vehicle impacts, the proposed car park at Stage 5B is located above the PMF flood level.

	environments. The summary report states that this will be addressed in updates to the current Environmental Management Plan. Flooding comments covering a range of issues including: i. Events modelled ii. Vehicle stability iii. Vehicle movement during a PMF iv. Spillway design for a range of events v. Potential for embankment failure and potential impacts vi. Freeboard vii. Losses assumed viii. Blockage scenarios not modeled ix. Invert levels assumed	Spillway design will undertaken to accommodate 100 year ARI and PMF flood depths and velocities. Water levels within bunded areas will generally be similar to adjacent water levels though ground water or flood flow overtopping impacts. Periods of difference in water level between dredge ponds and outer environment will be limited as ponds will be emptied to allow for dredge operations to resume. The bund freeboard is based on limiting the risk of inflows into the basins, as such freeboard guidelines used for the design of flood/stormwater retention structures to provide protection in residential areas is not necessarily applicable. Refer to sections 3.0 and 4.0 of the SWA for detail on the updated flood modelling.
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Please contact the undersigned if you have any questions regarding this letter.

Yours sincerely,

A handwritten signature in black ink, appearing to read 'L Bain', written in a cursive style.

Lachlan Bain

Environmental Engineer BEng (Env) MEM.

Surface Water Assessment for Modification 2 of the Dunmore Lakes Sand Project.

**Report Prepared for: Element Environment, on behalf of
Dunmore Sand & Soil Pty Limited**

February 2019 (updated June 2019)

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1.0 INTRODUCTION

1.1. Background

Southeast Engineering and Environmental has been engaged by Element Environment (Element on behalf of Dunmore Sand & Soil Pty Ltd (DSS) to undertake a detailed surface water assessment report as part of a modification to the current Project Approval (195-8-2004) made under Section 75W of the *Environmental Planning and Assessment Act 1979* (EP&A Act). This modification will provide an additional extraction area (Stage 5) on adjoining private land, encompassing two separate extraction areas, Stage 5A and Stage 5B (hereafter referred to as the 'modification').

The objective of this assessment is to outline, and where possible, quantify the potential water quality and quantity impacts and issues associated with the modification and to develop management and mitigation measures as required.

1.2. Proposal

The modification seeks to establish additional extraction areas (Stage 5) on adjoining private property which is to be leased by DSS. The Stage 5 extraction areas would be separated into two, namely Stage 5A (immediately south of Riverside Drive), and Stage 5B (to the north of the Minnamurra River). The approximate sand resource to be extracted from Stage 5A is estimated at 234,000 tonnes, while Stage 5B would extract approximately 1,123,000 tonnes. The aforementioned quantities are the estimated sand resource only, and additional tonnage of soil material may also be extracted in addition to the sand resource. The current approval allows for a total extraction of 800,000 tonnes per annum (tpa).

Sand will be transferred from the Stage 5A and 5B dredge ponds to the Stage 2 area for processing via a transfer pipe. The transfer pipe will be laid on the ground surface, floated over existing pond areas, beneath roads within existing culverts and suspended over Rocklow Creek.

Mobile plant and equipment utilised at the site would be operated across both extraction areas within Stage 5. Extraction methods would be identical to those currently implemented in Stage 2 and 3 of the approved operations.

2.0 RELEVANT LEGISLATION, POLICY AND GUIDELINES

2.1. Planning context

The proposed works are sought via a modification to the current Project Approval (195-8-2004) made under Section 75W of the *Environmental Planning and Assessment Act 1979* (EP&A Act). Part 3A of the EP&A Act exempts a development from a range of approvals and legislation, including:

- (a) the concurrence under Part 3 of the *Coastal Protection Act 1979* of the Minister administering that Part of the Act,
- (b) a permit under section 201, 205 or 219 of the *Fisheries Management Act 1994*,
- (h) a water use approval under section 89, a water management work approval under section 90 or an activity approval under section 91 of the *Water Management Act 2000*.

2.2. Legislation

2.2.1. Fisheries Management Act 1994

Permits to dredge, reclaim, harm marine vegetation or block fish passage are not required as the original development is considered to be approved under Part 3A of the EP&A Act. However, the objectives of the *Fisheries Management Act 1994*, particularly those associated with part 7, Protection of aquatic habitats, and part 7A, Threatened species conservation, need to be observed, and have been considered in the development of the proposed modification.

The *Policy and guidelines for fish habitat and conservation management* (DPI, 2013) have been incorporated into this assessment, in particular, the proximity of works to Type 1 Highly sensitive key fish habitat and Class 1 waterways and the potential impacts associated with the modification activities.

2.2.2. State Environmental Planning Policy 2018 (Coastal Management)

The aim of SEPP 2018 (Coastal Management) is to promote an integrated and coordinated approach to land use planning in the coastal zone in a manner consistent with the objects of the *Coastal Management Act 2016*. The proposed modification encroaches into the defined Coastal Environment Area, and Stage 5A of the modification encroaches into the Coastal Wetland proximity Area (Figure 3.8). The legislation requires that the development will not significant impacts ecological values, water quality and quantity, create adverse impacts on a range of ecological and social values associated with the coastal environment and mitigate adverse impacts where impacts are unavoidable. These requirements have been incorporated into the assessment and design of the modification, in particular the isolation as much as possible of the extraction areas from adjacent wetland and estuarine areas.

2.2.3. Water Management Act (WMA) 2000

The principles outlined in Section 5 of the WMA apply to the proposed modification, specifically:

(4) In relation to water use:

- (a) water use should avoid or minimise land degradation, including soil erosion, compaction, geomorphic instability, contamination, acidity, waterlogging, decline of native vegetation or, where appropriate, salinity and, where possible, land should be rehabilitated, and
- (b) water use should be consistent with the maintenance of productivity of land in the long term and should maximise the social and economic benefits to the community, and
- (c) the impacts of water use on other water users should be avoided or minimised.

(6) In relation to floodplain management:

- (a) floodplain management must avoid or minimise land degradation, including soil erosion, compaction, geomorphic instability, contamination, acidity, waterlogging, decline of native vegetation or, where appropriate, salinity and, where possible, land must be rehabilitated, and
- (b) the impacts of flood works on other water users should be avoided or minimised, and
- (c) the existing and future risk to human life and property arising from occupation of floodplains must be minimised.

(7) In relation to controlled activities:

- (a) the carrying out of controlled activities must avoid or minimise land degradation, including soil erosion, compaction, geomorphic instability, contamination, acidity, waterlogging, decline of native vegetation or, where appropriate, salinity and, where possible, land must be rehabilitated, and
- (b) the impacts of the carrying out of controlled activities on other water users must be avoided or minimised.

These objectives have been incorporated into the modification design and associated management and mitigation measures, in particular the bunding of extraction areas, assessment of floodplain impacts and proposed rehabilitation.

2.2.3.1. Controlled Activities

Controlled activity approval under the WMA is not required as the development is considered to be approved under Part 3A of the EP&A Act. Nevertheless, the guidelines managed by the Natural resources Access Regulator (NRAR) need to be followed.

Relevant guidelines considered in this SWA are:

- *Guidelines for Controlled Activities on Waterfront Land - Riparian Corridors (NRAR, 2018)*
- *Guidelines for Instream Works on Waterfront Land (DPI Water, 2012a)*
- *Guidelines for Laying Pipes and Cables in Watercourses on Waterfront Land (DPI Water, 2012b)*
- *Guidelines for Outlet Structures on Waterfront Land (DPI Water, 2012c)*
- *Guidelines for Vegetation Management Plans on Waterfront Land (DPI Water, 2012d)* and
- *Guidelines for Watercourse Crossings on Waterfront Land (DPI Water, 2012e).*

2.2.3.2. Surface Water Sharing Plans

The site is located within the Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources within the defined 'Illawarra Rivers' water source.

The current operation has a groundwater Water Access Licence (WAL24477) issued under the *Water Management Act 2000*. The licence permits the taking of 65ML/y of water from the Sydney Basin South Groundwater Source and is subject to a number of conditions. Associated 'work approvals' include 10WA106713 and 10WA106714.

The additional Stage 5 extraction area would require additional water demand for operations of the Dunmore Lakes Sand Project. The current water demand is at the threshold of licensed extraction volumes. This is discussed in section 4.0.

An additional Water Access Licence (WAL 42100) for 15ML has been obtained, at the time of preparing this report no Water Supply Work approval has been nominated in conjunction with this licence. A WAL for a further 20ML of allocation which has been secured is being applied for.

2.2.4. 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. The PoEO Act is relevant to the Modification as it contains requirements relating to the prevention of the pollution of waters.

The current Environmental Protection Licence (EPL) has a range of surface water related controls relating to sediment management and flooding along with the approval conditions (refer to section 2.4).

2.3. Guidelines

2.3.1. Erosion and sediment control guidelines

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). In this case, the sand extraction process generates a sediment basin by default and is isolated from surrounding runoff. Fines management will occur in the existing fines management basin at Stage 2.

Chapter 6 of *Managing Stormwater: Soils and Construction, Volume 2A – Installation of services* (DECC, 2008) outlines a range of sediment and erosion controls applicable for the installation of the transfer pipeline, particularly where vegetation clearing is required. Refer to section 4.0.

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 unsealed access road from the end of the existing sealed Fig Hill Lane, the car parking area adjacent to the Stage 5B area, as well as the haul roads surrounding the Stage 5A and 5B areas. Refer to section 4.0.

2.3.2. NSW Floodplain Development Manual

The *NSW floodplain development manual* (DIPNR) outlines a merit based approach for the assessment of development within the floodplain, including the risks associated with development to determine whether that use of the floodplain is appropriate and sustainable. Section 4.0 outlines the potential floodplain impacts of the proposed development.

2.3.3. NSW State Rivers and Estuaries Policy (1993)

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 surface water management of the modification has been designed in accordance with the objectives of the Policy. The key aspect is to demonstrate that there is no degradation of adjacent unnamed tributaries, Rocklow Creek, the Minnamurra River and associated estuaries.

2.4. Environment Protection Licence and Current approval conditions relating to surface water management

This proposal is a modification to an existing approval. Controls within the existing EPL that relate to surface water management are as follows:

L1.1 Except as may be expressly provided in any other condition of this licence, the licensee must comply with section 120 of the Protection of the Environment Operations Act 1997.

O5.1 TRUCK WASH

All vehicles must pass through the truck wash facility prior to leaving the premises.

O5.2 STORMWATER/SEDIMENT CONTROL - CONSTRUCTION AND OPERATIONAL PHASES

O5.3 Any pond subject to dredging, or containing turbid water due to recent dredging, must be maintained and operated to prevent discharges of any water from these ponds.

O5.4 Backfilling of the dredge ponds must not take place when they are overflowing.

O5.5 The fines return pond(s) must be bunded to an elevation that prevents inundation by floodwaters caused in a 1:100 year flood level. Note: The predicted 1:100 year flood level for the site is 3.7 m AHD.

The current development consent contains the following conditions relating to water quality control, stormwater management and floodplain management for the ponds and for discharges from the site:

SCHEDULE 3 – SPECIFIC ENVIRONMENTAL CONDITIONS

Pollution of waters

22. Except as may be expressly provided by an Environment Protection Licence, the Applicant must comply with section 120 of the Protection of the Environment Operations Act 1997 during the carrying out of the development.

Water Discharge Limit

23. Except as may be expressly provided by an Environmental Protection Licence, the Applicant must ensure that the discharges from any licenced discharge point/s do not cause additional exceedances of the criteria in Table 6:

Table 6: Water Discharge Pollution Limits

Pollutant	Unit of Measure	100 Percentile Concentration Limit
Total Suspended Solids	mg/L	50
pH	pH	± 1.0

Water Quality Objectives

24. The Applicant must ensure that water quality in the dredge ponds and in groundwater comply with the water quality objectives in Table 7, or other such level as approved by the Secretary:

Table 7: Water Quality Objectives

Pollutant	Unit of Measure	Water Quality Objective
Turbidity	NTU	5-20
pH	pH	6.5 – 8.5
Salinity	µS/cm	<1,500
Dissolved oxygen	mg/L	>6
Total phosphorus	µg/L	5-50
Total nitrogen	µg/L	100-500
Chlorophyll-a	µg/L	2-10
Faecal coliforms	Median No./100mL	<1000
Enterococci	Median No./100mL	<230
Algae and blue-green algae	No.cells/mL	<15,000
Sodium	mg/L	400
Potassium ion	mg/L	50
Magnesium ion	mg/L	50
Chloride ion	mg/L	300
Sulphate ion	mg/L	250
Bicarbonate ion	mg/L	750
Soluble Iron ion	mg/L	6
Ammonium ion	mg/L	20

Notes:

- The objectives for dissolved oxygen, turbidity and algae are relevant to surface water only;
- The Department acknowledges that short term exceedances of these objectives may occur during natural events such as heavy rainfall or tidal saline water inflow.

Stormwater Management

25. The Applicant must ensure that any pond subject to dredging or backfilling, or containing turbid water due to recent dredging or backfilling, must be maintained and operated to prevent discharges of any turbid water (as defined in Tables 6 and 7) from these ponds.

26. The Applicant must cease backfilling activities not less than 12 hours prior to the commencement of overflow from any dredge pond. No backfilling must occur when the dredge ponds are overflowing.

Flood Management

27. The Applicant must ensure that the flood storage capacity of the site is no less than the pre-existing flood storage capacity at all stages of the development. Details of the available flood storage capacity must be reported in the Annual Review.

28. The access road entrance off Tabbita Road, processing and stockpile area, and the fines return pond(s) must be constructed and maintained so as to prevent inundation by floodwaters caused by the 1 in 100 year ARI flood level. Prior to the commissioning of the processing area, the Applicant must provide certification to the Secretary that this condition has been complied with.

29. Following the cessation of dredging and backfilling operations, the Applicant must commission a suitably qualified hydrologist to define the flood-related limits of the final landform. The flood study must be undertaken in consultation with the Department and Shellharbour Council, and to the satisfaction of the Secretary.

3.0 SURFACE WATER CONTEXT

3.1. Overall catchment

The Stage 5A and Stage 5B extraction areas are located between the Minnamurra River to the south, an unnamed tributary almost directly west, and Rocklow Creek to the north (Figure 3.1 and Figure 3.2).

The existing processing area is located within the Stage 2 area of the DSS operations, extending over a portion of the floodplain of Rocklow Creek, and associated tributaries to the north of the Stage 5A area.

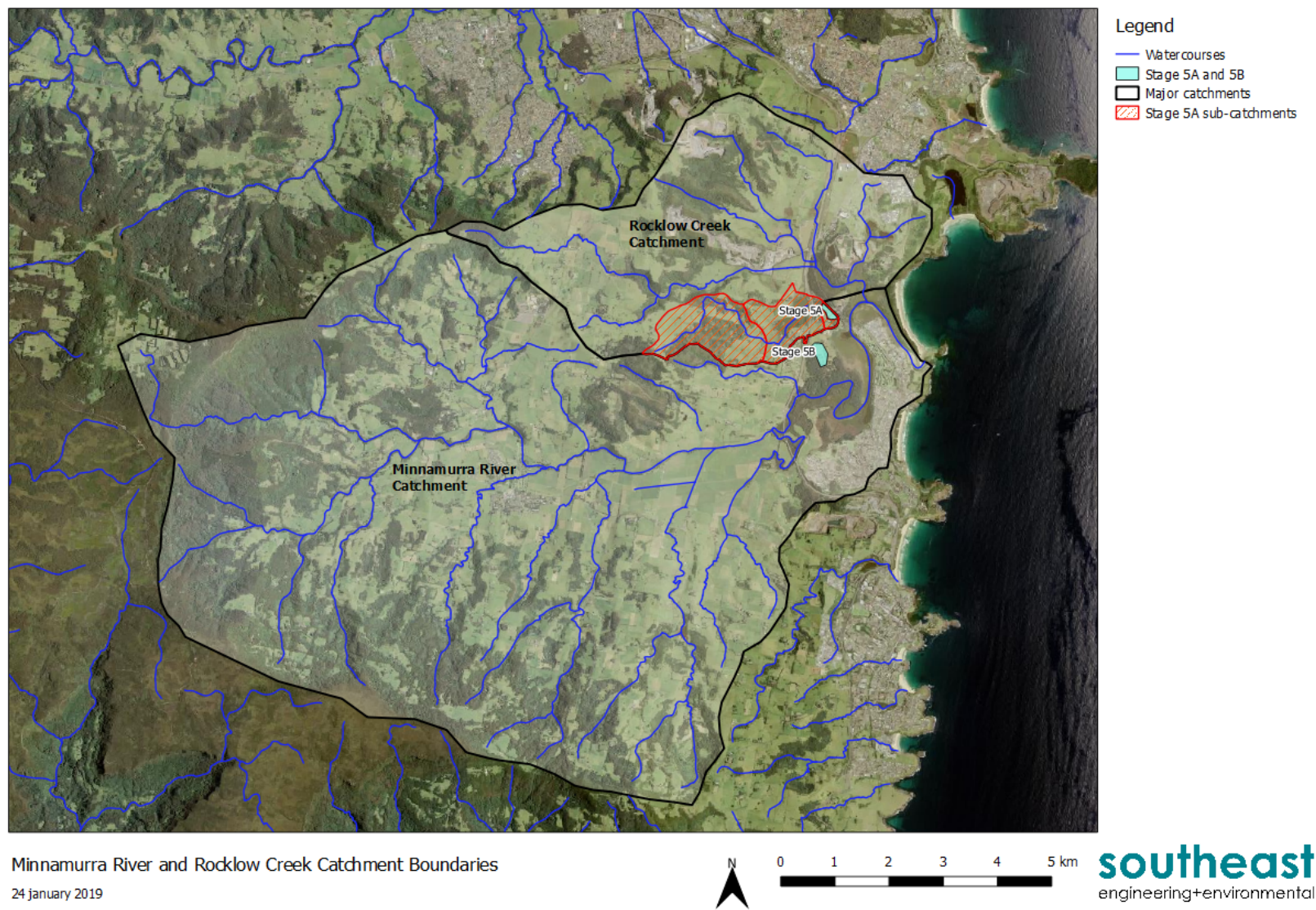


Figure 3.1 Proposal and catchment context

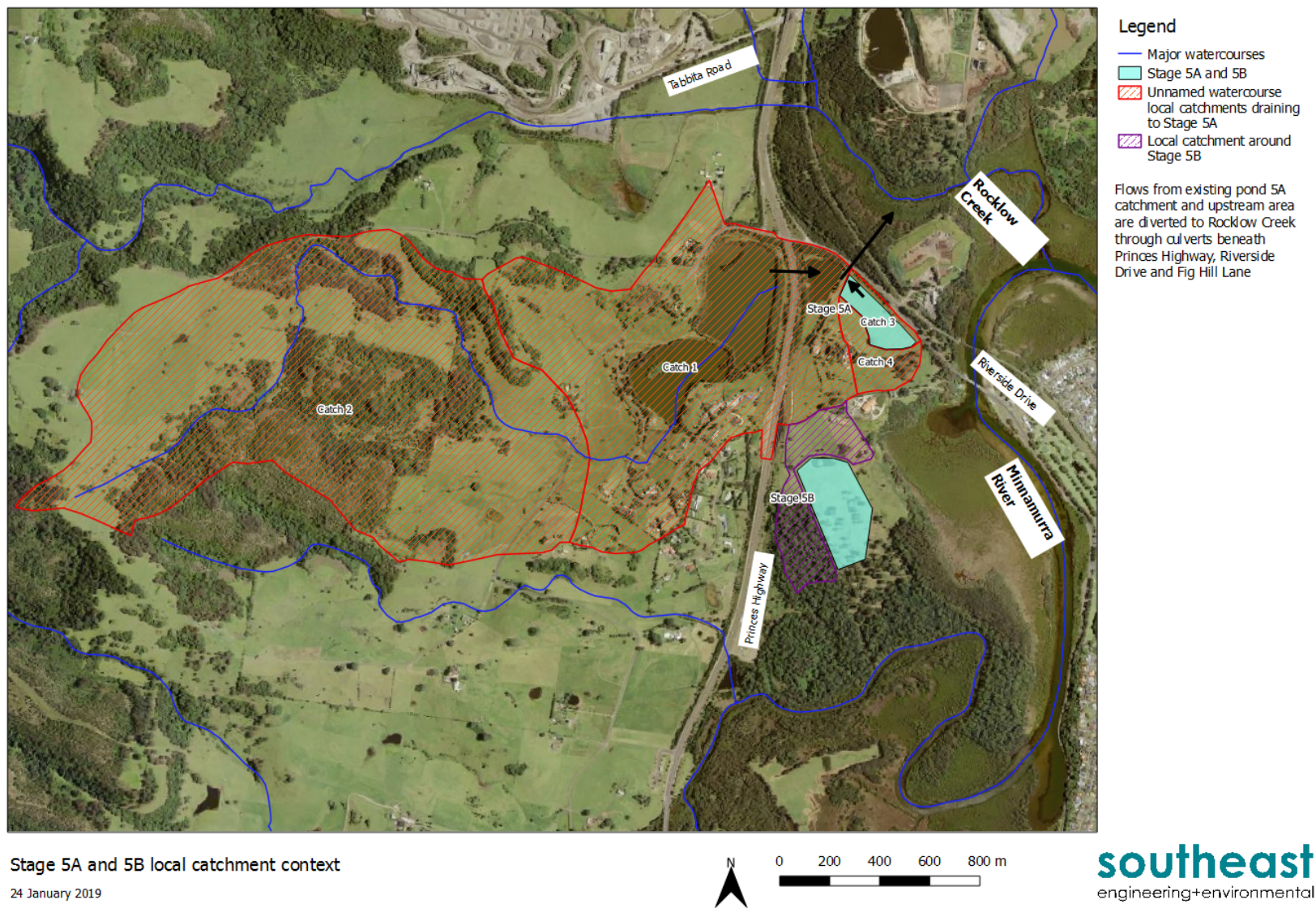


Figure 3.2 Local catchments draining directly to Stages 5A and 5B

3.2. Stage 5A

Stage 5A comprises an area of approximately 4 hectares (ha) and is located on the northern side of a hill with relief from approximately 9m Australian Height Datum (AHD) to about 1.3m AHD close to the driveway entrance to Dunmore House. Much of the Stage 5A extraction area is currently low lying with current ground surface generally below 3.0m AHD. The area is influenced by three main surface flow behaviours; surface flows from the adjacent hillside, runoff associated with the catchment to the west, and backwater flooding associated with Rocklow Creek and ultimately the Minnamurra River.

Local flows from the small hillside catchment (approximately 6 ha) to the south drain to the proposed Stage 5A extraction area. Currently, runoff from this local catchment traces existing low points and a constructed drainage channel along the southern boundary of Riverside Drive, making its way to the twin 900mm culverts beneath Fig Hill Lane in the northern corner to the adjacent pond, then beneath Riverside Drive via three 2.7m wide x 2.4m high culverts to Rocklow Creek and ultimately the Minnamurra River (Figure 3.3).

The pond system immediately to the west of the Stage 5A extraction area drains a catchment of approximately 315 ha (Figure 3.2), extending west approximately 3 km. The catchment is a mixture of cleared farmland and forested areas over the steeper slopes, with a relatively incised and steep sided watercourse through the mid catchment, opening out into pond areas in the lower catchment created as part of previous dredging operations.

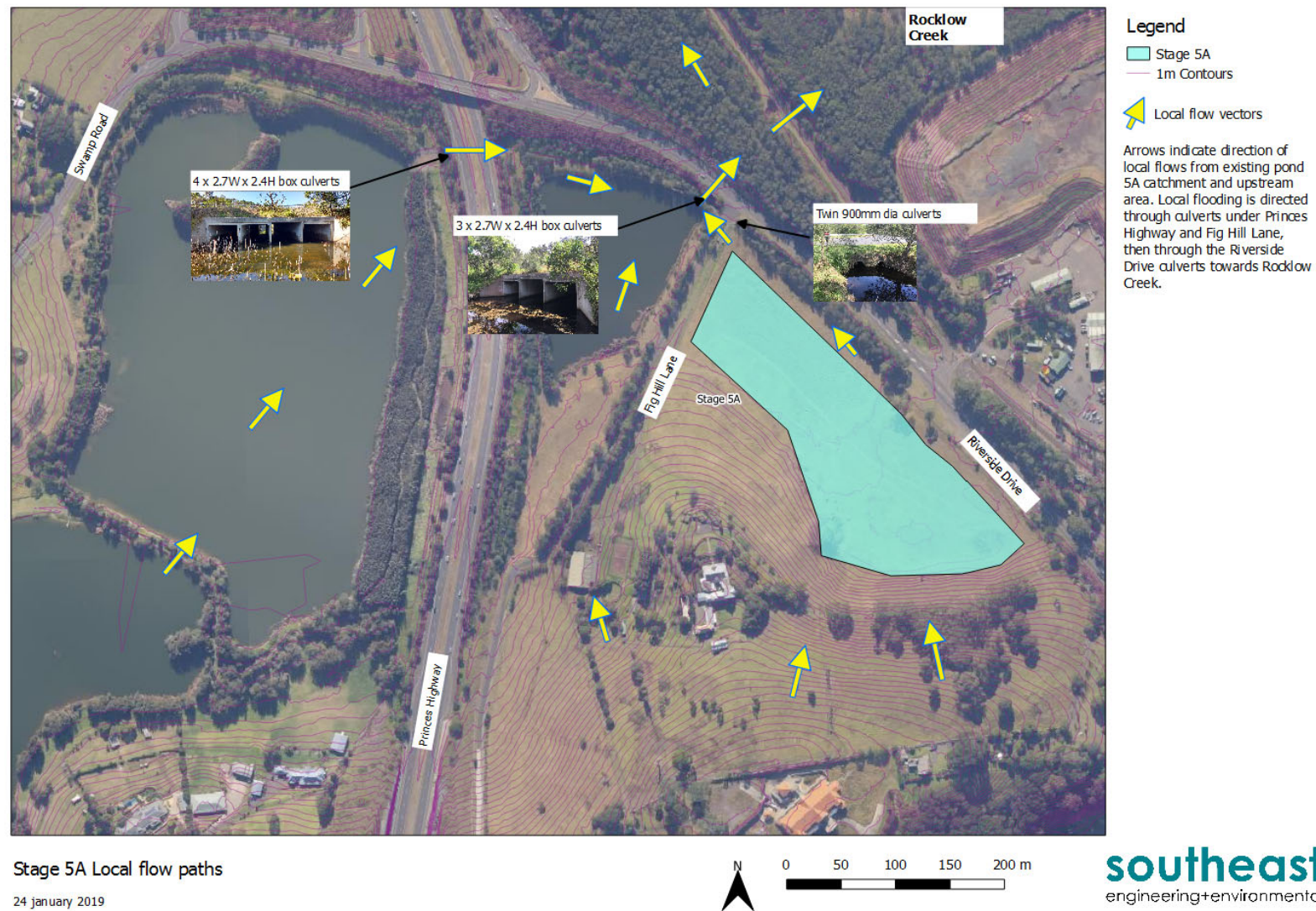


Figure 3.3 Surface flows around Stage 5A

3.3. Stage 5B

The Stage 5B extraction area is located on a flat area at the southern base of a hill with elevations ranging from 2.5 - 4m AHD. The area is located on the floodplain within a large meander of the Minnamurra River with the channel approximately 400m to the south and 500m to the east of the extraction area.

Local drainage, including the small catchment on the hillside to the north drains down to a sequence of small depressions which drain to the Minnamurra River estuary to the east (Figure 3.4).

The Minnamurra River catchment covers approximately 96 km², extending about 13km west to the Illawarra Range escarpment. The catchment is a mixture of steeper forested areas in the upper to mid catchment with undulating cleared rural land trending to cleared agricultural floodplains in the lower catchment. Within the lower alluvial plains of the catchment, known as the Terragong Swamp, the River and floodplain have been drained and the River straightened to improve agricultural productivity. From approximately the Princes Highway east, the River becomes more estuarine as it meanders to the north and east where it meets the ocean at Minnamurra Point. The estuary is characterised as a wave dominated barrier estuary (i.e. the opening of the estuary is highly influenced by wave action and longshore sediment transport). The entrance is permanently open and is not a trained (rock walls) entrance.



Figure 3.4 Surface flows around Stage 5B

3.4. Transfer pipeline and booster pumps

An overland transfer pipeline would be established from the Stage 5A extraction area and Stage 5B extraction areas to the Stage 2 processing area (Figure 3.5). The pipeline would consist of twin 355mm diameter polyethylene pipes, one to transfer dredged material to Stage 2 for processing and one to return treated water to ponds 5A and 5B.

Water transfer volumes will be measured by recording pump operation times to check extracted volumes and the equivalent treated water returned to the ponds to ensure a neutral water balance is maintained. Booster pumps would be located above the Stage 5B dredge pond and adjacent to the Stage 5A dredge pond.

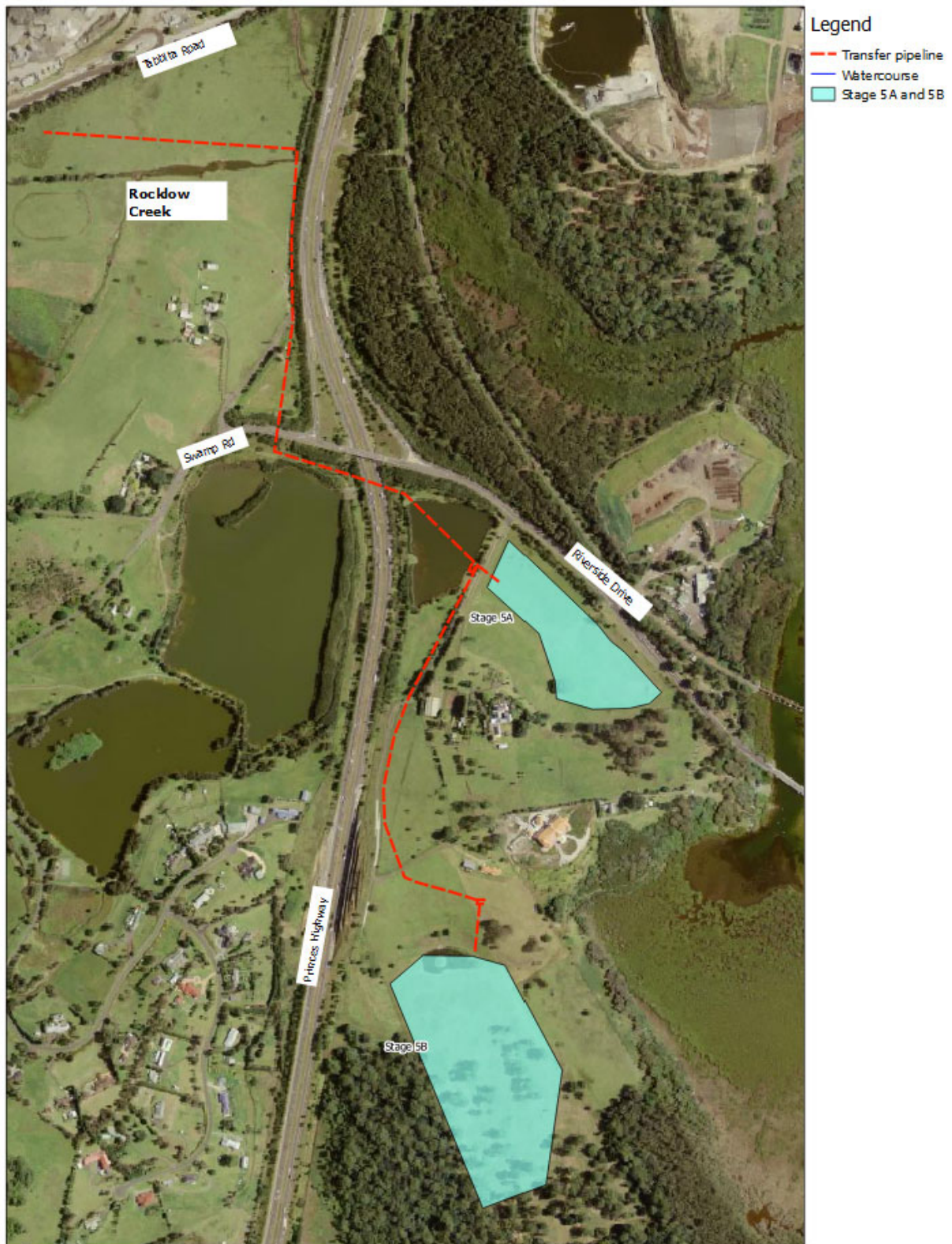
The proposed pipeline route starts at the edge of the Stage 5B pond and travels over the Dunmore House hill to the Stage 5A dredge pond (adjacent to the existing access road for much of the way). The pipeline will then run across the existing pond to the north of Stage 5A and through existing culverts beneath the Princes Highway and Swamp Road.

The culverts beneath the Princes Highway are 4m x 2.7mW x 2.4mH box culverts which connect the upstream catchment of about 205ha to downstream. The 1% AEP flood level in these culverts is estimated at 2.9m AHD, the invert of the culvert is approximately 1.7m AHD.

The Swamp Road culvert is a single 2.7mW x 2.4mH box culvert primarily installed to incorporate infrastructure that led to the previous wash plant located to the north of Swamp Road, and to provide a hydraulic connection to this area.

The transfer pipeline will also traverse Rocklow Creek then connect to the Stage 2 processing area.

The pipeline is temporary infrastructure that will be removed on completion of dredging in the Stage 5 extraction area.



Stage 5A and 5B and transfer pipeline route

24 January 2019



0 100 200 300 m

southeast
engineering | environmental

Figure 3.5 Transfer pipeline location

3.5. Rocklow Creek and Minnamurra River Flood Behaviour

3.5.1. Historical studies

A number of flood investigations have been undertaken for Rocklow Creek and the Minnamurra River for a range of purposes, including previous expansions to the Dunmore Sand and Soil operation, and investigations into the impact of the construction of the North Kiama bypass. These include those reviewed in the Surface Water Assessment of the *Dunmore Lakes Sand Extraction Proposal: Stages 2, 3 and 4* (Bewsher Consulting, 2004) and a flood study on the Minnamurra River carried out by Connell Wagner Pty Ltd as part of impact assessment for the North Kiama Bypass Environmental Impact Statement (Connell Wagner, 1990).

Estimated flood levels for Rocklow Creek as interpreted in the *Dunmore Lakes Sand Extraction Proposal: Stages 2, 3 and 4* (Bewsher Consulting, 2004) are listed in Table 3.1.

Table 3.1 Estimated backwater flooding levels for Stages 2, 3 and 4 and proxy for 5A. (Bewsher, 2004)

Event	Flood level (m AHD)
1% AEP	3.6
5% AEP	3.3
10% AEP	3.2

The results of the Minnamurra River flood study for the North Kiama Bypass EIS concluded:

Comparison of the 1 in 100 year event indicates an afflux of approximately 10mm hydraulic analysis undertaken indicates that encroachments of up to 300 metres into the south side of the Minnamurra flood plain along the route proposed, will not have a significant effect on flood heights, flow distributions and velocities within the catchment. (Connell Wagner, 1990).

These previous investigations estimated the 1% AEP Minnamurra River flood level around the Stage 5B extraction area ranges from 4.14m AHD at the southern end, to 3.67m AHD at the eastern side (Figure 3.6). For the 5% AEP the flood level ranges from 3.78m AHD at the southern end to about 3.3m AHD at the eastern end.



Figure 3.6 Extract from Nth Kiama Bypass Flood Study, 1% AEP Flood Levels (Approximate location of Stage 5B extraction area in red) (Connell Wagner, 1990)

3.5.2. Current flood investigations

More recently, the *Flood and Coastal Study, Stage 2 Report, Minnamurra River Boardwalk* (Cardno, 2019) was prepared for Kiama Municipal Council to assess the potential impacts of the proposed Minnamurra River Boardwalk Project, a shared user path running alongside and within the Minnamurra River. The hydrologic and hydraulic models created for this study cover both the Stage 5A and Stage 5B areas of investigation (Figure 3.7). This report has been approved by Kiama Council and is currently on exhibition as part of the community consultation process.



Figure 3.7 Hydraulic model extents (Cardno, 2019).

The hydrologic model used to estimate design hydrographs was the Watershed Bounded Network Model (WBNM). The hydraulic model used to translate design hydrographs into estimated water surfaces across the model boundary area was TUFLOW. Parameters within the models were adjusted to align model outputs for the June 2016 rainfall event such that modelled water levels closely matched recorded water levels at the Manly Hydraulic Laboratory (MHL) gauge located close to the confluence of Rocklow Creek and Minnamurra River. This adjusted model was then used to estimate design flood behaviour over the hydraulic model extents.

The hydraulic model prepared by Cardno, previously accepted by the DPE and Kiama Council, was modified to include detailed survey information for the existing topography over the sites to establish existing flood conditions. The hydraulic model was then updated to incorporate the modified surfaces associated with the Stage 5A and 5B areas, including the isolations bunds and then run. Model run output for the 5 year, 20 year, 100 year ARI and PMF events is contained in Appendix A.

For detailed information regarding the hydrology model and hydraulic model assumptions refer the *Flood and Coastal Study, Stage 2 Report, Minnamurra River Boardwalk* (Cardno, 2019).

3.6. Existing flood impacts

Stage 5A extraction area is currently low lying with current ground surface generally below 3.0m AHD, with levels as low as 1.3m AHD in the northern corner. The area is inundated up to 1.3m deep in a 5 year ARI flood event, and deeper for larger events.

The Stage 5B area is less influenced by flood flows due to site topography being predominantly over 4m AHD. Surface levels over the Stage 5B extraction area range from 4.0 to 2.2m AHD along the eastern face. The northern quarter of the extraction area sits between 3.0 and 4.0m AHD, with the reminder at about 4.0m AHD.

Accordingly, across most of the site, flood depth in the 100 year ARI event is relatively shallow (100-200mm). In more frequent events most of the Stage 5B extraction area will remain flood free, apart from the lower areas (2 to 3m AHD) at the base of the hillside at the northern end of the site which may experience backwater inundation in events as frequent as the 5 to 10 year ARI events.

Given the proposed isolation of these areas from flood waters, there will be impacts from the loss of flood storage and potential flow diversion. This is addressed in further chapters.

Maximum flood depths for a range of events are listed in Table 3.2. Appendix A contains figures showing flood levels and extents over the proposed development areas.

Table 3.2 Maximum flood depths for a range of ARI floods

Flood event	Maximum flood level over the development area (m AHD)	
	Stage 5A	Stage 5B
5 year ARI	2.61	2.36
20 year ARI	2.95	2.97
100 year ARI	3.42	4.12
PMF	4.36	5.15

3.7. Interface between surface and sub-surface flows

The permeable nature of soils over the proposed modification areas (3.0-3.5m/d), the generally high water table (nominal 0.6m below ground surface), low hydraulic gradient, and estimated high rainfall recharge all combine to create a strong hydraulic connection between surface and sub-surface flows (Environmental and Earth Sciences, 2004).

For light to moderate rainfall events, little runoff is expected, given the permeable nature of surface soils. In heavier rainfall events, or periods of prolonged rainfall, the high water table places a limit on soil storage, and extensive areas of waterlogging and ponding will occur over the low lying areas, exacerbated by the shallow hydraulic gradients which limit discharge and prolong surface water retention. It is possible that in the case of heavy rain and high recharge, some areas will experience localised flooding due to the piezometric head associated with groundwater recharge. In flood events, areas isolated hydraulically on the surface can experience similar flood levels for this reason.

3.8. Water quality and receiving environments

Rocklow Creek the Minnamurra River Estuary are the receiving waters for the currently approved operations area, and the proposed modification. The Stage 5A extraction area currently drains to the mangrove wetlands surrounding Rocklow Creek, whilst the area over Stage 5B drains to the mangrove wetlands between the extraction footprint and the Minnamurra River. These wetlands are classified as coastal wetlands in the Coastal Management SEPP 2018 (Figure 3.8) and contain Type 1 Highly sensitive key fish habitat and Class 1 waterways as defined in the policy and guidelines for fish habitat conservation and management (DPI, 2013).



Figure 3.8 Stages 5A and 5B location in relation to Coastal management SEPP boundaries

The Coastal Zone Management Plan for the Minnamurra River Estuary (Hydrosphere, 2015) summarises the recent historical and current estuary conditions, pressures on the estuary and water quality data recorded within the estuary and upstream. Key findings of relevance to the proposed modification are:

- Based on the NSW Natural Resources Monitoring, Evaluation and Reporting (MER) program, the overall condition rating for the Minnamurra River Estuary was assessed as “Good” from an average of all scores which ranged from poor for seagrass (due to a loss in area) to very good ratings for turbidity and saltmarsh.
- The key pressures on the estuary are increased sediment and nutrient inputs, with an estimated increase of approximately 500% from natural conditions. The overall pressure score for the estuary was ‘Moderate’ as assessed in the MER.
- Analysis of water quality data (2006/2007, 2007/2008 and 2011/2012) shows median water quality values that exceed guideline nutrient levels (<0.03mg/L for Total Nitrogen (TN) and <0.03mg/L for Total Phosphorus (TP)) throughout the catchment, including the receiving water areas close to proposed Stages 5A and 5B which have median values over the sampling period of 0.52 mg/L TN and 0.05 mg/L TP at Sample sites M3 (Mid Estuary Minnamurra River) and 1.5 mg/L TN and 0.2mg/L at R1 (Rocklow Creek). As well as median turbidity values (12.1 NTU) above estuarine guideline level of <10 NTU at R1 (Rocklow Creek).

In summary, the Minnamurra River is in a good condition, however there are significant land use pressures that increase the risk of condition degradation. Water quality monitoring results for Rocklow Creek and the Minnamurra estuary exceed ANZECC trigger values for a range of parameters, and in some periods Rocklow Creek shows highly eutrophic conditions (Hydrosphere, 2015). Eutrophic conditions are an indication of likely algal blooms, the result of high nutrient availability.

3.9. Water quality monitoring

As part of the existing Dunmore Lakes Sand Project approval conditions, water quality monitoring is carried out monthly and after 20mm or more of rainfall within a 24 hour period. Water quality samples are collected at five Environment Protection licence (EPL) sites (see Figure 3.9) along with a range of other pond sampling sites and inflow points to the site to provide background water quality data. During high flow and flood events, additional sampling is taken upstream from normally dry watercourses to improve upstream and downstream water quality comparison.

The existing water quality monitoring objectives reflect the NSW ANZECC Water Quality Objectives (WQOs) for lowland rivers and estuaries in the Illawarra region.



Figure 3.9 Current EPL monitoring points

Table 3.3 shows the average monitored results for the five EPL monitoring points over the 2017 and 2018 financial years, including pH, turbidity (NTU), total suspended solids (TSS) and electrical conductivity (EC) (salinity). Note that DW-20 is the only point directly influenced by the existing site activities, and the other points are used as baseline conditions. For DW20 in 2017, measured turbidity levels exceeded the limit 5 times; however on average were significantly lower than DW12 and DW11, both upstream of the Site. In 2018, EC levels were exceeded 3 times at DW20 and the average of samples taken was above the threshold. This is an indication of saline influence into the stage 3 pond over time.

The proposed modification will necessitate an expansion of the water quality monitoring program, as discussed below.

Table 3.3 Financial year average water quality results, (number of exceedances), red denotes average above threshold.

Monitoring point	Location characteristics	Fin year	pH	NTU	TSS	EC
DW12 (EPL11)	Upstream of Site. Highly influenced by farming and also by a different quarry	2017	6.9 (1)	478.8 (1)	161.6 (1)	242
		2018	-	-	-	-
DW11 (EPL12)	Upstream of Site. Highly influenced by farming and also by a different quarry	2017	7.76	61.68 (2)	46.62 (2)	596
		2018	-	-	-	-
DW21 (EPL10)	Downstream of Site. Influenced by Princes Highway runoff. Not influenced by Site activities	2017	7.44	14.6 (1)	19.72	4676 (5)
		2018	7.5	11.6 (1)	15.9 (2)	27107 (13)
DW18 (EPL13)	Upstream of Site. Influenced by farming and discharged water from an unrelated Boral quarry	2017	7.3	26.1 (6)	19.2 (3)	1907 (2)
		2018	7.3	22.7 (3)	34.5 (1)	10617 (5)
DW20(a) (EPL9)	Downstream of Site. Influenced by stage 2 water discharge and Princes Highway runoff	2017	7.68	34.33 (5)	21.4 (1)	667 (1)
		2018	7.5	17.4 (1)	24.8 (1)	4341 (3)
WQO			6.5-8.5	5-20	<50	<1500

3.10. Existing Water Balance

As part of the development consent, DSS are required to provide a water balance outlining the following:

- a) include details of all water extracted and used by the development; and*
- b) provide for the reporting of annual water extraction and maximum instantaneous pumping rates to the Department in accordance with the licence under the Water Act 1912.*

The latest Annual Review from DSS for 2017/2018 contains the following information relating to water use on site:

Water is used for dust suppression and sand processing and is sourced from the fines pond and dredge pond under a groundwater Water Access Licence (WAL24477) issued under the Water Management Act 2000. The licence permits the taking of 65ML of water from the Sydney Basin South Groundwater Source and is subject to a number of conditions. Associated 'work approvals' include 10WA106713 and 10WA106714.

Surface water enters the site ponds from the Western Eastern and Northern Tributaries and flows out of the ponds back into the re-aligned Western Tributary. The influence of surface water on the site water balance is therefore considered to be neutral. Water extracted from the ponds is measured and considered in relation to the applicable groundwater licence.

Figure 3.10 outlines water movement around the existing operations areas.

The two extractive water uses on site are dust suppression and water exported from the site as moisture content in sand products.

Dust suppression

Boral estimates that for the current Stage 2 to 4 operations, up to five 30,000L tanker loads are used on non-rain days during the year and that on average there are about 200 non-rain days.

An interrogation of local climate data collected from the Bureau of Meteorology (Foxground Road rainfall gauge 68197 1945-2018), approximately 14km from the extraction area, suggests that on average the number of non-rain days is about 230 per year. Assuming 230 days, this would equate to 34.5 ML/y of water required for dust suppression.

Water used in processing and exported

Based on DSS records, approximately 19.5ML/d (7.1 GL/y) is used for sand processing, including dredge pumping (10.8ML/d), pumping to the sand wash bin for dust washing (6.5ML/d) and water use in the oversize screen sprayers (2.2ML/d). The average moisture content of sand leaving the site is around 8%. Based on the 2017 production of 401,582 tonnes, approximately 32.12ML/y currently leaves the site. The remainder (7.07GL/y) returns to the surrounding landscape ponds as runoff or as infiltration to groundwater.

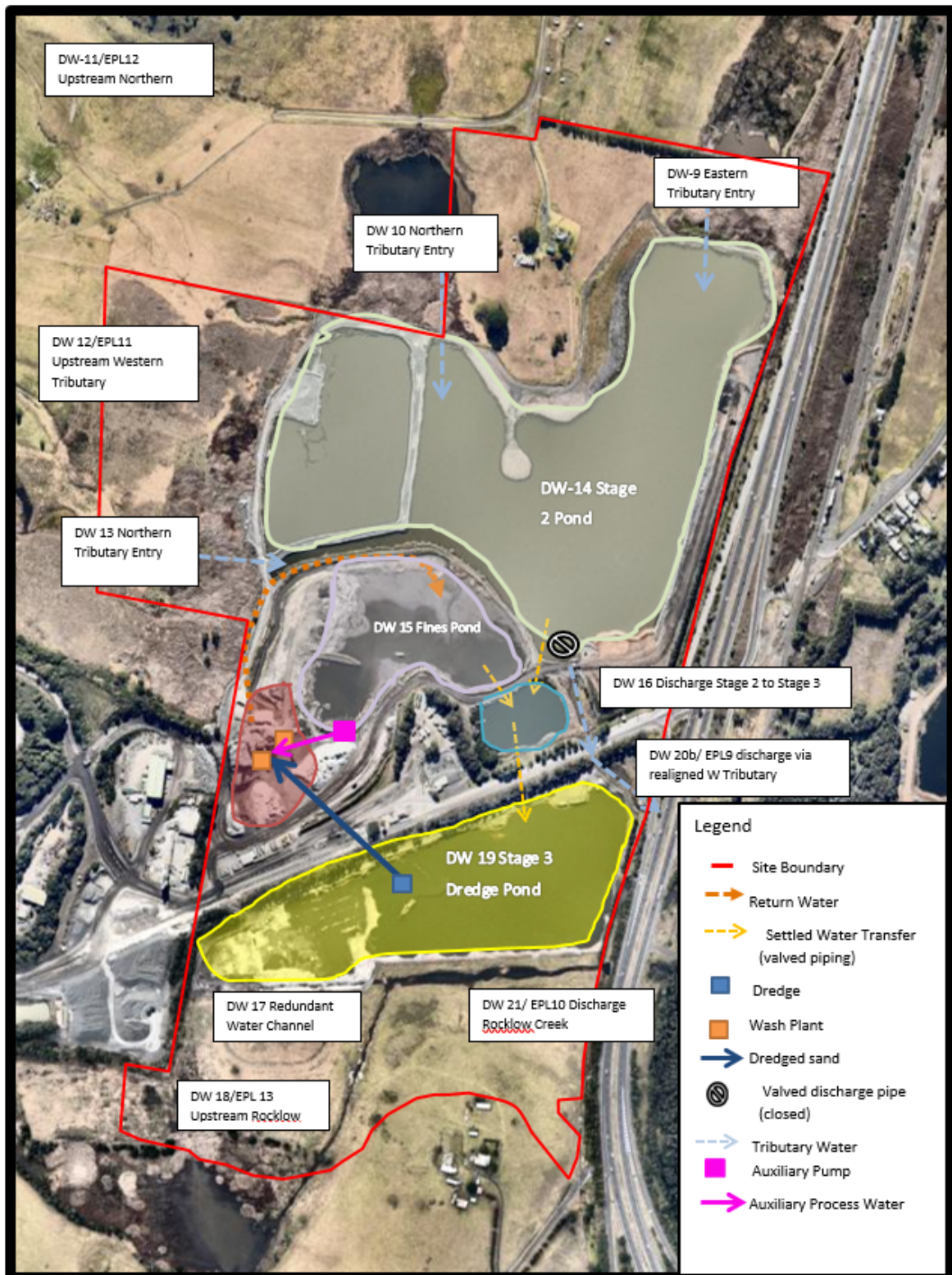


Figure 3.10 Current water transfers over Stages 2 to 4.

4.0 SURFACE WATER IMPACTS AND MANAGEMENT

4.1. Water quality management – Construction phase

Construction impacts at the site are predominantly associated with the earthworks required to establish the extraction areas and infrastructure for material movements.

4.1.1. Access Roads, site office and parking

Fig Hill Lane will need to be extended to the south to provide access to the Stage 5B extraction area, this includes an unsealed road running down the hillside to the site office facilities and parking area.

Exposed soils generated through the construction of the access roads, site office and parking will be managed through standard sediment and erosion controls, refer to *Managing Urban Stormwater: soils and construction, Volume 1 and Volume 2C: Unsealed roads and 2D: main road construction* (DECC 2008) for the preparation of Soil and Water Management Plans (SWMPs) for the construction phase of the project.

Maintenance tracks will also be required around both of the Stage 5A and 5B extraction areas. Additional unsealed areas and sealed areas will need to be constructed for site office facilities at the northern part of the Stage 5B extraction area. These areas can be diverted to the dredge pond which will act as a sediment basin.

4.1.2. Dredge Ponds, stockpile areas and haul roads

The Stage 5A and Stage 5B dredge ponds are to be bunded to prevent interaction with surface flows and floodwaters, and to prevent the associated potential water quality risks to adjacent receiving waters. Bunds are to be constructed in conjunction with the initial site clearing. These bunded areas will function as sediment basins for surrounding cleared areas.

Bunds will need to be engineered, and will likely require either VENM imported to the site or material other than excavated sands to ensure their structural integrity.

Clearing and grubbing of the proposed extraction areas and construction of water diversion structures and flood protection bunds will generate areas of exposed materials increasing the potential for erosion and transfer of material to receiving waters. In particular, the outer batter slopes of the flood protection bunds should be adequately stabilized with vegetation to limit erosion and sediment transport off site. Refer to *Managing Urban Stormwater, Soils and Construction, Volume 2E Mines and Quarries* (DECC, 2008) for specific information on batter treatment and diversion drain design.

In addition to the isolation of the dredge ponds from surrounding surface and river flows, the bunds provide significant freeboard of up to 2 to 3m from the normal operating water level (likely to be close to local groundwater surface levels of around 1m AHD) (Environmental Earth Sciences, 2019). The freeboard will reduce the possibility of basin overflows in flood and high rainfall events and also allow the ponds to act as sediment basins through the provision of detention storage. As a comparison, sediment basin sizing assuming a 5 day, 95th percentile rainfall capture, as recommended in *Managing Urban Stormwater, Soils and Construction, Volume 2E Mines and Quarries (DECC, 2008)*, the calculated sediment basin volume against the available storage volume within the bunded dredge ponds are outlined in Table 4.1. The available storage within the dredge ponds will exceed the recommended sediment basin volumes by an order of magnitude.

Table 4.1 Comparison of available retention volume in dredge ponds against sediment basin sizing calculations

	Catchment Area (ha)	Storage volume		
		Bunded dredge pond (above local groundwater level of 1m AHD) (m ³)	Type D/F basin storage based on catchment (m ³)	Type C basin storage calculation (m ³)
Stage 5A dredge pond and surrounds.	4.3	78000	3000	2500
Stage 5B dredge pond and surrounds.	11.1	270000	6000	5000

4.1.3. Transfer pipeline

For the majority of the transfer pipeline alignment, the pipe will be placed on the surface and secured to the ground. Some clearing will be necessary along the edges of the existing ponds to accommodate the transfer pipeline. Clearing will be confined to limited shrub removal, with groundcover vegetation to remain. Surface water impacts are limited to temporary impacts associated with machinery access and will be minor. Erosion and sediment controls shall be installed where required. Refer to *Managing Urban Stormwater, Soils and Construction, Volume 2A Installation of Services (DECC, 2008)* for specific information on mitigating erosion and sedimentation for linear construction as well as *Guidelines for Laying Pipes and Cables in Watercourses on Waterfront Land (DPI Water, 2012b)*

4.2. Water quality management - Operational phase

4.2.1. Stage 5A and Stage 5B

For Stage 5A, the haul road surrounding the dredge pond and stockpile area shall drain to the dredge pond. The dredge pond will provide the water quality treatment for these areas during dredge pond operations.

For Stage 5B, part of the unsealed access road, the car-park, office and amenities area shall drain to the dredge pond, along with the haul road surrounding the dredge pond to provide for water quality treatment during operations.

The available storage in both dredge ponds exceeds the sediment basin volumes outlined in *Managing Urban Stormwater, Soils and Construction, Volume 2E Mines and Quarries* (DECC, 2008) for sensitive receiving waters, by an order of magnitude. Discharge from these ponds is not expected during normal operation, nor during rain events as the storage available in the ponds equates to a rainfall depth of 1800mm over the catchment drainage to the Stage 5A dredge pond, and 2400mm of rainfall over the catchment drainage to the Stage 5B dredge pond.

Refer to section 4.1 for a discussion on sediment basin volume and treatment.

4.2.1. Processing

Once site preparation is complete, sand from Stage 5A and 5B will initially be extracted using an excavator and stockpiled adjacent to the extraction area until a pond is sufficiently large enough to float a dredge. These stockpiles will then be dredged with the underlying sand and pumped as a sand/water mix to the Stage 2 processing area.

Primary water quality impacts associated with processing consist of the water use during the pumping and washing of the sand material, and the management of fines from the dewatering process at the Stage 2 area. In accordance with the approved operations, water removed through the dewatering process will drain to an existing fines pond and a secondary settling pond, before being pumped back to the Stage 5A and Stage 5B dredge ponds.

Water pumped from the Stage 5 extraction areas will be returned to these extraction areas via the pumping pipeline. Pumped water volumes will be recorded by a flow meter and the same volume of water will be returned to the Stage 5 extraction areas to balance water extracted.

4.3. Water quality management – Rehabilitation and post extraction.

The Stage 5A area will be rehabilitated to emulate the existing landform. Strict sediment and erosion controls will need to be implemented during the import and placement of VENM fill to reinstate the landscape. During the filling process the bund should be retained to isolate the working area. As groundcovers are established over the filled area the bund can be removed in a staged approach and the bund footprint rehabilitated. Water quality risks during this process can be managed through the implementation of a SWMP based on appropriate Managing Urban Stormwater guidelines.

The Stage 5B area will retain an open water body at approximately 1-2.0m AHD depending on rainfall and groundwater levels. The bund will be removed in a staged process and dredge pond batters modified and rehabilitated to create a 'natural' littoral and riparian landform around the pond edge. Bund removal should be timed to allow for the establishment of vegetation on the pond embankments.

On completion of rehabilitation, the Stage 5B dredge pond area will be connected to the Minnamurra floodplain for events around the 5 year ARI and above. Water quality within the pond is likely to be of higher quality than the Minnamurra River itself given the basin size relative to the local catchment draining to it. Bund removal for the Stage 5B area shall also be conditional on water quality within the pond meeting ANZECC guideline levels for a period of 12 months prior to bund removal to limit the potential of adverse water quality impacts when the area is reconnected to the floodplain.

4.4. Protection of aquatic and coastal environment

Both Stage 5A and 5B are located on land within the *coastal environment area* as defined within the Coastal Management SEPP 2018. Relevant considerations in relation to development within the *coastal environment area* outlined in Clause 13 of the policy include:

- a) the integrity and resilience of the biophysical, hydrological (surface and groundwater) and ecological environment,
- b) coastal environmental values and natural coastal processes,
- c) the water quality of the marine estate (within the meaning of the Marine Estate Management Act 2014), in particular, the cumulative impacts of the proposed development on any of the sensitive coastal lakes identified in Schedule 1,
- d) marine vegetation, native vegetation and fauna and their habitats, undeveloped headlands and rock platforms,

Both the Stage 5A and 5B areas have been designed to avoid and minimise potential adverse environmental impacts. The primary management measure being the isolation of the dredge ponds up to the 100 year ARI flood event to limit the potential for external surface water interactions with dredge ponds. Some adjustments to local hydrology will occur during operation as local surface flows are redirected to avoid the extraction areas. Impacts of these diversions are small, and consist of the concentration of local catchment surface flows which can be managed through the construction of stable discharge points and connections to existing drainage.

Risks to water quality within the adjacent estuary are to be minimised through a range of management and mitigation measures (Table 4.2). Cumulative impacts, particularly in the long term post rehabilitation are likely to be neutral, or beneficial, given the eventual land use modification from grazing to rehabilitated ponds in Stage 5B, this is discussed in further detail in section 4.8.

Both Stage 5A and Stage 5B disturbance footprints are well beyond mapped marine vegetation extents. No clearing of marine vegetation is necessary, or proposed. Potential threats to marine vegetation from the project are associated with sediment and turbidity within discharged water. No new discharge points are proposed and the EPL will remain. Risks of unlicensed discharges are mitigated as outlined in Table 4.2.

Stage 5A is located within the *coastal wetland proximity area* (Figure 4.1) and within about 150m of mangrove areas within the Minnamurra River and 250m of mangrove areas within Rocklow Creek. Stage 5B is located about 160m from saltmarsh and mangrove areas on the tidal flats of the Minnamurra River. These adjacent aquatic areas are considered 'Type 1 – Highly sensitive key fish habitat' due to their coastal wetland characterisation and the presence of mangrove, saltmarsh and seagrass communities. Table 4.2 contains a summary of key risks to aquatic habitats and recommended management measures to mitigate these risks.

The recommended riparian buffer to provide protection for these sensitive communities is a minimum of 100m. The proposed disturbance areas for Stage 5A and 5B are beyond 100m from these sensitive areas.

The transfer pipeline will be floated over the pond to the northwest of Stage 5A, and suspended from the roof of culverts beneath the Princes Highway and Swamp Road. The pipeline is flexible and can be installed without tree removal, some clearing of smaller, shrub riparian vegetation will be necessary to allow for machinery access for installation.

The pipeline will cross Rocklow Creek. A gangway is proposed to support the pipeline above the creek. Gangway supports will be located on the overbanks. No works are required in-stream.

In these cases there is no discernable impact on impact on aquatic habitat, or fish passage.

There is a risk of pipeline leakage or failure, either through mechanical failure or damage from an external cause. System monitoring and maintenance shall be incorporated into operational procedures for the transfer pipeline to limit the possibility of failure, and allow for the swift identification of failure, should it occur.

Table 4.2 Risks to aquatic habitat and management

Key risks associated with the construction operation and rehabilitation of the dredge ponds	Management and mitigation
Erosion of exposed areas and sediment transfer to adjacent waterways during construction	Prepare and implement a SWMP for the construction phase of various components.
Erosion and sediment transfer during operational phase	Direct runoff from unsealed areas to dredge ponds. Ensure surface diversion drains and outer bund batters are stable and well vegetated.
Transfer of sediment and fines through inflow and overflow from dredge ponds	Dredge pond areas are to be bunded to the nominal 100 year ARI flood level to isolate them from local river and estuarine flooding and prevent uncontrolled discharge.
Failure of sand/water pipe resulting in sand entering water courses	Double skinned pipe at watercourse crossings and regular inspection of the pipe. Mechanisms to shut down pumping system during high risk periods (flooding), and when a leak occurs.
Failure of outer bunds resulting in sediment entering the water courses	Design and construction with appropriate geotechnical expertise and materials.
Impacts of water extraction associated with sand slurry transfers	Water volume extracted to be measured and returned from Stage 2 processing area to dredge ponds to maintain local water balance.
Water quality impacts during the rehabilitation of Stage 5A	Retain the bund during the filling and revegetation phases. Undertake staged removal of the bund as vegetation cover allows.
Water quality impacts during the rehabilitation of Stage 5B and into the future.	Retain the bund during reshaping and revegetation. Dewater to allow revegetation whilst retaining the bund. Undertake water quality monitoring of pond, and begin staged removal of bund once water quality within pond meets ANZECC guideline trigger values over a period of 12 months.



Figure 4.1 Stage 5A and 5B and transfer pipeline Proximity to aquatic habitat

4.5. Local surface flows and flooding

4.5.1. Stage 5A

The area currently receives surface flows from the adjacent hillside, flood flows from the unnamed watercourse to the west and backwater flooding from Rocklow Creek and the Minnamurra River estuary. Runoff from Riverside Drive and parts of the western edge of the site is captured in an open drain that runs along the boundary with Riverside Drive.

Flows from the hillside catchment to the south can be diverted around the proposed Stage 5A extraction area. This will consist of a series of diversion drains to divert flows around the extraction area. (Figure 4.2). The VENM stockpile area and surrounding haul road shall drain to the dredge pond, where sediment can settle out. As outlined in Section 4.1, the available storage exceeds the recommended volumes to manage sediment as recommended in the *Managing Urban Stormwater* suite of documents.

Flows and flooding from the unnamed watercourse to the west pass through the adjacent existing ponds, prior to discharge through the culverts beneath Riverside Drive. The 100 year ARI flood level in the Stage 5A area is 3.42m AHD. Which covers most of the proposed Stage 5A extraction area.

To limit potential water quality impacts or turbid water from the active Stage 5A extraction area entering Rocklow Creek and ultimately the Minnamurra River during flooding events, it is proposed to provide an earth bund around the 5A extraction area up to the 100 year ARI flood level, plus freeboard at 3.7m AHD to isolate dredging activities from the local floodwaters and surface flows.

Bunding of the Stage 5A extraction area effectively removes the extraction area and associated access roads from floodplain storage. The impact of this on local flood flows has been assessed for a range of flood recurrence intervals, with the largest impact associated with the smaller 5 year ARI event, where flood levels to the west increase by up to 45mm, and up to 16mm increase in flood levels over Riverside Drive.

Impacts to the land to the west are considered insignificant, given the small change in depth, and the land use of the area (pond and grazing land). This land is owned by the landholder that Boral is entering into an agreement with for the extraction. The change in flood depth over Riverside Drive is at most 16mm for the events modelled, and is considered insignificant.

Velocity changes are largest for the PMF event, with localised increases of up to 0.3m/s over Riverside Drive. For the 100 year ARI event and below, velocity changes are around 0.2m/s or less. Appendix A contains a summary of flood levels and flood height and velocity changes for the 5y ARI, 20y ARI, 100y ARI and PMF events.

Given the temporary nature of the works, estimated at three to five years, and the limited impact on flood levels and velocities, the temporary loss of floodplain storage on flood levels is not significant. The impact of minor flood changes are outweighed by the water quality benefits associated with isolating the dredge areas from external flows and potential discharge.

To accommodate the possibility of inundation of the Stage 5A extraction area due to water levels within the extraction area either through rising groundwater levels, local catchment flows draining to the dredge pond, or large flood events in excess of the bund level, a preferential flow path into and out of the extraction area is recommended. An armoured spillway 100mm lower than the bund height (3.6m AHD) and 20m long will allow for the basin to drain to the spillway crest over about 1 hour, allowing the upper storage to drain in line with the falling flood wave.

There is the potential for a significant difference in water level inside and outside of the bunded areas of up to 2.5m in areas. This may occur if surrounding floodwaters have drained, and the dredge pond remains full, or in the opposite case where floodwaters are much higher than water levels within the pond. Bund design will need to allow for the appropriate hydrostatic pressures, along with the potential for internal erosion through the bund material.

Once resource extraction is complete, reinstatement of floodplain storage shall be undertaken through the staged removal of the bund, backfilling of the Stage 5A extraction area and associated site rehabilitation.



Surface Water management - Stage 5A

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Figure 4.2 Stage 5A Surface water management

4.5.1. Stage 5B

The 100 year ARI flood levels currently extend over the extraction area at shallow depths of around 100mm over most of the site, apart from the low lying parts in the north east corner of the site where flood depths are up to 2m. Local surface flows from the hillside to the north currently drain down towards the proposed 5B extraction area.

As for Stage 5A, an earth bund above the estimated 100 year ARI flood level (4.12m AHD at the southern end to 3.60m AHD along the eastern face) is to be established around the Stage 5B extraction area to isolate it from local surface flows and flood flows from the Minnamurra River. A bund level of 4.30 AHD is proposed. This will isolate flood storage over the dredge pond footprint and also impact on flood flow hydraulics.

The largest flood height impact is along the southern bund face for the 100 year ARI event, as the flood wave approaches the bund and is diverted and a local flood height increase of up to 45mm is created.

The impact on flood velocities includes with localised increases of 0.1 to 0.2m/s for the 100 year ARI and PMF events as well as a large increase (1.5m/s) for the PMF event over the proposed spillway area, likely the result of dredge pond outflows during the falling limb of the PMF flood hydrograph. Therefore spillway design, armouring and interface with the downstream ground surface is critical to ensure the stable operation of the spillway for events in excess of the 100 year ARI.

Spillway dimensions should be approximately 60m long and 200mm deep. This allows for the basin to be drained to the spillway crest over about 1 hour, and roughly match the falling limb of a flood wave through the Minnamurra River.

On completion of the resource extraction, floodplain storage shall be reinstated through the removal of the bund, and necessary reshaping and revegetation. The pond will be retained as an open water area.

4.5.2. Bund Stability

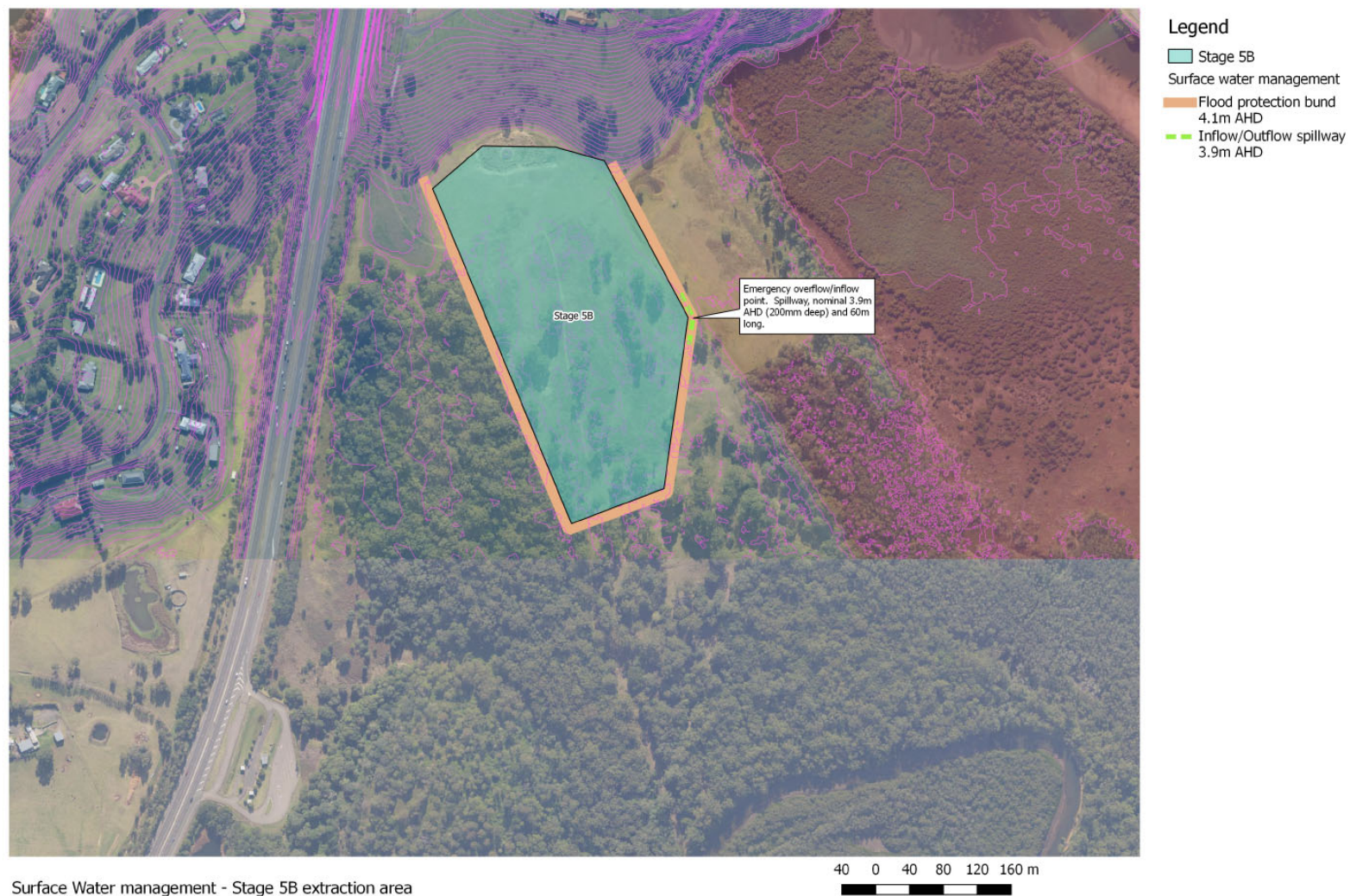
Bund failure, particularly in conditions where water levels in the dredge ponds are at high levels compared to local water levels present a significant risk to water quality, and infrastructure and human safety downstream. These conditions are only possible after a large flood event above the bund height or if flow diversions around the dredge ponds do not work correctly in times of high rainfall, these situations are unlikely. Nevertheless, as the impact of failure would be high, bund design, construction and operational monitoring are of high importance.

Key design components:

- Sizing and armouring design for the inflow-outflow spillways
- Armouring of bund batters, particularly where flood flow velocities are likely to be above 1m/s.
- Geotechnical assessment of foundation soils and bund construction materials
- Design of bund/embankment wall, including assessment of static hydraulic loads, pore pressures, etc.

Operation and monitoring

- Prepare an operation and maintenance plan to incorporate monitoring and maintenance of the dredge pond bunds to ensure structural integrity and correct operation.



Surface Water management - Stage 5B extraction area

Figure 4.3 Stage 5B surface water management.

4.5.3. Transfer pipeline

The nominal 355mm diameter sand slurry transfer pipes travel from the Stage 5B extraction area to Stage 5A and then to the Stage 2 processing area as described in Section 3.4.

The pipe will be secured to the ground and clearing will be required where vegetation prevents access for machinery and placement of the pipe, along with excavation necessary to install the booster pumping stations. The pipe will need to be secured to existing culverts beneath the Princes Highway and Swamp Road and will cross Rocklow creek.

Where clearing is required, standard erosion and sediment controls shall be applied, refer to *Managing Stormwater: Soils and Construction, Volume 2A – Installation of services* (DECC, 2008) when preparing sediment and erosion controls for this component. *Guidelines for Laying Pipes and Cables in Watercourses on Waterfront Land (DPI Water, 2012b)* should be considered when designing and constructing the pipelines.

The transfer pipeline will be floated across the pond adjacent to dredge pond 5A. maximum velocities in a 1% AEP event across this pond are approximately 0.5m/s. Design of the floatation and the fixing system where the pipeline connects back to the pond banks will need to consider the hydraulic forces associated with flood flows along with the variation in water levels.

To traverse the roadways it is proposed to attach them to the side of existing culverts in the upper corner. At the Princes Highway the existing culverts are 2.7m wide by 2.4m high (Figure 4.4) with invert level at approximately 1.7m AHD at the upstream end. The culverts provide a flow area of about 26m². The installation of the transfer pipes will require about 0.25m² of potential flow area, reducing culvert capacity by about 1%.

Additionally, local 1% AEP flood levels are about 2.9m AHD, about 1.2m below the culvert obvert. Backwater flooding from broader catchment flooding from Rocklow Creek and the Minnamurra River may inundate the culverts. Given the small flow area removed and low flow velocity the hydraulic capacity impacts of the transfer pipeline on the Princes Highway culverts are not considered significant.



Figure 4.4 Culverts beneath Princes Highway

The transfer pipe will also pass through the culvert beneath Swamp Road. This culvert was installed primarily for infrastructure that connected the previous sand extraction area with the previous processing plant (Figure 4.5). The culvert also allows for the movement of flows from a catchment of about 2ha. The addition of the transfer pipes to the side of this culvert will not have an impact on hydraulic capacity.



Figure 4.5 Swamp Road culvert

The transfer pipe will also cross Rocklow Creek. To limit riparian and hydraulic impacts, the transfer pipe will be installed on a gangway approximately 1.5m above the creek banks and a span of about 12m. The gangway construction will consist of concrete footings beyond the existing top of bank. No piers within the watercourse will be required. Design and construction management should be undertaken in compliance with:

- *Guidelines for Controlled Activities on Waterfront Land - Riparian Corridors (NRAR, 2018)*
- *Guidelines for Instream Works on Waterfront Land (DPI Water, 2012a)*

There is a risk of pipeline leakage or failure, either through mechanical failure or damage from an external cause. Risks are mitigated through the use of a double skinned HDPE pipeline. System monitoring and maintenance shall be incorporated into operational procedures for the transfer pipeline to limit the possibility of failure, and allow for the swift identification of failure, should it occur.

4.6. Water balance and water licensing

As outlined in Section 3.10, water leaving the existing Dunmore Lakes Sand Project operations includes water used for dust suppression for roads and stockpile areas as well as water exported from the site as moisture content in the outgoing sand product.

Water used to transfer the sand slurry from Stages 5A and 5B will be metered and the same volume returned to ensure the local surface and groundwater balance is maintained.

The current approval allows for the removal of 800,000tpa. Current, and expected extraction averages around 400,000 to 500,000tpa. It is expected that this demand will remain in this range.

Average moisture content of material leaving the site is around 8%. Assuming an average extraction of 450,000tpa, approximately 36ML of water will leave the Site with sand products.

The current dust suppression water use is about 4.5ML/ha/y and covers about 7.6 ha (Pers comm Ben Williams, DSS Environmental Co-ordinator).

The Stage 5A and 5B access roads and stockpile areas cover about 0.7ha. Applying the same rate will increase current dust suppression water use from about 34.2ML/y to about 38ML/y.

Total water use for a production level of 450,000tpa is 74ML/y (36ML/year as moisture content in exported material and 38ML/year for dust suppression).

The creation of dredge ponds will alter the surface water/groundwater interactions. A 'window' to the groundwater table will be created. Previous landscape recharge over the pond footprints will be replaced with direct inflow from rainfall onto the ponds, and losses associated with direct evaporation over the pond surfaces. Based on the Bureau of Meteorology (BOM) gridded data over the site area, average annual rainfall is 1494mm/y and average annual evaporation is 1640mm/y, generating an average annual loss of 146mm/y. The operating pond areas are approximately 3.1ha and 6.4ha for Stage 5A and 5B respectively. Table 4.3 contains a summary of losses during and after operations over the pond footprints. These losses may need to be accounted for as extractions associated with the project.

Table 4.3 Losses over the Stage 5A and 5B dredge pond areas.

Stage	Losses during dredge pond operations (Rainfall - evaporation) x pond area.	Losses post rehabilitation (Rainfall - evaporation) x pond area.
Stage 5A	-4.52ML/y	0
Stage 5B	-9.34ML/y	-9.34ML/y
Total	-13.86 ML/y	-9.34ML/y

Currently DSS has a Water Access Licence (WAL) and associated Water Supply Work (WSW) approval for 65ML/y from the Sydney Basin South Groundwater source. DSS also have a WAL for an additional 15ML/y from the Metropolitan Coastal Sands Groundwater source, however are yet to obtain a WSW for this allocation. Once a WSW is nominated, likely over the Stage 5 extraction areas, and approved, DSS will have a total of 80ML/y available for extraction which will nominally allow for extraction up to 525,000tpa, based on existing assumptions.

Should evaporation losses from the dredge ponds need to be accounted for, allocations for an additional maximum of 13.86ML/y and associated WAL and WSW will be required.

A further allocation of 20ML has been secured from the Metropolitan Coastal Sands Groundwater source however both a WAL and WSW are pending for this allocation.

4.7. Water quality objectives and monitoring

The current water quality and discharge controls for the existing operations are outlined in Section 2.4, and include water quality targets for water discharged at licenced discharge points, and water quality objectives for the basins themselves.

It is proposed that the same water quality objectives are applied to the Stage5A and 5B extraction areas, apart from conductivity objectives, as interaction with more saline groundwater in these areas is possible

Current groundwater monitoring notes that salinity of groundwater to the east of the Princes Highway is consistently higher than that to the west and increases at depth, with values potentially exceeding currently consented water quality objectives for conductivity. (EES, 2018). In the currently approved Groundwater Management Plan, Environmental Earth Sciences (EES, 2018) have recommended that trigger values for groundwater salinity be increased from <1500 to 33000µS/cm for groundwater monitoring sites to the east of the Princes Highway to reflect the saline influence on groundwater in this area.

The Stage 3 dredge pond currently experiences elevated electrical conductivity due to this saline tidal inflow which is above the current consented limit of 1500µS/cm. Rocklow Creek is tidal in this area. Adjacent bore holes (BHF and BHD) also reported elevated electrical conductivity levels in May 2018 (EES, 2018). Saline intrusion is a possible cause, particularly given the depth of dredge pond excavation is up to 15m deep and extends into the deeper aquifer which has higher salinity levels (EES, 2018).

Surface water salinity in the channel to the northwest of Stage 5A, on the eastern side of Riverside Drive is brackish. Recent groundwater assessment in the northern corner the Stage 5A area (bore MW5A3) reports TDS levels around the current objective level at a depth of around 0.6m AHD and that the tidal effect on groundwater is typically between 5 and 50 m from a tidal creek, depending on soil permeability (EES, 2019).

The proximity of the Stage 5A and 5B dredge ponds to tidally influenced and saline watercourses, and the groundwater salinity levels measured in the vicinity, creates the potential for saline groundwater intrusion into these ponds. The likelihood increases as pond excavation deepens as well as during periods of pond draw-down either through extraction or evaporation. Further, the transfer of water from Stage 5A and 5B to the processing facility (Stage 2) and return flows mean that salinity levels in the Stage 2 fines pond will be influenced by Stages 5A and 5B and vice versa.

As this is possible, an increase to the current surface water electroconductivity trigger from <1500µS/cm should be considered. Some water quality characterisation will be necessary to assist in determining any new objectives.

The expanded operation associated with the modification will continue to make use of the existing EPL provisions for wastewater (effluent) and discharge from ponds associated with the extraction activities and crushing, grinding and separating activities. No additional discharge points are proposed for the modification, and all processing will be undertaken at the existing facility in the Stage 2 processing area, along with water quality management in the existing fines and settling ponds.

Uncontrolled discharges from the Stage 5A or Stage 5B extraction areas are unlikely as the proposed confinement bunds would provide protection of receiving waters by:

- Protecting interaction with external flood flows up to the 100 year ARI event; and
- Providing storage (nominally 2-3m depth) within the basins to allow for local rainfall and variations in flow transfer to these ponds.

The current monitoring locations outlined in the EPL should be maintained. In addition, four new monitoring points, along with the new Stage 5A and 5B dredging ponds themselves should be added to the existing water quality monitoring program.

The new monitoring points are recommended to be located upstream and downstream of the extraction areas to allow for comparison. For Stage 5A, an upstream monitoring point should be positioned at the pond west of the Princess Highway and a downstream monitoring point positioned upstream of the Riverside Drive culvert crossing. Similarly, for the Stage 5B extraction area, water quality monitoring shall be undertaken at sites upstream, and downstream within the Minnamurra River. Refer to Figure 4.6 for locations of proposed water quality monitoring locations.

Monitoring at these four points, along with the Stage 5A and 5B dredging ponds themselves should be carried out in accordance with the current monitoring program.



Figure 4.6 Proposed water quality monitoring points upstream (U/S) and downstream (D/S) of Stage 5A and 5B extraction areas.

4.8. Cumulative Impacts

The key pressures identified in the NSW natural resources Monitoring Evaluation and Reporting (MER) program for the Minnamurra Estuary are land clearing, population, sediment input and nutrient inputs. Sediment and nutrient inputs are estimated to have increased by up to 500% from natural catchment conditions (DECCW, 2011) associated with land clearing and the changes in land use to cropping, intensive agriculture, urbanisation waste management and resource extraction.

OEH has used the Coastal Eutrophication Risk Assessment Tool (CERAT) to identify key contributors to pollutant load inputs within the Rocklow Creek and Minnamurra River catchment with areas with irrigated crops and pastures, horticulture, or areas of intensive animal production or waste treatment and disposal had the highest levels of pollutant exports, although the CERAT does not consider EPA licencing controls (Hydrosphere, 2015). These areas include existing resource extraction sites and waste management facilities within the catchment. Grazing presents a low to moderate contributor, depending on agricultural practices and soil types and topography.

The proposed development will modify existing grazing land use to a resource extraction land use, with environmental controls implemented through an environmental management plan and the existing EPL.

The change from grazing to resource extraction will reduce nutrient loads leaving the site. Increased exposed surfaces necessary to create the extraction areas, particularly during the establishment phases have the potential to increase sediment loads if not managed correctly. A range of soil and water management measures are specified within this assessment to limit the risk of sediment movement from the extraction areas to receiving waters.

At completion of extraction, rehabilitation of the dredge ponds will reinstate grazing land over the Stage 5A footprint and create a pond and revegetated area over the Stage 5B footprint. Post rehabilitation, pollutant loads from the development area will be less than existing, as grazing over the Stage 5B area will not be reinstated. This corresponds to approximately a 30% reduction in TSS, TP and TN loads over this area, based on estimated land use pollutant concentrations (Fletcher et al., 2004).

Overall, the change in land use is unlikely to change the overall pollutant loads reaching the estuary. Over the longer term, the change from grazing to rehabilitated pond areas has the potential to improve estuary water quality.

4.9. Rehabilitation

The 5A dredge pond will be filled once resource extraction is complete. Surface water protection bunds will be removed and surface levels restored to similar pre-extraction levels and revegetated.

The 5B dredge pond will be retained as an open water area. Flood protection bunds will be removed and the site revegetated. Water levels in the pond will be driven by groundwater and local catchment flows.

The primary connection to the Minnamurra River will be in the north east corner of the pond, where the existing point is at about 2.1m AHD. When floodwaters exceed this level in the Minnamurra River (approximately 5 year ARI event) backwater flows will enter the rehabilitated pond.

Rehabilitation plans for both dredge ponds will need to be prepared and should take into consideration surface flow movements after surface reshaping and provide an armoured inflow and outflow point.

5.0 SUMMARY

The proposed modification will open up additional areas for resource extraction and make use of the existing processing and water management facilities located in Stage 2 of the approved operations. The following summary outlines the key surface water impacts, along with their mitigation and management measures.

5.1. Floodplain impacts

The proposed extraction areas are located on the local floodplains. The isolation of these areas from surface and flood flows by establishing bunds, removes storage from the floodplain. This removal is temporary.

The impact from the loss of floodplain storage is not significant, with a maximum of about 16mm increase in flood level across Riverside Drive for the 5 year ARI event, for the Stage 5A area, and a localised increase of about 45mm to the south of the Stage 5B area; confined to within the property.

Armoured spillways are proposed for both Stage 5 extraction areas to allow for the potential inundation in large flood events and controlled inflow and outflow of floodwaters.

On completion of resource extraction, the Stage 5A bund will be removed and the landscape reinstated, restoring the existing floodplain.

Likewise, on completion of extraction, the Stage 5B bund will be removed in a staged process. Open water will be maintained at the natural surface interface at the eastern edge of the Stage 5B dredge pond at about 2.0m AHD. This will increase flood storage within the floodplain by about 130,000m³ due to the material removed from the site above the normal pond water level (2.0m AHD).

5.2. Water quality

5.2.1. Construction and operation

SWMPs will be required for the construction phase of both stages, for all components of infrastructure. Key aspects will be:

- Design of diversion drains for surface flow diversion; and
- Surface treatment of external bund batters to prevent erosion.

Bund and diversion drains will isolate the extraction areas from local surface flows and surrounding flood flows to reduce the possibility of uncontrolled discharges from the extraction areas.

The existing Stage 2 processing area will process all materials from Stage 5A and Stage 5B, with waste process water managed through the existing fines and settling ponds.

Additional water quality monitoring locations are to be established upstream and downstream of Stages 5A and 5B, as well as monitoring of the new dredging ponds themselves. Monitoring frequency and parameters shall be maintained as per the current approval.

The current licensed discharge points shall be maintained along with discharge pollutant limits. An increase to the salinity water quality objective from $<1500\mu\text{S}/\text{cm}$ should be considered given the potential influence of saline groundwater on the Stage 5 dredge ponds.

5.2.2. Closure, rehabilitation and future

Water quality risks during the rehabilitation of Stage 5A and Stage 5B can be mitigated by retaining the bunds during the filling and revegetation processes. SWMPs will be required to manage water quality risks during the removal of the bunds and eventual reconnection of the dredge pond areas with the local floodplain.

The Stage 5B dredge pond will remain as open water once extraction is complete. With the bund removed, floodwaters from the Minnamurra River will interact with the pond at levels of around 2.1m AHD and higher. To limit water quality risks, a water quality monitoring program should be undertaken over 12 months post revegetation, and bund removal contingent on water quality within the Stage 5B pond area meeting ANZECC guideline trigger values.

5.3. Water Use and Water balance

Water extracted from Stages 5A and 5B is to be measured, and the same volume returned to maintain the local water balance.

The additional extraction areas will require additional water, primarily for dust suppression over the additional exposed areas. Water exported from the site as moisture content in exported sand product may also increase, depending on export rates. Based on an average extraction of 450,000tpa and the additional dust suppression, total water use is 74ML/y (36ML/year as moisture content in exported material and 38ML/year for dust suppression). The current water access licence is for 65ML/y.

The current Water Access Licence will need to be increased to accommodate the expected annual extraction at the site.

5.4. Legislation

Relevant clauses from pertinent legislation are summarised in Table 5.1 Table 5.2 and Table 5.3 below.

Table 5.1 State Environmental Planning Policy 2018 (Coastal Management)

Relevant clauses	Key management and mitigation measures
<i>Clause 11</i> (1) Development consent must not be granted unless the consent authority is satisfied that the proposed development will not significantly impact on: a) the biophysical, hydrological or ecological integrity of the adjacent coastal wetland, or b) the quantity and quality of surface and ground water flows to and from the adjacent coastal wetland. In order to not significantly impact the biophysical, hydrological or ecological integrity of the adjacent coastal wetland it is important to as much as possible maintain the existing runoff regime from the wetlands contributing catchment. Maintaining the existing runoff regime includes maintaining: • existing runoff flow paths and discharge points; and • runoff quality and quantity (a function of land use and imperviousness)	• The extraction areas are to be isolated from the local floodplain up to the 100 year ARI flood level. Uncontrolled discharge from the extraction areas to adjacent wetland areas is unlikely. • The water balance within each proposed extraction area is to be maintained. Water extracted as part of the sand slurry transfer is to be measured and returned to limit modification to groundwater flows and levels. • Surface diversion drains are to be stable and well vegetated where slopes allow and existing discharge points to be maintained where possible. • Bund batter slopes shall be well vegetated to limit runoff and protect against erosion.

Table 5.2 Fisheries Management Act 1994 and Policy and guidelines for fish habitat conservation and management 2013

Relevant clauses	Key management and mitigation measures
Section 201 - permit to carry out works of dredging or reclamation (i.e. any excavation within, or filling or draining of, water land or the removal of woody debris, snags, rocks or freshwater native aquatic vegetation or the removal of any other material from water land that disturbs, moves or harms these in-stream habitats), Section 219 – permit to obstruct the free passage of fish. NSW DPI will generally require riparian buffer zones to be established and maintained for developments or activities in or adjacent to TYPE 1 or 2 habitats or CLASS 1-3 waterways	Although no permits are required for this modification, an assessment of extraction impacts and fish passage impacts are incorporated into this assessment. Extraction activities are undertaken beyond the recommended buffer distances (100m) for adjacent Type 1 habitats and Class 1 waterways. Obstruction of fish passage impacts associated with the transfer pipe have been assessed, and are negligible. Water quality during construction will be managed based on relevant sediment and erosion control guidelines. Operation water quality management will continue to be controlled through the operations EPL and consent conditions.

Table 5.3 Water Management Act 2000

Relevant section	Key management and mitigation measures
5. Water management principles (6) In relation to floodplain management: (a) floodplain management must avoid or minimise land degradation, including soil erosion, compaction, geomorphic instability, contamination, acidity, waterlogging, decline of native vegetation or, where appropriate, salinity and, where possible, land must be rehabilitated, and (b) the impacts of flood works on other water users should be avoided or minimised, and (c) the existing and future risk to human life and property arising from occupation of floodplains must be minimised. (7) In relation to controlled activities: (a) the carrying out of controlled activities must avoid or minimise land degradation, including soil erosion, compaction, geomorphic instability, contamination, acidity, waterlogging, decline of native vegetation or, where appropriate, salinity and, where possible, land must be rehabilitated, and (b) the impacts of the carrying out of controlled activities on other water users must be avoided or minimised.	• The extraction areas will require clearing of the floodplain during operation. For Stage 5A backfilling with VENM, and revegetation of the floodplain will be undertaken once resource extraction is complete. For 5B, bunds will be removed and an open water area retained. • Bunding of the extraction areas will temporarily remove some floodplain storage. The impact is small in a 1% AEP event. Bunding will be removed once resource extraction is complete and floodplain storage will be restored. • The existing and future risk to human life and property from the works on the floodplain is very low and temporary. • Temporary crossings of existing ponds and Rocklow Creek are required. These are to be undertaken in accordance with controlled activity guidelines: ○ <i>Guidelines for Controlled Activities on Waterfront Land - Riparian Corridors (NRAR, 2018)</i> ○ <i>Guidelines for Instream Works on Waterfront Land (DPI Water, 2012a)</i> ○ <i>Guidelines for Laying Pipes and Cables in Watercourses on Waterfront Land (DPI Water, 2012b)</i> • Soil and water management plans are to be prepared for all aspects of construction. • Rehabilitation of the floodplain will be undertaken on completion of the resource extraction.

6.0 REFERENCES

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APPENDIX A – FLOODPLAIN MODELLING RESULTS.



Legend

— Dredge pond bunds and earthworks

5y ARI Flood level (m AHD)

- 2
- 2.39
- 2.78
- 3.17
- 3.56
- 3.95
- 4.34
- 4.7
- 5

FIG 1. 5y ARI Flood height, existing conditions.

18/06/2019

0 100 200 300 400 m





Legend

— Dredge pond bunds and earthworks

20y ARI Flood level (m AHD)

- 2
- 2.39
- 2.78
- 3.17
- 3.56
- 3.95
- 4.34
- 4.7
- 5

FIG 2. 20y ARI Flood height, existing conditions.

18/06/2019

0 100 200 300 400 m



southeast
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Legend

— Dredge pond bunds and earthworks

1% AEP Flood level (m AHD)

- 2
- 2.39
- 2.78
- 3.17
- 3.56
- 3.95
- 4.34
- 4.7
- 5

FIG 3. 1% AEP Flood height, existing conditions.

18/06/2019

0 100 200 300 400 m





Legend

— Dredge pond bunds and earthworks

PMF Flood level (m AHD)

- 2
- 2.52
- 3.04
- 3.56
- 4.08
- 4.6
- 5.12
- 5.6
- 6

FIG 4. PMF Flood height, existing conditions.

18/06/2019

0 100 200 300 400 m



southeast
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Legend

— Dredge pond bunds and earthworks

100y ARI max velocity (m/s)

- 0.0157
- 0.274
- 0.532
- 0.79
- 1.05
- 1.31
- 1.56
- 1.8
- 2

FIG 5. 100y ARI Max velocity, existing conditions.

18/06/2019

0 100 200 300 400 m



southeast
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Legend

— Dredge pond bunds and earthworks

PMF Max velocity (m/s)

- 0.0157
- 0.274
- 0.532
- 0.79
- 1.05
- 1.31
- 1.56
- 1.8
- 2

FIG 6. PMF Max velocity, existing conditions.

18/06/2019

0 100 200 300 400 m



southeast
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Legend

— Dredge pond bunds and earthworks

Flood height difference (m)

0

0.0125

0.025

0.0375

0.05

FIG 7. 5y ARI Flood height difference

18/06/2019

0 100 200 300 400 m



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Legend

— Dredge pond bunds and earthworks

Flood height difference (m)

0

0.0125

0.025

0.0375

0.05

FIG 8. 20y ARI Flood height difference

18/06/2019

0 100 200 300 400 m



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Legend

— Dredge pond bunds and earthworks

Flood height difference (m)

0

0.0125

0.025

0.0375

0.05

FIG 9. 100y ARI Flood height difference

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0 100 200 300 400 m



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Legend

— Dredge pond bunds and earthworks

Flood height difference (m)

0

0.0125

0.025

0.0375

0.05

FIG 10. PMF Flood height difference

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0 100 200 300 400 m



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Legend

— Dredge pond bunds and earthworks

Max velocity difference (m/s)

- 0
- 0.125
- 0.25
- 0.375
- 0.5

FIG 11. 5y ARI Max velocity difference

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0 100 200 300 400 m





Legend

— Dredge pond bunds and earthworks

Max velocity difference (m/s)

0

0.125

0.25

0.375

0.5

FIG 12. 20y ARI Max velocity difference

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0 100 200 300 400 m





Legend

— Dredge pond bunds and earthworks

Max velocity difference (m/s)

- 0
- 0.125
- 0.25
- 0.375
- 0.5

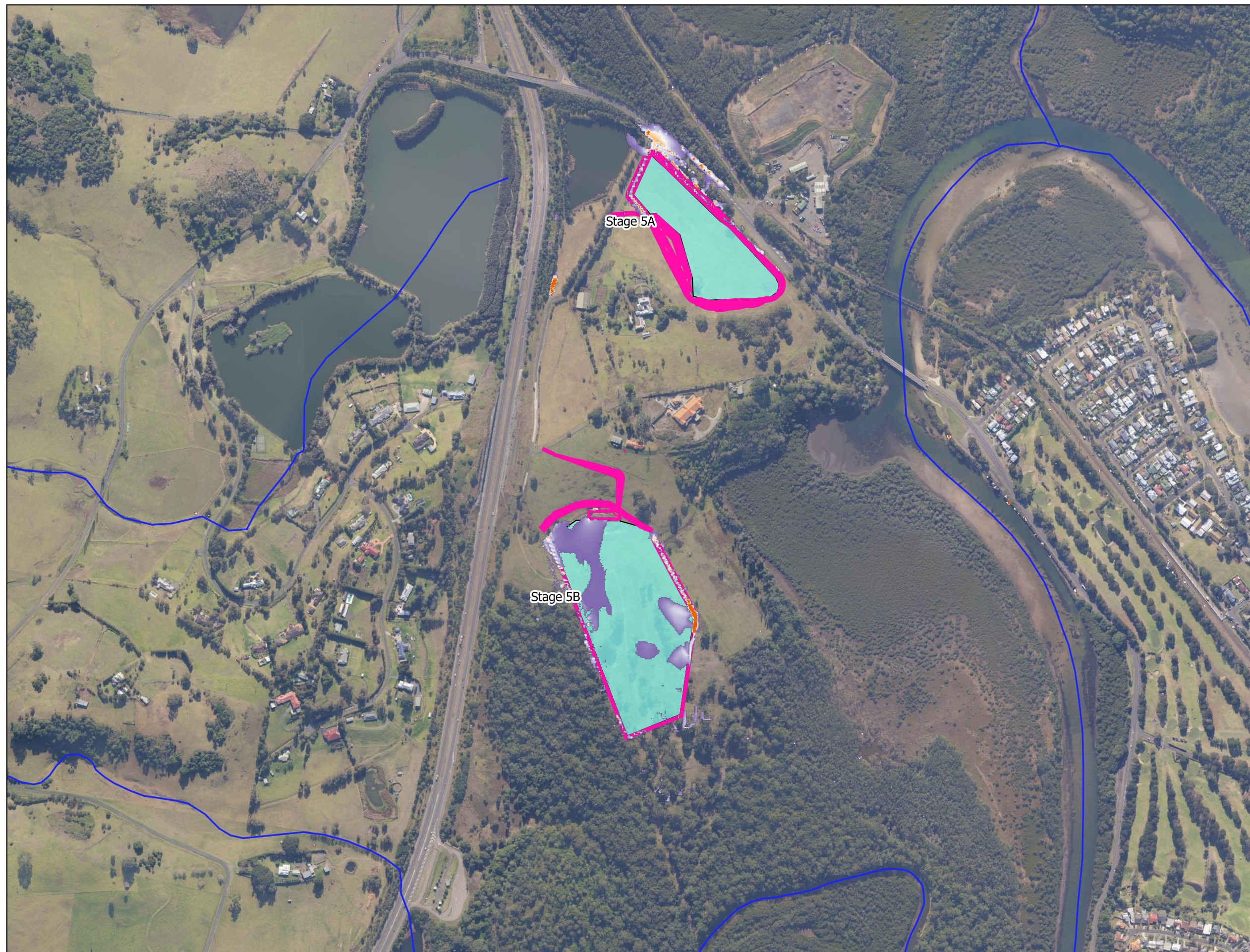
FIG 13. 100y ARI Max velocity difference

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0 100 200 300 400 m



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Legend

— Dredge pond bunds and earthworks

Max velocity difference (m/s)

0

0.125

0.25

0.375

0.5

FIG 14. PMF Max velocity difference

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0 100 200 300 400 m



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