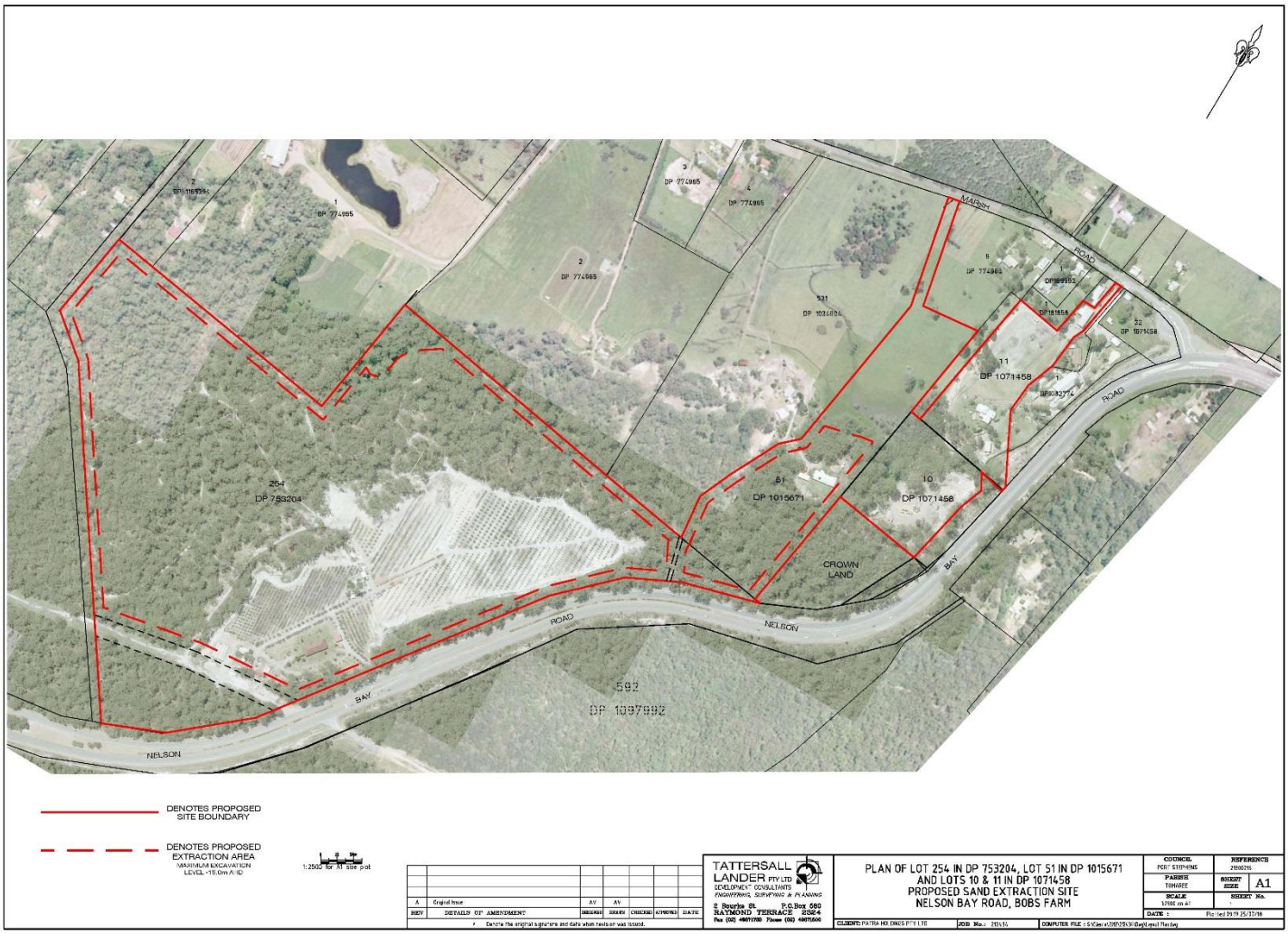


Bobs Farm Sand Mine

Environmental Impact Statement
Volume 1

AMMOS Resource Management Pty Ltd
November 2018

Bobs Farm Sand Mine

Environmental Impact Statement

AMMOS Resource Management Pty Ltd

November 2018

Job No: 212434

SUBMISSION OF ENVIRONMENTAL IMPACT STATEMENT

PREPARED UNDER PART 4: ENVIRONMENTAL PLANNING AND ASSESSMENT ACT 1979

EIS PREPARED BY

Names:	Robert Lander
Qualifications:	*BSurv (Hons)*
Address:	2 Bourke Street RAYMOND TERRACE NSW 2324

PROPOSED DEVELOPMENT

Tattersall Lander Pty. Ltd. on behalf of Ammos Resource Management Pty Ltd is seeking approval for:

- The establishment and operation of a quarry (over 15 years) to extract and process sand at a rate of 750,000 tonnes per annum from a total resource of 10 million tonnes; and
- Associated extractive materials processing and transport infrastructure; and
- Site rehabilitation and consideration of alternative future land uses.

PROJECT APPLICATION

Applicant Name:	AMMOS RESOURCE MANAGEMENT PTY LTD c/-Tattersall Lander Pty. Ltd.
Applicant Address:	PO Box 580, RAYMOND TERRACE, NSW 2324
Land to be developed:	Lots 10 & 11 DP 1071458 & Lot 254 DP 753204 & Lot 51 DP 1015671 Nelson Bay Road, Bobs Farm

ENVIRONMENTAL IMPACT STATEMENT

An Environmental Impact Statement is attached which addresses all matters listed under Part 4 of the Environmental Planning and Assessment Act 1979.

CERTIFICATE

I certify that I have prepared the contents of this EIS and to the best of my knowledge:
(i) the statement has been prepared in accordance with this Schedule, and
(ii) the statement contains all available information that is relevant to the environmental assessment of the development, activity or infrastructure to which the statement relates, and
(iii) that the information contained in the statement is neither false nor misleading.

Name: Robert Lander
Signature:

Date: November 2018

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Bobs Farm Sand Mine

Environmental Impact Statement

Prepared for
AMMOS Resource Management Pty Ltd
November 2018

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Annex W – Power Point Presentation
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GLOSSARY

Aquifer	A water bearing stratum of permeable rock, sand or gravel, able to transmit substantial quantities of water Arboreal Adapted for living in and/or moving around in trees. Bioregion Region in which the boundaries are primarily determined by (or reflect) similarities in geology, climate and vegetation.
Cleared Land	Where the native over-storey has been cleared, there is no native mid-storey and less than 50% of the groundcover vegetation is native species or greater than 90% of the groundcover (dead or alive) is cleared.
Clearing	Clearing of native vegetation is defined in the *Native Vegetation Act 2003* as any one or more of the following: - cutting down, felling, thinning, logging or removal; - killing, destroying, poisoning, ringbarking, uprooting or burning.
Community	The recognisable association of species that regularly occur together in similar environments.
Critical Habitat	Habitat declared to be critical in relation to that species or ecological community under the *Threatened Species Conservation Act 1995* or under the *Environment Protection and Biodiversity Conservation Act 1999.*
Endangered	A species, population or ecological community that is likely to become extinct or is in immediate danger of extinction.
Endangered Ecological Community	Ecological community specified as endangered under Part 3 of Schedule 1 of the *Threatened Species Conservation Act 1995* or under the *Environment Protection and Biodiversity Conservation Act 1999*.
Endangered Population	Population identified as endangered under Part 2 of Schedule 1 of the *Threatened Species Conservation Act 1995.*
Endemic	Restricted to a particular area having originated there.
Exotic Species	A non-indigenous species.
Fauna	The animals of a particular region, habitat or geological region.
Flora	The plants of a particular region, habitat or geological region.
Floristics	Species composition of a plant community.
Groundwater	Water held underground in the soil or in pores and crevices in rock.
Habitat	An area or areas occupied or periodically occupied by a species, population or ecological community and includes any biotic or abiotic component necessary to sustain survival and reproduction.
Hollow-Bearing Tree	Tree where the base, trunk or limbs contain hollows, holes or cavities that have formed as a result of decay, injury or other damage.
Hydraulic Conductivity	A coefficient of proportionality describing the rate at which water can move through a permeable medium.

Hydraulic Gradient	The change in total head with a change in distance in a given direction.
Indigenous	Native to, or originating in, a particular region or country.
Life Cycle	The series or stages of reproduction, growth, development, ageing and death of an organism.
Local Population	The population that exists in the study area as well as any individuals occurring in the adjoining areas known or likely to utilise habitats in the study area.
Native Species	A species that is indigenous to Australia or an external Territory, or periodically or occasionally visits.
Noxious	Harmful to the environment or ecosystem.
Offset (Biodiversity)	One or more appropriate actions put in place in an appropriate location to counterbalance or offset an impact on biodiversity values.
pH	Measure of the acidity or alkalinity of a substance, with 1 being the most acidic, 7 being neutral and 14 being the most alkaline.
Population	A group of animals or plants of the same species, potentially capable of interbreeding and sharing the same habitat in a particular area at a particular time.
Propagation	The reproduction of plants.
Ramsar wetland	Under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth), a Ramsar wetland is either an Australian wetland on the List of Wetlands of International Importance kept under the Ramsar Convention; or a wetland declared to be a Ramsar wetland by the Commonwealth Environment Minister.
Rare	An animal is rare / near threatened if the population size or distribution of the wildlife is small and may become smaller; or the population size of the wildlife has declined, or is likely to decline, at a rate higher than the usual rate for population changes for the wildlife; or the survival of the wildlife in the wild is affected to an extent that the wildlife is in danger of becoming vulnerable.
Recharge	The process involving the infiltration of water from the surface to groundwater.
Regeneration	Where native vegetation is allowed to return naturally to an area generally by removing existing impacts such as grazing or slashing.
Regrowth	A young, usually even-aged forest stand that has regenerated after disturbance.
Rehabilitation	Making the land useful again after a disturbance. It involves the recovery of ecosystem functions and processes in a degraded habitat.

Remnant Vegetation	Any native vegetation that is not regrowth.
Revegetation	Use of methods such as planting of tubestock and direct seeding to return native vegetation to an area.
Risk of Extinction	The likelihood that the local population will become extinct either in the short term or long term as a result of direct or indirect impacts on the viability of that population.
Sediment	Any usually finely divided organic and / or mineral matter deposited by air or water in non-turbulent areas.
Soil Profile	The physical and chemical features of the soil imagined or seen in vertical section from the surface to the point at which the characteristics of the parent rock are not modified by surface weathering or soil processes.
Species	A group of biological entities that (a) interbreed to produce fertile offspring; or (b) possess common characteristics derived from a common gene pool.
Terrestrial	Pertaining to land, the continents, and/or dry ground. Contrasts to aquatic.
Topography	Description or representation of natural or artificial features of the landscape; the description of any surface, but usually the earth's.
Translocation	The transfer of plants and animals from one part of their range to another.
Viable	The capacity to successfully complete each stage of the life cycle under normal conditions.
Vulnerable	A species or ecological community that is rare, not presently endangered but likely to become endangered unless the circumstances and factors threatening its survival or evolutionary development cease to operate.
Weed	A plant that is considered undesirable because it threatens the persistence of native plants.
Wetland	Low-lying areas regularly inundated or permanently covered by shallow water. Usually important areas for birds and other wildlife.
Wildlife Corridor	A strip of habitat that facilitates fauna movement between otherwise isolated patches of habitat.

ABBREVIATIONS

AHD	Australian Height Datum
AHIMS	Aboriginal Heritage Information Management System
AEMR	Annual Environmental Management Report
AMMOS	AMMOS Resource Management Pty Ltd
ANPI	Australian National Pollutant Inventory
ASM	Acid Sulfate Materials
ASS	Acid Sulfate Soils
AWS	Automatic Weather Station
BoM	Bureau of Meteorology
CKPoM	Comprehensive Koala Plan of Management
DAP	Data Analysis Protocol
dB	Decibel
DGRs	Director-General's Requirements
DoPE	Department of Planning and Environment
PI	Primary Industries Division of Trade & Investment NSW
EEC	Endangered Ecological Community
EHS	Environment, Health and Safety
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
EP&A Act	*Environmental Planning and Assessment Act 1979*
EP&A Regulation	Environmental Planning and Assessment Regulation 2000
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPI	Environmental Planning Instrument
EPL	Environmental Protection Licence
ERM	Environmental Resources Management Australia Pty Ltd
ESD	Ecologically Sustainable Development
FM Act	*Fisheries Management Act, 1994*
GDEs	Groundwater Dependent Ecosystems

GPS	Global Positioning System
GWP	Groundwater Management Plan
HA	Heritage Assessment
Ha	Hectare
INP	Industrial Noise Policy (EPA, 2000)
Km	Kilometres
km/hr	kilometres per hour
KMU	Koala Management Units
LALC	Local Aboriginal Land Council
LEP 2013	Port Stephens Local Environmental Plan 2013
LGA	Local Government Area
LHCCREMS	Lower Hunter Central Coast Regional Environmental Management Strategy
m/d	metres per day
mg/L	milligrams per litre
MP	Major Project
MU	Map Unit
µS/cm	micro Siemens per centimetre
NEPM	National Environment Protection Measure
NOW	New South Wales Office of Water
NPWS	National Parks and Wildlife Service
NP&W Act	*National Parks and Wildlife Act 1974*
NSW	New South Wales
NV Act	*Native Vegetation Act 2003*
OEH	Office of Environment and Heritage
PAA	Project Application Area
PASS	Potential Acid Sulfate Soils
Pea	Proposed Extension Area
PHA	Preliminary Hazard Analysis
POEO Act	*Protection of the Environment Operations Act 1997*
PMGEs	Predicted Maximum Groundwater Elevations

PM2	Particulate Matter less than 2 microns
PM10	Particulate Matter less than 10 microns
PSC	Port Stephens Council
PSNC	Project Specific Noise Criteria
QMS	Quarry Mining Systems Pty Ltd
RAP	Registered Aboriginal Parties
RBL	Rating Background Level
RMS	Roads and Marine Service
ROTAP	Rare or Threatened Australian Plants
SAT	Spot Assessment Technique
SEPP	State Environmental Planning Policy
SEPP 14	State Environmental Planning Policy 14 – Coastal Wetlands
SEPP 33	State Environmental Planning Policy 33 – Hazardous and Offensive Development
SEPP 44	State Environmental Planning Policy 44 – Koala Habitat Protection
SEPP 55	State Environmental Planning Policy 55 – Remediation of Land
SEPP 71	State Environmental Planning Policy 71 – Coastal Protection
SEPP (Major Development)	State Environmental Planning Policy (Major Development)
SIS	Species Impact Statement
subsp.	Subspecies
Tattersall Lander	Tattersall Lander Pty Ltd - Development Consultants
TSC Act	*Threatened Species Conservation Act 1995*
TSP	Total Suspended Particulates
WLALC	Worimi Local Aboriginal Land Council
WM Act	*Water Management Act 2000*
Water Act	*Water Act 1912*

EXECUTIVE SUMMARY

INTRODUCTION

Tattersall Lander Pty Ltd has been engaged by AMMOS RESOURCE MANAGEMENT PTY LTD to prepare this Environmental Impact Statement (EIS), to accompany an application to the Minister for Planning under Part 4 of the Environmental Planning and Assessment Act 1979. The application is for State Significant Development and seeks approval to construct and operate a sand extraction and processing operation at Bobs Farm, NSW. The Bobs Farm Sand Mine is located on the western side of Nelson Bay Road and south of Marsh Road at Bobs Farm and it is within the Port Stephens Local Government Area.

The Department of Planning and Environment was consulted in relation to the development proposal and the Director-General's Requirements (DGRs) for SSD14/6395 were issued on 21 March, 2014.

As two years had passed from the release of the DGRs the Department was further consulted with a request for Secretary's Environmental Assessment Requirements (SEARs). SEARs were provided on 12 April, 2017.

A full copy of the DGRs and SEARs (with additional agency comments) are included at Annexure 1 and are largely similar in requirements. DGRs are included as a result of agency referral to them in their revised response to SEARs. A summary of the EIS responses to DGRs and to SEARs follows below.

The application is also nominated integrated development pursuant to section 91(1) of the *Environmental Planning & Assessment Act 1979*.

The proposed development requires a license pursuant to Section 48 of the *Protection of the Environment Operations Act 1997* (Schedule 1 Activities (Premises-Based), Item 19 Extractive Industries). Item 19 specifies:

19 Extractive activities
(1) This clause applies to the following activities:
land-based extractive activity, meaning the extraction, processing or storage of extractive materials, either for sale or re-use, by means of excavation, blasting, tunnelling, quarrying or other such land-based methods.
water-based extractive activity, meaning the extraction of extractive materials, either for sale or re-use, by means of dredging or other such water-based methods.
(2) In this clause, extractive materials means clay, sand, soil, stone, gravel, rock, sandstone or similar substances that are not minerals within the meaning of the Mining Act 1992.
(3) Each activity referred to in Column 1 of the Table to this clause is declared to be a scheduled activity if it meets the criteria set out in Column 2 of that Table.

Table

Column 1	Column 2
Activity	Criteria
land-based extractive activity	involves the extraction, processing or storage of more than 30,000 tonnes per year of extractive materials
water-based extractive activity	involves the extraction of more than 30,000 cubic metres per year of extractive materials

The proposed development also requires a license pursuant to Section 91(3) of the *Water Management Act 2000* for the purposes of an aquifer interference approval.
An aquifer interference approval confers a right on its holder to carry out one or more specified aquifer interference activities at a specified location, or in a specified area, in the course of carrying out specified activities.

The EIS describes the project, outlines relevant statutory provisions, identifies the key issues and comprehensively assesses potential environmental and socio-economic impacts. It describes a range of management and mitigation measures to ensure that short term impacts are minimised and that there is a net benefit from the proposal in the medium to long term.

EIS Response to DGRs and SEARs

Secretary's Environmental Assessment Requirements (SEARs)12 April, 2017 General SEARs Requirements State Significant Development SSD 6395: Proposed Sand Mine Lots 10 & 11 DP 1071458 & Lot 254 DP 753204 & Lot 51 DP 1015671 Nelson Bay Road, BOBS FARM			
Prescription	Summarised Issue	Detail	Location as addressed in EIS
Department of Planning & Environment General SEARs Requirements	Full Development Description including: • a full description of the development, including: - the need for the development; - the resource to be extracted, including the amount, type and composition; - the site layout and extraction plan, including cross-sectional plans; - the production process and processing activities, including the in-flow and out-flow of materials and points of discharge to the environment; - surface infrastructure and facilities (including any infrastructure that would be required for development, but the subject of a separate approvals process); - a waste (overburden, rejects, tailings etc.) management strategy; - a water management strategy; - a rehabilitation strategy to apply during, and after completion of extraction operations, and proposed final use of site; and - the likely interactions between the development and any existing, approved or proposed development in the vicinity of the site;	EIS text overview	Chapters 1, 2, 5, 6, 7, 16, 20, 22 and 23 Annexures E, F

	• A list of any approvals required before the development may commence	Prescribed in EIS	Chapters 1 and 3
	• an assessment of the likely impacts of the development on the environment, focussing on the key issues identified below, including: - a description of the existing environment likely to be affected by the development, using sufficient baseline data; - an assessment of the likely impacts of all stages of the development, including any cumulative impacts, taking into consideration any relevant laws, environmental planning instruments, guidelines, policies, plans and industry codes of practice; - a description of the measures that would be implemented to avoid, minimise, mitigate and/or offset the likely impacts of the development, and an assessment of: o whether these measures are consistent with industry best practice, and represent the full range of reasonable and feasible mitigation measures that could be implemented; o the likely effectiveness of these measures; and o whether the contingency measures would be necessary to manage any residual risks; and a description of measures that would be implemented to monitor and report on the environmental performance of the development if it is approved;	Detailed prescription in EIS	Chapters 4-26 and Annexures C – T, X
	• a consolidated summary of all the proposed environmental management and monitoring measures, identifying all the commitments in the EIS;	Detailed prescription in EIS	Chapter 26
	• consideration of the development against all relevant environmental planning instruments (including Part 3 of the *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007)*;	Detailed prescription in EIS	Chapter 3

	• a conclusion justifying why the development should be approved, taking into consideration: - alternatives; - the suitability of the site - the biophysical, economic and social impacts of the project, having regard to the principles of ecologically sustainable development; and whether the project is consistent with the objects of the Environmental Planning and Assessment Act 1979; and	Detailed prescription in EIS	Chapters 3, 26, 27, 28
	• a signed declaration from the author of the EIS, certifying that the information contained within the document is neither false nor misleading.	Included as required	Foreword
	• capital investment value (as defined in Clause 3 of the Environmental Planning and Assessment Regulation 2000) of the development, including details of all the assumptions and components from which the capital investment value calculation is derived	Detailed prescription in EIS	Executive Summary and Annexure U
	• jobs that would be created during each stage of the development.	Detailed prescription in EIS	Chapters 2, 18 and 27
Consultation	During the preparation of the EIS, you must consult with relevant local, State and Commonwealth Government authorities, service providers, Aboriginal stakeholders, community groups and affected landowners. In particular, you must consult with: • affected landowners; • community groups; • Port Stephens Council; • Office of Environment and Heritage (including the Heritage Branch); • Environment Protection Authority; • Division of Resources and Energy within the Department of Industry; • Department of Primary Industries (including the DPI Water, NSW Forestry, Agriculture and Fisheries sections and Crown Lands division); • Roads and Maritime Services; • NSW Rural Fire Service; and • Hunter Local Land Services. The EIS must: • describe the consultation process used and demonstrate that effective consultation has occurred;	Detailed prescription in EIS	Chapters 1-28

	• describe the issues raised by public authorities, service providers, community groups and landowners; • identify where the design of the development has been amended in response to issues raised; and otherwise demonstrate that issues raised have been appropriately addressed in the assessment.		
Key Issues	The EIS must address the following key issues: • Water – including: - a detailed site water balance and an assessment of any volumetric water licensing requirements, including a description of site water demands, water disposal methods (inclusive of volume and frequency of any water discharges), water supply infrastructure and water storage structures; - identification of any licensing requirements or other approvals under the Water Act 1912 and/or Water Management Act 2000; - demonstration that water for the construction and operation of the development can be obtained from an appropriately authorised and reliable supply in accordance with the operating rules of any relevant Water Sharing Plan (WSP); - a description of the measures proposed to ensure the development can operate in accordance with the requirements of any relevant WSP or water source embargo; - an assessment of any likely flooding impacts of the development; - a detailed consideration of maintenance of an adequate buffer between all excavations at the highest predicted regional groundwater table; - an assessment of potential impacts on the quality and quantity of existing surface and ground water resources, including a detailed assessment of proposed water discharge quantities and quality against receiving water quality and flow objectives; and - a detailed description of the proposed water management system (including sewage), water monitoring program and other measures to mitigate surface groundwater impacts	Detailed prescription in EIS	Chapters 3, 5, 6, 7, 8, 16, 26 Annexures E – H, T
	• Noise – including a quantitative assessment of potential: - construction, operational and off-site transport noise impacts in accordance with the Interim Construction Noise Guideline, NSW Industrial Noise Policy and the NSW Road Noise Policy respectively; - reasonable and feasible mitigation measures to minimise noise emissions; and - monitoring and management measures, in particular real-time and attended noise monitoring.	Detailed prescription in EIS	Chapter 11 Annexure J

	• Air Quality – including a quantitative assessment of potential: - construction and operational impacts, in accordance with the Approved Methods for Modelling and Assessment of Air Pollutants in NSW, and with a particular focus on dust emissions including PM2.5 and PM10; - dust and other emissions generated from blasting, processing, operational activities and transportation of quarry products; - reasonable and feasible mitigation measures to minimise dust and emissions; and - monitoring and management measures, in particular, real-time air quality monitoring.	Detailed prescription in EIS	Chapter 12 Annexure L
	• Biodiversity – including: - accurate predictions of any vegetation clearing on site; - a detailed assessment of the potential biodiversity impacts, paying particular attention to threatened species, populations and ecological communities and groundwater dependent ecosystems and having regard to the relevant policies and guidelines listed in Attachment 1; and - an offset strategy (depending on the outcomes of the assessment of biodiversity impacts) to ensure the development maintains or improves the biodiversity values of the region in the medium to long term, including evidence that the appropriate type and quantum of offsets will be available.	Detailed prescription in EIS	Chapter 14 Annexures N and X
	• Heritage – including: - an assessment of the potential impacts on Aboriginal heritage (cultural and archaeological), including evidence of appropriate consultation with relevant Aboriginal communities/parties and documentation of the views of these stakeholders regarding the likely impact of the development on their cultural heritage; and - identification of Historic heritage in the vicinity of the development and an assessment of the likelihood and significance of impacts on heritage items, having regard to the relevant policies and guidelines listed in Attachment 1.	Detailed prescription in EIS	Chapters 9 and 10 Annexures C and D
	• Traffic and Transport – including: - Accurate predictions of the road traffic generated by the construction and operation of the development, including a description of the types of vehicles likely to be used for transportation of quarry products; - a detailed assessment of potential traffic impacts on the capacity, condition, safety and efficiency of the local and State road network (as identified above), including a road safety audit; and - a detailed description of the measures or works (including concept plans) that would be used and/or implemented to upgrade, maintain and improve the capacity, efficiency and safety of the road network over the life of the development.	Detailed prescription in EIS	Chapter 15 Annexure O

	• Land Resources – including a detailed assessment of: - potential impacts on soils and land capability (including potential erosion and land contamination) and the proposed mitigation, management and remedial measures (as appropriate); - potential impacts on landforms (topography), paying particular attention to the long-term geotechnical stability of any new landforms (such as overburden dumps, bunds etc.); - potential impacts on areas of regionally significant farmland and associated industries including biosecurity risk assessment and subsequent response and contingency plans; and - the compatibility of the development in accordance with the requirements in Clause 12 of State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007.	Detailed prescription in EIS	Chapters 3, 5 and 24
	• Waste – including estimates of the quantity and nature of the waste streams that would be generated or received by the development and any measures that would be implemented to minimise, manage or dispose of these waste streams.	Detailed prescription in EIS	Chapter 20
	• Hazards – including an assessment of the likely risks to public safety, paying particular attention to potential bushfire risks and the transport, handling and any use of any hazardous or dangerous goods.	Detailed prescription in EIS	Chapters 1-28
	• Visual – including an assessment of the likely visual impacts of the development on private landowners in the vicinity of the development and key vantage points in the public domain, including with respect to and new landforms.	Detailed prescription in EIS	Chapter 17
	• Social & Economic – including: - a detailed assessment of the likely social impacts of the development on the local and regional community; and - a detailed assessment of the likely economic impacts of the development, paying particular attention to: o the significance of the resource; o the costs and benefits of the project; identifying whether the development as a whole would result in a net benefit to NSW, including consideration of fluctuation in commodity markets and exchange rates; and - the demand for the provision of local infrastructure and services; and	Detailed prescription in EIS	Chapter 18 Annexure K
	• Rehabilitation – including the proposed rehabilitation strategy for the site having regard to the key principles in the Strategic Framework for Mine Closure, including: - rehabilitation objectives, methodology, monitoring programs, performance standards and proposed completion criteria;	Detailed prescription in EIS	Chapters 5, 16, 22, 23 and 28

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

Secretary's Environmental Assessment Requirements (SEARs)12 April, 2017 Agency SEARs Comments (with additional relevant references to previous DGR comments as noted) State Significant Development SSD 6395: Proposed Sand Mine Lots 10 & 11 DP 1071458 & Lot 254 DP 753204 & Lot 51 DP 1015671 Nelson Bay Road, BOBS FARM			
Agency/Authority Correspondence Referenced in SEARs and DGRs	Issue	Detail	EIS Location
Port Stephens Council (Previous DGRs) Council has Stated Continued Relevance and Application	Planning	1. Bushfire Prone Land 2. Acid Sulphate Soils 3. Aboriginal archaeological assessment 4. Noise 5. Air Quality 6. Hunter Water Issues	Chapter 19 Chapter 5 Chapter 9 Annexure C Chapter 11 Annexure J Chapter 12 Annexure L Chapter 21
	Engineering	1. Restrictions on the use of Marsh Road 2. Traffic Impact Assessment to include: - • Assessment of vehicular routes • Current traffic counts • Additional traffic movements for construction and operational phases • Traffic impacts on existing and proposed intersections. Identify necessary road upgrades • Intersection analysis using SIDRA. Current traffic counts and 10 year growth projections • 95th percentile back of queue lengths • Delays and LOS for all intersection legs	Chapter 15 Annexure O

		• Electronic data to be supplied to Council • Impact of construction traffic on road network	
	Ecology	1. Site background (a) High biological diversity Important winter food resource 2. Site Characteristics to include: - (a) Supplementary Koala Habitat (a) Old growth coastal sands Blackbutt association (b) Maintenance of connectivity / important corridor (c) Contains habitat for Squirrel Gliders<EEC's and Diuris areaaria and Diuris praecos, threatened microbat species 3. Requirements to include: - (a) Undertake spotlighting Etc (a) Address PSC CKPOM (b) Assessment of Significance (c) Assessment of habitat value (d) Undertake targeted surveys for orchid species (e) Assessment of an appropriate buffer	Chapter 14 Annexure N
	Aboriginal Cultural Heritage Considerations	Appropriate studies, including consultation	Chapter 9 Annexure C
Port Stephens Council (SEARs)	Planning	1. Ecology 2. Social Impact Assessment	Chapter 14 Annexures N & X Chapter 18 Annexure K
Department Trade & Investment Resources & Energy	Resource & Assessment	1. Summary of regional and local geology 2. Size of resource and method of determining its size. 3. Properties of the resource	Chapter 4 Annexure G Chapters 2,4 & 16 Annexures G & T Chapters 2, 4 & 16

Mineral Resources (Previous DGRs) NSW Planning & Environment Has Stated Continued Relevance and Application & No additional SEARs		4. Methods used to assess the quality of the resource and suitability for intended applications 5. Annual production and staging sequence and intended life of the mine 6. Alternative resources and impact of not proceeding 7. Justification in terms of local and regional context 8. Information on the location and size of proposed markets 9. Transport routes 10. Disposal of waste products, location & size of stockpiles. 11. Assessment of noise and vibration and dust, measures to mitigate 12. Proposed rehabilitation procedures 13. Assessment of the ecological sustainability of the proposal	Annexures G & T Chapters 2,4 & 16 Annexures G & T Chapters 2 & 16 Annexure T Chapter 2 Chapters 2& 27 Chapters 2 & 27 Chapter 15 Annexure O Chapter 20 Chapters 11 & 12 Annexures J & L Chapters 2 & 23 Chapter 14 Annexure N
	Health & Safety Issues	Operations to comply with relevant Acts and Regulations	EIS General
	Mineral Ownership	Operation of the Mining Act 1992	Chapter 3
Department of Trade & Investment (Primary Industries Division)	General Requirements – Aquatic Habitat Protection Requirements	1. Area affected by development on 1:25,000 Map & aerial photograph 2. All waterbodies 3. Descriptions and maps of aquatic vegetation 4. Fish species 5. Identification of recognised recreational and commercial fishing grounds	Chapters 14 & 23

(Previous DGRs) Department of Primary Industries Has Stated Continued Relevance and Application		6. Location of parts of the development including infrastructure relating to stages 7. Aspects of the management of the proposal, site rehabilitation, EMP, Rehabilitation Plans, compensatory offsets for each freshwater body identified on the plan its hydrology and stream morphology 8. For each marine or estuarine area identified its hydrology and stream morphology	
	Dredging and Reclamation Activities	1. Purpose of works 2. Types and distribution of marine vegetation 3. Methods of dredging to be used 4. Timing and duration of works 5. Dimension of the area of the works and volume of material to be extracted 6. Method of marking area subject to works 7. Environmental safeguards to be used during and after works 8. Measures for minimising harm to fish habitat 9. Spoil type and source location for reclamation activities 10. Method of disposal of dredge material 11. Location and duration of spoil stockpiling, if planned or placed as fill	Chapters 2 & 16 Annexure T
	Activities that Damage Marine Vegetation	1. Type of marine vegetation to be harmed 2. Map and density distribution of marine vegetation 3. Reasons for harming marine vegetation 4. Methods of harming marine vegetation 5. Construction details 6. Duration of works/activities 7. Measures for minimising harm to marine vegetation 8. Method and location of transplanting activities	Chapter 14 Annexure N

	Activities that block fish passage	9. Type of activity that changes the characteristics of a stream 10. Length of time fish passage is to be restricted 11. Timing of proposed restriction 12. Remediation or compensatory works to offset impacts	Chapter 14 Annexure N
	Threatened Species	1. Threatened aquatic species (Section 5c EP&A Act) 2. Seven Part Test	Chapter 14 Annexure N
	Fishing and Aquaculture	1. Outline commercial, recreational and indigenous fishing activities that may be affected 2. Will the activity interfere or impact on the continuing operation and viability of nearby aquaculture or mariculture ventures	Chapter 14 Annexure N
		Initial assessment including: 1. Threatened Species, endangered populations and EEC's to be provided. Discuss previous landuses 2. Altered hydrological regimes	Chapter 14 Annexure N
		Assessment of Likely Impacts: 1. Significant habitat areas 2. Indicate the location, nature and extent of habitat removal or modification 3. Discuss the potential impact of habitat modification 4. Identify and discuss the potential for proposal to introduce barriers to the movement of fish species 5. Describe and discuss potential impacts on fish species. 6. For species that will be disrupted, discuss locations of adjoin populations	Chapter 14 Annexure N
		Ameliorative Measures: - 1. Consider how proposal can be modified to conserve fisheries habitat. 2. Discuss alternatives to the proposal.	Chapter 14 Annexure N

		3. Any proposed monitoring plans? 4. Concurrence request?	
	Fisheries	Impact on nearby waterways or aquaculture ventures and include: - 1. Drawdown of water table 2. Salinization of groundwater 3. Discharges – volume and quality 4. Consideration of SEPP 62 – Sustainable Aquaculture and impacts on water quality	Chapter 14 Annexure N
	NSW Office of Water	Assessment of potential impacts on:- 1. Groundwater resources 2. GDE 3. Existing groundwater users 4. Measures to mitigate potential impacts both during and post operations. 5. Address the Aquifer Interference Policy	Chapters 3, 6 & 7 Annexure E
	NSW Office of Water	Proposed water management on site: - 1. Water extraction volumes, 2. surface water capture 3. water use 4. management structures 5. disposal/retention methods	Chapters 6 & 7 Annexure F
	NSW Office of Water	Proposed water licencing requirements in accordance with the Water Management Act and relevant water sharing plans	Executive Summary & Chapter 3
	NSW Office of Water	Preparation of a surface water management plan to identify adequate monitoring and mitigation requirements to address: 1. surface water	Chapters 6 & 7 Annexures E & F

		2. groundwater integration of proposed water balance and management of the site as per Attachment A of the DGRs.	
	Office of Agricultural Sustainability & Food Security	Agricultural Impact Statement	Chapter 24
NSW Department of Primary Industries Previously Department of Trade & Investment (Primary Industries Division) SEARS	Land Resources	Biosecurity Risk Assessment, Response and Contingency	N/A
	Water Resources	1. Predicted generation and disposal methods of tailings and potential acid forming (PAF) material such as pyrite and whether oxidation may pose a potential acid sulphate soils risk 2. Groundwater baseline information; including water level and water quality analysis in line with any proposed water uses.	Chapters 6 & 7 Annexure E
	Policies, Guidelines & Plans	1. Reference to Draft Agricultural Impact Assessment Guidelines 2011 (DP&I) to be removed – superseded 2. Inclusion of the following: • *Agricultural Impact Statement Technical Notes (2013)* • *Land Use Conflict Risk Assessment Guideline (2011)* • *Agricultural Issues for Extractive Industry Development (2012)* • *NSW Aquifer Interference Policy (2012)*	Noted
	Environmental Impacts of the Proposal	Impacts to be assessed, quantified and repor: 1. Air issues 2. Noise & Vibration 3. Waste and chemicals 4. Water & Soils, soils, water quality	 Chapter 12 Annexure L Chapter 11 Annexure J Chapter 20 Chapters 5, 6 & 7 Annexures E & F
EPA (Previous DGRs) EPA Has	The Proposal	Objectives to clearly state: - 1. Size and type of the operation 2. Nature of the processes and the products, by-products and wastes 3. Use or disposal of products	Chapters 2 & 16 Annexure T

Stated Continued Relevance and no additional SEARs		4. Anticipated level of performance in meeting required environmental standards and cleaner production principles 5. Staging and timing of the proposed proposals relationship to any other industry or facility	
	The Premises	Full identification of all processes and activities for the site over the life of the development, including details on:-	
		1. Location of the proposed facility and details of the surrounding environment.	Chapter 2
		2. Proposed layout of the site	Chapters 2 & 16
		3. Appropriate landuse zoning	Chapter 3
		4. Ownership details of any residence and/or land likely to be affected by the proposed facility.	N/A
		5. Maps and diagrams showing the location of residences and properties likely to be affected, other industrial developments, conservation areas, wetlands in the locality	EIS General
		6. All equipment proposed to be used on the site.	Chapter 2
		7. Chemicals, including fuel proposed to be used on site and proposed methods for their transportation, storage, use and emergency management	Chapter 20
		8. Surface water management systems	Chapter 6 Annexure F
		9. Waste generation and disposal	Chapter 20
		10. Methods to mitigate expected environmental impacts	EIS General
		11. Site rehabilitation following termination of the development	Chapters 2 & 23
	Consultation	Contact Hunter Water Corporation	Chapter 21
	Licencing Requirements	Separate licencing post approval	Executive Summary & Chapter 3

	Air issues	Detailed Air Quality Impact Assessment, including: - 1. Assess the risks associated with potential discharges of fugitive and point soiurce emissions for all stages. Assess risks relating to environmental harm, risk to human health and amenity. 1. Justify the level of assessment on the basis of risk factors including location, characteristics of pollutants emitteand type and quantity of pollutants emitted 2. Describe the receiving environment in detail-local, regional and inter-regional. Description must include: - (a) Metrology and climate (a) Topography (b) Surrounding land use, receptors (c) Ambient air quality 3. Detailed description of proposal including all processes that could result in air emissions. Location of emission sources marked on a plan for key years of the development. Identification of emission quantities, size, source and discharge points. 4. Include a worst-case emission scenario and impact limits 5. Account for cumulative impacts 6. Include air dispersion modelling and assess: - (a) Dust disposition (b) TSS (c) PM_{10} particulate matter 7. Demonstrate projects ability to comply with relevant regulations. 8. Provide an assessment of the project in term of the priorities and targets under the NSW Stage Plan 2010 and its implementation plan, Action for Air 9. Detail emission control techniques/practices that will be employed. PM_{10} monitoring technology cost analysis.	Chapter 12 Annexure L
	Noise and Vibration	1. Assessment under the Industrial Noise Policy - construction 2. Vibration for all activities – construction and operation 3. Operational noise as per Industrial Noise Policy	Chapter 11 Annexure J

		4. Noise on public roads 5. Noise from new or upgraded roads	
	Waste and Chemicals	1. Identify, characterise and classify all waste generated onsite through excavation, demolition or construction activities 2. Identify, characterise and classify all waste disposed offsite including proposed quantities and locations. Include reuse waste 3. Include all procedures and protocols to ensure that all waste it transported and disposed of lawfully and not pose a risk to human health or the environment. 4. Include a statement that the proponent is aware of the legislative requirements for the disposal of waste or relevant Resource Recovery Exemptions	Chapter 20
	Water and Soils	1. An assessment of potential impacts on soil and land: - a. Soil erosion and sediment transport b. Mass movement c. Urban and Regional Salinity 2. Description of mitigation and management options to prevent, control, abate or minimise impacts. Assess the effectiveness and reliability of intended measures and any residual impacts.	Chapters 5, 6 & 7
	Water	Describe proposal: - 1. Describe proposal including intakes and discharges, volumes, water quality and frequency of all water discharges. 2. Demonstrate practical options to avoid discharges and impacts minimised 3. Water balance for the development 4. Confirmation that the proposal complies with any requirements, restrictions and /or conditions of the Hunter Water Regulation 2010.	Chapters 5, 6 & 7 Annexures E & F

		Background Conditions: - 5. Describe existing surface water and ground water quality. 6. State water quality objectives for the relevant receiving water. 7. State the indicators and associated trigger values or criteria for the environmental values 8. State local specific objectives, criteria or targets. Impact assessment: - 9. Nature and degree of impact from discharges 10. Assess impacts against relevant water quality outcomes. Demonstrate protection of water quality objectives for receiving waters 11. If discharge includes a mixing zone, how waste water will meet ANZECC criteria at edge of zone 12. Assess impacts on groundwater and GDE's. 13. Management of stormwater 14. Detailed description of water storage ponds or basins including location, volume capacities and expected water quality 15. Detail assessments on the ground water and surface water including Tilligerry Creek at all depths, including: - (a) Pyrite and other sulphides (b) Mobilisation of iron and other metals (c) ASS	
	Biodiversity	Biodiversity Report to be prepared consistent with the Framework for Biodiversity Assessment Focus required for: • Tall Rustyhood (*Pterostylis chaetophora*) • Mahoney's Toadlet (Uperoleia mahonyi)	Chapter 14 Annexures N & X

NSW Office of Environment & Heritage SEARs Specifically chose not to reissue DGRs (primarily due to alterations to biodiversity assessment guidelines)	Aboriginal Cultural Heritage	Reports to be prepared consistent with: • Guide to Investigating, Assessing and Reporting on Aboriginal Cultural heritage in NSW (DECCW, 2011) • Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010 (DECCW)	Chapter 9 Annexure C
	Historic Heritage	• Comprehensive study outlining an assessment of impacts, mitigation and management measures	Chapter 10 Annexure D
	Water and Soils	1. Mapping of acid sulphate soils; rivers, streams, wetlands and estuaries; groundwater; groundwater dependent ecosystems; proposed intake and discharge locations; 2. Background conditions for any water resource likely to be affected by the development; 3. Water quality impacts; 4. Water balance considerations; Comprehensive analysis of impacts of the development on hydrology.	Chapters 5, 6 & 7 Annexures E & F
	Flooding and Coastal Erosion	1. Identification of any flood prone land, flood planning area and hydraulic categorisation; 2. Where relevant, identification of flood design levels; 3. Where relevant, modelled effect on flood behaviour; 4. Where relevant, management of impacts.	Chapter 8
NSW Roads & Maritime Services (DGRs) No additional SEARS	Traffic & Transport Study	Study to include: - 1. Relevant traffic routes and intersections to/from site 2. Current traffic count 3. Additional vehicle generation for both construction and operational stages I. Distribution of trips on road network. II. Traffic analysis using SIDRA III. Consideration of pedestrians and cyclists IV. Consideration of traffic impacts on intersections and the capacity of the local and classified road network V. Upgrade requirements	Chapter 15 Annexure O

Background

The current site is utilised as an olive and fig farm that has limited commercial viability and little opportunity to expand into the surrounding landform under current existing environmental constraints. The site has direct access to a major road, Nelson Bay Road and the frontage has dual carriageway capacity. Nelson Bay Road provides a direct link to export potential at Newcastle Harbour and manufacturing operations in Newcastle and Sydney that involve glass, ceramic and chemical industries.

The sand resource within the proposed development site has been assessed and has been found to be suitable for a large range of uses that includes at the highest end, relatively scarce high purity glass sand, a very sought-after resource, through to horticultural sand, landscape sand for high end recreational uses on golf courses and playing fields, decorative sands, soft fall sands, construction sands as well as fill sands at the lower end of market return. A large component of the resource is of a quality for glass and high-end technology screen and computer component manufacturing.

Project Description

The proposed development incorporates the following:

- Establishing a quarry to extract and process sand at a rate of 750,000 tonnes per annum, from a total resource of 10 million tonnes; and
- Constructing extractive materials processing and transport infrastructure; and
- Transporting extractive materials off-site via public road; and
- Site rehabilitation; and
- Options for final landform and land use incorporating an internal water body that would be used for a tourist facility or a solar energy farm, post mining.

It is intended to progressively remove the existing olive and fig farm and consequently introduce the sand mining operation in associated sequence. Initially, the sand mining operation will operate above the water table. Subject to the acquisition of sufficient water licences, a dredging operation would then be undertaken to increase the production rate of the sand extraction.

It is expected that the availability of the higher-grade resource will be in high demand. It is anticipated that the resource would take up to 15 years to be extracted. During that time the following employment generation is anticipated:

- 80 on site jobs, including transportation;
- 15 jobs in downstream manufacturing processes; and
- 10 jobs in recreational, landscaping and construction industries.

STAKEHOLDER CONSULTATION

For the purposes of the EIS, the following are considered stakeholders:

- Adjoining land owners

- The wider Bobs Farm community
- Relevant Bobs Farm Community Group(s)
- Bobs Farm Primary School
- Relevant Aboriginal individuals, communities and associations
- Persons with connections to any European heritage considerations relevant to the site and to the proposed development of the land
- Council
- Local Businesses
- Statutory and non-statutory agencies

With any commencement of on-site operations, the stakeholder group will be expanded to include:

- Mining Company employees
- Company Management
- Shareholders, if appropriate.

The details of consultation with stakeholders is documented in the Social Impact Assessment.

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

Noise Assessment

An operational noise impact assessment and a contruction noise assessment has been undertaken to determine the potential noise impact of the proposed sand mine at Bobs Farm on noise sensitive receptors in the surrounding area of the proposed development site.

The findings of the noise impact assessment have identified a number of receptors that may potentially be impacted by the proposed sand mine operational activities for different phases of the proposed operation.

In order to mitigate these exceedances a number of acoustic barriers and bunding are proposed at different parts of the property and access roads at appropriate timings to ensure compliance with the respective noise criteria. Copies of these reports are contained in Annexes J and K.

Vibration Assessment

Activities associated with the initial development phase of the sand mine and operational activities associated with sand mine have the potential to generate measureable vibration levels on-site. However, the nearest potentially affected receptors are located approximately 120 metres to the north-west of the site, at the western end of the mine and approximately 60 metres to the north-east of the site, at the eastern end of the mine. On this basis it is unlikely that there would be any vibration impacts generated by the plant and machinery that will be utilised at the site that would give rise to annoyance or structural damage at any of the nearest receivers. The vibration assessment is included in the noise assessment contained in Annex J.

Air Quality

The project will have minimal impact on the air quality of the surrounding region. Proposed management measures and operational controls for those activities that impact on air quality, being vehicle usage, material handling and material transfers have been predicted and in all stages of the development, the TSP, PM_{10} (annual), $PM_{2.5}$ and dust deposition predictions comply with relevant criteria.

Sand extraction cells will be progressively rehabilitated throughout the life of the extraction so it is anticipated that no more than three hectares be exposed at any one time.

The air quality assessment concludes that the proposed operations as modelled would meet the OEH air quality impact criteria for total suspended particulates (TSP), particulate matter less than 10 microns (PM10) and dust deposition and with the installation of a Tapered Element Oscillating Microbalance (TEOM) machine and weather station proposed for the site, proactive dust control measures can be enforced to reduce the likelihood of any exceedances. The air qualityassesssment is contained in Annex L.

Traffic and Transport

The proposed development proposes that all heavy vehicles will access the site off Nelson Bay Road at the south of the proposed development site. Light vehicles will use the current access arrangements off Marsh Road.

All heavy vehicles will egress Marsh Road, turning immediately east, along Nelson Bay Road. Heavy vehicles will not travel west along Marsh Road, including past the Bobs Farm Primary School. Any heavy vehicles wishing to travel west will complete a U-turn at the roundabout controlled intersection of Nelson Bay Road and Port Stephens Drive.

A small section of Marsh Road will be upgraded to an appropriate Council standard to cater for the increased vehicle movement.

Consultations with Port Stephens Council have not indicated any specific safety, capacity or operational issues with the proposal, including in relation to any potential impacts on the safety of primary school students.

The proposal will marginally increase traffic volumes in the locality with respect to Nelson Bay Road.

The following traffic management recommendations are proposed to be implemented to reduce potential site and locality impacts:

1. All heavy vehicle entry is to be via a new access point off Nelson Bay Road at the south of the proposed development site. Light vehicle access will be from Marsh Road.
2. All heavy vehicles will enter the south of the proposed development site directly off Nelson Bay Road via an upgraded access. This will require a left turn deceleration lane to be built on Nelson Bay Road and this will be designed and constructed in accordance with RMS and Council requirements. All heavy vehicles will then drive

through the site and exit via the existing egress point on Marsh Road proceeding to the intersection with Nelson Bay Road.

3. Due to potential delays for the heavy vehicles turning right out of Marsh Road and associated safety concerns, all heavy vehicles will turn left out of Marsh Road and proceed in an eastbound direction along Nelson Bay Road. The heavy vehicles wishing to travel westwards will then complete a U-turn at the roundabout controlled intersection of Nelson Bay Road and Port Stephens Drive. Those heavy vehicles will continue their journey along Nelson Bay Road utilising Richardson Road to travel towards Raymond Terrace and the Pacific Highway, or Cabbage Tree Road to travel towards the New England Highway and Maitland or continue along Nelson Bay Road towards Newcastle. Both Nelson Bay Road and Cabbage Tree Road are RAV approved routes suitable for heavy haulage.
4. All light vehicles will enter and exit the site via the access point on Marsh Road. This will reduce the conflict between light and heavy vehicle and will allow direct access to the site office.
5. The site access points have been reviewed on site and allow for safe vehicle movements, with adequate sight lines available based upon vehicle speeds and the posted speed limits.
6. All parking can be accommodated on site. The trucks will not be parked on site over-night and there are minimal on-site staffing levels requiring minimal on-site parking.

Ecological Assessment

The proposed sand mining footprint will have a direct impact on approximately 38ha of the 50.06 ha study area. This will involve the clearing of native vegetation in a staged or incremental fashion.

A total of three vegetation types have been delineated within the study area:

- Vegetation Type 1 - HU860 – Smooth-barked Apple - Blackbutt - Old Man Banksia woodland on coastal sands of the Central and Lower North Coast (Moderate/Good High Condition) (35.41ha). An area of derived grassland (0.9ha) was also consistent with Vegetation Type 1;
- Vegetation Type 2 – HU938 – Broad-leaved Paperbark - Swamp Oak - Saw Sedge swamp forest on coastal lowlands of the Central Coast and Lower North Coast (Moderate/Good) (1.15ha);
- Vegetation Type 3 – HU533 - Coastal freshwater lagoons of the Sydney Basin Bioregion and South east Corner Bioregion Moderate/Good Poor) (0.32ha).

Two additional vegetated areas were highly altered and could not be assigned a community Vegetation Type:

- Orchard, Cleared/Modified (9.6ha);
- Grassland/Pasture (4.0ha).

The study area was found to contain two Endangered Ecological Communities (EEC's):

- Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South east Corner Bioregions - Broad-leaved Paperbark - Swamp Oak - Saw Sedge swamp forest on coastal lowlands of the Central Coast and Lower North Coast (1.15ha)

- Freshwater wetlands on coastal floodplains of the NSW North Coast, Sydney Basin and South east Corner bioregions - Coastal freshwater lagoons of the Sydney Basin Bioregion and South-east Corner Bioregion (0.32ha).

The areas of Swamp Sclerophyll Forest and Freshwater Wetland are located outside the proposed mining footprint. Taking the recommendations for these two EEC's into consideration, the proposal is unlikely to have an adverse effect that their composition or local occurrence such that they will be placed at extinction.

Identified vegetation communities within the study area that are exclusively reliant on groundwater are Broad-leaved Paperbark - Swamp Oak - Saw Sedge swamp forest and Coastal freshwater lagoon. One community, Smooth-barked Apple - Blackbutt - Old Man Banksia woodland which contains species which obtain groundwater in the capillary fringe; occurs within the proposed mining footprint. The proposed sand mine will require excavation below the groundwater level within the study area. An assessment undertaken (Martins, 2015) found drawdown of the permanent groundwater system at these vegetation communities is modelled to be a maximum of approximately 0.07 m. Based on the NSW Aquifer Interference Policy (Department of Primary Industries Office of Water, 2012) and the post Water Sharing Plan the local groundwater natural level range is of the order of 3 m (or more). The adopted permissible drawdown at a 40 m buffer from the GDEs is 0.30 m (i.e. 10% x 3.00). This drawdown threshold is met for vegetation communities exclusively reliant on groundwater. Consequently, based on modelling results, the proposed development does not exceed the drawdown impact criterion set out in the NSW Aquifer Interference Policy (NOW, 2012).

A total of 108 individual specimens of Diuris arenaria (Tomaree Doubletail) were recorded within the study area as a result of targeted surveys. With the exception of one plant occurring approximately 6m to the north of the electrical easement, the remaining specimens of D. arenaria were found to be confined to the maintained electrical easement in the far west of the study area. Outside the study area D. arenaria also occurs within the same electricity easement to the west and east (ERM, 2003 & Wildthing Environmental Consultants, 2018). Within the study area the orchids were located within native derived grassland with no canopy which has been created and maintained as an electrical easement by Ausgrid. No other occurrences of D. arenaria were recorded over the remainder of the study area during targeted surveys. The absence of D. arenaria over the remainder of the study area is likely to be attributed to the density of trees and shrubs shading suitable habitat. However, suitable habitat was considered to be present within other areas of Coastal Sand Apple Blackbutt Forest with a sparse canopy cover.

No specimens of D. arenaria are required to be removed as a result of the proposal. The 15m buffer to the north of the electrical easement to the extraction zone will also offer protection from secondary impacts such as increased weed incursion and dust. It is recommended that there is a no-go zone below the extraction zone to avoid any unintended removal/disturbance of these orchids. This will require the erection of a barrier fence on the boundary of the extraction zone. It will also be important to liaise with Ausgrid regarding maintenance of their easements to minimise impacts and support the protection of D. arenaria.

Despite targeted searches no additional threatened flora species were recorded within the study area during fieldwork. The study area was considered to contain potential habitat for an additional 11 of the 30 threatened flora species addressed in the report:

- Diuris praecox (Newcastle Doubletail);

- Corybas dowlingii (Red Helmet Orchid);
- Cryptostylis hunteriana (Leafless Tongue Orchid);
- Rhizanthella slateri (eastern Underground Orchid);
- Pterostylis chaetophora (Tall Rustyhood);
- Maundia triglochinoides (Maundia);
- Persicaria elatior (Tall Knotweed);
- Zannichellia palustris (Horned Pondweed);
- Eucalyptus parramattensis subsp. decadens (Drooping Red Gum);
- Melaleuca biconvexa (Biconvex Paperbark);
- Syzygium paniculatum (Magenta Lilly Pilly);

Of these threatened flora species, the most likely habitat within the study area was considered to be present for D. praecox. Specimens of D. praecox are known to be present approximately 200m to the south-west within the same electrical easement which runs through the study area. Due to the absence of preferred habitat and lack of nearby local records the study area was only considered to provide marginal habitat for the remaining flora species.

A total of eight threatened fauna species were recorded within the study area during fieldwork:

- Glossopsitta pusilla (Little Lorikeet)
- Haliaeetus leucogaster (White-bellied Sea eagle);
- Petaurus norfolcensis (Squirrel Glider)
- Pteropus poliocephalus (Grey-headed Flying-fox)
- Scoteanax rueppellii (Greater Broad-nosed Bat)
- Falsistrellus tasmaniensis (eastern Falsistrelle)
- Miniopterus australis (Little Bentwing-bat)
- Miniopterus schreibersii oceanensis (Large Bentwing-bat)

As a result of secondary evidence an additional two threatened fauna species were also noted within the study area:

- Ninox strenua (Powerful Owl)
- Phascolarctos cinerea (Koala)

Of the remaining 90 assessed threatened fauna species the study area was found to contain suitable habitat for 43. Taking the habitat and local records into consideration the most likely of these 43 species to utilise the study area would include Daphoenositta chrysoptera (Varied Sittella), Tyto novaehollandiae (Masked Owl), Dasyurus maculatus maculatus (Tiger Quoll), Saccolaimus flaviventris (Yellow-bellied Sheathtail Bat) and Mormopterus norfolkensis (eastern Freetail-bat). The proposal will result in a significant loss of habitat for a number of the addressed species particularly species such as P. norfolcensis. However, taking into consideration the relatively large amount of similar habitat in the local area and given the recommendations the proposal is unlikely to disrupt the life cycle the addressed threatened species such that local extinction would occur.

Within the NSW North Coast Bioregion and Port Stephens LGA the population of the Emu has been listed as Endangered. The Emu was not recorded within the study area during the survey. Open Forest vegetation that covers the majority of the study area would provide some habitat for this species, which prefers more open habitat. Taking into consideration the large amount of suitable habitat along Stockton Bight and lack of recent local records the proposal is unlikely to result in the local extinction of a viable local population of the Emu.

The main habitat types within the study area are:

- Dry Sclerophyll Forest (34.5 ha);
- Swamp Sclerophyll Forest (1.15 ha);
- Freshwater Wetland (0.32 ha);
- Orchard (9.6 ha);
- Cleared Open Areas (4 ha).

In general, the habitats within the study area offer a wide range of habitat opportunities for a range of native species. The habitats proposed to be affected by the proposal range from less ecologically significant areas such as cleared areas and orchards to relatively intact Dry Sclerophyll Forest that is capable of offering suitable resources to both resident and transitory species.

The study area forms part of a significant ecological corridor that runs down the coast from the Tomago Sandbeds in the south along the Stockton Bight to the Tomaree Peninsula in the north. The ecological corridor occurring along Stockton Bight is restricted by the bare shifting sand dunes to the east and largely cleared agricultural land to the west. The Lower Hunter and Central Coast Regional Biodiversity Conservation Strategy (House, 2003) also identifies the Coastal Sand Apple – Blackbutt Forest occurring along the Stockton Bight dune system as a regionally significant habitat linkage. The Hunter Regional Plan 2036 (NSW Government, 2016) also shows the site to occur within a Biodiversity Corridor. The fragment of vegetation that the study area is situated has also been mapped as a key habitat (NPWS 2002). The proposal will result in the removal of approximately 25.90ha of key habitat largely consisting of Coastal Sand Apple Blackbutt Forest from the north-east section of the corridor. The section of the corridor where the study area is located is approximately 1.5km wide.

The proposal will result in the reduction in the width of the corridor by approximately 600m (the majority of habitat occurring on the northern side of the dual carriage way of Nelson Bay Road). The wider southern portion of the regional corridor occurring south of Nelson Bay Road is located on the protected Worimi Conservation Lands. Within the vicinity of the study area the ecological corridor is traversed by the dual carriage way of Nelson Bay Road to the immediate south-east and a power easement which runs east-west through the southern portion of the study area. Cleared agricultural land also bordered parts of the north-east boundary. The proposal will result in a reduction in connectively to smaller areas of open forest habitat contained within Lots 1, 2 & 521 to the immediate north of the study area. Considering the presence of the dual carriageway of Nelson Bay Road (without a treed traffic island) the proposal will also result in a reduction in connectivity for open forest areas within Lot 10 and the adjoining crown reserve (Lot 7374). A 15m vegetated buffer zone around the sand mine footprint together with adjoining habitat such as the road reserve along Nelson Bay Road will still provide connectivity to these areas of habitat. The connectivity to these areas will also improve after the mine site has been progressively revegetated.

A total of 1217 habitat (hollow-bearing) trees were identified within the study area as a result of a hollow-bearing tree survey. The vast majority of hollow-bearing trees were present within Smooth-barked Apple - Blackbutt - Old Man Banksia woodland on coastal sands assemblage. Many of these trees were considered to be significant as a result of their very large size as well as the variety and number of hollows they contained. Hollows were available for roosting or nesting avifauna species, arboreal mammals, reptiles and tree roosting microchiropteran bat species.

The Port Stephens CKPoM assessment found the study area was largely composed of Supplementary Koala habitat and to a lesser extent Mainly Cleared Land. Two smaller areas of preferred Koala habitat occupied the areas of Swamp Sclerophyll Forest located within the north and north-east of the study area within Lot 10 and 254. Eucalyptus robusta (Swamp Mahogany) was the only preferred Koala Feed Tree Species recorded within the study area. A total of 19 individual specimens of E. robusta were found to be confined to two areas of Swamp Sclerophyll Forest within the study area. No Koalas were recorded within the study area during the survey period. A small number of specimens of E. robusta within Lot 10 had scratches and characteristic 'pock marks' consistent with that of the Koalas although no faecal pellets were found under the trees. According to database records contained in the NSW Wildlife Atlas (OEH, 2015) and Hunter Koala Preservation Society (2015) a small number of records of Koalas occur within proximity to the study area. The evidence suggests that the study area particularly the area of Swamp Sclerophyll Forest in the far north is utilised infrequently by a small number of Koalas. The CKPoM requires a 50m buffer from the areas of Preferred Koala Habitat over Supplementary and Mainly Cleared habitat. The proposal will result in the loss of Supplementary Koala Habitat however no areas of Preferred Koala Habitat will be removed.

Consideration has been given to the Commonwealth Environment Protection and Biodiversity Conservation (EPBC) Act (1999). No nationally threatened communities were present within the study area. One nationally threatened species Pteropus poliocephalus (Grey-headed Flying-fox) was recorded foraging within the site during fieldwork. An additional threatened species Phascolarctos cinereus (Koala) was also identified as utilising the study area from the presence of scratches on preferred feed tree species. The proposal will result in a reduction in habitat for both these two nationally threatened species however is unlikely to have a significant impact.

Three listed migratory species; White-bellied Sea-eagle, Rufous Fantail and Cattle Egret were recorded within the study area during fieldwork. Considering the relative commonality of these three migratory species and large amount of suitable habitat in the locality it is unlikely that these species or any of the addressed listed migratory species would be significantly impacted by the proposal.

The proposed Sand Mine will result in the following direct and potential impacts or losses:

- Approximately 25.90ha of Coastal Sand Smooth-barked Apple Blackbutt Forest;
- Approximately 9.5ha of Orchard;
- Approximately 25.90ha of Supplementary Koala Habitat;
- Approximately 25.90ha of known habitat for ten affected threatened fauna species; Glossopsitta pusilla (Little Lorikeet), Ninox strenua (Powerful Owl), Haliaeetus leucogaster (White-bellied Sea eagle), Petaurus norfolcensis (Squirrel Glider), Scoteanax rueppellii (Greater Broad-nosed Bat), Falsistrellus tasmaniensis (eastern Falsistrelle), Miniopterus australis (Little Bentwing-bat), Miniopterus schreibersii oceanensis (Large Bentwing-bat), Phascolarctos cinereus (Koala) and Pteropus poliocephalus (Grey-headed Flying-fox);
- Suitable habitat for a number of additional threatened and other flora and fauna species likely to utilise the study area;
- Approximately 877 hollow-bearing trees;
- Habitat Fragmentation;
- Injury/Mortality to native fauna during felling of trees.

The proposed sand mine will result in the following potential indirect impacts;

- Increased spread of noxious weeds;
- Increased spread of pest fauna species;
- Edge effects;
- Impact on Groundwater Dependent Ecosystems (GDE's) through changes to groundwater levels;
- Increase in noise from machinery;
- Increase in artificial lighting. Increased lighting may be the result of security lighting.

A number of mitigation measures have been specified to minimise the impact of the loss of habitat. The measures will include:

- Provision of compensatory habitat (Offsetting) using the Biobanking Assessment Methodology (DECC, 2009);
- Protection of remaining habitat/vegetation;
- Protection of fauna during habitat removal;
- Provision of mitigation measures for affected species such as translocation of specimens of Diuris arenaria (Tomaree Doubletail);
- Rehabilitation of extraction area;
- Monitoring of groundwater levels and groundwater dependant ecosystems within proximity to the extraction area;
- Reduction of ongoing mine impacts such as noise and artificial lighting.

To help ensure these measures are carried out, a detailed vegetation/habitat management plan will need to be developed to address any impacts associated with the proposed sand mine to ensure the long-term viability of remaining and rehabilitated habitat.

The FBA Credit Calculator generated a Credit Profile for the Development Area. The Development Biobank Credit Reports generated by the Credit Calculator are provided below.

Plant Community Type	Area (ha)	Credits
HU860 – Smooth-barked Apple - Blackbutt - Old Man Banksia woodland on coastal sands of the Central and Lower North Coast	35.41	1681
HU938 - Broad-leaved Paperbark - Swamp Oak - Saw Sedge swamp forest on coastal lowlands of the Central Coast and Lower North Coast	1.15	8.17
HU533 - Coastal freshwater lagoons of the Sydney Basin Bioregion and South-east Corner Bioregion	0.32	1.31

Table A - FBA Credit Calculations

The proposed sand mine will result in an incremental loss of habitat for a number of the addressed threatened species occurring within the local area. Taking into account the relatively large amount of similar habitat along Stockton Bight and given the recommendations which include a Biobanking Offset it is believed that the proposal is unlikely to disrupt the life cycle of any addressed threatened species, endangered population or endangered ecological community such that local extinction would occur.

Additionally, parts of the site being part Lot 254 DP 753204 and some adjoining land part Lot 253 DP 753204 have been proposed as part of the Biobank Offsite area. A Biobank Assessment Report has been prepared and is included in the attachments.

Heritage Assessment

The cultural heritage assessment identified five (5) new historic heritage sites or areas and that the proposed sand extraction will impact.

The Aboriginal cultural heritage assessment was undertaken in accordance with the NSW Department of Planning and Environment's (DP&E) Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation (DECCW, 2005) and with reference to the NSW Office of Environment and Heritage's Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales (DECCW 2010b) and Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in NSW (OEH 2011). Aboriginal community consultation for the assessment was conducted in accordance with OEH's Aboriginal Cultural Heritage Consultation Requirements for Proponents (DECCW 2010). The six Registered Aboriginal Parties (RAPs) for this assessment included the Worimi Local Aboriginal Land Council, Mur-Roo-Ma Inc, Nur-Run-Gee Pty Ltd, Lower Hunter Aboriginal Incorporated, Do-Wa-Kee and Maaiangal Aboriginal Heritage.

Archaeological survey of the Project area was undertaken over two days by a combined field team of two AECOM archaeologists and three RAP field representatives per day. In accordance with the draft assessment methodology provided to RAPs, the survey focussed on enhanced areas of exposure and Ground Surface Visibility (GSV) across the Project area, specifically, on light vehicle tracks criss-crossing the elevated dune field landform unit, the cleared powerline easement in the southwestern portion of the site and the heavily modified orchard complex on Lot 254 on DP753204. The estuarine flat landform unit was visually inspected from Marsh Road. However, in light of universally poor GSV conditions and the unit's low Aboriginal archaeological potential, this area was not subject to pedestrian survey. All survey was conducted on foot, with a total of 23 transects completed over the course of the survey. Effective coverage data for the survey undertaken indicate that generally poor exposure and GSV conditions did constraint its effectiveness with regards to the identification of surface evidence of past Aboriginal occupation/activity. Nonetheless, observations made during survey suggest that the majority of exposed ground within the Project area was physically inspected for Aboriginal objects.

A total of five new Aboriginal archaeological sites were identified during the survey undertaken for this assessment. These consist exclusively of low density surface scatters of marine and/or estuarine midden shell within the Project area's elevated dune field landform unit. All are located on unsealed light vehicle tracks. However, one site incorporates (in places) remnant land surfaces on either side of the track. No finds other than shell (e.g., flaked stone artefacts, mammal bone) were identified at any site nor were any compact, in-situ lenses of shell observed. All identified sites are interpreted as disturbed surface manifestations of former subsurface shell midden deposits. Two sites have been assessed as being of moderate scientific significance and three as being of low scientific significance. No surface sites of high scientific significance were identified during the survey.

A geomorphological assessment of the Project area's two aeolian landform units, undertaken by a qualified geomorphologist under the supervision of an AECOM archaeologist and RAP

field representatives, was undertaken post-survey. Field investigations for this assessment, which included augering, suggest that the potential for preservation of subsurface archaeological materials across the majority of these units is high owing to the presence of undisturbed/minimally disturbed podsol soil profiles associated with Thom et al.'s (1992) Ridge I transgressive dune sheet. Preservation potential in grossly disturbed areas (i.e., the orchard complex on Lot 254 and residences/work areas on Lots 51 and 10), in contrast, is low.

On the basis of the desktop research and field investigations undertaken for this assessment, the majority of land within the Project area is assessed as being of moderate archaeological sensitivity. A moderate sensitivity rating for all non-grossly disturbed portions of the Project area's two aeolian landform units is predicated on the proposition that although these areas retain high subsurface archaeological preservation potential, extant subsurface occupation deposits are not expected to be of high archaeological complexity or significance. Previous Aboriginal archaeological investigations within the stabilised Ridge I dune field of the Outer Barrier sand mass have demonstrated an occupational emphasis on low elevation, low gradient ridgelines bordering pockets of freshwater swamp forest as well as low, elevated dune spurs extending into the former estuarine swamp environment of the Interbarrier Depression. Given the absence of these specific landscape features from the Project area, subsurface deposits indicative of long term or repeated occupation are not anticipated to occur within the site. In keeping with the results of the archaeological survey undertaken, subsurface evidence for past Aboriginal use of the Project area is expected to be consistent with transient or short-term occupation events. Nonetheless, the potential for impacts to subsurface features of high scientific and cultural significance, namely Aboriginal burials, is recognised.

Areas of low archaeological sensitivity within the Project area comprise areas of grossly disturbed terrain and the former estuarine swamp environment of the Interbarrier Depression (i.e., the estuarine plain landform unit). Although their presence cannot be ruled out, subsurface archaeological deposits are unlikely to occur in highly disturbed portions of the Project area owing to the severity of the ground disturbances that have previously occurred in these areas. Similarly, while a highly attractive resource zone for Aboriginal people occupying the Outer Barrier sand mass throughout the mid-to-late Holocene, subsurface archaeological deposits are not anticipated within the estuarine plain landform unit owing to unfavourable occupation conditions.

All five Aboriginal archaeological sites identified within the Project area are expected to be directly impacted by the Project. At the same time, it is considered highly likely that a body of subsurface Aboriginal archaeological material will be impacted by the Project. Management of the Aboriginal heritage resource of the Project area requires a consideration of this potential resource. The potential for impacts to previously unidentified scarred trees in areas of remnant native vegetation within Project's proposed extraction area is also recognised.

To manage potential impacts to the known and potential Aboriginal heritage resource of the Project area, it is recommended that a detailed Aboriginal Cultural Heritage Management Plan (ACHMP) be prepared for the Project. The ACHMP should be prepared in consultation with RAPs and OEH, and to the satisfaction of DP&E. The commitment for the development of this ACHMP should be addressed in the EIS.

Key components of the proposed ACHMP for the Project are as follows:

- A comprehensive archaeological salvage program incorporating:
  - surface collection of the three sites of low scientific significance (BF-SC1-14, BF-SC2-14, and BF-SC3-14); and
  - surface collections and archaeological excavations at the two sites of moderate scientific (BF-SC4-14 and BF-SC5-14);
- A program of archaeological monitoring by RAPs during vegetation clearance activities, with scope for test and salvage excavations (where required);
- Monthly RAP inspections of stockpiled samples of reject screen material for the first 12 months of active operations;
- An unexpected finds procedure for any suspected or definitive Aboriginal objects identified throughout the life of the Project, with management action(s) varying according to the type of object(s) identified, its significance (both scientific and cultural) and the nature of potential impacts;
- A standard procedure for the management of any potential human skeletal remains identified throughout the life of the Project; and
- The development of an Aboriginal cultural heritage awareness training package for use throughout the life of the Project.

The historical heritage assessment undertaken for the project and discussed in Chapter 10 and Annex D has found that while there were European settlers in the Bob's Farm area from the 1820s, the northern portion of the Project area was not granted until the late 1870s or early 1880s to T.R Upton, later being transferred to Henry Upton. The southern portion of the Project area was not sold until 1948, following its use during World War II as a camp for Portuguese and Timorese evacuated from Timor before its fall to the Japanese. The Camp was almost certainly located towards the northern boundary of this grant, close to T.R. Upton's land and within the Project boundary. It is known that the Camp disposed of some waste off-site, however some was buried within walking distance. Archaeological deposits associated with the Camp therefore have the potential to be preserved within the Project area. These potential archaeological deposits have been assessed as holding historic, research and rarity values. There is no known plan of the Camp during its operation. The location of the huts, tents and refuse disposal area (which may have archaeological potential and significance) can therefore not be identified with any certainty. However, as Henry Upton offered to buy one of the water tanks associated with the Camp, which was located on his land, it can be presumed that the huts are likely to have been located in the northern section of the site.

A search of the relevant heritage registers was undertaken. No sites were identified within the Project area. One item, the Stockton Beach Dune System listed on the statutory Port Stephens LEP 2013 and the non-statutory Register of the National Estate (RNE), is located directly adjacent to the Project area. Two further items of local interest were identified to the north of the Project area. The Bobs Farm School and the Bobs Farm Hall, which held a pivotal place in the local community, are located adjacent to the northern section of the Project area.
An impact assessment was undertaken, which determined that no direct impacts have been identified as a result of the Project at this time. However, there is potential for archaeological deposits or relics associated with the Bobs Farm Cadre Camp to be preserved within the Project area. The location, extent and nature of these deposits are unknown, as no surface expression has been located. Should deposits be located within the Project area, the Project would result in direct impacts to the deposits. No indirect impacts, as a result of increased vibrations or visual alterations, have been identified to items identified in the vicinity of the

Project area. This is because the Project will not use blasting as an extraction method and the mine layout retains an adequate vegetation screen to ensure the mine is not visible from public space.

No Statements of Heritage Impact (SoHIs) are required as no quantifiable impacts have been determined. A Historic Heritage Management Plan (HHMP) is also not warranted as there are no items within the Project area that will require on-going management. It is therefore considered that the Project's Environmental Management Plan (EMP) will be able to adequately manage and protect the heritage values of the Project area. It is recommended that the EMP include contingency policies for the management of unexpected historic heritage finds and skeletal remains. It is also recommended that a suitably qualified archaeologist be engaged to prepare an Archaeological Research Design and Methodology prior to undertaking a watching brief with test and salvage excavation, if warranted, during vegetation clearance within areas of high archaeological potential.

Groundwater

Possible impacts of the proposed excavation of sand extraction on groundwater resources are examined in Chapter 7 and the full report is contained in Annex E. The proposal will see a reduction in ground water levels in the immediate area of the operations with minimal impact on adjoining farms and Groundwater Dependent Ecosystems (GDE's). The reduction in ground water levels adjoining the GDE's is within the allowable limits as required under the Water Management Act 2000. A proposed Groundwater Management Plan and monitoring regime will be prepared and be effective in managing these proposed operations. The potential impacts associated with the proposed sand mine can be successfully managed through implementation and monitoring of the impacts on the groundwater operations and the proposal is not expected to adversely impact on groundwater that is being utilised by adjoining farming operations.

The extraction of sand below the water table will create a window lake that will require the acquisition of water licences prior to the interception or dredging works.

Groundwater levels on the site and at surrounding bores will not be significantly altered as the proposed method of sand extraction below the water table is via dredge and therefore unlikely to result in significant groundwater drawdown. Some local groundwater level reduction may occur on the site due to evaporation of the 'window lake' and a changed recharge regime, however, this is expected to be minor given the high conductivity of the aquifer material surrounding the 'window lake'.

The nett groundwater demand has been determined to be 132.9ML/year.

Acid Sulphate Soils Assessment

A series of sample tests have been undertaken and further discussed in Chapter 5 and this report is included in Annex G. Potential acid sulphate soils are present and a detailed management plan is required to be prepared but given that potential acid sulphate soils (PASS) are present at levels below 0.8m AHD a details management plan will only be required for excavations below that level. PASS soils are in bands and the majority of the resource is not PASS affected. Generally, it is anticipated that the sand resource will only require controlled

monitoring as the resource is generally within acceptable limits of acidity and treatment. It has been concluded that: -

PASS are likely to be present at the site at levels close to or below groundwater table, typically located between 2 and 3 m AHD. A detailed ASS management plan (ASSMP) is only required for the proposed sand dredging operations. As AASS or PASS was generally not found above the groundwater table (apart from one anomaly in BH3 at +12.5 to +11.5 m AHD), no management plan is considered necessary for sand mining of this material. A series of recommendations have been made and these relate to: -

- No specific management is required associated with soil salinity.
- Use of soil materials will need to consider mild aggressivity.
- No specific management is required associated with soil dispersion.
- Supplementary borehole drilling, sampling and testing across the site and along site boundaries to better define the extent and depth of PASS below the groundwater table.
- Further testing of soil above the groundwater level in the vicinity of BH3 to confirm assumed anomalous test results.
- Installation of 5 new wells around the dredge pond to detect possible movement of sulfidic acidic impacted groundwater

Surface Water

Further discussed in Chapter 6 and the full report is contained within Annex F. The assessment concludes that the: -

- In regards to waste water, the proposal for shallow subsurface irrigation is adequate.
- In regard to stormwater quality assessment, the water quality objectives will be met by the proposed stormwater treatment train in the process plant area and across the greater site. This in turn shall protect sensitive receivers and achieve the Government endorsed environmental values and human uses criteria for the Karuah River and Great Lakes Catchments.

All water used during site operations shall be sourced, treated, recycled and reused on site. No discharge of waters is anticipated as a result of regular operations. In the event that the bioretention basin volume is exceeded, overflow shall be redirected to the extraction pit. Further, the nature of site soil profile (fine to medium grained sands) means that during rainfall events a high amount of infiltration and a low volume of surface runoff on the site is expected.

A monitoring plan is proposed as part of the EMP.

Coastal Hazard Assessment

Further discussed in Chapter 8 and the full report is contained within Annex H. The assessment concludes that the: -

- Hazard lines suggest that the subject site is unlikely to be affected by sea level rise effects within the Tilligerry Creek estuarine system. The proposed 15 m vegetated buffer zone and diversion bunds around the site perimeter will also limit some of these effects. It is recommended that diversion bund design consider potential sea level rise effects on the site.

- Ecological zone regression into the site is not likely to be significant. Appropriate diversion bund and buffer zone designs will further limit any potential ecological regression into the site due to sea level rise.
- Expected estuarine regression due to sea level rise should not impact site development.

Visual Assessment

Chapter 17 shows that the visual modification and sensitivity of the proposed development is low. In the short term, sand extraction may result in minor visual impacts from vantage points along Nelson Bay Road and the electricity easement, to the east and south west of the site respectively. However, these impacts will be relatively short lived as extraction areas would be progressively rehabilitated and screened. The final form of the site would see a relatively large water body that would be available for use as a significant tourist facility or potential solar energy farm that also has to a full native vegetation buffer which should enhance visual amenity. The visual impact of the proposed development will not significantly decrease the current visual amenity.

Social and Economic Assessment

The social and economic assessment is outlined in Chapter 18 and the fullSocial Impact Assessment is contained in Annex X. The proposed sand mine represents a scarce significant source of high-grade silica sand close to the Sydney and Newcastle glass and technology manufacturing markets. These markets are existing and there is limited local resources available for the suppling of these markets. The sand extraction would provide a cost-effective supply of high quality silica sand for local glass, ceramic and chemical industries.

The proposed operation would source only workers from the Port Stephens and local regional areas, so creating local sustainable jobs. The proposed sand mine provides a significant opportunity in many aspects of sand products thus supporting local employment at the Bobs Farm facility and other local and regional businesses through the multiplier effect. The proposed sand extraction through the life of the mining operations would allow for the continued employment of local workers and future operations as a tourist facility or solar energy farm would provide a significant long-term use with major positive ecological impacts.

The SIA has identified a range of perceived and actual community/ other stakeholder considerations associated with the proposal. Relevant community and technical mitigation strategies have been cited for engagement purposes; specifically, relevant to address the variety of issues which have been raised.

The EIS prepared for the proposed development incorporates a significant number of specific mitigation strategies in relation to:

- Traffic Impact Assessment
- Ecological Impact Assessment
- Noise and Vibration
- Air Quality
- Groundwater
- European Heritage
- Aboriginal Cultural Heritage
- Visual Impact Considerations

- Social Impact Assessment
- Statement of Commitments

As is the case with many resource extraction projects, the perceived and experienced social impacts/ issues are often greatest for those living in closest proximity to the proposal, or those who perceive they will be most directly impacted by the development. Consequently, should the development application be approved, an appropriate social impact monitoring program should be developed to assess the degree to which impacts are occurring and appropriate methodologies by which to mitigate any impacts.

It will be vital for the proponent to maintain an ongoing dialogue with local residents throughout the operation of the sand mine in relation to issues of relevance and importance to the community.

Bushfire Assessment

The vegetation within and around the proposed sand extraction area is identified as bush fire prone on the Port Stephens Council bush fire prone land map. Accordingly, under Section 79BA of the EP&A Act, the development proposal is required to address the requirements of the Rural Fires Act 1997, and in particular the document Planning for Bush Fire Protection (NSW Rural Fire Service, 2006). The proposal is not subdivision or for special fire protection purposes and is therefore not integrated development. The applicant therefore does not require a bush fire safety authority from the NSW Rural Fire Service but will undertake the development with regard to the intent of the Planning for Bushfire Protection 2006.

Bush fire protection measures incorporated into the current operations would be applied to the proposal. These measures aim to reduce fuel accumulation, control ignition sources, provide services on site to assist in fire fighting and minimise the spread of bush fire. Further clarification of the bushfire impacts is described in Chapter 19.

Waste Assessment

The proposed operation will have minimal to no solid waste management issues and no significant waste streams are expected as part of the proposed sand extraction. There may be a small amount of general waste and consumables produced and any waste would be removed regularly and recycled or disposed of directly at a licensed landfill.

Toilet wastes are proposed to be utilised as part of the rehabilitation works. Refuelling of machinery will be undertaken by mobile tankers, so there would be no waste materials generated onsite by such operations.

Where possible, waste suitable for reuse or recycling would be treated in accordance with the NSW Government's Waste Reduction and Purchasing Policy.

Utilities and Services

The site does not contain reticulated water or sewer services but does have access to mains electricity and telecommunications services.

A major electricity sub transmission line is located in the easement that transects Lot 254 DP 753204, and forms part of the proposed sand extraction area. The transmission line is controlled by Ausgrid and services Nelson Bay. It is proposed that this transmission line will be relocated into a new location in the rehabilitated batter of the final landform and discussions with Ausgrid have confirmed that their concurrence will be provided for these future relocation works.

Onsite telecommunication services will not be impacted by the operations.

Cumulative Impacts

The proposed sand extraction operations are expected to coexist in relative harmony with the community. There are no other major existing or planned activities operating in the locality that would cause significant cumulative environmental impacts in conjunction with the proposed extension. The potential environmental impacts have been assessed with respect to factors including noise, air quality, Aboriginal and European heritage, surface water and groundwater conditions, traffic, waste generation and visual amenity. There are no other activities that would be likely to increase the environmental, social or economic impacts of the proposal by virtue of cumulative impacts.

Environmental Management Plan (EMP)

A comprehensive EMP will be developed and would operate in place for the life of the proposed sand extraction operations and it is intended that this EMP would be updated as necessary to industry best practice and applied to works in the proposed site area. The EMP would be updated to reflect the commitments made within this application and would comprehensively cover conditions of consent and license conditions that arise from any project approval.

The EMP will have a number of sub-plans addressing specific operational issues, such as environmental induction and training, extraction area and depth monitoring, groundwater management, cultural heritage management, vegetation and landform rehabilitation, and erosion and sediment control.

A major element of the EMP is the requirement for an Annual Environmental Management Report (AEMR). It is intended that the AEMR process would form part of the monitoring process for works in the proposed sand mine area.

Capital Investment Value

The complete project involves the purchase of vehicles and machinery that includes excavators, dump trucks, loaders, conveyors, hoppers, pumping equipment and dredging equipment.

The project also requires the construction of temporary gravel haul roads, sealed haul roads as well as upgraded site accesses from Marsh Road and Nelson Bay Road. A site operations shed will also be constructed along with a stockpile and loading area and screening area.

The staged plan of the operation involves the initial clearing of vegetation and stripping of topsoil, the dry extraction and transportation of sand, wet extraction and transportation of sand and finally the vegetation rehabilitation.

The total cost includes the site preparation, construction of roads, shed and stockpile areas, purchase of vehicles and machinery and remediation of the site.

A Capital Investment Value Construction Cost Estimate has been advised by Quanto Pty Ltd that the independent estimated construction cost for the complete construction of the new proposed sand mine operation to total $4,450,000 exclusive of GST. A copy of the report is containe in Annex U.

CONCLUSION

The proposed sand mine will ensure the supply of a full suite of sand products that include the winning of high quality deposits of sand for high end uses. The project can be implemented with minimal adverse socio-economic and environmental impacts as demonstrated throughout this ea. The project is justified on the basis of the efficient utilisation of available existing resources and overall economic benefits to local, regional and State economies. It satisfies the objectives of ecologically sustainable development.

1 INTRODUCTION

Chapter 1 introduces the proposal, provides an overview and objectives of the proposed sand extraction operations, and briefly discusses the approval process.

1.1 BACKGROUND TO THE PROPOSAL

The proposed development is situated at Bobs Farm approximately 1.0km south west of the intersection of Marsh Road and Nelson Bay Road. The site is on the western side of Nelson Bay Road, which is a dual land main roan under the control of the RMS. The current use of the site is for an olive and fig farm. The surrounding development includes a small primary school to the immediate north of the site, and west of the proposed access/egress route, a community hall to the west of the school, rural residential properties that undertake a variety of small scale rural activities to the north and west, Worimi National Park to the east and south, a tourist go-kart track to the northeast and a tourist shark and ray aquarium to the northwest.



Plate 1-1 - Bobs Farm Primary School to the west of the proposed egress point



Plate 1-2 - Existing Marsh Road access looking towards Nelson Bay Road



Plate 1-3 - Proposed access road through Lot 11 DP 1071458

1.1.1 Site History

Lot 254 DP 753204 and Lot 51 DP 1015671 are the main sections of the proposed sand mining works. Whilst there were European settlers in the Bob's Farm area from the 1820s, the northern portion of the Project area was not granted until the late 1870s or early 1880s to T.R Upton, later being transferred to Henry Upton. The southern portion of the Project area was not sold until 1948, following its use during World War II as a camp for Portuguese and Timorese evacuated from Timor before its fall to the Japanese. The Camp was almost certainly located towards the northern boundary of this grant, close to T.R. Upton's land and within the Project boundary. Lots 10 & 11 DP 1071458 are included in the application but merely provide the access/egress route for the projects vehicular movements.

The southern boundary of Lot 254 includes a 33Kv sub transmission feeder line under the control of Ausgrid.



Plate 1-4 - Exisitng Ausgrid Sub Transmission Line

Heavy vehicle access is proposed to be via a controlled access point on Nelson Bay Road in the vicinity of the current access point to the fig and olive farm.

1.1.2 Current Operations

Currently, the fig and olive farm fully occupies a cleared area of around 9.6ha. The farm has limited financial viability and little possibility of economically expanding its operations. The farm is supplied with water from licenced bores, sells its products to the local area and at the regionally local, Newcastle Vegetable Markets.

1.2 OVERVIEW OF THE PROPOSAL AND PROJECT OBJECTIVE

Ammos Resource Management Pty Ltd is seeking development consent under Part 4 of the EP&A Act for the mining and processing of sand into a suite of sand product lines for the local, regional, interstate and international markets. An indicative layout is included as part of the plans in Annex T and is generally comprising the following: -

a) General layout of the proposed operations indicating the proposed locations for:-
    i. Main access/egress points.
    ii. Proposed effective mining area.
    iii. Buffer areas.
    iv. Adjoining Land Identifiers/residences.
    v. Existing residence
    vi. Screen Areas, Operations Shed
    vii. Stockpiling and loading areas

The existing site plan is included in Annex U as a detail plan indicating the contours and general existing site features.

1.3 APPLICATION AND APPROVAL PROCESS

Tattersall Lander prepared an Application for Director General Requirements and these DGR's were issued on the 21st March 2014. Planning and Environment and other Agencies advised a series of key issues and these agencies include: -

- Department of Planning & Environment (previously Planning & Infrastructure);
- Port Stephens Council (PSC);
- Roads and Maritime Services (RMS);
- Trade & Investment – Resources and Energy Division, Primary Industries Division;
- Environment Protection Authority (EPA);
- Office of Environment & Heritage (OEH);
- Local Land Services (LLS);
- Department of Primary Industries – Fisheries NSW, NSW Office of Water.

1.4 STRUCTURE AND CONTENT OF THE ENVIRONMENTAL ASSESSMENT

This Environmental Assessment has 27 chapters. The structure is as follows:

- Chapters 1-4 – background, description of proposal and overview of stakeholder consultation;
- Chapters 5-24 – description of existing environment and assessment of the potential impacts of the proposal;
- Chapter 25 – cumulative impact assessment;
- Chapter 26 – mitigation measures;
- Chapter 27 & 28 – project justification and conclusions;
- Annexes (including specialist studies and Departmental Environmental Assessment Requirements).

2 DESCRIPTION OF THE PROPOSAL

Chapter Two provides a detailed description of the proposal including an outline of the existing landuse, the proposed mining area, extraction methods and transport operations, rehabilitation works, revegetation method and final landform.

2.1 LOCATION

The Bobs Farm Sand Mine is located at Bobs Farm, immediately south of the Marsh Road intersection with Nelson Bay Road and on the western side of Nelson Bay Road. The proposed operations are indicated in Figures 2.1 to 2.4 below.

2.2 PROJECT AREA

The project area includes mining (extraction) operations within Lot 254 DP 753204 and Lot 51 DP 1015671, Lots 10 and 11 DP 1071458 would be utilised for access and egress. Approximately 39.07ha out of a total of 47.52ha would be mined and part of that mined area or about 11.74ha would contain future rehabilitated batters.

Lot 254 is owned by Patra Holding Pty Ltd, Lot 51 is owned by Patra Holdings Pty Ltd and RA Christie and Lots 10 and 11 are owned by Al & EC Hay. To the immediate northeast of Lot 254 there is a small parcel of Crown land. To the immediate west and south there is a series of small to medium rural lots that undertake either no agricultural activities or a small-scale farming operation. Nelson Bay Road runs along the eastern boundary with the Worimi National Park to the immediate west of Nelson Bay Road.

To the north and northwest there is the small Bobs farm Primary School and the Bobs farm Community Hall and some additional rural properties.

At the southern corner of the land is an Ausgrid sub transmission line. To the north there is also a Right of Way for Lot 521 DP 1034604. Figures 2.1 & 2.2 provide the details.

2.3 LAND TITLES AND TENURE

Description	Owner
Lot 254 DP 753204	Patra Holdings Pty Ltd
Lot 51 DP1015671	Patra Holdings Pty Ltd & RA Christie
Lots 10 & 11 DP 1071458	Al & EC Hay

Figure 2.1 – Land Tenure
Approvals of landowners have been obtained to lodge this application for the sand mine.

2.4 EXISTING SITE CHARACTERISTICS AND LAND USE

The proposed extraction area is one of a number of sand deposits within the Stockton Bight and comprises sands deposited approximately 4500 -7000 years ago in the Holecene Epoch. The site contains dune ridges to the north and west and sand plains to the east. The ridges have attained a height of up to 35m AHD with the lowest sand plain at 5m AHD. The majority of the land within the site > 8-10m AHD and Figure 2.2 indicates the existing contours.

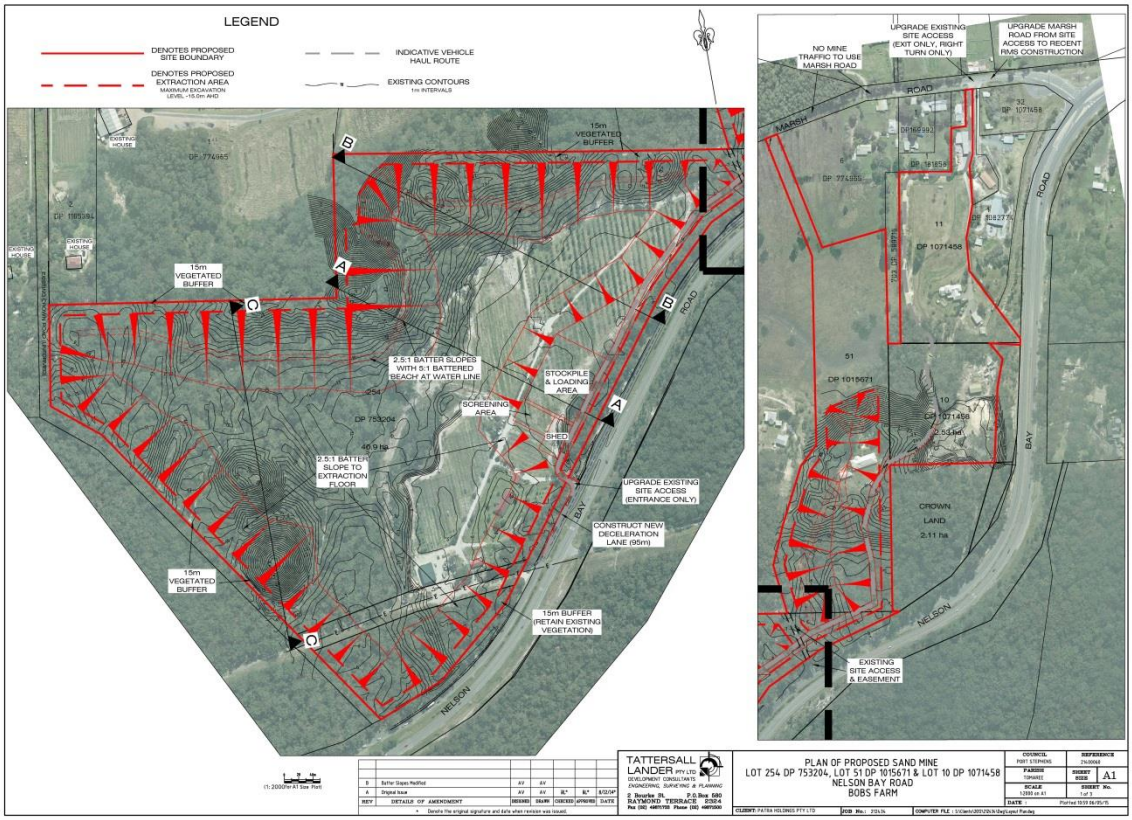


Figure 2.2 - Proposed Sand Mine with Aerial

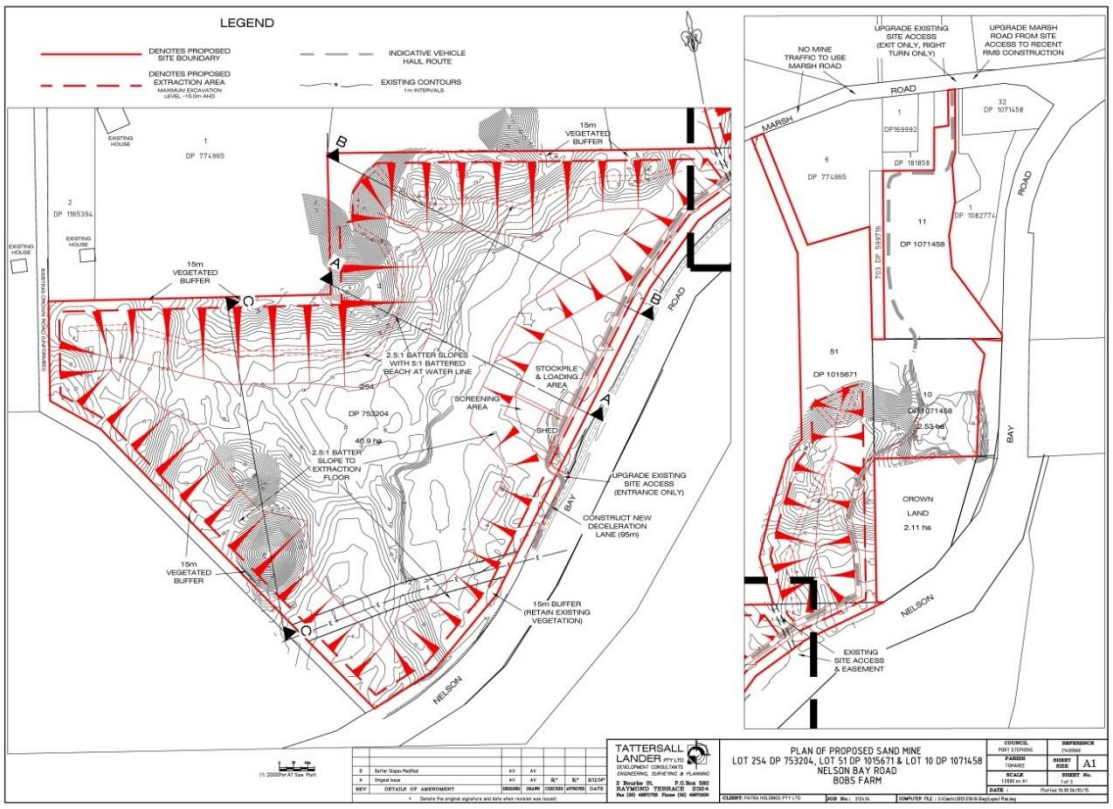


Figure 2.3 - Proposed Sand Mine

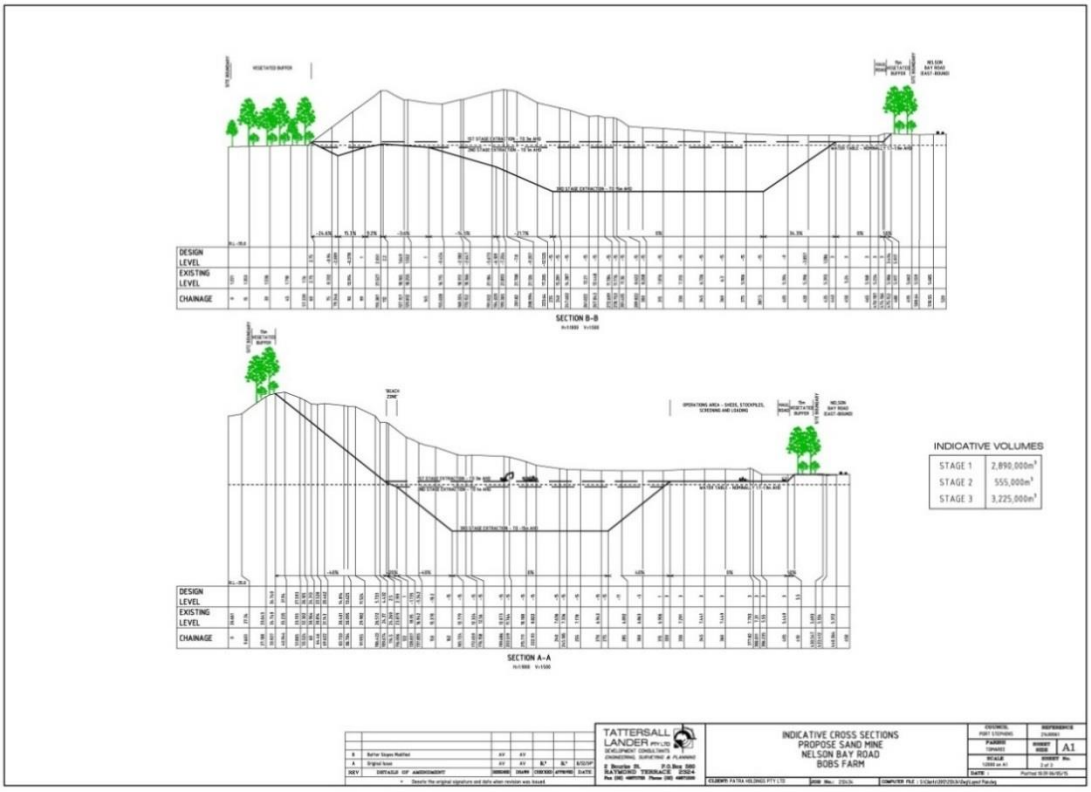


Figure 2.4 - Cross Sections A-A & B-BF

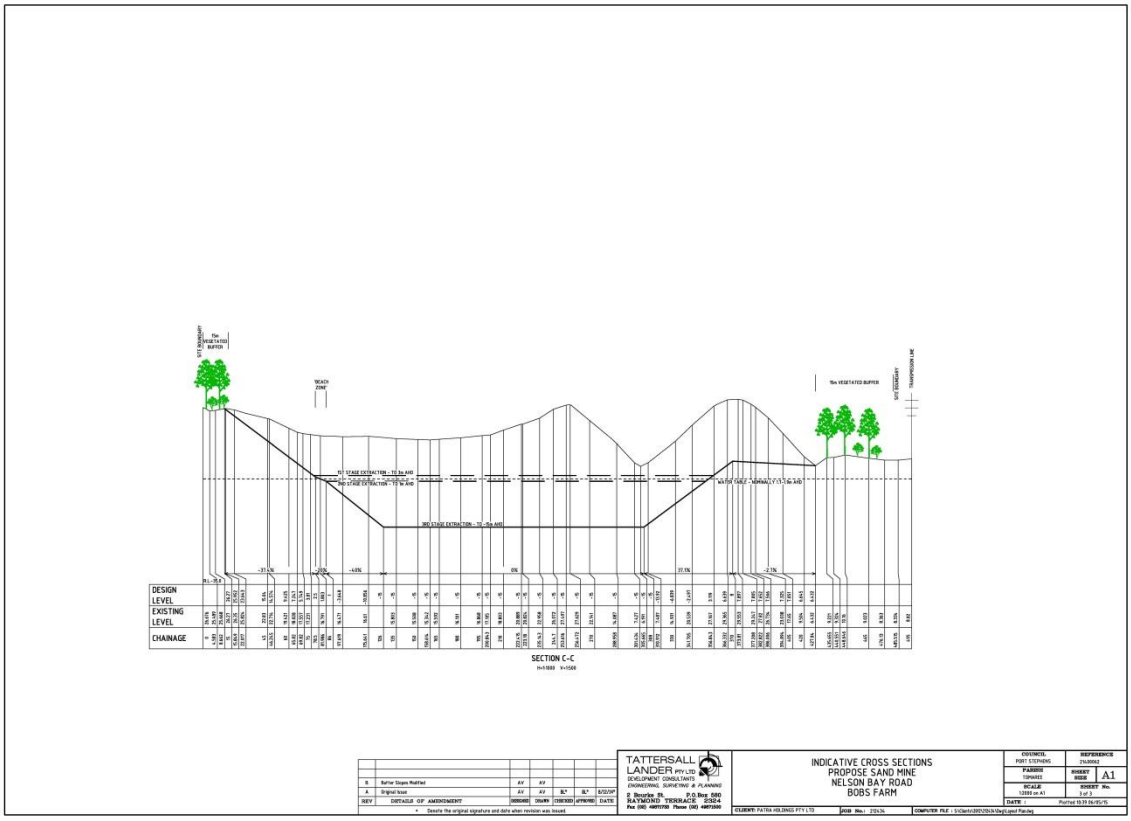


Figure 2.5 - Cross Section C-C

The local Bobs Farm School and Community Hall are to the north and west and adjoin Marsh Road west of the proposed egress point.

Current operations on Lot 254 are for an olive and fig farm that has been there for nearly 15 years. Access to the farm for the public is from Nelson Bay Road. Lot 521 DP 1034604 also has an access Right of Way over part of the mine site and there will be no significant interference to the Right of Way during the mining operations other than a public safety accommodation by the landowners as they will need to pass egressing trucks to gain access to Nelson Bay Road.

2.5 DESCRIPTION OF PROPOSED MINING OPERATIONS

The proposal seeks to undertake a sand mining operation over an area of about 39.26ha. The resource estimates provided by QMS indicate that around 6 million cubic meters of resource is available and the vast majority of sand products, with the exclusion of fracking sand are likely to be accommodated. Figures 2.1 – 2.4 indicate the proposed final profile of the mine with an internal water body that would be used for a tourist facility or a solar energy farm, post mining.

On top of the original 15m offset from the existing boundaries and the maintenance of an appropriate buffer to the central EEC, there will be an enhanced buffer around the whole of the mine that will be progressively rehabilitated. Advice from Martens & Associates has indicated the required batter slope for long term stability.

It is proposed that the area adjoining Nelson bay Road will be developed initially with the construction of the access off Nelson bay Road, operations shed/screens and stockpile areas. These works would also include the egress track out of the site and onto Marsh Road together

with the required mitigation measures to restrict noise and air quality issues, the installation of permanent water monitoring bores and an on-site weather station. The winning of particular sand stock will then follow the general mining plan as detailed by QMS in Chapter 16, Annex I, and shown as Figure 2.6 below:-

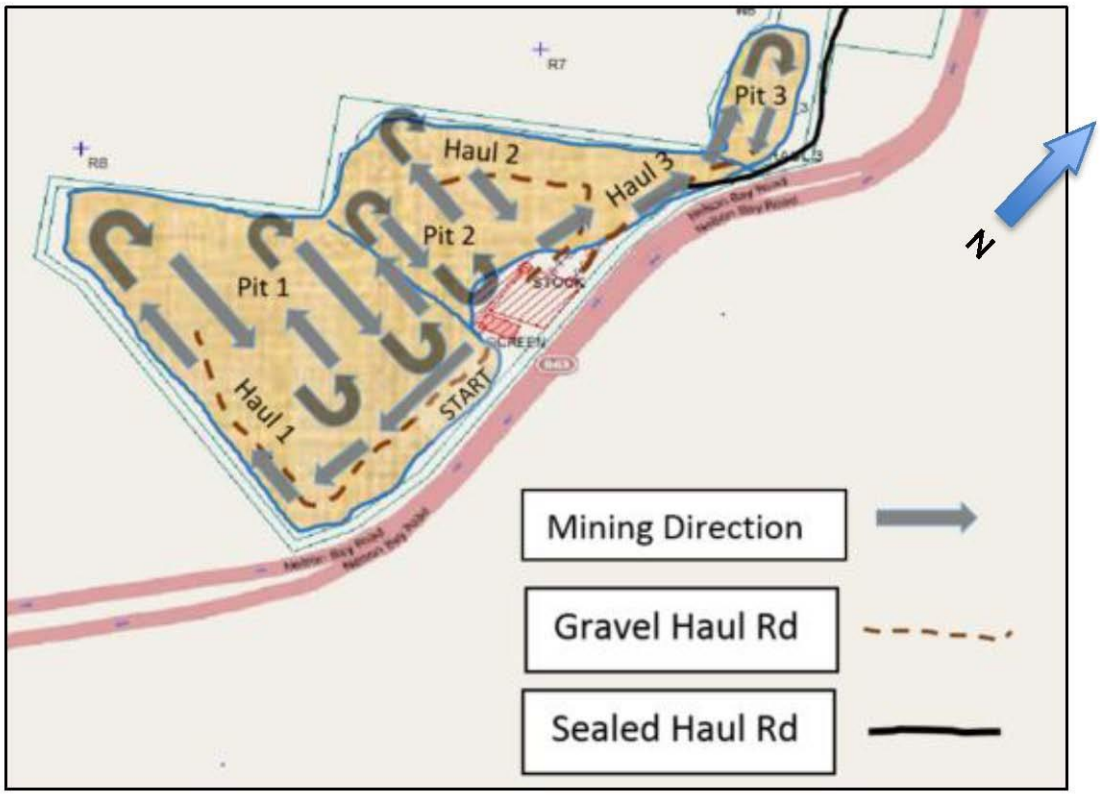


Figure 2.6 - Proposed Mining Plan and Extraction Cell Arrangement

The proposed steps in the mining plan would be generally as follows: -

- Vegetation clearing;
- Topsoil stripping and stockpiling;
- Dry exteraction and either processing for market requirements or direct loading onto trucks for market supply.
- Topsoil respread over exposed areas once the final mine profile is achieved, including the dry mining areas.

It is expected that the extraction arrangements would involve 3-4, one-hectare working cells being actively worked at any one time.

As can be seen the active cell extraction is planned to commence in the south eastern corner of the site extending west then returning east as per the illustrated extraction flow direction.

Each active cell is to be stripped of existing vegetation in turn and prepared for mining. It will then be dry mined to within 2 metres of the water table, before switching to wet mining.

Main haul road 3 will be constructed and maintained with a bituminous seal to minimise dust generation; with haul roads 1 and 2 gravel during mining operation.

2.5.1 Dry Mining

Dry mining of the Bobs Farm deposit will commence with stripping of existing vegetation from the surface by excavator with a grab and bulldozer. The vegetation that can be saved will be stored onsite to provide the required seed stock of natives for rehabilitation while the remainder would be processed into mulch and stockpiled onsite in a location that will not cause problematic leachate discharge during rain events. This mulch material will be needed throughout the life of the deposit to vegetate the final bund profiles so should be easily accessible for this future re-use.

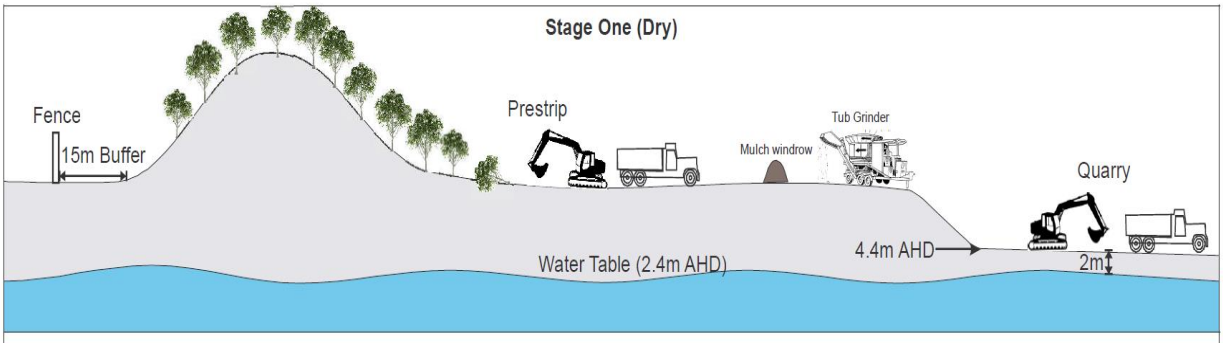


Figure 2.7 - Dry Mining Schematic

The final stages of dry mining will involve removal of the PASS black mud layer, for treatment or disposal, reducing the acid sulphate soil risk for that portion of the site. In accordance with the Martens acid sulphate management plan for the site this removal will be done by excavator which will operate at or just below the water table in removing this layer. If testing confirms pH of the sand has dropped below 5 pH points it will be treated with Lime in accordance with a PASS treatment plan to be provided by Martens.

2.5.2 Wet Mining

Wet mining is to commence upon establishment of the dedicated suction cutter dredge upon the water table.

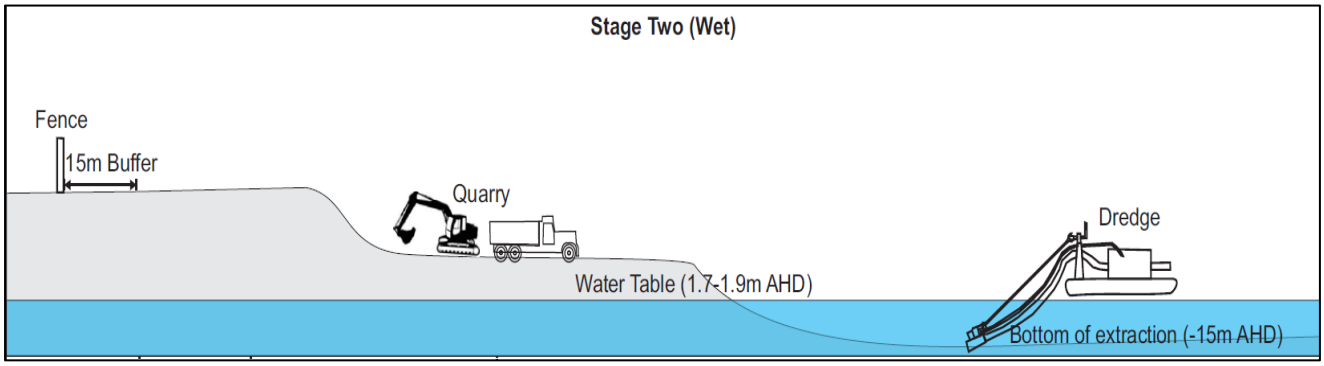


Figure 2.8 - Wet Mining Schematic

Wet mining will involve the winning of sand feed by suction cutter dredge.

Sand remaining above the water table will be placed into the dredge pond by excavator with a bulldozer feeding the excavator to assist the process.

The operation of the dredge will be such that it will mine the sand feed below the water table to a final profile as provided by Martens.

2.6 RATES OF EXTRACTION – PROJECTED

The Director General requirements for the Bobs Farm site outlined at peak production a maximum of 750,000 TPA of sand feed may be extracted for processing. This would equate to approx. 450 Tonnes per hour based on 11 months of sand production at 19 days per month and 8 hours per day (=> 750,000 /11/19/8 = 448.56t /hr => ~ 450t/hr of extracted feed). That estimate allows enough time for plant maintenance, shutdowns and production interruptions.

The build-up of sand production volume up to the specified maximum of 750,000TPA depends on the market take up of sand products.

A conservative approach for build-up of sand product volumes and sales is estimated in Tables 16.9 to 16.12 achieving maximum at year 4 onwards.

2.7 DESCRIPTION OF THE PROPOSED FINAL LANDFORM

Surface elevations vary from 5m AHD to 35m AHD and the detail survey contained in Annex U provides relevant details. The highest ridges are contained generally to the west of the land.

Figures 2.1.to 2.4 provide plans of the existing and indicative final profiles. Given that no part of the extraction mining operation will encroach within the 15m buffer area, the impact on adjoining neighbours is expected to be minimal and the change in landform will not impact neighbouring properties. The proposal is to undertake early rehabilitation of the final landform profiles including on that part of the mine that will contain only dry mining operations will provide an enhanced buffer for the adjoining neighbours at the earlier stages of the operations. The rehabilitated areas would return to a typical existing bush configuration.

It is proposed that the final landform will provide a significant tourist or even a solar farm option potential. The tourist facility would be based on water sports, water activities and recreational accommodation that will potentially include:-

- Cable skiing;
- Diver training;
- Tourist cabins;
- Kayaking;
- Paddle skies.

There is also the potential for the use of the site as a solar energy farm of the type that is currently being trialled in South Australia.

Plans of both the tourist and solar energy farm operations are contained within Chapter 22.

2.8 STAGED LANDFORM AND VEGETATION REHABILITATION

The propose landform rehabilitation would be managed as per the formal EMP process.

The objective of the Plan will be to ensure that the post extraction landform profile does not adversely impact on adjoining neighbours and that the surface profiles are conducive to the re-establishment of the vegetation communities that pre-existed on the site.

The vegetation rehabilitation plan would specify a minimum required tree and shrub cover undertaken with best practice techniques and a reasonable period of post-extraction monitoring.

The staged clearing of the existing vegetation would see an ecologist supervised removal of the vegetation and the recovery of any fauna. Replacement of a number of nest boxes to partially mitigate the removal of habitat trees is part of the recommendations within the Flora and Fauna Report by Wildthing and further discussed in Chapter 14 and Annex N. The topsoil that would be stockpiled will also act as a soil seed stock for the extracted areas involved with the dry mining operations.

Depending on the success of the proposed rehabilitation works, there will be a requirement to also consider direct drilling of native species, tubestock plantings and in some cases transplanting of locally important Grass trees, *Xanthorrhoea spp,* which are suitable for this sort of actions and has been undertaken on many sites within the Peninsula.

Weed control will be also included in the site EMP and given the active site presence of machinery and mine staff, the control of weeds into surrounding bush will be an activity that is regular and continuous.

Given the final profile will intercept the water table, it is suggested that the site also undertake the rehabilitation with a view of planting Koala feed trees in areas that create the opportunity for the relevant species to extend their territory. The current areas of Koala activity do not extend into the site and this opportunity to extend their feeding territory should not be wasted.

The monitoring of all rehabilitation works will be undertaken by ecologists and the results will be documented in the reports required by the relevant Agencies. The EMP will be a active document and modifications to the rehabilitation works and methodology will be undertaken when and where it is necessary.

2.9 PROCESSING AND TRANSPORTING OF SAND

It is intended that the processing of the sand would be fully contained with the mine site. The processing steps for the dry mining component are: -

- Winning of feed
- Feed delivered to processing plant by haul truck
- Haul truck tips into feed stockpile / hopper
- Loader feeds grizzly if oversize present then onto a feed conveyor
- Feed conveyor to double deck screen (maybe a wash screen as required by product)
- Fines to waste stream and possible treatment
- Sand screw to radial stacker and final product

Possible Additional Dry Mining Plant Options

- Spirals for glass sand manufacture
- Attrition cells to remove stubborn adhering contaminants

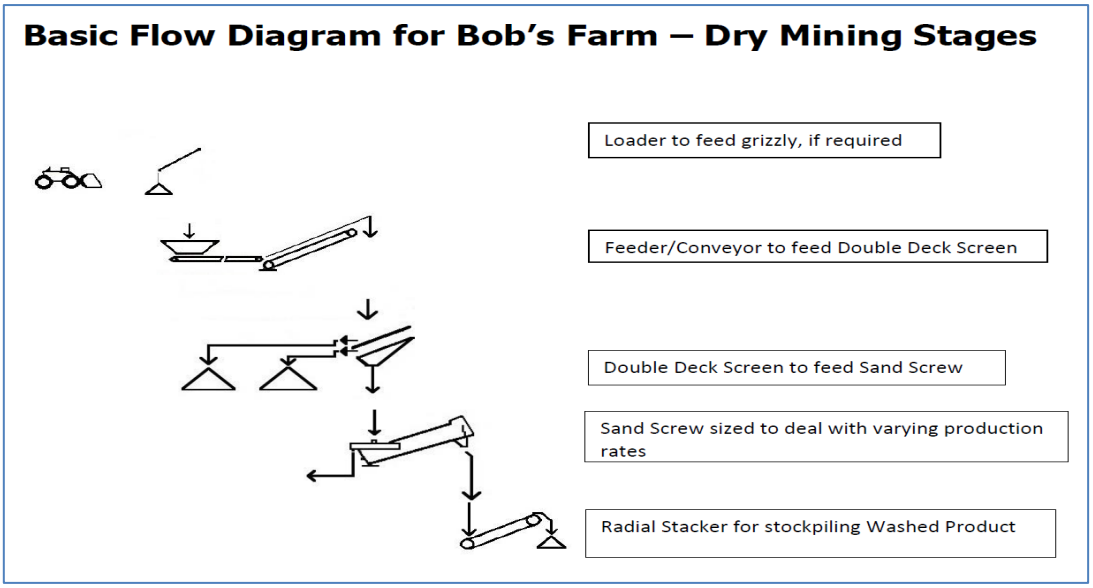


Figure 2.9 - Typical Dry Mining Operation

The wet mining operations include: -

- Dredge to pump box
- Pump to double deck vibrating wet screen
- Dewatering classifying tank
- Sand screws to radial stackers and final product

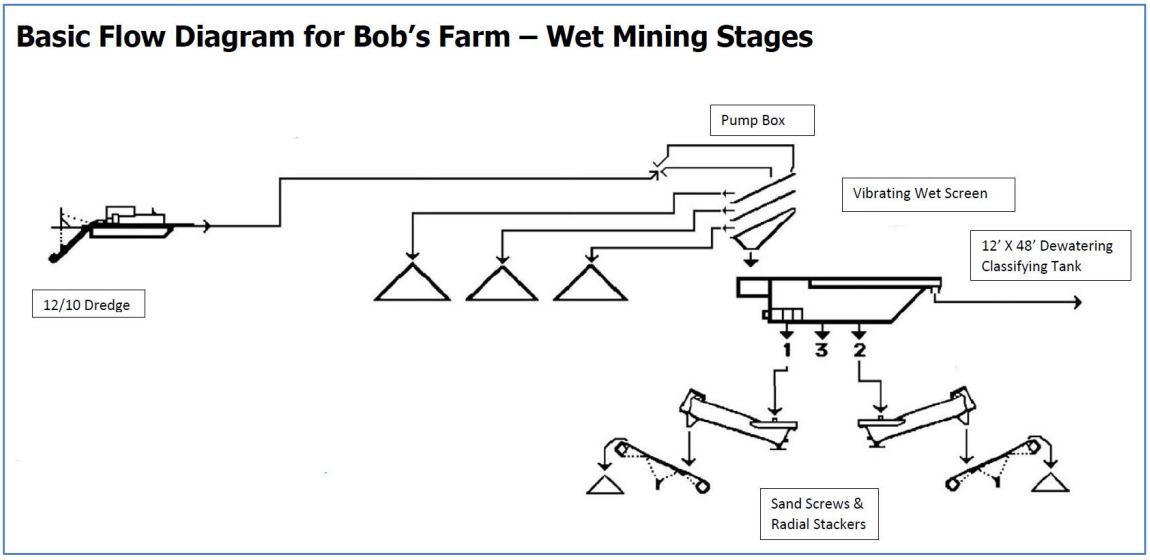


Figure 2.10 - Typical Wet Mining Operation

The proposed transportation of the sand out of the site would see the use of an existing, generally sealed road within Lots 10 and 11 DP 1071458 which would exit onto Marsh Road to the east of the Bobs farm Primary School and then onto Nelson bay Road. Trucks would the head east about 5km to the roundabout at Port Stephens Drive prior to heading westward towards the majority of the expected markets in Newcastle, Newcastle Port and surrounding districts. It is expected that the initial truck usage will be around 10 trucks/hr ramping up to 200trucks/hr for the wet mining operation.

2.10 HOURS OF OPERATION AND EMPLOYMENT

The site would operate 6am to 6pm, six days a week with no work on Sundays or Public Holidays. It is proposed to limit transportation of the sand products to 7am to 5pm and the shoulder hours would see on site activities being undertaken.

It is expected that around 80 jobs would be generated with 7-10 on site, 50-70 involved in transportation, 15 in downstream manufacturing and laboratory activities and 10 in the use of product for recreational purposes.

2.11 MACHINERY, EQUIPMENT, MATERIALS AND CONSUMABLES

Depending on the stage of the operations the machinery and equipment will change to suit the site requirements but generally the following will be utilised: -

- Chainsaws (initial clearing)
- Mulching equipment
- Excavators
- Dump trucks
- Loaders
- Conveyors
- Hoppers
- Screens
- Pumps
- Water carts

Diesel fuel will be the major product consumed on site and the diesel will be bought onto site on a needs basis. Hydraulic fluid and engine oils would also be consumed with major servicing undertaken off-site.

The site will produce minimal paper and domestic waste which will be collected, sorted and disposed off-site by waste management contractors.

2.12 NEED FOR THE MINE AND ALTERNATIVE SAND SOURCES

High grade white silica sand deposits are scarce, and the deposits of the Tilligerry & Tomaree Peninsula are unusually pure dune deposits of glass and manufacturing making quality. These deposits represent the only significant source of this grade of sand close to Sydney. The nearest source of equivalent grade sand outside these Peninsulas is located interstate. The processed sand from the Bobs Farm Sand Mine is about 99.9% silica and contains negligible amounts of contaminants. The proposal seeks to maximise the utilisation of the silica sand deposits in the vicinity of the manufacturing and port facilities in the region.

2.13 ALTERNATIVE TRANSPORT AND SAND EXTRACTION OPTIONS

2.13.1 Alternative Transport Routes

An option to utilise Nelson Bay Road as both the entry and exit point for the operations was initially considered. This option was rejected in early planning due to the identified need to: -

- Separate the traffic streams
- Reduce the single point impacts on Nelson Bay Road

- Economic costs required for the upgrade of Nelson bay Road with respect to the exiting procedures.
- Availability of the Marsh Road option with an already constructed intersection capable of containing the transport vehicles (and depending on compliance regarding the intersection of the access track with Marsh Road with respect to noise, vibration, and the safety with the adjoining Public School).

The preferred option was to utilise the opportunity of the Marsh Road intersection as it is considered that the necessary compliance requirements could be managed and that the overall impacts to road users, the community and the school would be within logical, manageable and reasonable limits.

2.13.2 Alternative Sand Extraction Strategies

An option exists to not undertake the mining operation and to attempt to continue the current farming operations involving the fig and olive farm. The resource is limited within the area and the need for the resource is growing both locally and regionally. The farming operation is not: -

- A significant employer
- Able to expand operations due to the financial constraints associated with an expansion.
- Seen by DPI as a viable long-term sustainable operation.

Undertaking the mining operation would see: -

- Significant local employment
- Supply of a limited resource into a market that is continuing to grow locally and regionally.
- Operations within controlled levels for noise, water quality and visual impact
- Mitigation measures to minimise environmental impacts.

2.14 ALTERNATIVE OF NOT PROCEEDING

The sand deposits at Bobs Farm are of an exceptional quality that has been identified to be able to supply over 14 known markets that include: -

- High Purity Glass Sand- LCD TVs, Silicon Computer Chips etc
- Optical sand glass / watches etc
- Glass sand (Clear- general)
- Glass sand (Coloured)
- Foundry/furnace sand
- Specialist grout sand
- Horticulture sand - propagation sands etc
- Landscape sand (High end)- horse sand/golf, bunker, green, fairway sands
- Decorative sands- resorts, national / international
- Filter sands / bio retention
- Soft fall / sand pit sands- kindergartens, wet & wild etc.
- Landscape sand (lower end)- top dress etc
- Construction sands
- Fill sands

The resource is close to established markets and the impacts associated with the extraction are known and measured. The site has been shown to be able to exist with little adverse impacts on adjoining neighbours. Not proceeding would ultimately see the land cease long term as an orchard and little, if any primary production being carried out. Long term sustainable jobs would utilise the post mining operation with options for a tourist development as well as a solar energy farm being considered.

3 STATUTORY REQUIREMENTS

3.1 COMMONWEALTH LEGISLATION

3.1.1 Environment Protection & Biodiversity Conservation Act 1999

The Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) requires approval from the Commonwealth Minister for the Environment, for actions that may have a significant impact on matters of national environmental significance. The EPBC Act also requires Commonwealth approval for certain actions on Commonwealth land. Matters of national environmental significance under the EPBC Act are:

- World Heritage properties; National Heritage places;
- Great Barrier Reef Marine Park;
- Ramsar wetlands of international importance;
- Threatened species or ecological communities listed in the EPBC Act;
- Migratory species listed in the EPBC Act;
- Commonwealth marine environment; and Nuclear actions.

The site is not listed as or located on or adjacent to Great Barrier Reef, a World Heritage property, a National Heritage place or a wetland of international significance. The land is not designated as Commonwealth land and nuclear actions are not listed within 10 km of the site. No nationally threatened communities were present within the study area. One nationally threatened species Pteropus poliocephalus (Grey-headed Flying-fox) was recorded foraging within the site during fieldwork. An additional threatened species Phascolarctos cinereus (Koala) was also identified as utilising the study area from the presence of scratches on preferred feed tree species.

The proposal will result in a reduction in habitat for both these two nationally threatened species however is unlikely to have a significant impact.

Three listed migratory species; White-bellied Sea-eagle, Rufous Fantail and Cattle Egret were recorded within the study area during fieldwork. Considering the relative commonality of these three migratory species and large amount of suitable habitat in the locality it is unlikely that these species or any of the addressed listed migratory species would be significantly impacted by the proposal. An assessment of whether the development will have or is likely to have a significant impact on these matters of national environmental significance is summarised in the ecological assessment as outlined in *Chapter 14* and provided in full in *Annex N*.

Under Part 9 of the EPBC Act, any action that is likely to have a significant impact on a matter of National Environmental Significance may only progress with approval of the Commonwealth Minister for the Department of the Environment. An action is defined as a project, development, undertaking, activity, series of activities, or alteration. An action will also require approval if:

- it is undertaken on Commonwealth land and will have or is likely to have a significant impact;
- it is undertaken outside Commonwealth land and will have or is likely to have a significant impact on the environment on Commonwealth land; and
- it is undertaken by the Commonwealth and will have or is likely to have a significant impact.

The EPBC Act defines 'environment' as incorporating both natural and cultural environments and therefore includes Aboriginal heritage items. Under the Act, protected heritage items are listed on the National Heritage List (items of significance to the nation) or the Commonwealth Heritage List (items belonging to the Commonwealth or its agencies). These two lists replaced the Register of the National Estate (RNE). Statutory references to the RNE in the EPBC Act were removed on 19 February 2012. However, the RNE remains an archive of over 13,000 heritage places throughout Australia.

The heritage registers mandated by the EPBC Act have been consulted and there are no Aboriginal heritage sites or places listed in these registers that are located within the Project area.

3.1.2 Aboriginal & Torres Strait Islander Heritage Protection Act 1984

The Aboriginal and Torres Strait Islander Heritage Protection Act 1984 (the ATSIHP Act) provides for the preservation and protection of places, areas and objects of particular significance to Indigenous Australians. The stated purpose of the ATSIHP Act is the "preservation and protection from injury or desecration of areas and objects in Australia and in Australian waters, being areas and objects that are of particular significance to Aboriginals in accordance with Aboriginal tradition" (Part I, Section 4).

Under the Act, 'Aboriginal tradition' is defined as "the body of traditions, observances, customs and beliefs of Aboriginals generally or of a particular community or group of Aboriginals, and includes any such traditions, observances, customs or beliefs relating to particular persons, areas, objects or relationships" (Part I, Section 3). A 'significant Aboriginal area' is an area of land or water in Australia that is of "particular significance to Aboriginals in accordance with Aboriginal tradition" (Part I, Section 3). A 'significant Aboriginal object', on the other hand, refers to an object (including Aboriginal remains) of like significance.

For the purposes of the Act, an area or object is considered to have been be injured or desecrated if:

a) In the case of an area:
    i. it is used or treated in a manner inconsistent with Aboriginal tradition;
    ii. the use or significance of the area in accordance with Aboriginal tradition is adversely affected; and
    iii. passage through, or over, or entry upon, the area by any person occurs in a manner inconsistent with Aboriginal tradition
b) in the case of an object:
    i. it is used or treated in a manner inconsistent with Aboriginal tradition.

The ATSIHP Act can override state and territory laws in situations where a state or territory has approved an activity, but the Commonwealth Minister prevents the activity from occurring by making a declaration to protect an area or object. However, the Minister can only make a decision after receiving a legally valid application under the ATSIHP Act and, in the case of long term protection, after considering a report on the matter. Before making a declaration to protect an area or object in a state or territory, the Commonwealth Minister must consult the appropriate minister of that state or territory (Part 2, Section 13). Matters of Aboriginal significance are discussed in *Chapter 9* and *Annex C*.

3.2 NEW SOUTH WALES STATE LEGISLATION

3.2.1 Environmental Planning & Assessment Act 1979

The provisions of the Environmental Planning and Assessment Act 1979 (EP&A Act) and the Environmental Planning and Assessment Regulation 2000 (EP&A Regulation) enable the preparation of local environmental plans, development control plans, regional environmental plans and State environmental planning policies to control development at the local, regional and State level. Those planning instruments and policies that are applicable to the proposal along with other relevant statutory considerations are addressed here.

The proposal is State Significant Development pursuant to section 4.36 of the *Environmental Planning & Assessment Act 1979*. The Act stipulates that a development will be considered SSD if it declared to be such by the new State Environmental Planning Policy (State and Regional Development) 2011 (SEPP SRD).

Under Clause 8(1) of SEPP SRD, a development is declared to be State Significant Development if:

a) the development on the land concerned is, by the operation of an environmental planning instrument, permissible with development consent under Part 4 of the EP&A Act; and

b) the development is specified in Schedule 1 or 2 of SEPP SRD.

The Project is SSD as it meets both of these criteria, namely:

- it is permissible with development consent on the land on which it is located; and
- it is development that is specified in Schedule 1 of SEPP SRD.

The Project was declared SSD by the Minister for Planning and Infrastructure on 21 March 2014.

The application is also (nominated) integrated development pursuant to section 4.46 of the *Environmental Planning & Assessment Act 1979* and associated Regulation.

The Environmental Planning and Assessment Act 1979 (EP&A Act), administered by the NSW Department of Planning and Environment, requires that consideration be given to environmental impacts as part of the land use planning process in NSW. In NSW, environmental impacts are interpreted as including impacts to Aboriginal and non-Aboriginal (i.e., European) cultural heritage.

DEC's (now OEH) draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation (DEC, 2005) detail the relevant statutory requirements for Aboriginal cultural heritage assessments conducted under Division 4.1 of Part 4 of the EP&A Act. These guidelines require Aboriginal heritage assessments to be conducted in accordance DECCW's (2004) Interim Community Consultation Requirements for Applicants and the NSW National Parks and Wildlife Service's (1997) Aboriginal Cultural Heritage Standards and Guidelines Kit. However, it is noted that the NSW Office of Environment and Heritage's Aboriginal Cultural Heritage Consultation Requirements for Proponents (DECCW, 2010), Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales (DECCW, 2010b) and Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in NSW (OEH,

2011) have effectively replaced these earlier policies and currently represent best practice guidelines for the assessment of Aboriginal cultural heritage in NSW.

3.2.2 Protection of the Environment Operations Act 1997

The proposed development requires a license pursuant to Section 48 of the *Protection of the Environment Operations Act 1997* (Schedule 1 Activities (Premises-Based), Item 19 Extractive Industries). Item 19 specifies:

19 Extractive activities

(1) This clause applies to the following activities:

land-based extractive activity, meaning the extraction, processing or storage of extractive materials, either for sale or re-use, by means of excavation, blasting, tunneling, quarrying or other such land-based methods.

water-based extractive activity, meaning the extraction of extractive materials, either for sale or re-use, by means of dredging or other such water-based methods.

(2) In this clause, extractive materials means clay, sand, soil, stone, gravel, rock, sandstone or similar substances that are not minerals within the meaning of the Mining Act 1992.

(3) Each activity referred to in Column 1 of the Table to this clause is declared to be a scheduled activity if it meets the criteria set out in Column 2 of that Table.

Column 1 **Activity**	**Column 2** **Criteria**
land-based extractive activity	involves the extraction, processing or storage of more than 30,000 tonnes per year of extractive materials
water-based extractive activity	involves the extraction of more than 30,000 cubic metres per year of extractive materials

Table 3.1 – Extractive Activities

Within the meaning as set out in Schedule 1 (Clause 19) the silica sand extraction operation is a land-based extractive industry and will involve the extraction of approximately 750,000 tonnes of silica sand per annum and therefore meets the criteria of a schedule activity under Schedule 1 of the POEO Act. An Environment Protection Licence from the EPA will be required.

3.2.3 Threatened Species Conservation Act 1995/Biodiversity Conservation Act 2016

The TSC Act provides for the conservation of threatened species, populations and ecological communities of animals and plants. The Act sets out a number of specific objectives relating to the conservation of biological diversity and the promotion of ecologically sustainable development. Schedules 1 & 2 of the TSC Act contain lists of flora and fauna species, population and communities that have been determined by the NSW Scientific Community. These species have been determined as being under threat of serious decline that could ultimately lead to extinction. Schedule 3 of the Act also contains a list of "Key Threatening Processes" which have been determined to have a detrimental impact on threatened species, populations or communities. Under Section 5A of the EP&A Act an assessment of significance (Seven Part Test) is applied to species, populations and ecological communities

listed on Schedules 1, 1A and 2 of the TSC Act which may be affected directly or indirectly by the proposed action.

Projects determined by a statutory authority of the NSW State Government are required to be also assessed in accordance with the EP&A Act, as amended by the Biodiversity Conservation 2016(BC Act). The BC Act lists threatened species, populations and ecological communities under Schedules 1 and 2 of the Act, that are priorities for conservation within NSW. Schedule 4 of the BC Act lists Key Threatening Processes for species, populations and ecological communities within NSW.

The EP&A Act lists factors that must be taken into account in the determination of the significance of potential impacts of a proposed development on threatened species, populations or ecological communities (or their habitats) listed under the TSC Act/BC Act. *In* August 2017, the BC Act commenced operation and changed the way impacts to biodiversity are assessed and offset in NSW, with offsetting required for any projects exceeding certain clearing thresholds outlined in the Biodiversity Conservation Regulation 2017 (BC Regulation).

Under the Biodiversity Conservation (Savings and Transitional) Regulation 2017 - Major projects (state significant development/state significant infrastructure) - development applications (or modification applications) the proposal is to be submitted under the previous legislation.

This assessment is provided in full in *Annex N* and summarised in *Chapter 14*.

3.2.4 National Parks & Wildlife Act 1974

The *National Parks and Wildlife Act 1974* (NP&W Act) guides the management of conservation areas as well as the protection of native vegetation, native fauna and Aboriginal objects across the State. Under the NP&W Act it is illegal to move, damage, deface or destroy a relic without written permission from the DECCW.

Under Section 5 of the Act, "Aboriginal Object" means any deposit, object or material evidence (not being a handicraft made for sale) relating to the Aboriginal habitation of the area that comprises New South Wales, being habitation before or concurrent with (or both) the occupation of that area by persons of non-Aboriginal extraction, and includes Aboriginal remains. All Aboriginal objects within the State of New South Wales are protected under Section 90 of the NP&W Act.

The NPW Act gives the Director General of OEH responsibility for the proper care, preservation and protection of 'Aboriginal objects' and 'Aboriginal places', defined under the Act as follows:

- An *Aboriginal object* is any deposit, object or material evidence (that is not a handicraft made for sale) relating to Aboriginal habitation of NSW, before or during the occupation of that area by persons of non-Aboriginal extraction (and includes Aboriginal remains).
- An *Aboriginal place* is a place declared so by the Minister administering the NPW Act because the place is or was of special significance to Aboriginal culture. It may or may not contain Aboriginal objects.

Part 6 of the NPW Act provides specific protection for Aboriginal objects and places by making it an offence to harm them and includes a 'strict liability offence' for such harm. A 'strict liability offence' does not require someone to know that it is an Aboriginal object or place they are causing harm to in order to be prosecuted. Defences against the 'strict liability offence' in the

NPW Act include the carrying out of certain 'Low Impact Activities', prescribed in Clause 80B of the *National Parks and Wildlife Amendment Regulation 2010* (NPW Regulation), and the demonstration of due diligence.

An Aboriginal Heritage Impact Permit (AHIP) issued under Section 90 of the NPW Act is required if impacts to Aboriginal objects and/or places cannot be avoided. An AHIP is a defence to a prosecution for harming Aboriginal objects and places if the harm was authorised by the AHIP and the conditions of that AHIP were not contravened. Consultation with Aboriginal communities is required under OEH policy when an application for an AHIP is considered and is an integral part of the process. AHIPs may be issued in relation to a specified Aboriginal object, Aboriginal place, land, activity or person or specified types or classes of Aboriginal objects, Aboriginal places, land, activities or persons.

Pursuant to Section 89J of the EP&A Act, AHIPs are not required for projects approved under Division 4.1 of Part 4 of the EP&A Act. Impacts to Aboriginal heritage values associated with approved SSD projects are typically managed under Aboriginal Cultural Heritage Management Plans (ACHMPs). ACHMPs are statutorily binding once approved by the Planning Assessment Commission (PAC) or DP&E under delegation from the Director-General.

Section 89A of the NPW Act requires notification of the location of Aboriginal sites within a reasonable time, with penalties for non-notification. Section 89A is binding in all instances, including Division 4.1 projects. This assessment is provided in full in *Annex C* and summarised in *Chapter 9*.

3.2.5 Coastal Management Act 2016

The Coastal Management Act provides clarification of the relevant coastal zones and management objectives. The Coastal Zone as being land comprised as:-

(a) the coastal wetlands and littoral rainforests area,

(b) the coastal vulnerability area,

(c) the coastal environment area,

(d) the coastal use area.

The subject land is within the *Coastal Environment Area* and the requirements are:-

8 Coastal environment area

(1) The coastal environment area means the land identified by a State environmental planning policy to be the coastal environment area for the purposes of this Act, being land containing coastal features such as the coastal waters of the State, estuaries, coastal lakes, coastal lagoons and land adjoining those features, including headlands and rock platforms.

(2) The management objectives for the coastal environment area are as follows:

(a) to protect and enhance the coastal environmental values and natural processes of coastal waters, estuaries, coastal lakes and coastal lagoons, and

enhance natural character, scenic value, biological diversity and ecosystem integrity,

(b) to reduce threats to and improve the resilience of coastal waters, estuaries, coastal lakes and coastal lagoons, including in response to climate change,

(c) to maintain and improve water quality and estuary health,

(d) to support the social and cultural values of coastal waters, estuaries, coastal lakes and coastal lagoons,

(e) to maintain the presence of beaches, dunes and the natural features of foreshores, taking into account the beach system operating at the relevant place,

(f) to maintain and, where practicable, improve public access, amenity and use of beaches, foreshores, headlands and rock platforms.

Comment: The proposed development is located south of the limits of the Coastal Environment Area Map. The northern part of Lot 51 DP 1015671 is within the Coastal Environment Area Map and the development activities and access roads are specifically designed to be outside the Coastal Zone.

All proposed operations have been designed to protect the biological diversity and ecosystem integrity, together with water quality and estuary health. It is also noted that the NSW Coastal Management Maps include a *Proximity Area for Coastal Wetlands* but the SEPP does not define aims or objectives that need to be considered for this map.

3.2.6 Water Act 1912

In those water sources (rivers, lakes and groundwater aquifers) in NSW where water sharing plans have not been gazetted and commenced, the Water Act 1912 (the "Water Act") still regulates new water licences and the trade of water licences and allocations. Even though the site is within a gazetted water sharing plan area – the Tomago Tomaree Stockton Groundwater Sources (July, 2004) - the Water Act does apply for the issuing of testing and monitoring licences (that is, bore licences). Section 112 of the Water Act 1912 requires all bores to be licensed and states:

1. The sinking of a bore shall not be commenced, nor shall a bore be enlarged, deepened, or altered unless:
    a. in pursuance of a licence issued under this Part, or
    b. the bore is to be sunk, enlarged, deepened, or altered by the Crown.

Therefore, a bore licence under Section 112 and 116 of the Water Act 1912 should be obtained prior to the installation of any new bores. Further consideration and discussion of water use and management issues is included in *Chapter 7* and *Annex E*.

3.2.7 Water Management Act 2000

The objectives of the Water Management Act 2000 (WM Act) are to provide for the sustainable and integrated management of the water sources of the State for the benefit of both present

and future generations. The provisions of the WM Act are being progressively implemented in NSW, repealing various other pieces of legislation in the process.

The licensing and approvals system under the WM Act have been in effect in those areas of NSW covered by operational water sharing plans. These areas cover most of the State's major regulated river systems. The site is within a gazetted water sharing plan area (the Tomago Tomaree Stockton Groundwater Sources); therefore, the WM Act applies.

The WM Act describes, under Sections 89, 90 and 91, a range of approvals including water use approvals, water management work approvals and activity approvals. The provisions of Sections 89 and 90 are in force only within water sharing areas. Given the site is within a water sharing area these provisions must be considered. Controlled activity approvals under Section 91 of the WM Act now apply in all areas of the state.

In relation to the proposed development, Section 89J (g) of the EPA Act applies:

- a water use approval under Section 89 of the WM Act is not required as the extraction of sand does not involves the extraction of surface water;
- a water management work approval under Section 90 of the WM Act is not required as the proposed development does not involve water supply work, drainage work or flood work; and
- an activity approval under Section 91 of the WM Act is required as the proposed development will intercept the predicted maximum ground water aquifer.

Further consideration and discussion of water use and management issues is included in *Chapters 6 and 7* and *Annex E and F*.

3.2.7.1 Harvestable Rights

A land owner's 'harvestable right' is the amount of water owners of land are entitled to capture and use pursuant to the harvestable rights Order published in the NSW Government Gazette on 23 March 2001 under Section 54 of the Act. It is most simply understood to be 10% of the runoff generated by a property.

The open extraction pit will form a 'window lake' which intersects groundwater and captures rainfall. Collected rainfall will be available for reuse and form part of the site's water reuse system.

Previous consultation with NOW confirms that direct rainfall onto a window lake which has no, or minimal, catchment is exempt from harvestable rights calculations under the Farm Dams Policy (NSW Government Gazette 40; 31 March, 2006 pg. 1628 - 1631). The capture and use of the water is also exempt from licensing under the Water Management Act (2000).

3.2.7.2 Aquifer Access License

It is anticipated that a WAL and Aquifer Interference Activity Approval with sufficient share component for the taking of water will be required. The grant of the WAL and the management of allocation and share component which attach to it are bound by the rules within the Tomago, Tomaree and Stockton Groundwater Sources Water Sharing Plan (2003).

Further details regarding groundwater access, impacts and licensing is provided in the Groundwater Management Plan (Martens and Associates, 2014c).

3.2.8 Hunter Water Regulation 2010

The purpose of the Hunter Water Regulation 2010 is to regulate implementation of the Hunter Water Act 1991. In relation to the proposed development:

- The site is not included in a 'special area' under Part 2, which therefore does not apply.
- It does not involve plumbing or drainage work that affects the Hunter Water Corporation (i.e. does not propose to include or affect a water main, sewer main or stormwater drain of the Corporation). Part 3 and Part 4 of the Regulation therefore do not apply.

The proposed development therefore complies with the Hunter Water Regulation.

3.2.9 Water Sharing Plan for the Tomago Tomaree Stockton Groundwater Sources 2003 & the Karuah River Water Source Water Sharing Plan

Surface Water

Discussion with NSW Office of Water (July 15, 2014) confirmed that the site surface water is managed under the Karuah River Water Source Water Sharing Plan (WSP). Under this WSP there are 5 management zones. The site lies in areas downstream of the downstream limit of zone 5, and is not covered by a management zone.

The extraction basin has no licensable take, does not require Water Management Act (2000) licensing and is therefore not subject to the WSP.

Groundwater

As outlined in above, in accordance with the Tomago, Tomaree and Stockton Groundwater Sources Water Sharing Plan (2003), a share component equivalent to the anticipated groundwater 'take' is to be sought under an aquifer access license.

3.3 STATE ENVIRONMENTAL PLANNING POLICIES (SEPP)

3.3.1 SEPP (State and Regional Development) 2011

Division 4.1 of the EP&A Act provides a determination regime for State Significant Development (SSD). Clause 4.36 of the EP&A Act stipulates that a development will be considered SSD if it declared to be such by the new State Environmental Planning Policy (State and Regional Development) 2011 (SEPP SRD).

Under Clause 8(1) of SEPP SRD, a development is declared to be State Significant Development if:

a. the development on the land concerned is, by the operation of an environmental planning instrument, permissible with development consent under Part 4 of the EP&A Act; and
b. the development is specified in Schedule 1 or 2 of SEPP SRD.

Schedule 1 State significant development—general

7 Extractive industries

(1) Development for the purpose of extractive industry that:

(a) ***extracts more than 500,000 tonnes of extractive materials per year****, or*

(b) ***extracts from a total resource (the subject of the development application) of more than 5 million tonnes****, or*

(c) extracts from an environmentally sensitive area of State significance.

(2) Subclause (1) (c) does not apply to extraction:

(a) by a public authority in maintenance dredging of a tidal waterway, or

(b) in maintenance dredging of oyster lease areas, or adjacent areas, in Wallis Lake.

(3) Development for the purpose of extractive industry related works (including processing plants, water management systems, or facilities for storage, loading or transporting any construction material or waste material) that:

(a) is ancillary to or an extension of another State significant development project, or

(b) has a capital investment value of more than $30 million.

(4) This clause does not apply to development for the purpose of extractive industry or extractive industry related works that is part of a single proposed development if any other part of the development is State significant infrastructure.

The relevant development standards relate to the scale of the proposed operations and as the Application is seeking the potential to win 750,000 tonnes/year and would disturb >2ha of land, the required trigger values for a SSD have been met. It is not intended that any development standard will not be met.

The Project is SSD as it meets both of these criteria, namely:

- it is permissible with development consent on the land on which it is located; and
- it is development that is specified in Schedule 1 of SEPP SRD.

The Project was declared SSD by the Minister for Planning and Infrastructure on 21 March 2014.

3.3.2 State Environmental Planning Policy (Coastal Management) 2018

This SEPP became operational 3 April 2018 and provided a consolidated planning instrument for land in the coastal zone. The SEPP is supported by interactive mapping for the coastal area and the maps identify that the site is located as being part of the *Coastal Environment Area*.

Clause 13 applies to the land and provides:

13 Development on land within the coastal environment area

(1) Development consent must not be granted to development on land that is within the coastal environment area unless the consent authority has considered whether the proposed development is likely to cause an adverse impact on the following:

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

(b) coastal environmental values and natural coastal processes,

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

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

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

(f) Aboriginal cultural heritage, practices and places,

(g) the use of the surf zone.

(2) Development consent must not be granted to development on land to which this clause applies unless the consent authority is satisfied that:

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

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

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

(3) This clause does not apply to land within the Foreshores and Waterways Area within the meaning of Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005.

Comment:

- The development has been designed to have no part of the sand mining activity footprint within the Coastal Zone and rehabilitation works that will be carried out will help restore the ecological environment, refer Diagram 3.1 below.
- Impacts on groundwater have been calculated and have been determined to be within acceptable ranges and this includes the expected impacts on a Groundwater Dependent Ecosystem to the immediate north of the mine and haul road.
- Water quality is expected to be maintained and a full regime of water monitoring bores is proposed for the life of the project to ensure that impacts on groundwater quality is maintained to the existing levels. Impacts on the marine estate are not expected as there will be no discharges from the lake to surrounding watrer bodies and the proposed activities are not adjacent to any Schedule 1 sensitive coastal lake.

- The development is not adjacent to any existing public beach, sensitive coastal lake, headland, rock platform, foreshore and surf zone.
- Impacts on Aboriginal Cultural Hertiage have been assessed and a full archaeological report has been included in this documentation.
- The development is not within the surf zone.
- It is also noted that the NSW Coastal Management Maps include a *Proximity Area for Coastal Wetlands* but the SEPP does not define aims or objectives that need to be considered for this map.

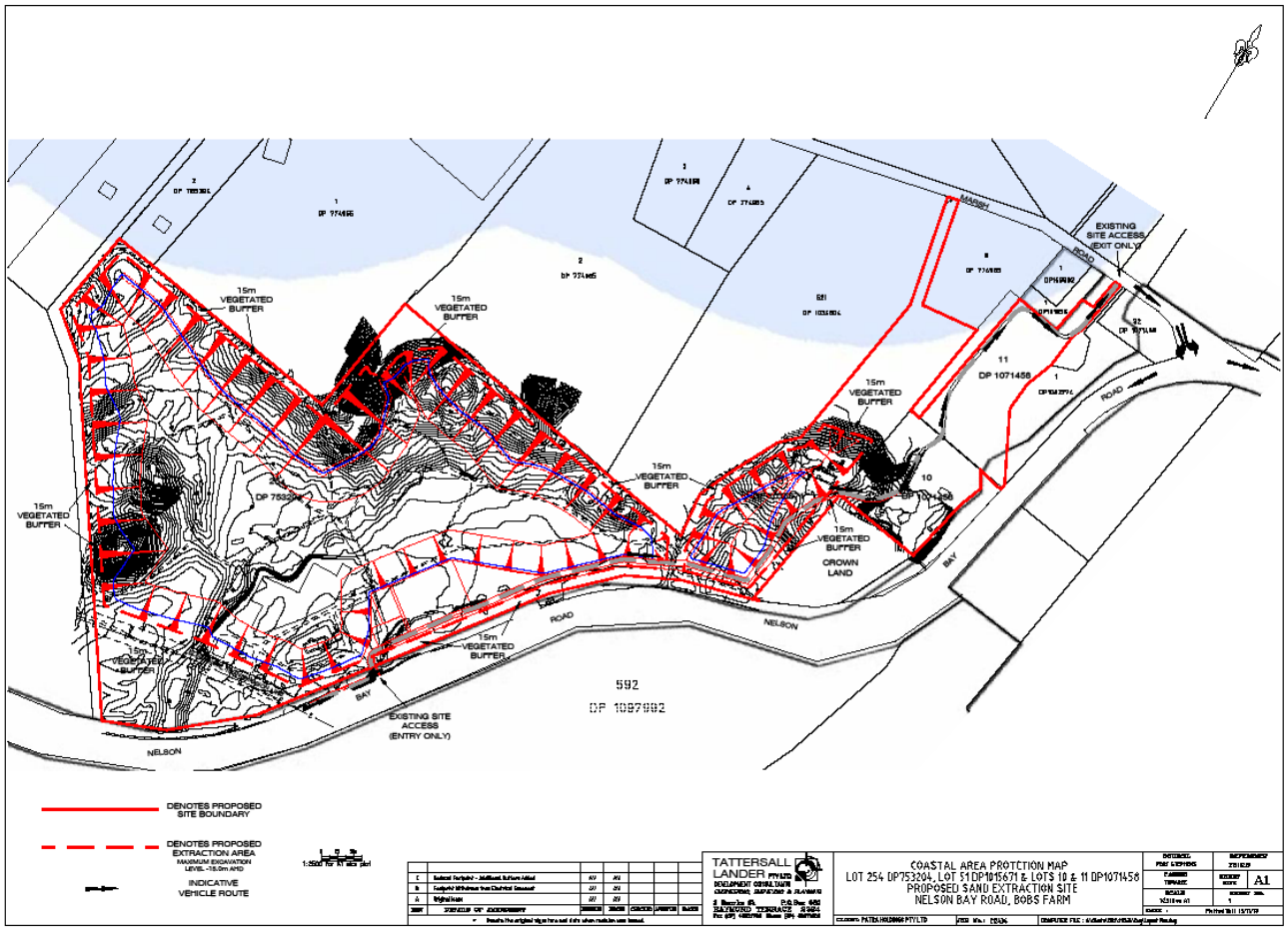


Diagram 3.1- Impact of the Coastal Area Protection Map on the Development Footprint.

3.3.3 SEPP Mining, Petroleum Production & Extractive Industries 2007

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

(a) to provide for the proper management and development of mineral, petroleum and extractive material resources for the purpose of promoting the social and economic welfare of the State, and

(b) to facilitate the orderly and economic use and development of land containing mineral, petroleum and extractive material resources, and

(b1) to promote the development of significant mineral resources, and

(c) to establish appropriate planning controls to encourage ecologically sustainable development through the environmental assessment, and sustainable management, of development of mineral, petroleum and extractive material resources, and

(d) to establish a gateway assessment process for certain mining and petroleum (oil and gas) development:

(i) to recognise the importance of agricultural resources, and

(ii) to ensure protection of strategic agricultural land and water resources, and

(iii) to ensure a balanced use of land by potentially competing industries, and

(iv) to provide for the sustainable growth of mining, petroleum and agricultural industries.

Discussion of the economic and sustainable development parameters of the proposal are discussed in Chapters 14 and 20 of this report.

Clause 7(3)(a) of SEPP (Mining, Petroleum Production and Extractive Industries) states:

Development for any of the following purposes may be carried out with development consent:

a. extractive industry on land on which development for the purposes of agriculture or industry may be carried out (with or without development consent).

Agriculture is permissible under the Port Stephens Local Environmental Plan RU2 zone with development consent. Therefore, under the provisions of Clause 7(3)(a) of SEPP (Mining, Petroleum Production and Extractive Industries), extractive industries are permitted with development consent within the site.

Part 3 of the policy identifies matters for consideration by the consent authority in determining an application for consent for development for the purposes of mining, petroleum production or extractive industries, including:

- Non-discretionary development standards.
- compatibility of proposed mine, petroleum production or extractive industry with other land uses;
- consideration of voluntary land acquisition and mitigation policy.
- natural resource management and environmental management;
- resource recovery;
- transport; and
- rehabilitation.

Table 3.3 identifies and discusses the relevant matters for consideration in assessment of the proposal as set out in Part 3 of the SEPP.

	Cumulative Noise Level	Compliance has been achieved with the INP, refer *Chapter 11* and *Annex J and K*

Clause 12 AB – Non – discretionary development standards	Cumulative Air Quality	Compliance has been achieved with OEH guidelines, *refer Chapter 12* and *Annex L*
	Airblast overpressure	Not relevant
	Ground Vibration	Compliance has been achieved with the INP, refer *Chapter 11* and *Annex J*
	Acqifer Interference	Refer *Chapter 7* and *Annex E*
Clause 12 – Compatibility with other land uses	Compatibility with other land uses	Sand extraction undertaken in similar areas within the locality since 1990, with few known complaints from adjoining landowners. The site is in a rural location. Surrounding land uses include low intensity rural farms, rural living and nature conservation. Sand extraction is permissible in the zone and modelling of dust and noise impacts on nearby residences meet the criteria set by Council and OEH. Therefore, the sand extraction extension is not likely to have a significant impact on other land uses in the locality.
Clause 12A	Voluntary Land Acquisition	Given that the significance criteria of OEH on nearby residences has been achieved, no acquisition is envisaged. However, should the mine operations exceed the standard criteria, the Policy requires that the voluntary acquisition is undertaken.
Clause 13	Compatibility of proposed development with mining, petroleum production or extractive industry	This proposed mine is not closely related to any other sand extraction operation. There are similar mining operations with the general locality.
Clause 14 - Natural resource management and environmental management	Significant impacts on water resources	Matters addresses in *Chapter 6 and 7* and *Annex E& F.*
	Impacts on Threatened Species	Matters addresses in *Chapter 14* and *Annex N.*
	Greenhouse Gas Emissions	Matters addresses in *Chapter 13* and *Annex M.*
Clause 15 – Resource Recovery	Resource Recovery	Extraction of sand will involve the removal of topsoil and overburden, which will then be stockpiled separately to enable immediate landscaping of the site once the silica sand has been removed. The sand extraction plan has been developed to ensure that resource recovery is maximised and there is minimal waste of resource in extraction and processing.

Clause 16 - Transport	Transport	The proposal will increase the truck movements along Nelson Bay Road. The capacity of the road has been assessed as being capable to accommodate the increase. There is no alternative to the use of trucks. The proposed routes have been chosen to ensure minimal road user conflict. Matters addressed in *Chapter 15* and *Annex O*.
Clause 17 - Rehabilitation	Rehabilitation	The area will be progressively rehabilitated. These works will be undertaken in accordance with a Site Rehabilitation Plan and regularly monitored. A discussion is provided in *Chapter 22*.

Table 3.3 - Matters for Consideration SEPP Mining, Petroleum Production & Extractive Industries 2007

3.3.4 SEPP 44 Koala Habitat Protection & Port Stephens Comprehensive Koala Plan Management

The aims of SEPP 44 are: "to encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas, to ensure permanent free-living populations over their present range and to reverse the current trend of population decline:

(a) by requiring the preparation of plans of management before development consent can be granted in relation to areas of core koala habitat;

(b) by encouraging the identification of areas of core koala habitat;

(c) by encouraging the inclusion of areas of core koala habitat in environment protection zones.

State Environmental Planning Policy No.44 – Koala Habitat Protection (SEPP 44) applies to the proposed development. The Port Stephens Comprehensive Koala Plan of Management (CKPoM) is an adopted Management Plan under the provisions of SEPP 44. Detailed reporting of the proposed development against the Port Stephens Comprehensive Koala Plan of Management is contained in Chapter X of the EIS.

No Koalas were directly observed within the study area during fieldwork completed for this report or previous reports (Wildthing Environmental Consultants, 2009). However, evidence of Koala activity in the form of characteristic scratches on the trunks of a very small number of specimens of *Eucalyptus robusta* (Swamp Mahogany), a preferred feed tree species under the Port Stephens Comprehensive Koala Plan of Management CKPoM, was present within the area of Swamp Forest in the far east of the study area. *Eucalyptus robusta* was the only preferred Koala Feed Tree Species recorded within the study area. No Koala faecal pellets were found within the study area despite a search beneath every individual specimen of *E.*

robusta (a total of 19 trees) and searches conducted over the entire study area during the hollow-bearing tree survey.

3.3.5 SEPP 33 Hazardous and Offensive Development

This Policy aims:

a) to amend the definitions of hazardous and offensive industries where used in environmental planning instruments, and

b) to render ineffective a provision of any environmental planning instrument that prohibits development for the purpose of a storage facility on the ground that the facility is hazardous or offensive if it is not a hazardous or offensive storage establishment as defined in this Policy, and

c) to require development consent for hazardous or offensive development proposed to be carried out in the Western Division, and

d) to ensure that in determining whether a development is a hazardous or offensive industry, any measures proposed to be employed to reduce the impact of the development are taken into account, and

e) to ensure that in considering any application to carry out potentially hazardous or offensive development, the consent authority has sufficient information to assess whether the development is hazardous or offensive and to impose conditions to reduce or minimise any adverse impact, and

f) to require the advertising of applications to carry out any such development.

Definitions of "potentially hazardous industry" and "potentially offensive industry" are as follows:

"potentially hazardous industry means a development for the purposes of any industry which, if the development were to operate without employing any measures (including, for example, isolation from existing or likely future development on other land) to reduce or minimise its impact in the locality or on the existing or likely future development on other land, would pose a significant risk in relation to the locality:

a) to human health, life or property, or
b) to the biophysical environment,

and includes a hazardous industry and a hazardous storage establishment".

"potentially offensive industry means a development for the purposes of an industry which, if the development were to operate without employing any measures (including, for example, isolation from existing or likely future development on other land) to reduce or minimise its impact in the locality or on the existing or likely future development on other land, would emit a polluting discharge (including for example, noise) in a manner which would have a significant adverse impact in the locality or on the existing or likely future development on other land, and includes an offensive industry and an offensive storage establishment".

Other potentially pertinent definitions which have been considered include:

"hazardous industry means a development for the purposes of an industry which, when the development is in operation and when all measures proposed to reduce or minimise its impact on the locality have been employed (including, for example, measures to isolate the development from existing or likely future development on other land in the locality), would pose a significant risk in relation to the locality:

a) to human health, life or property, or
b) to the biophysical environment".

"hazardous storage establishment means any establishment where goods, materials or products are stored which, when in operation and when all measures proposed to reduce or minimise its impact on the locality have been employed (including, for example, measures to isolate the establishment from existing or likely future development on the other land in the locality), would pose a significant risk in relation to the locality:

a) to human health, life or property, or
b) to the biophysical environment".

"offensive industry means a development for the purposes of an industry which, when the development is in operation and when all measures proposed to reduce or minimise its impact on the locality have been employed (including, for example, measures to isolate the development from existing or likely future development on other land in the locality), would emit a polluting discharge (including, for example, noise) in a manner which would have a significant adverse impact in the locality or on the existing or likely future development on other land in the locality".

"offensive storage establishment means any establishment where goods, materials or products are stored which, when in operation and when all measures proposed to reduce or minimise its impact on the locality have been employed (including, for example, measures to isolate the establishment from existing or likely future development on other land in the locality), would emit a polluting discharge (including, for example, noise) in a manner which would have a significant adverse impact in the locality or on the existing or likely future development on other land in the locality".

The proposed development is not considered to be characterised by any of the above land use definitions.

Bushfire considerations, public safety and transport considerations (as detailed by SEARs under the heading of 'Hazards') have been appropriately considered under relevant chapters of the EIS. As discussed with the Department of Planning & Environment (pers.comm. Genevieve Seed, DoPE, 3 September, 2018: 3:50 pm), the only other potential minimal 'hazards' on the site relate to the storage of glyphosate (Roundup) in the amount of 4 L (at a low-concentration containing glyphosate and 2 percent pelargonic.) and the provision of lime (calcium carbonate) at amounts relevant to neutralise and acidic soils if and as relevant.

3.3.6 SEPP Rural Lands 2008

State Environmental Planning Policy Rural Lands (2008) applies to all rural lands zoned RU1 to RU6 and Environment Protection Zones E1 to E4. These zonings cover descriptions and uses

described in Port Stephens LEP. The aims of the policy as outlined in Clause 2 are to, amongst other matters, facilitate the orderly and economic use and development of rural lands for rural and related purposes.

The SEPP operates under distinct principles, including:

a. the promotion and protection of opportunities for current and potential productive and sustainable economic activities in rural areas,

b. recognition of the importance of rural lands and agriculture and the changing nature of agriculture and of trends, demands and issues in agriculture in the area, region or State,

c. recognition of the significance of rural land uses to the State and rural communities, including the social and economic benefits of rural land use and development,

d. in planning for rural lands, to balance the social, economic and environmental interests of the community,

e. the identification and protection of natural resources, having regard to maintaining biodiversity, the protection of native vegetation, the importance of water resources and avoiding constrained land,

f. the provision of opportunities for rural lifestyle, settlement and housing that contribute to the social and economic welfare of rural communities,

g. the consideration of impacts on services and infrastructure and appropriate location when providing for rural housing,

h. ensuring consistency with any applicable regional strategy of the Department of Planning or any applicable local strategy endorsed by the Director-General.

As demonstrated in the preceding and following chapters of this EIS, the proposed sand extraction extension meets these principles.

3.4 REGIONAL ENVIRONMENT PLANS & POLICIES

3.4.1 Lower Hunter Regional Strategy

The Lower Hunter Regional Strategy outlines the provision of sufficient and appropriately located housing and employment lands to cater for the projected population growth for the Lower Hunter region to 2031. The Strategy does not contain specific controls that the proposed development must meet, but does include strategic outcomes to be achieved within the region. The Strategy identifies the site as an area containing non-coal extractive resources and does not identify any urban development within the area. The proposed sand extraction development is consistent with the Strategy.

3.5 LOCAL ENVIRONMENT PLANS

3.5.1 Port Stephens Local Environmental Plan 2013

Port Stephens Local Environmental Plan 2013 (LEP 2013) is the principal local environmental planning instrument governing land use in the Port Stephens LGA. LEP 2013 zones the site of the

application area as RU2 Rural Landscape, Figure 3.1 identifies the application area in relation to the zoning of the land.

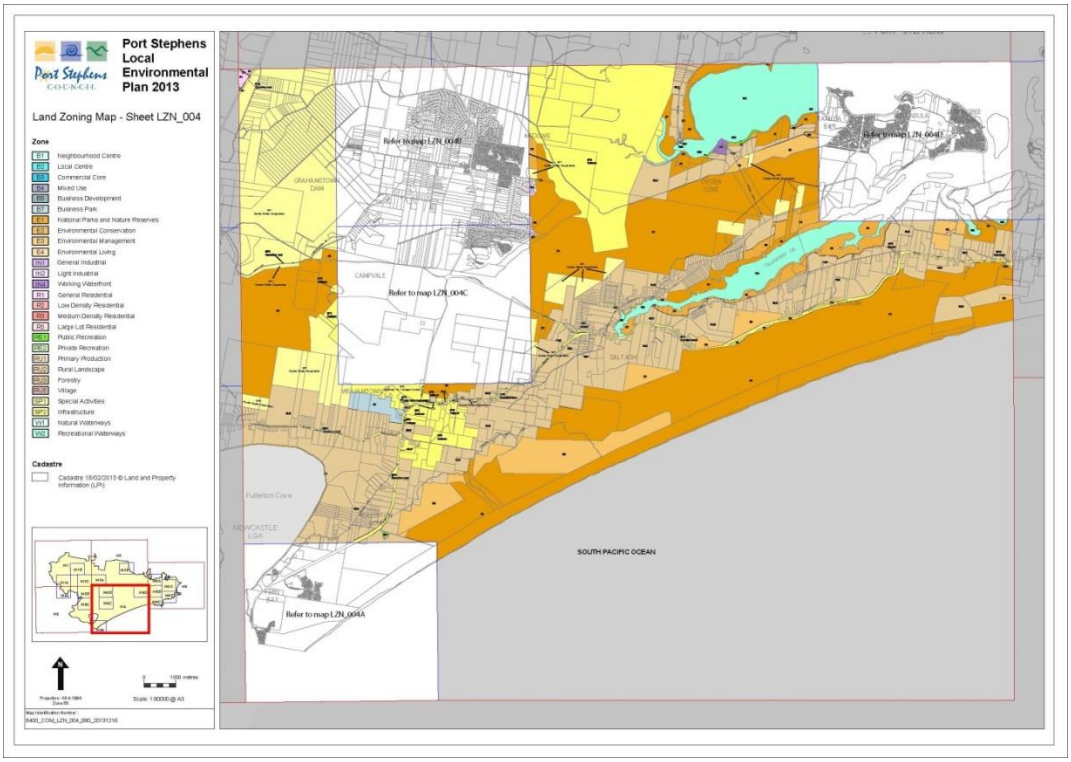


Figure 3.1 - LEP Zoning Map

The Aims, Objectives and controls for this zone are: -

1 Objectives of zone

- To encourage sustainable primary industry production by maintaining and enhancing the natural resource base.
- To maintain the rural landscape character of the land.
- To provide for a range of compatible land uses, including extensive agriculture.

2 Permitted without consent

Extensive agriculture; Home occupations; Intensive plant agriculture

3 Permitted with consent

Agriculture; Airstrips; Animal boarding or training establishments; Boat launching ramps; Boat sheds; Building identification signs; Business identification signs; Camping grounds; Cellar door premises; Cemeteries; Community facilities; Correctional centres; Crematoria; Dual occupancies; Dwelling houses; Eco-tourist facilities; Environmental facilities; Environmental protection works; **Extractive industries**; Farm buildings; Flood mitigation works; Forestry; Group homes; Helipads; Home-based child care; Home businesses; Home industries; Information and education facilities; Jetties; Landscaping material supplies; Plant nurseries; Recreation areas; Roads; Roadside stalls; Rural industries; Tourist and visitor accommodation; Turf farming; Veterinary hospitals; Water recreation structures; Water supply systems

4 Prohibited

Backpackers' accommodation; Hotel or motel accommodation; Serviced apartments; Any other development not specified in item 2 or 3

Extractive Industries is defined as: -

extractive industry means the winning or removal of extractive materials (otherwise than from a mine) by methods such as excavating, dredging, tunnelling or quarrying, including the storing, stockpiling or processing of extractive materials by methods such as recycling, washing, crushing, sawing or separating, but does not include turf farming.

Note. Extractive industries are not a type of **industry**—see the definition of that term in this Dictionary.

extractive material means sand, soil, gravel, rock or similar substances that are not minerals within the meaning of the Mining Act 1992.

The zoning of the land indicates that the activity is permissible.

Under Part of LEP 2013 consideration also needs to address Clause 5.5.

LEP Clause 5.5 Development within the coastal zone

(1) The objectives of this clause are as follows:

(a) to provide for the protection of the coastal environment of the State for the benefit of both present and future generations through promoting the principles of ecologically sustainable development,

(b) to implement the principles in the NSW Coastal Policy, and in particular to:

(ii) protect, enhance, maintain and restore the coastal environment, its associated ecosystems, ecological processes and biological diversity and its water quality, and

(iii) protect and preserve the natural, cultural, recreational and economic attributes of the NSW coast, and

(iv) provide opportunities for pedestrian public access to and along the coastal foreshore, and

(v) recognise and accommodate coastal processes and climate change, and

(vi) protect amenity and scenic quality, and

(vii) protect and preserve rock platforms, beach environments and beach amenity, and

(viii) protect and preserve native coastal vegetation, and

(ix) protect and preserve the marine environment, and

(x) ensure that the type, bulk, scale and size of development is appropriate for the location and protects and improves the natural scenic quality of the surrounding area, and

(xi) ensure that decisions in relation to new development consider the broader and cumulative impacts on the catchment, and

(xii) protect Aboriginal cultural places, values and customs, and

(xiii) protect and preserve items of heritage, archaeological or historical significance.

(2) Development consent must not be granted to development on land that is wholly or partly within the coastal zone unless the consent authority has considered:

(a) existing public access to and along the coastal foreshore for pedestrians (including persons with a disability) with a view to:

(i) maintaining existing public access and, where possible, improving that access, and

(ii) identifying opportunities for new public access, and

(b) the suitability of the proposed development, its relationship with the surrounding area and its impact on the natural scenic quality, taking into account:

(i) the type of the proposed development and any associated land uses or activities (including compatibility of any land-based and water-based coastal activities), and

(ii) the location, and

(iii) the bulk, scale, size and overall built form design of any building or work involved, and

(c) the impact of the proposed development on the amenity of the coastal foreshore including:

(i) any significant overshadowing of the coastal foreshore, and

(ii) any loss of views from a public place to the coastal foreshore, and

(d) how the visual amenity and scenic qualities of the coast, including coastal headlands, can be protected, and

(e) how biodiversity and ecosystems, including:

(i) native coastal vegetation and existing wildlife corridors, and
(ii) rock platforms, and
(iii) water quality of coastal waterbodies, and
(iv) native fauna and native flora, and their habitats,

can be conserved, and

(f) the cumulative impacts of the proposed development and other development on the coastal catchment.

(3) Development consent must not be granted to development on land that is wholly or partly within the coastal zone unless the consent authority is satisfied that:

(a) the proposed development will not impede or diminish, where practicable, the physical, land-based right of access of the public to or along the coastal foreshore, and

(b) if effluent from the development is disposed of by a non-reticulated system, it will not have a negative effect on the water quality of the sea, or any beach, estuary, coastal lake, coastal creek or other similar body of water, or a rock platform, and

(c) the proposed development will not discharge untreated stormwater into the sea, or any beach, estuary, coastal lake, coastal creek or other similar body of water, or a rock platform, and

(d) the proposed development will not:

(i) be significantly affected by coastal hazards, or

(ii) have a significant impact on coastal hazards, or

(iii) increase the risk of coastal hazards in relation to any other land.

In addition, Part 7 of LEP 2013 requires consideration of Acid Sulphate Soils

LEP Clause 7.1 Acid sulfate soils

(1) The objective of this clause is to ensure that development does not disturb, expose or drain acid sulfate soils and cause environmental damage.

(2) Development consent is required for the carrying out of works described in the Table to this subclause on land shown on the Acid Sulfate Soils Map as being of the class specified for those works.

Class of land	Works
1	Any works.
2	Works below the natural ground surface. Works by which the watertable is likely to be lowered.
3	Works more than 1 metre below the natural ground surface. Works by which the watertable is likely to be lowered more than 1 metre below the natural ground surface.
4	Works more than 2 metres below the natural ground surface. Works by which the watertable is likely to be lowered more than 2 metres below the natural ground surface.
5	Works within 500 metres of adjacent Class 1, 2, 3 or 4 land that is below 5 metres Australian Height Datum and by which the watertable is likely to be lowered below 1 metre Australian Height Datum on adjacent Class 1, 2, 3 or 4 land.

(3) Development consent must not be granted under this clause for the carrying out of works unless an acid sulfate soils management plan has been prepared for the proposed works in accordance with the Acid Sulfate Soils Manual and has been provided to the consent authority.

(4) Despite subclause (2), development consent is not required under this clause for the carrying out of works if:

(a) a preliminary assessment of the proposed works prepared in accordance with the Acid Sulfate Soils Manual indicates that an acid sulfate soils management plan is not required for the works, and

(b) the preliminary assessment has been provided to the consent authority and the consent authority has confirmed the assessment by notice in writing to the person proposing to carry out the works.

(5) Despite subclause (2), development consent is not required under this clause for the carrying out of any of the following works by a public authority (including ancillary work such as excavation, construction of access ways or the supply of power):

(a) emergency work, being the repair or replacement of the works of the public authority, required to be carried out urgently because the works have been damaged, have ceased to function or pose a risk to the environment or to public health and safety,

(b) routine maintenance work, being the periodic inspection, cleaning, repair or replacement of the works of the public authority (other than work that involves the disturbance of more than 1 tonne of soil),

(c) minor work, being work that costs less than $20,000 (other than drainage work).

(6) Despite subclause (2), development consent is not required under this clause to carry out any works if:

(a) the works involve the disturbance of less than 1 tonne of soil, and

(b) the works are not likely to lower the watertable.

The site is mapped as partly Class 3 and 4 within the ASS Maps. The area mapped as Class 3 will not be subjected any mining activity. Development consent is required for the mining operation below 2m below the natural surface.

A detailed preliminary assessment of the Acid Sulphate Soils (ASS) and Potential Acid Sulphate Soils (PASS) has been undertaken and is further addressed in *Chapters 5 and 7* and *Annex E and G*.

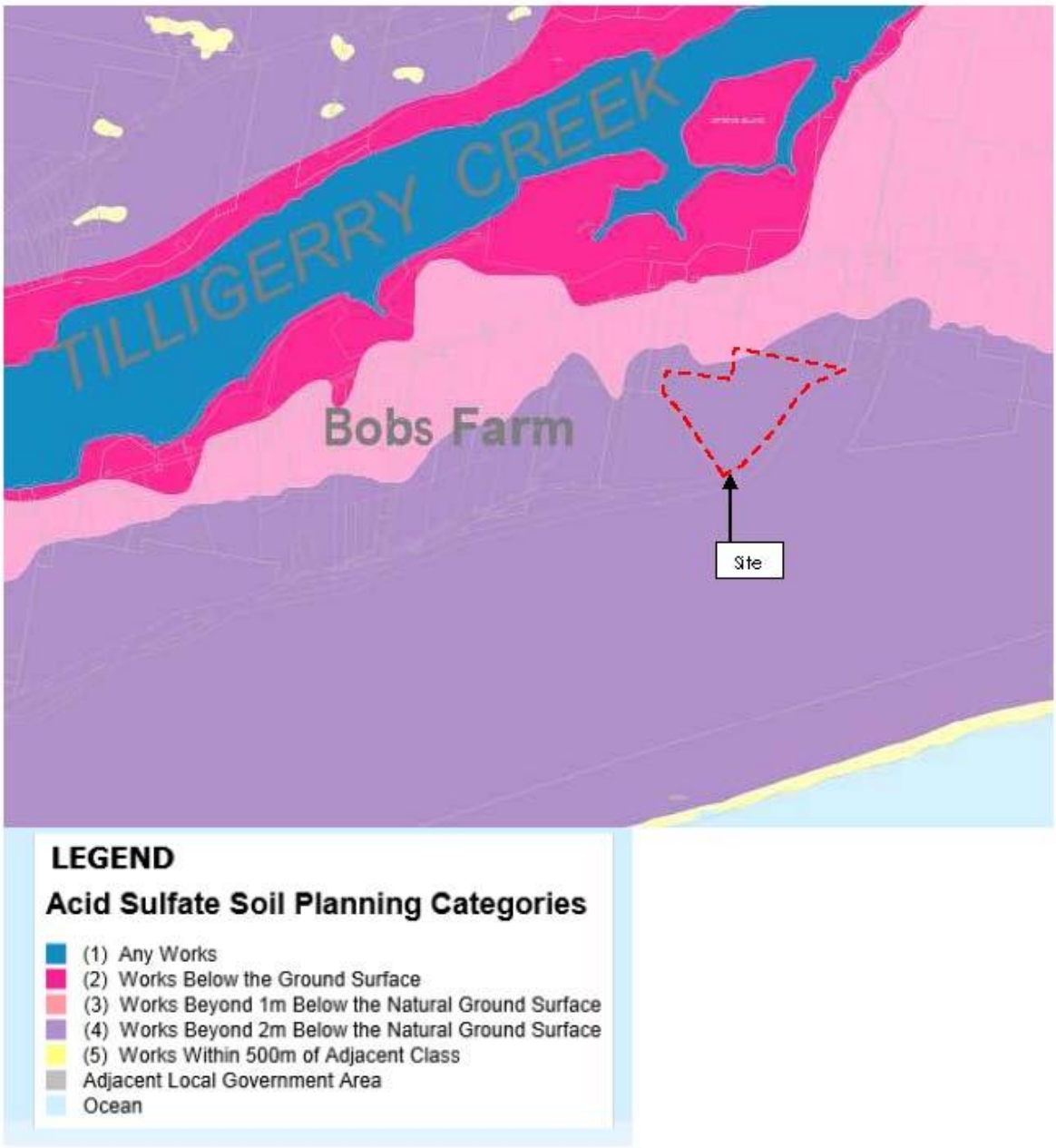


Figure 3.2 - Acid Sulphate Soils LEP Mapping

ASS and PASS have not been detected generally above and adjacent to the water table and therefore the Stage 1 works >1m above the water table will not require the preparation of an Acid Sulphate Soils Management Plan.

An ASSMP will be prepared for the Stage 2 and 3 works that will intercept the water table. Note that only soils at or in close proximity of the existing water table have been assessed as being PSAA with all sands at lower depths being clear.

3.6 SUMMARY OF LICENCES & APPROVALS REQUIRED

The following approvals and licenses are required for the proposed development:

- approval as State Significant Development under the *Environmental Planning & Assessment Act 1979*;

- Environmental Protection Licence by virtue of Section 48 and Schedule 1 of the *Protection of the Operations Act 1997*; and
- Aquifer Interference Licence pursuant to section 91(3) of the *Water Management Act 2000*.

4 STAKEHOLDER CONSULTATION

4.1 CONSULTATION WITH GOVERNMENT AUTHORITIES

For the purposes of the development, the following are considered stakeholders:

- Adjoining land owners
- The wider Bobs Farm community
- Relevant Bobs Farm Community Group(s)
- Bobs Farm Primary School
- Relevant Aboriginal individuals, communities and associations
- Persons with connections to any European heritage considerations relevant to the site
- Council
- Local Businesses
- Statutory and non-statutory agencies, HWC, Ausgrid

With any commencement of on-site operations, the stakeholder group will be expanded to include:

- Mining Company employees
- Company Management
- Shareholders, if appropriate.

4.2 CONSULTATION WITH THE LOCAL COMMUNITY

4.2.1 Public Meeting

A Public Meeting was facilitated by Tattersall Lander to discuss the development proposal. Stakeholders were advised by Public Notice of the intention to hold the Public Meeting. Public Notice was given by way of advertisement in the Public Notes section of the Port Stephens Examiner; the date of publication being 20 November, 2014.



Plate 4-1 - Director Tattersall Lander (Bob Lander) during presentation to the Public Meeting on 25 November, 2014

64 residents/stakeholders recorded their attendance at the community meeting held at Bobs Farm Community Hall on 25 November, 2014.

Locational representation of public meeting attendees, including business owners, features below.

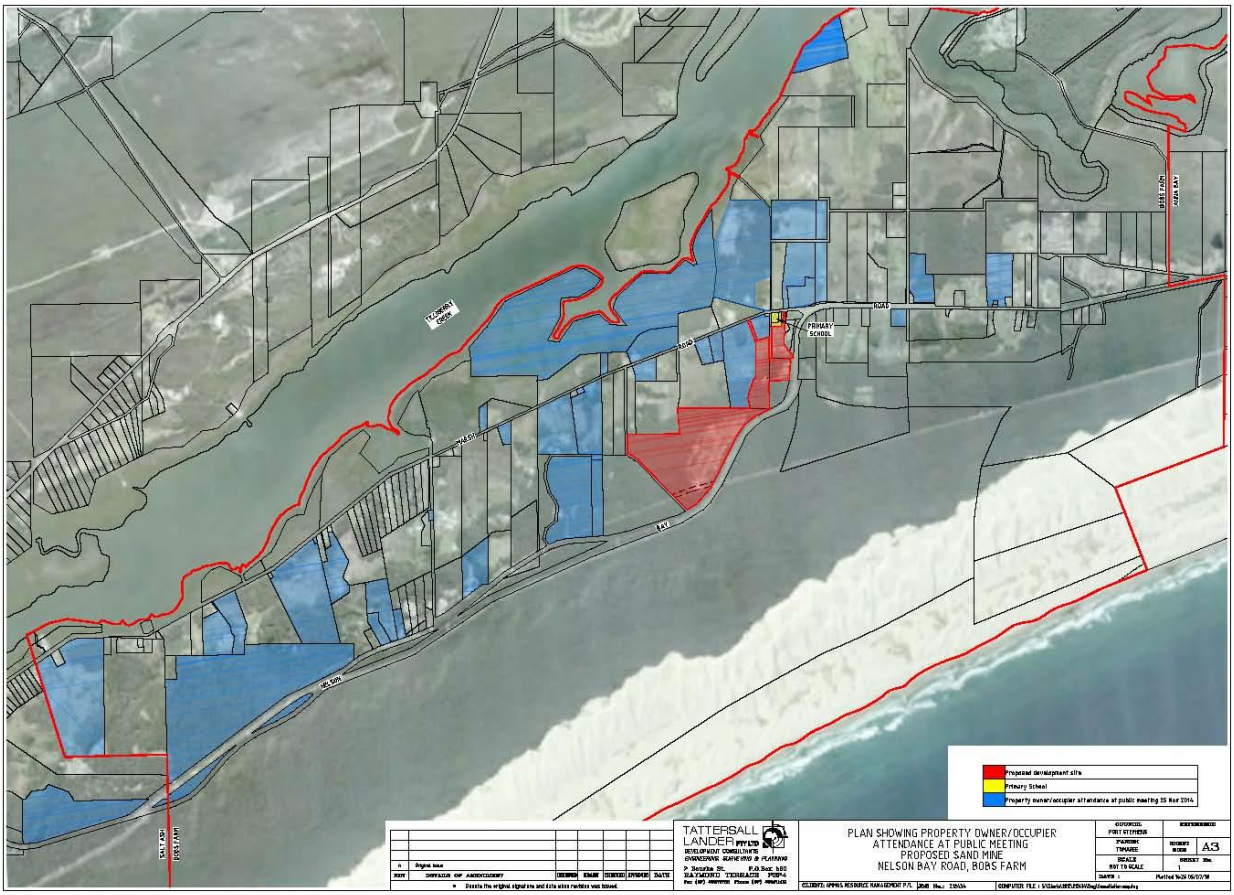


Figure 4-1 - Addresses of Recorded Attendees at Public Meeting 25 November, 2014 and Locational Relationship to Proposed Development Site and Primary School

Suburb/Township	Number of Attendees
Corlette	3
Anna Bay	2
Salt Ash	1
Newcastle	1
Warners Bay	1
Toongabbie	1

Table 4-1- Recorded Attendees not from Bobs Farm or Immediate Locality

A full copy of the public presentation given by Tattersall Lander at the Public Meeting is included in the Annexures.

A further meeting was held with the community on the 10th October 2018 at the Bobs Farm Community Hall. 42 people recorded their details as being at the meeting. Issues raised at this and the 2014 meeting have been tabulated and considered in Annex B.

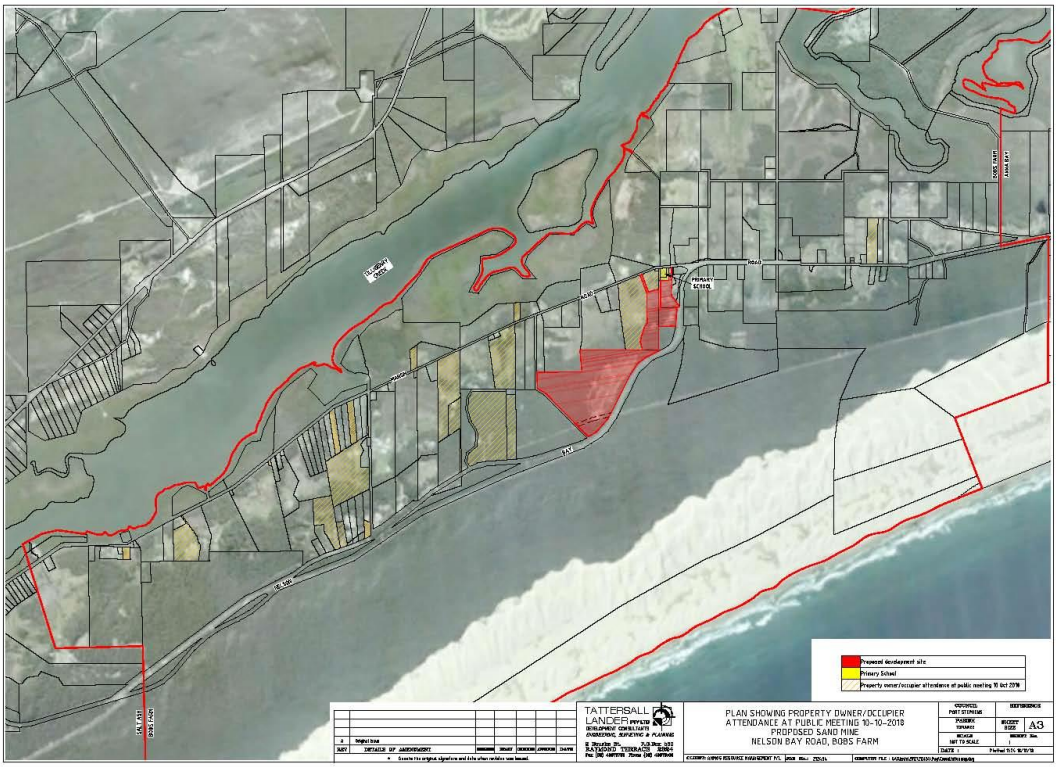


Figure 4-2 - Addresses of Recorded Attendees at Public Meeting 10th October 2018 and Locational Relationship to Proposed Development Site and Primary School

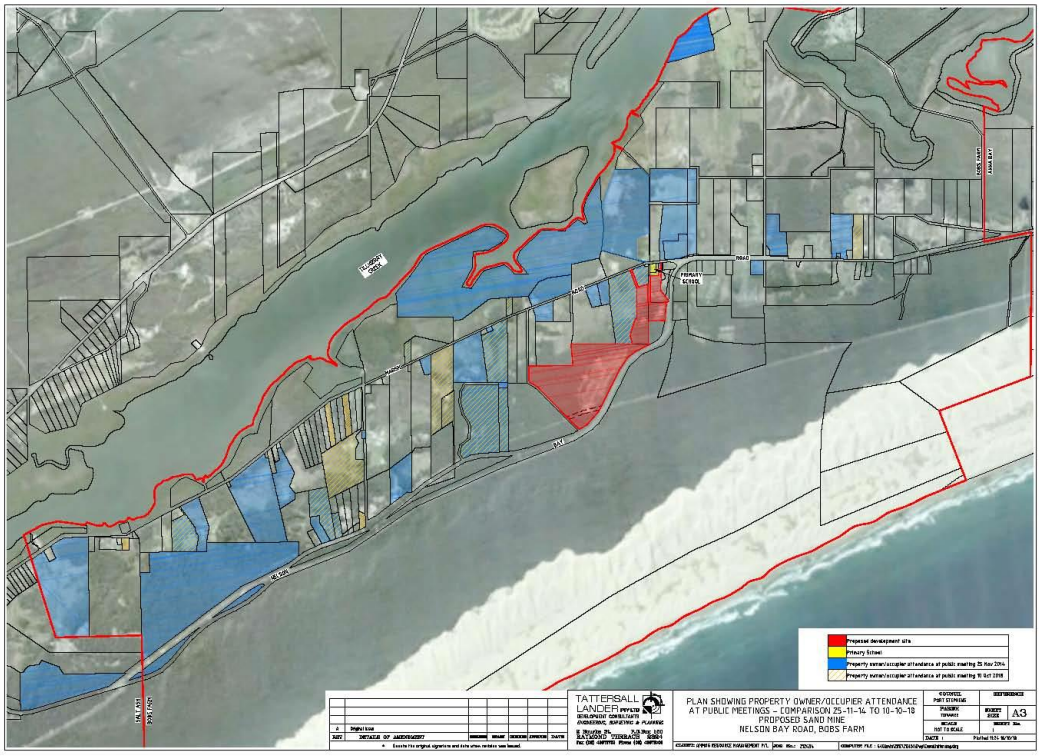


Figure 4-3 – Attemndance Comparison 2014-2018 Recorded Attendees at Public Meetings and Locational Relationship to Proposed Development Site and Primary School

4.3 CONSULTATION WITH THE ABORIGINAL COMMUNITY

4.3.1 Consultation with the Aboriginal Community

The active involvement and input of the local Aboriginal community is an essential part of any Cultural Heritage Assessment. Consultation with the Aboriginal community will be an ongoing operational part through the life of this development. Specific details of the engagement of the Registered Aboriginal Parties and their involvement in the Cultural Heritage Assessment is contained in the Annexures.

4.4 CONSULTATION WITH AGENCIES

Consultation has been undertaken will all relevant Departments and Agencies. A Contacts Register has been prepared and is included in Annex B.

5 LANDFORM, GEOLOGY & SOILS

Chapter Five discusses the general landforms and geology of the region as well as Acid Sulphate Soils and landform stability.

5.1 REGIONAL LANDFORM & GEOLOGY

According to the regional geological map (Newcastle 1:250,000 Geological Series Sheet S1 56-2 First Edition - 1966), the site is underlain by Permian gravel, sand, silt, clay, 'Waterloo Rock', marine and freshwater deposits. The Stockton Dune lies on the Tomaree Peninsula/ Headland which is a relatively low-lying coastal area characterised by extensive unconsolidated sand dunes and estuarine deposits. Local hills are dominated by rocky outcrops that are acid volcanic and sedimentary (Carboniferous) in origin and are located mainly at Nelson Bay to the east at the end of the peninsula. To the north of the deposit lies Tilligerry Creek and the Tilligerry Peninsula, another source of sand mining activity on the Inner Barrier.

Marine, aeolian and estuarine sands and mud deposits dominate the coastal margin in this location. The site lies in the northern part of the Holocene deposits that began to form about 6500 years ago. The sandbeds are east-northeast trending sand ridges comprised of two barriers: the Inner Barrier (Tomago Sand Beds) and the Outer Barrier (Stockton Sand Beds). The site is located on the Outer Barrier, which extends from east of Tomago to the Tomaree Peninsula

The site consists of a series of rounded dunes of varying heights separated by lower areas with significant sand deposits, laid down by wind and marine processes. The rounded beach dune ridges have been reworked through aeolian processes in the late Quaternary into a series of discontinuous parabolic, longitudinal and transgressive dunes. Dune depth and heights vary considerably from relatively lower levels around ~10m AHD to high dunes up to 30 m AHD in height.

The base of the economic sand resource is limited to the technical ability of a dredge to win material and this has been set at ~-15m AHD. The stratigraphy of the sandbeds is described in Table 5.1 below: -

Table 5.1 - Details the layers thickness with depth across the Bobs Farm site.

Hole Number	Upper Grey Sand Unit (RL m)	Blonde Sand Unit (RL m)	Black Palaeosol Unit (RL m)	Lower grey Sand (RL m)	Hole Depth (m)
BH 1	5.8 – 4.8	4.8 – 2.0	2.2 – 1.3		19.00
BH 2	11.7 – 6.8	6.8 – 1.2	1.2 - -0.3	-0.3- -14.8	26.50
BH 3	15.4– 12.4	12.4 – 0.0	0.0 - -1.4	-1.4- -11.9	26.50
BH 4			2.8 – 1.9	1.9 -	24.00
BH 5					26.50

Table 5.1 - Depths of Sand Thicknesses

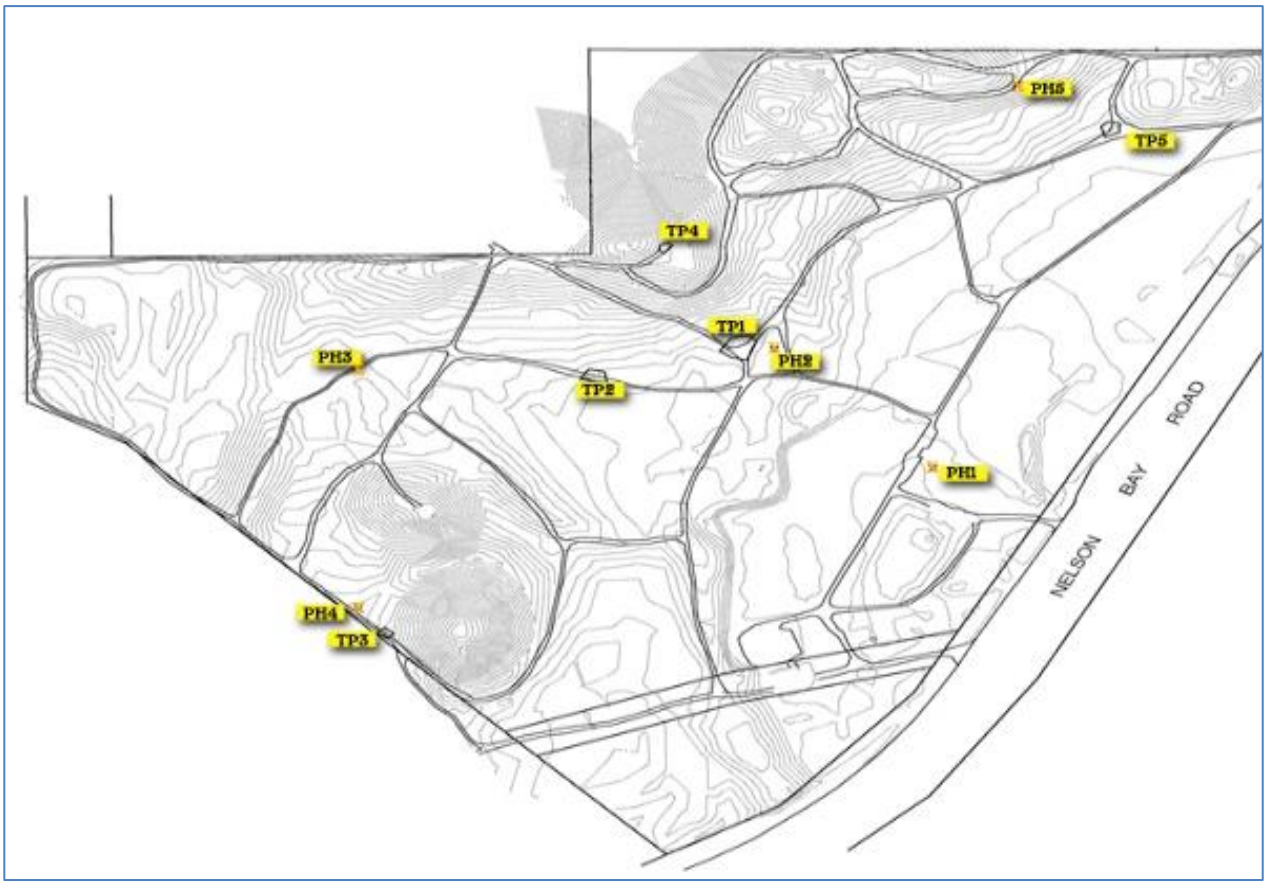


Figure 5.1 - Location of Boreholes and Test Pits

5.2 ACID SULFATE SOILS

Potential Acid Sulfate Soils (PASS) are naturally occurring sediments and soils containing iron sulfides (principally pyrite) and/or their precursors or oxidation products. The exposure of the sulfides to oxygen by drainage or excavation leads to the generation of sulfuric acid (Stone et al, 1998) and formation of actual Acid Sulfate Soils (ASS).

Most commonly PASS occur on estuarine soils and marine sediments, that are waterlogged and subject to reducing conditions. Although PASS is concentrated in coastal environments, there is potential for other acid sulfate materials (for example, rocks containing sulphide minerals) to have wider distribution in the landscape. If disturbed, all forms of acid sulfate materials can cause unacceptable environmental impacts, including acidification of waterways, major fish kills, habitat destruction, loss of agricultural productivity, geotechnical instability and corrosion of concrete and steel structures.

Previously Port Stephens Council's Acid Sulfate Soils Policy (PSC, 2004) (the "ASS Policy") outlined Council's policy for managing any potential disturbance of acid sulfate soils within the Port Stephens LGA. LEP 2013 now contains the relevant controls and these have been discussed in Section 3.5.1 above. The LEP refers to the Port Stephens Acid Sulfate Soil Planning Maps (the "ASS Map") which places all lands within the LGA into one of five risk-based classes for planning purposes which are further described in the ASS Policy controls within the LEP.

As discussed in Section 3.5.1, the site is generally on Class 4 land. A small section of Cklass 3 land has been excluded from the general mining activity. Under the ASS Policy, development consent would normally be required for works more than 2 m below the natural ground surface;

or, works likely to lower the watertable to a depth of more than 2 m below the natural ground surface. Under the proposal extraction would occur to depths greater than 2 m below the natural ground surface; and Stages 2 and 3 of the operation and involving the dredge, the lowering of the water table will occur.

Considering the above, the proposed development is likely to present an environmental risk as a result of the presence of ASS.

The proposed Stage 1 extraction operations are not expected to encounter or disturb PASS, nor lower the water table on adjacent lands to expose PASS to oxidation for the following reasons:

- the site occurs at elevations of between about 10 m and 30 m AHD, well above the elevations where coastal ASS are usually found (<2 m AHD on marine or estuarine sediments). The lowest extraction depth would be approximately 3 m AHD;
- the site soils comprise aeolian (wind blown) sands and do not possess the requisite conditions for formation of PASS. The soils are well drained and occur above the watertable, in an oxidising environment; and
- extraction would maintain a 1 m vertical buffer to the level of the predicted maximum watertable. This will minimise any potential impacts on groundwater levels.

5.2.1 Expected Subsoil Conditions

VGT & Quarry Mining Systems Pty Ltd (QMS) in August, 2013, drilled and sampled five boreholes (BH1 to BH5) to a target depth of 16 m below the groundwater table. The boreholes were converted to wells upon completion. An additional 5 test pits (TP1 to TP5) were excavated but did not reach their target depth due to significant soil cave-in during excavation. Borehole/well and test pit locations are provided in Figure 5.1. The main objective of the boreholes/test pits was to assess sand quality changes with depth across the site and whether retrieval and subsequent processing of the sand would be commercially viable and sustainable.

The soil profile at the site was divided by VGT & QMS (2013) into five major units:

- Unit 1: Organic Topsoil
- Unit 2: Mottled Sand (Upper Grey Sand)
- Unit 3: Blonde Sand
- Unit 4: Sand/Black Dark Mud
- Unit 5: Lower Grey Sand

Unit	Layer[1]	Depth (m BGL[2]) *Elevation (m AHD)*																							
		BH101[3]		BH102[3]		BH103[3]		BH104[3]		BH105[3]		BH106[3]		BH107[3]		BH108[3]		BH1[3]		BH2[4]		BH3[4]		BH4[4]		BH5	
Unit 1: Topsoil	SAND with Organics – Grey	0.0	***11.0***	0.0	***5.0***	0.0	***10.0***	0.0	***29.0***	0.0	***12.0***	0.0	***20.0***	0.0	***6.0***	0.0	***6.0***	0.0	***5.8***	0.0	***11.7***	0.0	***15.5***	0.0	***9.5***	0.0	***18.2***
Unit 2: Aeolian Sand	SAND: Light Grey/Grey	0.2	***10.8***	0.3	***4.7***	0.2	***9.8***	0.2	***28.8***	0.3	***11.7***	0.3	***19.7***	NE	***NE***	0.4	***5.6***	NE	***NE***	0.5	***11.2***	0.3	***15.2***	0.2	***9.3***	NE	***NE***
Unit 3: Aeolian Sand	SAND: Orange/ Brown	1.5	***9.5***	2.0	***3.0***	0.9	***9.1***	1.2	***27.8***	1.5	***10.5***	NE	***NE***	NE	***NE***	1.0	***5.0***	1.0	***4.8***	3.5	***8.2***	1.0	***14.5***	NE	***NE***	1.0	***17.2***
	SAND: Yellow/Brown	NE	***NE***	NE	***NE***	NE	***NE***	3.5	***25.5***	NE	***NE***	2.5	***17.5***	0.2	***5.8***	NE	***NE***	NE	***NE***	5.0	***6.7***	4.0	***11.5***	3.0	***6.5***	5.5	***12.7***
	SAND: Light Yellow/White	4.5	***6.5***	3.5	***1.5***	4.8	***5.2***	7.0	***22.0***	3.0	***9.0***	NE	***NE***	NE	***NE***	NE	***NE***	NE	***NE***	NE	***NE***	14.0	***1.5***	NE	***NE***	19.5	***-1.3***
Unit 4: Marine Organic Sand	CLAYEY SAND/CLAY with Organics: – Dark Brown/Grey/ Black	NE	***NE***	4.9	***0.1***	8.0	***2.0***	NE	***NE***	NE	***NE***	NE	***NE***	NE	***NE***	NE	***NE***	3.8	***2.0***	10.5	***1.2***	14.5	***1.0***	5.6	***3.9***	20.0	***-1.8***
	Water Table	11.0	***0.0***	3.5	***2.5***	6.8	***2.2***	NE	***NE***	NE	***NE***	NE	***NE***	4.5	***1.5***	3.5	***2.5***	3.5	***2.3***	10.2	***1.5***	13.2	***2.3***	7.3	***2.2***	15.4	***2.8***
Unit 5: Marine Sand	SAND: Light Brown/Grey	NE	***NE***	6.5	***-1.5***	8.5	***1.5***	NE	***NE***	NE	***NE***	NE	***NE***	4.0	***2.0***	3.5	***2.5***	4.5	***1.3***	NE	***NE***	NE	***NE***	6.5	***3.0***	22.6	***-4.4***
	SAND: Lower Grey Bands	NE	***NE***	NE	***NE***	NE	***NE***	NE	***NE***	NE	***NE***	NE	***NE***	NE	***NE***	6.0	***0.0***	6.0	***-0.2***	12.0	***-0.3***	16.0	***-0.5***	11.5	***-2.0***	23.5	***-5.3***
Borehole Depth		13.0	***-2.0***	10.0	***-5.0***	10.0	***0.0***	10.0	***19.0***	10.0	***2.0***	10.0	***10.0***	10.0	***-4.0***	13.0	***-7.0***	19.0	***-13.2***	26.5	***-14.8***	26.5	***-11.0***	24.0	***-14.5***	26.5	***-8.3***

Notes:
[1] Based on visual assessment of drilling spoil. Refer to borehole logs (Appendix C) for more detailed descriptions.
[2] Approximate depths in metres below ground level to top of layer and elevation (RL) of Surface level at borehole location approximated from survey plan; boreholes not surveyed.
[3] Borehole drilled by MA (2014).
[4] Borehole drilled by QMS (2014).
NE = Not encountered or included in bordering unit.

Table 5.2 - Summary of inferred soil profiles at borehole locations drilled by Quarry Mining Systems Pty Ltd (2013) and Martens and Associates (2014)

Results of laboratory testing of soil samples selected by VGT & QMS (2013) indicate:

- Site sands are generally subrounded to rounded with moderately high sphericity.
- Soil acidity ranges from slight to extreme.
- Soil salinity is generally low, apart from 3 samples collected from below the water table: BH1-BL-G1-SO 0.5, a moderately saline sand sampled from BH1; BH5-M-SO 0.633, an extremely saline clay sampled from BH5; and BH2-10.5-12.0-SO 0.7, a very highly saline clay sampled from BH2.
- The level of exchangeable sodium and soil sodicity is generally high, indicating that where clay soils occur, they are prone to dispersion.

A preliminary ASS assessment was completed by MA (2014) to assess the presence of AASS or PASS at the site. A total of 27 soil samples, collected by VGT & QMS from three boreholes (BH3, BH4 and BH5), were selected by MA for sPOCAS testing. The samples covered a range of locations and depths (refer **Table 5.3**). In addition, groundwater samples were collected from each groundwater monitoring well (BH1 to BH5) for sPOCAS testing.

BH	Samples Analysed	Surface Elevation	Upper Sample Elevation (m AHD)	Lower Sample
BH3	8	15.48	12.5	-13
BH4	8	9.45	5.5	-13.5
BH5	11	18.25	8.5	-7.5

Table 5.3 - Summary of samples analysed by laboratory for sPOCAS

Laboratory certificates for previous sPOCAS testing are provided in Annex G, with results summarised in **Table 5.4 below**.

Sample ID	Sample Depth (mAHD) [2]	Material Type [1]	pH_{KCL} [3]	pH_{ox} [3]	TPA (mol H+/t) [4]	TSA (mol H+/t) [5]	S_{POS} (%) [6]	Assessment [7]	Recommended Liming Rate [9] (kg $CaCO_3$/t)
Assessment Criteria		(F) Fine grained. > 40 % clay.	≤ 4 = AASS	< 3.5 = PASS pHK_{CL}-pH_{OX}>1 = PASS	62	62	0.100	TPA, TSA, S_{POS} > criteria = PASS. Exposed soil >1000t, used coarse grained material criteria.	
		(M) Medium grained. 5-40 % clay.			36	36	0.060		
		(C) Coarse grained. < 5 % Clay.			18	18	0.030		
3897/101/2.5	8.5	C	5.0	4.4	5	5	0.005	NA	<0.75
3897/101/8.5	2.5	C	5.6	4.3	5	5	0.005	NA	<0.75
3897/101/13.0	-2.0	C	5.4	5.7	5	5	0.005	NA	<0.75
3897/102/2.5	2.5	C	4.6	3.5	5	5	0.005	NA	0.9
3897/102/5.0	0.0	M	4.8	2.1	190	180	0.260	PASS	13
3897/102/7.0	-2.0	C	5.1	2.7	47	40	0.100	PASS	5
3897/103/2.5	7.5	C	5.4	4.2	5	5	0.005	NA	<0.75
3897/103/8.0	1.0	C	5.0	2.5	25	20	0.050	PASS	2.6
3897/103/10.0	0.0	C	5.4	3.3	12	10	0.040	PASS	2.1
3897/104/2.5	26.5	C	5.0	4.5	5	5	0.005	NA	<0.75
3897/104/10.0	19.0	C	5.7	5.0	5	5	0.005	NA	<0.75
3897/105/2.5	9.5	C	5.2	3.9	5	5	0.005	NA	<0.75
3897/105/10.0	2.0	C	5.5	5.5	5	5	0.005	NA	<0.75
3897/106/5.5	14.5	C	5.6	5.1	5	5	0.005	NA	<0.75
3897/106/10.0	10.0	C	5.2	4.7	5	5	0.005	NA	<0.75
3897/107/5.5	0.5	C	5.2	6.3	5	5	0.005	NA	<0.75
3897/107/10.0	-4.0	C	5.2	4.0	5	5	0.005	NA	<0.75
3897/108/2.5	3.5	C	4.5	3.4	22	12	0.005	PASS	0.75
3897/108/5.5	0.5	C	5.3	5.2	5	5	0.010	NA	0.93
3897/108/8.5	-2.5	C	5.2	2.8	35	30	0.060	PASS	3.1
3897/108/13.0	-7.0	C	5.2	2.8	35	32	0.050	PASS	2.8
3897/BH03/+12.5 to +11.5	+12.5 to +11.5	C	4.8	3.9	30	20	<0.005	PASS	0.75
3897/BH03/+6.5 to +5.5	+6.5 to +5.5	C	5.4	4.5	<5	<5	<0.005	NA	<0.75
3897/BH03/+1.5 to +0.5	+1.5 to +0.5	F	5.6	4.5	<5	<5	<0.005	NA	<0.75
3897/BH03/-0.5 to -1.1	-0.5 to -1.1	C	5.6	4.4	10	7	<0.005	NA	<0.75
3897/BH03/-1.3 to -1.5	-1.3 to -1.5	C	5.4	3.2	250	240	0.080	PASS	4.6
3897/BH03/-1.3	-1.3	C	5.2	2.7	460	450	0.130	PASS	7
3897/BH03/-3.1	-3.1	C	4.5	2.3	360	340	0.510	PASS	25
3897/BH03/-13	-13.0	C	5.3	3.3	27	25	0.030	PASS	1.5
3897/BH04/+5.5 to +3.0	+5.5 to +3.0	C	5.2	4.3	17	12	<0.005	NA	<0.75
3897/BH04/+3.3 to +2.5	+3.3 to +2.5	C	5.3	4.5	17	15	<0.005	NA	<0.75
3897/BH04/+0.8 to +0.5	+0.8 to +0.5	C	4.9	3.8	37	27	<0.005	PASS	0.75
3897/BH04/-0.5 to -1.5	-0.5 to -1.5	C	5.3	4.4	12	7	<0.005	NA	<0.75
3897/BH04/-2.5 to -3.0	-2.5 to -3.0	C	5.5	4.4	17	16	<0.005	NA	<0.75
3897/BH04/-6.0 to -7.5	-6.0 to -7.5	C	5.3	3.4	27	26	0.020	PASS	1.2
3897/BH04/-11.0 to -13.5	-11.0 to -13.5	C	5.4	3.8	20	19	0.020	PASS	0.93
3897/BH04/-13.5 to -12.1	-13.5 to -12.1	C	5.4	3.7	20	17	0.020	NA	0.92
3897/BH05/+2.0 to +1.0	+2.0 to +1.0	C	5.5	4.5	12	10	<0.005	NA	<0.75
3897/BH05/+0.0 to -0.5	+0.0 to -0.5	C	4.4	3.4	47	40	<0.005	PASS	<0.75
3897/BH05/+0.0 to -1.0	+0.0 to -1.0	C	5.3	4.5	7	<5	<0.005	NA	<0.75
3897/BH05/-1.1 to -1.5	-1.1 to -1.5	C	5.7	4.5	5	<5	<0.005	NA	<0.75
3897/BH05/-1.5 to -2.0	-1.5 to -2.0	F	5.6	4.6	<5	<5	<0.005	NA	<0.75
3897/BH05/-2.5 to -3.0	-2.5 to -3.0	F	5.6	4.4	<5	<5	<0.005	NA	<0.75
3897/BH05/-5	-5.0	C	5.9	2.2	1500	1500	2.6	PASS	120
3897/BH05/-5.5	-5.5	C	7.9	4.1	120	120	1.4	PASS	28
3897/BH05/-6.5	-6.50	C	7.0	2.2	820	820	1.5	PASS	65
3897/BH05/-7.5	-7.50	C	8.1	2.9	67	67	0.2	PASS	6.6

Table 5.4 - ASS (sPOCAS) testing results. (Samples exceeding the ASSMAC action criteria are highlighted).

Notes:

1. Material type based on field texture assessment or laboratory report.
2. Metres above Australian Height Datum. Surface level at borehole location approximated from survey plan; boreholes not surveyed.
3. pH (actual acidity).
4. pH after oxidation with peroxide (potential acidity).
5. Titratable Peroxide Acidity (Moles H+/tonne).
6. Titratable Sulfidic Acidity (Moles H+/tonne). 5 Oxidisable sulphur (%). 6 ASSMAC (1998) p.27, for >1,000 tonnes disturbed soil. 7 Soil samples are clay – all other samples are sand.
7. Percentage oxidisable sulphur.
8. NA = not AASS or PASS, AASS = Actual Acid Sulfate Soil, PASS = Potential Acid Sulfate Soil.
9. Refer to laboratory certificates (Annex G).

Results for 13 of the 27 samples tested exceeded the ASSMAC action criteria, indicating PASS to be present at the site below approximately 0.8 m AHD, except for one anomalous sample located at 12.5 – 11.5 m AHD. However, of 22 samples tested close to or below the groundwater table, 10 were outside action criteria, indicating the presence of possible layers below the water table are not AASS or PASS.

The pH of collected groundwater samples was between 5.2 (BH4) and 6.0 (BH5). Based on a pH of less than 5.5 for three samples, the presence of AASS was considered likely.

PASS are likely to be present at the site at levels close to or below groundwater table, typically located between 2 and 3 m AHD. A detailed ASS management plan (ASSMP) is required for the proposed sand dredging operations. As AASS or PASS was generally not found above the groundwater table (apart from one anomaly in BH3 at +12.5 to +11.5 m AHD), no management plan is considered necessary for sand mining of this material.

MA (2014) concluded that a detailed ASSMP is required and recommended that additional sampling/laboratory testing is carried out to better delineate spatial extent and depth of PASS and enable application of variable liming rates for treatment.

5.2.2 Acid Sulphate Soils Management Plan (ASSMP)

5.2.2.1 Introduction

Current and previous soil test results indicate that AASS/PASS are likely to be encountered below the groundwater table, but unlikely to be present above groundwater levels. This ASSMP covers proposed works associated with soil extraction below the water table only (stages 2 & 3).

5.2.2.2 Source

The potential source of impact comprises oxidised sulfide minerals that, if exposed to the atmosphere, may oxidise and generate sulfidic acidity. The acidity can mobilise iron, aluminium, arsenic and other heavy metals from the soil profile (sands/ clays). The release of these heavy metals can be detrimental to biota, human health and infrastructure. Oxidisation of sulfide minerals may occur during the dredging of sand containing PASS or as a result of a lowering of the water table.

5.2.2.3 Pathways

If oxidisation of in-situ PASS generates sulfidic acid, then groundwater is the initial pathway by which impacts may migrate. Acidity could migrate downwards by leachate, upwards with groundwater rebound or laterally through groundwater flows and through dispersion. If acidic groundwater mobilises heavy metals they may migrate along similar pathways. Given the proposed method of sand extraction below the water table by dredging, groundwater levels at the site and at surrounding bores will unlikely be significantly altered. Although significant groundwater drawdown from dredging is unlikely, some local groundwater level reduction may occur due to evaporation of the 'window lake'. However, this is expected to be minor given the high conductivity of the aquifer material surrounding the 'window lake'.

5.2.2.4 Receptors

Possible ecological, human and built environment receptors include site workers, flora and fauna and mining equipment. Off-site receptors include Tilligerry Creek (approximately 1.4 km to the north), Stockton Beach (approximately 1.8 km to the south), Worimi National Park (approximately 60 m to the south), areas using non-potable water or irrigated areas.

5.2.2.5 Groundwater

Groundwater across the site is naturally slightly acidic with a pH ranging from 5.2 to 6.0. The slightly acid conditions are not likely to pose an immediate risk to ecological receptors.

5.2.2.6 Treatment Plan

Treatment plan for the below groundwater level mining process (Stages 2 & 3) is summarised in **Table 5.5**. It should be noted that at the time of report writing, details of possible methodologies for sand dredging and soil processing were unknown.

Mining Operation	Treatment
Dredge slurry separation	Coarse material = no treatment required. Fines to sedimentation pond: - pH testing against trigger value of 4. - If pH <4, application of lime to neutralise. - Stockpile on-site. - Lime treatment if necessary. - Retain on site, or disposal off-site.
Periodic removal of fines from sedimentation pond:	Stockpile on-site. Lime treatment, if necessary. Retain on site, or disposal off-site.

Table 5.5 - Treatment plan for mine operations

5.2.2.7 Monitoring Plan

A monitoring plan for the five wells on-site and the dredge pond is summarised in **Table 5.6**.

Location	Frequency	Parameters	Trigger Value1
Dredge pond	3 months2	pH, EC	pH <4, EC = NA
5 on-site wells	3 months2	pH, EC	pH <4, EC = NA

Table 5.6 - Dredging pond and groundwater wells monitoring plan

Notes:

6 Preliminary value to be revised after 6 months monitoring.
7 3 months monitoring over at least a 12-month period.

5.2.2.8 Further Works

We recommend the following additional investigation works are carried out:

- Supplementary borehole drilling, sampling and testing across the site and along site boundaries to better define the extent and depth of PASS below the groundwater table.
- Further testing of soil above the groundwater level in the vicinity of BH3 to confirm assumed anomalous test results.
- Installation of 5 new wells around the dredge pond to detect possible movement of sulfidic acidic impacted groundwater.

5.3 GEOTECHNICAL ASSESSMENT

5.3.1 Encountered Subsurface Conditions

Supplementary borehole investigations by MA confirmed the presence of the five general units described by VGT & QMS (2013). A generalised description of these units is presented below, from youngest to oldest:

- Unit 1: Very loose grey organic sand with rootlets (topsoil), typically less than 0.4 m thick across the site.
- Unit 2: Very loose and loose light grey/grey aeolian sand, typically 1.2 m thick across the site.
- Unit 3: Loose and medium dense orange/yellow aeolian sand, with minor dense layers, typically 8.7 m thick across the site, and very loose sand in dune knolls in the western end of the site (DCP105).
- Unit 4: Medium dense marine sand and clayey sand with organic content, below ground water level likely derived from the paleo tidal zone of Tilligerry Creek. This unit is likely to be encountered in lenses across the site given that it was only intercepted in BH102 and BH103 by MA and BH1 to BH5 by VGT from levels ranging between approximately 3.9 m and -1.8 m AHD.
- Unit 5: Dense light brown/grey marine sand, containing minor heavy mineral bands, below the groundwater table from levels ranging between approximately 3.0 m and -4.4 m AHD.

Detailed borehole logs are provided in Annex G.

A summary of the soil profiles and depth ranges encountered in each of the boreholes drilled at the site (BH1 to BH5 and BH101 to BH108) is provided in Table 5.2 above.

An interpretation of the depositional history of the units is summarised below from oldest to youngest.

- Unit 5: Marine beach sands derived from Stockton Beach are deposited across the site.
- Unit 4: Tidal zone of Tilligerry Creek extends across the site and deposits organic rich sands, silts and clays in low-lying areas.
- Unit 3: Tilligerry Creek tidal zone regresses with localised erosion of Unit 4 sands. Aeolian sands from Stockton Beach transgress across the site in a north westerly direction (dominant wind direction).
- Unit 2: Sequence of deposition of aeolian sand and erosion of these and the underlying Unit 3 sands.
- Unit 1: Recent stabilisation of dunes by vegetation, mainly consisting of grasses and trees, and development of a thin surface layer of organic-containing topsoil.

5.3.2 Assessments

5.3.2.1 Preliminary Geotechnical Material Properties and design parameters

Preliminary geotechnical soil strength, estimated from visual assessment, DCP test results and rate of auger advancement (V-bit), using our experience from similar environments, are provided in Table 5.7 – Preliminary estimates of soil strength properties.

A typical increase in soil density was observed corresponding with age of deposition or overburden pressure. An exception to this general trend are two cone shaped sand dunes (between BH105 and BH106), found to consist of loose to very loose sands from surface to about 10.05 m BGL.

Owing to varying conditions, design of footings should consider conditions at actual location. For preliminary assessment, an allowable end bearing pressure of 50 kPa may be adopted for shallow footings founding on loose and medium dense (or bedded) sand subject to >1 m above groundwater table; to at least 2 x width of footing below foundation level; and embedment of >0.75 m in the unit. Preliminary earth pressures for retaining wall design of Ka = 0.4 and Kp = 2.8 may be adopted for aeolian sands and Ka = 0.3 and Kp = 3.3 for marine sands.

Unit	Description1	Ydry2 (kN/m3)	Ysat3 (kN/m3)	Cu4	□□'5 (◦)	E6
Unit 1: Organic Sand	Very Loose	14	17	-	23	2
Unit 2: Aeolian Sand	Very Loose or Loose7	14	17	-	25	3
Unit 3: Aeolian Sand	Loose	15	18	-	27	5
	Medium Dense	17	20	-	32	15
Unit 4: Marine Organic Sandy Clay/Clayey Sand	Loose or Medium Dense7	17	20	-	30	10
	Soft	15	17	-	-	5
Unit 5: Marine Sand	Loose, Medium Dense and Dense7	19	21	-	36	30

Table 5.7 - Preliminary estimates of soil strength properties

Notes:

1. Typical density. Refer to borehole logs (Appendix C) for full soil description details.
2. Dry unit weight (+/- 2kN/m3).
3. Saturated unit weight (+/- 2kN/m3).
4. Undrained cohesion.
5. Effective friction angle (+/-2°).
6. Effective elastic modulus (based on visual assessment, +/- 10 %).
7. Assumed average value for unit.

5.3.2.2 Safe Excavation Batter Assessment

A slope stability analysis was undertaken using the *SLIDE 6.0* modelling software to assess a Factor of Safety (FOS) against soil sliding. Cross Section A-A, shown on Figure 5.2, was used as a basis for the model.

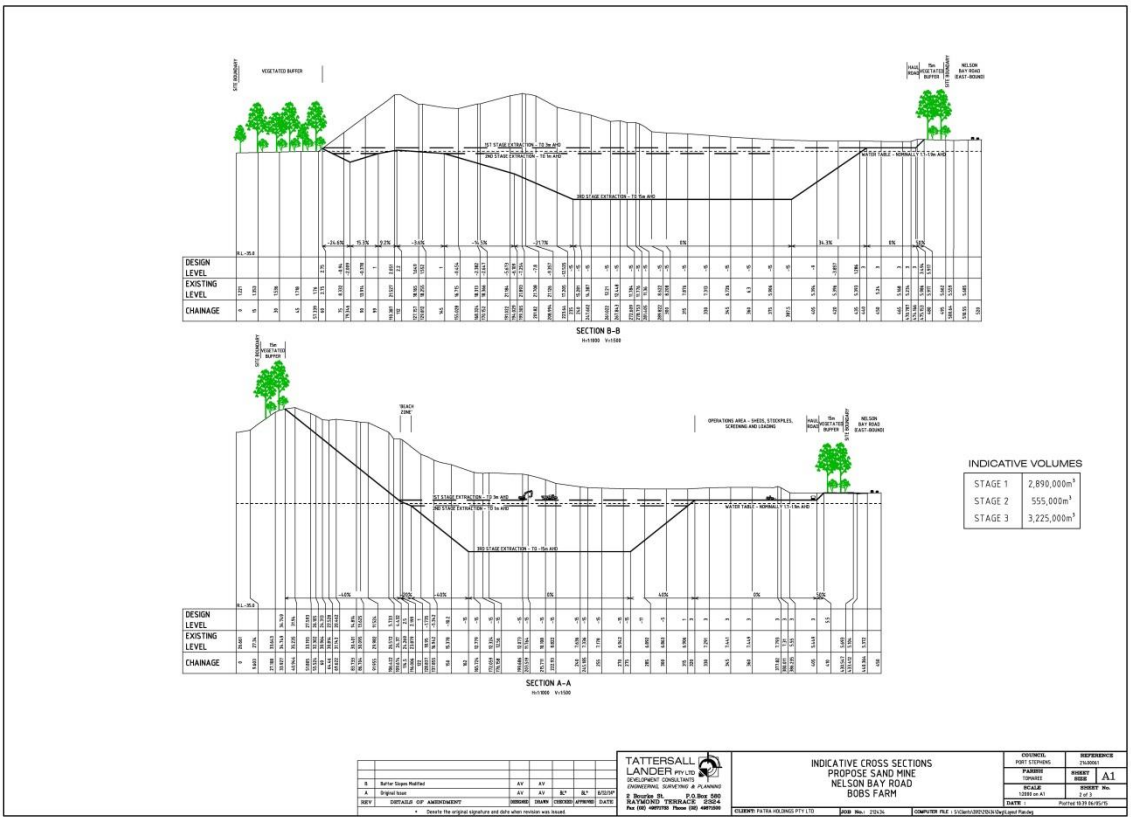


Figure 5.2 - Proposed Final Landform Cross Sections

Existing site conditions and expected ground conditions, resulting from the proposed development (extraction Stages 2 and 3), were analysed adopting the design batter angle of 1V:2H, expected soil properties presented in **Table 5.8** and a mean groundwater level groundwater level of 2 m AHD.

Additional sensitivity analyses were carried out to assess potential impacts of model parameter variations on FOS, including:

- Decrease in batter angle of 1:2.5 and 1:3.
- Peak soil conditions, assuming material is stronger than expected, and residual conditions, assuming material is weaker than expected, refer Table 5.8.
- A groundwater level of 3 m AHD, considered the peak groundwater level (MA, February 2014).

Modelling Assumptions

Development of the model assumed:

- Cross section A-A (Attachment A, Figure 5.2) is representative of conditions across the proposed mine footprint.
- Profile divided into 3 soil layers according to composition and inferred density/ consistency.
  - A: Very loose and loose Aeolian sand.
  - B: Medium dense Aeolian and marine sand with some loose and dense layers.
  - C: Very loose to medium dense marine clayey sand/ soft sandy clay.

- No impacts from excavation-induced vibrations.
- No earthquake-induced impacts.
- No impacts from wave movements during dredging.
- Interpolated unit thicknesses and conditions between boreholes.
- Unit 4 marine organic sands/clays are present across the entire site.
- Homogeneous soil conditions throughout each unit.
- Similar or better soil conditions in all other areas of the site, not modelled.
- eastern section considered only stage 3 (full excavation).
- Only considered rotational failure mechanism, likely to be the dominant failure mechanism impacting site stability.
- A minimum design FOS of 1.1 was adopted, which is considered typical for medium to long term (> 1 month <20 years) mining operations.

Layer	Material[1]	γ_d (kN/m^3)[2]	γ_{sat} (kN/m^3)[3]	Expected Strength[5]		Sensitivity Analysis			
						Peak Strength		Residual Strength	
				C' (kPa)[4]	ϕ'(°)[5]	C' (kPa)[4]	ϕ'(°)[5]	C' (kPa)[4]	ϕ'(°)[5]
A	Very loose and loose Aeolian sand	16	20	-	26	-	28	-	24
B	Loose and medium dense Aeolian and marine sand	17	21	-	28	-	30	-	26
C	Clayey sand/sandy clay layer	17	21	1	22	2	24	0	20

Table 5.8 - Assumed soil strength properties used in *SLIDE 6.0* model

Notes:
[1] Preliminary soil strength properties estimated from DCP data; adopted average value for unit thickness.
[2] Dry unit weight.
[3] Saturated unit weight.
[4] Inferred effective cohesion.
[5] Inferred friction angles.

Modelling Results

Table 5.9 summarises the lowest FOS of all slip surfaces analysed for each modelled scenario. Results for each analysis are shown as images in Annex G.

Soil Strength States	Groundwater Levels	FOS For Batter Angle2		
		Varying		
Existing site conditions				
Expected	2m AHD	1.691		
	3m AHD	1.691		
		1:2	1:2.5	1:3
Stage 2 (excavation to 1m AHD)				
Expected	2m AHD	1.065	1.202	1.641
	3m AHD	1.065	1.202	1.641
Stage 2 (excavation to 1m AHD)				
Expected	2m AHD	1.073	1.281	1.612
	3m AHD	1.071	1.198	1.587
Stage 3 (excavation to -15m AHD)				
Expected	2m AHD	1.0503	1.2373	1.541
	3m AHD	1.0463	1.2333	1.537
Peak (upper bound)	2m AHD	1.142	1.397	1.675
	3m AHD	1.139	1.393	1.671
Residual (lower bound)	2m AHD	0.960	1.175	1.411
	3m AHD	0.957	1.172	1.408

Table 5.9 - Minimum FOS for modelled conditions using SLIDE 6.0

Notes:

1. An assessed minimum FOS of 1.011 for an isolated existing cutting along an access track was considered to be of small scale and non-representative of site conditions; therefore, not included in our assessment.
2. Design batter angle (Vertical:Horizontal).
3. Assessment of the eastern excavation face along section AA at Stage 3 indicates a FOS of 1.064 and 1.331 for batter angels of 1:2 and 1:2.5 respectively.

Assessed Safe Batter Angles

A batter angle of 1:2 is considered generally to provide a FOS of > 1 but may result in unstable conditions from excavations below groundwater level. We therefore recommend adopting a safe batter angle of 1:2.5. This can be revisited once operations proceed and exposed excavations are monitored, and long-term stability is observed.

Risk Assessment

A geotechnical hazard risk assessment for the proposed works has been completed in accordance with the qualitative risk matrices provided in Section 7 of the AGS (2007) guidelines. Four forms of slope movement are considered likely at the site: translational slide, rotational slide, soil creep and lateral spread. Soil creep and gross instability (slide) are considered most likely to impact or be impacted by the proposed development. A summary of a risk assessment for these hazards is presented in Table 5.10 as a minimum, having been implemented. Risk evaluation calculations are provided in Appendix G.

Description	Treatment Measures	Likelihood1	Risk to Life Established Probability2	Risk	Risk to Property Consequence	Risk
Soil creep	Maintain vegetation of undeveloped areas. Maintain good site drainage.	Possible1	5.35 x 10-7	Tolerable	Minor	Low
Gross Instability (slide)	Good hill slope engineering practice. Maintain good site drainage. Do not load crest of excavation batter. Limit vibrations near batters. Do not over-steepen batters (maximum batter slope of not greater than 25° i.e. about 1V:2H).	Unlikely1	8.20 x 10-7	Tolerable	Moderate	Low

Table 5.10 - Summary of slope instability risk assessment, based on AGS (2007)

Notes:

1. Based on 'treated' site conditions.
2. Annual probability of loss of life of an individual most at risk.

Based on AGS, the risk is considered acceptable. However, we point out that it is the responsibility of the client and stakeholders to ultimately decide whether the risk is acceptable.

5.3.3 Recommendations

5.3.3.1 Recommended Safe Batter Angles

Proposed extraction of sand resources will need to take into consideration long-term stability of the excavation perimeter, such that impact on buffer zones of adjacent land is limited. To

this extent, it is suggested that an average batter slope of not greater than 22° (about 1V:2.5H) be adopted both above and below groundwater level.

Recommended interim maximum safe batters are provided in Table 5.11. These can be refined with further assessment at detailed design stage.

Unit	Maximum Slope Batter1
Unit 1: Organic Sand	1:3.0
Unit 2: Aeolian Sand	1:3.0
Unit 3: Aeolian Sand	1:2.5
Unit 4: Marine Organic Sand	1:2.5
Unit 5: Marine Sand	1:2.5

Table 5.11 - Recommended interim maximum batter angles

Notes:

1. Maximum batter slopes (vertical: horizontal).

5.3.3.2 Existing Infrastructure

The edge of the proposed sand mine excavation is offset approximately 15 m from Nelson Bay Road. The deepest proposed excavation nearest Nelson Bay Road will be approximately 16 m BGL.

Should the recommended maximum batter slope angles be adopted, the excavation will be located outside the zone of influence of Nelson Bay Road (estimated by extending down 30 degrees from the edge of Nelson Bay Road). If excavation extends into the zone of influence, then these excavations should take into consideration requirements of the NSW Department of Planning and Environment (DoPE) and RMS Development Near Rail Corridors and Busy Roads – Interim Guideline, 2008). Alternatively, batter angles may need to be further reduced.

5.3.3.3 New Infrastructure

Owing to varying subsurface conditions across the site and with depth, foundation design for new infrastructure should consider conditions at actual locations. However, allowable end bearing pressures of 50 kPa may be adopted for preliminary design of high-level lightly loaded footings founding on loose and medium dense (or better) sand respectively, subject to a minimum cover of 1 m to the groundwater table; uniform foundation conditions to a depth of at least twice the least footing dimension below foundation level and a minimum embedment of 0.75 m. Preliminary retaining wall designs, should they be required, may be carried out using a triangular pressure distribution and adopting active and passive earth pressure coefficients of Ka = 0.4 and Kp = 2.8 respectively for aeolian sands and Ka = 0.3 and Kp = 3.3 respectively for marine sands.

5.3.3.4 Additional Testing

DCP testing was limited to 5 locations. We recommend that additional testing is carried out to assist with detailed site design to better define soil strength properties across the entire site and identify anomalies to the general conditions assumed for this report. The following additional DCP testing is recommended:

- Along the boundary to Nelson Bay Road.
- At the crest of the sand dunes to the north and west of the site.
- Along site boundaries.
- Within the current orchards and low-lying areas.

5.3.3.5 Construction Considerations

Stage one mining of the soil profile would most likely involve stripping topsoil and root affected sand (Unit 1) by dozer and/or excavator. Subsequent mining of Units 2 and 3 will likely also be carried out by dozer/ excavator. Stockpiling of soil may be required before loading onto trucks and removal from site. As the groundwater table is approached, it is anticipated that trafficability may be reduced due to potential ground heave of saturated soils. A dredging system is expected to be utilised for excavation of soils below groundwater level (stage two).

Table 5.12 provides recommendations for consideration during construction and expected mining operations.

Item	Recommendations
Excavations and Vibrations	All excavation work should be completed with reference to the Code of Practice 'Excavation Work', dated October 2013 by Safe Work Australia. Excessive vibrations in the vicinity of any open sand excavation should be avoided to limit the risk of vibration-induced slope movement. Slopes below groundwater are particularly sensitive to vibrations.
Working Platforms, where required	Working platforms will be required where high localised loading is expected. Engineer to design working platforms, particularly where adjacent to crest of excavations or natural batters.
Trafficability and Access	Trafficability on exposed sand above the groundwater table is likely to be poor. Excavation of the site may be limited to the use of tracked machinery.

Item	Recommendations
	Trafficability closer to the groundwater table is expected to deteriorate and sand dredging methods may need to be employed or dewatering may need to be carried out. Crushed concrete or aggregate should be placed along access and haul roads to facilitate site access by dump trucks and utility vehicles. Further assessment of subgrade e.g. CBR conditions be carried out for pavement thickness design of longer term access roads.
Soil Erosion Control	Sand mining should be performed in a manner that reduces the risk of soil erosion and sedimentation on neighbouring lands by water or wind. Site vegetation should only be cleared as mining progresses and maintained where possible. Surface drainage should be directed away from the crest of batters and batter slopes should be kept vegetated or covered to limit erosion. Erosion of, and transportation of sediments off-site from, soil stockpiles should be limited by providing erosion control measures such as bunding and cover, e.g. geotextile or plastic sheeting.

Table 5.12 - Recommendations for consideration in construction and mining operations

5.4 IMPACT ASSESSMENT

Extraction of sand will remove the elevated dune and result in a lowering of the landform, with the final landform being utilised for other purposes.

The soil profile will change by removal (in part) of the quartz sand layer. However, the topsoil will be replaced and all batter slopes will be rehabilitated in accordance with the proposed future use options. The internal controls and the management of ASS will be adequately addressed as part of the site EMP.

The proposed EMP would be implemented at the commencement of the operations and be continued for the life of the project. The EMP will include specific plans for landscape and vegetation rehabilitation. Implementation of these plans will help ensure the impacts on adjoining neighbours, landform, the environment and soils are minimised.

6 SURFACE WATER AND WASTEWATER

Chapter Six describes existing issues related to surface water and waste water management, examines potential impacts on the water catchment, and describes the existing groundwater environment, potential impacts on groundwater and groundwater dependent ecosystems, and mitigation measures to manage hydrological risks. The original report has been reviewed by the DoPE and additional clarifications regarding key adequacy issues are contained within an Addendum attached to Annex E.

6.1 SURFACE WATER

This part of the EIS has been prepared to address the following specific DGRs:-

- Assessment of the impacts on the quality of existing surface and groundwater resources.
- Assessment of the impacts on the quality of regional water supplies.
- A detailed water balance assessment.
- Identification of licensing requirements and approvals under relevant state government legislation.
- Compliance assessment in accordance with the relevant Water Sharing Plan (WSP).
- Detailed description of the water quality monitoring program.

It shall also address the specific comments in Attachment A of the DGRs provided by Fisheries NSW, NSW Office of Water (NOW) and NSW Environmental Protection Authority (NSW EPA).

6.1.1 Site Flooding

Areas to the north west of the site, below 10 m AHD, are below the 1 in 100 year flood level. These may be affected by flooding from Tilligerry Creek refer Figure 6.1. However, given these areas are located beyond elevated parts of the buffer zone, we have assumed that flooding of Tilligerry Creek will not impact the proposed development. Given the sites dunal sand profile there is no surface stormwater retained on the site. No further consideration of flooding of Tilligerry Creek has been included in this assessment.

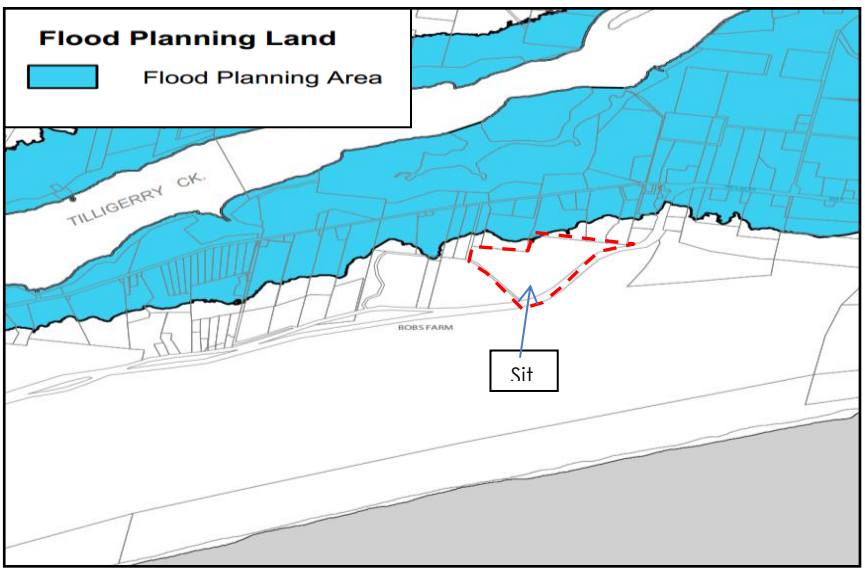


Figure 6.1 - 1:100 Flood Impact

6.1.2 Existing Conditions

The majority of the site slopes towards the east, however, some portions of the site slope to the north, west and south west. Slopes are low (typically 0-5%) in the eastern portion of the site and higher (typically 10-50%) over the remainder of the site. The high slopes occur on dune knolls.

Site elevation ranges from approximately 35 mAHD at a knoll in the north west to approximately 2 mAHD at a depression in the site's north.

6.1.3 Proposed Development

The proposed development is for the construction and operation of a sand mine at the site. Although conceptual, the extraction works are assumed to cover the majority of the site excluding a 15m vegetated buffer to site boundaries and a dedicated processing and administration area. Preliminary staging plan for mining operations is provided in Table 6.1.

Stage	Excavation level (mAHD)	Activities	Processes / Activities	Duration
1	Approximately 2 mAHD	General site clearing	Staged removal of vegetation Stripping of topsoil and stockpiling	6 – 10 years
		Construction	Establish site sheds, office, haul roads and stockpiles	
		Excavation	Extraction of topsoil sand and processing for future rehabilitation works, landscape soil base and sports field top-dress material.	
2 [1]		Excavation	Extraction of 'blonde' Aeolian sands above the groundwater table using conventional excavation/extraction techniques.	1 – 2 years
3 [2]	-15 mAHD	Excavation	Extraction of grey marine sand below the water table using a dredge.	6 – 10 years
4 [3]	NA	Rehabilitation	Site revegetation and rehabilitation	TBC

Table 6.1 - Preliminary operations staging plan

Notes

Stage 2 is anticipated to run concurrently with the later part of Stage 1.
Stage 3 is anticipated to be a stand-alone stage and will intercept groundwater table at approximately 2 mAHD.
Site rehabilitation is subject to preparation of a rehabilitation plan and is not within the scope of this assessment.

The proposed extraction pit will be surrounded by an earth bund to manage any upslope runoff and limit the pit's catchment area to only capturing direct rainfall.

6.1.4 Proposed Water Management Scheme Overview

6.1.4.1 Stage 1 – Stage 2

During this period, excavations are not anticipated to breach the groundwater table. Water management during this time is expected to be as follows:

1. A sump or bore shall be excavated to the underlying aquifer to supply the processing plant and satisfy processing demand.
2. Based on information provided by the future operator, 98% of initially extracted process water will be returned as process wastewater and made available for reuse in the plant again. A storage tank / basin shall temporarily detain process wastewater during this time. Any water quality treatment required (e.g. lime dosing for acid sulfate soils or sedimentation of suspended fines) will occur during this temporary detention.
3. Water required to satisfy dust suppression demands shall also be sourced from groundwater as required.
4. Roof runoff from the amenities block and processing plant shall be captured and detained within a rainwater tank. Water is to be reused to satisfy demands in the amenities block (i.e. toilet flushing, other water fixtures).
5. Wastewater from amenities is to be treated onsite by a small packaged treatment plant and disposed onsite.
6. Runoff from the truck washdown, stockpile area and landscaping area as well as rainwater tank overflow shall be directed to a treatment basin located adjacent to the processing plant area. Water in this basin shall be reused for truck washdown to form a closed circuit. Any overflow from this basin shall be directed into the excavation pit.
7. A bund shall be constructed around the excavation pit area to ensure that it has no catchment and any upslope runoff (excluding haul road and treatment basin overflow) is directed around the pit.

6.1.4.2 Stage 3 Onwards

During later parts of Stage 2 or Stage 3, the groundwater table (anticipated at approximately 2 mAHD) will be penetrated and works shall become a dredging operation. Water management during this time is expected to be as follows:

1. The excavation pit will become a window lake. Water to satisfy process plant, dust suppression and truck washdown demands shall be sourced from the window lake.
2. All other components of the management regime will remain the same as for Stage 1 – 2.

The following sections provide detail on the various components of the water management system for site operations.

6.1.5 Watercourse Assessment

6.1.5.1 Existing Conditions

Catchment Characteristics

The site is a localised high point, sitting on a relict dune system of Stockton Beach to the site's east. It does not receive run off from surrounding properties.

The site catchment is predominately vegetated with tall open eucalypt forest. The majority of the site flows east to Nelson Bay Road and Worimi National Park. A catchment area of approximately 1.9 ha of Lot 254 and 4.3 ha of Lot 51 drains to the north east and form part of the Tilligerry Creek catchment.

Site Drainage, Watercourses and Waterbodies

According to the 1:25 000 topographic map (Figure 6.2) there are no watercourses, waterbodies or notable drainage features onsite. An unnamed tributary of Tilligerry Creek is located 30m to the north east of the northern boundary of Lot 51 on the opposite side of Marsh Road and an existing lake is located approximately 120m to the north west of Lot 254 within the Shark and Ray Centre facility.

Site investigations completed on 29/07/2014 – 30/07/2014 included a walkover to assess site topography, drainage, vegetation and landscape characteristics. No drainage features or waterbodies were noted during these investigations. Some surface dampness was noted in the eastern corner of Lot 254, adjacent to Nelson Bay Road however this is likely to be caused by the low elevation in this area along with a high organic content in the soil reducing soil infiltration.



Figure 6.2 - Topographical Aerial Photograph

6.1.5.2 Impact Assessment

The proposed development is not expected to impact local watercourses/waterbodies as:

1 There are no significant drainage features on site.
2 The excavation pit will be self-draining and no runoff from this area shall leave the site.
3 The excavation pit is approximately 400m away from the nearest mapped watercourse.
4 No development is proposed on the northern portion of Lot 51. There is therefore no change anticipated in runoff quality doing to the nearby tributary Tilligerry Creek.
5 There are no works proposed on site that are within 40m of a watercourse.

6 Water quality treatment measures (see Section 6.2.7.4) shall ensure runoff from working areas of the quarry (e.g. stockpile area, truck washdown, roof areas) will be appropriately treated.

The site catchment area draining to the western neighbouring Shark and Ray Centre dam will approximately half as a result of the pit excavation. Given this area represents only a small portion of the dams greater catchment (approximately 15%), and that the site's sandy soils mean that very little surface runoff is generated from the site, the impacts of this are considered negligible.

6.1.5.3 Conclusion

The site does not contain any significant drainage features or waterbodies. The nearest feature to the site is a mapped watercourse approximately 30m north of Lot 51 (across Marsh Road), however no works are proposed within 100m of this feature.

The proposed excavation pit is approximately 400m away from the nearest significant drainage feature. The pit will be self-draining and no process water from operations shall be discharged from the site. Water quality treatment structures shall ensure runoff from operational areas outside the pit is suitably detained and treated.

The development proposal is therefore not expected to impact on local drainage features or watercourses.

6.1.6 Stormwater Quality Assessment

6.1.6.1 Sensitive Receptors

The following sensitive receivers have been identified as those potentially impacted by water quality of stormwater discharging from the site:

- Groundwater.
- Tilligerry Creek.
- Worimi National Park.

This assessment is completed to determine water quality treatment measures required as part of the proposed development to ensure no adverse impacts on these environments.

6.1.6.2 Water Quality Objectives

NSW EPA (February 20, 2014) requires runoff discharging from the site to be assessed in accordance with community agreed environmental values and human uses endorsed by the NSW Government. According to DECCW (2006) the site lies within the *Karuah River and Great Lakes Catchments* and has the following water quality objectives for receiving waters:

- Aquatic Ecosystems: Maintaining or improving the ecological condition of waterbodies and their riparian zones.
- Visual Amenity: Aesthetic qualities of waters.
- Secondary Contact Recreation: Maintaining or improving water quality for activities such as boating and wading, where there is a low probability of water being swallowed.
- Primary Contact Recreation: Maintaining or improving water quality for activities such as swimming in which there is a high probability of water being swallowed.

These values are applied to the proposed development by adopting a neutral or beneficial effect (NorBe) objective (i.e. post development runoff water quality is to be better than or equal to that of the pre-development).

6.1.6.3 Modelling Methodology

Overview

Quarry Pit Areas

A negligible amount of runoff from quarry pit areas is expected after infiltration, evaporation and recharge. Given the proposed excavation pit will be self-draining, any captured surface water runoff will form part of the closed cycle reuse scheme whereby water retained in the excavation pit (primarily groundwater) will be used to satisfy process plant reuse (excluding approximately 2% which is lost)

Quarry pit areas are not anticipated to generate off site runoff that may impact on sensitive receivers and are therefore not included in the water quality modelling exercise.

Quarry Ancillary Areas

Small areas of the site, including the truck washdown, process plant and amenities roof, and stockpile areas will generate runoff that may contain various contaminants. Although these areas are not proposed to discharge offsite, runoff from them does require treatment prior to reuse or infiltration.

As these areas reflect an 'urbanised' setting, the Model for Urban Stormwater Improvement Conceptualisation (MUSIC, Version 6.0) developed by the CRC for Catchment Hydrology was utilised to evaluate pre and post development pollutant loads.

The following modelling scenarios were considered:

I. Pre-development – the existing portion of the site to contain built infrastructure.

II. Post development– The built infrastructure. Water quality treatment measures are included to achieve adopted objectives.

MUSIC model layouts are provided in Figures 6.3 and 6.4 below.

Modelling was undertaken iteratively to determine appropriate type, size and location of stormwater treatment devices.

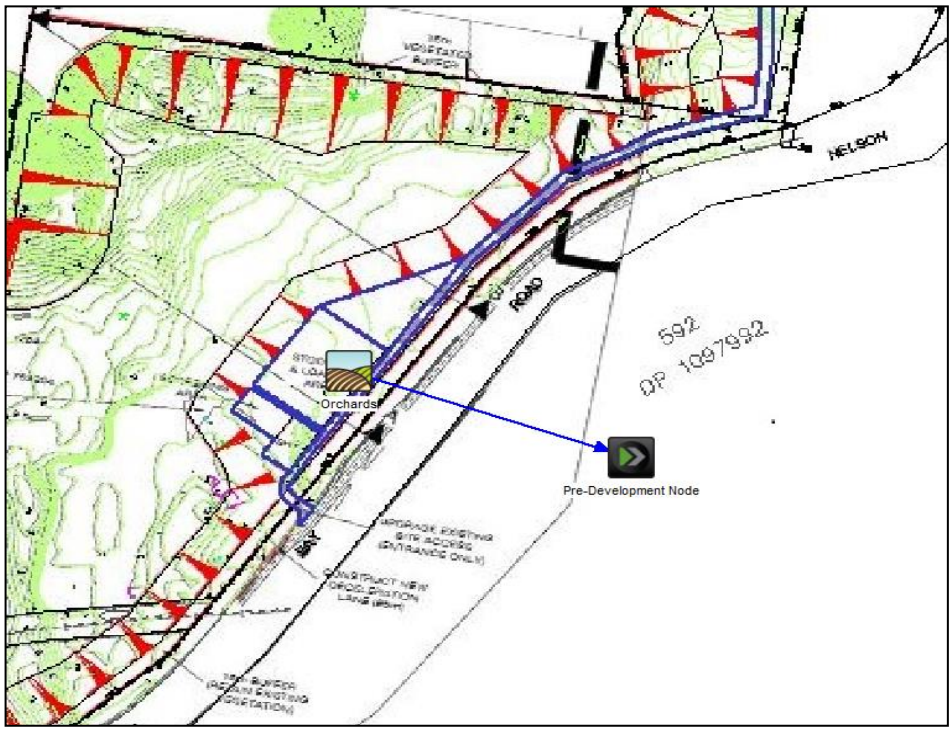


Figure 6.3 - MUSIC Model Pre-Development

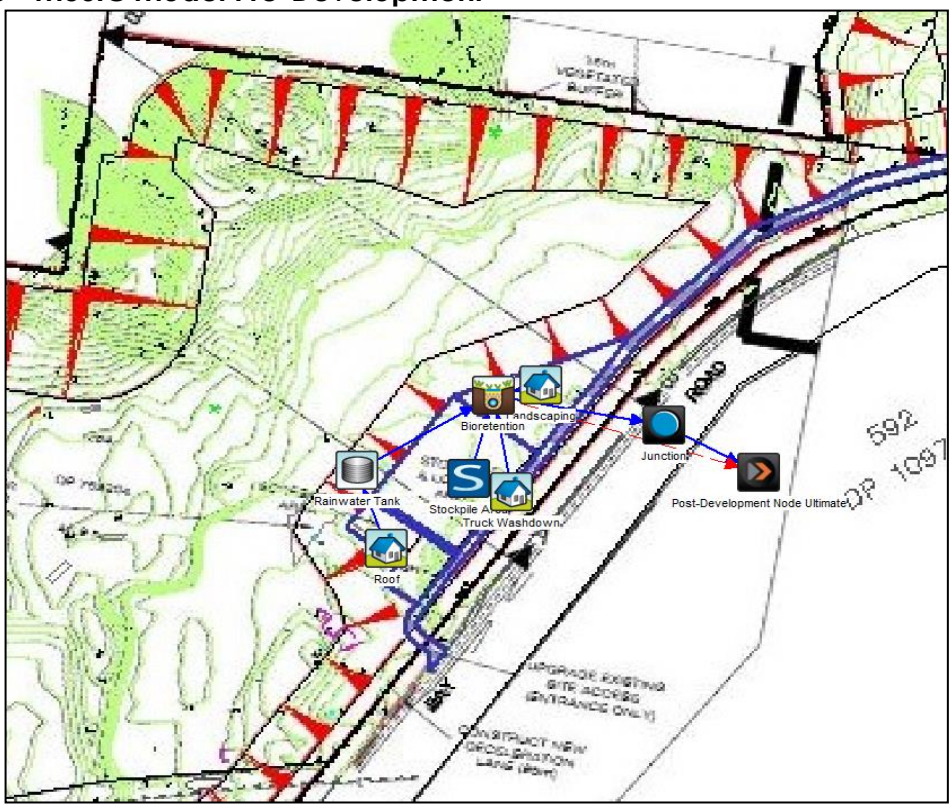


Figure 6.4 - MUSIC Model Post Development

Climate Data

MUSIC was run using climatic data from Williamtown RAAF. The data was run on a 6-minute timestep from 1/01/2002 – 31/12/2006.

Input Parameters

Input parameters for source and treatment nodes are consistent with Sydney Metropolitan Catchment Management Authority (SMCMA) (2010) Draft NSW MUSIC Modelling Guidelines. Attachment D summarises input parameters.

Catchment Areas

Pre and post development catchment areas, pervious and impervious areas and modelled landuse are provided in Attachment E. The following comments are made in relation to catchment areas:

- The portion of the site to contain the process plant, stockpile area, amenities block, truck washdown area and general landscaping is currently used for orchards. Pre-development landuse was therefore modelled as agriculture.
- Post development areas were modelled as a mixture of roof (process plant and amenities), residential (landscaping), unsealed road (truck washdown areas) and quarry (stockpile areas).
- All quarry areas will drain internally and be treated by the site's long-term stormwater management plan.

Model Parameters

Event Mean Concentration (EMC) inputs (Table 6.2 - Adopted EMCs for source nodes6.2) were derived from SMCMA (2010). Given soil material is primarily sand, stockpile areas are expected to reflect active quarry areas and have a high total suspended solids (TSS) generation rate; but a negligible impact on total nitrogen (TN) and phosphorus (TP) loads. To simulate this, a generic node was created adopting Sydney Catchment Authority (2012) TSS generation rate for quarry/unsealed roads and TN and TP generation equivalent to pre-development rates (i.e. agricultural landuse).

		Base Flow (mg/L)		Storm Flow (mg/L)	
Land Use	**Parameter**	**Log (mean)**	**Log (stdev)**	**Log (mean)**	**Log (stdev)**
Roof	TN	na	na	0.300	0.190
	TP	na	na	-0.890	0.250
	SS	na	na	1.300	0.320
Residential	TN	0.110	0.120	0.300	0.190
	TP	-0.850	0.190	-0.600	0.250
	SS	1.200	0.170	2.150	0.320
Unsealed Roads	TN	0.110	0.120	0.340	0.190
	TP	-0.850	0.190	-0.300	0.250
	SS	1.200	0.170	3.000	0.320
Agricultural	TN	0.040	0.130	0.480	0.260
	TP	-1.050	0.130	-0.220	0.300
	SS	1.300	0.130	2.150	0.310
Forest	TN	-0.520	0.130	-0.050	0.240
	TP	-1.520	0.130	-1.100	0.220
	SS	0.780	0.130	1.600	0.200
Rural Residential	TN	-0.050	0.120	0.300	0.190
	TP	-1.220	0.190	-0.660	0.250
	SS	1.150	0.170	1.950	0.320
Quarry Generic	TN	0.040	0.130	0.480	0.260
	TP	-1.050	0.130	-0.220	0.300
	SS	1.200	0.170	3.000	0.320

Table 6.2 - Adopted EMCs for source nodes

Note: Adopted EMC for each catchment are provided in Annex E.

6.1.6.4 Treatment Train Philosophy

Processing Plant Works Area

Stormwater quality improvement devices (SQIDs) are outlined below:

- Rainwater Tank: A 15 KL rainwater tank will capture roof water to service onsite amenities. A reuse rate of 309 L/day was applied as per the Wastewater Assessment (Section 6.4). Water security modelling (Section 6.6) indicates this tank has a 99.8% security to satisfy this demand.

- Bioretention Basin: A bioretention basin will be located adjacent to the plant and stockpile area to capture and treat runoff from the rainwater tank, stockpile, truck washdown and general landscaped area. Basin location and specifications are to be confirmed during detailed design. Preliminary specifications are as follows:

- Basin to be lined
- Extended detention depth: 0.3m
- Minimum filter area: 200 m2
- Minimum surface area: 200 m2 (i.e. walls may be retained or battered)
- Filter depth: 0.5m

- Filter media: loamy sand
- An exfiltration rate of 180 mm/hr (equivalent to sand) has been included and the basin modelled as unlined. A secondary drainage link has been included to direct exfiltration directly to the outlet node to maintain model water balance.
- A highflow bypass has been included equivalent to 50% of the 1 year ARI event flow rate (from the contributing catchment areas and the daily truck washdown contribution).

Water to satisfy truck washdown demands shall be sourced from the basin to form a closed circuit. As shown in Attachment F, a basin area with a capacity of 80 KL will be required adjacent to the basin and connected via the basin's underdrain. The basin shall detain treated runoff for reuse in truck washdown.

Remainder of the Site

A number of additional treatment measures are proposed for the site to further improve water quality management. These features were not modelled in MUSIC however are to be included as part of the site's best management practice

- Diversion Bunds: Diversion bunds shall be constructed around the perimeter of the site and around the process plant area to direct runoff into the excavation pit for retention and treatment (Attachment F). These will also limit the catchment area of the pit to direct rainfall only.

- Haul Road Swale: The haul road between the Nelson Bay Road entrance and the existing road in the site's north shall be treated by a vegetated roadside swale (Attachment F). The swale shall capture sediment in runoff from the road and provide treatment through detention, evaporation and infiltration. As trucks will be washed down before leaving the site, contaminated runoff from this area is expected. Where possible, the swale shall direct runoff into the quarry pit to form part of the closed water reuse scheme.

- North and West Quarry Areas: For a period of Stage 1 - 2 (prior to extraction becoming a dredging operation), quarry areas to the north and west will continue to discharge offsite until excavation levels are deep enough to reverse these flows (Attachment F). During this time sediment fences and straw bales shall be placed at the downslope extent to allow capture of TSS prior to discharge offsite. Sediment and erosion control features are to be installed and managed in accordance with Landcom (2004) *Soils and Construction Handbook*.

- Reuse Water Treatment: The preliminary Acid Sulfate Soils (ASS) assessment (Martens and Associates, 2014b) found that potential ASS (PASS) are likely to be present below the groundwater table. An additional storage sump / basin is therefore required between groundwater extraction point and the processing plant to allow ASS treatment (lime dosing) and settlement of any fine suspended sediment. The level of treatment required is to be confirmed at detailed design stage.

- Quarry Extraction Basin: Once extraction breaches the groundwater table (approximately Stage 3 onwards) a window lake will form. This lake will capture any runoff from surrounding quarry excavation areas (primarily pit batter areas) and retain the water. The lake will also perform a water quality function for runoff through sedimentation, infiltration, detention and evaporation.

6.1.6.5 Music Modelling Results

MUSIC modelling results are provided in **Table 6.3**.

Parameter	Pre-Development	Post-Development	Achieved Reduction (%)	Complies (Y/N)
TSS (kg/year)	117.00	60.50	48	Y
TP (kg/year)	0.52	0.44	15	Y
TN (kg/year)	5.49	4.61	16	Y

Table 6.3 - MUSIC results

MUSIC results show that the NorBE criteria is achieved for the modelled area of the site with the implementation of the proposed treatment train.

6.1.6.6 Sediment and Erosion Control

Once detailed design of the proposed quarry has been completed, a detailed sediment and erosion control plan (SECP) and soil and water management plan (SWMP) shall be prepared to ensure that sensitive receivers are not impacted throughout quarrying operations. This plan shall detail erosion control measures for during the:

- Establishment phase.
- Operation phase.
- Rehabilitation phase.

We note that during establishment and early parts of the operational phase, sediment and erosion control measures will be required, in particular in the site's north and west, to treat any runoff that is directed offsite. These are required to remain in place until such time that excavations reverse runoff flow direction towards the site and into the excavation pit.

The SECP and SWMP are to be prepared in accordance with Volume 2E, Mines and Quarries, of the Managing Urban Stormwater: Soils and Construction guidelines (DECC, 2008).

6.1.6.7 Conclusion

Water quality objectives will be met by the proposed stormwater treatment train in the process plant area and across the greater site. This in turn shall protect sensitive receivers and achieve the Government endorsed environmental values and human uses criteria for the Karuah River and Great Lakes Catchments.

6.1.7 Surface Water Balance Assessment

6.1.7.1 Overview

A surface water balance has been prepared for the site based on anticipated water demands and proposed sources of water supply. The primary objective of the water balance assessment is to calculate if sufficient water supply is available to satisfy operational demands and if additional entitlements are required.

A water balance flow chart is provided in Figure 6.5 to support this assessment.

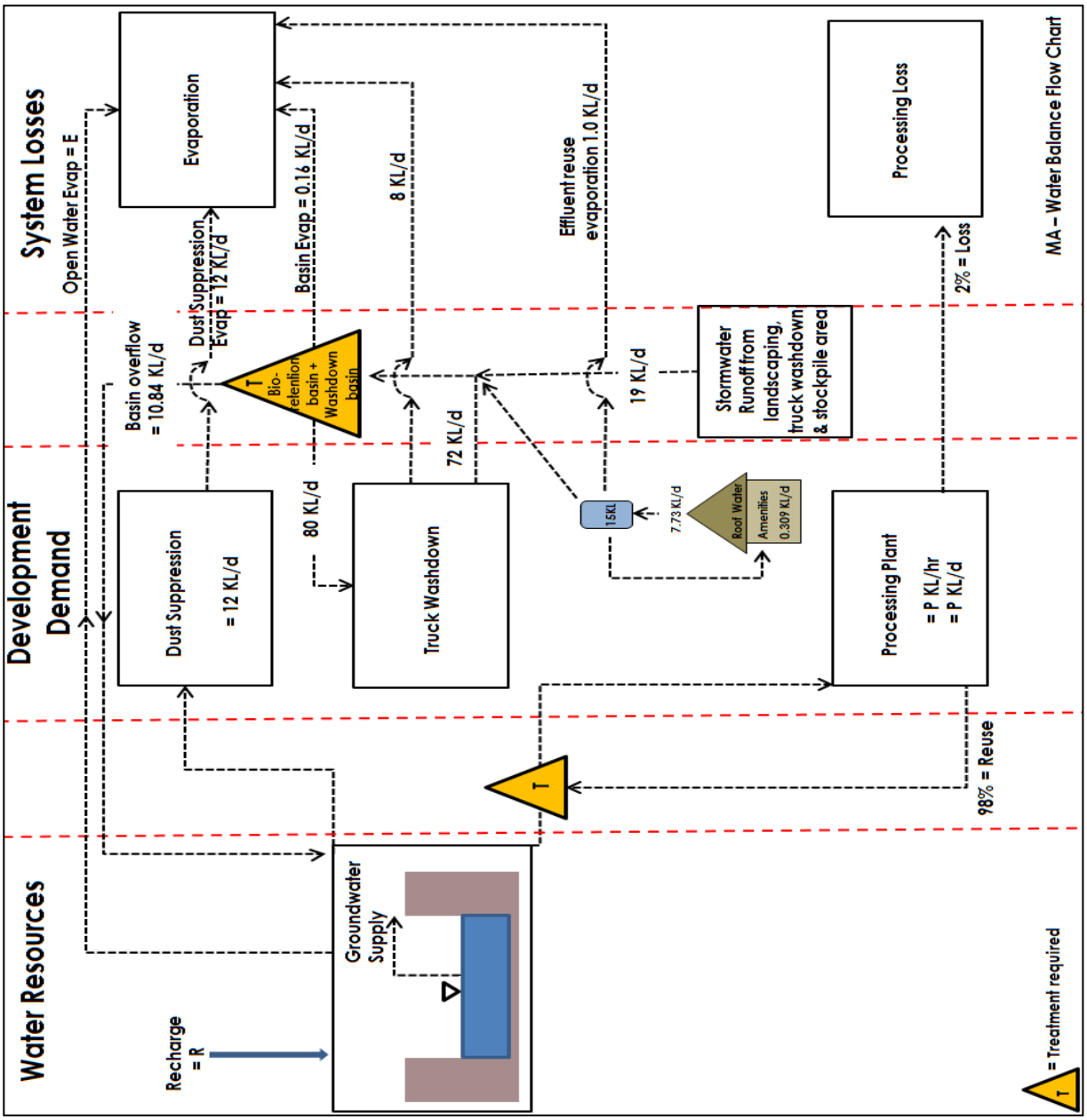


Figure 6.5 - Water Balance Flow Chart

6.1.7.2 Site Water Demands

Site water demands are summarised in **Table 6.4**.

Element	Demand (KL/day)	
Site amenities	0.309 [1]	
Processing plant [2]	Year 1	2,116.80
	Year 2	3,528.00
	Year 3	6,350.40
	Year 4	10,584.00
Dust suppression	12.00 [3]	
Truck washdown	80.00 [4]	

Table 6.4 - Summary of site water demands

Note:
1 As calculated in Wastewater Assessment.
2 As provided by the client.
3 As determined by Vipac Engineers and Scientists.
4 Trucks will require washdown to prevent sediment accumulated on wheels etc. from being transported and deposited offsite. Adopted figure for the site based on: truck washdown rate of 0.5 KL/truck (adopted from Teralba Quarry extension Environmental Impact Assessment, BMT WBM, 2011); anticipated 20 truck movements per hour (SECA solution, 2014, Traffic Impact Assessment); and an operation day of 8 hours.

6.1.7.3 Water Supply

Site water supply sources are summarised in **Table 6.5**.

Element	Supply (KL/day)	
Roofwater	7.73 [1]	
Dredge Basin/Sump (groundwater) [2]	Year 1	43.20 + 12.00
	Year 2	72.00 + 12.00
	Year 3	129.60 + 12.00
	Year 4	216.00 + 12.00
Works area runoff	18.84 [3]	
Truck washdown wastewater	72.00 [4]	
Bioretention basin overflow	10.84 [5]	
Process wastewater [6]	Year 1	2,116.80
	Year 2	3,528.00
	Year 3	6,350.40
	Year 4	10,584.00
Licensed groundwater bore	109.59 [7]	

Table 6.5 - Summary of site water supply sources

Note:
1 Daily water supply from roof to rainwater tank taken from MUSIC modelling results. Rainwater tank storage requirements based on Watcycle water security modelling completed over a 14-year period using climate data from Williamtown RAAF BOM station. Section 0 provides details of the assessment and results.

2 Up t0 2% of the daily water required by the processing plant may be lost (i.e. evaporation, in product etc.). This loss shall be resupplied by groundwater from the basin/sump plus an additional 12 KL/day for dust suppression.
3 Stormwater runoff from stockpile, truck washdown, landscaped areas and rainwater tank overflow (19 KL/day less 0.16 KL/day evaporation as determined by MUSIC modelling) shall be captured within the bioretention basin. This water shall contribute to supplying water to satisfy truck washdown demands.
4 An estimated 72 KL/day (80 KL/day less approximately 8 KL/day of evaporation) of truck washdown wastewater shall be directed to the bioretention basin for treatment and reuse again for truck washdown.
5 An estimated 10.84 KL/day of overflow (combination of infiltration, weir overflow and high flow bypass) from the bioretention basin (basin water supplies less evaporative loss and truck washdown reuse) shall be directed to the extraction basin sump/basin to supplement groundwater extraction.
6 98% of the water used in the processing plant will be returned to the extraction basin / sump where it will be available once again for reuse.
7 The site contains two licensed bores with a water supply works and use approval (approval 20CA202365) to access the Stockton Groundwater Source. The irrigation bore is also covered by a Water Access License (WAL) (WAL5960) with an annual entitlement of 40 ML.

6.1.7.4 Water Loss

There are two primary water 'losses' considered in the water balance assessment:

1 Processing plant loss:
- 2% of plant demand.

2 Evaporation:
- 100% of water utilised for dust suppression shall be evaporated from the watered-down surface.
- Groundwater shall be evaporated from the extraction basin (once a window lake is formed). This forms the primary water loss from the system.

These water 'losses' form the site 'take' of groundwater for which entitlements will be required.

6.1.7.5 Water Balance Assessment

Rainwater Reuse in Buildings

Based on a roof catchment area of 3,000 m2 and a daily demand of 309 L/day, provision of:

- A 15 KL tank will have a 99.8% water security.
- A 25 KL tank will have a 100% water security.

In the event that tank water shortages are experienced due to periods of extended dry weather or increased demand, tank water supply shall be 'topped up' via tanker.

Operational Reuse

Table 6.6 provides a water balance assessment to determine if sufficient water is available to satisfy operational demands. The balance is provided for each operational 'year' when processing demand is expected to increase up to Year 4 (Stage 3 onwards) when processing demand reaches it.

	Element	Year 1	Year 2	Year 3	Year 4 +
Groundwater Extraction	Dust Suppression (KL/day)	- 12.0	- 12.0	- 12.0	- 12.0
	Plant Loss (KL/day)	- 43.2	- 72.0	- 129.6	- 216.0
	Window Lake Evaporation (KL/day)	- 0	- 0	- 244.3	- 244.3
Groundwater Gain	Bioretention Basin Overflow (KL/day)	+ 10.84	+ 10.84	+ 10.84	+10.84
Net Groundwater Demand (KL/day)		**- 44.4**	**- 73.2**	**- 375.1**	**- 461.5**
Net Groundwater Demand (ML/year) [1]		**- 7.6**	**- 13.6**	**- 114.8**	**- 132.9**

Table 6.6 - Operational water balance assessment

Note:

1 Annual demand takes into account that operational losses occur on operational days only (i.e. based on 19 operational days/month and 11 operational months/year); while window lake evaporation occurs year-round (i.e. 365 days/year).

6.1.8 Surface Water Monitoring Plan

6.1.8.1 Sensitive Receivers

The following sensitive receivers have been identified as being in close proximity to the site with potential to experience indirect or direct impacts resulting from site operations:

1 Worimi National Park.
2 Tilligerry Creek.
3 Neighbouring properties water storages.

6.1.9 Monitoring Plan

Overview

All water used during site operations shall be sourced, treated, recycled and reused on site. No discharge of waters is anticipated as a result of regular operations. In the event that the bioretention basin volume is exceeded, overflow shall be redirected to the extraction pit. Further, the nature of site soil profile (fine to medium grained sands) means that during rainfall events a high amount of infiltration and a low volume of surface runoff on the site is expected.

This plan therefore focuses on inspection and monitoring of water quality treatment structures and elements of the site water management scheme to ensure appropriate operation and functioning.

Bioretention Basin

The proposed bioretention basin and truck washdown extraction pit shall be monitored as follows:

1. Weekly visual inspection:
    - Check basin structural integrity.
    - Check outlet for signs of scour/failure.
    - Check sediment volume.
    - Check and record water level.

Records of water storage inspections are to be kept in the site register (Attachment G) along with rainfall, evaporation and general observations.

Water Use

The following water transfers / uses are to be metered and recorded daily in the site register (Attachment G) to ensure water supply and demands are appropriately managed and water loss is minimised:

- Groundwater extraction volume from the sump / basin to the processing plant.
- Return process wastewater pumped from the plant to the interim basin / sump.
- Water extracted from the basin / sump to the water cart for dust suppression.
- Water extracted from the bioretention basin to the truck washdown area.

Water Quality

The following water quality monitoring is required onsite during operation:

1 Water quality monitoring of pH, EC and TSS (or similar) from within the bioretention storage basin. Monitoring is to be completed on a weekly basis. Trigger criteria for monitoring parameters is to be determined by plant operator based on operational requirements.

2 Water quality monitoring of process wastewater transferred to the extraction basin pit / sump. Monitoring parameters and frequency to be determined by the plant operator based on operational requirements.

6.1.10 Contingency and Response Plan

Table 6.7 provides an outline of operational issues identified as having potential to occur on site and contingency response to be executed.

Issue	Response
Pump failure	Appropriate contractor to be contacted to rectify pumps.
Water meter failure	Rectify and replace (where required) water meter.
Leak is detected from bioretention basin / truck washdown basin	Contact environmental engineer and arrange inspection. Engineer to advise on how to best repair leak.
Water balance indicates process water return < 98 % (i.e. more than 2% loss).	Examine the system for leaks and where required rectify. Check meters are functioning correctly. Check records are logged correctly.
Groundwater extraction rates exceed forecasted levels.	Check for leaks and/or adjust water consumption.
Water quality in bioretention basin and / or extraction basin exceeds required target criteria.	Complete an additional round of water quality sampling to confirm results. Inspect treatment basins for leaks / failures. Inspect and assess operational area for sources of increased pollutant loads. If repeated exceedance occurs contact environmental engineer to inspect and advise.

Table 6.7 - Contingency response plan

6.1.11 Reporting and Auditoring

Annual surface water management reporting is to be completed as part of the site's long-term management. Reporting is to include:

- rainfall conditions for the calendar year.
- Progress of quarrying operations.
- Any changes to the surface water management system.
- Any sediment and erosion 'events' experienced (e.g. major storm event, basin failure).
- Records of treatment basin inspection and maintenance.
- Records of water use and water quality monitoring.
- Comparison of water balance records with the previous year and any long-term observations/trends.
- Identification of events/issues experienced and management/remedial process.
- An audit of the stormwater management and monitoring system and any recommendations for continued operation.

6.1.12 Adaptive Management

The site SWMP shall be considered a 'living' document that should be reviewed annually and updated as required. Given site surface water conditions will change as quarrying progresses, the management plan needs to be adaptive to remain relevant and effective.

6.1.13 Policy Compliance Assessment and Licencing

6.1.13.1 Water Management Act 2000

Harvestable Rights

A land owner's 'harvestable right' is the amount of water owners of land are entitled to capture and use pursuant to the harvestable rights Order published in the NSW Government Gazette on 23 March 2001 under Section 54 of the Act. It is most simply understood to be 10% of the runoff generated by a property.

The open extraction pit will form a 'window lake' which intersects groundwater and captures rainfall. Collected rainfall will be available for reuse and form part of the site's water reuse system.

Previous consultation with NOW on similar quarrying operations (e.g. Hanson's Wagga Wagga Sand Quarry) confirms that direct rainfall onto a window lake which has no, or minimal, catchment is exempt from harvestable rights calculations under the Farm Dams Policy (NSW Government Gazette 40; 31 March, 2006 pg. 1628 - 1631). The capture and use of the water us also exempt from licensing under the Water Management Act (2000).

Aquifer Access License

It is anticipated that a WAL and Aquifer Interference Activity Approval with sufficient share component for the taking of water will be required. The grant of the WAL and the management of allocation and share component which attach to it are bound by the rules within the Tomago, Tomaree and Stockton Groundwater Sources Water Sharing Plan (2003).

Further details regarding groundwater access, impacts and licensing is provided in the Groundwater Management Plan (Martens and Associates, 2014c).

6.1.13.2 Water Sharing Plan

Surface Water

Discussion with NSW Office of Water (July 15, 2014) confirmed that the site surface water is managed under the Karuah River Water Source Water Sharing Plan (WSP). Under this WSP there are 5 management zones. The site lies in areas downstream of the downstream limit of zone 5, and is not covered by a management zone.

The extraction basin has no licensable take, does not require Water Management Act (2000) licensing and is therefore not subject to the WSP.

Groundwater

As outlined in Section 6.2.15.1.1, in accordance with the Tomago, Tomaree and Stockton Groundwater Sources Water Sharing Plan (2003), a share component equivalent to the anticipated groundwater 'take' is to be sought under an aquifer access license.

6.1.13.3 Hunter Water Regulation 2010

The purpose of the Hunter Water Regulation 2010 is to regulate implementation of the Hunter Water Act 1991. In relation to the proposed development:

- The site is not included in a 'special area' under Part 2, which therefore does not apply.

- It does not involve plumbing or drainage work that affects the Hunter Water Corporation (i.e. does not propose to include or affect a water main, sewer main or stormwater drain of the Corporation). Part 3 and Part 4 of the Regulation therefore do not apply.

The proposed development therefore complies with the Hunter Water Regulation.

6.2 WASTEWATER ASSESSMENT

6.2.1 Overview

This assessment has been completed in accordance with:

- Australian / New Zealand Standard (AS/NZS) 1547 (2012), On-site domestic wastewater management.
- NSW Health (2001) Septic Tank and Collection Well Accreditation Guidelines
- Port Stephens Council (PSC) (2011) Onsite Sewage Development Assessment Framework.
- Department of Environment and Conservation (DEC) (2004), Use of Effluent By Irrigation.

The assessment provides preliminary details on management of wastewater produced as part of daily operations at the site.

6.2.2 Wastewater Sources

Process Water

During processing of extracted material, waste process water will be generated during washing and screening. This waste stream is managed separately to sewerage, as outlined in Section 6.2.6.3.

Sewerage

Amenities will be provided onsite to service staff and visitors. For the purposes of this assessment it is assumed that these amenities are likely to include male and female toilets and shower, and a small kitchenette.

Given the site is not services by reticulated town sewer, wastewater generated shall require onsite treatment and disposal.

6.2.3 Process Wastewater Management

Process waste water will be returned to the extraction basin / sump for storage prior to onsite reuse for dust suppression and again in product processing. Process water management and treatment is further discussed in Sections 6.1.6 and 6.1.7.

6.2.4 Sewerage Management

Overview

This assessment determines preliminary system requirements to ensure sewerage wastewater generated at the site is appropriately treated and disposed. It has been prepared based on a desktop analysis of site capability and in accordance with DECCW (2004) and PSC (2011).

PSC (2011) notes that for non-domestic systems 2 – 4 options for wastewater management should be provided. However based on discussions with PSC (A. Weekes, September 9, 2014) and given the small scale of the proposed system, this assessment has been completed assuming wastewater will be secondary treated and treated effluent will be disposed via subsurface irrigation.

Site Hazard Class

Based on information provided by PSC (A. Weekes, September 9, 2014) the site is classed as 'high' risk for onsite sewage management hazard (Figure 6.6). In accordance with PSC (2011) this wastewater assessment has been completed based on this classification and a 'non-domestic' proposed landuse.

Effluent Disposal Field Location and Buffer Requirements

The proposed effluent disposal field (EDF) shall be located in the vicinity of the administration/processing plant area while incorporating site buffer requirements (Table 6.8) and not being subject to vehicular access.

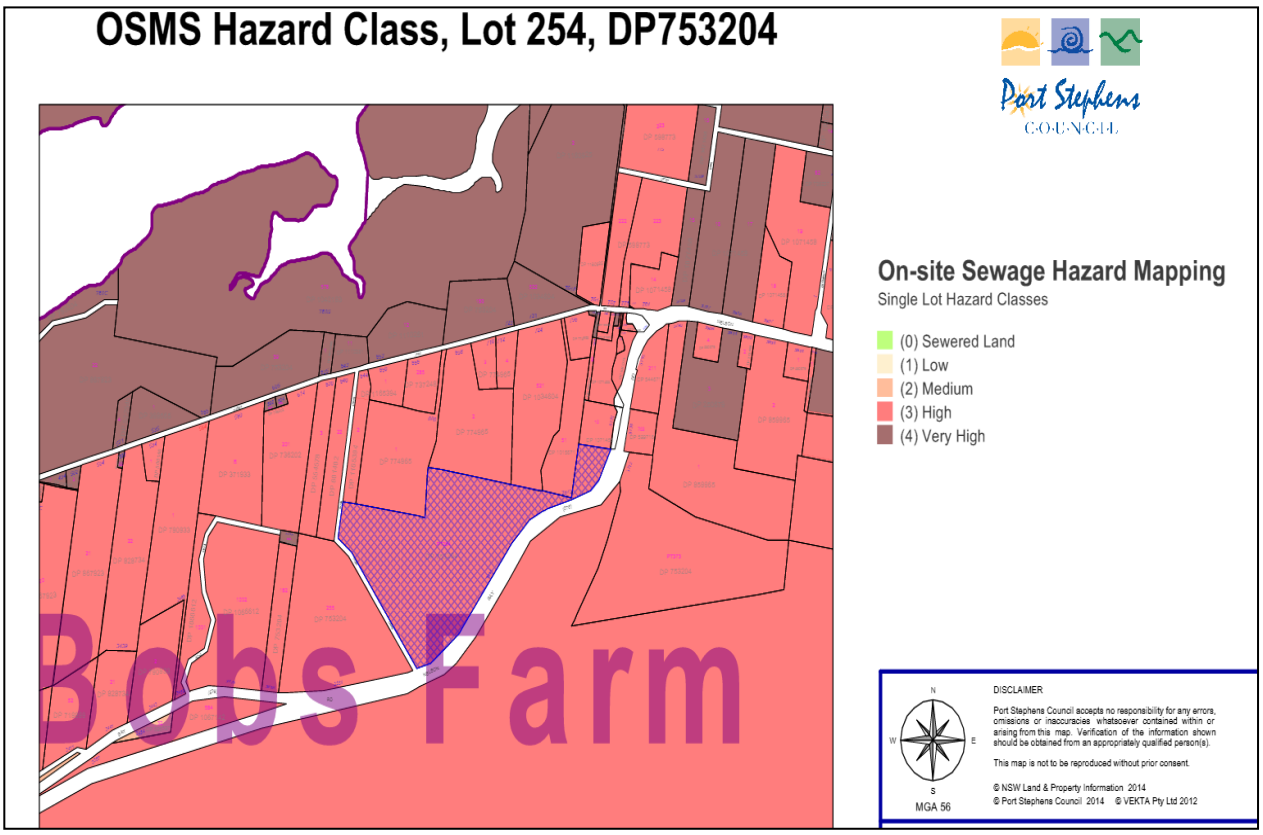


Figure 6.6 - OSMS Hazard Map

Application System	Site Feature	DEC (2004) requirement (m)[1]	PSC (2004) requirement (m)[2]	Buffer Provided (m)
All Application Systems	Permanent surface waters (e.g. lake/dam)	100	100	> 100 [4]
	Domestic groundwater wells	Site specific	250	> 400 [3]
	Other waters (intermittent waterways, dams, drainage channels)	Site specific	40	>40 [5]
	Extraction Pit	NA[6]	NA[6]	20 [7]
Subsurface Irrigation	External property boundaries	NA[6]	6/3 [2]	6/3 [2]
	Driveways and buildings	NA[6]	6/3 [2]	6/3 [2]
	Depth to bedrock	NA[6]	0.6	0.6

Table 6.8 - Buffer recommendation

Note:

1 Buffers based Table 4.9 of DEC (2004) based on low strength effluent.
2 /y indicated requirements for areas down / upslope of the disposal area
3 Groundwater investigations completed by Martens and Associates (2014a) found 13 bores within 2 km of the site. The closest 3 to the proposed EDF registered for domestic use (GW080296, GW056098 & GW079677) are more than 400m away.
4 The nearest permanent water body to the proposed EDF is the Shark and Ray Centre dam to the site's west which is approximately 550m away.
5 As per Section 3, no watercourses are within 40m of the proposed EDF.
6 Recommended buffer not provided by guideline.
7 The proposed EDF is 20m from the top of batter of the ultimate excavation pit which is considered sufficient distance to prevent migration of treated effluent into the pit.

Land and Soil Capability for Effluent Application

Land and soil suitability for effluent disposal in the nominated location is assessed in accordance with Table 2.1 and 2.2 of DEC (2004) and Table 6-1 of PSC (2011) (Table 6.9

Site details are based on site inspection, intrusive soil investigations and available information obtained from the *Soil Landscapes of Port Stephens* (DLWC, 1995).

Soil Feature	Site Details	Limitation Rating
Slope	< 1 %	Nil[1]
Exposure	High sun and wind exposure	Nil
Vegetation	Currently crops. Proposed field shall be grassed	Nil
Flood	None or rare	Nil
Run-on and upslope seepage	None	Nil
Landform	Hill crest and plains	Nil
Rocks and rock outcrops	Nil	Nil
Site drainage	No visible signs of dampness	Nil
Depth to bedrock/limiting horizon	> 10m	Nil
Depth to groundwater	3.27 m [3]	Moderate
Coarse fragments	< 10%	Nil
Fill	No fill	Nil
pH [2]	5.0	Moderate
EC [2]	0.25	Nil
Effective CEC [2]	1.4	Severe
ESP (%) [2]	16	Severe
Phosphorus sorption [2]	250 (low)	Severe

Table 6.9 - Land and soil capability assessment

Note:

1 DEC (2004) rating for disposal via underground irrigation. The proposed area for effluent disposal is proposed to be primarily level.
2 Site details as per DLWC (1995). Details to be confirmed during S68 detailed design.
3 Mean groundwater level for MW1 as per Martens (2015) Groundwater Management Plan. Existing surface level is approximately 5 mAHD (groundwater therefore at approximately 1.73 mAHD). Approximate proposed surface level of irrigation field is 3 mAHD (i.e. depth to groundwater is 1.27 mAHD).

With regards to soil chemical limitations, the following comments are made:

- pH limitation may limit plant species that can be planted within the irrigation area, however, existing site vegetation shows good growth habit and appear to suffer no ill effects from pH.
- A nutrient balance shall be undertaken to appropriately size the effluent irrigation field and manage P sorption limitations.
- Nutrient balance and hydraulic design shall ensure appropriate effluent application rate is applied and depth to groundwater limitation is managed.

Design Wastewater Load

Based on information provided by the client, anticipated site population will include:

- 5 permanent full-time staff.
- Visitors equivalent to 3 full time staff.

The proposed facility shall operate Monday – Saturday and be closed Sundays.

According to NSW Health (2001) *Septic Tank and Collection Well Accreditation Guidelines* a daily wastewater generation rate allowance of 45 L/person/day is to be adopted for mines.

Site wastewater load is calculated in Table 6.10.

Population	Wastewater generation rate (L/p/day)	Daily wastewater load (L/day)	Weekly wastewater load (L/week) [1]	Average daily wastewater load (L/day) [2]
8	45	360	2,160	309

Table 6.10 - Wastewater load calculations

Note:

1 Based on a 6-day working week.
2 Average daily load over 7 days.

EDF Sizing

Hydraulic Design

Table 6.11 sizes the EDF assuming disposal via subsurface irrigation.

Soil Texture	Indicative Permeability (m/d)	DIR (mm/day) [1]	Average Daily Effluent Load (L/day)	Area Required (m^2)
Sand	> 3.0	5	309	62

Table 6.11 - EDF sizing; subsurface irrigation

Note:

1 Design irrigation rate as per Table M1 of AS/NZS 1547 (2012).

Nutrient Balance

Results of nutrient balance modelling is summarised in Table 6.12.

Parameter	Minimum area required (m^2)
Nitrogen	141
Phosphorus	184

Table 6.12 - Results of nutrient balance modelling

Final Design

Based on the outcomes of Table 6.11 - EDF sizing; subsurface irrigation0 and Table 6.12 - Results of nutrient balance modelling11, a minimum area of 184 m^2 is required to assimilate the load and nutrients applied to the soil during effluent irrigation. This includes 62 m^2 reserve area (100% of area required by hydraulic design).

The effluent irrigation field can be accommodated adjacent to the proposed administration/processing plant area with suitable buffers applied (Attachment C).

Specific Construction Requirements

Treatment System

All sewerage wastewater generated onsite is to be treated by an Aerated Wastewater Treatment System (AWTS) or similar. The system shall be designed based on the following preliminary design requirements:

- Design ADWF treatment capacity of 309 L/day.
- Wastewater system to provide treatment to a secondary standard.
- System location to provide necessary access for maintenance and management
- System to be designed to allow for intermittent and peak flows through the day.
- All sewerage wastewater is to be transferred to the system via suitable pipe and pump system.

Treatment and disposal system design and capacity are to be confirmed during detailed design, prior to provision of Section 68A certificate.

Irrigation field

Shallow subsurface drip irrigation is considered appropriate for the site. Design of the irrigation field is to be generally in accordance with AS/NZS 1547 (2012) as follows:

- A 184 m2 primary area is to be provided for nutrient and water assimilation. This area includes the required reserve disposal area (62 m2).
- Effluent is to be distributed via a series of irrigation lines buried parallel to site contours at 1.0 m apart (centres). This will result in approximately 184 linear metres of irrigation line. Appropriate delivery mains with non-return valves and flushing lines are to be installed in the irrigation system.
- Vegetation cover is to be maintained over the irrigation field.
- The irrigation area shall not be used for growing fruit, vegetables or other edible plants.
- An effluent filtration system shall be fitted in accordance with the irrigation line manufacturer's requirements.
- The treatment system dispersal pump and delivery mains are to be sized to provide adequate flow through the proposed irrigation system.
- Effluent is to be distributed along the trenches using a pressure compensating subsurface irrigation line such as "Netafim", "Amiad PC" or "Wasteflow". These products have been specifically designed for the distribution of secondary effluent and allow for the even distribution of flows along and between irrigation lines.
- A reticulated flushing main with shut off valve is to be constructed for system flushing. Water from flushed lines is to be sent back to the inlet of the treatment system.

System Monitoring, Inspections and Maintenance

The following monitoring and inspections and maintenance are required:

1. Basic monitoring of the operation of the system will be required in accordance with manufacturer's specification. Critical system components including any sewage transfer pumps, aeration equipment and effluent irrigation pumps should be alarmed, with redundant systems fitted where appropriate.

2. The wastewater management system shall be maintained quarterly or in line with manufacturer's recommendations by a qualified contractor. As part of system maintenance, the subsurface irrigation system is to be flushed and the system filter removed, cleaned and replaced.

3. The effluent distribution system will require weekly visual inspection by the site owner / operator to identify any leaks within the distribution system or any areas of over irrigation within the disposal areas.

Further Approvals

Prior to the construction of a site sewage management system, an approval under Section 68A of the Local Government Act (1993) will be required, where final design specifications for the treatment and effluent irrigation systems shall be submitted for approval to Council. This shall be done prior to the issuing of a construction certificate for the site sewage management system. No discharge licence from DEC will be required given that all sewage is treated and reused onsite. As water and sewer shall be managed entirely within the site no WICA approvals are expected to be required.

Summary of Recommendations

- Sewage Collection: Generated sewage collected and reticulated to a secondary sewage treatment system (AWTS or similar) through a system of gravity mains.
- Sewage Treatment: Design treatment capacity of no less than 309 L/day.
- Minimum Irrigation Field: 184 m2 is to be provided to assimilate nutrients and applied water, in order to protect public health and the environment.
- Irrigation Type: shallow subsurface drip irrigation.
- Land Capability: Available irrigation area is identified in Attachment C.
- Further Approvals: In accordance with Section 68a of the Local Government Act 1993 (NSW), final design specifications for the site sewer, STP and effluent reuse system shall be submitted to Council for approval. This shall be done prior to commencement of construction of the site sewage management system.

7 GROUNDWATER ASSESSMENT & MANAGEMENT PLAN

Chapter Seven describes existing groundwater conditions, its levels, quality and flow directions. The Chapter examines potential impacts on the local groundwater system, establishes baseline quality monitoring data, outlines trigger values and describes the, potential impacts on groundwater and groundwater dependent ecosystems, and mitigation measures to manage hydrological risks.

The original report has been reviewed by the DoPE and additional clarifications are contained within an Addendum attached to Annex E. In particular it addresses the required DGRs for:-

- Document existing groundwater conditions (levels, quality and flow directions).
- Outline indicative hydrogeological hydraulic parameters.
- Develop a conceptual groundwater model.
- Assess impact of the proposed mine with respect to the local groundwater system having regard to NSW Department of Primary industries' (2012) NSW Aquifer Interference Policy.
- Establish baseline groundwater quality monitoring data.
- Establish groundwater quality and level monitoring locations, frequencies, analytes, and outline trigger values.
- Establish course of action in case of trigger value breach.
- Comment on groundwater licensing.

7.1 SITE DESCRIPTION – LOCATION AND SETTING

Site background information is summarised in **Table 7.1** with a site survey provided in **Figure 2.2**.

Item	Detail
Site address	3631, 3679 & 3721 Nelson Bay Road, Bobs Farm 774 Marsh Road, Bobs Farm
Lot and DP (Title Information)	Lot 254 DP 753204 Lot 51 DP 1015671 Lot 10 & Lot 11 DP 1071458
Local government area (LGA)	Port Stephens Council.
Site Area	Approximately 53 ha
Existing landuse	Approximately 19 % of the site's area is currently utilised for agriculture (typically olive and fig plantations) with a small proportion of this area occupied by farm sheds, a farm hand residence and a master residence. Approximately 67% of the site's area is forested and undeveloped apart from vehicle tracks. The remaining 14% of the site is cleared and occupied by sheds, residences and plant (Lot 10 DP1071458). This area is in the north east of the site and aside from the cleared area surrounding the dwelling on Lot 51 DP 1015671, extraction is not proposed in this region.

Item	Detail
	An above ground electricity easement (poles and wires) cuts across the southern corner of the site.
Proposed land use	Sand mine operation with a maximum annual yield of 750,000 tonnes.
Surrounding land uses	Rural residential allotments border the site to the north, west, south west, and in the north east of the site, to the east. Nelson Bay Road borders the site to the south east, with Worimi National Park located on the southern side of the road. The Australian Shark and Ray Centre is located along the western end of the northern site boundary.
Topography and drainage	The majority of the site slopes towards the east, however, some portions of the site slope to the north, west and south west. Slopes are low (typically 0-5 %) in the eastern portion of the site and higher (typically 10-50 %) over the remainder of the site. The high slopes occur on dune knolls. Site elevation ranges from approximately 35 mAHD at a knoll in the north west to approximately 2 mAHD at a depression in the site's north. No watercourses, drainage features or surface ponding were noted onsite. The majority of the site drains east into Worimi National Park. The north west portion drains north west into a large dam on the neighbouring Shark and Ray Centre property or into the drainage network of Tilligerry Creek, located approximately 1km north west of the site.
Vegetation	Agricultural area of the site is planted with olive and fig plantations. The majority of the site is forested with tall open forest dominated by the canopy species Eucalyptus pilularis (Blackbutt) and Angophora costata (Smooth-barked Apple) (Wildthing Environmental Consultants, 2013). Two Groundwater Dependent Ecosystems GDEs exist on the site, Swamp Mahogany Paperbark Forest and Tall Alluvial Moist Forest (Wildthing Environmental Consultants, 2013). The location of these GDEs is shown in Figure 7.10.

Table 7.1 - Site Background Information

7.2 HYDROLOGICAL ENVIRONMENT

7.2.1 Available Hydrological Data

The following information has been utilised for this investigation:

1. Stage 2 Sand Deposit Investigation (Quarry Mining Systems, 2013) and Stage Two Geological Assessment (VGT & Quarry Mining Systems, 2013) – these reports document:

    - Five TPs (TP1, TP2, TP3, TP4 and TP6) to depths ranging from 4 m to 6.5 mBGL.
    - Five boreholes to depths ranging between 19 and 26.5 mBGL using a hydraulic auger with all boreholes completed as groundwater monitoring bores. In terms of mAHD datum, the boreholes were taken to levels ranging between -8.25 and -14.78 mAHD.
    - Laboratory testing including particle shape analysis and particle size distribution.

2. MA field investigations undertaken on 07.08.2013, 22.08.2013, 01.10.2013, 09.01.2014, 17.03.2014, 02.05.2014, 17.07.2014, 29.07.2014, 30.07.2014, 13.10.2014, 29.01.2015 and 01.05.2015 which included:

    - Walkover inspection of the site to assess existing site conditions and local topography, geology, soil conditions and vegetation.
    - Measurement of groundwater levels via dip meter at all site bores.
    - Four rounds of groundwater quality sampling at all site bores.
    - Slug testing at all site bores to determine hydraulic conductivity.
    - Commissioning of automated data loggers at BH1, BH2 and BH3 to monitor groundwater levels between 22.08.2013 and 13.10.2014 at 15-minute intervals, and at BH4 and BH5 between 22.08.2013 and 09.01.2015 at 15 minute intervals.
    - Eight boreholes (BH101 to BH108) drilled to maximum depths of 10 to 13 mBGL for the purpose of acid sulfate soil assessment (ASS) (not within the scope of this report).

3. Public domain bore data (NSW Natural Resource Atlas).
4. Survey data provided by Tattersal Lander.
5. LIDAR data obtained from NSW Government Land and Property Information.

MA (2014) installed automated data loggers in wells constructed by VGT & QMS (2013). Groundwater levels were measured from 22.08.2013 at 15-minute intervals to 09.01.2014 (approximately 3 months) for BH4 and BH5 and to 17.07.2014 (approximately 11 months) for BH1 to BH3 (ref. P1303897JR01V01). Summaries of measured groundwater levels are provided in **Table 7.2** (datum = mBGL) and **Table 7.3** (datum = mAHD). **Figure 7.1** provides the locations of site test pits and bore holes.

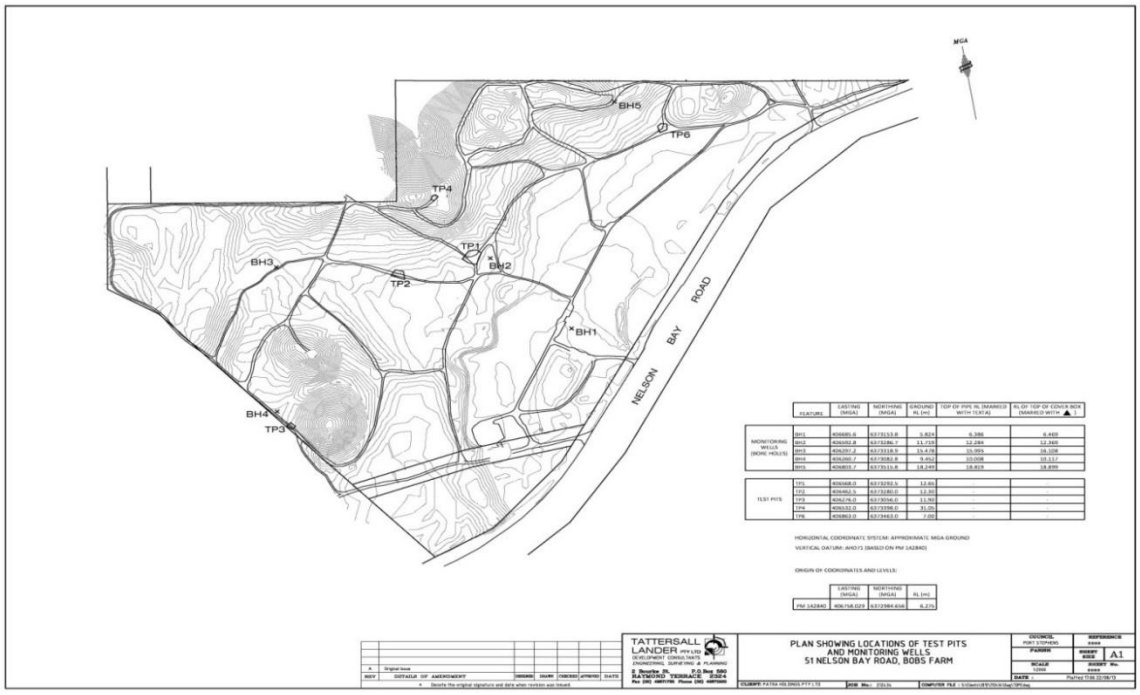


Figure 7.1 - Test Pits and Bore Holes

	Groundwater Depth (m BGL)				
	BH1	**BH2**	**BH3**	**BH4**	**BH5**
Minimum	2.72	9.13	13.08	7.25	15.30
Mean	3.28	9.50	13.28	7.36	15.42
Maximum	3.53	9.78	13.55	7.50	15.57
Range	0.81	0.65	0.47	0.26	0.27

Table 7.2 - Statistical summary of groundwater depths (m BGL) measured by data loggers in existing site wells (BH1 to BH5) between 22.08.2013 and 17.07.2014.

	Groundwater Level (m AHD)				
	BH1	**BH2**	**BH3**	**BH4**	**BH5**
Minimum	2.29	1.94	1.93	1.95	2.68
Mean	2.55	2.22	2.20	2.09	2.83
Maximum	3.10	2.59	2.40	2.21	2.95
Range	0.81	0.65	0.47	0.26	0.27

Table 7.3 - Statistical summary of groundwater levels (m AHD) measured by data loggers in existing site wells (BH1 to BH5) between 22.08.2013 and 17.07.2014.

The following observations are made:

- Mean groundwater level ranges from 2.09 m AHD in BH4 (located near south west site boundary) to 2.83 m AHD in BH5 (located near northern site boundary).

- Groundwater level responds to rainfall.

- BH1 and BH2 displayed the most prominent response to a recharge event, which occurred between 17.11.2013 and 19.11.2013 and comprised 137 mm of rainfall. Increases in groundwater level associated with this event were approximately 0.42 m and 0.32 m for BH1 and BH2 respectively.

- Groundwater level fluctuations at BH1 and BH2 may be influenced by irrigation of fig plantations. The plantations are typically watered daily for a period of 2 hours with a sprinkler head at every fig plant.

- Further to the above, groundwater levels in BH1 may also be influenced by pumping of the site water supply bore, located to the south of the main dwelling.

7.2.2 Geological Conditions

7.2.2.1 Geological Mapping

The Newcastle and Port Stephens 1:100,000 Geological Series Sheet 9232 indicates that the site is underlain by Quaternary Holocene sand (stable dunes). The area to the north of the site (beyond the northern boundary) is underlain by silts, clays and estuarine sediments derived from Tilligerry Creek. The area to the south of the site (southern side of Nelson Bay Road) is underlain by Quaternary Holocene sands derived from older beach deposition and covered by low level windblown dunes (Figure 7.2).

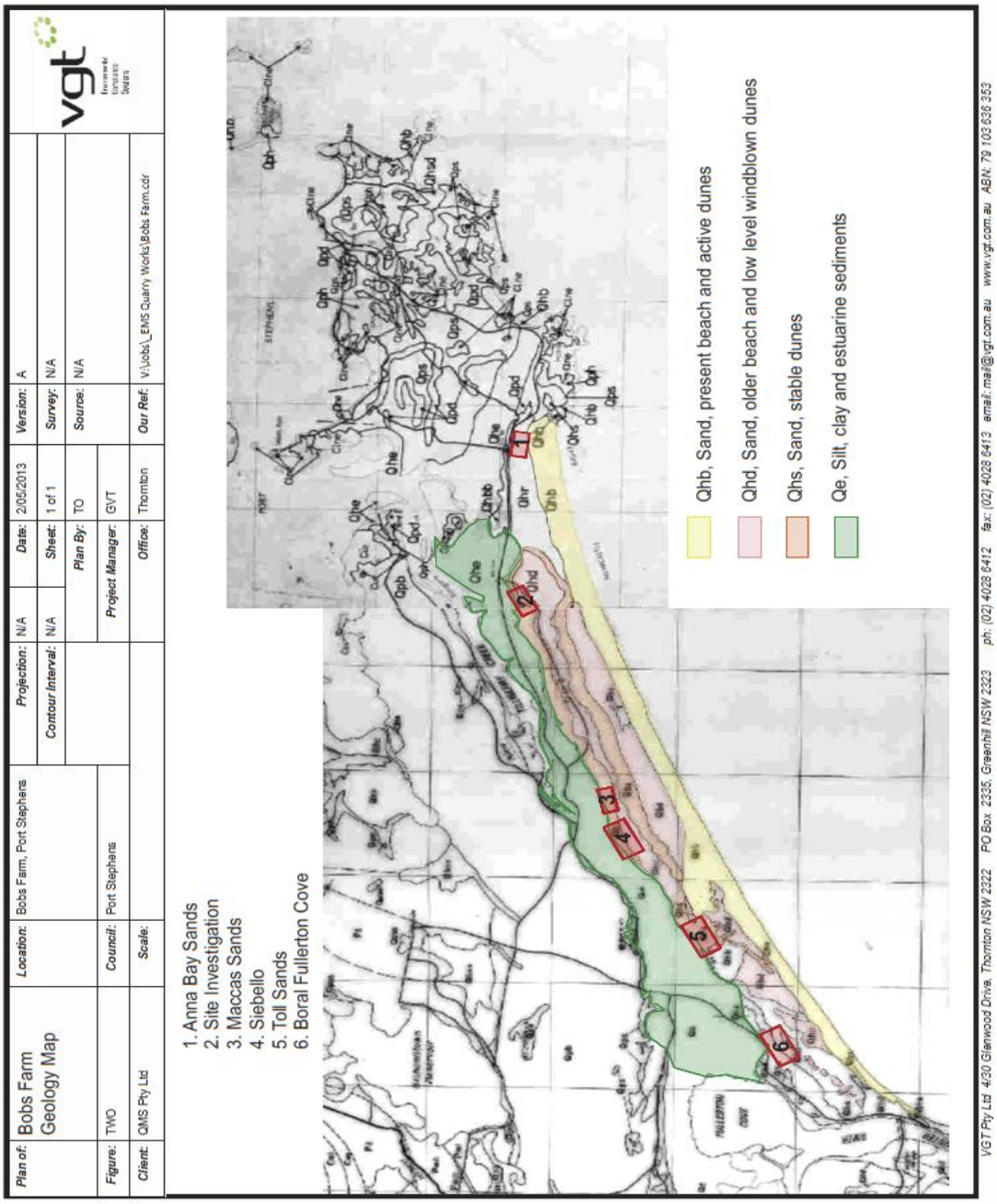


Figure 7.2 - Sand Dune Formations

7.2.2.2 Borehole Investigations

With the exception of an intermittent clay/high organics layer located in the vicinity of the water table, borehole and test pit excavations generally revealed fine to medium grained sand to investigation levels (Table 7.4). The top of the clay/high organics layer varied from 0.78 to 4.61 m below the water table at BH1, BH2, BH3 and BH5 with thickness varying from 0.2 to 2.4 m. At BH4 the top of the clay/high organics layer was 1.46 m above the water table with a thickness of 0.4 m.

At the eight boreholes drilled by MA, the clay/high organics layer was only observed at BH102 and comprised clayey sand with sandy clay layers. The layer was approximately 1.6 m thick and occurred between 1.1 and -0.5mAHD. The top of the layer was approximately 1.4 m below the water table. Detailed borehole logs are provided in Annex E.

Based on laboratory testing documented in VGT & Quarry Mining Systems (2013), site sands are generally subrounded to rounded with moderately high sphericity.

BH	Ground Level (mAHD)	BH Depth (m)	BH Base (mAHD)
1	5.82	19.0	-13.18
2	11.72	26.5	-14.78
3	15.48	26.5	-11.02
4	9.45	24.0	-14.55
5	18.25	26.5	-8.25
101	11 [1]	13.0	-2
102	6 [1]	10.0	-4
103	9 [1]	10.0	-1
104	27 [1]	10.0	17
105	15 [1]	10.0	5
106	20 [1]	10.0	10
107	6 [1]	10.0	-4
108	6 [1]	13.0	-7

Table 7.4 - Summary of borehole investigations levels

Notes:

1 Based on survey plan – BH location not surveyed therefore levels indicative.

BH	Top of Clay/Organic Layer (mAHD)	Bottom of Clay/Organic Layer (mAHD)	Groundwater Level (mAHD)
1	1.52	1.32	2.31 [1]
2	1.22	-0.28	2.03 [1]
3	0.88	-0.12	2.33 [1]
4	3.65	3.25	2.19 [1]
5	-1.75	-4.15	2.86 [1]
101	NA	NA	0 [2]
102	1.10	-0.50	2.5 [2]
103	NA	NA	2.2 [2]
104	NA	NA	NA
105	NA	NA	NA
106	NA	NA	NA
107	NA	NA	1.5 [2]
108	NA	NA	2.5 [2]

Table 7.5 - Summary of clay/high organics layer and groundwater levels

Notes:

1 Based on groundwater level observed on 22.08.2013.
2 Based on groundwater level observed during borehole drilling – indicative.
3 NA = not encountered.

7.2.3 Groundwater Levels

7.2.3.1 NSW Natural Resource Atlas

Review of the NSW Government Natural Resource Atlas (Figure 7.3) indicates 13 bores exist within approximately 2 km of the site. Based on available data (Table 7.6), bores are characterised as having shallow depths, viable yields and shallow SWLs. It is noted that no salinity data was available.

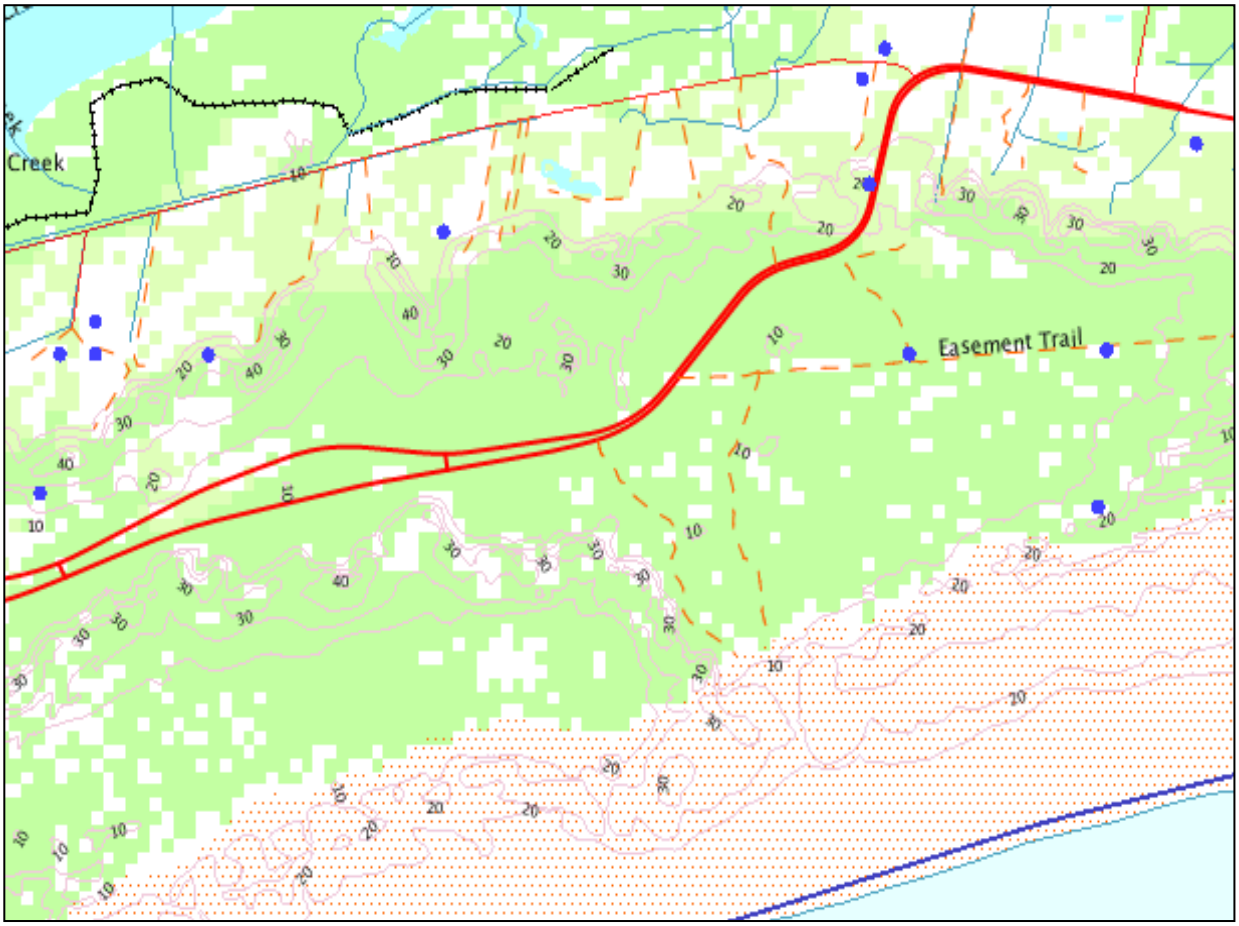


Figure 7.3 - Surrounding Bores

Bore I.D [1]	Bore No# [2]	Purpose	Depth (m)	SWL (mBGL)	Salinity (µS/cm or TDS – unknown)	Yield (L/s)	Drilling Date
1	GW078478	Domestic	11			5	
2	GW062123	Irrigation	4				1938
3	GW062125	Irrigation	4				1938
4	GW062124	Irrigation	4				1938
5	GW080277	Irrigation	8			6	
6	GW080296	Domestic, farming, irrigation					2002
7	GW080269	Stock					2002
8	GW067296	Domestic	8	0.5		2.5	1991
9	GW056098	Domestic, Stock	13.3	3		6.31	1982
10	GW079677						
11	GW079354						
12	GW079401						
13	GW078618	Domestic	10				

Table 7.6 - NSW Natural Resource bore data summary

Notes:

1 Identification adopted for this report.
2 NSW Natural Resource Atlas bore number.
3 Void table cells = no data available.

7.2.3.2 PINNEENA Data

The NSW government's PINNEENA groundwater database was reviewed to assess continuous groundwater monitoring bore data within the local area of the site. Review indicated 5 locations in the region of the site had continuous groundwater monitoring bore data available (Figure 7.16). Continuous groundwater level monitoring data for the five locations is provided in Figure 7.16 to Figure 7.22 of Annex E and summarised below in Table 7.7 - Groundwater level variation in local area of site, post Water Sharing Plan commencement (01.07.2004), as derived from PINNEENA plots (refer Figure 16 to Figure 22 Annex E7.7).

	Groundwater Level [1]		
Bore I.D.	Minimum	Maximum	Range
GW080079	1.04	4.47	3.43
GW080084	0.88	3.00	2.12
GW080081	1.69	3.64	1.95
GW080083_1	3.49	5.78	2.29
GW080083_2	-0.09	3.82	3.91
GW80359	2.27	2.95	0.68
GW080082	2.00	3.59	1.59

Table 7.7 - Groundwater level variation in local area of site, post Water Sharing Plan commencement (01.07.2004), as derived from PINNEENA plots (refer Figure 16 to Figure 22 Annex E)

Notes:

1 Datum stated as 'bore level below MP' on PINNEENA plot.

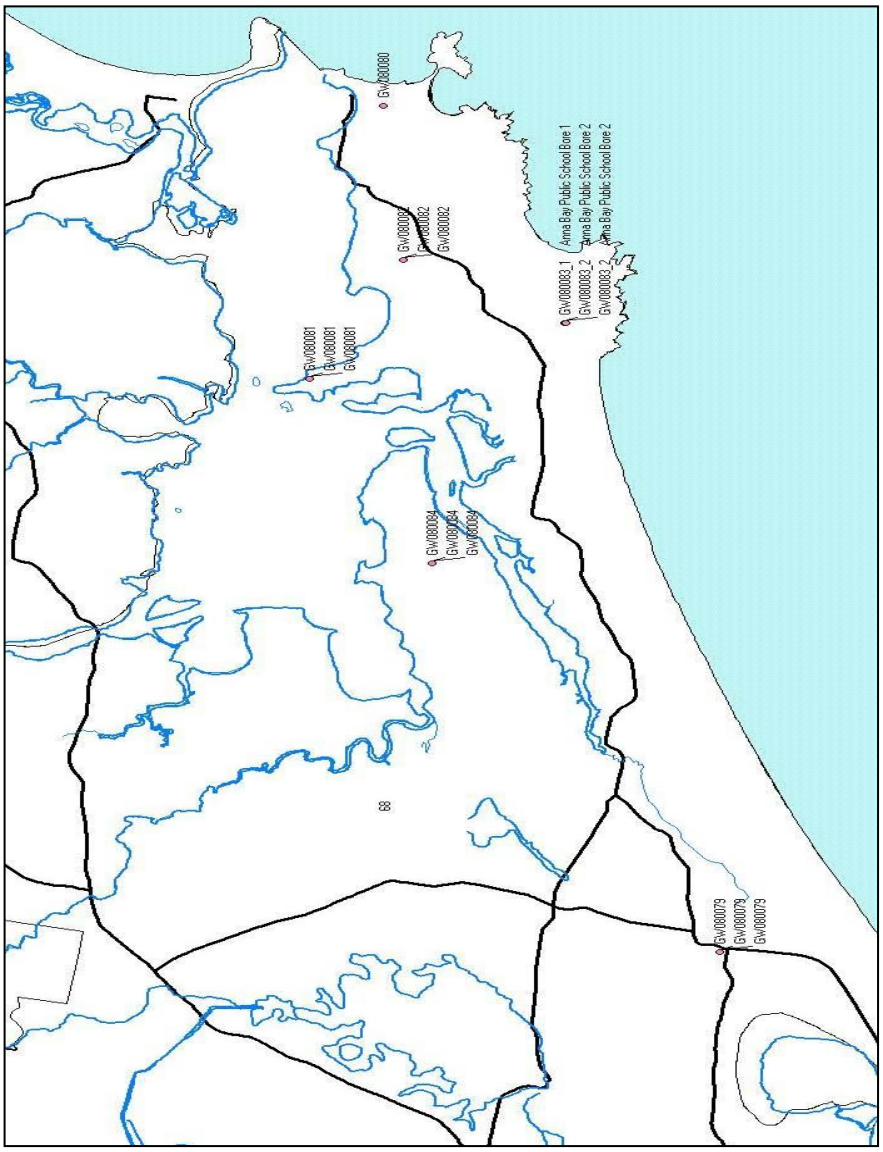


Figure 7.4 - Locations of Continuous Bore Locations

7.2.3.3 Site Levels

Groundwater was observed in all of the site's monitoring bores.

Dipped groundwater levels for the site's monitoring bores are provided in **Table 7.8** (datum = mBGL) and **Table 7.9** (datum = mAHD).

All site monitoring bores were equipped with data loggers to measure groundwater levels at 15-minute frequencies for a period of approximately 3 months. This data is summarised in Table 7.8 (datum = mBGL) and Table 7.9 (datum = mAHD) and plotted with rainfall on the secondary axis in Figure 7.5, Figure 7.6, Figure 7.7 and Figure 7.8.

Groundwater Level (mBGL)									
Bore	22.08.2013	01.10.2013	09.01.2014	17.03.2014	02.05.2014	17.07.2014	13.10.2014	29.01.2015	01.05.2015
BH1	3.52	3.35	3.14	3.34	3.23	3.50	3.17	3.52	2.66
BH2	9.69	9.76	9.44	9.58	9.48	9.25	9.49	9.81	9.03
BH3	13.15	13.11	13.18	13.28	13.34	13.54	13.31	13.42	13.39
BH4	7.26	7.31	7.44	7.70	7.71	7.75	7.48	7.84	7.47
BH5	15.39	15.43	15.47	15.66	15.66	15.89	15.50	15.77	15.40

Table 7.8 - Dipped groundwater levels (mBGL) at site bores

Groundwater Level (mAHD)									
Bore	22.08.2013	01.10.2013	09.01.2014	17.03.2014	02.05.2014	17.07.2014	13.10.2014	29.01.2015	01.05.2015
BH1	2.31	2.48	2.69	2.49	2.60	2.33	2.66	2.31	3.17
BH2	2.03	1.96	2.28	2.14	2.24	2.47	2.23	1.91	2.69
BH3	2.33	2.37	2.30	2.20	2.14	1.94	2.17	2.06	2.09
BH4	2.19	2.14	2.01	1.75	1.74	1.70	1.97	1.61	1.98
BH5	2.86	2.82	2.78	2.59	2.59	2.36	2.75	2.48	2.85

Table 7.9 - Dipped groundwater levels (mAHD) at site bores

	Groundwater Depth (mBGL)				
Bore	BH1	BH2	BH3	BH4	BH5
Minimum	2.72	9.08	13.08	7.25	15.30
Mean	3.27	9.45	13.30	7.36	15.42
Maximum	3.54	9.78	13.55	7.50	15.57
Range	0.81	0.71	0.47	0.26	0.27

Table 7.10 - Statistical summary of groundwater levels (mBGL) monitored by data logger at site bores between 22.08.2013 and 13.10.2014 (BH1, BH2, BH3) and 22.08.2013 and 09.01.2014 (BH4 and BH5)

Bore	Groundwater Depth (mAHD)				
	BH1	BH2	BH3	BH4	BH5
Minimum	2.29	1.94	1.93	1.95	2.68
Mean	2.55	2.27	2.18	2.09	2.83
Maximum	3.10	2.64	2.40	2.21	2.95
Range	0.81	0.71	0.47	0.26	0.27

Table 7.11 - Statistical summary of groundwater levels (mAHD) monitored by data logger at site bores between 22.08.2013 and 13.10.2014 (BH1, BH2, BH3) and 22.08.2013 and 09.01.2014 (BH4 and BH5)

The maximum range in groundwater level at an individual monitoring bore within the site was 0.88 m and occurred at BH1. BH1's minimum groundwater level of 2.29 mAHD occurred during the data logger monitoring period whilst the maximum groundwater level of 3.17 mAHD occurred during manual dip level monitoring undertaken on 01.05.2015.

7.2.3.4 Site Levels and Relationship to Rainfall

Groundwater level/rainfall plots (Figure 7.5, Figure 7.6, Figure 7.7. Figure 7.8 and Figure 7.9) indicate groundwater levels respond to rainfall recharge. With respect to hydrograph trends, BH1 and BH2 are similar to one another, and BH3, BH4 and BH5 are similar.

BH1 and BH2 displayed the most prominent responses to recharge events which occurred between 17.11.2013 and 19.11.2013 (137 mm of rainfall) and between 16.08.2014 and 08.09.2014 (313 mm of rainfall). Increases in groundwater level associated with the first recharge event were approximately 0.42 m and 0.32 m for BH1 and BH2 respectively. For the second recharge event, increases in groundwater level were 0.54 m and 0.25 m for BH1 and BH2 respectively.

BH3, BH4 and BH5 each responded to the 17.11.2013 to 19.11.2013 recharge event albeit to a lesser degree and more slowly than BH1 and BH2. Increases in groundwater level associated with this recharge event were approximately 0.04 m, 0.18 m and 0.22 m for BH3, BH4 and BH5 respectively.

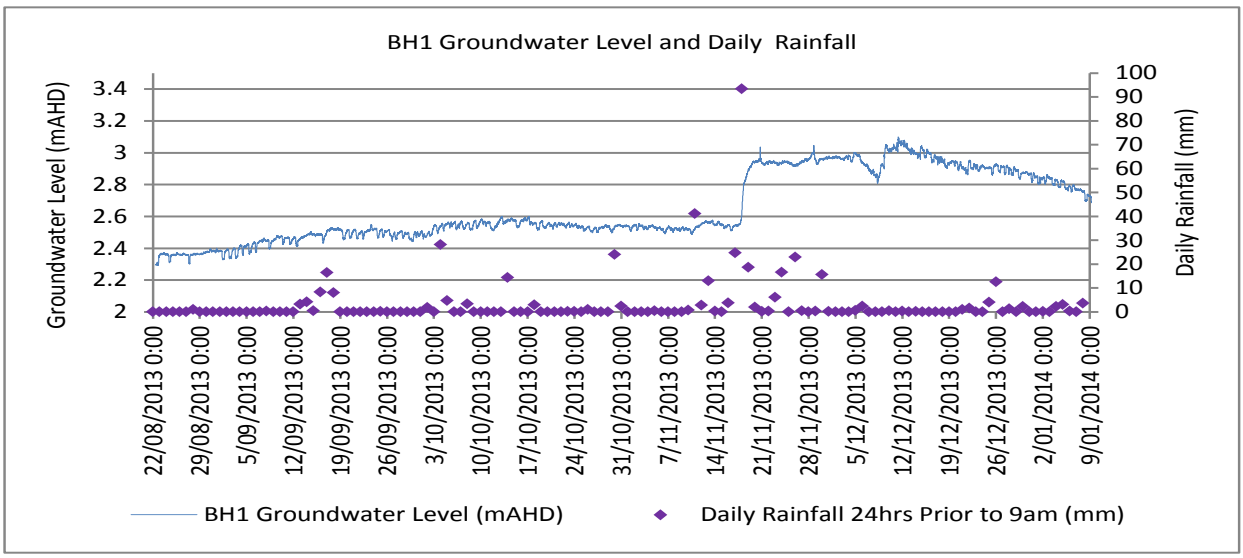


Figure 7.5 - BH1 Groundwater Levels Monitored by Data Logger

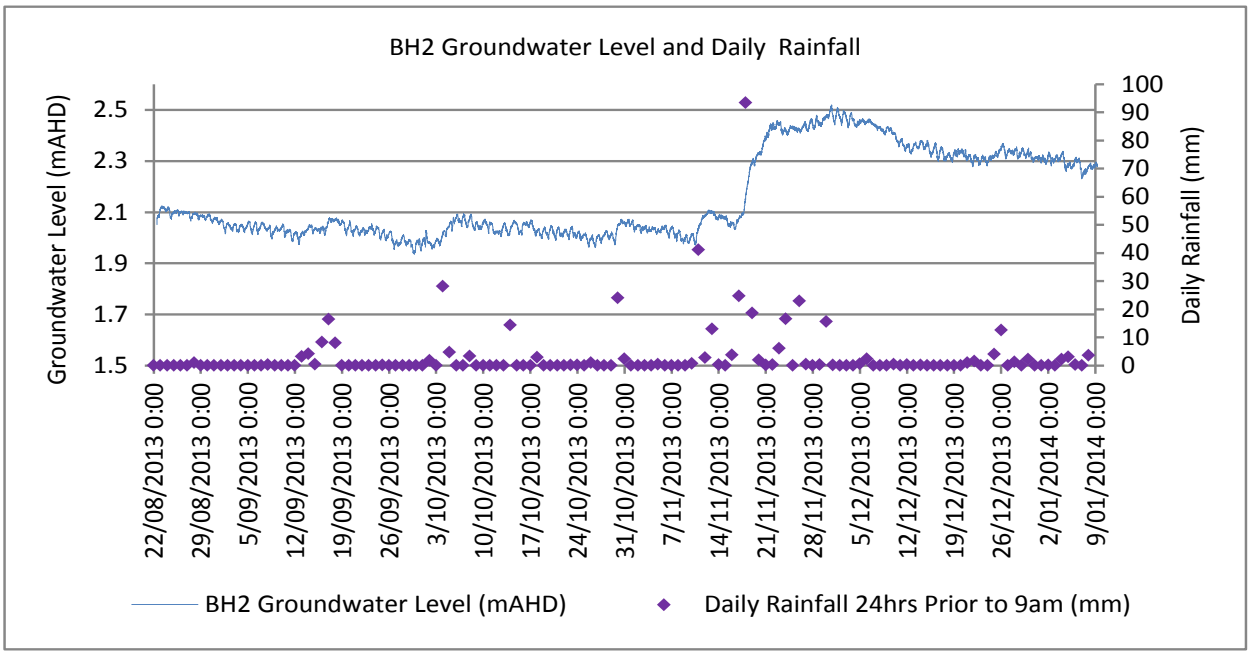


Figure 7.6 - BH2 Groundwater Levels Monitored by Data Logger

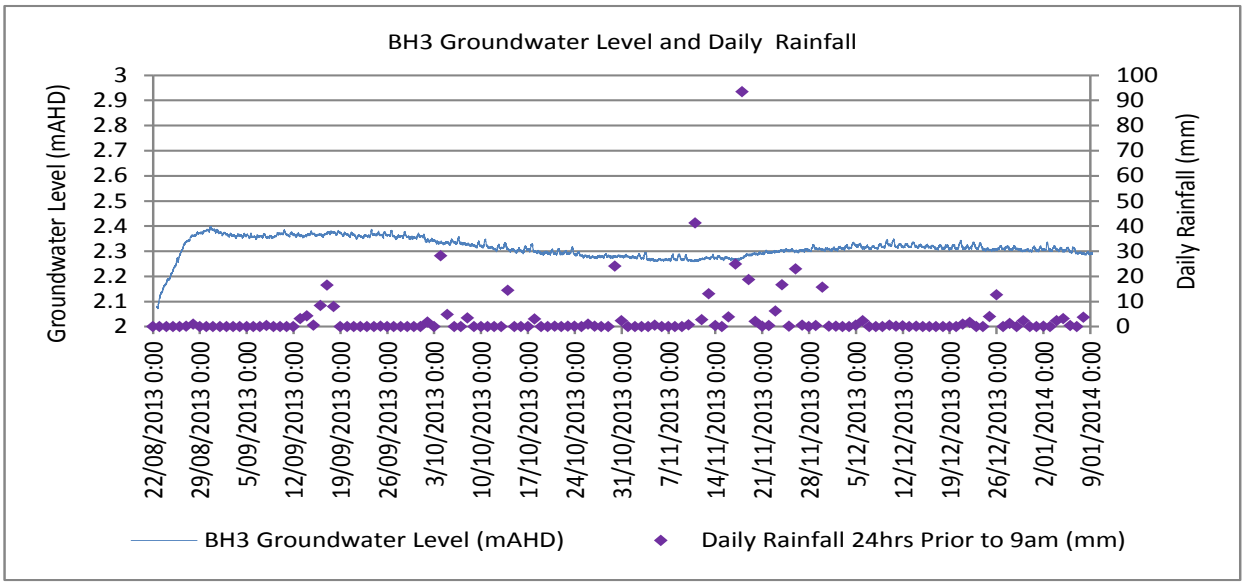


Figure 7.7 - BH3 Groundwater Levels Monitored by Data Logger

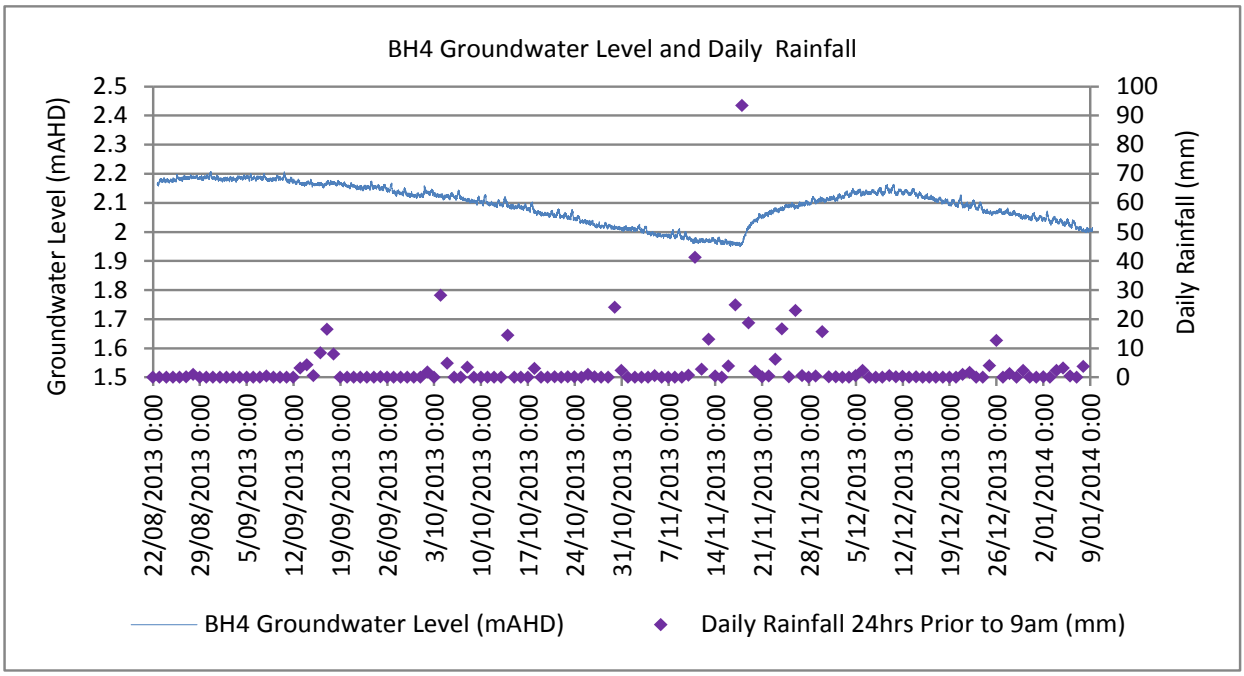


Figure 7.8 - BH4 Groundwater Levels Monitored by Data Logger

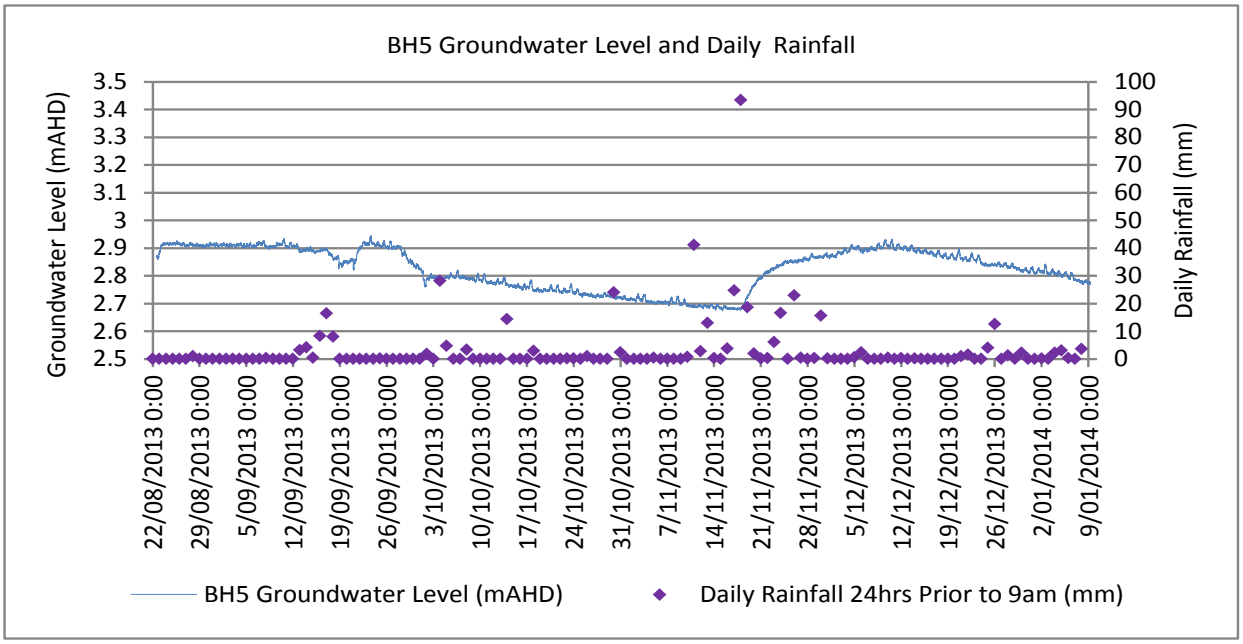


Figure 7.9 - BH5 Groundwater Levels Monitored by Data Logger

7.2.3.5 Groundwater Level Range Summary

In light of site groundwater level monitoring and post Water Sharing Plan (2004) commencement groundwater level variation documented in PINNEENA plots, the expected range of background groundwater level variability is likely to be of the order of 2 m to 4 m within and between years in the region of the site.

7.2.4 Background Groundwater Quality

Groundwater quality samples were taken from site bores on 22.08.2013, 16.10.2014, 30.01.2015 and 01.05.2015 and submitted to a laboratory for analysis. Key analytes are summarised in Table 7.12 with laboratory reports for the complete suite of analytes in Annex E and summary comments below.

- Groundwater is acidic. Minimum and maximum pH values were 3.5 and 6.0 respectively.
- Groundwater had a maximum salinity concentration of 490 mg/L and is therefore fresh in the context of salinity classes summarised in Table 7.13.
- Total Nitrogen (TN) had mean and median concentrations of 13.84 mg/L and 9.75 mg/L respectively. The mean and median values were strongly influenced by elevated oxidised nitrogen concentrations at BH1 and BH2 (maximum concentration of 43.00 mg/L), and by elevated TKN of samples collected on 01.05.2015, a sampling event which followed significant extended rainfall.
- The elevated oxidised nitrogen concentrations at BH1 and BH2 may be due to application of fertilisers or some other agricultural source (geese are kept near BH1), or a combination of both.
- Total Phosphorus (TP) had mean and median concentrations of 0.16 mg/L and 0.05 mg/L respectively. For the 14 of the 20 samples which had a concentration less than the practical quantification limit (PQL), the PQL of 0.05 mg/L was adopted for mean and median calculations.

Bore	Sample date	pH	EC [1] µS/cm	TDS [2] mg/L	TKN [4] mg/L	NOx [5] mg/L	TN [6] mg/L	TP [7] mg/L
BH1	22.08.2013	5.3	500	310	1.9	16.00	17.90	0.10
	16.10.2014	5.2	570	490	0.7	43.00	43.70	0.80
	30.01.2015	5.8	410	240	2.1	7.80	9.90	<0.05
	01.05.2015	5.0	580	370	15.0	31.00	46.00	1.10
BH2	22.08.2013	5.4	490	270 [3]	2.3	21.00	23.30	<0.05
	16.10.2014	5.1	190	160	0.9	9.50	10.40	<0.05
	30.01.2015	5.5	390	210	1.3	19.00	20.30	<0.05
	01.05.2015	5.4	360	290	14.0	19.00	33.00	<0.05
BH3	22.08.2013	5.6	250	138 [3]	0.5	0.01	0.51	<0.05
	16.10.2014	3.5	390	210	0.3	0.10	0.40	<0.05
	30.01.2015	4.7	300	160	0.8	0.20	1.00	<0.05
	01.05.2015	4.9	280	150	11.0	0.08	11.08	0.20
BH4	22.08.2013	5.2	190	105 [3]	0.3	<0.005	0.30	<0.05
	16.10.2014	4.7	150	120	1.6	0.02	1.62	<0.05
	30.01.2015	5.1	150	92	0.6	0.04	0.64	<0.05
	01.05.2015	5.4	220	140	40.0	<0.005	40.00	<0.05
BH5	22.08.2013	6.0	270	149 [3]	1.7	0.86	2.56	0.07
	16.10.2014	5.9	400	350	1.5	0.86	2.36	<0.05
	30.01.2015	5.6	430	280	1.5	0.81	2.31	<0.05
	01.05.2015	5.6	400	220	9.4	0.20	9.60	0.30

Table 7.12 - Site groundwater quality summary

Notes:

1 EC = electrical conductivity.
2 TDS = total dissolved solids.
3 Estimated from EC * 0.55 due to laboratory error.
4 TKN = total kjeldahl nitrogen.
5 NOx = nitrogen oxide.
6 TN = total nitrogen.
7 TP = total phosphorous.

Class	Salinity (mg/L)	Irrigation Suitability [1]	Suitable for Potable [2]
Fresh	< 1,000	500 – 1,000 can have detrimental effects on sensitive crops	0 - 600 good 600 – 900 fair 900 – 1000 poor
Brackish	1,000 – 5,000	1,000-2,000 adverse effects on many crops, requiring careful management practices	1000-1200 poor > 1,200 unacceptable / unpalatable
Highly Brackish	5,000 – 15,000	2,000 – 5,000 can be used for salt tolerant plants on permeable soils with careful management practices	No
Saline	15,000 – 30,000	Not suitable	No
Sea Water	30,000 – 40,000	Not suitable	No

Table 7.13 - Summary of water uses on the basis of salinity

Notes:
1 From NSW Department of Conservation and Land Management (1992).
2 From Australian Drinking Water Guidelines (2011).

7.2.5 Hydraulic Conductivity (K) Data

7.2.5.1 Regional Data

Aquifer(s) in the region of the site are characterised by medium to high K values which are typical of fine to medium grained quartz sand. Published K values for the Stockton Aquifer, the aquifer which the site occupies, are limited. However, Umwelt (2009) utilised a modelling pre-calibration K range of 10 – 30 m/d and final calibrated K value of 10 m/d in a groundwater model which was developed to accompany an EIS for a proposed sand mine located approximately 2.8 km south west of the site within the Stockton dune complex.

A groundwater model developed by SKM (2009) for the Tomago Aquifer, an aquifer located to the north of the Stockton Aquifer which the site occupies, utilised a K value of 3 m/d which was based on field testing. Geary (2003) reported that the typical K range for the Tomago Aquifer is 10 – 20 m/d.

The typical range of K values for fine to medium grained sand is of the order of 0.6 to 15 m/d (Bair and Lahm, 2006).

7.2.5.2 Site Data

Slug testing was undertaken at all site bores to estimate K. Approximately 10 L to 20 L of water was poured rapidly into each bore. The response was recorded by a data logger measuring at 1 second intervals and data analysed using the Hvorslev solution. Estimated K values were presented in MA (February, 2014). We note that the site's bores were constructed with long screens of 12 m and 18 m long (not constructed by MA) and therefore potential diminished

bore responses due to near immediate water loss are likely to have caused estimated K values to be artificially low.

In light of the above, as well as regional K data and site particle size grading suggesting that K values are likely to be higher than estimated in MA (February, 2014), slug test data has been reinterpreted with a nominal screen length of 2 m. Results are summarised in Table 7.14 - Summarised slug test data 7.14 and are in line with regional data and values in the literature.

Bore	Hydraulic Conductivity (m/d)
BH1	6.78
BH2	17.21
BH3	9.00
BH4	2.38
BH5	3.95
Geomean	**6.29**

Table 7.14 - Summarised slug test data

In addition to slug testing, the results of laboratory particle size grading tests documented within VGT & Quarry Mining Systems (2013) were assessed to enable an estimation of K. The mean percent passing was calculated for each sieve size for 21 samples. This generated a single representative particle distribution curve from which the 10% passing diameter was estimated. The 10% passing diameter was applied in a Kozeny-Carman equation (1956) to calculate an estimated K value of 10.5 m/d. We note that as site samples were noted to have been collected by bailer, some fine particles, if present, would have been lost. Consequently, the estimated K value of 10.5 m/d may be representative of the site's upper range of K values.

7.2.6 Groundwater Dependent Ecosystems (GDEs)

Based on information provided by the project's ecological consultant, Wildthing, two GDEs exist on/near the site, Swamp Mahogany Paperbark Forest and Tall Alluvial Moist Forest. The location of these GDEs is shown in Figure 7.10.

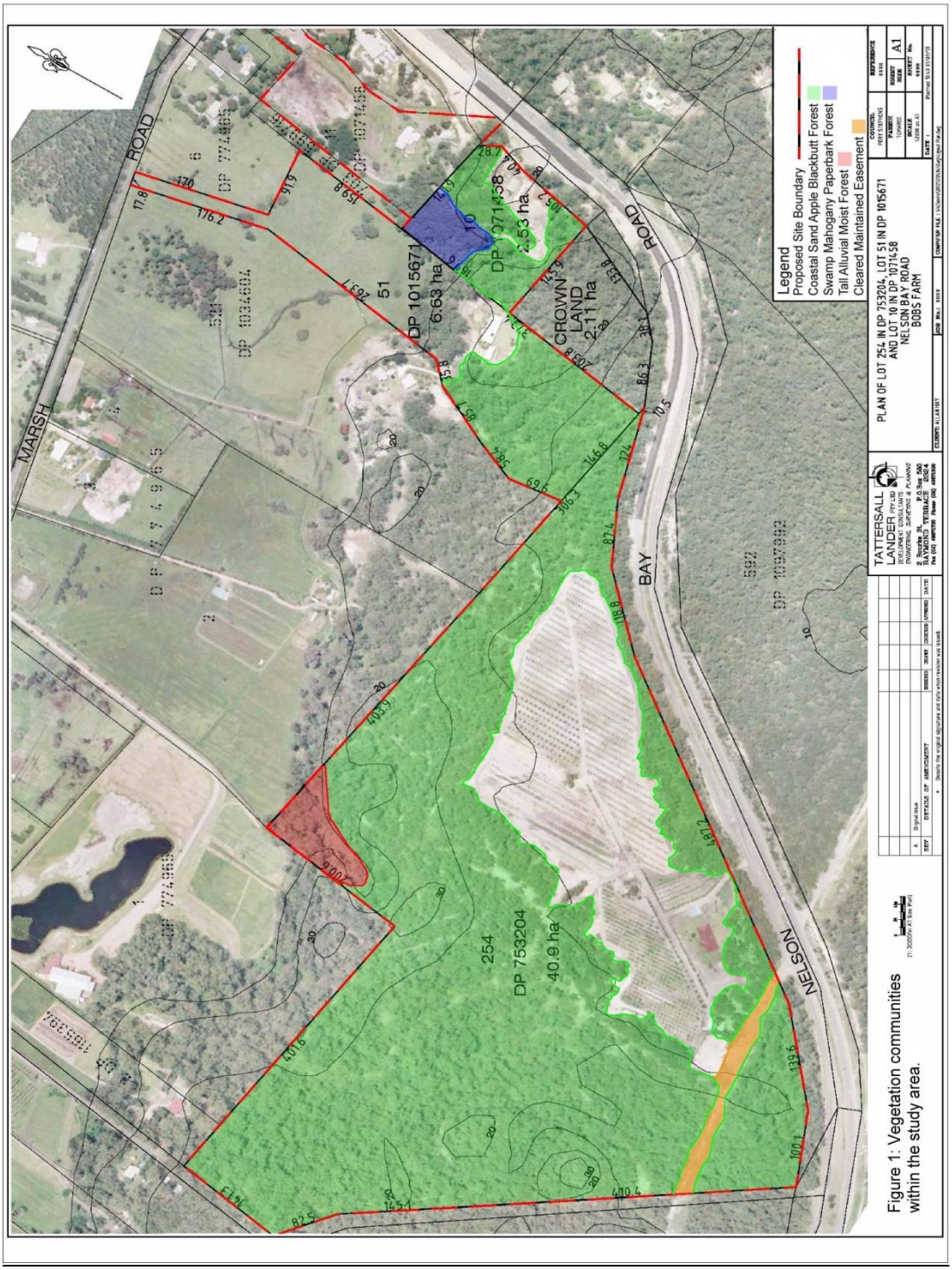


Figure 1: Vegetation communities within the study area.

Figure 7.10 - Location of Groundwater Dependent Ecosystems (GDE's)

7.2.7 Conceptual Groundwater Model

Based on data presented in preceding sections of this report, a conceptual groundwater model (CGM) plan (Figure 7.11) and cross section (Figure 7.12) were prepared and indicate:

- A groundwater flow divide likely exists approximately 200 to 400 m south east of the site and forms a groundwater ridge between Tilligerry Creek and the Tasman Sea. The groundwater ridge is situated between the active Stockton dune and the stable dune which occupies the site. Groundwater flow is to the north west towards Tilligerry Creek in the area of the site.

- Hydraulic gradients are low with only a 0.74 mAHD range in mean groundwater level between all site bores for the data logging period.
- Groundwater depth is highly variable due to varying land surface levels. Maximum groundwater depth is of the order of 32 mBGL whilst minimum groundwater depth may be of the order of 0.5 to 1 mBGL in the far north of the site where land surface levels are 2 mAHD.
- With the exception of a clay/high organics layer located just below the water table, the investigation and soil profile generally comprises fine to medium grained sand that is subrounded to rounded with moderately high sphericity.
- Localised hydraulic conductivity is likely to frequently fall between say 0.6 and 15 m/d but may vary outside of this range.
- Specific yield of sands is likely to be of the order of 0.25 based on typical values in Bair and Lahm (2006).
- Groundwater is generally fresh in the site area.
- Groundwater is recharged via rainfall and exits the study area via throughflow with ultimate discharge to Tilligerry Creek and the ocean.

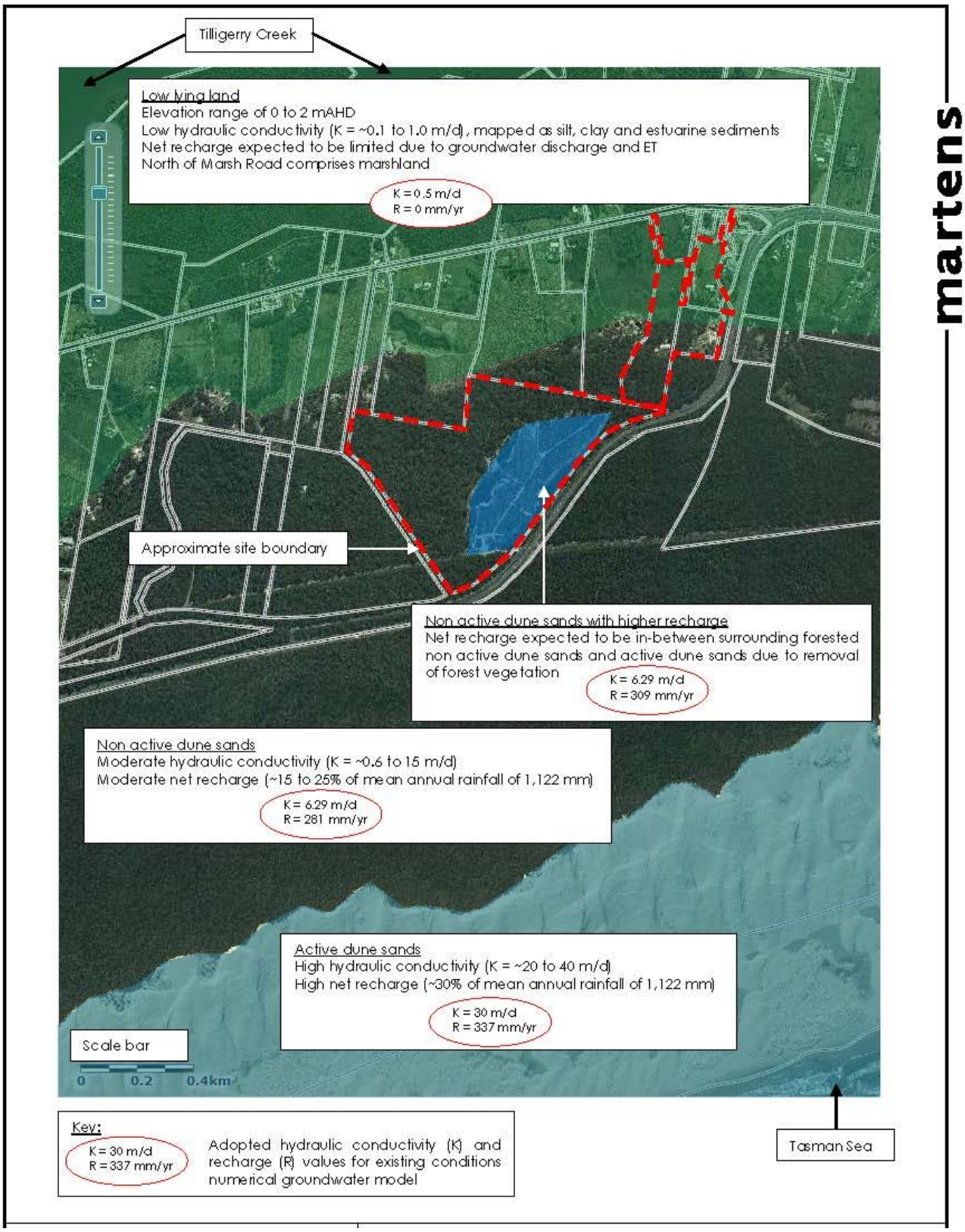
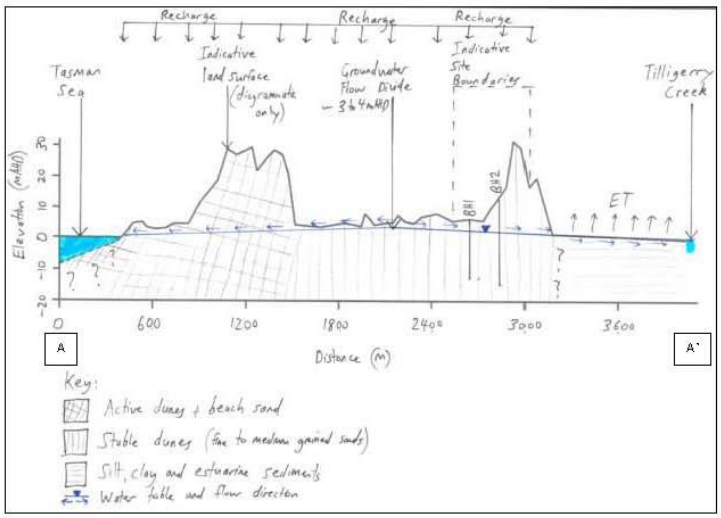


Figure 7.11 - Conceptual Groundwater Model



Notes:
1. Refer site survey plan, Attachment A, for section location.
2. Schematic and diagrammatic only.
3. Vertical exaggeration = 20.
4. Based geological mapping within Quarry Mining Systems (2013) and site boreholes which generally found fine to medium grained sands to investigation level of approximately -14 mAHD.
5. Clay/high organic layer near water table not shown, refer to report for detail.

Figure 7.12 - Hydrogeological Cross Section

7.3 GROUNDWATER IMPACT ASSESSMENT

7.3.1 Numerical Groundwater Model

7.3.1.1 Overview

To assess the impact of the proposed development on the permanent groundwater system, a two-layered steady state numerical groundwater model (MODFLOW) was established for existing and proposed conditions.

In accordance with Australian groundwater modelling guidelines (June, 2012), the model is considered to represent a model in-between a 'Class 1' and 'Class 2' model confidence-level.

This degree of model confidence-level is considered appropriate for assessment purposes given the water table has minor variation over the entire site, and because although some groundwater extraction is required for water supply purposes, the principal mechanism of groundwater extraction is evaporation of the proposed dredge lake.

7.3.1.2 Objective

The objective of the model was to estimate drawdown due to:

- The dredge lake exposing groundwater to the atmosphere (i.e. facilitating evaporation).
- Pumping of groundwater to meet site operational demands.

7.3.1.3 Software

Visual MODFLOW Pro was used with SURFACT's pseudo soil function as the engine.

7.3.1.4 Layers

The model had two layers. For Layer 1, ground surface was established based on LIDAR survey data, with the base of the layer set to -15 mAHD (maximum extraction level). The base of Layer 2 was set to -20 mAHD.

7.3.1.5 Calibration Model Parameters and Boundary Conditions

For existing conditions, the model was established with net recharge and conductivity zones as outlined on the conceptual model plan (Figure 7.11). With the exception of the non active dune sand zone, conductivity values were assigned to be in the middle of the ranges noted on the conceptual model plan. The non active dune sand was assigned a K value of 6.29 m/d which was the geomean of site test values at BH1, BH2, BH3, BH4 and BH5 (Table 7.14 - Summarised slug test data).

Recharge values were assigned based on ranges outlined on the conceptual model plan (Figure 7.11) and adjusted during calibration. Adopted calibration values are also shown in Figure 7.11.

Constant heads (0 mAHD) were utilised at the extremities of the active model domain at Tilligerry Creek and the Tasman Sea.

7.3.1.6 Calibration

The model was calibrated to maximum observed head over the monitoring period at BH1, BH2, BH3, BH4 and BH5.

The model had a mean error at site bores of 0.34 m. The minimum error was 0.03 m (BH1) whilst the maximum error was 0.76 m (BH4).

The model is considered relatively poorly calibrated in the region of BH4 and BH5. Notwithstanding this, the calibration is adequate to achieve model objective of assessing drawdown caused by evaporation and pumping of the dredge lake.

Groundwater contours from the calibration model (i.e. existing conditions) are provided in Figure 7.13

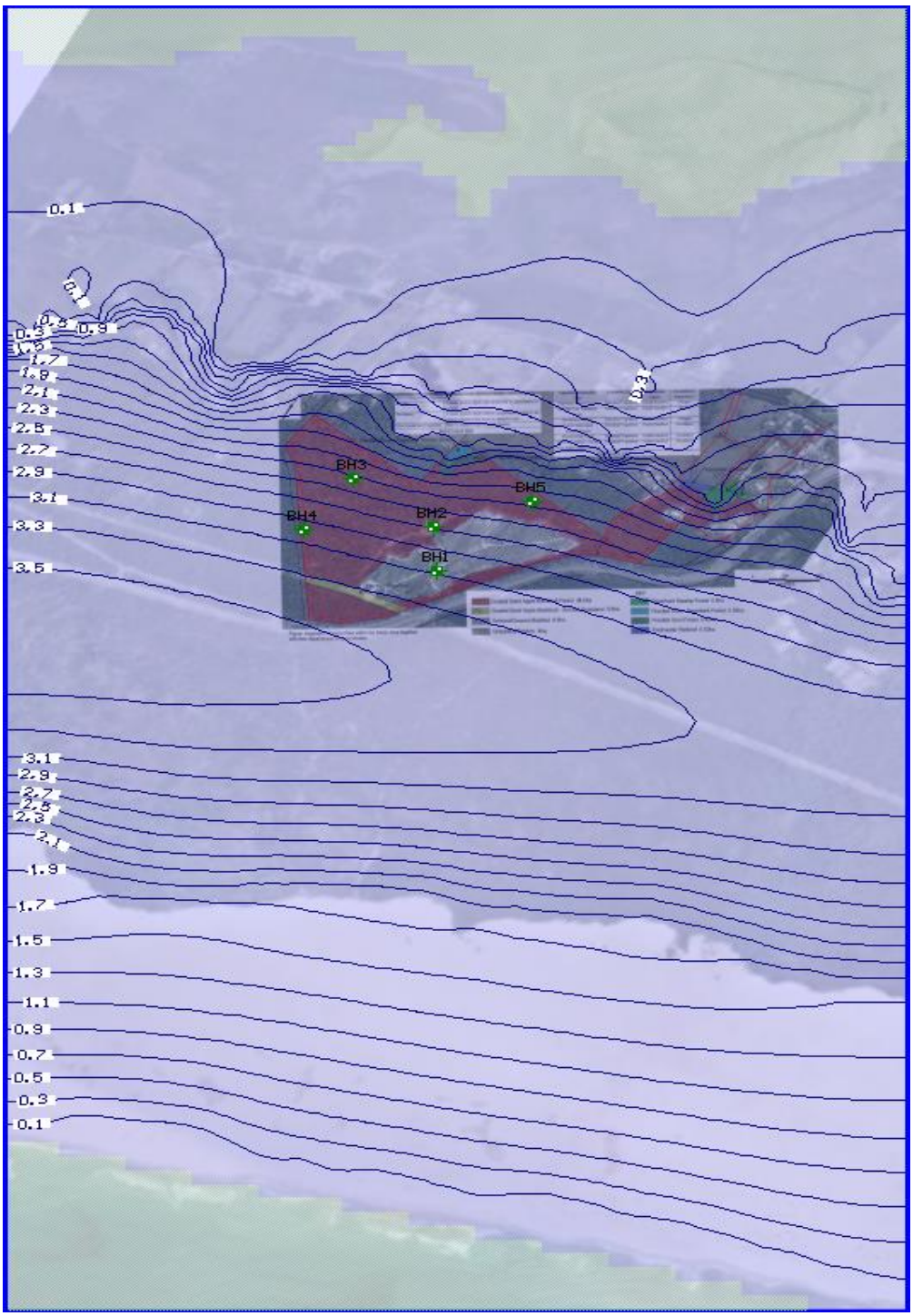


Figure 7.13 - Exisiting Groundwater Contour Condition (mAHD)

7.3.1.7 Simulation Model Parameters and Boundary Conditions

For the simulation model, parameters and boundary conditions were as per the calibration model except for the following:

- Net recharge was decreased over the dredge lake to -297 mm/year to represent the balance of mean annual direct rainfall of 1,122 mm and mean annual evaporation of 1,731 mm (both taken from Williamtown BOM station) multiplied by a pan factor of 0.82 for Williamtown (McMahon et al., date omitted).
- Hydraulic conductivity in the area of proposed mining was increased from 6.29 m/d to 1,000 m/d for the model's top layer. The top layer's base level was -15 mAHD and therefore represented the extent of dredging. The conductivity change was implemented to represent the lake which will form due to site dredging.
- A pumping bore was established in Layer 1 of the model in the area of the dredge lake to represent ongoing water demand associated with the washing plant and truck washing. The bore was set to extract 120 m^3/d and was based on demands outlined in Section 7.3.4. The extraction rate of 120 m^3/d accounts for groundwater gains associated with bioretention overflow was documented in MA (April, 2015).

7.3.1.8 Simulation Results

Groundwater contours from the proposed development model are provided in Figure 7.14. Drawdown contours are shown in Figure 7.15 and indicate that the dredge lake, at maximum extent, could result in a maximum drawdown of approximately 1.6 m. The maximum drawdown occurs in the south south western corner of the site.

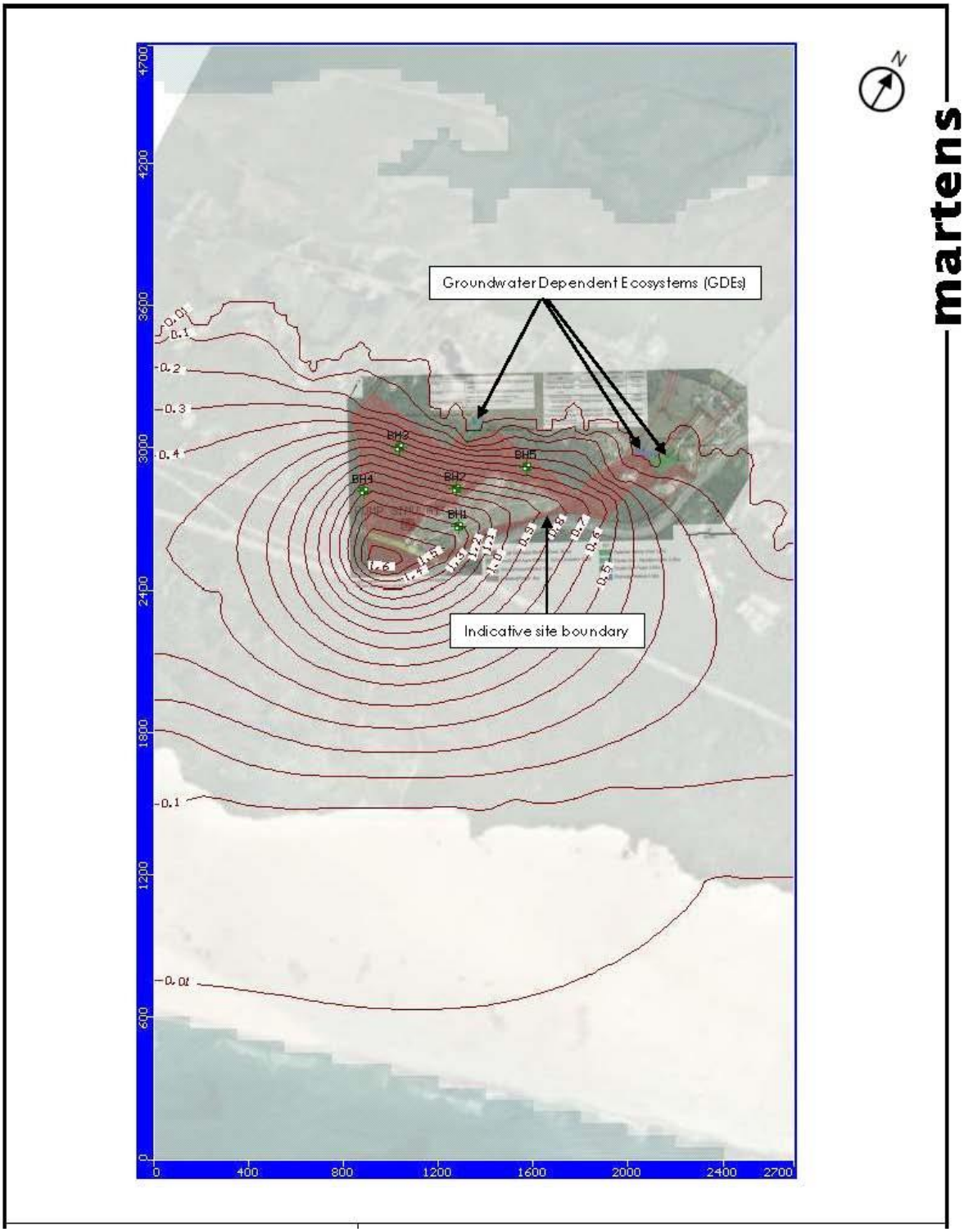


Figure 7.14 - Developed Conditions Groundwater Contours (m)

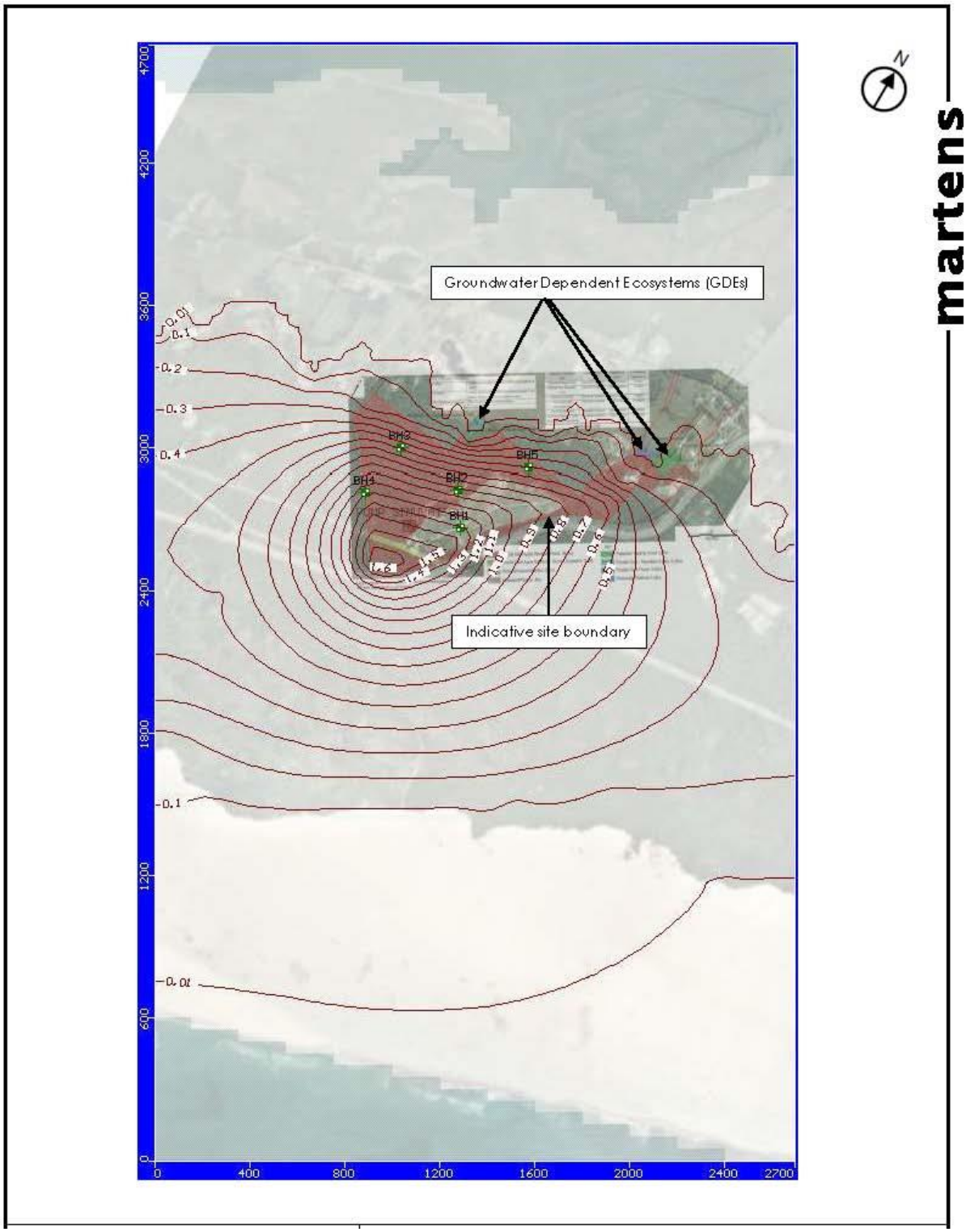


Figure 7.15 - Developed Conditions Drawdown Contours (m)

7.3.2 Impact on Groundwater Dependent Ecosystems

Identified vegetation communities that are exclusively reliant on groundwater (Section 7.2.6) are located outside of the proposed mining footprint.

Drawdown of the permanent groundwater system at these vegetation communities is modelled to be a maximum of approximately 0.07 m.

Based on the NSW Aquifer Interference Policy (NOW, 2012) and the post Water Sharing Plan local groundwater natural level range of the order of 3 m (or more), (refer Section 7.2.3.2), the adopted permissible drawdown at a 40 m buffer from the GDEs is 0.30 m (i.e. 10% x 3.00).

This drawdown threshold is met for vegetation communities exclusively reliant on groundwater. Consequently, based on modelling results, the proposed development does not exceed the drawdown impact criterion set out in the NSW Aquifer Interference Policy (NOW, 2012).

7.3.3 Impact on Existing Bores and Farm Dams

Groundwater level changes at existing surrounding bores and farm dams due to the project are anticipated to be negligible. As water table decline is not predicted to be above the stipulated threshold of 2 m (NOW, 2012), make good provisions do not apply.

7.3.4 Groundwater Licencing

In accordance with the Tomago, Tomaree and Stockton Groundwater Sources Water Sharing Plan (2003), a share component equivalent to the project's anticipated maximum annual groundwater take, is to be sought under an aquifer access license.

Groundwater take will comprise:

- Evaporation from the dredge lake resulting in a volume of 89.16 ML/yr (297 mm/yr net evaporative loss over maximum dredge lake area of 30.02 ha).
- 2% of maximum plant demand (216 m³/operation day) resulting in a volume of 45.14 ML/yr. The 2% represents losses due to minor spills, splashing on plant start up, or blockages, if and when they occur. Water demand volumes and the estimated loss of 2% were provided by Quarry Mining Systems.
- Net losses from dust suppression (12 m³/operation day) resulting in a volume of 2.51 ML/yr.
- Any other groundwater extraction volumes.

Based on above, maximum groundwater take is estimated to be 137 ML/yr.

There may be an opportunity to account for groundwater gains of 4 ML/yr associated with site bioretention basin overflow documented in MA (April, 2015). We recommend NSW Office of Water be consulted to confirm groundwater take for licensing, and to confirm if bioretention overflow groundwater gains can offset the estimated take of 137 ML/yr, yielding a reduced take of 133 ML/yr, should this be desirable.

7.4 GROUNDWATER MANAGEMENT PLAN

7.4.1 Groundwater Management/Maintenance Elements

Key groundwater elements to be managed/maintained at the site include:

- The monitoring bore-field.
- pH of water within the dredge lake, pH of water exiting the washing plant prior to re-entering the dredge lake and pH of stockpile leachate.

7.4.2 Bore-field

The existing bore-field comprises five bores (BH1, BH2, BH3, BH4 and BH5). All bores except BH4 are within the proposed mining area. Consequently, as mining progresses, BH1, BH2, BH3 and BH5 will at some point, be destroyed.

The bore-field throughout the mine's operation should comprise five functional bores, being BH4, and four replacement bores which should be installed following project approval.

Of the four replacement bores, one should be installed at each GDE group, one in the area of the proposed plant/shed and one in the north western corner of the site.

It is important the replacement bores are installed immediately following project approval as this will enable collection of background data for the four replacement bores prior to mining commencement.

7.4.3 Bore-field Maintenance

As part of routine bore-field inspections, the bore-field shall be maintained to ensure that collected groundwater samples are representative. Maintenance shall include at a minimum visual inspection and purging the bore until such time as water quality being pumped is uniform.

Bores found to be damaged, lost or vandalised are to be replaced.

Bores with excessive algae matt build up are to be remediated with chlorine flushing and pumping, or if this is ineffective, replaced.

7.4.4 Management

7.4.4.1 Overview

As actual acid sulfate soil and potential acid sulfate soil may be encountered below the current groundwater level, the dredge lake's pH and pH of water exiting the washing plant prior to re-entering the dredge lake should be monitored and managed throughout the life of the proposed development.

To facilitate treatment of pH, pond(s) and stockpile bases should be lined.

7.4.4.2 Monitoring

The dredge lake's level and pH should be monitored continuously by data logger throughout the life of the development. To provide a reference level for data logger levels, an accessible gauge to mAHD datum will need to be established on the perimeter of the dredge lake.

In addition to the dredge lake's continuous level and pH monitoring, the same analytes as proposed for groundwater analysis should be sampled quarterly and tested by laboratory.

7.4.4.3 Trigger Value

A pH of <4 is to trigger hydrated liming to neutralise acidity.

Water with a pH <4 should not be returned to the dredge lake until liming increase the pH to ≥4.

7.4.4.4 Further Works

Detailed pH management systems are to be confirmed at detailed design stage once the mine's plant and process details are available.

7.4.5 Groundwater Monitoring

7.4.5.1 Groundwater Level

Groundwater level should be monitored at weekly intervals, or preferably continuously via data logger at 5 bores throughout the life of the development. Until such time as the replacement bores are constructed, the five existing bores should be monitored by data logger.

7.4.5.2 Groundwater Quality

7.4.5.2.1 Background Levels and Parameters

Groundwater quality should be sampled quarterly at five bores throughout the life of the development. Until such time as the replacement bores are constructed, the five existing bores should be monitored.

Samples should be analysed for the following:

- Total Nitrogen
- Nitrogen sub-species
- Total Phosphorus
- Hydrocarbons
- pH
- EC
- Manganese
- Arsenic
- Chromium
- Cobalt
- Zinc

7.4.5.2.2 Trigger Values

Trigger values for the analytes listed in Section 7.4 5.2.1 will be determined prior to commencement of mining based on 2 standard deviation over the observed mean value of background data at both the existing and proposed bores.

7.4.5.2.3 Action Requirements

Action will be required if trigger values are exceeded. Action will involve the following:

- Site owner to engage a suitably qualified professional to provide advice.
- Reviewing the data in light of environmental/climate conditions.
- Determine if further investigation is warranted.
- Spatially identify key areas requiring action.
- Determine appropriate action based on circumstances in consultation with Council and NSW DECCW.
- Undertake action.

7.4.6 Reporting

All monitoring data is to be presented in an annual report that will be forwarded to Council. Council and NSW DECCW are to be notified if results above trigger values are found.

8 COASTAL HAZARD ASSESSMENT

Chapter Eight describes the coastal setting and assesses the active coastal processes, coastal regression and provides recommendations to accommodate future coastal hazards.

8.1 PROPOSED DEVELOPMENT OVERVIEW

The proposed development is for the construction and operation of a sand mine at the above site. The extraction works are assumed to cover the majority of the site excluding a 15m vegetated buffer to site boundaries and a dedicated processing and administration area. Preliminary staging plan for mining operations is provided in Table 8.1.

Stage	Activities	Processes
Preliminary	Preliminary works	Provision of access roads and an intersection with Nelson Bay Road. Initial clearing of existing structures. Setting up of screening operations, loading ramp and storage shed. Construction of the main exit road onto the existing bitumen sealed road within Lot 10 DP 1071458.
1	General site clearing	Clearing of topsoil and stockpiling, for likely processing into landscape soil base and sports field top-dress material.
	Extraction	Extraction of aeolian sands to approximately 3 m above the groundwater table, using conventional excavation/extraction techniques, and stockpiling for later use for various purposes.
2	Extraction	Extraction of aeolian sands to approximately 1 m above the groundwater table, using conventional excavation/extraction techniques, and stockpiling for later use for various purposes.
3	Extraction	Extraction of aeolian and marine sand from approximately 1 m above to 16 m below the groundwater table, by dredging, and stockpiling for later use for various purposes.
4	Rehabilitation	Rehabilitation for likely use of the resultant lake as a tourist attraction.

Table 8.1 - Preliminary operations staging plan

8.2 SITE CHARACTERISATION

8.2.1 Location and Description

Figure 8.1 provides site aerials. Figure 8.2 provides a proposed site plan.

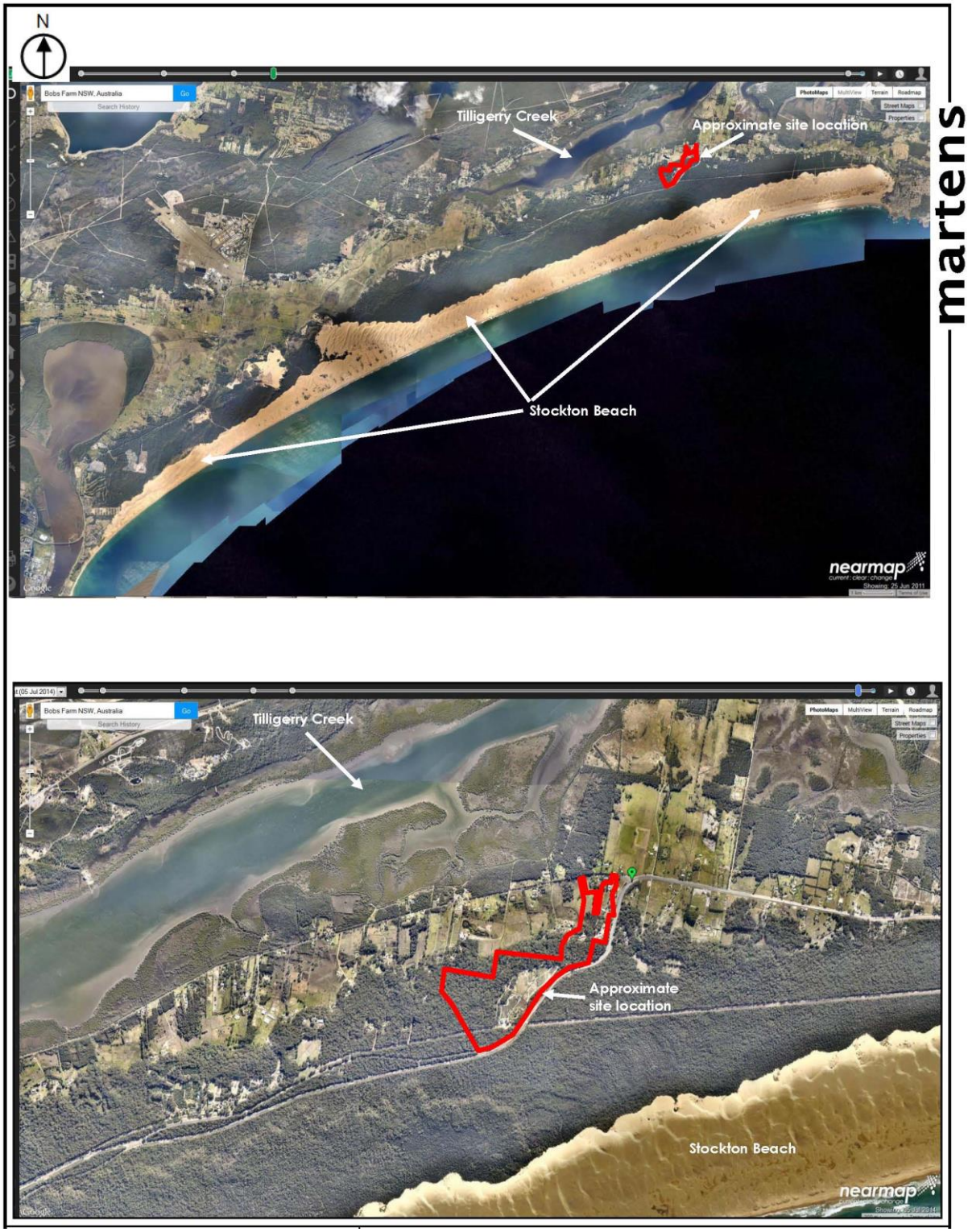


Figure 8.1 - Site Location and Regional Context

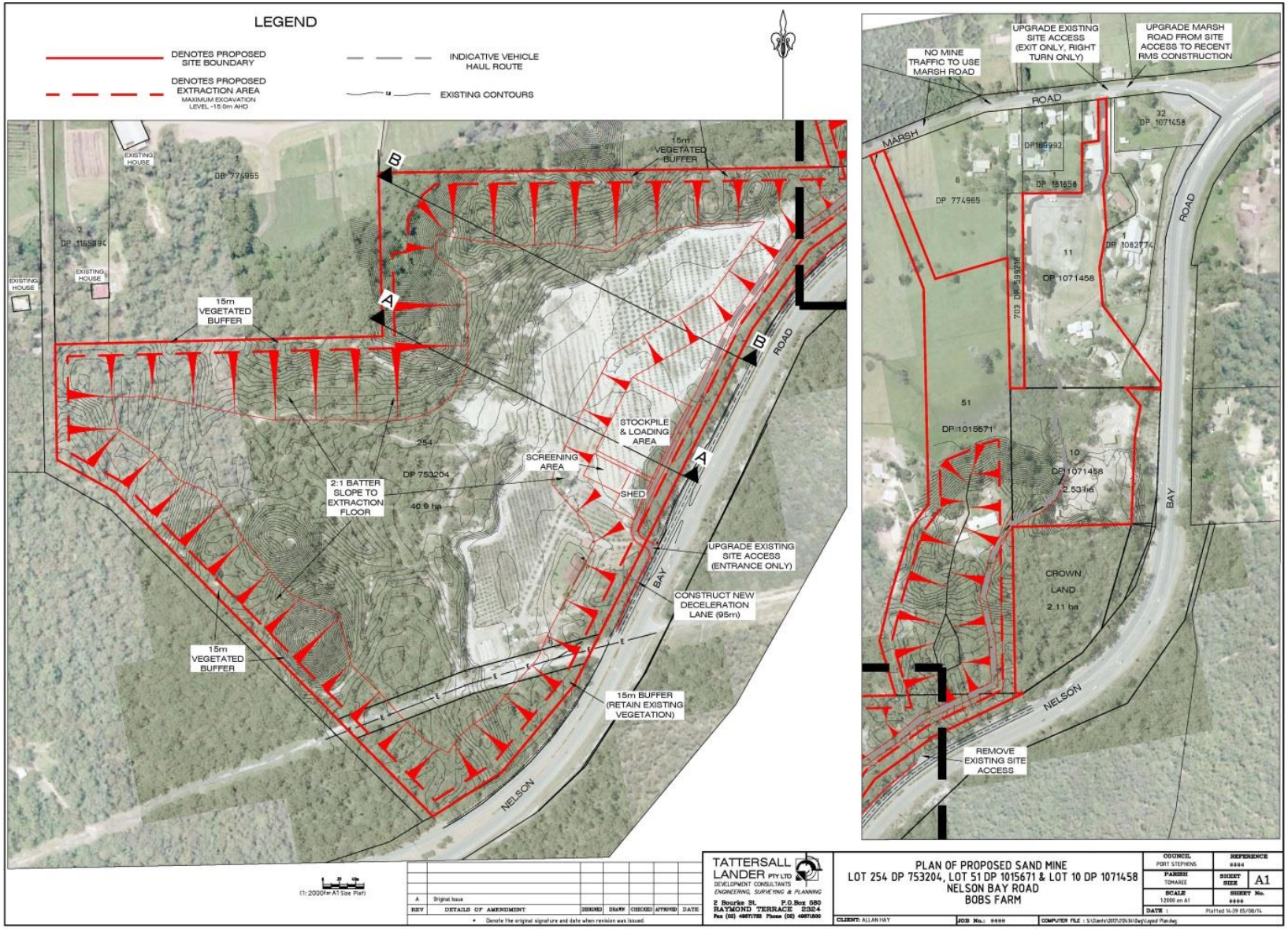

LEGEND
DENOTES PROPOSED SITE BOUNDARY
DENOTES PROPOSED EXTRACTION AREA
MAXIMUM EXCAVATION LEVEL -15.0m AHD
INDICATIVE VEHICLE HAUL ROUTE
EXISTING CONTOURS
EXISTING HOUSE
15m VEGETATED BUFFER
2:1 BATTER SLOPE TO EXTRACTION FLOOR
STOCKPILE & LOADING AREA
SCREENING AREA
SHED
UPGRADE EXISTING SITE ACCESS (ENTRANCE ONLY)
CONSTRUCT NEW DECELERATION LANE (95m)
15m BUFFER (RETAIN EXISTING VEGETATION)
NELSON BAY ROAD
NO MINE TRAFFIC TO USE MARSH ROAD
UPGRADE EXISTING SITE ACCESS (EXIT ONLY, RIGHT TURN ONLY)
UPGRADE MARSH ROAD FROM SITE ACCESS TO RECENT RMS CONSTRUCTION
MARSH ROAD
CROWN LAND 2.11 ha
REMOVE EXISTING SITE ACCESS
DP 774965
DP 753204
DP 1015671
DP 1071458
40.9 ha
2.53 ha
TATTERSALL LANDER PTY LTD
DEVELOPMENT CONSULTANTS
ENGINEERING, SURVEYING & PLANNING
PLAN OF PROPOSED SAND MINE
LOT 254 DP 753204, LOT 51 DP 1015671 & LOT 10 DP 1071458
NELSON BAY ROAD
BOBS FARM
COUNCIL PORT STEPHENS
PARISH TOMAREE
SCALE 1:2000 on A1
SHEET SIZE A1
DATE : Plotted 14-39 05/08/14
CLIENT: ALLAN HAY

Figure 8.2 - Proposed Development Layout

Item	Detail
Site address	3631, 3679 and 3721 Nelson Bay Road and 774 Marsh Road, Bobs Farm, NSW.
Lot and DP (Title Information)	Lot 254 DP753204 Lot 51 DP1015671 Lot 10 DP1071458 Lot 1 DP 1082774
Local government area (LGA)	Port Stephens Council (PSC).
Site Area	Approximately 40 ha.
Existing Site Development	Approximately 25 % of the site's area is utilised for agricultural purposes (primarily olive and fig plantations) with a small proportion of this area occupied by farm sheds, a farm hand residence and a master residence. A power transmission line easement (poles and wires) cuts across the southern corner of the site. The remaining 75 % of the site area remains undeveloped apart from some vehicle tracks.
Current land use	Rural residential and agriculture.
Proposed land use	Extractive (mining).
Surrounding land uses	Rural residential allotments border the site to the north, west and south west. Nelson Bay Road borders the site to the south east, with Worimi National Park located on the southern side of Nelson Bay Road. The Australian Shark and Ray Centre is located along the western end of the northern site boundary.
Topography and drainage	The site is located on a relict dune system and is characterised by dune knolls that create localised high and low points. The majority of the site slopes towards the east towards Nelson Bay Road, however, some portions of the site slope to the north, west and south west. Slopes are low (typically 0-5 %) in the eastern portion of the site and higher (typically 10-50 %) over the remainder of the site. The high slopes occur on dune knolls. The Tilligerry Creek floodplain to the north of the site comprises predominantly flat on near-level land. Site elevation ranges from approximately 35 mAHD at a knoll in the north west to approximately 2 mAHD at a depression in the site's north.

Item	Detail
	The majority of the site drains towards Stockton Beach (Woromi National Park), with a small portion adjacent to the north west boundaries draining to Tilligerry Creek. The lower eastern portion of the site has typical elevations of between 2 and 8 m AHD. The majority of the site drains southwards towards Stockton Beach No watercourses, drainage features or surface ponding were noted onsite.
Flooding	The north western corner of the site is potentially partially affected by flood waters from Tilligerry Creek.
Vegetation	The majority of the site is forested with the low lying areas near Nelson Bay Road utilised for agricultural purposes (typically olive and fig plantations). An ecological study undertaken by Wildthing Environmental Consultants (2013), found the forested vegetation largely consists of uncleared tall open forest dominated by the canopy species Eucalyptus pilularis (Blackbutt) and Angophora costata (Smooth-barked Apple). Two smaller areas of wetter forest were also identified within lower areas of ground. A small EEC community of Swamp Oak Floodplain Forest was identified in the north eastern area of the site.
Hydrology	The site is a localised high point, sitting on a relict dune system of Stockton Beach to the site's east. An unnamed tributary of Tilligerry Creek is located 30m to the north east of the northern boundary of Lot 51 on the opposite side of Marsh Road and an existing lake is located approximately 120m to the north west of Lot 254 within the Shark and Ray Centre facility.
Geology	The Newcastle and Port Stephens 1:100,000 geological sheets indicate that the site is underlain by Holocene sand (stable dunes).
Soil Landscape	Borehole investigations completed by Martens and Associates (2014b) found that soil profile consists of fine to medium grained sands with bands of an organic soils found in the vicinity of the groundwater table.

Table 8.2 - Site background information

8.2.2 Geomorphology

8.2.2.1 Stockton Beach

The Stockton Beach dune profile to the north west consists of a mobile largely unvegetated dune system up to 40 m AHD ranging from 0.5 to 1.5 km inland, and an incipient dune sporadically vegetated with grasses and shrubbery to approximately 5.0 mAHD. The foredune crest is approximately 1,400 m south east of the site boundary. Access fences have been installed along parts of the foredune by Port Stephens Council to restrict access to some parts of the dunes.

8.2.2.2 Tilligerry Creek

To the site's northwest lies Tilligerry Creek, which may have existed as an estuarine lagoon system behind Stockton sand dunes in periods of higher sea levels (DPI, 2009). Tilligerry Creek is an interbarrier estuary draining to Port Stephens with a mean tidal range of 1.01 m (NSW OEH, 2011). The creek system generally flows north east with a catchment of approximately 130 km2. The area's elevation is generally very low lying between 0 and 2 mAHD, with wetlands and a swamp landscape. A series of floodgate structures controlling tidal hydrology are located along the creek (DPI, 2009).

8.2.3 Wave Climate

The following Sydney regional wave climate data obtained from Manly Hydraulics Laboratory and Stockton Beach Coastal Processes Study (DHI, 2006) was applied to the site:

- 12 hr yearly exceedance significant wave height (Hs12): 5.00m
- Mean significant wave period (T): 12.0 sec

8.2.4 Ocean Tides

The site experiences ocean tides similar to that of the Sydney region (Table 8.3 - Sydney tidal data3).

Tide	Sydney Tidal Planes 2003 (mAHD)
HHWSS - higher high-water solstice springs	0.986
MHWS - mean high water spring	0.641
MHW - mean high water	0.514
MHWN - mean high water neap	0.388
MSL - mean sea level	0.000
MLWN - mean low water neap	-0.387
MLW - mean low water	-0.513
MLWS - mean low water spring	-0.640

Table 8.3 - Sydney tidal data

8.3 COASTAL HAZARD ASSESSMENT

8.3.1 Introduction

According to NSW DECCW (2010) 'Coastline Risk Management Guide', the most significant impact of climate change is the projected rise in mean sea level. Site inspection indicates that of all the potential consequences of sea level rise (as listed by NSW DECCW, 2010), landward shoreface recession and estuarine regression are the most relevant to the site.

Sea levels are expected to continue rising throughout the twenty-first century, with no evidence to suggest when that trend will be reversed. In 2009 the NSW government determined benchmarks sea level rise, with mean sea level rises of 40 cm by 2050 and 90 cm by 2100 (NSW Government, 2012). Sea level rises not only affect the average water level of oceans and estuaries but also recession of beach and sand dunes, higher saline water tables, extension of salt water further upstream in estuaries and increased coastal flooding.

The following assessment quantifies these consequences for the site and discusses the likely future impact.

8.3.2 Policy Application

8.3.2.1 NSW DECCW (2010)

The DECCW (2010) guidelines require Council's coastal hazard assessments to incorporate 2050 and 2100 sea level rise benchmarks and coastal hazard limits/areas.

8.3.2.2 Port Stephens Council (PSC)

Council has developed a number of plans to manage and improve the water quality of Port Stephens and surroundings, in accordance with predicted sea level rise (Table 8.4 - Port Stephens Council plans relevant to predicted sea level rise changes4).

Documentation	Year	Description
Climate Change Assessment, Risk Assessment (Report 2) and Adaptation Action Plan (Report 3) prepared by BMT WBM Pty Ltd.	2009	o Risk-based assessment established under the Australian Government funded Adaptation Pathways Program. o Assessment used upper predicted sea level rise of 0.91 m and lower value of 0.49 m for 2100. o Identified and prioritised a number of risks to local area including extreme impacts to stormwater systems, localised and more regular flooding, and very high risk of an increase in coastal and foreshore erosion. o Treatment options were proposed for identified risks.
Foreshore Management Plan for Port Stephens, (prepared by Umwelt Environmental Consultants).	2009	o Provides a framework for the protection and enhancement of the estuarine foreshore areas of Port Stephens Bay across two local Councils. o The Plan identifies potential threats to foreshore areas, including effects of sea level rise, and proposes appropriate management action.
Port Stephens Planning Strategy.	2011	o High level strategic plans to guide future growth and sustainability of the LGA, including identifying significant impacts due to sea level rise and managing the implications of climate change.
Port Stephens – Great Lakes Marine Park.	2005	o Port Stephens – Great Lakes Marine Park established in 2005 by the NSW Government. o Aim of the park is to preserve ecological processes, biological diversity and marine habitats. o Authority structure is comprised of representatives from the Department of Primary Industries, Department of Environment and Conservation, and the Premiers Department. o All development applications within the estuary need to be reviewed by the Authority for comments. o Recognises marine park contribution to facilitate biodiversity, and potential effects of sea level rise on marine ecosystems.
Port Stephens and Myall Lakes Estuary Management Plan (prepared by Umwelt (Australia) Pty Limited).	2000	o Plan intended to protect and enhance the estuary and surroundings through use and development guidance. o Recognition of potential effects of sea level rise on uses of the estuary and foreshore areas.

Table 8.4 - Port Stephens Council plans relevant to predicted sea level rise changes

8.3.2.3 Previous Studies

Previous studies suggest erosion at Stockton Beach is progressively worsening, with further detailed analysis required to determine erosion processes, including detailed modelling of sand movement (Umwelt, 2003). DHI Water & Environment's (2006) study estimated a net northward sediment transport along Stockton Beach of approximately 55,000 m3/year (north of the sewage treatment plant ponds) for the period 1992 – 2004.

DHI's report (2006) identified predicted sea level rise effects at Stockton Beach as follows (**Table 8.5**):

Year	Low	Mid	High
2026	0.8	3.6	8.0
2056	3.2	14.0	25.6

Table 8.5 - Predicted beach retreat due or shoreline recession due to sea level rise for the next 20 and 50 years at Stockton (in metres)

8.3.3 Coastal Shoreline Recession Calculations

8.3.3.1 Depth of Closure

Depth of closure was calculated using Hallermeier (1981) inner depth of closure as 10.2 m for Stockton Beach using data information from DHI (2006), being significant wave height exceeded for 12 hours per year of 5.0 m and wave period of 12 seconds.

$$D = 2.28H - 68.5\left(\frac{H^2}{gT^2}\right)$$

Where: D = "inner" (closer to shore) closure depth (m)
H = significant wave height exceeded for 12 hours per year (m)
g = gravity (m/sec2)
T = significant waver period exceeded for 12 hours per year (sec)

8.3.3.2 Beach Profile

Using detailed site survey and topographic information (LIDAR), the following information was obtained for 10 profile sections across Stockton Beach (see SK001, Attachment C):

- A profile extending from -30 mAHD to the sand dunes, including dune morphology;
- An average dune height; and
- A profile length (i.e. distance from dune to depth of closure mAHD).

Beach profile information is summarised in Table 8.6 - Stockton Beach profile data8.5, with cross section locations and details provided in Attachment C, Annex H.

Profile	Dune Height (mAHD)	Profile Length (m)	Depth of Closure (m)	Slope (degrees)
A	27.9	1453.0	10.2	1.509
B	27.5	1246.4	10.2	1.73
C	28.0	1195.2	10.2	1.83
D	35.9	1247.0	10.2	2.12
E	38.4	1068.4	10.2	2.60
F	20.7	1306.7	10.2	1.35
G	20.6	1125.9	10.2	1.57
H	24.4	1148.1	10.2	1.73
I	26.1	1051.51	10.2	1.98
J	20.1	844.9	10.2	2.05
Averages	27.0	1168.7	10.2	1.82

Table 8.6 - Stockton Beach profile data

8.3.3.3 Shoreline Recession

Recession estimates were modelled using the Bruun rule and summarised in **Table 8.6**:

$$R = (\frac{L}{B+h})S$$

Where; R = shoreline recession (m)
L = active profile length (m)
B = dune height (m)
h = depth of closure (m)
S = sea level rise (m)

Average Dune Height (mAHD), based on LIDAR data	Average Length of Profile (m)	Depth of Closure (m, depth), based on Hallemeier (1981) calculations	Recession Estimates for 0.4 m Sea Level Rise (by 2050)	Recession Estimates for 0.9 m Sea Level Rise (by 2100)
27.0	1169	10.2	12.6	28.3

Table 8.7 - Shoreline recession estimates for Stockton Beach (Bruun rule) for profiles A to J, averaged

Stockton Beach profiles (A to J) for sea level rise calculations, and hazard lines for coastal shoreline recession are provided in Attachment C, Annex H.

8.3.3.4 Impacts on Site Development

Recession estimates (hazard lines) are presented in Drawing SK007, Attachment C, Annex H. These demonstrate:

1. The site is not affected by coastal shoreline recession.
2. Sand from the foredune is not expected to ingress into the site.
3. The coastal hazard is acceptable and should not prohibit site redevelopment.
4. Foundations must be designed for hydrostatic pressure and elevated groundwater tables.

8.3.4 Risk Assessment of Coastal Lagoon Regression

8.3.4.1 Effects of Coastal Lagoon Regression

PSC has identified potential risks relating to estuarine sea level rise, with flooding one of the major issues, and relevant factors identified as.

- More regular flooding at Bobs Farm, and potential compromising of the integrity and functionality of the Bobs Farm levees with major flood and some excessive tidal events historically overtopping the barriers (PSC, 2009a).
- Access to Bobs Farm and nearby communities would be vulnerable, and associated higher water levels may impact on groundwater, vegetation, building foundations, increase in acid sulphate soils oxidation and road infrastructure.
- As catchment landscape in the region is generally low at 0 – 2 mAHD, sea level rise will impact the extent of flooding in the region.
- It is expected that a rise in ocean levels will affect the entire Tilligerry estuary system by a similar amount (Port Stephens & Great Lakes Councils, 2010).

8.3.4.2 Hazard Lines

Estuarine hazard lines attributable to sea level rise (0.4 m and 0.9 m) are identified in Drawing SK002 (Attachment C, Annex H).

Hazard lines indicate the site is free from the effects of sea level rises to 0.4 and 0.9 mAHD, with Marsh Road (generally from 0.8 up to 1.2 mAHD) acting as a buffer.

Proposed 15 m vegetated buffer zones, as well as diversion bunds around the site perimeter for stormwater management will also limit estuarine regression effects (Martens & Associates, 2014).

8.3.4.3 Ecological Habitats

Effects of sea level rise on Tilligerry Creek may reduce the extent of existing SEPP 14 wetlands and populations of Endangered Ecological Communities (EEC) comprising Swamp Oak Floodplain Forest, which occur along the creek foreshore areas. An EEC pocket occurs on the northern eastern portion of the site on Lot 11 DP1071458.

8.3.4.4 Results and Conclusions

Assessment of coastal lagoon regression indicates:

1. Hazard lines suggest that the subject site is unlikely to be affected by sea level rise effects within the Tilligerry Creek estuarine system. The proposed 15 m vegetated buffer zone and diversion bunds around the site perimeter will also limit some of these effects. It is recommended that diversion bund design consider potential sea level rise effects on the site.

2. Ecological zone regression into the site is not likely to be significant. Appropriate diversion bund and buffer zone designs will further limit any potential ecological regression into the site due to sea level rise.

3. Expected estuarine regression due to sea level rise should not impact site development.

9 ABORIGINAL CULTURAL HERTIAGE ASSESSMENT

Chapter Nine provides a summary of a detailed Aboriginal Cultural Heritage Assessment undertaken by Aecom archaeologists to assess the impacts of the proposed sand extraction mine on items of Aboriginal heritage. The heritage report is provided separately in Annex C.

9.1 INTRODUCTION AND BACKGROUND

9.1.1 Introduction

This assessment forms part of an Environmental Impact Statement (EIS) being prepared by Tattersall Lander to support an application for State Significant Development (SSD) Consent under Division 4.1 of Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act) for the Project, which will involve the establishment of a sand quarry with an estimated extraction and processing rate of approximately 750,000 tonnes per annum.

This Aboriginal cultural heritage assessment report documents the results of AECOM's assessment and has been compiled with reference to the NSW Department of Planning and Environment's (DP&E) Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation (DECCW, 2005) as well as the NSW Office of Environment and Heritage's Aboriginal Cultural Heritage Consultation Requirements for Proponents (DECCW, 2010), Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales (DECCW, 2010b) and Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in NSW (OEH, 2011).

9.1.2 Project Area

The Project area for this assessment, shown on Figure 9.2, is an irregularly-shaped 53 ha parcel of land located in the sparsely populated rural suburb of Bobs Farm, approximately 25 km east-northeast of the City of Newcastle and 7 km west-northwest of the township of Anna Bay on the Hunter Valley's Coastal Plain.

Situated between MGA grid coordinates 406060 and 407440 east and 6372810 and 6374190 north on the Morna Point (9332-3) 1:50,000 topographic map sheet, the Project area is located within the Newcastle Bight embayment, the largest sedimentary basin of Quaternary age in the greater Port Stephens-Myall Lakes area (Thom et al. 1992). Aeolian sand dunes within the Project area form part of the Outer Barrier of the Newcastle Bight Sand Dune System, an intensively investigated geomorphological complex consisting of an inner Pleatocene barrier (the 'Inner Barrier'), an outer Holocene barrier (the 'Outer Barrier') and a broad interbarrier depression filled with Holocene estuarine swamp deposits (the 'Interbarrier Depression') (Thom et al. 1981, 1992).

Largely vegetated, the Project area is bounded to the south and east by Nelson Bay Road, to the north by Marsh Road and rural residential allotments and to the west by native bushland. Surrounding suburbs include Anna Bay to the east, Oyster Cove and Tanilba Bay to the north and Salt Ash to the west. Parks and reserves in the local area include Worimi National Park, which borders Nelson Bay Road to the immediate south of the Project area, Worimi Regional Park, which adjoins Worimi National Park to the east, Tilligerry National Park to the west, Tilligerry State Conservation Area to the northwest and Tilligerry Nature Reserve to the northeast.

Topographically, the Project area is dominated by steep stabilised aeolian sand dunes associated with the oldest of the Outer Barrier's three transgressive long-walled 'ridges' (i.e., Ridge I) (Thom et al. 1992). In the northeastern portion of the Project area, Thom et al.'s (1992) stabilised Ridge I dunes abruptly give way to flat, low-lying and formerly swampy terrain associated with the Interbarrier Depression's now heavily drained Holocene estuarine plain. A similarly abrupt topographic transition occurs in the and central and western portions of the Project area, with the Ridge I dune field rapidly transitioning, towards Nelson Bay Road, into a low relief sand plain now largely occupied by a commercial fig/olive orchard and associated buildings.

Reference to the Geographical Names Register of NSW indicates that the Project area falls wholly within the boundaries of the Port Stephens Local Government Area (Port Stephens LGA) and is situated in the Parish of Tomaree in the County of Gloucester. Land within the Project area has been registered as Lots 10 and 11 on DP1071458, Lot 254 on DP753204 and Lot 51 on DP1015671.

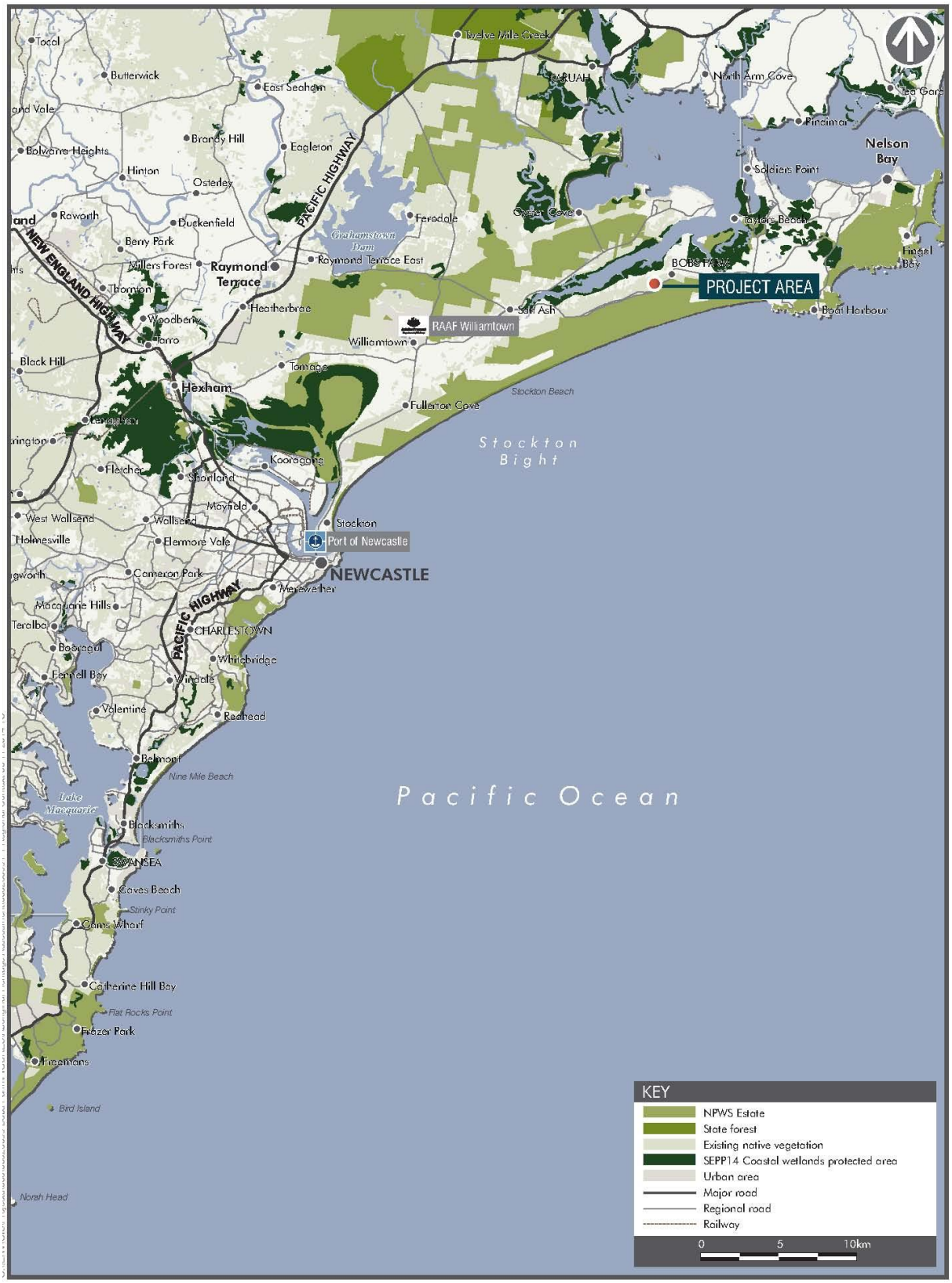


Figure 9.1 - Regional Context

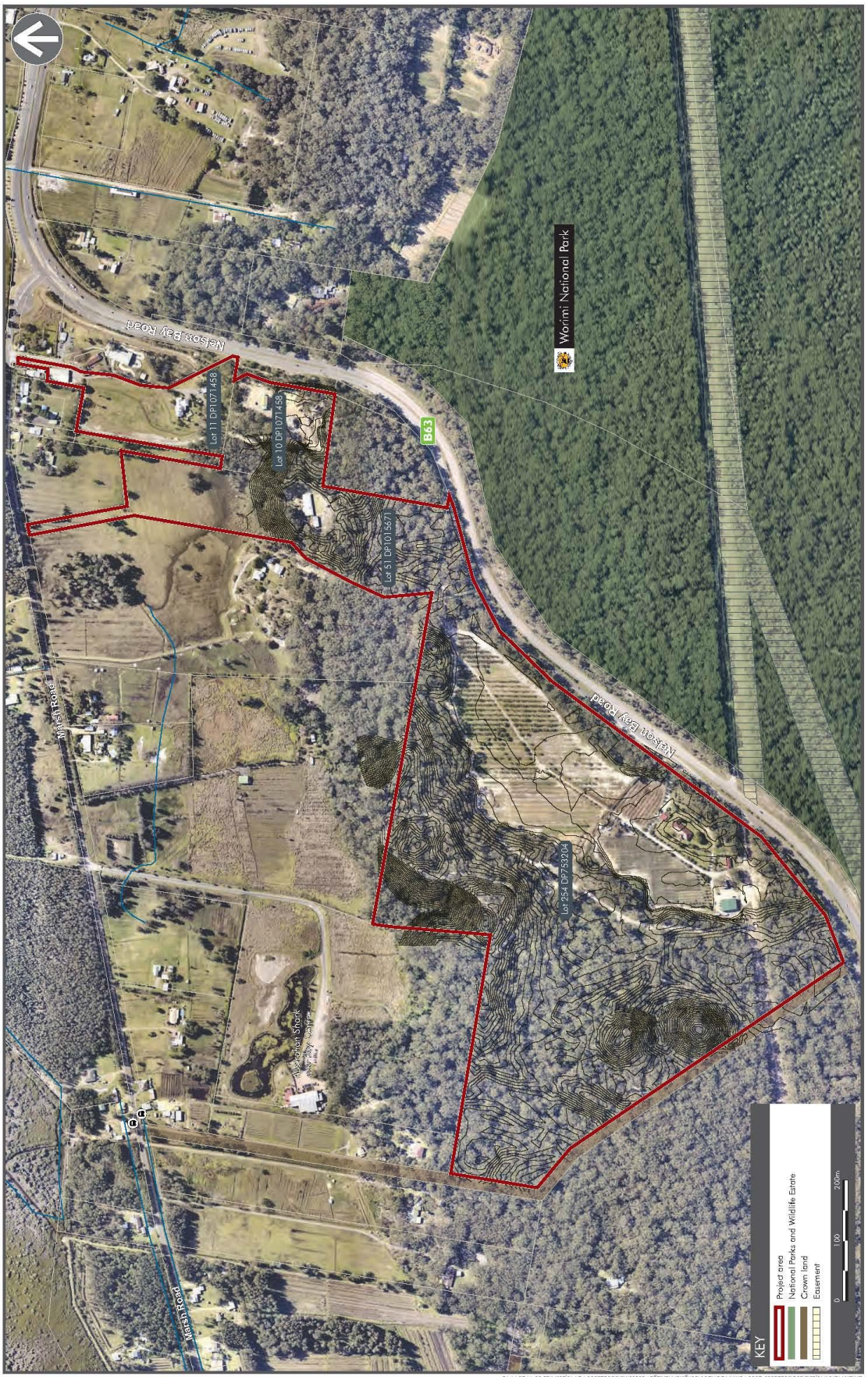

Nelson Bay Road
Worimi National Park
B63
Lot 11 DP1071458
Lot 10 DP1071458
Lot 51 DP1015671
Lot 254 DP753204
Marsh Road
Marsh Road
Nelson Bay Road
KEY
Project area
National Parks and Wildlife Estate
Crown land
Easement
0
100
200m

Figure 9.2 - Project Area

Upgrade Marsh Road from site access to recent RMS construction
Upgrade existing site access (exit only, right turn only)
Nelson Bay Road
Lot 11 DP1071458
Lot 10 DP1071458
B63
Worimi National Park
Lot 51 DP1015671
Upgrade existing site access (entrance only)
Construct new deceleration lane (95m)
Nelson Bay Road
Marsh Road
Stockpile & loading area
Shed
Lot 254 DP753204
Screening area
2:1 batter slope to extraction floor
1.5m vegetated buffer
1.5m vegetated buffer
Worimi Shore Dolphin Watch Centre
KEY
Project area
National Parks and Wildlife Estate
0
100
200m

Figure 9.3 - Project Layout

9.1.3 The Project

Ammos Resource Management is seeking State Significant Development Consent under Division 4.1 of Part 4 of the EP&A Act for the Project, which would involve:

- the establishment of a sand quarry to extract and process sand at a rate of approximately 750,000 tonnes per annum, from a total sand resource of 10 million tonnes;
- construction of extractive materials processing and transport infrastructure;
- transportation of extractive materials off-site via roads; and
- site rehabilitation.

Ammos Resource Management proposes to stage the development and operation of the Project as follows:

1. Development Stage - involving the installation of an access location on Nelson Bay Road, initial clearing of the quarry site, the setting up of screening operations and the construction of a loading ramp, storage shed and main exit road;

2. Operational Stage 1 - involving the clearing and stockpiling of topsoil and production of initial sand material that is likely to be processed into landscape soil base and sports field top-dress material;

3. Operational Stage 2 - involving the processing of extracted blonde sand material for various product uses; and

4. Operational Stage 3 - involving the setting up of dredging operations and winning of sand material for various product uses.

Site access throughout the life of the Project would be off Nelson Bay Road with egress via Marsh Road and then back onto Nelson Bay Road. Key project activities would include:

- construction of extractive materials processing and transport infrastructure;
- bulk handling of sand material using front end loaders and trucks;
- staged vegetation clearance employing logging and mulching;
- screening and sizing of extracted sand material;
- washing of selected extracted sand material;
- dredging of sand material below the economic reach of mechanical equipment. Approximately 50% of the recoverable resource would be dredged;
- transportation of extractive materials off-site via roads; and
- site rehabilitation.

The conceptual layout of the Project is shown on Figure 9.3.

9.1.4 Director-General's Requirements

The Director General of the NSW Department of Planning and Environment (DP&E) issued the Director General's Environmental Assessment Requirements (DGRs) for the Project on 21 March 2014. For Aboriginal heritage, the DGRs require the completion of an Aboriginal cultural heritage assessment (including cultural and archaeological significance) which must:

- demonstrate effective consultation with Aboriginal communities in determining and assessing impacts, and developing and selecting mitigation options and measures; and
- outline any proposed impact mitigation and management measures (including an evaluation of the effectiveness and reliability of the measures).

Attachment 1 (Technical and Policy Guidelines) of the DGRs lists the Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation (DECCW, 2005) and The Burra Charter (The Australia ICOMOS Charter for Places of Cultural Significance) as the relevant guidelines for the Aboriginal heritage component of the Project's environmental assessment. The former require Aboriginal heritage assessments to be conducted in accordance DECCW's (2004) Interim Community Consultation Requirements for Applicants and the NSW National Parks and Wildlife Service's (1997) Aboriginal Cultural Heritage Standards and Guidelines Kit. However, it is noted that the NSW Office of Environment and Heritage's Aboriginal Cultural Heritage Consultation Requirements for Proponents (DECCW, 2010) (the Consultation Requirements), Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales (DECCW, 2010b) (the Code of Practice) and Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in NSW (OEH, 2011) have effectively replaced these earlier policies and currently represent best practice guidelines for the assessment of Aboriginal cultural heritage values in NSW.

9.1.5 Assessment Approach

This assessment has been undertaken in accordance with DP&E's Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation (DEC, 2005) as well as the OEH's Code of Practice and Consultation Requirements. As such, its key requirements have been:

- to conduct a search of OEH's Aboriginal Heritage Information Management System (AHIMS);
- to review the landscape (i.e., environmental) context of the Project area with specific consideration to its implications for past Aboriginal land use;
- to review relevant archaeological and ethnohistoric information for the Project area and environs;
- to prepare a predictive model for the Aboriginal archaeological record of the Project area;
- to undertake an archaeological survey of the Project area;
- to identify, notify and register Aboriginal people who hold cultural knowledge relevant to determining the cultural significance of Aboriginal objects and/or places in the Project area;
- to provide RAPs with information about the scope of the proposed works and Aboriginal heritage assessment process;
- to facilitate a process whereby RAPs can:
  - contribute culturally appropriate information to the proposed assessment methodology;
  - provide information that will enable the cultural significance of Aboriginal objects and/or places within the Project area to be determined; and
  - have input into the development of cultural heritage management options; and
- to prepare and finalise an Aboriginal cultural heritage assessment report with input from RAPs.

9.1.6 Project Team

The core project team for this assessment included archaeologists from AECOM and personnel from six Registered Aboriginal Parties (RAPs). Associate Professor Patricia Fanning from Macquarie University, Sydney, was also involved in a specialist capacity. Dr Andrew McLaren (Archaeologist, AECOM) managed and participated in all aspects of the assessment detailed herein and was the primary author of this report. Other AECOM staff involved in this assessment included Geordie Oakes (Archaeologist), Luke Atkinson (Geoarchaeologist), Kelly Pearsall (Principal Environmental Planner) and Tim Osborne (Designer). Luke participated in fieldwork and assisted in the production of this report. Unless otherwise specified, all figures within this report were created by Tim. Technical and QA review of this report was provided by Geordie and Kelly respectively. Trish Fanning produced the geomorphological assessment report attached in Annex C.

Aboriginal community consultation for this assessment was undertaken in accordance with OEH's Consultation Requirements (DECCW 2010b). Full details of the consultation process undertaken are provided in Section 3.0. Aboriginal persons and organisations consulted as part of this assessment are listed in **Table 9.1**.

Registered Aboriginal Party (RAP)	Primary contact person
Worimi Local Aboriginal Land Council	Jackie Henderson
Maaiangal Aboriginal Heritage	Carol Ridgeway-Bissett
Lower Hunter Aboriginal Incorporated	David Ahoy
Doo-Wa-Kee	Mick Leon
Mur-Roo-Ma Inc	Anthony Anderson
Nur-Run-Gee Pty Ltd	Leanne Anderson

Table 9.1- Registered Aboriginal Parties for the current assessment

9.2 APPLICABLE POLICY & LEGISLATION

9.2.1 Commonwealth Legislation

9.2.1.1 Aboriginal and Torres Strait Islander Heritage Protection Act 1984

The Aboriginal and Torres Strait Islander Heritage Protection Act 1984 (the ATSIHP Act) provides for the preservation and protection of places, areas and objects of particular significance to Indigenous Australians. The stated purpose of the ATSIHP Act is the "preservation and protection from injury or desecration of areas and objects in Australia and in Australian waters, being areas and objects that are of particular significance to Aboriginals in accordance with Aboriginal tradition" (Part I, Section 4).

Under the Act, 'Aboriginal tradition' is defined as "the body of traditions, observances, customs and beliefs of Aboriginals generally or of a particular community or group of Aboriginals, and includes any such traditions, observances, customs or beliefs relating to particular persons, areas, objects or relationships" (Part I, Section 3). A 'significant Aboriginal area' is an area of land or water in Australia that is of "particular significance to Aboriginals in accordance with Aboriginal tradition" (Part I, Section 3). A 'significant Aboriginal object', on the other hand, refers to an object (including Aboriginal remains) of like significance.

For the purposes of the Act, an area or object is considered to have been be injured or desecrated if:

a) In the case of an area:
   i. it is used or treated in a manner inconsistent with Aboriginal tradition;
   ii. the use or significance of the area in accordance with Aboriginal tradition is adversely affected; and
   iii. passage through, or over, or entry upon, the area by any person occurs in a manner inconsistent with Aboriginal tradition
b) in the case of an object:
   i. it is used or treated in a manner inconsistent with Aboriginal tradition.

The ATSIHP Act can override state and territory laws in situations where a state or territory has approved an activity, but the Commonwealth Minister prevents the activity from occurring by making a declaration to protect an area or object. However, the Minister can only make a decision after receiving a legally valid application under the ATSIHP Act and, in the case of long term protection, after considering a report on the matter. Before making a declaration to protect an area or object in a state or territory, the Commonwealth Minister must consult the appropriate minister of that state or territory (Part 2, Section 13).

9.2.1.2 Environment Protection and Biodiversity Act 1999

The Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) took effect on 16 July 2000. Under Part 9 of the EPBC Act, any action that is likely to have a significant impact on a matter of National Environmental Significance may only progress with approval of the Commonwealth Minister for the Department of the Environment. An action is defined as a project, development, undertaking, activity, series of activities, or alteration. An action will also require approval if:

- it is undertaken on Commonwealth land and will have or is likely to have a significant impact;
- it is undertaken outside Commonwealth land and will have or is likely to have a significant impact on the environment on Commonwealth land; and
- it is undertaken by the Commonwealth and will have or is likely to have a significant impact.

The EPBC Act defines 'environment' as incorporating both natural and cultural environments and therefore includes Aboriginal heritage items. Under the Act, protected heritage items are listed on the National Heritage List (items of significance to the nation) or the Commonwealth Heritage List (items belonging to the Commonwealth or its agencies). These two lists replaced the Register of the National Estate (RNE). Statutory references to the RNE in the EPBC Act were removed on 19 February 2012. However, the RNE remains an archive of over 13,000 heritage places throughout Australia.

The heritage registers mandated by the EPBC Act have been consulted and there are no Aboriginal heritage sites or places listed in these registers that are located within the Project area.

9.2.2 State Legislation & Policies

9.2.2.1 Environmental Planning and Assessment Act 1979

The Environmental Planning and Assessment Act 1979 (EP&A Act), administered by the NSW Department of Planning and Environment, requires that consideration be given to environmental impacts as part of the land use planning process in NSW. In NSW, environmental impacts are interpreted as including impacts to Aboriginal and non-Aboriginal (i.e., European) cultural heritage.

Upon repeal of Part 3A of the EP&A Act on 1 October 2011, the Environmental Planning and Assessment Amendment (Part 3A Repeal) Act 2011 inserted a new Division 4.1 into Part 4 of the EP&A Act. Division 4.1 provides a determination regime for State Significant Development (SSD). Section 89C of the EP&A Act stipulates that a development will be considered SSD if it declared to be such by the new State Environmental Planning Policy (State and Regional Development) 2011 (SEPP SRD).

Under Clause 8(1) of SEPP SRD, a development is declared to be State Significant Development if:

a) the development on the land concerned is, by the operation of an environmental planning instrument, permissible with development consent under Part 4 of the EP&A Act; and
b) the development is specified in Schedule 1 or 2 of SEPP SRD.

The Project is SSD as it meets both of these criteria, namely:

- it is permissible with development consent on the land on which it is located; and
- it is development that is specified in Schedule 1 of SEPP SRD.

The Project was declared SSD by the Minister for Planning and Infrastructure on 21 March 2014.

DEC's (now OEH) draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation (DEC, 2005) detail the relevant statutory requirements for Aboriginal cultural heritage assessments conducted under Division 4.1 of Part 4 of the EP&A Act. These guidelines require Aboriginal heritage assessments to be conducted in accordance DECCW's (2004) Interim Community Consultation Requirements for Applicants and the NSW National Parks and Wildlife Service's (1997) Aboriginal Cultural Heritage Standards and Guidelines Kit. However, it is noted that the NSW Office of Environment and Heritage's Aboriginal Cultural Heritage Consultation Requirements for Proponents (DECCW, 2010), Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales (DECCW, 2010b) and Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in NSW (OEH, 2011) have effectively replaced these earlier policies and currently represent best practice guidelines for the assessment of Aboriginal cultural heritage in NSW.

9.2.2.2 National Parks and Wildlife Act 1974

The National Parks and Wildlife Act 1974 (NPW Act), administered by OEH, is the primary legislation for the protection of Aboriginal cultural heritage in NSW. The NPW Act gives the Director General of OEH responsibility for the proper care, preservation and protection of 'Aboriginal objects' and 'Aboriginal places', defined under the Act as follows:

- An Aboriginal object is any deposit, object or material evidence (that is not a handicraft made for sale) relating to Aboriginal habitation of NSW, before or during the occupation of that area by persons of non-Aboriginal extraction (and includes Aboriginal remains).
- An Aboriginal place is a place declared so by the Minister administering the NPW Act because the place is or was of special significance to Aboriginal culture. It may or may not contain Aboriginal objects.

Part 6 of the NPW Act provides specific protection for Aboriginal objects and places by making it an offence to harm them and includes a 'strict liability offence' for such harm. A 'strict liability offence' does not require someone to know that it is an Aboriginal object or place they are causing harm to in order to be prosecuted. Defences against the 'strict liability offence' in the NPW Act include the carrying out of certain 'Low Impact Activities', prescribed in Clause 80B of the National Parks and Wildlife Amendment Regulation 2010 (NPW Regulation), and the demonstration of due diligence.

An Aboriginal Heritage Impact Permit (AHIP) issued under Section 90 of the NPW Act is required if impacts to Aboriginal objects and/or places cannot be avoided. An AHIP is a defence to a prosecution for harming Aboriginal objects and places if the harm was authorised by the AHIP and the conditions of that AHIP were not contravened. Consultation with Aboriginal communities is required under OEH policy when an application for an AHIP is considered and is an integral part of the process. AHIPs may be issued in relation to a specified Aboriginal object, Aboriginal place, land, activity or person or specified types or classes of Aboriginal objects, Aboriginal places, land, activities or persons.

Pursuant to Section 89J of the EP&A Act, AHIPs are not required for projects approved under Division 4.1 of Part 4 of the EP&A Act. Impacts to Aboriginal heritage values associated with approved SSD projects are typically managed under Aboriginal Cultural Heritage Management Plans (ACHMPs). ACHMPs are statutorily binding once approved by the Planning Assessment Commission (PAC) or DP&E under delegation from the Director-General.

Section 89A of the NPW Act requires notification of the location of Aboriginal sites within a reasonable time, with penalties for non-notification. Section 89A is binding in all instances, including Division 4.1 projects

9.2.2.3 Lower Hunter Regional Strategy (LHRS) & Regional Conservation Plan (RCP)

The Lower Hunter Regional Strategy (LHRS), finalised in 2006, details the New South Wales Government's planning priorities for the Lower Hunter Valley and identifies proposed areas of growth. The Regional Conservation Plan (RCP) is a partner document to the LHRS and outlines a 25-year program to direct and drive conservation planning and efforts within the Lower Hunter.

Both individually and in combination, the LHRS and RCP recognise the importance of Aboriginal objects and places to contemporary Aboriginal people, as well as the landscapes associated with them. However, both documents also acknowledge that the continued growth of the Lower Hunter's population and industries will raise challenges for their long-term protection. In recognition of these challenges, the LHRS has identified the following key actions for the long-term protection and management of the Aboriginal and Historic (non-Indigenous) heritage resource of the Lower Hunter Valley:

- councils are to ensure that Aboriginal cultural and community values are considered in the future planning and management of the LGA;
- the DP&E and Councils will review the scope and quality of the existing statutory lists of heritage items and ensure that all places of significance are included in the heritage schedules of local environmental plans; and
- the cultural heritage values of major regional centres and major towns that will be the focus of urban renewal projects will be reviewed, with the aim of protecting cultural heritage.

The RCP proposes a number of mechanisms to ensure that high value conservation lands in the Lower Hunter Valley are identified, protected and managed for their biodiversity values as well as their Aboriginal cultural heritage values. Stage 1 of the RCP, implemented in 2006, involved the transfer of c.20,000 hectares of public high value conservation land into conservation reserves. The transfer of an additional 12,000 hectares of private land into the reserve system is expected to occur under the RCP over the next few years.

9.2.3 Local Government

9.2.3.1 Port Stephens LEP 2013

Clause 5.10 of the Port Stephens LEP 2013 provides specific provisions for the protection of heritage items, heritage conservation areas, Aboriginal objects and Aboriginal places of heritage significance within the Port Stephens LGA, defined in the LEP as follows:

- A heritage item means a building, work, place, relic, tree, object or archaeological site, the location and nature of which is described in Schedule 5 of the LEP;
- A heritage conservation area means an area of land of heritage significance:

  (a) shown on the Heritage Map as a heritage conservation area, and

  (b) the location and nature of which is described in Schedule 5 of the LEP,

- and includes any heritage items situated on or within that area.
- An Aboriginal object means any deposit, object or other material evidence (not being a handicraft made for sale) relating to the Aboriginal habitation of an area of New South Wales, being habitation before or concurrent with (or both) the occupation of that area by persons of non-Aboriginal extraction, and includes Aboriginal remains.
- An Aboriginal place of heritage significance means an area of land, the general location of which is identified in an Aboriginal heritage study adopted by the Council after public exhibition and that may be shown on the Heritage Map, that is:

  (a) the site of one or more Aboriginal objects or a place that has the physical remains of pre-European occupation by, or is of contemporary significance to, the Aboriginal people. It may (but need not) include items and remnants of the occupation of the land by Aboriginal people, such as burial places, engraving sites, rock art, midden deposits, scarred and sacred trees and sharpening grooves, or

(b) a natural Aboriginal sacred site or other sacred feature. It includes natural features such as creeks or mountains of long-standing cultural significance, as well as initiation, ceremonial or story places or areas of more contemporary cultural significance.

Under the Port Stephens LEP, development consent is required for any of the following:

(a) demolishing or moving any of the following or altering the exterior of any of the following (including, in the case of a building, making changes to its detail, fabric, finish or appearance):
    (i) a heritage item,
    (ii) an Aboriginal object,
    (iii) a building, work, relic or tree within a heritage conservation area,
(b) altering a heritage item that is a building by making structural changes to its interior or by making changes to anything inside the item that is specified in Schedule 5 in relation to the item,
(c) disturbing or excavating an archaeological site while knowing, or having reasonable cause to suspect, that the disturbance or excavation will or is likely to result in a relic being discovered, exposed, moved, damaged or destroyed,
(d) disturbing or excavating an Aboriginal place of heritage significance,
(e) erecting a building on land:
    (i) on which a heritage item is located or that is within a heritage conservation area, or
    (ii) on which an Aboriginal object is located or that is within an Aboriginal place of heritage significance,
(f) subdividing land:
    (i) on which a heritage item is located or that is within a heritage conservation area, or
    (ii) on which an Aboriginal object is located or that is within an Aboriginal place of heritage significance.

Schedule 5 of the Port Stephens LEP 2013 provides a list of heritage items, heritage conservation areas and archaeological sites within the Port Stephens LGA. There are no Aboriginal heritage sites or places listed in this schedule that are located within the Project area.

9.3 ABORIGINAL COMMUNITY CONSULTATION

Aboriginal community consultation acknowledges the right of Aboriginal people to be involved, through direct participation, on matters that directly affect their heritage. Involving Aboriginal people in all facets of the assessment process ensures that they are given adequate opportunity to share information about cultural values, and to actively participate in the development of appropriate management and/or mitigations measures. The successful identification, assessment and management of Aboriginal cultural heritage values are dependent on an inclusive and transparent consultation process.

As indicated in Section 9.1.5, Aboriginal community consultation for the current assessment was undertaken in accordance with OEH's Aboriginal Cultural Heritage Consultation Requirements for Proponents (DECCW, 2010b) (hereafter, 'the Consultation Requirements'). The results of the consultation process undertaken are detailed in the sections that follow. A consultation log is provided Annex C.

9.3.1 Stage 1 - Notification and Registration

The aim of Stage 1 of the Consultation Requirements is to identify, notify and register Aboriginal people who hold cultural knowledge relevant to determining the cultural significance of Aboriginal objects and/or places in the Project area.

9.3.1.1 Consultation with Regulatory Agencies

Section 4.1.2 of the Consultation Requirements stipulates that proponents are responsible for ascertaining, from reasonable sources of information, the names of Aboriginal people who may hold cultural knowledge relevant to determining the cultural significance of Aboriginal objects and/or places. Proponents are required to compile a list of Aboriginal people who may have an interest in the proposed Project area and hold knowledge relevant to determining the cultural significance of Aboriginal objects and/or places by writing to:

a) the relevant regional office of the NSW Office of Environment & Heritage (OEH)

b) the relevant Local Aboriginal Land Council(s);

c) the Registrar, Aboriginal Land Rights Act 1983 for a list of Aboriginal owners;

d) the National Native Title Tribunal for a list of registered native title claimants, native title holders and registered Indigenous Land Use Agreements;

e) Native Title Services Corporation Limited (NTSCORP Limited);

f) the relevant local council(s); and

g) the relevant catchment management authorities for contact details of any established Aboriginal reference group.

In accordance with this requirement, the following agencies were contacted on 11 July 2014 requesting information on relevant Aboriginal persons and organisations:

- OEH - Hunter Central Coast Region Office (e-mail with letter attachment);
- Worimi Local Aboriginal Land Council (Worimi LALC) (letter).
- Office of the Registrar, *Aboriginal Land Rights Act 1983* (NSW) (letter) ;
- The National Native Title Tribunal (NNTT) (e-mail with search request attachment);
- NTSCORP Limited (letter);
- Port Stephens Council (letter); and
- Hunter-Central Rivers Catchment Management Authority (HCR CMA) (letter).

Responses were received from six agencies and are attached as Appendix C, Annex C:

- OEH responded on 11 July 2014 providing the details of eight Aboriginal persons and organisations who may wish to be consulted as part of the assessment.
- The Office of the Registrar responded on 14 July 2014 advising that the Project area is close to the Worimi Conservations Lands (WCL) which has Registered Aboriginal Owners pursuant to Division 3 of the *Aboriginal Land Rights Act 1983* (NSW). The Office of Registrar suggested contacting the WCL Board of Management through Mr Graeme Russell (Joint Management Coordinator).

- Worimi LALC responded on 17 July 2014 advising that they would like to register their interest in the Project; and

- NTSCORP responded on 17 July 2014 advising that although their privacy guidelines restrict them from providing proponents with contact details for Traditional Owners, they would forward our correspondence to relevant individuals, groups and organisations.

- The NNTT responded on 15 July 2014 advising the results of searches of the *Schedule of Applications (unregistered claimant applications*), *Register of Native Title Claims*, *National Native Title Register*, *Register of Indigenous Land Use Agreements* and *Notified Indigenous Land Use Agreements*. The NNTT advised that six native title determinations (NND2005/002, NND2005/003, NND2006/006, NND2008/002, NND2012/001 and NND2012/002) apply to the search area. Associated extracts from the *National Native Title Register* indicate that all six determinations relate to native title proceedings between the Worimi LALC and the NSW State Government. Determination outcomes for all six entries are listed as "Native title does not exist"; and

- Port Stephens Council responded on 25 July 2014 advising that Mr Andrew Smith, CEO of the Worimi LALC, would be the appropriate point of contact for our request.

Subsequent to receiving the Office of the Registrar's response, on 28 July 2014, the Board of Management for the Worimi Conservations Lands (WCL) was contacted by letter requesting information on relevant Aboriginal persons and organisations. Mr Graeme Russell, Joint Management Coordinator for the WCL, responded on 30 July 2014 providing the details of five Aboriginal organisations who may wish to be involved in the Project. In addition, Mr Russell advised that the WCL Board of Management would determine at an upcoming meeting if they would like to be consulted regarding the Project. Mr Russell's response is included in Appendix C, Annex C.

9.3.1.2 Public Notification

Section 4.1.3 of the Consultation Requirements requires that in addition to writing to the Aboriginal people identified by the agencies listed in Section 9.3.1.1, the proponent must also place a notice in the local newspaper circulating in the general location of the proposed project. The notification must outline the project and identify its location.

In accordance with this requirement, a public notice was placed in the Port Stephens Examiner on 31 July 2014 (Appendix D, Annex C). The closing date for registration via this notice was 14 August 2014, which provided the necessary minimum 14 day period for expressions of interest.

No responses to the notice were received prior to, or after, this date.

9.3.1.3 Invitations for Expressions of Interest

Section 4.1.3 of the Consultation Requirements necessitates that proponents must write to the Aboriginal people whose names were obtained through the regulatory agencies and the relevant Local Aboriginal Land Council(s) to notify them of the proposed project and invite them to register an interest in participating in a process of community consultation.

In accordance with this requirement, letters inviting expressions of interest and containing summary information on the Project were sent to all Aboriginal persons and organisations identified by the regulatory agencies. A total of nine Aboriginal stakeholders were invited to register an interest in being consulted, with letters for all but one identified party (i.e., Worimi

Knowledgeholders Aboriginal Corporation, identified by Mr Graeme Russell in his response dated 30 July 2014) mailed out on 28 July 2014. The closing date for expressions of interest for those parties sent the EOI letter on 28 July 2014 was 11 August 2014, which provided the necessary minimum 14 day period for expressions of interest. The EOI letter for Worimi Knowledgeholders Aboriginal Corporation was mailed out on 30 July 2014.

By close of registration, six parties had registered an interest in the assessment. In a letter dated 7 August 2013, and received by AECOM on 9 August 2014, Worimi Knowledgeholders Aboriginal Corporation formally declined AECOM's invitation to register an interest in the Project. Summary information on all RAPs for the Project, including registration dates, is provided in Table 9.2 - Registered Aboriginal Parties.

Registered Aboriginal Party (RAP)	Date of registration	Method of registration	Primary contact person
Worimi Local Aboriginal Land Council	17-07-14	Email	Jackie Henderson
Maaiangal Aboriginal Heritage	11-08-14	Phone	Carol Ridgeway-Bissett
Lower Hunter Aboriginal Incorporated	06-08-14	Email	David Ahoy
Doo-Wa-Kee	12-08-14	Phone	Mick Leon
Mur-roo-ma Inc	30-07-14	Email with letter attachment	Anthony Anderson
Nur-run-gee Pty Ltd	31-07-14	Email with letter attachment	Leanne Anderson

Table 9.2 - Registered Aboriginal Parties

9.3.1.4 Notification of Registered Aboriginal Parties (RAPs)

Section 4.1.6 of the Consultation Requirements requires that the proponent make a record of the names of each Aboriginal person who registered an interest and provide a copy of that record, along with a copy of the EOI letter forwarded to the Aboriginal parties, to the relevant OEH regional office and LALC within 28 days of the closing date for EOIs. Section 4.1.5 of the Consultation Requirements provides the opportunity for Aboriginal persons to withhold their details from being forwarded to these parties.

In accordance with these requirements, on 4 September 2014, a list of the six Aboriginal organisations that had registered an interest in the assessment, as well as a copy of the EOI letter sent out on 28 July 2014, was forwarded to the relevant OEH regional office (i.e., Hunter Central Coast) and the Worimi LALC. No RAP requested that their details be withheld from OEH and/or the Worimi LALC.

9.3.2 Stage 2 - Presentation of Information about the Project

The aim of Stage 2 of the Consultation Requirements is to provide RAPs with information about the scope of the proposed project and the proposed cultural heritage assessment process.

For the current assessment, presentation of information about the Project was provided to RAPs as part of the registration of interest process detailed in Section 9.3.1.3. Basic information on the proponent and the Project was included in the EOI letter mailed on 28 July 2014.

9.3.3 Stage 3 - Gathering Information about Cultural Significance

The aim of Stage 3 of the Consultation Requirements is to facilitate a process whereby RAPs can:

a) Contribute to culturally appropriate information gathering and the assessment methodology;

b) Provide information that will enable the cultural significance of Aboriginal objects and/or places on the proposed Project area to be determined; and

c) To have input into the development of any cultural heritage management measures.

For current assessment, consultation with RAPs regarding the cultural heritage values of the Project area included:

- a request with the draft assessment methodology for any initial comments regarding the Aboriginal cultural heritage values of the Project area;
- discussion of cultural heritage values during fieldwork; and
- the provision of a draft report to all RAPs for comment prior to finalisation.

9.3.3.1 Draft Survey Methodology

Sections 4.3.1 and 4.3.2 of the Consultation Requirements require that the proponent present and/or provide the proposed methodology for the cultural heritage assessment to RAPs and that RAPs be given a minimum of 28 days to review and provide feedback on this methodology.

In accordance with these requirements, on 19 August 2014, all RAPs were sent a draft of AECOM's proposed methodology for this Aboriginal cultural heritage assessment. A request for any initial comments regarding the cultural values was also made in the covering letter accompanying the methodology. The specified closing date for comments was 17 September 2014, which provided the necessary minimum 28-day period for RAP comment.

Four written responses and two verbal responses to the draft methodology were received from RAPs. These responses are summarised in Table 9.3. Where appropriate, AECOM's responses are also provided. Written RAP responses to the draft methodology are attached as Appendix E, Annex C.

9.3.3.2 Archaeological Survey & Geomorphological Field Inspection

With the exception of Maaiangal Aboriginal Heritage and Do-Wa-Kee, who had indicated in their verbal responses to the draft assessment methodology that they would (or could) not participate in the fieldwork component of this assessment, all RAPs were provided the opportunity to participate in an archaeological survey of the Project area as well the field inspection component of Fanning's geomorphological assessment for the Project (Appendix A, Annex C).

Notification of the archaeological field survey, including insurance requirements, was provided in writing to all relevant RAPs on 23 September 2014. Four RAPs provided field representatives for participation in the survey and geomorphological field inspection. Representatives are listed by organisation in **Table 9.4**.

RAP field representatives involved in the archaeological survey and geomorphological field inspection identified the following social or cultural values for the Project area in conversations with AECOM field staff:

- The Interbarrier Depression landward of the elevated Ridge I dune field would have been a focal resource area for Aboriginal people camping within or passing through the Project area. However, this area would have been unsuitable for camping;

- The elevated dunes overlooking the Interbarrier Depression are likely to have been favoured for occupation owing to their proximity to this important resource area;
- The lack of freshwater sources within the Project area's elevated Ridge I dune field and adjoining sand plain landform units means that these areas would not have been suitable for long-term occupation;
- Identified surface sites within the Project area are typical of those encountered locally in terms of containing a mixture of estuarine and marine shellfish species;
- Local flaked stone artefact assemblages, including those from sites excavated as part of recent upgrades to Nelson Bay Road, are dominated by artefacts manufactured out of tuff;
- Dune crests associated with the two prominent conical-shaped dunes in the southwestern portion of the Project area are likely to have functioned as lookouts and may have been used as campsites; and
- The elevated Ridge I dune field that dominates that topography of the Project area forms part of culturally significant songline for local Worimi people.

Registered Aboriginal Party (RAP)	Date of response	Method of response	Summary of response	AECOM response to RAP comments
Worimi LALC	18.09.14	Letter	Worimi LALC support the draft methodology	None required
Maaiangal Aboriginal Heritage	19.09.14	Phone (verbal)	Ms Carol Ridgeway-Bissett of Maaiangal Aboriginal Heritage advises that she can't comment on the draft methodology given that she is isn't allowed to access the site [i.e., participate in fieldwork due to the requirement for Public Liability and Workers Compensation insurances]. However, Carol advises that she is happy to receive a copy of the draft report for review. In addition, Carol advises that the current assessment (and any subsequent salvage works) should be undertaken in accordance with relevant NPWS (now OEH) guidelines.	AECOM notes that the current assessment is being undertaken in accordance with relevant statutory guidelines. Public Liability and Workers Compensation insurance were a client requirement for the fieldwork component of this assessment. AECOM will provide Maaiangal Aboriginal Heritage with a copy of the draft report for their review.
Lower Hunter Aboriginal Incorporated	24.09.14	E-mail	LHAI approve of the methodology and have no further comments	None required
Doo-Wa-Kee	17.09.14	Phone (verbal)	Mick Leon of Do-Wa-Kee advises that his organisation is happy "for the groups down there" to comment on the methodology and undertake fieldwork. In addition, Mick advises that Do-Wa-Kee is happy for their involvement in the assessment to be limited to receiving (for review) a copy of the draft report.	None required
Mur-roo-ma Inc	22.08.14	Letter	Mur-roo-ma fully understands and endorses the draft methodology and believe that AECOM has consulted in a respectful manner. Mur-roo-ma advises that all possible Aboriginal objects and places within the Project area are of great value to Worimi people. In addition, Mur-roo-ma advises that the presence of AHIMS registered sites in close proximity to the Project area and their belief that the site was utilised by Worimi people in the past make it highly significant to the local Aboriginal community.	None required
Nur-run-gee Pty Ltd	01.09.14	E-mail	Nur-run-gee agrees with the methodology	None required

Table 9.3 - RAP responses to draft assessment methodology

Registered Aboriginal Party (RAP)	Field representative(s)	Field date(s)
Worimi LALC	Jamie Merrick	1/10/14 to 2/10/14; 23-10-14
Lower Hunter Aboriginal Incorporated	Gordon Ahoy & Ben Quinlan	1/10/14 (Gordon); 23-10-14 (Ben)
Mur-roo-ma	Chris Collison & Bec Young	1/10/14 to 2/10/14 (Chris); 23-10-14 (Bec)
Nur-run-gee	Leanne Anderson & Chris Collison	1/10/14 (Leanne); 2/10/14 & 23-10-14 (Chris)

Table 9.4 - RAP field representatives by organisation

9.3.4 Stage 4 - Review of Draft Cultural Heritage Report

The aim of Stage 4 of the Consultation Requirements is to prepare and finalise an Aboriginal cultural heritage assessment report with input from RAPs.

In accordance with Section 4.4.2 of the Consultation Requirements, on 21 November 2014, all RAPs were sent a draft of the Aboriginal cultural heritage assessment for review and comment. The specified closing date for comments was 22 December 2014, which provided the necessary minimum 28-day review period.

Responses to the draft report were received from all RAPs and are summarised in Table 9.5 - RAP responses to draft report.5. Written responses are attached as Appendix F, Annex C.

Registered Aboriginal Party (RAP)	Date of response	Method of response	Summary of response	AECOM response to RAP comments
Nur-Run-Gee	16.12.14	Letter	Nur-Run-Gee agree with and understand the draft report, especially Sections 7.0 (Archaeological Survey) and 10.0 (Management Strategy). Nur-Run-Gee recommend that once initial clearing has been undertaken a further field assessment should be undertaken. In addition, Nur-Run-Gee recommend that a cultural investigation be completed each month.	Recommendations relating specifically to RAP monitoring of vegetation clearance activities and monthly RAP inspections of stockpiled samples of reject screen material have been incorporated into the management strategy detailed in **Section 9.10.0**.
Mur-Roo-Ma	10.12.14	Letter	Mur-Roo-Ma confirm the following: • Mur-Roo-Ma fully understand the contents of the draft report; • A representative of Mur-Roo-Ma was present for the fieldwork component of the assessment; • Mur-Roo-Ma agree that appropriate management strategies have been proposed for the project and should be adhered to; • Mur-Roo-Ma endorse the recommendations and conclusions of the draft report;	A recommendation relating to RAP inspections of stockpiled samples of reject screen material has been added to the management strategy detailed in **Section 9.10.0**.

Registered Aboriginal Party (RAP)	Date of response	Method of response	Summary of response	AECOM response to RAP comments
			• Mur-Roo-Ma believe that all reasonable care and action was taken to identify Aboriginal objects and sensitive areas; and • Mur-Roo-Ma found the consultation program undertaken to be respectful of the local Aboriginal community. In addition, Mur-Roo-Ma: • Suggest that all extracted sand is screened; • Require monthly site visits to inspect screen overburden for the first twelve months of sand extraction; • Support the establishment of an ACHMP and look forward to providing input; • Request that the words "identified sites" in **Section 9.10.2.1** are replaced with "cultural objects"; • Note that the only way to achieve a truthful and accurate assessment is to consult and employ local Worimi Knowledge Holders; • Note that all Aboriginal objects within the Project area are of great value to Worimi people.	
Maaiangal Aboriginal Heritage	27.01.15	Phone	Carol Ridgeway-Bissett has advises that she is fundamentally opposed to any form of mining within the traditional Country of the Worimi people. Carol believes that mining projects benefit no-one but the State Government and have the potential to negatively affect local water supplies. In addition, Carol believes that it is highly likely that additional, previously unrecorded Aboriginal objects are present within the Project area. These points notwithstanding, Carol advises that should any archaeological salvage activities be undertaken within the Project area, these should be carried out in strict accordance with relevant OEH guidelines. In addition, Carol believes that salvaged artefacts should not be held by the Worimi LALC but rather should be reburied on-site.	Noted. Any previously unrecorded Aboriginal objects identified within the Project area during the life of the Project would be managed in accordance with an unexpected finds policy to be detailed in the ACHMP. Management action(s) will vary according to the type of evidence identified, its significance (both scientific and cultural) and the nature of potential impacts. Subject to Project and ACHMP approval, any proposed archaeological salvage activities within the Project area would be undertaken in accordance with a detailed Research Design and Methodology (RD&M). This RD&M, to be developed in

Registered Aboriginal Party (RAP)	Date of response	Method of response	Summary of response	AECOM response to RAP comments
				consultation with RAPs, would be included in the ACHMP for the Project.
Lower Hunter Aboriginal Incorporated	27-01-15	E-mail	David Ahoy of LHAI advises that LHAI Worimi field representative Ben Quinlan hopes that identified midden sites can be protected as they provide a link to his ancestors.	Noted. Impacts to identified midden sites within the Project area cannot be avoided owing to their position relative to proposed sand mining activities. Nonetheless, site impacts are to be mitigated through a comprehensive archaeological salvage program.
Do-Wa-Kee	02-02-15	Phone	Mick Leon of Do-Wa-Kee advises that he "can't see any problems with the report or management recommendations"	None required
Worimi LALC	06-02-15	Phone	Jamie Merrick (Sites Officer) advises that Worimi LALC is happy with the report and proposed management strategy, which reflects what was discussed in the field.	None required

Table 9.5 - RAP responses to draft report

9.4 LANDSCAPE CONTEXT

The nature and distribution of Aboriginal archaeological materials are closely linked to the environments in which they occur. Environmental variables such as topography, geology, hydrology and vegetation will have played a critical role in influencing how Aboriginal people moved within and utilised their respective Country. Amongst other things, these variables affected the availability of suitable campsites, drinking water, economic plant and animal resources, and raw materials for the production of stone and organic implements. Accordingly, any attempt to predict or interpret the character and distribution of Aboriginal sites in a given landscape must take such environmental factors into account. At the same time, an assessment of historic land use activities and geomorphic processes, both contemporary and historic, allows predictions to be made concerning the survival, visibility and integrity of Aboriginal archaeological materials within the same landscape.

9.4.1 Physical Setting

The Project area is located in the sparsely populated rural suburb of Bobs Farm, approximately 25 km east-northeast of the City of Newcastle and 7 km west-northwest of the township of Anna Bay on the Hunter Valley's coastal plain (Figure 1 Annex C). Situated between MGA grid coordinates 406060 and 407440 east and 6372810 and 6374190 north on the Morna Point (9332-3) 1:50,000 topographic map sheet, the Project area is bounded to the south and east by Nelson Bay Road, to the north by Marsh Road and to the west by native bushland. Irregularly-shaped, it covers an area of approximately 53 hectares.

Surrounding suburbs include Anna Bay to the east, Oyster Cove and Tanilba Bay to the north and Salt Ash to the west. Parks and reserves in the local area include Worimi National Park, which borders Nelson Bay Road to the immediate south of the Project area, Worimi Regional Park, which adjoins Worimi National Park to the east, Tilligerry National Park to the west, Tilligerry State Conservation Area to the northwest and Tilligerry Nature Reserve to the northeast.

Reference to the Geographical Names Register of NSW indicates that the Project area falls wholly within the boundaries of the Port Stephens Local Government Area (Port Stephens LGA) and is situated in the Parish of Tomaree in the County of Gloucester. Land within the Project area has been registered as Lots 10 and 11 on DP1071458, Lot 254 on DP753204 and Lot 51 on DP1015671.

9.4.2 Geomorphic Setting

As indicated in Section 9.1.3, the Project area is located within the Newcastle Bight embayment, the largest sedimentary basin of Quaternary age in the greater Port Stephens-Myall Lakes area (Thom et al. 1992). Bordered to the south by the Hunter River and the north by an outcrop of Nerong Volcanics at Lemon Tree Passage, this broad south-southeast facing embayment is dominated by an extensive dual sand barrier system consisting of an inner Pleatocene barrier (the 'Inner Barrier'), an outer Holocene barrier (the 'Outer Barrier') and a broad interbarrier depression filled with Holocene estuarine swamp deposits (the 'Interbarrier Depression'). Reference to Thom et al.'s (1992) generalised morphological map of the Newcastle Bight embayment (Figure 9.4) indicates that the Project area is located towards the northeastern end of the Outer Barrier at the interface of the oldest of the barrier's three long-walled transgressive dune 'ridges' (i.e., Ridge I) and the Interbarrier Depression's now heavily-drained Holocene estuarine plain (Figure 9.4). Both features are described further in this section.

The subject of numerous geomorphological investigations over the past five decades (e.g., Ly 1976, 1978; Roy and Crawford, 1980; Roy et al. 1981; Roy et al. 1995; Thom 1965, 1978; Thom et al. 1978; Thom et al. 1981; Young et al. 1993; Lees 2006; Thom et al. 1992; Thom et al. 1994), the geomorphic chronology and evolution of the Newcastle Bight embayment, including its dual sand barrier system, are now well understood, albeit in broad terms. Drawing, in particular, on studies by Thom et al. (1981), Thom et al. (1992) and Roy and Thom (1981), a brief synthesis of the geomorphic history of the embayment is provided below. Key morphological and stratigraphic features of the embayment, which incorporates a sieaZble component of the Hunter 'delta' described by Roy et al. (1995) and others (e.g., Chappell 1993), are illustrated in Figure 9.4 and Figure 9.5 respectively, while Figure 9.6 illustrates Thom et al.'s (1992) six stage model of the embayment's geomorphic evolution.

As shown on Figure 6, prior to the Last Interglacial (i.e., >140,000 years BP) the present-day Newcastle Bight embayment comprised part of a large estuary behind a coastal sand barrier on the upper part of the inner continental shelf slope (Roy and Crawford's (1980) "proto-barrier"). Formation of this estuary, which is represented in the embayment's Late Quaternary sedimentary record by a thick unit of interbedded clays and sands with a relatively uniform seaward slope (see Figure 5), was associated with pre-Last Interglacial high-sea levels. Thom et al. (1992: 158) have interpreted the thickness of this unit as a product of the "polycyclic accumulation" of estuarine sediments, with each depositional cycle associated with an interglacial/interstadial high sea-level. Underlying basal fluvial sands and gravels, in contrast, have been linked to sea-levels lower than the present day (Thom et al., 1992: 158).

The Inner Barrier of the Newcastle Bight embayment has a maximum length of 32 km and width ranging from 3-6 km. Thom et al. (1992: 107) report a general elevation of c.10 m + Mean Sea Level

(MSL) but note considerable variation in relief (c.5 to 60 m). Key morphological components of the Inner Barrier, which occupies both a bay-head and mid-bay position, include a relict foredune plain at its eastern end and well-stabilised linear and parabolic dunes at its western end (Thom et al. 1992: 107-112). U-Th and amino racemization dates on corals and shells indicate that the Inner Barrier formed during the Last Interglacial period (c.135,000 to 120,000 years BP) which included a major marine transgression and subsequent "stillstand" or oscillating sea level (Thom et al. 1981: 357). Formation of the Inner Barrier blocked off several valleys, resulting in the formation of extensive swamps (e.g., Grahamstown Swamp (now Grahamstown Reservoir) and Moffats Swamp) and the southerly realignment of the Hunter River. Raised estuarine shell beds at Largs, behind the Inner Barrier, have been assigned a Last Interglacial age and are indicative of a sea level around 5 m above present MSL (Roy et al. 1995: 70; Thom & Murray-Wallace, 1988; Thom et al. 1981). Associated terrace deposits, the modern distribution of which has been mapped by Roy et al. (1995), are remnants of the Last Interglacial floodplain that blanketed the estuary referred to above (Roy et al. 1995: 70).

The Last Glacial period (c.120,000 and 10,000 years BP) has been interpreted as a period of oscillating sea levels, with levels descending to depths below -100 m during the Last Glacial Maximum (LGM) c.25,000 to 15,000 years BP (Thom et al. 1981: 357). During the LGM, the coastline was on the continental shelf around 25km east of its present position. For the Newcastle Bight embayment, Thom et al. (1992) identify two major geomorphic processes for the Last Glacial period: valley incision and aeolian reworking of the Inner Barrier's relict foredune plain (beach-ridge) plain. Incision of the present day rivers of the Hunter 'delta' into their respective valleys commenced with the onset of glacial cooling and its attendant (progressive) reduction in sea levels. Erosion and transportation of much of the Last Interglacial floodplain in the millennia leading up to and comprising the LGM have been attributed to prolonged sub-aerial weathering and the lateral migration of river channels across this low gradient floodplain (Roy et al. 1995: 71). Undated evidence of probable Late Glacial fluvial deposition, comprising fluvial sands and gravels, has been identified near Fullerton Cove (Unit 5 in Figure 9.5). To the north/northeast of Fullerton Cove, radiometric dates for the Inner Barrier's linear and parabolic dunes indicate development during the LGM (Thom et al. 1994: 236-237). Dune formation is argued to have occurred as a result of strong westerly (offshore) winds and sand surface instability associated with a drier, moisture deficient and windier LGM climate (Thom et al. 1994). Thom et al. (1992: 160) note that differences in the degree of soil profile development between the stabilised dunes of the Inner Barrier and Outer Barrier indicate that the former have been stable for a considerably longer period of time than the latter.

Rising sea levels associated with the Postglacial Marine Transgression (PMT) (c.10,000 to 6,500 years BP) inundated the coastal valleys created during the Last Glacial and resulted, in the case of the Hunter 'delta', in an estuary extending approximately 35 km inland from the present coastline (Figure 9.7). In the Newcastle Bight embayment, remnants of nearshore and transgressive beach sediments occur in subsurface contexts and have been dated to the early to mid-Holocene (for dates see Umwelt 2000: 4.3) (Figure 9.5). Backbarrier sand flats preserved landward of and beneath the Outer Barrier (Figure 9.4) were primarily formed during the PMT and represent a residual, overwash environment of deposition (Roy and Thom 1981: 477). Landward of the Outer Barrier, these flats interfinger with the Holocene estuarine muds associated with Interbarrier Depression. Backbarrier accumulation, Thom et al. (1992: 363) report, ceased shortly after the termination of the PMT due the formation of high foredunes or beach ridges.

Initiation of the Outer Barrier commenced shortly after the cessation of the PMT around 6,500 to 6,000 years BP (Thom et al. 1981: 360). Thom et al. (1992) have characterised the mid-Holocene

(c.6,500 to 3,000 years BP) as a period of marked geomorphic change within the Newcastle Bight embayment and describe for this period an episodic history of sedimentation involving three key processes: (i) initial progradation and beach-ridge formation; (ii) aeolian instability and transgressive dune development; and (iii) additional beachfront and foredune accumulation with some shoreline progradation. Regarding (i), Roy and Thom's (1981) schematic model of sand barrier development, which applies to Pleatocene Inner Barriers as well, remains the dominant explanatory model for the Newcastle Bight embayment (Figure 9.8) (but see Young et al. 1993 for an alternative model). Roy and Thom (1981) have described the process of barrier development as follows:

> [A] rising sea level induces landward translation of the shoreline across a relatively shallow and low gradient shelf. Few topographic obstacles impede the coastwise exchange of sediment. Low near-shore gradients are maintained during the transgression and the zone of wave energy dissipation is broad. Lagoons and low barrier shorelines are formed on these gently sloping surfaces and are partially retained following submergence. Washover and estuary mouth processes that transfer sand landwards are envisaged as being important during marine transgressions…Superficial reworking produces a transgressive sand sheet, which constitutes the winnowed parent sand body from which present day coastal barriers were formed. When a transgression terminates, wave energy is dissipated over a broad and relatively shallow inner shelf surface. Net onshore sand transport by shoaling waves operating in a shore-normal direction results in beach-ridge progradation. During low sea level periods, sand is added to the inner shelf by littoral and fluvial processes, while onshore winds blow sand from the shelf to form transgressive dune complexes on the mainland.

The Outer Barrier of the Newcastle Bight embayment occupies a bay mouth position between Nobbys Head and Buribi Point and is separated from the Inner Barrier by the Interbarrier Depression, which extends from the Hunter River to Port Stephens and includes Fullerton Cove and Tilligerry Creek. A composite feature, the Outer Barrier incorporates a relict strand or beach-ridge plain (now largely buried), two stabilised long-walled transgressive dune 'ridges' (referred to as Ridge I and Ridge II) and a mobile dune sheet whose leading edge comprises the Outer Barrier's third long-walled transgressive dune 'ridge' (Ridge III). Key morphological characteristics of these features have been described in detail by Thom et al. (1992: 112-121). Ridge I and Ridge II parallel the shoreline for most of their length (c.24 km) and are separated by a low relief sand plain characterised by shallow Melaleuca swamps and low dunes which trend sub-parallel to the shoreline and are rarely exceed 5 to 7 m in height (Figure 9.9). Both stabilised ridges curve seawards in the Bobs Farm area. As with Ridges I and II, Ridge III follows the general alignment of the shoreline. However, its detailed plan form is highly irregular.

Formation of the of the Outer Barrier's three transgressive dune ridges has been linked to periods of aeolian instability prior to 4,500 BP (Ridge I), between 3,000 and 1,500 BP (Ridge II) and since 500 BP (Ridge III) (Thom et al. 1992). Ridge I overlies beach ridges which are older than 5,000 BP and exhibits soil development consistent with a mid-Holocene date (Thom et al. 1992: 364). Ridge II has yet to be directly dated. However, Thom et al. (1992: 366) note that it exhibits a poorly developed soil profile comparable to a parabolic dune at Eurunderee younger than 2,320±110 BP. Thom et al. (1992: 364, 366) cite a date of "around 3,000 to 3,500 years BP" for the development of a vegetative cover on Ridge I and a date range of 1,200 to 1,800 years BP for the same process on Ridge II. As for the development of Ridge III, Thom (1978) has tentatively correlated the period of dune instability responsible for the formation of this ridge with the deteriorated climate of the Little Ice Age (LIA), which appears to have been characterised by higher intensity east coast storms and stronger onshore winds. Sand drift assessments for the Outer Barrier's mobile dune sheet

indicate a net encroachment rate of four to ten metres per year (cf. P.W.D. 1977 and Robson et al. 1986 in Thom et al. 1992: 118).

Mid-to-late Holocene estuarine and deltaic sedimentation in the Newcastle Bight embayment has been discussed in detail by Roy et al. (1995) who describe a dual infilling process involving the building of tidal delta marine sand into the estuary mouth from the open ocean and the deposition of land-supplied fluvial-estuarine sediments through rivers and creeks. Estuarine environments were most common during the mid-Holocene but have progressively decreased in size through estuary infilling. Estuarine muds associated with the Hunter palaeoestuary vary laterally in response to existing environmental conditions. Towards the coast, where salinity levels are relatively stable and the estuary is marine-dominated, the muds are shell-rich. However, further inland, organic-rich muds with less shell predominate, a product of significantly higher freshwater inflows (Roy et al. 1995: 76). At Maitland, behind the Inner Barrier, estuarine muds are up to 17 m thick and contain fluvial deltaic sand units. These muds are overlain by up to 8 m of Holocene flood plain alluvium, with well-developed levees present (Roy et al. 1995: 77). Flood plain deposits in this and other portions of the Hunter palaeoestuary have been described as consisting of "complexly interbedded muddy sands and sandy muds with minor organics" (Roy et al. 1995: 71).

Further discussion on the geomorphological context of the Project area is provided in Fanning's geomorphological assessment report for the Project, attached as Appendix A, Annex C.

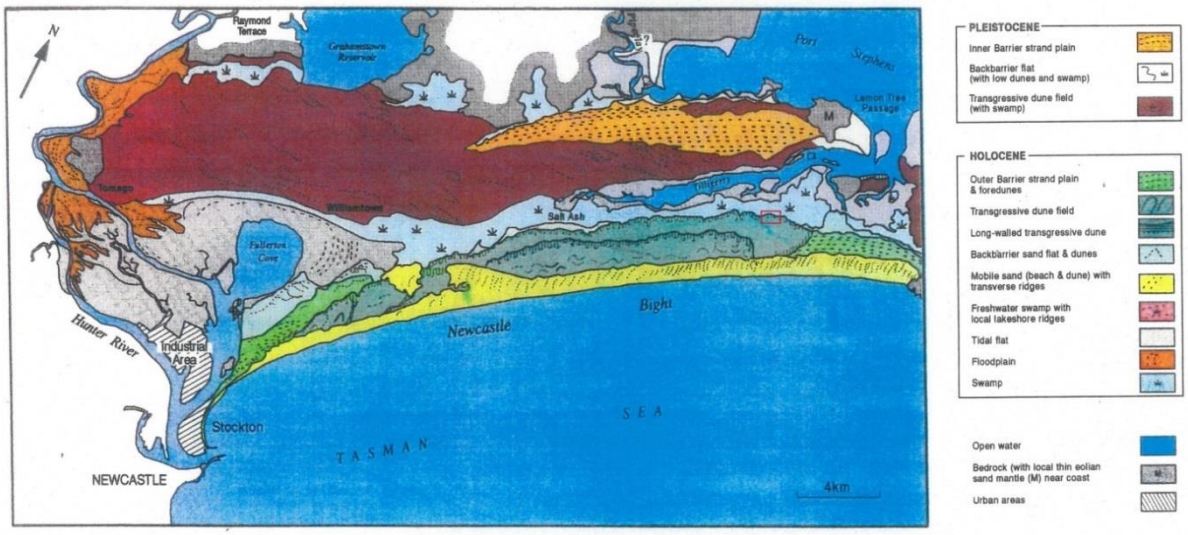


Figure 9.4 - Generalised morphological map of the Newcastle Bight embayment (from Thom et al., 1992: 104-5, Fig., 4-1b and c). Approximate location of Project area marked in red

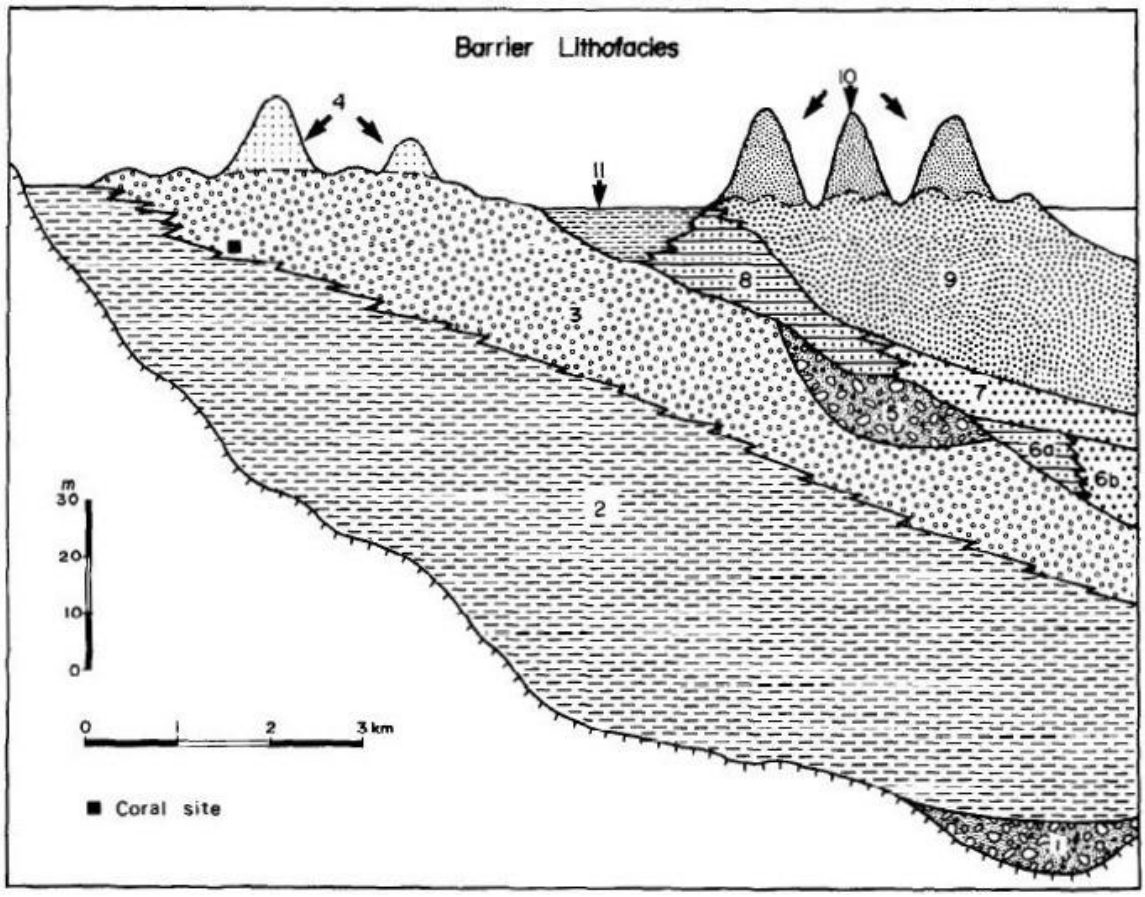


Figure 9.5 - Geologic cross section through Newcastle Bight embayment **showing lithofacies: 1) basal fluvial sands and gravels; 2) interbedded clays and sands (composite estuarine unit); 3) Inner Barrier Marine Sands; 4) Pleatocene sand dunes; 5) fluvial sands and gravels; 6) late Pleatocene marine and estuarine sands; 7) marine transgressive sands; 8) backbarrier sands and muddy sands; 9) Outer Barrier marine sands; 10) Outer Barrier transgressive dune sands; and 11) Holocene estuarine muds (from Thom *et al.* 1981: 348, Fig. 2)**

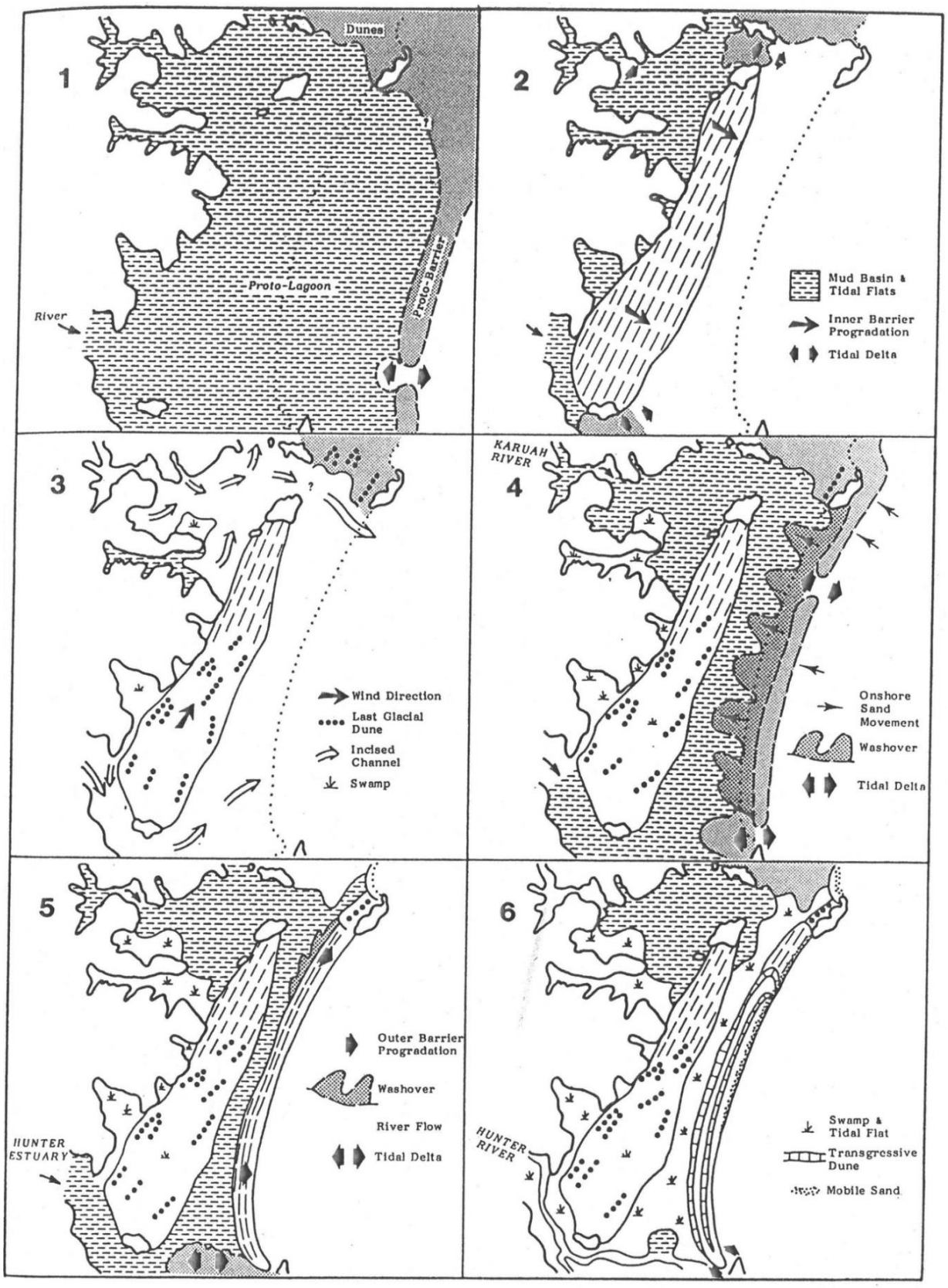


Figure 9.6 - Thom et al.'s (1992) six-stage model of the geomorphic evolution of the Newcastle Bight embayment. **Period and date ranges for each stage are as follows: 1) Pre-Last Interglacial, >140,000 BP; 2) Last Interglacial, c.120,000 BP; 3) Last Glacial, 120,00-10,000 BP; 4) Post Marine Transgression 10,000-6,500 BP; 5) 6,500-3,000 BP; and 6) <3,000 BP**

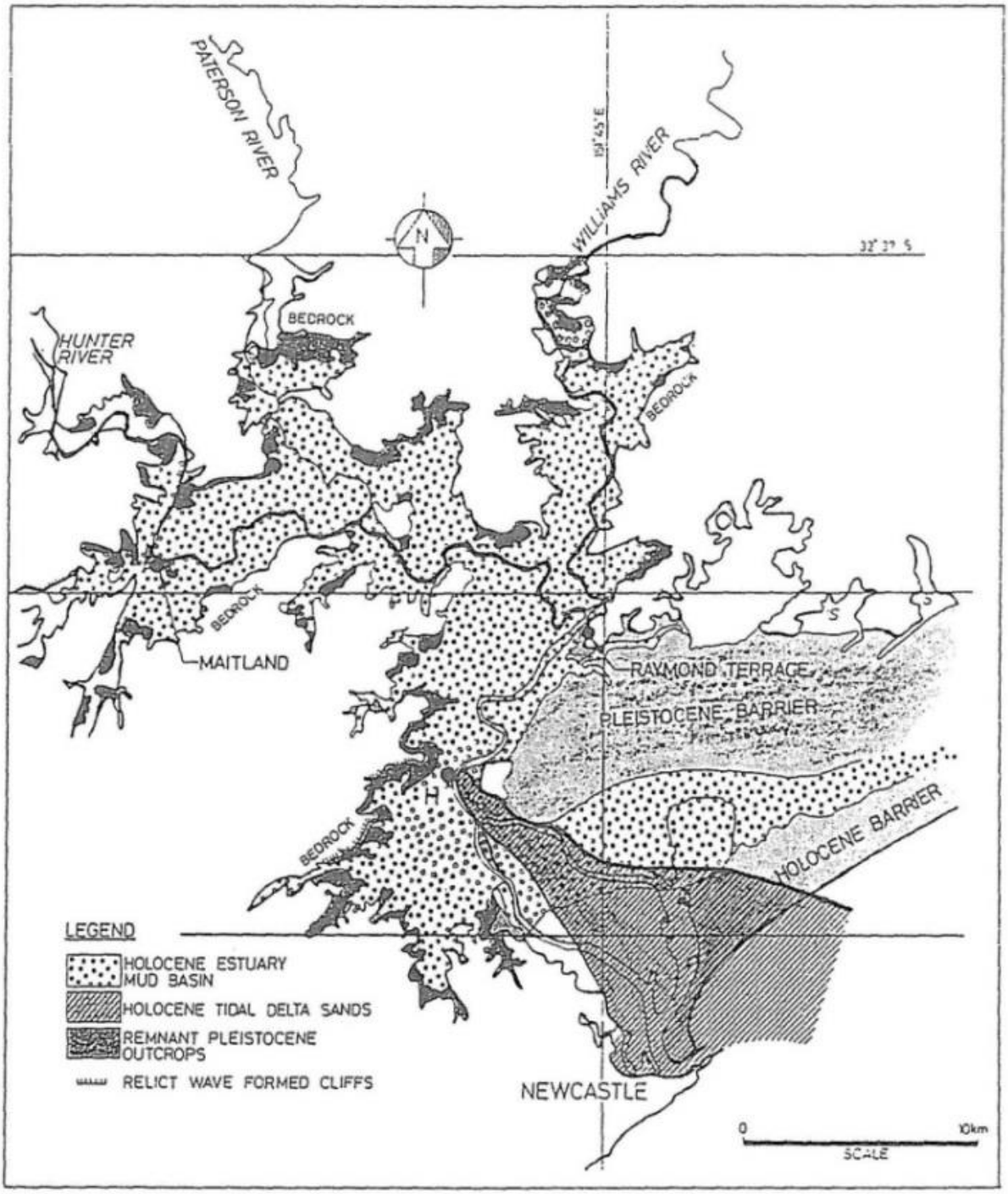


Figure 9.7 - Map showing the aerial extent of the main Holocene valley fill lithofacies of the Hunter "delta" (from Roy et al., 1995: 72, Fig. 6)

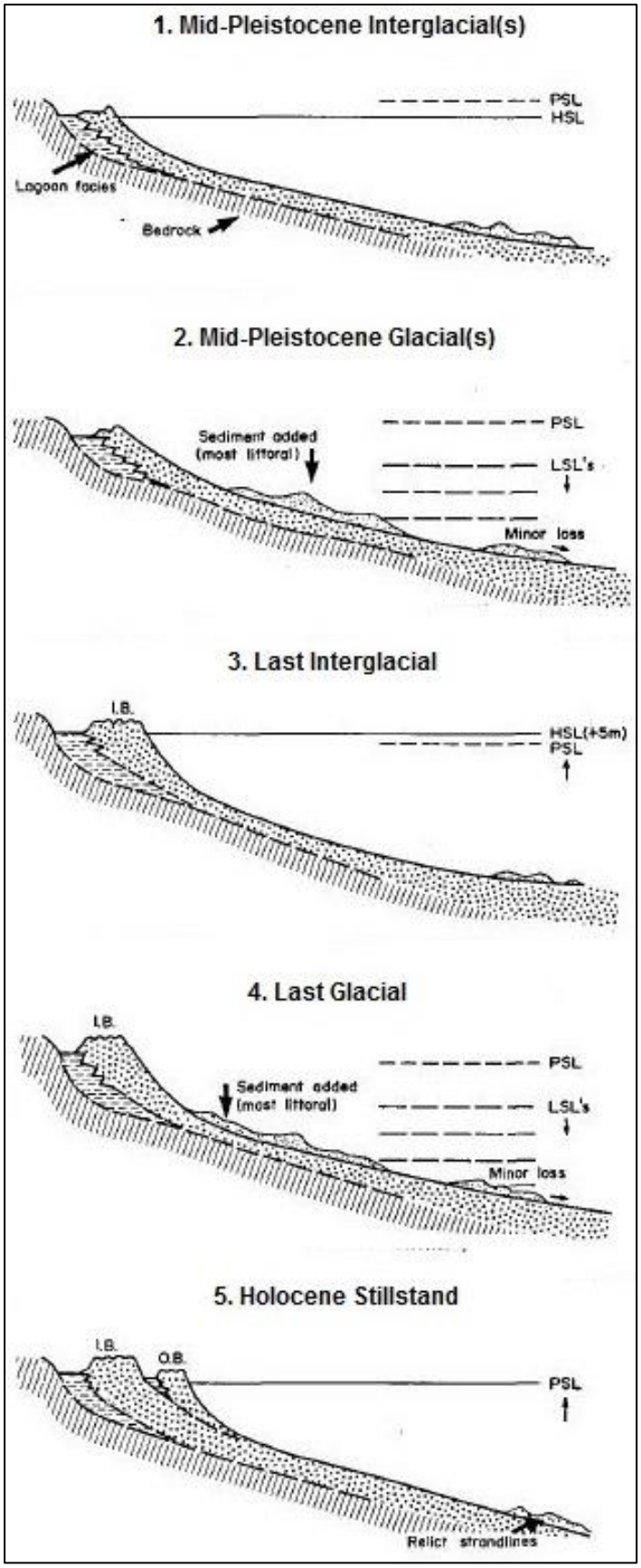


Figure 9.8 - Roy and Thom's (1981) schematic model of sand barrier development north of Newcastle (modified from Roy and Thom 1981: 486, Fig. 9)

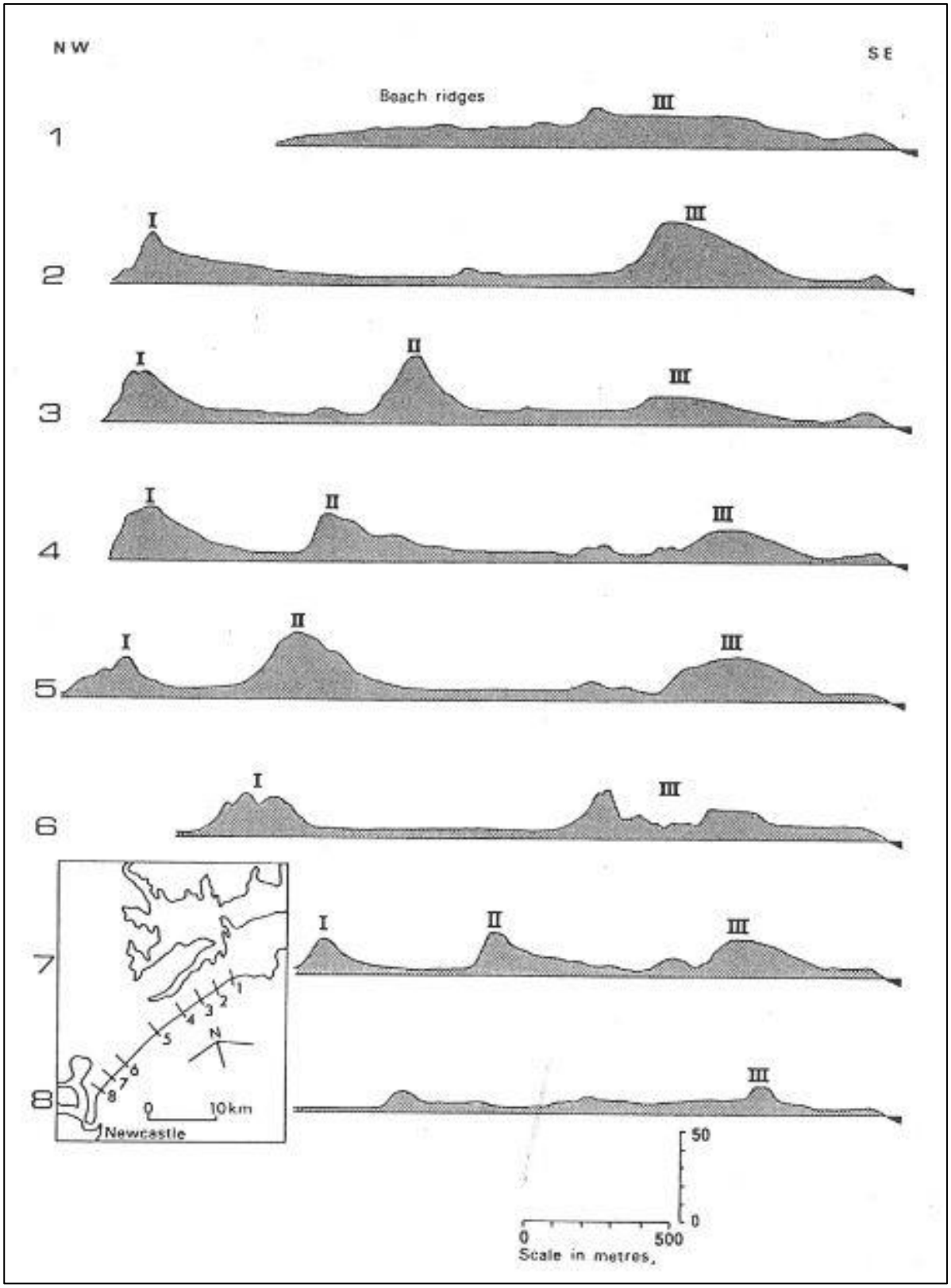


Figure 9.9 - Topographic cross-sections across the Outer Barrier of the Newcastle Bight embayment (from Thom et al. 1992: 113, Fig.4-5)

9.4.3 Topography

As shown on Figure 9.10, the Project area is located towards the northeastern end of the Outer Barrier at the interface of the barrier's oldest stabilised transgressive long-walled dune 'ridge' (i.e., Ridge I) and the Interbarrier Depression's now heavily drained Holocene estuarine plain. At this point along the barrier, Ridge I is separated from the actively-transgressing Ridge III by a low relief sand plain with a maximum width of around 1.3 km. The second of the Outer Barrier's stabilised long-walled ridges, Ridge II, which lies nested between Ridges I and III in the central and southwestern portions of the barrier (Figure 9.9), is not present at this point along the barrier. However, it is clearly visible on aerial photographs of the Bobs Farm area, its northeastern edge curving seaward to the southwest of the site (Figure 9.10). At its closet point, the Outer Barrier's stand or beach-ridge plain, which has a maximum length of 6.6 km and maximum width of c.1km (Thom et al. 1992: 114), is located approximately 1.5 km to the east of the Project area. To the south, west and immediate east of the Project area, this plain has been consumed by transgressive dunes. Backbarrier sand flats preserved to the east of the Project area landward of the strand plain have likewise been consumed by transgressive dunes (see Figure 9.4).

Reference to Thom et al. (1992) indicates that the Project area contains three distinct landform units, two of which can be characterised as 'aeolian units' and the third, as an 'estuarine unit' (Figure 9.9). Aeolian units within the Project area include the elevated Ridge I dune field and adjoining low relief sand plain, while the estuarine unit comprises the Interbarrier Depression's drained Holocene estuarine plain. Topographically, the Ridge I dune field is characterised by a series of steep-sided dunes, both 'conical' and 'irregular' in shape (after Thom et al. 1992: 47), separated by cols/depressions of variable width and elevation. Elevation within the Ridge I dune field ranges from 36 m to around 8 m AHD, providing a total local relief of 28 m. Towards Nelson Bay Road, the Ridge I dune field abruptly gives way to a low relief sand plain now largely occupied by an orchard and associated buildings. Low dunes within this sand plain trend sub-parallel to the shoreline and attain a maximum elevation of 10 m AHD. In the northeastern portion of the Project area, a similarly abrupt topographic transition occurs between the Ridge I dune field and the Interbarrier Depression's drained Holocene estuarine plain, with the latter characterised by flat (<1% slope), low-lying (<1 m AHD) and formerly swampy terrain.

9.4.4 Hydrology

Owing to highly permeable soil materials, there are no permanent or ephemeral freshwater creeks present within the stabilised or mobile portions of the Outer Barrier sand mass. However, in the case of the former, which encompasses the Project area, potable water can be found in pockets of freshwater swamp forest occupying low-lying, poorly-drained swales and depressions. No such pockets are present within the current Project area[1] (cf. ERM 2005). However, it is noted that available vegetation mapping and aerial photographs indicate the presence of several such features, some quite large, to the south of the Project area within the low relief sand plain separating Ridge I and III. A permanent watertable is typically present within 30 cm of the ground surface in these contexts (Matthei 1995: 217).

[1] Swamp Mahogany-Paperbark Forest has been identified in the northEAstern portion of the Project arEA (i.e., on the Interbarrier Depression's Holocene estuarine plain). However, prior to historic draining, this arEA would have comprised part of an extensive estuarine swamp environment.

Ephemeral freshwater wetlands and ponds are also present within the Outer Barrier's modern deflation basin, c. 1.5 km south of the Project area, and alongside 'interior' pockets of swamp forest, will have comprised an important source of drinking water for Aboriginal people occupying the Outer Barrier throughout the mid-to-late Holocene. The distribution and permanency of these features, which represent the only source of freshwater within the Outer Barrier's mobile dune sheet, has been linked to a variety of factors including frontal dune continuity, the distribution of washovers, water table depth and localised sand movements (Umwelt 2000: 4.11).

Prior to historic draining for grazing and crop production, the Interbarrier Depression landward of the Outer Barrier would have consisted of an extensive estuarine swamp environment subject to the daily tidal cycle of the Pacific Ocean. In the vicinity of the Project area, the Interbarrier Depression is drained principally by Tilligerry Creek, a regionally significant estuarine watercourse that rises along the eastern shore of Fullerton Cove and discharges into Port Stephens approximately 5km northeast of the Project area. Natural flows along Tilligerry Creek have been substantially altered by an extensive network of floodgates and constructed drains. Upstream of the Tilligerry Creek Floodgates, which provide an artificial tidal limit, the creek comprises a freshwater stream. However, downstream of this point, it remains estuarine. Other locally significant creeks include Bobs Farm Creek (c.2.1 km northeast), Fenninghams Island Creek (c. 3km northeast) and Wallis Creek (c. 5km northeast). All discharge directly into Tilligerry Creek and comprises estuarine watercourses.

Bobs Farm Creek
B63
Nelson Bay Road
Beach-ridge plain
Stockton Beach
Stockton Bight
Bobs Farm
Worimi National Park
Masons Road
Upton Island
B63
Ridge I
Low relief sand plain
Ridge II
Ridge III
Nelson Bay Road
Masons Road
Tilligerry Creek
KEY
Project area
0
400
800m

Figure 9.10 - Topographic Context

Worimi National Park
Nelson Bay Road
Nelson Bay Road
Nelson Bay Road
Lot 11 DP1071458
Lot 10 DP1071458
Lot 51 DP1015671
Lot 254 DP753204
B63
Australian Shark Encounter
KEY
Project area
National Parks and Wildlife Estate
Landform Units
Low relief sand plain
Estuarine plain
Elevated ridge 1 dune field
0
100
200m

Figure 9.11 - Landform Units

9.4.5 Geology & Soils

Reference to the Port Stephens 1:25 000 Quaternary Geology Map Sheet indicates that the near surface geology of the Project area consists principally of aeolian marine sands of Holocene antiquity (Qhbd), with saline swamp deposits (Qhes) also present but restricted to the northeastern portion of the site in association with the Interbarrier Depression's drained Holocene estuarine plain.

No outcrops or deposits of stone(s) suitable for the production of flaked stone artefacts are present within or immediately surrounding the Project area. However, it is noted that in common with the Newcastle Bight embayment as a whole, local flaked stone artefact assemblages attest to an emphasis on the procurement and reduction of fine-grained volcanic tuffs, often cream or grey in colour. Such tuffs occur in a number of Permian era geological units on the peripheries of the Newcastle Bight embayment (e.g., Newcastle Coal Measures, Tomago Coal Measures and Dalwood Group) and appear to have been sourced from both bedrock outcrops and alluvial gravel deposits. Nobbys Tuff, the best known of the volcanic tuffs used by Aboriginal people for flaked stone artefact manufacture within the Newcastle Bight embayment, outcrops at Nobbys Head approximately 26 km southwest of the Project area. Nerong Volcanics of Carboniferous age outcrop at various locations to the east and northeast of the Project area. However, rocks associated with this geological formation are generally unsuitable for flaked stone artefact production (but see Dyall 2004 and Hall 1928 for examples of limited use).

Soils within the Project area have been mapped by Matthei (1995) and Murphy (1995) as belonging to the Boyces Track (bt), Hawks Nest (hn) and Bobs Farm (bf) soil landscapes. Dominant soil materials for these landscapes have been described as consisting of variably developed, well-to-poorly drained Podzols (bt and hn) and very poorly drained Humic Gleys (bf). In general, the aeolian bt and hn landscapes are characterised by deep (>1 m), highly permeable 'A' horizon soils, with well-differentiated A1 and A2 horizons. However, fibrous peats and saturated sands can also occur in low lying, poorly-drained swales and depressions. Levels of soil development differ according to landscape position within the Outer Barrier, with the most strongly developed profiles occurring towards the rear (i.e., landward margin) of the sand mass (Matthei 1995: 206). Near surface soils in the estuarine Bobs Farm landscape tend to consist of organic rich loams and estuarine clays. However, peaty Humus Podzols are sometimes present at the aeolian/estuarine interface (Matthei 1995: 188-189).

Further discussion on the soils of the Project area, including their geoarchaeological implications, is provided in Fanning's geomorphological assessment report, attached as Appendix A, Annex C.

9.4.6 Flora & Fauna

Uncleared native vegetation within the Project area is more-or-less intact and consists largely of Coastal Sand Apple-Blackbutt Open Forest, with small areas of Swamp Mahogany-Paperbark Forest and Tall Alluvial Moist Forest also present but restricted to low-lying areas landward of the elevated Ridge I dune field (Wildthing Environmental Consultants 2013). In the northeastern portion of the Project area, on the Interbarrier Depression's drained and largely cleared Holocene estuarine plain, available reference materials and field observations are suggestive of a former vegetative cover of estuarine-adapted swamp forest, with key species including Casuarina

glauca (Swamp Oak), Melaleuca quinquenervia (Broad-leaved Paperbark), Eucalyptus robusta (Swamp Mahogany) and Blechnum indicum (Swamp Water Fern) (Matthei 1995: 188). Closer to Tilligerry Creek, outside of the Project area, scattered remnants of this now heavily cleared vegetation community give way to extensive mangrove and saltmarsh communities.

Coastal Sand Apple-Blackbutt Open Forest is the most widely distributed native vegetation community on the stabilised sections of the Outer Barrier sand mass. Key canopy species include Eucalyptus pilularis (Blackbutt) and Angophora costata (Smooth-barked Apple). Common sub-canopy and shrub species, meanwhile, include Banksia serrata (Old Man Banksia), Acacia ulicifolia (Prickly Moses), Dillwynia retorta (Heathy Parrot Pea), Bossiaea rhombifolia, Macrozamia communis (Burrawang), Acacia terminalis (Sunshine Wattle) and Persoonia levis (Broad-leaved Geebung) (Hunter-Central Rivers CMA nd.; Matthei 1995: 202, 205). The ground stratum is dominated by Pteridium esculentum (Bracken Fern), with Themeda australis (Kangaroo Grass), Imperata cylindrical var. major (Blady Grass), Gonocarpus teucrioides (Germander Raspwort), Aotus ericoides (Common Aotus) and Dianella caerulea (Blue Flax-lily) also well represented.

Although available historical records provide only limited insight into Aboriginal exploitation of plants within the lower Hunter Valley, including the Newcastle Bight embayment, it can be confidently asserted that the original vegetation communities of the Project area and its environs will have supplied Aboriginal people camping within or travelling through the area with an extensive array of edible and otherwise useful plant species (Table 9.6 - Selection of economic plant species known to occur in the native vegetation communities of the Project area). Recorded native vegetation communities and locally occurring aquatic features (e.g., estuarine and freshwater swamps and creeks) will likewise have supported a large and diverse range of economic terrestrial, aquatic and avian fauna. Archaeological and historical evidence for the Aboriginal exploitation of faunal resources on the Hunter Valley's coastal plain is discussed in further detail in Sections 9.9.5 and 9.9.6.

Botanical name	Common name	Use(s)	Reference(s)
Acacia spp.	Acacia	Seeds and gum edible; wood suitable for making range of implements; bark & gum have medicinal properties	Stewart & Percival (1997)
Eucalypt spp.	Eucalypts	Bark has multiple uses (e.g., shelter, shields, baskets, fish nets); wood suitable for making range of implements (e.g., spears, clubs); leaves, gum & bark have medicinal properties	Stewart & Percival (1997); Isaacs (2002)
Banksia spp.	Banksia	Nectar can be sucked from flowers or flowers soaked in water to make sweet liquid	Stewart & Percival (1997); Isaacs (2002: 218)
Callistemon spp.	Bottlebrush	Nectar can be sucked from flowers or flowers soaked in water to make sweet liquid	Isaacs (2002: 219)
Livistona australis	Cabbage tree palm	Young shoots and leaves eaten raw; fibrous bark can be used to make fishing lines; leaves can be used as roof thatch.	Isaacs (2002: 225)
Eustrephus latifolius	Wombat berry	Seed pods and roots edible	Zola & Gott 1992
Dioscorea transversa	Native yam	Tubers edible raw or roasted	Stewart & Percival (1997: 19)

Botanical name	Common name	Use(s)	Reference(s)
Macrozamia communis	Burrawang	Nuts edible after leaching and cooking	Stewart & Percival (1997: 37)
Lomandra longifolia	Spiny-headed matrush	Leaf bases and flowers edible; leaves can be used to make baskets	Stewart & Percival (1997)
Melaleuca spp.	Paperbark & Honeymyrtle	Nectar-filled flowers can be soaked in water to sweeten it; bark has multiple uses; (e.g., shelter, dressing for wounds, wrapping)	Stewart & Percival (1997)
Pteridium esculentum	Bracken fern	Rhizomes and fronds edible; rhizomes must be baked or roasted to destroy toxins	Stewart & Percival (1997)
Blechnum indicium	Swamp Fern	Stems hammered to break fibres then roasted	Isaacs (2002: 218)
Dianella caerulea	Blue flax-lily	Berries and roots edible	Isaacs (2002: 220)
Phragmites australis	Common Reed	Roots edible; Straight flowering stems can be used as spear shafts; leaves can be twisted into rope	Zola & Gott (1992: 12)
Themeda australis	Kangaroo Grass	Seeds ground and baked	Isaacs (2002: 229)
Persoonia levis	Broad-leaf Geebung	Fruit edible	Low 1988
Exocarpus cupressiformis	Native cherry	Fruit edible	Isaacs (2002: 223)

Table 9.6 - Selection of economic plant species known to occur in the native vegetation communities of the Project area

9.4.7 Land Disturbance

Together with available historical records, historic aerial photographs for the Project area provide a framework for assessing the nature and extent of past ground disturbances within it. While a significant portion of the Project area consists of undisturbed/minimally disturbed native bushland, examination of aerials from 1951 (Figure 9.12), 1975 (Figure 9.13), 1983, 1987, 1992 (Figure 9.14), 2004 (Figure 9.15), 2010 and 2013 indicates that a range of land use activities involving various forms of ground disturbance have occurred across the site. These activities include:

- selective logging and/or grazing in areas of native bushland, as evidenced by the noticeably 'thinner' nature of Project area's vegetative cover in 1951 (cf. **Figure 9.12** and **Figure 9.13**);
- traditional crop production and grazing activities in the northeastern portion of the Project area (comprising the Interbarrier Depression's drained Holocene estuarine plain);
- the development of a commercial olive and fig cultivation operation on Lot 254 of DP753204;
- the construction of multiple residential dwellings with associated structures (e.g., work sheds) and driveways;
- the installation of essential services (e.g, power lines); and
- the construction/use of multiple unsealed light vehicle tracks across the elevated Ridge I dune field.

Key ground surface impacts associated with these land use activities have included native vegetation clearance (both targeted and broad area), heavy earthworks and ploughing.

To varying degrees, all of the above-cited land use activities are relevant to the survival, integrity and identification of Aboriginal archaeological evidence within the Project area. Key implications for the current assessment include:

- the likely destruction, in areas of grossly modified terrain, of any pre-existing sites and deposit(s);
- the disturbance of pre-existing archaeological deposits through both direct (e.g., ploughing, vehicle movements) and indirect (e.g., erosion) means, resulting in a loss of archaeological integrity; and
- an increase, in eroded and otherwise disturbed areas (e.g., vehicle tracks), of archaeological site visibility.

Figure 9.16 comprises a land disturbance map for the Project area. Three basic levels of disturbance are recognised: undisturbed/minimally disturbed, moderately disturbed and highly disturbed. Areas of highly disturbed terrain within the Project area are unlikely to retain in-situ or intact evidence of past Aboriginal occupation owing to the severity of the past ground surface disturbances that have occurred within them.

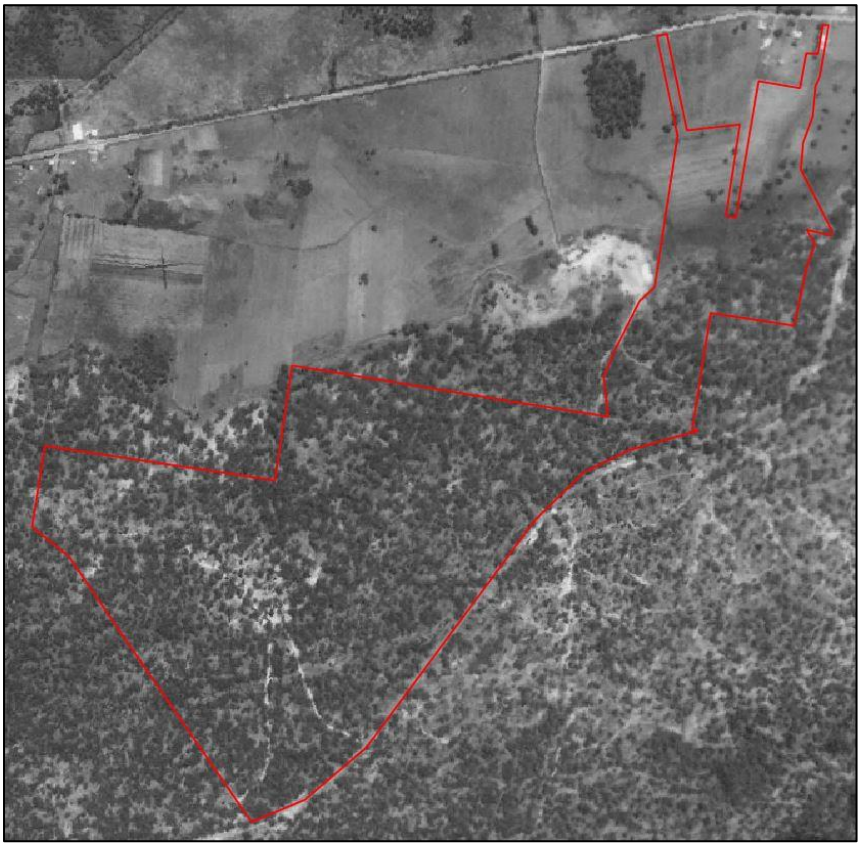


Figure 9.12 - 1951 Aerial photograph of the Project area and environs (Source: Land & Property Information NSW)



Figure 9.13 - 1975 Aerial photograph of the Project area and environs (Source: Land & Property Information NSW)

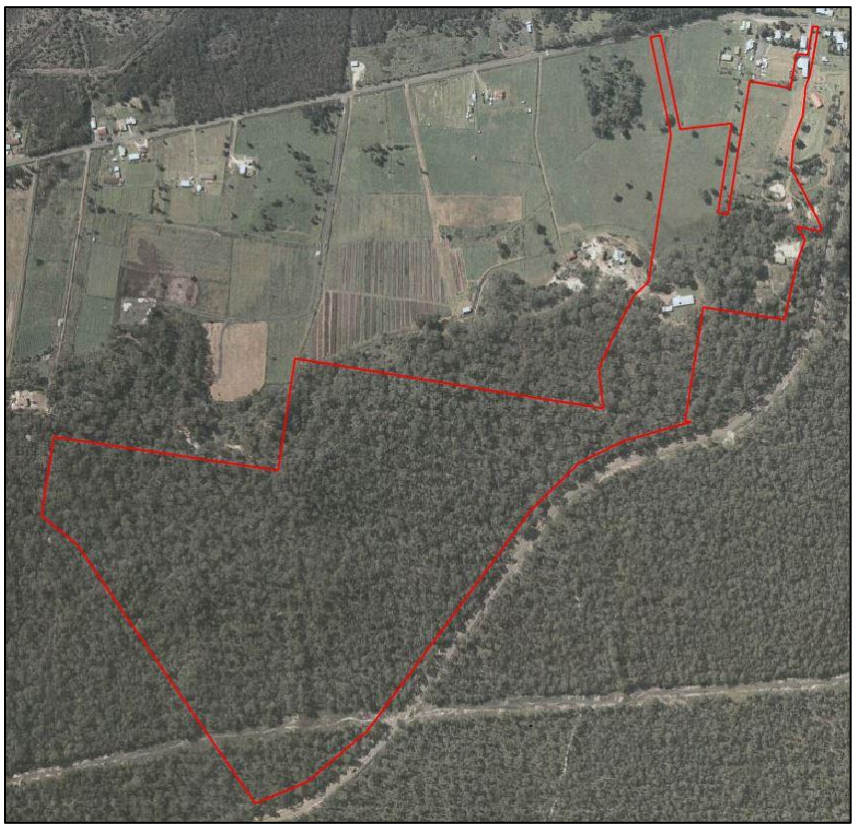


Figure 9.14 - 1992 Aerial photograph of the Project area and environs (Source: Land & Property Information NSW)

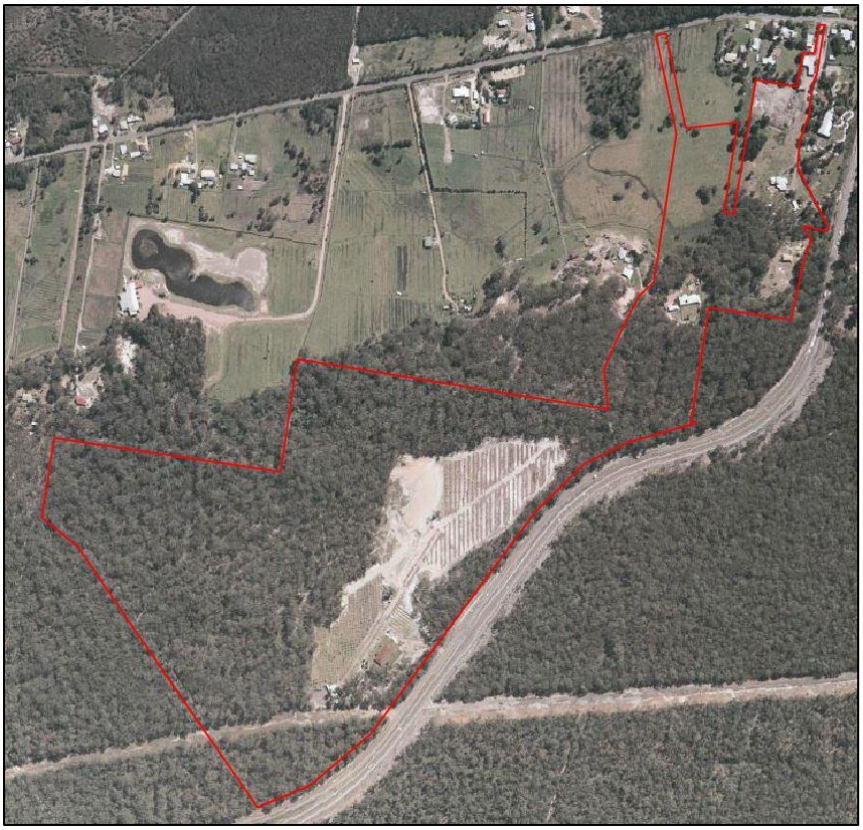


Figure 9.15 - 2004 Aerial photograph of the Project area and environs (Source: Land & Property Information NSW)

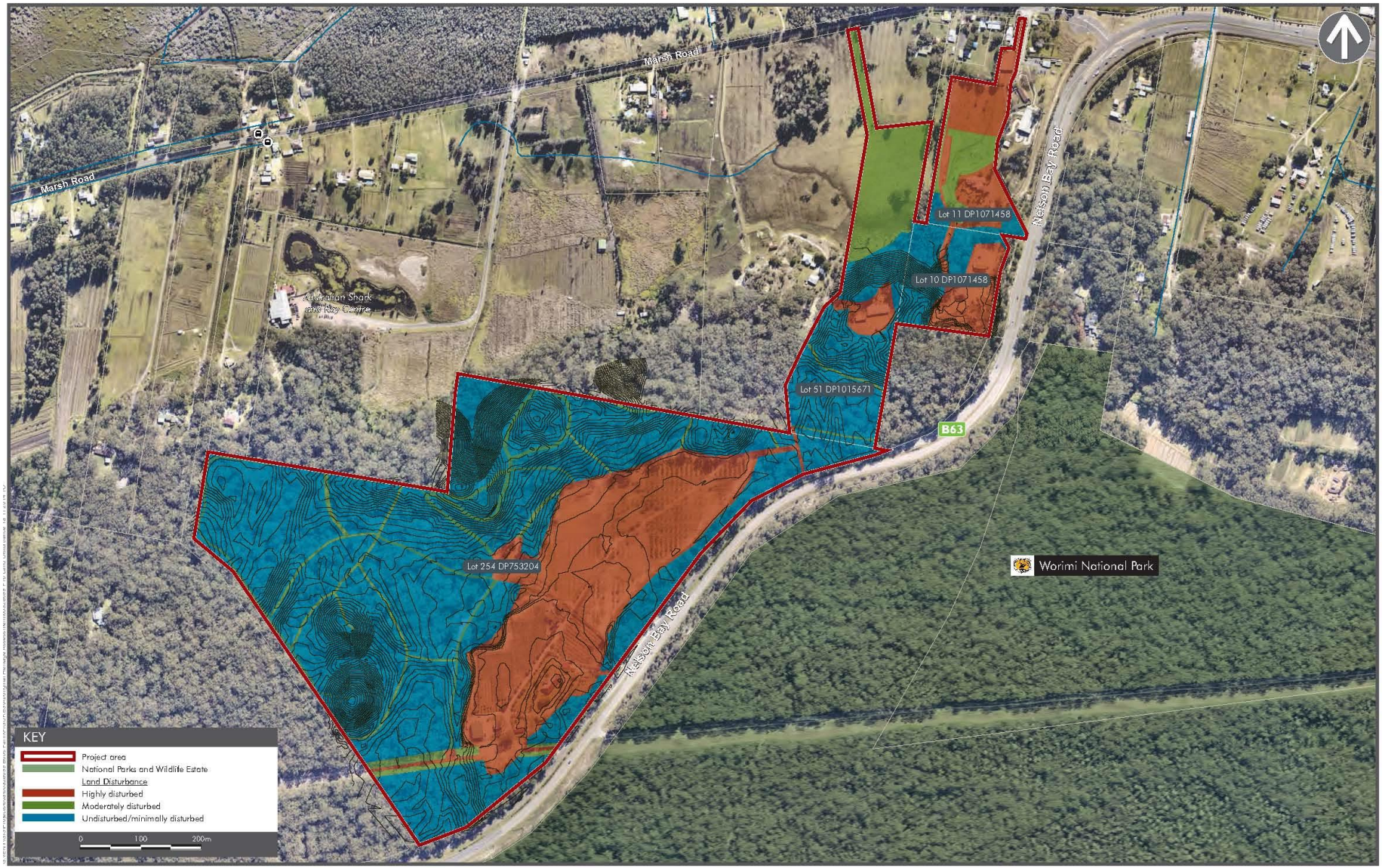

Marsh Road
Marsh Road
Australian Shark and Ray Centre
Lot 11 DP1071458
Lot 10 DP1071458
Nelson Bay Road
Lot 51 DP1015671
B63
Lot 254 DP753204
Nelson Bay Road
Worimi National Park
KEY
Project area
National Parks and Wildlife Estate
Land Disturbance
Highly disturbed
Moderately disturbed
Undisturbed/minimally disturbed
0
100
200m

Figure 9.16 - Land Disturbance

9.4.8 Key Observations

Key observations to be drawn from a review of the environmental context of the Project area are as follows:

- Aeolian sand dunes within the current Project area form part of the Outer Barrier of the Newcastle Bight Sand Dune System, an intensively investigated geomorphological complex consisting of an inner Pleatocene barrier (the 'Inner Barrier'), an outer Holocene barrier (the 'Outer Barrier') and a broad interbarrier depression filled with Holocene estuarine swamp deposits (the 'Interbarrier Depression');

- The Project area is located towards the northeastern end of the Outer Barrier at the interface of the oldest of the Outer Barrier's three long-walled transgressive dune 'ridges' (i.e., Ridge I) and the Interbarrier Depression's now heavily-drained Holocene estuarine plain (see Figure 9.4 above);

- Only one of the Outer Barrier's three long-walled transgressive dune ridges (i.e., Ridge I) is present within the current Project area. Ridge II curves seaward to the southwest of the site (see Figure 9.10 above) while Ridge III is currently located approximately 1 km to the south of the Project area;

- Extant aeolian landform units within the Project area have not been actively transgressed since their formation. Accordingly, stabilised land surfaces within these units will be at or close to the current ground surface;

- Formation of the of the Outer Barrier's three transgressive dune ridges has been linked to periods of aeolian instability prior to 4,500 BP (Ridge I), between 3,000 and 1,500 BP (Ridge II) and since 500 BP (Ridge III) (Thom *et al.* 1992);

- Three topographically-discrete landform units are present within the Project area, two of which can be characterised as 'aeolian units' and the third, as an 'estuarine unit'. Aeolian units comprise the elevated Ridge I dune field and the low relief sand plain that separates Ridges I and III at this point along the Outer Barrier. The estuarine unit comprises the Interbarrier Depression's drained Holocene estuarine plain and is restricted to the northeastern portion of the Project area;

- Prior to widespread draining for grazing and crop production activities, the Interbarrier Depression landward of the Outer Barrier would have consisted of an extensive estuarine swamp environment rich in economic floral and faunal resources;

- Pockets of freshwater swamp forest, which would have served as focal resource areas for Aboriginal people occupying or traversing the stabilised portions of the Outer Barrier sand mass throughout the mid-to-late Holocene, are not present within Project area's two aeolian landform units. However, these do occur locally, with several such pockets occurring to the south of the site within the low relief sand plain separating Ridge I and III;

- Elevated, low gradient dune surfaces within the Project area, particularly those overlooking the Interbarrier depression, are likely to have been favoured for occupation (albeit short-term);

- Outcrops and/or deposits of stone suitable for the production of flaked stone artefacts are not present within or immediately surrounding the Project area. However, it is noted that local flaked stone artefact assemblages attest to an emphasis on the procurement and reduction of fine-grained volcanic tuffs derived from Permian era geological formations on the peripheries of the Newcastle Bight embayment;

- Areas of remnant bushland within the Project area, which do not, on the basis of available data, appear to have been cleared or intensively logged, retain good potential for the presence of culturally scarred trees. Scattered mature paddock trees may likewise exhibit cultural scars;

- Examination of historic aerial photographs for the Project area indicates that, while a significant portion of the Project area consists of undisturbed/minimally disturbed native bushland, a range of land use activities involving various forms of ground disturbance have (or are likely to have) occurred across the site. Key ground surface impacts associated with these activities have included native vegetation clearance (both targeted and broad area), heavy earthworks and ploughing; and

- Areas of highly disturbed terrain within the Project area are unlikely to retain *in-situ* or intact evidence of past Aboriginal occupation owing to the severity of past ground surface disturbances that have occurred within them.

9.5 ARCHAEOLOGICAL CONTEXT

9.5.1 Regional Context - Newcastle Bight Embayment

Formal academic interest in the Aboriginal archaeological record of the Newcastle Bight embayment can be traced to the late 1920s, with Hall's (1928) and Thorpe's (1928) descriptions of selected flaked stone implements from the Birubi Point midden complex (Hall) and various sites in the Newcastle and Port Stephens districts (Thorpe) representing two of the earliest studies of their kind in the Hunter Valley as a whole (Hiscock 1986). McCarthy's (1947) comparative assessment of selected assemblages of large retouched implements from five Aboriginal 'workshops' located on the north coast of New South Wales, including Birubi Point and Anna Bay, built on these earlier studies and was followed in the mid-to-late 1960s and 70s by a series of archaeological surveys undertaken by Dyall (1971, 1975) and various Australian Museum personnel under the direction of then Curator of Anthropology David Moore (Moore 1981). These surveys were critical in demonstrating the archaeological potential of the embayment and, alongside natural and anthropogenic disturbances, were an important stimulus for Dyall's major 1978/79 salvage excavation at Birubi Point, which yielded what remains one of the region's largest and most diverse excavated archaeological finds assemblages (Dyall 1979, 1982, 2004).

Increasing development pressures since this time have prompted dozens of Aboriginal archaeological investigations, including a dedicated regional study (Dean-Jones 1990), with the majority undertaken as part of larger environmental impact assessments associated with proposed residential, linear infrastructure and sand mining projects. Not surprisingly, these investigations have varied significantly in scale and scope, ranging from targeted small-scale surveys to complex, multi-phase survey and excavation projects over large areas. Nonetheless, together, they have generated a large and diverse body of evidence for past Aboriginal occupation, with hundreds of Aboriginal sites now registered on OEH's Aboriginal Heritage Information Management System (AHIMS) database. Particularly informative investigations to

date have included those undertaken by Baker (1994), Dean-Jones (1990, 1992), Dyall (1979, 2004), Umwelt (1997, 2000), ERM (2003b, 2005) and McCardle Cultural Heritage (2006).

In contrast to the Hunter Valley 'proper', in which the dominant site type is the open artefact site (ERM 2004; Hughes 1984), the Aboriginal archaeological record of the Newcastle Bight embayment is overwhelmingly dominated by shell middens, both with and without associated stone artefacts and other cultural materials/features (e.g, hearths, burials) (Dean-Jones 1990). Other site types, such open camp sites (i.e., artefact scatters and isolated artefacts), scarred trees, quarries, grinding grooves, burials and ceremonial sites have also been identified but are comparatively rare. Accordingly, shell middens remain the most intensively investigated component of the Aboriginal archaeological record of the embayment, with research to date focussing on site distribution, chronology, occupation patterns and the technology of associated stone artefact assemblages. The geoarchaeological implications of the embayment's dynamic geomorphic history have likewise been a focus of discussion, with various researchers highlighting the now well established fact that the character of the embayment's Aboriginal archaeological record at any given point in time (i.e., in terms of site distribution and integrity) can be attributed in large measure to geomorphic processes which serve variously to expose, obscure and destroy archaeological sites and materials (Dean Jones 1990, 1992; Umwelt 1997, 2000).

Distributed across a range of geomorphic units of varying ages, recorded surface and subsurface shell midden sites within the Newcastle Bight embayment vary significantly in size, composition and complexity and have associated faunal assemblages that attest to the exploitation - for food and tool manufacture (e.g., fish hooks, bone points) - of a diverse suite of aquatic, avian and terrestrial fauna, principally shellfish (various estuarine and beach species) but also fish, land mammals, reptiles and birds (Table 9.7 - Key characteristics - by landform unit - of previously recorded shell midden sites within the Newcastle Bight embayment (from Sullivan & Hibberd 1994:9, Table 1); Dean Jones 1990; ERM 2003a; Dyall 2004). Elevated, low gradient land surfaces with ready access to estuarine and/or freshwater or marine resources appear to have been favoured for sustained or repeated occupation, with the largest and most complex sites occurring in these contexts (Dean-Jones 1990, 1992; Dyall 2004; ERM 2003b, 2005; Umwelt 2010). Associated stone artefact assemblages, meanwhile, attest to an emphasis on the procurement and reduction of fine grained volcanic tuffs, often grey or cream in colour, derived from Permian era geological formations on the peripheries of the embayment (e.g., Newcastle Coal Measures, Tomago Coal Measures) and contain a variety of formal tool types including asymmetrical and symmetrical backed artefacts (i.e., Bondi points, geometric microliths and elouera), grindstones, edge-ground hatchet heads and Worimi cleavers.

As in other parts of the state (e.g., Attenbrow 2010), including the Hunter Valley proper (see ERM 2004), evidence for late Pleatocene and/or early Holocene Aboriginal occupation of the Newcastle Bight embayment is rare, a situation in part attributable to the embayment's geomorphic evolution (Dean-Jones 1990: 118). To date, dated and undated evidence from these periods has been obtained from only two sites (i.e., Moffats Swamp Dune and Galloping Swamp), both located on the Pleatocene Inner Barrier (Baker 1994).

Initial occupation of the Moffats Swamp Dune site, excavated by Baker (1994), has been dated to 14,750±130 BP (NZA 3016) (Baker 1994: 35). The Galloping Swamp site remains undated. However, a terminal Pleatocene/early Holocene antiquity for this site has been inferred on the basis of strong technological and typological similarities between the flaked stone artefact assemblages recovered from it and the Moffats Swamp Dune site (Baker 1994: 37). In common with the Hunter Valley as a whole, Baker's (1994) analysis of the flaked stone assemblage

recovered from Moffats Swamp Dune and a sample of that recovered from Galloping Swamp suggests that the flaked stone artefact technology employed by Aboriginal people occupying the Newcastle Bight embayment during the terminal Pleatocene/early Holocene was focused on the opportunistic or non-specific reduction of early reduction cores (sensu Moore 2000), a proportion of which were also used as tools. Core reduction appears to have geared towards the production of robust flakes for immediate use or retouch into simple scrapers, with no evidence for the complex, hierarchically-organised reduction sequences typical of the mid-to-late Holocene (see, for example, Hiscock (1993), Koettig (1992, 1994), Moore (2000) and White (1999, 2012)).

In contrast to the late Pleatocene/early Holocene, evidence for mid-to-late Holocene Aboriginal occupation of the Newcastle Bight embayment abounds, with all previously identified surface and subsurface sites on the Holocene Outer Barrier, for example, dateable to this part of the Holocene on geomorphic grounds (Dean-Jones 1990). Few sites have been directly dated. However, dates for those that have (e.g., Birubi Point, Dyall 2004; Fern Bay Estate Sites 'C' and '8', ERM 2005; and Site 'A3', Umwelt 2010) all fall within the mid-to-late Holocene. In combination with available geomorphic data, the presence within some sites of flaked and/or edge-ground stone implement types of demonstrated chronological significance (e.g., backed artefacts, edge-ground hatchet heads) has also, at times, been used to assign these sites to the mid-to-late Holocene (e.g., ERM 2005).

Landform unit	Nature and contents
Recent	
Open beach foredune	Highly disturbed middens. Predominantly pipi (*Donax deltoides*).
Linear deflation basin behind open beach complex	Extensive middens with large quantities of flaked stone and some bone. Smaller, disturbed sites also present.
Estuarine shoreline mangrove flats	Small midden scatters of local species (i.e., whelk (*Pyrazus ebeninus*) and cockle (*Anadara trapezia*)). Flaked stone absent.
Estuarine sandy beach shoreline	Disturbed middens in backbeach deposits.
Estuarine sandy headlands	Extensive middens with sandflat species cockles and 'mud' oyster (*Ostrea angasi*). Flaked stone present.
Estuarine saltmarsh and wet heath	Deflated midden shell and flaked stone exposed as lag deposit in intertidal zone.
Holocene	
Transgressive dune crests and upper slopes	Small middens with beach and estuarine shell species.
Margins of transgressive dune wetlands	Extensive middens, some partially buried, with large quantities of flaked stone.
Beach ridge plains	No sites recorded.
Pleatocene	
Margins of transgressive dune wetlands	Rare shell remnants with large and small scatters of flaked stone.
Beach ridge plains	No sites recorded.

Table 9.7 - Key characteristics - by landform unit - of previously recorded shell midden sites within the Newcastle Bight embayment (from Sullivan & Hibberd 1994:9, Table 1)

9.5.2 Local Context - Bobs Farm Locality

9.5.2.1 AHIMS Database

The AHIMS database, administered by OEH, contains records of all Aboriginal objects reported to the Director General of the Department of Premier and Cabinet in accordance with Section 89A of the NPW Act 1974. It also contains information about Aboriginal places which have been declared by the Minister to have special significance with respect to Aboriginal culture. Previously recorded Aboriginal objects and declared Aboriginal places are known as 'Aboriginal sites'.

Searches of the AHIMS database on 7 August 2014 for a 10 x 10 km area centred on the Project area (AHIMS search area) identified 121 registered Aboriginal sites. As is typical for the Newcastle Bight embayment, shell middens (including those with stone artefacts) are the most common site type represented within the AHIMS search area, accounting for 81% of registered sites. Most (n = 82, 83.7%) registered midden sites within the AHIMS search area are listed on AHIMS as containing both shell and stone artefacts. Those listed as containing only shell (n = 15, 15.3%) or shell and other features[2] (n = 1, 1%), in contrast, are comparatively poorly represented. Remaining site types within the AHIMS search area include nine open camp sites (i.e., artefact scatters and isolated artefacts), six areas of Potential Archaeological Deposit (PAD), two burials, three scarred trees and one rockshelter with shell, artefacts and art.

AHIMS registered sites whose centroid coordinates place them in or within 100 m of the Project area are listed in Table 9.9 - Centroid site locations these sites are shown on Figure 9.17 - AHIMS Registered Sites

All AHIMS registered sites whose centroid coordinates place them in or within 100 m of the Project area are listed on AHIMS as 'Valid' sites. However, it is noted that a review of associated reporting for shell midden sites Tomaree 2a (38-5-0257) and Tomaree 2b (38-5-0258) (i.e., McCardle Cultural Heritage 2006) indicates that both sites were, in fact, salvaged (i.e., destroyed) in 2006 under AHIP#2197. Reference to McCardle Cultural Heritage (2006) indicates that Tomaree 2a and Tomaree 2b were sub-components of nearby shell midden site Tomaree 2 (38-5-0218), which is correctly listed on AHIMS as 'Destroyed'. AHIMS coordinates for Tomaree 2 demarcate the northern limit of what was, prior to salvage, an extensive shell midden site covering an area of approximately 8,000 m² (200 m long x 40 m wide). AHIMS entries for Tomaree 2a and Tomaree 2b refer to discrete subsurface deposits of shell identified within the Tomaree 2 site during the salvage program undertaken in 2006. It is also noted that, *contra* their AHIMS coordinates, available mapping for 38-5-0218, 38-5-0257, 38-5-0258 indicates that all three sites were located on the western side of Nelson Bay Road.

AHIMS coordinates for previously recorded PAD 38-5-0234 (PAD5: Tomaree to Tomago) place it approximately 40 m to the west of the Project area on the Interbarrier Depression's low-lying and formerly swampy Holocene estuarine plain. However, a review of the site card and associated report for this PAD (i.e., ERM 2003a) indicates that this location is incorrect. As defined by ERM (2003a), PAD 38-5-0234 encompasses a large (c.7km long by 500 m wide) area of stabilised "dune crests and slopes" to the east of the Project area. Maps provided by ERM (2003a) suggest that PAD 38-5-0234 extends eastward from the intersection of Nelson Bay Road and the cleared

[2] In this instance, evidence suggestive/indicative of stone quarrying

powerline easement in the southwestern corner of the Project area to the intersection of Nelson Bay Road and Gan Gan Road, northwest of Anna Bay. ERM (2003a: 40) assessed this PAD as having a "moderate level of archaeological sensitivity for intact archaeological/cultural deposits".

AHIMS coordinates for previously identified shell midden site 38-4-0309 (M1) place it in the southwestern corner of the Project area. However, the site card for this site, which was identified by Dean-Jones (1990), indicates that it was identified *at least* 300 m to the west of the Project area within the powerline easement to the north of its AHIMS registered location. The AHIMS registered location of shell midden site 38-4-0310 (M2), which was also identified by Dean-Jones (1990), is likewise incorrect. The site card for this site indicates that it was identified approximately 100m west of 38-4-0309 within the same powerline easement.

Based on the above review of associated sire cards and reports, it is concluded that there are no valid AHIMS registered Aboriginal sites within the Project area.

Site type	Site Feature(s)	Number	%
Midden	SHL (shell); SHL & AFT (artefact); SHL, AFT & STQ (stone quarry)	98	81
Open Camp Site	AFT	11	9.1
Potential Archaeological Deposit (PAD)	PAD	6	5
Scarred tree	TRE (modified tree)	3	2.5
Burial(s)	BUR (burials)	2	1.7
Rockshelter	SHL, AFT & Art (ART)	1	0.8
Total	**-**	**121**	**100**

Table 9.8 - AHIMS search results

AHIMS Site ID	Site name	MGAE	MGAN	Site type	AHIMS status	Actual status
38-4-0309	M1	406505	6372889	Midden	Valid	Presumed extant
38-4-0310	M2	406305	6372889	Midden	Valid	Presumed extant
38-5-0208	Nelson Bay Road PAD1	406703	6372964	PAD	Valid	Presumed extant
38-5-0234	PAD5: Tomaree to Tomago	407114	6374089	PAD	Valid	Presumed extant
38-5-0257	Tomaree 2a	407505	6373889	Midden	Valid	Destroyed
38-5-0258	Tomaree 2b	407505	6373889	Midden	Valid	Destroyed

Table 9.9 - AHIMS registered sites whose centroid coordinates place them in or within 100 m of the Project area

9.5.2.2 Previous Aboriginal Heritage Investigations

Existing AHIMS data indicate that numerous Aboriginal cultural heritage assessments incorporating survey and/or subsurface investigations have been undertaken in the greater Bobs Farm area since the late 1980s. Notable investigations to date have included surveys by Byrne (1987, 1994), Dean-Jones (1990), ERM (1998, 2002b, 2003b), Umwelt (2012) and Roberts (2001), subsurface testing programs by ERM (1998, 2002a) and a major salvage excavation by McCardle Cultural Heritage (MCH) (2006).

With the exception of Dean-Jones' (1990) survey, which was completed as part of a government-funded, regional-scale assessment of the Aboriginal archaeological record of Newcastle Bight, all of these investigations were undertaken in a commercial contracting framework in response to proposed development activities. Roberts' (2001) survey, undertaken as part of an Aboriginal archaeological constraints study for the establishment of the olive farm on Lot 254 of DP753204, appears to have covered a significant component of the current Project area while those of Dean-Jones (1990) and ERM (2003b) are known to have included the section of cleared powerline easement in the southwestern portion of the site. The remaining investigations were undertaken in areas adjacent or within close proximity to the Project area.

The results of the above-cited investigations are summarised in Table 9.10 - Previous Aboriginal Heritage Investigations. Those of a selection of other significant investigations undertaken within the mobile and/or stabilised dune fields of the Outer Barrier (i.e., Dean-Jones 1992; ERM 2005; Umwelt 1997, 2000, 2010) have also been included for contextual purposes.



Figure 9.17 - AHIMS Registered Sites

Consultant/ Researcher	Year	Project / Location	Investigation type	Summary of investigation & results	Reference(s)
D.Byrne	1987	132kv transmission line between Williamtown and Anna Bay	Survey	Pedestrian survey of c.20 km long by 30 m wide 132kv electricity transmission line easement between Williamtown and Anna Bay. easement inspected "at a number of points" between Larvis Lane in the west and Anna Bay in the east, with survey points selected on the basis of access considerations (Byrne 1987: 6). Byrne (1987: 6) reports that approximately 40% of the easement was subject to survey. Levels of GSV ranged from zero to c.60%. Recently burnt areas and vehicle tracks noted as having the highest Ground Surface Visibility (GSV). One archaeological site - Boyces Track #1 - identified during survey. This consisted of a small exposure of pipi midden on a deviation track running west off Boyces Track. Byrne (1987: 7) describes the site as consisting of a 5 cm thick layer of 'eroded' pipi shell in a shallow, exposed soil profile on the southern edge of the track in question. The midden deposit was located 5 cm below the ground surface and was exposed for a length of 70 cm. Byrne (1987) concluded that the midden deposit likely extended beyond shell-bearing exposure. No stone artefacts or other cultural materials were noted in association with the midden deposit. In addition to the subsurface midden deposit, a low-density scatter of pipi shell was observed on the surface of the deviation track between the site and Boyces Track.	Byrne 1987
P.Dean-Jones	1990	Newcastle Bight Aboriginal Sites Study	Survey	Regional-scale assessment of the Aboriginal archaeological record of Newcastle Bight aimed broadly at locating, recording and assessing the significance of Aboriginal archaeological sites at Newcastle Bight as a basis for guiding the future management of the region's Aboriginal heritage resource (including areas of archaeological sensitivity). Specific aims for the survey component of the study, which sampled the full range of geomorphic units present at Newcastle Bight, were to identify a representative sample of sites "sufficient to allow accurate prediction of areas of high archaeological sensitivity" (Dean-Jones 1990: 78) and to assess the capacity of then existing NSW NPWS land holdings to preserve a representative sample of the archaeological record. Initial sampling strategy developed for the survey incorporated a series of transects normal and parallel to the alignment of the dual barrier system. However, in practice, the placement of transects was determined by access and GSV conditions. Dean-Jones (1990: 79) reports that "the survey concentrated on areas where the natural surface had been disturbed by deflation and/or human activity". Total of ten geomorphic units sampled via targeted pedestrian and/or vehicle transects. Survey coverage estimates for sampled units ranged from '5-10%' to 70%, with estimates for the two geomorphic units relating to the Outer Barrier's stabilised dune fields cited as '5-10%'. Outside of the 'Beach, foredune & swale' and 'Seward margin of transgressive dune' geomorphic units, which	Dean-Jones 1990

Consultant/ Researcher	Year	Project / Location	Investigation type	Summary of investigation & results	Reference(s)
				were characterised by 100% GSV, areas of very good to excellent GSV (i.e., 80-100%) were restricted to vehicle tracks and other disturbed areas (e.g., quarries, sand pits, powerline easements). Total of 119 sites recorded during survey, with an additional 40-50 midden sites noted in Dean Jones' (1990) 'Beach, foredune & swale' geomorphic unit but not recorded due to time constraints. Identified sites divided into 14 types, the majority (n = 10) of which can be broadly characterised as midden sites. Dean-Jones (1990: 16) notes that 73.4% of identified sites included at least a thin scatter estuarine or marine shell. However, dense concentrations of packed shell were rare, occurring in only 12.3% of sites. Small numbers of stone artefacts (<5) observed in "many sites", particularly thin, disturbed shell scatters (Dean-Jones 1990: 16). High density concentrations of flaked stone artefacts restricted to two types of identified site: 1) midden complexes associated with stable late Holocene dune surfaces overlooking the deflation basin at the rear of the beach; and 2) open campsites on Pleatocene dunes associated with freshwater wetlands, and also Holocene estuarine wetlands. Geomorphic contexts identified as containing the largest and most complex archaeological assemblages included: 1) stable dune surfaces at the swale/active transgressive dune interface; 2) stable Pleatocene dunes associated with freshwater wetlands; and 3) the bedrock headland at the northeastern end of the Outer Barrier (i.e., Birubi Point). Majority (n = 62, 52.1%) of sites located in the 'Beach, foredune & swale' (n = 28) and 'Seward margin of transgressive dune' (n = 34) geomorphic units. Sites (n = 10) identified on the margin of the Holocene transgressive dunes, overlooking the Interbarrier Depression, were generally located on the crest of dune front and were observed to "vary considerably in their content and size" (Dean-Jones 1990: 98). These sites contained both estuarine and marine shell species and, in some instances, flaked stone artefacts. The identification of sites at all inspected areas in this geomorphic environment was considered "significant" and used to assign it high archaeological sensitivity (Dean-Jones 1990: 98). Further inland, within the body of the stabilised transgressive dune field, identified sites (n = 8) comprised thin scatters of fragmented shell (both marine and estuarine species) with no associated stone artefacts. Recorded sites in this context included AHIMS registered sites M1 (38-4-0309) and M2 (38-4-0310), both of which were identified in the powerline easement to the west of the current Project area (see **Section 5.2.1**). On the basis of the survey results summarised above, Dean-Jones (1990) identified the following geomorphic environments within the Newcastle Bight sand mass as being of high archaeological sensitivity: 1) the outer margin of the active transgressive dunes and inland	

Consultant/ Researcher	Year	Project / Location	Investigation type	Summary of investigation & results	Reference(s)
				margin of the deflation basin; 2) transgressive dune surfaces on either side of the Interbarrier Depression; and 3) the relict beach ridge plain at the northeastern end of the Outer Barrier.	
P.Dean-Jones	1992	Fern Bay	Survey and test excavation	Survey and test excavation program undertaken as part of archaeological assessment for broad-area rezoning application at Fern Bay. Land units surveyed included the stabilised (Ridge I and II) and active (Ridge III) dune fields, the relict deflation basin separating Ridge I and II and the modern deflation basin. Nineteen sites, comprising shell midden and open artefact sites, identified during field survey. Majority located on ridges within the Ridge I dune field. Three out of four sites identified along the landward margin of the modern deflation basin occurred in direct association with exposures of remnant stable soil surfaces. No sites located within relict deflation basin. Subsurface testing undertaken at three sites within the Ridge I dune field to provide further information on site content and structure. Testing also undertaken at three locations within the Ridge II dune field to determine whether the paucity of surface sites in this environment equated to a lack/paucity of subsurface evidence. Shovel testing at the three sites within the Ridge I dune field revealed discrete concentrations of shell and flaked stone and demonstrated the presence of archaeological material up to 90 cm below current ground surface. No subsurface archaeological materials were identified at the areas tested within the Ridge II dune field. Dean-Jones' key conclusions for this project were as follows: • Archaeological evidence is concentrated on elevated ground but not necessarily on the main or higher ridge crests; • Archaeological evidence is widespread along the entire inner (landward) margin of the Ridge I dune field. These dunes have remained relatively stable over the period of estuarine filling of the Interbarrier Depression; • Archaeological evidence within the Ridge II dune field is rare, except along its seaward margin. No sites were recorded along the inner margin of this due system; • There appears to be a relationship between site distribution and the presence of freshwater wetlands within the dune field; • Sites in the dune field include shell only, flaked stone only or both flaked stone and shell; • The distribution of shell species across the dune field suggest that shellfish obtained from estuarine and marine sources were not carried across the barrier system. Sites with pipi are confined to the outer margin of the barrier, and sites with Pyrazus and Oyster are distributed across the inner part of the barrier; and	Dean-Jones 1992

Consultant/ Researcher	Year	Project / Location	Investigation type	Summary of investigation & results	Reference(s)
				• There is abundant evidence of occupation along the outer margin of the active transgressive dunes. This evidence includes both midden shell and flaked stone and is typically both fragmented and heavily weathered.	
D.Byrne	1994	Nelson Bay Road upgrade between Salt Ash and Bobs Farm	Survey	Pedestrian survey of c.8 km long by 53 m wide road easement between Salt Ash and Bobs Farm. easement pegged but not cleared at the time of survey. All areas not characterised by dense understorey vegetation subject to pedestrian survey. Byrne (1994: 8) reports "little evidence of ground disturbance" along the easement and cites a total survey coverage of 60-70%. GSV typically very poor due to dense understorey, with areas of higher GSV limited to vehicle tracks and other disturbed areas. Two sites identified during survey, both small shell scatters. Identified sites designated as Nelson Bay Road 1 and Nelson Bay Road 2. Nelson Bay Road 1 consisted of a scatter of cockle (Anadara sp.) and mud whelk (Pyrazus sp.) shell across an area of c.100 m² on a broad, rounded dune crest. No stone artefacts were identified in association with the shell. Nelson Bay Road 2 was identified on level ground between dune ridges and consisted of a scatter of fragmented pipi shell. As with Nelson Bay Road 1, no stone artefacts were identified at this site. Sub-surface testing recommended for both sites to confirm presence/absence of subsurface materials and lateral extent.	Byrne 1994

Consultant/ Researcher	Year	Project / Location	Investigation type	Summary of investigation & results	Reference(s)
Umwelt	1997	Fullerton Project, southwestern end of Outer Barrier	Survey and test excavation	Survey and test excavation program for proposed sand mining operation (Fullerton Project) at the southwestern end of the Outer Barrier. Project area for investigation included the modern deflation basin, mobile dune sheet, stabilised 1200 BP dune (Ridge II) and the relict deflation basin separating Ridge II and the mobile dune sheet. Field survey component of investigation located 19 remnant topsoil exposures, 11 of which were associated with archaeological material, either on the surface of the topsoil profile, or immediately downslope. Majority of exposures located on coastward ridge of the mobile dune sheet and characterised by 'ridges' of black topsoil varying in width from 1-1.5 m. All identified exposures interpreted by Umwelt (1997) as belonging to the 1200 BP (Ridge II) dune. Total of 77 flaked stone artefacts, consisting of two cores, 22 flakes, four retouched flakes (inc. two backed artefacts) and 49 flaked pieces, recovered from identified topsoil exposures. Cluster of artefacts identified at one exposure interpreted as possible knapping floor. No evidence for heat treatment noted. All identified artefacts manufactured out of Nobbys Tuff. Pipi dominant shell material. Five exposures, four of which had flaked stone artefacts on the ground surface, sampled using shovel test pits. Three located on coastward ridge of active dune sheet, one on landward ridge and one in modern deflation basin. Number of pits per exposure ranged from 9 to 15. Two distinctive soil horizons, interpreted as 'A 'and 'B' horizons, identified, with former further differentiated into two sub horizons (i.e., A_1 and A_2). No stone artefacts recovered from any pits. No features (e.g., hearths, heat treatment pits) identified. Single lens of shell identified at A/B horizon interface in one tested exposure. Umwelt (1997: 39) concluded that this lens likely accumulated through a combination of natural and cultural processes.	Umwelt 1997
ERM	1998	Nelson Bay Road upgrade between Salt Ash and Bobs Farm	Survey and test excavation	Follow-up investigation to Byrne's earlier survey (1994) involving subsurface testing at four shell midden/scatter sites, three of which were identified after Byrne's (1994) survey, and additional pedestrian survey of a cleared c.3km section of the road route. Excluding the previously recorded Nelson Bay Road 1 (NBR 1) site, ERM (1998) report the identification of an additional eleven sites during the survey component of this investigation. These included two scarred trees, one of which exhibited climbing notches and was interpreted as a 'honey tree', and nine shell midden/scatter sites without stone artefacts. Three cockle shells at NBR 1 site showed signs of use-wear. Location of newly identified sites deemed consistent with Dean-Jones' (1990) finding that sites within the stabilised dune fields of the Outer Barrier tend be located on dune crests. Sites subject to subsurface testing included NBR 1, previously identified by Byrne (1994), Nelson Bay Road 4 (NBR 4) (38-4-0491), a disturbed midden containing cockle, mud whelk	ERM 1998

Consultant/ Researcher	Year	Project / Location	Investigation type	Summary of investigation & results	Reference(s)
				and pipi shell, Nelson Bay Road 5 (NBR 5) (38-4-0492), another disturbed midden containing cockle, mud whelk, oyster and pipi shell, and Nelson Bay Road 7 (NBR 7) (38-4-0483), a midden, likewise disturbed, containing cockle and mudwhelk shell. The number of test 'probes' excavated at these sites ranged from one at NBR 7 to 27 at NBR 4. At NBR 1, 4 and 5, test probes were "placed initially within the areas of the densest shell material" but were also "extended into areas with little or no shell to test for buried material" (ERM 1998: 3.1). In general, test probes at all sites confirmed the presence of shallow subsurface deposits of shell. Shell, where present, was restricted to, or concentrated in, the top 10 cm of excavated soil profiles, leading ERM (1998: 4.1) to conclude "that 5 cm would be the maximum proven depth of the [tested] middens". At NBR4 and 5, the presence of spatially discrete concentrations of estuarine and marine shellfish were interpreted as products of discrete consumption "events". No other cultural materials (e.g., stone artefacts, bone) were identified during the subsurface testing program.	
Umwelt	2000	Fullerton Project / southwestern end of Outer Barrier	Survey	Archaeological survey of c.1,000 ha study area at the southwestern end of Outer Barrier undertaken as part of a comprehensive, multi-component Aboriginal archaeological assessment for BHP's Fullerton Project. Study area for this assessment included the beach and foredune, modern deflation basin and elevated transgressive dune sheet. Total of 33 Aboriginal sites, consisting of five open artefact sites and 28 midden sites, identified during survey. Fourteen sites defined by midden shell alone, with no flaked stone or bone observed. Twenty-eight sites included pipi shell considered to be of archaeological origin. Majority of sites (n = 22, 66.6%) located within modern deflation basin. Remaining sites located on lower seaward slopes of transgressive dune sheet. Umwelt (2000: 7.10) report that the majority of identified sites were not stratified and retained no direct association with former (i.e., Ridge I and II) soil surfaces. Total of 214 flaked stone artefacts recorded. Tuff dominant raw material. No backed artefacts observed. Limited evidence of heat treatment noted. Bone, potentially of cultural origin, noted at several sites (macropod, bird and reptile).	Umwelt 2000
L.Roberts	2001	Olive farm, Lot 254 on DP753204	Survey	Combined pedestrian/vehicle survey of Lot 254 on DP753204 undertaken as part of Aboriginal archaeological constraints study for the establishment of a commercial olive farm on the property. Roberts (2002: 18) reports that the property was first circumnavigated by car to "gain an overall picture of the site" and then systematically walked, with particular attention paid to the area proposed to be cleared. Percentage of exposed ground in identified landform units (i.e., swale, knoll and highest knoll) ranged from <3% (highest knoll) to <30% (swale), with visibility ratings cited as 'poor' (<40% overall) (knolls), medium (<50% overall) (swale) and medium (approx. 50%) (highest knoll).	Roberts 2001

Consultant/ Researcher	Year	Project / Location	Investigation type	Summary of investigation & results	Reference(s)
				No Aboriginal archaeological sites identified during survey. Survey results interpreted by Roberts (2002: 21) as a reflection of the fact that the study area was probably not used by Aboriginal people, likely due to both an absence of freshwater and the fact that its aspect is more westerly (i.e., relatively unprotected from prevailing westerlies and southerlies). Regarding the potential for scarred trees on the property, Roberts (2002: 19) concluded that "the trees on the subject property were not old enough, nor the appropriate type for scarred trees".	
ERM	2002	Nelson Bay Road Upgrade, Bobs Farm to Anna Bay	Survey & test excavation	*Reports unavailable from AHIMS*. McCardle Cultural Heritage (2006) report a combined pedestrian/vehicle survey of the expansion corridor associated with the upgrading of Nelson Bay Road between Bobs Farm and Anna Bay and note that this survey was followed by subsurface testing programs involving targeted probing and the excavation of 28 1m² test pits. Sites identified via survey consisted of seven midden sites, including Tomaree 2 (38-5-0218) adjacent to the current Project area. MCH (2006) report that no Aboriginal archaeological materials were recovered as a result of the subsurface testing programs undertaken.	ERM 2002a, 2002b
ERM	2003	Electricity supply upgrade, Tomago to Tomaree	Survey	Combined pedestrian/vehicle survey of a c.40 km long by 15 to 50 m wide powerline easement undertaken as part of an Aboriginal cultural heritage assessment for the upgrading of electricity powerlines from Tomago to Tomaree. Study area divided into a 13 survey units, each corresponding to one of three broad geomorphic units: Pleatocene dunes, Interbarrier Depression and Holocene dunes. Several units further subdivided on the basis of internal landform elements. Parts of one primary survey unit and three sub-units surveyed by vehicle, the remainder, on foot. GSV reported as varying from fair to poor, with exposures associated with unsealed easement maintenance tracks, drains, unsealed driveways and erosion offering the highest GSV (ERM 2003a: 23). Total of 15 sites identified during survey. However, three previously recorded midden 'sites' (38-4-0659, 38-4-0660 and 38-4-0661) were reassessed as natural shell deposits, leaving 12 legitimate Aboriginal archaeological sites, nine of which were new recordings. Confirmed sites consisted exclusively of shell midden/scatter sites with (n = 7) and without (n = 5) associated stone artefacts and/or other cultural materials. Majority of sites (n = 10, 83.3%) reported as being located on Pleatocene (n = 3) or Holocene (n = 7) dune crests and/or slopes overlooking the Interbarrier Depression. Sites A1 (38-4-0647) A2 (38-4-0468) and A10 (38-4-0676), located on a south-facing slope of a Pleatocene dune overlooking the Interbarrier Depression, all contained backed artefacts, with 29 examples manufactured out of "various types of silcrete" and Nobby's Tuff identified at A1. Shellfish present within these sites included cockles, oysters, and pipi. At A10, fish, lizard, bird and kangaroo bone	ERM 2003b

Consultant/ Researcher	Year	Project / Location	Investigation type	Summary of investigation & results	Reference(s)
				were also observed throughout the site. Shellfish present within sites located on the landward margin of the Holocene dune system overlooking the Interbarrier Depression included oyster, pipi, cockle and mud whelk. Kangaroo bone pieces also noted at one site (i.e., A4, 38-4-0643). Stone types utilised for flaked stone artefact manufacture at these sites included Nobby's tuff, silcrete and chert. Backed artefacts present in three sites (A3 (38-4-0643), A4 & A5 (38-4-0650)), with thumbnail scrapers also noted in site A4. Survey results interpreted as reflecting an occupational emphasis on "dune areas overlooking the Interbarrier Depression" (ERM 2003a: 38). Presence of estuarine and marine shellfish species at most sites argued to reflect a wide foraging range. Survey units/sub-units assessed as retaining moderate to high potential for intact archaeological/cultural deposits designated as PADs (n = 7). Within the Holocene dune system, sand hills, ridges, dune crests and slopes facing the Interbarrier Depression identified as archaeologically sensitive. Those further away assessed as having "reduced sensitivity" (ERM 2003a: 40).	
ERM	2005	Fern Bay Seaside Village, Fern Bay	Test excavation	Three phase test excavation program undertaken as part of an Aboriginal heritage assessment for the 'Fern Bay Seaside Village' residential development at Fern Bay. Study area for investigation, which had been previously assessed by Dean-Jones (1992) (see above), included Ridge I and II ridgelines and intervening relict deflation basin. Several areas of 'Swamp Forest' were present within study area. Phase 1 comprised test excavation of five previously identified sites identified as having potential for stratified sub-surface deposits. Phase 2 involved auger sampling of toposequences within the Ridge I dune field. Phase 3 comprised test excavation of areas where archaeological material was identified during Phase 2. Key conclusions for this project were as follows: • Aboriginals sites found at Fern Bay are no older than 4000 BP. Prior to this time, the study area was a mobile sand dune and no archaeological evidence would have been retained because of the movement of the sand dune deflating and dispersing archaeological material; • Aboriginal people were living in the study area *at least* as early as 2,600 years ago. Carbon dating of a charcoal sample from an Aboriginal hearth at Site 8 yielded a date of 2,584±45 BP; • The 4000 BP stable dune ridgelines were the focus of occupation within the study area whereas the deflation basin, swamp forests and 1200 BP dune sequence were only very sparsely occupied. No archaeological material was found within 1200 BP dune sequence; • Occupation of the 4000 BP stable dune ridgelines was focussed on the lower	ERM 2005

Consultant/ Researcher	Year	Project / Location	Investigation type	Summary of investigation & results	Reference(s)
				ridgelines, particularly adjacent to or between swamp forests. Low ridgelines are more sheltered from prevailing winds and are in closer proximity to the water and plant resources of the swamp forests; • Marked differences in the vertical distributions of stone and shell at some sites likely reflects the decomposition of shell at depth in earlier deposits and a decline in the use of stone artefacts during recent occupation; • Site content cannot be adequately assessed on the basis of surface evidence alone due to marked differences in the vertical distributions of stone and shell at some sites. The proportion of shell relative to stone is much higher on the surface than it is sub-surface; • Archaeological deposits at Fern bay have stratigraphic integrity, as evidenced by a lack of evidence for artefactual size sorting in excavated deposits. The bimodal distribution demonstrated at one site provides strong evidence of site integrity; • A range of activities can be inferred from the test excavations at Fern Bay, including hunting plant processing, stone knapping, shellfish gathering and camping; • The raw material used for flaked stone artefact manufacture at Fern Bay was predominantly Nobby's Tuff, with silcrete the second most common material. Proximity to raw material source appears to have been the most important consideration when selecting raw materials for artefact manufacture; • Functional analysis of a Worimi Cleaver found at Site 8 indicates that the tool was likely used for processing Bungwall Fern (*Blechnum indicum*); and • Worimi Cleavers appear to have functioned as specialised implements at Stockton Bight over a period of at least 8,000 years, as evidenced by the Worimi Cleaver recovered from the charcoal matrix of the Site 8 hearth (dated to 2,584±45 BP) and one recovered from the Moffats Swamp Dune site in a context dated to c.11,000 BP (Baker 1994).	
McCardle Cultural Heritage Pty Ltd	2006	Nelson Bay Road Upgrade	Salvage excavation	Archaeological salvage program for the Tomaree 2 (35-5-0218) shell midden site incorporating surface collection, targeted salvage excavation by hand and mechanical scrapes. Initial phase of salvage program involved surface collection of a small portion of the original Tomaree 2 site, which MCH (2006) report as having consisted of surface shell scatters of varying density and concentration across an area of approximately 8,000 m² (200 x 40 m). Following underbrush removal, a spatially-discrete deposit of compact midden shell, designated as Tomaree 2a (38-5-0257), was uncovered approximately 5-10 cm below ground surface to the east (downslope) of the surface-collected portion of Tomaree 2. Tomaree 2a was subsequently salvaged via the excavation of seven contiguous 1m² pits	MCH 2006

Consultant/ Researcher	Year	Project / Location	Investigation type	Summary of investigation & results	Reference(s)
				and five 40 cm² shovel test pits, all hand excavated. MCH (2006: 29) report that the former were used to determine the vertical extent of the midden while both were used to determine horizontal extent. Subsequent to the completion of the Tomaree 2a excavation, a second subsurface deposit of shell, designated as Tomaree 2b (38-5-0258), was identified by mechanical scraping to the southwest of Tomaree 2a. A small, highly disturbed scatter of pipi shell, Tomaree 2b was salvaged by surface collection. Excavation depths for the hand excavated 1m² pits at Tomaree 2a ranged from 40 to 45 cm (mean: 42.7 cm). A compact layer of midden material - designated as Stratigraphic Unit (SU) 2 - was encountered between 1 and 28 cm across the excavated squares. Excavated finds assemblage dominated by cockle, whelk, oyster and pipi shell, with mammal tooth/bone, fish bone (isolated fragment) and stone artefacts also present lesser quantities. MCH (2006) observed distinct layers of estuarine and marine shellfish species within the Tomaree 2a midden and proposed that this layering "could be suggestive of either the effects of environmental flux or change, different occupation times, availability of the food source of human choices" (MCH 2006: 61). Mammals positively identified within the Tomaree 2a faunal assemblage included kangaroo, wallaby, bandicoot and possum. Flaked stone artefact assemblage restricted to flake and non-flake debitage, with no cores or retouched implements recovered. Artefact types included flaked pieces (n = 15), complete flakes (n = 13) and broken flakes (n = 2). Five artefacts noted as exhibiting "use-wear scars" (MCH 2006: 46). Two raw materials represented: tuff (n = 20) and silcrete (n = 10).	
Umwelt	2012	Optus Fibre Optic Cable (FOC), Campvale to Nelson Bay	Survey	Pedestrian survey of proposed Optus Fibre Optic Cable (FOC) route between Campvale and Nelson Bay. Project area for this investigation comprised those portions of the proposed FOC route considered to have greater than low risk of harm to Aboriginal objects. FOC route divided into four survey areas, with the current Project area located directly adjacent to part of Area 4. Umwelt (2012: 13) report that the survey focused on areas of enhanced visibility and exposure within each survey area. In Area 3, relatively low density surface scatters of estuarine shell fragments were observed at four locations. A potential scarred tree was also identified adjacent to the Project area. For Area 4, Umwelt (2012: 14) report a "scatter of estuarine and marine shell" extending for approximately 500 m south of the intersection of the stabilised dune system with the Interbarrier Depression and note that shell densities within this scatter "varied between low density, highly fragmented distributions to areas in which whole shells could be seen eroding from an intact soil profile eposed within a cutting at the base of the dune". Identified sites in Area 5, located to the west of the intersection of Port Stephens Drive and Nelson Bay Road, comprised four shell scatters, one of which was associated with a potential remnant soil	Umwelt 2012

Consultant/ Researcher	Year	Project / Location	Investigation type	Summary of investigation & results	Reference(s)
				profile. Both estuarine and marine shell was represented in these sites. Less disturbed portions of Areas 3 and 4 assessed as meeting the criteria for PAD. Test excavation recommended.	

Table 9.10 - Previous Aboriginal Heritage Investigations

9.5.3 Archaeological Predictions

On the basis of its environmental and archaeological context, the following predications are made regarding the Aboriginal archaeological record of the Project area:

- Surface evidence of past Aboriginal occupation/activity within the Project area is likely to be restricted to disturbed shell midden sites. However, there remains reasonable potential for the presence of open artefact sites and scarred trees;
- Aboriginal burials may be present within the Project area's two aeolian landform units. However, it is highly unlikely these would be identified during survey;
- Most, if not all, surface shell midden/scatter sites within the Project area will contain only shell;
- Large, archaeologically complex sites indicative of long term or repeated occupation are unlikely to occur within Project area's two aeolian landform units owing to an absence of pockets/areas of freshwater swamp forest;
- Identified surface shell midden/scatter sites will contain of mixture of estuarine and marine (i.e., beach) shellfish species, with the former predominating;
- The largest shell midden/scatter sites within the Project area will occur on elevated, low gradient dune surfaces overlooking the Interbarrier Depression;
- Aboriginal archaeological sites are highly unlikely to occur within the estuarine plain landform unit (i.e., Interbarrier Depression) owing to unfavourable occupation conditions;
- Flaked stone assemblages, if present, will be dominated by flake debitage (*sensu* Andrefsky 2005), with formed objects (i.e., cores and retouched flakes) comparatively poorly represented;
- The dominant raw material for flaked stone artefact production within the Project area will be a cream and/or grey coloured volcanic tuff, with silcrete the second most common material; and
- Tool types of demonstrated temporal significance, if present, will be limited to edge-ground hatchet heads and backed artefacts.

9.5.4 Key Observations

Key observations to be drawn from a review of the local and regional archaeological context of the Project area are as follows:

- An understanding of the geomorphic evolution of the Newcastle Bight embayment is critical to interpreting its associated Aboriginal archaeological record;
- Shell middens/scatters with and without associated flaked stone artefacts and other cultural materials/features are the most common site type on a local and regional scale;
- Known sites occur in a variety of geomorphic settings of differing ages and variously attest to the operation of a range of post-depositional geomorphic processes (e.g., burial, washover, deflation);
- Previous archaeological investigations within the Outer Barrier sand mass have identified low elevation, low gradient dune surfaces immediately adjacent to wetland areas (both estuarine

and freshwater) as being of high archaeological sensitivity, with the largest and most complex archaeological sites occurring in these contexts;

- Available archaeological data suggest that the Interbarrier Depression was a focal resource zone for Aboriginal people occupying the Outer and Inner Barriers throughout the mid-to-late Holocene. However, Aboriginal archaeological sites are unlikely to occur within this geomorphic environment owing to unfavourable occupation conditions;

- Archaeological faunal assemblages associated with previously identified sites within the stabilised and mobile portions of the Outer Barrier sand mass are dominated by shellfish, with various marine and estuarine species represented. Some assemblages contain bone from other fauna types (e.g., mammals, reptiles, fish, bird). However, such assemblages are rare;

- The strong representation of pipi shell in previously identified shell midden/scatter sites within the outer, stabilised portion of the Outer Barrier suggests that Aboriginal people occupying the Outer Barrier throughout the mid-to-late Holocene regularly foraged across it. This observation notwithstanding, a broad correlation between site location and the composition of shellfish assemblages is apparent, with estuarine species particularly well represented in sites adjacent to the Interbarrier Depression and marine species dominating sites seaward of the mobile sand sheet;

- Known sites within the mobile portion of the Outer Barrier are concentrated along the landward margin of the modern deflation basin (i.e., the deflation basin/active transgressive dune interface) and frequently occur in direct association with former stabilised soil profiles;

- Soil profiles associated with Ridge I, the oldest of the Outer Barrier's stabilised long walled transgressive dune ridges, show a greater degree of development than those associated with Ridge II;

- Archaeological evidence of Aboriginal occupation within the modern foredune and deflation basin are likely to have been subject to washover, deflation and burial by mobile dune sand as well as impacts from vehicle traffic;

- Mid-to-late Holocene flaked stone assemblages from the Outer Barrier attest to the use of a variety of raw materials for flaked stone tool manufacture. However, fine-grained volcanic tuffs, often grey or cream in colour, overwhelmingly dominate known assemblages. These tuffs occur in a variety of Permian era geological formations on the peripheries of the Newcastle Bight embayment and appear to have been sourced from both bedrock outcrops and alluvial gravel deposits; and

- No Aboriginal archaeological sites have been previously identified within the Project area. AHIMS coordinates for previously identified shell midden site 38-4-0309 (M1) place it in the southwestern corner of the Project area. However, the site card for this site indicates that this location is incorrect and that the site is, in fact, located at least 300 m to the west of the Project area within the powerline easement to the north of its AHIMS registered location.

9.6 ETHNOHISTORIC CONTEXT

9.6.1 Introduction

Information regarding the ways in which Aboriginal people likely used pre-contact landscapes is available to archaeologists through two primary sources: archaeological (i.e., survey and excavation) data and historical records. Section 9.9.5 has summarised the Aboriginal archaeological context of the Project area on both a regional and local scale. This section builds on this foundation by summarising relevant ethnohistoric information for the Project area and environs. As in other parts of NSW and Australia more broadly, non-Aboriginal people occupying the Lower Hunter Valley began to document Aboriginal culture from first contact, with explorers, missionaries, settlers and the like recording their observations of Aboriginal people and/or their material culture in letters, journals and official reports. Many of these accounts are overtly Eurocentric in tone and the content and veracity of some is, at best, questionable. Nonetheless, taken together, they form an important source of information on Aboriginal lifeways at the time of British colonisation and can, in conjunction with available archaeological data, be used to generate working predictive models of prehistoric Aboriginal land use.

Key sources, both primary and secondary, for the post-contact languages and lifeways of the Aboriginal people occupying the coastal and inland portions of the Lower Hunter Valley at contact include: Backhouse (1843), Barrallier (1802), Brayshaw (1987), Caswell (1841), Capell (1970), Dawson (1830), Dyall (2004), Ebsworth (1826), Enright (1900, 1901, 1932, 1933, 1936, 1937), Elkin (1932), Fawcett (1898a, 1898b), Ford (2010), Gunson (1974) , Hale (1846), Fraser (1892), Haslam et al. (1984), Larmer (1898), Lissarrague (2006), Matthews(1898, 1903), Miller (1887), McKiernan (1911), Threlkeld (1827, 1834, 1836, 1850), Scott (1929) and Sokoloff (1980). Although a detailed review of these sources is beyond the scope of this assessment, information of particular relevance to the current assessment is summarised in the following sections.

9.6.2 Language Groups & Boundaries

As highlighted by Brayshaw (1987) and a number of other researchers (e.g., ERM 2004; Kuskie 2012), reconstructing the social and territorial organisation of the Aboriginal groups occupying the Hunter Valley at contact is extremely difficult given the enormous social upheaval that preceded any formal investigations into their languages and lifeways. The sometimes contradictory nature of primary historical records has likewise complicated the situation as has the tendency of early observers to describe all named groups of Aboriginal people, regardless of size and/or composition, as 'tribes' (Brayshaw 1987: 36).

While acknowledging these difficulties, available historical records indicate that the current Project area is located within the traditional country of the Worimi people, who spoke the Kattang (also spelt Kutthung, Kuttang, Gadhang, Gadang and Gathang) language described by Enright (1900). Tindale (1974), for his part, describes the territory of the Worimi as a 3,900 km2 area extending from the Hunter River to Forster, near Cape Hawke, inland to near Gresford and south to Maitland. However, different territorial boundaries are reported by Elkin (1932) and Enright (1933). Enright (1933), for example, reports "that the Worimi occupied the country bounded by the seashore from the Manning [River] as far south as Norah Head and possibly to the Hawkesbury" and that "[t]hey extended up the Hunter Valley as far as Singleton". Elkin (1932), meanwhile, describes the Worimi as inhabiting "the Hunter River flats up to about the site of Maitland, and the land lying between the ocean on the one side, the Lower Hunter from its mouth to Maitland on the other, and south of a line drawn roughly from Maitland through Stroud to Tea Gardens". According to Tindale's (1974) oft-cited tribal map, the Worimi were bordered to the south by the Awabakal, to the west by the Wonnarua and Geawegal and to the north by the Birpai. However,

it is noted that Elkin (1932) saw the Worimi, Awabakal and Geawegal as 'local subdivisions' of a larger 'Kattang' tribe. Similarly, Enright (1936) concluded that the Awabakal and Geawegal were 'units' of the Worimi.

Notwithstanding the contradictory nature of Tindale's (1974), Elkin's (1932) and Enright's (1933) accounts, what is clear from available historical records is that although mutually intelligible, the Kattang language spoken by Aboriginal people occupying the greater Port Stephens area (including Newcastle Bight) was different to that spoken by Tindale's (1974) Awabakal and Wonnarua 'tribes', being the language described by the missionary Reverend Lancelot Threlkeld, who established an Aboriginal mission at Belmont on Lake Macquarie in 1826[3] (the 'Bahtahbah' mission), as 'The language of the Hunter River and Lake Macquarie'. More recently, this language has been named the 'Hunter River and Lake Macquarie language' (HRLM language) (Lissarrague 2006). Based her own linguistic research, Lissarrague (2006: 7) has proposed that the HRLM language was spoken by people now known as Awabakal, Kuringgai and Wonnarua, and may also have been spoken by members of Tindale's (1974) Geawegal 'tribe'.

Critical to current interpretations of the boundaries of the HRLM language and its relationship to the Kattang language are the observations of Reverend Threlkeld. Threlkeld's own account of the boundaries of the HRLM language, which comes from his 1838 report to the then NSW Legislative Council's Committee on the Aborigines Question, is reproduced below:

> The native languages throughout New South Wales, are, I feel persuaded, based upon the same origin; but I have found the dialects of various tribes differ from those which occupy the country around Lake Macquarie; that is to say, of those tribes occupying the limits bounded by North Head of Port Jackson, on the south, and Hunter's River on the north, and extending inland about sixty miles, all of which speak the same dialect.
>
> The native of Port Stephen's use a dialect a little different, but not so much so as to prevent our understanding one another but at Patrick's Plains the difference is so great, that we cannot communicate with each other; there are blacks who speak both dialects (Threlkeld 1838 in Ford, 2010).

Threlkeld's (1825) earlier observation that "the natives here [i.e., at Lake Macquarie] are connected in a kind of circle extending to the Hawkesbury and Port Stephens" is likewise worthy of mention here, hinting, as it does, at the strong social and linguistic ties that existed between the Aboriginal groups occupying the Lower Hunter Valley at contact (Threlkeld, 1825 in Ford, 2010: 328).

Threlkeld's observations are naturally of particular relevance to any reconstruction of the social organisation of Aboriginal groups occupying the Lower Hunter Valley at contact and provide strong primary evidence for the existence of a single shared language for Tindale's (1974) Awabakal and Wonnarua 'tribes'. At the same time, they indicate that this language was different to that spoken by the Worimi of the greater Port Stephens area (being Kattang) and those spoken by Aboriginal groups occupying the Mid and Upper Hunter Valley, namely Darkinjung and Kamilaroi (Brayshaw 1987; Ford, 2010). Although Threlkeld's proposed southern extent for the HRLM language does not accord with the observations of other early sources, principally R.H. Matthews, his suggestion of a single shared language for the Aboriginal groups occupying the catchments between the Hawkesbury River estuary of Broken Bay and the estuarine areas of the Lower Hunter River is well supported by available historical records and associated linguistic research (see, in particular, Capell 1970; Ford 2010)

[3] Subsequently relocated to Toronto in 1831and named 'Ebenezer' mission

Ford's (2010) recently completed historiographic analysis provides further insight into the social and territorial organisation of the Aboriginal groups occupying the Hunter Valley at contact and is also worthy of mention here. Based on his own critical review of available historical records, Ford (2010) has convincingly argued that, contrary to popular beliefs, the actual 'tribal' and/or language name for the HRLM-speaking Aboriginal groups occupying the estuarine areas of the lower Hunter River at contact was Wannungine and not Awabakal, with the latter term coined, alongside 'Guringai' (now Kuringgai), by Scottish ex-school teacher and Maitland resident John Fraser in 1892 (Fraser 1892). The term Wannungine, Ford (2010: 343) notes, was the term that celebrated surveyor and self-taught anthropologist R.H Matthews recorded as the language or tribal name for Aboriginal peoples occupying the coastline southward from the Hunter River estuary to 'Lane Cove', but not extending to the north shore of Port Jackson, and east to the coastal range[4]. Matthews also identified the term Wannerawa, applying it to the southern part of the identified Wannungine area (i.e., around Broken Bay) (Ford, 2010: 344).

Thus, although correctly identified by Matthews, it is Ford's contention that it was Miller's (1887) misapplication of the term Wannerawa (as 'Wonnarua') to the Mid and Upper Hunter Valley, subsequently reinforced through the publications of disgraced journalist J.W. Fawcett (1898a, 1898b), that has resulted in the historical anomaly of the Wannerawa (Miller's (1887) 'Wonnarua') being placed in the Mid and Upper Hunter. Miller's (1887: 352) reference to the principal ornament of the Wonnarua being a "nautilus shell cut into an oval shape and suspended from the neck" is cited as further evidence that Miller should actually have meant his Wonnarua to be coastal people (Ford, 2010: 354). Contrary to Miller's (1887) and Fawcett's (1898a, 1898b) widely cited accounts, Ford's research suggests that at the time of first European settlement, the mid Hunter was, in fact, occupied by Darkinjung-speaking peoples, whose territory encompassed the ranges bounded by the Hawkesbury River floodplain to the south and the Hunter River floodplain to the north and was bordered to the east/northeast by the coastal Wannungine (aka Wannerawa) (Ford, 2010: 10). Bordering the Darkinjung to the west/northwest, in the Upper Hunter, were Kamilaroi-speaking peoples, who Ford (2010: 467) suggests had penetrated over the Liverpool Range and were occupying the Hunter Valley as early as 1819.

[4] From north to south: the Sugarloaf Range, the Watagan Rage and PEAts Ridge.



Figure 9.18 - Excerpt from Tindale's (1974) tribal map (from Kuskie, 2012: 38, Fig. 7, after Tindale, 1974)

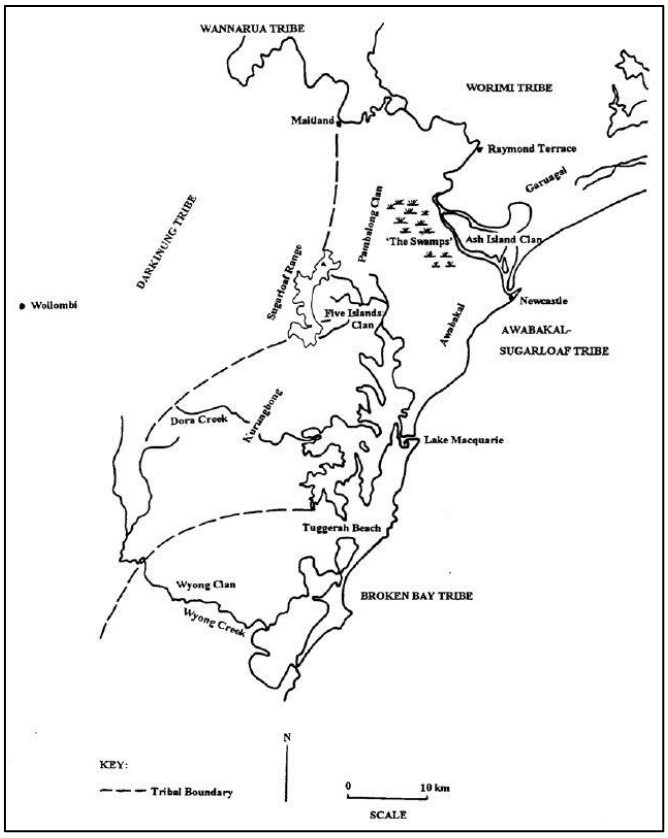


Figure 9.19 - Gunson's (1974) tribal map for the lower Hunter Valley, based on the observations of Reverend Lancelot Threlkeld (from Kuskie, 2012: 39, Fig. 8, after Gunson, 1974)

9.6.3 Social Organisation

In common with other regions of New South Wales (e.g., Attenbrow, 2010) and Australia more broadly (Peterson, 1976), available historical records suggest that the primary units of social organisation amongst the Aboriginal language groups present in the lower Hunter at contact were the clan and band. Although these terms are often used interchangeably (e.g., Kohen, 1993), following Attenbrow (2010), a distinction can, in fact, be drawn between the two, with clans comprising local descent groups and bands, land-using groups who, though not necessarily all of the same clan[5], camped together and cooperated daily in hunting, fishing and gathering activities. Individual bands will have habitually occupied and exploited the resources of particular tracts of land within the overall territory of their clan. However, the territorial boundaries of each band will have been permeable or elastic in the sense of complex kinship ties facilitating inter-band territorial movements and the reciprocal use and/or exchange of resources (Brayshaw, 1987: 36).

The size of the individual bands occupying the lower Hunter at contact appears to have varied considerably and was no doubt activity and season dependent (Brayshaw, 1987). However, an upper limit of around 70 individuals, consisting of several families, is suggested by available historical records (see, in particular, Table B in Brayshaw, 1987). Individual band sizes notwithstanding, much larger groups of Aboriginal people, numbering in the hundreds, are known to have come together for events such as corroborees, ritual combats and feasts (e.g., Anon 1877; Scott 1929: 32; Threlkeld in Gunson 1974: 55).

For the Worimi, Elkin (1932) and Enright (1932) report the existence of four 'named local groups', two of which - the Garugal and Maiangal - were 'salt-water' groups and two - the Gamipingal and Buraigal - 'inland' groups. Following Attenbrow (2010), it is possible that these named groups comprised bands. However, it is noted that they are commonly referred to as clans or "nurras". Regardless, Elkin (1932: 360) notes that each occupied "a definite area" within the overall territory of the Worimi. Reference to Elkin (1932) and Enright (1936) indicates that the current Project area falls within the territory of the Maiangal nurra, which extended from the Hunter River/Fullerton Cove in the south, to Tomaree Head in the north and eastward from the Pacific Ocean to Tilligerry Creek.

Social organisation amongst the Worimi, Elkin (1932) reports, was based on exogamous patrilineal totemic clan membership, with at least twelve clans, known as tambual, recognised. Sex totemism was reportedly also practised, with kulangulan, the bat, comprising the men's totem and dilmun, the wood-pecker, the women's (Elkin 1932: 361). In addition, certain individuals (e.g., 'clever men' or native doctors known as Karadji) had personal totems known as mingigal (Elkin 1932: 362).

9.6.4 Settlement & Subsistence

Available historical records attest to exploitation, for food and other resources (e.g., skins for clothing), of a large and diverse range of terrestrial, avian and aquatic fauna by Aboriginal peoples occupying the Lower Hunter Valley at contact. A broad economic division between 'coastal' and 'inland' groups is also evidenced, with the subsistence regimes of those living along the coast geared principally towards the exploitation of marine foods and those of inland groups based chiefly on the exploitation of land mammals (e.g., Ebsworth, 1826: 80).

Along the coast, the accounts of early observers such as Dawson (1830), Scott (1929) and Threlkeld (in Gunson 1974) are suggestive of a diet based principally on fish and shellfish, with crustacea (i.e., crabs and crayfish) and marine mammals, namely whales and dolphins also consumed, the

[5] Some individuals may have been related through marriage.

latter opportunistically (e.g., Threlkeld in Gunson 1974: 55). Fish, a dietary staple, were caught in a variety of ways including angling (i.e., hook and line fishing), spearing, hand netting and trapping, and were cooked in fires, sometimes in canoes while still on the water (Threlkeld in Gunson 1974: 190; Scott 1929: 17-18). Angling was undertaken by women and spearing by men (Dawson, 1830: 314; Scott, 1929: 18; Threlkeld in Gunson, 1974: 54). Crayfish were obtained by diving amongst the rocks, an activity that was undertaken by both sexes (cf. Scott 1929: 19 and Threlkeld in Gunson 1974: 55). Haslam et al. (1984: 22) report that shellfish were collected by women and children. However, Brayshaw (1987: 76) notes that there is no direct evidence as to who traditionally undertook this task.

The role of marine foods in the diets of Aboriginal groups occupying the lower Hunter at contact was complimented, or supplanted further inland, by a variety of freshwater animal foods, with kangaroos, wallabies, bandicoots, echidnas, possums, flying foxes, kangaroo-rats, koalas, dingos, lizards, goannas and snakes variously reported as having been hunted and/or eaten (see Brayshaw 1987; Haslam et al. 1984 and Sokoloff 1980 for primary references). Various species of freshwater and estuarine fish, eels and mussels were also consumed, as were turtles (e.g., Anon 1877b; Cunningham 1827: 151; Grant 1803: 61). Possums appear to have been a favoured food, particularly in inland areas, with a number of early accounts detailing their method of capture and remarking on the tree climbing skills of the Aboriginal people involved (e.g., Dawson, 1830: 238; Scott 1929: 21). Flying foxes, too, appear to have actively sought out by groups in both areas (e.g., Anon 1877a; Scott 1929: 23), though not by the Awabakal at Lake Macquarie who held the animal in high esteem (Threlkeld in Gunson, 1974: 206). Macropods were sometimes stalked and speared by individual huntsmen (Dawson 1830: 216; Threlkeld in Gunson, 1974: 190). However, their capture was more commonly a communal exercise (Dawson 1830: 182; Scott 1929: 20; Threlkeld in Gunson 1974: 191). Threlkeld (in Gunson, 1974: 206) and Fawcett (1898a: 153) report the burning off of particular tracts of land to promote new growth and attract kangaroos and wallabies.

References to the hunting and consumption of a variety of birds, including the emu, are also present in the writings of a number of early observers (e.g., Fawcett 1898a; Scott 1929: 23; Threlkeld in Gunson 1974: 55, 65). Scott (1929: 23), for example, reports that "[b]irds were easily secured and were an abundant part of the daily meal" while Fawcett (1898a: 153) reports the use of nets to trap emus and use of returning boomerangs to bring down "ducks and other birds". Larvae, namely 'Cabra' or shipworm (Teredo navalis) and other tree dwelling grubs, appear to have been a popular foodstuff in both coastal and inland areas (Anon, 1877b; Scott, 1929: 21-22). Honey collected from the hives of native bees was both eaten directly and mixed with water to form a sweetened drink (Breton 1833: 195; Dawson 1830: 60; Scott 1929: 34-35; Threlkeld in Gunson 1974: 67, 124).

Compared with their faunal counterparts, the plant food resources of coastal and inland groups are poorly represented in the writings of early colonial observers. Nonetheless, available descriptions do suggest that plants formed a regular part of the diets of groups in both areas. Fern roots, likely those of the bracken fern (Pteridium esculentum) and various water ferns (Blenchum spp.), appear to have played an important role in the diets of those Aboriginal people occupying the estuarine reaches of the Hunter River (Barrallier 1802: 81-82; Dawson, 1830: 92; Ebsworth 1826: 71; Threlkeld in Gunson 1974: 19). Other plant foods mentioned in the writings of early observers include yams, macrozamia seeds, various fruits and the stems of the water lily (Backhouse 1843: 380; Caswell 1841; Scott 1929: 41; Threlkeld in Gunson 1974: 74). Nectar obtained from the blossoms of the grass tree (Xanthorrhoea spp.) and flower spikes of the dwarf banksia was also consumed (Dawson 1830: 244).

Regarding levels of residential mobility, available records suggest that this was generally quite high. Dawson (1830: 172), for example, observed that "they [i.e., the Worimi people of the Port

Stephens area] seldom…stay more than a few days at these places [their camps], frequently not more than one night". Fawcett's (1898a) observation that the Wonnarua "had no permanent settlements, but roamed about from place to place within their tribal district" is similarly suggestive as is the 1877 observation by an anonymous long-term resident of Maitland that the Aboriginal people with whom he was familiar "appeared to lead a very restless kind of life, constantly on the move, shifting their camps from one place to another, seldom remaining more than three or four days in one camp" (Anon 1877e). Along the coast, Sokoloff (1980: 8) has suggested seasonal differences in settlement duration, proposing that "the relative abundance of marine sources of food in summer tended to make the natives more sedentary at this time". That occupation duration was tied to resource abundance is supported by Dawson's (1830: 126) observation that "their wandering habits seldom lead them to stay more than a day at any place, unless they have procured a plentiful supply of food". As for the selection of campsites, we limited are to Fawcett's (1898a: 152) observation that "in choosing the site, proximity to freshwater was one essential, some food supply a second, while a vantage ground in case of attack from an enemy was a third important item".

9.6.5 Material Culture

Aboriginal material culture is explicitly linked to the natural environment and resource availability. For the lower Hunter Valley, available historical records identify an extensive array of hunting and gathering 'gear' and provide detailed insight into associated materials and manufacturing processes. The form and construction of everyday domestic structures are likewise well documented. Brayshaw (1987), in particular, provides a useful synthesis of both forms of material culture and highlights regional variability in raw material acquisition and utilisation between coastal and inland groups.

Campsites and domestic structures are well-represented in the accounts of early observers and were often the subject of illustration (Plate 9.1 and Plate 9.2). Huts, commonly referred to as "gunyers" or "gunyahs", were of timber and bark construction. Fawcett (1898a: 152) describes the form and construction of huts as follows:

> A couple, or three, forked sticks, a few straight ones, and some sheets of bark, stripped from trees growing nearby, supplied the requisites for the construction of their home. The forked sticks were thrust into the ground and the straight ones placed horizontally in the forks. The sheets of bark were then set up against the horizontal poles in a slanting position, the bark of the structure being toward the windy point of the compass. The sides were frequently enclosed for further shelter, but the front was generally open. Before each one was a small fire, which was seldom allowed to go out, and which was used for warmth, or to cook by.

Similar hut forms and construction methods can be found in the accounts of several other early observers, for example, Scott (1929: 13), Dawson (1830: 171-72), Caswell (1841) and Threlkeld (in Gunson, 1974: 45).

Alongside its use in hut manufacture, tree bark also served as the primary construction medium for canoes, an integral component of the material culture repertoire of Aboriginal peoples occupying the lower Hunter Valley at contact. Available descriptions indicate that canoes were manufactured by bending, with the assistance of fire, a suitable sheet of bark into shape and securing the ends with bark cord or other 'wild vines' (Ebsworth, 1826: 82; Dawson 1830: 79; Fawcett 1898a; Mrs Ellen Bundock in Brayshaw 1987: 60; Scott 1929: 38-39; Threlkeld in Gunson 1974). Scott (1929: 39) reports that the gaps between the cord bindings at either end of the canoe were plugged with clay. Clay hearths were also added for warmth and cooking (Threlkeld in Gunson 1974; Scott, 1929: 39). At Lake Macquarie, leaking canoes were repaired by sewing

patches of tea tree bark over damaged areas and sealing them with melted grass tree resin (Threlkeld in Gunson 1974: 54).

Spears, which feature prominently in the literature, were an important component of men's 'gear' and were used in hunting, fishing, combat and ceremony (Scott 1929: 35; Threlkeld in Gunson 1974: 67-68). Spears for all purposes, Brayshaw (1987: 65) notes, were of composite manufacture and alongside sea shells, iron tomahawks and pieces of bottle glass, were important trade items, with significant numbers traded inland for possum skin rugs and fur cord (Dawson 1830: 135-136; Threlkeld in Gunson 1974: 65). Various hard woods and grass tree stems served as primary spear shafts and were shaped using shell scrapers and pieces of glass (Dawson 1830: 67, 135; Scott 1929: 35; Threlkeld in Gunson 1974: 67-68).

Threlkeld (in Gunson 1974: 67) describes the manufacture and use of three different types of spears in the Lake Macquarie area, namely the fishing spear, the hunting spear and the battle spear. Primary spear shafts, in all three instances, comprised grass tree stems. However, differing types of points were added according to function. For the fishing spear, Threlkeld (in Gunson 1974) describes the affixing of bone barbs onto three or four 'shorter spears' of fire-hardened wood, themselves fastened to the main spear shaft with bark thread and grass-tree gum, while the hunting spear is described as being equipped with a single hard wood point. The battle spear, Threlkeld (in Gunson 1974: 67) reports, also had a single hard wood point but differed from its hunting counterpart in having "pieces of sharp quartz stuck along the hard wood joint on one side so as to resemble the teeth of a saw" (Threlkeld in Gunson 1974: 66). The substitution of glass for quartz on battle spears is also known to have occurred. In common with the Lake Macquarie area, Scott (1929: 35) notes the use, around Port Stephens, of different types of spears for hunting, fishing and combat. Differing functions aside, spears of all varieties were launched using spearthrowers or woomeras, also of composite manufacture (Brayshaw 1987: 66).

Hatchets, like spears, were an important component of men's 'gear' and were used for variety of tasks including bark removal, animal butchery, cutting toeholds in trees and extracting game and honey from logs and trees (Anon 1877a; Dawson 1830: 202; Scott 1929: 41; Threlkeld in Gunson 1974: 67). Known as mogo, hatchets were composite implements consisting of an edge-ground stone hatchet head and withe or flat, hardwood handle, the former secured to the latter using grass tree resin and cord (Dawson 1830: 202; Fawcett 1898a: 153; Scott 1929: 40). Hatchets, Scott (1929: 5) notes, were carried by men in belts worn around the waist. Post-contact, stone hatchets appear to have been rapidly replaced by iron substitutes (Brayshaw 1987: 66; Dawson 1830: 16).

Other notable items of men's gear described in the accounts of early observers include several types of hard wood clubs, two types of shield (one broad and one narrow) and returning and non-returning hard wood boomerangs (Anon 1877b; Scott 1929: 36-38; Threlkeld in Gunson 1974: 41, 68). Threlkeld (in Gunson 1974: 68) also describes the use of a "wooden sword" similar to a boomerang but with "a handle at one end with a bend contrary to the blade".



Plate 9-1 - Joseph Lycett's 'Aborigines resting by camp fire, near the mouth of the Hunter River', ca.1820 (Source: National Library of Australia)



Plate 9-2 - Augustus earle's 'A Native Camp of Australian Savages near Port Stevens, New South Wales', 1826 (Source: National Library of Australia)

As for women's gear, Brayshaw (1987: 65) notes that in addition to their daily use in gathering activities, digging sticks, also known as yamsticks, were status symbols that were sometimes used during altercations. These implements, up to 2m long and c.4cm in diameter, were manufactured out of hard woods, were fire-hardened and typically not decorated (Brayshaw 1987: 65). Cord used in the manufacture of fishing lines and nets was made by women using the bark of various

trees (e.g., the Cabbage-tree (Livistona australis) and the Kurrajong (Brachychiton populneus) and is reported as having been extremely strong and durable (Ebsworth 1826: 79; Dawson 1830: 67; Scott 1929: 17). Dilly-bags were used by women for carrying small items such as fish-hooks, prepared bark cord, lumps of grass tree resin and food (e.g., fish and shellfish) and were worn slung around the head and draped down the back (Ebsworth 1826: 79-80).

Fish-hooks were manufactured out of oyster and pearl shell (Caswell 1841; Threlkeld in Gunson, 1974: 54; Sokoloff 1980: 23). Threlkeld (in Gunson 1974: 54) reports that a suitable shell was simply "ground down on a stone until it became the shape they wished". However, Dyall's (2004) analysis of archaeological examples from the Birubi Point midden complex suggests a more complex, multi-stage production process. Pieces of fine sandstone, shale and quartzite were used for filing down the hooks (Sokoloff 1980: 23).

Awls or 'needles' manufactured out of kangaroo bone were used in the repair of canoes and the sewing of skin cloaks (Fawcett 1898a; Threlkeld in Gunson 1974: 54). Items of clothing (where worn) included spun possum-fur belts, worn only by men, possum fur headbands and cloaks or rugs made from sewn kangaroo and possum skins (Dawson 1830: 15-16; Scott 1929: 5). Cloaks were worn by both men and women.

Alongside women's dilly bags, early accounts indicate the production and use of a variety of other containers, with tea tree bark a common construction material. Threlkeld (in Gunson 1974: 67, 156), for example, refers to tea-tree bark 'cups' and wooden 'bowls' "formed from some large protuberance of a growing tree" while Dawson (1830: 250) refers to "small baskets" made from tea tree bark.

Although particularly well represented in the archaeological record of the lower Hunter Valley, references to the production and/or use of flaked stone artefacts are virtually absent from the historical record. Excluding hatchets, Threlkeld's (in Gunson 1974: 67) reference to the use of "pieces of sharp quartz" for barbing battle spears remains the only known primary reference in this respect. Brayshaw (1987: 68), for her part, has proposed that effective absence of flaked stone artefacts from the historical record may be a product of the fact that such artefacts were not being used at the time of European settlement, having been replaced with other materials (e.g. shell, glass, wood and bone)[6]. However, she also acknowledges that their use may simply have escaped the notice or interest of early observers.

9.6.6 Ceremony & Ritual

Evidence for ceremonial or ritual behaviour amongst the Aboriginal groups occupying the lower Hunter Valley at contact can be found in the accounts of a number early observers (e.g., Anon 1877c; Dawson 1830; Enright, 1936; Fawcett 1898a, 1898b; Scott 1929; Threlkeld in Gunson 1974), with documented 'ceremonial' activities including corroborees, male initiation ceremonies, marriage, ritual combat and various burial, body adornment and modification practices. Although limited in number, references to spiritual beliefs of the Aboriginal groups occupying the region are also present and attest to regional variability in belief systems.

Male initiation ceremonies, in which boys were "initiated into the privileges of manhood" (Fawcett 1898a: 153), are described by Enright (1936), Fawcett (1898a), Scott (1929) and Threlkeld (in Gunson, 1974). Amongst the Wonnarua, Fawcett (1898a: 152) notes that the male initiation ceremony was known as Boorool. Enright (1936: 86), writing on the Worimi people, refers to the ceremony as the Keeparra while Scott (1929: 29) cites the terms poombit and bora in his

[6] Historic references (e.g., Dawson 1830: 67, 135; Scott 1929: 35) to the use of shell scrapers and/or fragments of bottle glass for the shaping/sharpening of wooden spEArs provide some support for this suggestion.

recollections, noting that the latter was a colloquial term for the former. Initiation grounds, referred to by Scott (1929: 29) as 'poombit grounds', were elaborately prepared and consisted of one or two[7] cleared circles in secluded areas of bushland. Images of animals and other designs were carved into surrounding trees and, in some cases, "figures of raised earth were created on the ground" (Brayshaw 1987: 83). Threlkeld (in Gunson 1974: 50-51, 63-65) describes attending, in November 1825, a ceremony "preparatory to removing the front tooth of several young men who would then be capable of marrying a wife". The site of this ceremony, Threlkeld (in Gunson 1974) reports, was known as the "Mystic Ring, or Porrobung" and consisted of a circle "thirty-eight feet in diameter" with a small hillock at is centre. Trees near the ring were marked with "representations of locusts, serpents &c on the bark chopped with an axe".

As for the ceremonies themselves, Enright (1936: 87) reports that the Keeparra, in which "candidates learnt all those laws which governed his future life", lasted approximately one month but was "only a prelude to a long system of instruction which lasted some five years". Fawcett (1898a: 154), meanwhile, describes a ceremony involving tests of skill and endurance, the teaching of tribal laws, "emblematical dances" and the restricted involvement of women. Scott (1929: 28-34), too, describes the restricted involvement of women and dancing in the poombit or bora ceremonies of the Port Stephens area. Alongside their other important roles, medicine men or native doctors, known as Karaji (also spelt Karadjys), appear to have played an active role in initiation ceremonies and, together with group elders, were responsible for overseeing initiates' observance of instructed laws (Enright 1936; Fawcett 1898a).

Alongside its use in the initiation ceremonies described above, body painting with animal fat and/or ochre was undertaken as part of corroborees and for the purposes of ritual combat. For men, tooth avulsion, body scarification and septum piercing appear to have been undertaken in ceremonies subsequent to that associated with initiation (Fawcett 1898b; Scott 1929). Regarding items of personal adornment, Miller (1887: 3543) notes that the "principal ornament" of the Wonnarua was a "nautilus shell cut into an oval shape and suspended from the neck" while Fawcett (1898a: 153), also writing on the Wonnarua, reports that "the girls often adorned themselves with flowers, bone or reed ornaments, and shell necklaces". References to the dressing of men's hair in a conical form with tufts of grass attached are present in Dawson (1830) and Anon (1877c).

Available historical records suggest that burial in the earth was the most common form of burial practised by Aboriginal groups occupying the Lower Hunter Valley at contact, with tea tree bark widely used as a burial shroud (Fawcett 1898b: 180; McKiernan 1911: 889; Miller 1877: 354; Scott 1929: 3; Threlkeld in Gunson 1974: 47, 89, 100). Grave goods consisted of items of personal gear such as spear and hatchets (McKiernan 1911: 889; Threlkeld in Gunson 1974: 47, 89, 100). Cremation is also known to have been practiced but is poorly represented in the historical record (Threlkeld in Gunson 1974: 99).

Regarding inter-group conflict, Haslam et al. (1981) have noted of the Hunter Valley as a whole that, although skirmishes were common, major clashes were infrequent. Ritual combat appears to have linked principally to unsanctioned territorial incursions and the abduction of women (Fawcett 1898b).

Gunson (1974) notes a distinct difference between the spiritual beliefs of the Aboriginal groups occupying the inland and coastal portions of the Hunter Valley at contact. In contrast to the Awabakal of Lake Macquarie[8], for example, whose supreme spiritual entity was known as Koun (pronounced cone), the inland Wonnarua and Kamilaroi are understood to have venerated the

[7] Where two circles were used, these were separated by a distance of up to 400 m.

[8] Dawson's (1830: 153, 158, 163 219, 220, 322) multiple references to an "evil spirit of woods" known as "Coen" suggest that the Worimi of the Port Stephens arEA, like the Awabakal, venerated *Koun* as opposed to *Biame*.

prominent sky cult hero Biame. Threlkeld (1834 in Keary 2009) reports that Koun was known by three names - Ko-in, Tip-pa-kál, and Pór-ráng - and describes him as follows:

> in appearance like a black; he resides in the thick brushes or jungles; he appears occasionally by day, but mostly at night. In general, he precedes the coming of the natives from distant parts, when they assemble to celebrate certain mysteries, as knocking out the tooth in the mystic rite, or when performing some dance. He appears painted with pipe clay, and carries a fire-stick in his hand; but, generally, it is the doctors, a kind of Magicians, who alone perceive him, and to whom he says, 'Fear not, come and talk.' At other times he comes when the blacks are asleep, takes them up as an eagle does his prey, and carries them away. The shout of the surrounding party often occasion him to drop his burthen; otherwise, he conveys them to his fireplace in the bush, where close to the fire he carefully deposits his load. The person carried tries to cry out, but cannot feeling almost choked: at daylight, Ko-in disappears, and the black finds himself conveyed safely to his own fire-side!

Available historical accounts indicate that that eagle-hawk (sea eagle) was a totem of particular importance to the Awabakal owing to its strong relationship with Koun, who resembled an eagle-hawk when in flight (Gunson 1974: 3; Keary 2009). Circular stone structures observed by Threlkeld on the Sugarloaf Range to the west of Lake Macquarie were explained by Threlkeld's primary informant Biraban as having been placed and assembled by eaglehawks (Keary 2009).

Another important spiritual entity for the coastal Awabakal was Puttikan, a feared supernatural spirit who inhabited the Sugarloaf Range. Threlkeld (in Gunson 1974: 61) describes Puttikan as follows:

> resembling a man but taller in stature; with arms, legs, face, and hair, very long on the head, but the feet are placed contrarily to the face being behind; and the body hairy, like an animal. The flesh is so hard in all parts of the body that it is imprenentrable [sic], except just between the legs, where a spear may penetrate, but at no other part. He is fierce, devouring men, and often pursuing the Aborigines in the mountains.

9.6.7 Post Contact History

As in other parts of NSW and Australia more generally, the post-contact history of the Aboriginal people of the lower Hunter Valley, including the valley's coastal plain, is primarily one of dispossession and loss, with traditional hunting and camping grounds rapidly claimed and settled by Europeans and populations decimated by introduced diseases. However, active resistance and friendly relations are also attested in available records.

As highlighted by Brayshaw (1987), the introduction of European diseases had a devastating impact on the Aboriginal population of the Hunter Valley, with diseases such as smallpox, typhoid, influenza, scarlet fever, measles, diphtheria, whooping cough and croup resulting in the deaths of large numbers of Aboriginal people. Major small pox epidemics between April and May 1789 and from 1829 to 1831 are known to have had a particularly deleterious impact on the valley's Aboriginal population (Butlin, 1983).

The loss of traditional hunting grounds and a decline in the abundance of game that populated these areas have also been identified as factors relevant to the marked population decline that accompanied European settlement of the Hunter Valley, as has the sexual violence perpetrated by non-Aboriginal men against Aboriginal women (Turner & Blyton 1995). The destruction, over time, of the complex systems of social and territorial organisation that existed prior to contact has

likewise been attributed to such factors, as has the collapse of traditional settlement and subsistence regimes.

Today, modern Awabakal, Wonnarua and Worimi people retain strong cultural connections to the Lower Hunter Valley and are actively involved in the protection and promotion of their culture for future generations.

9.7 ARCHAEOLOGICAL SURVEY

9.7.1 Aims & Objectives

The overarching aim of the archaeological survey undertaken for this assessment was to identify and record any existing surface evidence of past Aboriginal occupation within the Project area. Nested-objectives were as follows:

- To assess levels of ground surface integrity across the Project area;
- To identify areas that, irrespective of the presence or absence of surface artefacts, are likely to contain subsurface archaeological deposit; and
- To provide sufficient data to facilitate the development of an appropriate management strategy for the known and potential Aboriginal archaeological resource of the Project area.

9.7.2 Methodology

In developing an appropriate survey methodology for the current assessment, two key factors were taken into consideration:

1) Very poor Ground Surface Visibility (GSV) conditions across the majority of the Project area; and
2) Generally poor survey conditions within the undisturbed portions of the Project area's two aeolian landform units, with dense undergrowth impeding pedestrian survey and posing an OH&S risk.

In view of the above, it was decided that a targeted survey focusing on areas of enhanced exposure and GSV across the Project area (e.g., vehicle tracks) should be undertaken. In accordance with Sections 4.3.1 and 4.3.2 of the Consultation Requirements, this was conveyed to all RAPs in the draft assessment methodology document. No objections were raised in relation to AECOM's proposed survey methodology.

Archaeological survey of the Project area was undertaken over two days by a combined field team of two AECOM archaeologists and three RAP field representatives per day (for a list of RAP field representatives see Table 9.4 in Section 9.3.3.2). In accordance with the draft survey methodology, the survey focussed on enhanced areas of exposure and GSV, specifically, the light vehicle tracks that dissect the elevated Ridge I dune field, the cleared powerline easement in the southwestern portion of the Project area and the heavily modified orchard area. The estuarine flat landform unit was visually inspected from Marsh Road. However, in view of universally poor GSV conditions (owing to a thick cover of native and introduced grasses) and the unit's low Aboriginal archaeological potential, this area was not subject to pedestrian survey.

All survey was conducted on foot, with a total of 23 transects completed over the course of the survey. The location of each transect completed during survey, including start and end points, was recorded using one of two handheld differential GPS units, with associated transect data

(e.g., levels of visibility and exposure) entered directly into the same unit upon the completion of each transect.

All Aboriginal archaeological materials identified during survey were recorded to a standard comparable to that required by the Code of Practice (Requirement 7), with individual site boundaries captured by differential GPS. As with that recorded for individual survey transects, attribute data for all identified Aboriginal artefacts within the Project area were entered directly into a GPS unit using AECOM's standard digital open site recording form.

9.7.2.1 Site Definition & Subsurface Archaeological Potential

The definition, in spatial terms, of Aboriginal archaeological sites is a topic of considerable importance to modern cultural heritage management and one that has generated significant discussion in Australian archaeology (e.g., Doleman 2008; Holdaway, 1993; Holdaway et al. 1998, 2000; MacDonald & Davidson 1998; McNiven 1992; Robins 1997; Shiner 2008). Aboriginal archaeological sites can be broadly defined as places in the landscape that retain physical evidence of past Aboriginal activity. Such evidence, of course, can assume a range of forms, depending on the nature of the activity or activities that produced it, and can vary dramatically in quantity and extent. Some Aboriginal archaeological sites are, by their very nature, easy to define in spatial terms. Scarred trees and rockshelters, for example, can be readily delineated from their surrounding landscapes. Difficulties arise, however, for sites whose present-day physical extent is, more often than not, a product of geomorphic processes, as opposed to the actions of Aboriginal people in the past.

Although relevant to a variety of site types, geomorphic processes such as soil erosion and deposition are of particular relevance to the identification and definition of open artefact sites and shell midden/scatter sites. In the context of the Newcastle Bight Sand Dune System, for example, available data indicate that the visibility and present-day extent of such sites are often directly attributable to such processes, with transgressive sand movements variously exposing or burying them (Dean Jones 1990; Umwelt 2000). Site exposure, unsurprisingly, is highest on erosional surfaces and lowest on depositional ones.

Such evidence poses a significant analytical and interpretive dilemma. Defining sites on the basis of surface artefacts alone is clearly problematic, with modern site boundaries invariably reflecting the size and distribution of surface exposures as opposed to the actions of Aboriginal people in the past. Nonetheless, for pragmatic reasons, this is the most commonly used approach, with 'distance' and 'density-based' definitions dominating. In NSW, two of the most commonly employed distance-definitions are 'two artefacts within 50m of each other' and 'two artefacts within 100 m of each other'. Neither definition is derived from a particular theoretical approach or body of empirical research - they are simply pragmatic devices for site definition. Definitions based on artefact density also vary in their particulars. However, one of most commonly used definitions is that which isolates, within an arbitrarily defined 'background scatter' of one artefact per 100 m², higher density clusters that are subsequently defined as 'sites'.

Non-site or distributional archaeology offers an alternative approach to distance and density-based site definitions (Ebert 1992; Foley 1981), with individual artefacts, not sites, treated as the basic units of analysis (for published Australian examples see Doelman 2008; Holdaway et al. 2000; McNiven 1992; Robins 1997; Shiner 2008). While recognising the interpretive potential of non-site approaches with respect to data analysis and discussion, their implementation in the context of cultural heritage management studies is difficult. Here, the identification of 'sites' is required for reasons of recording (i.e., their entry into site databases such as AHIMS) as well as ease of relocation, protection, and ongoing management. The identification of spatially-discrete 'sites',

therefore, offers the most pragmatic approach to Aboriginal heritage management in impact assessment contexts (but see McDonald (1996) for a different view).

Site definition for the current assessment has been based on the 50 m distance convention cited above. Subsurface archaeological potential, meanwhile, is addressed in this report by the concept of 'archaeological sensitivity', with three potential levels of sensitivity recognised: low, moderate and high (Table 9.11). For the current assessment, the archaeological sensitivity of land within the Project area has been assessed on the basis of:

- The existing environment of the Project area, with particular consideration given to the occupation potential of extant landform units (**Section 9.4**);
- The results of the archaeological survey undertaken (**Section 9.7.4**);
- The results of previous local and regional Aboriginal heritage investigations (**Section 9.5**); and
- Levels of past land disturbance within the Project area (**Section 9.4)**.

Rating	Definition
Low	Highly disturbed land with low subsurface archaeological preservation potential and/or land characterised by unfavourable occupation conditions.
Moderate	Undisturbed/minimally disturbed land with high subsurface archaeological preservation potential. Existing environmental conditions conducive to transient or short stay occupation events. Subsurface occupation deposits of high archaeological complexity and significance not anticipated.
High	Undisturbed/minimally disturbed land with high subsurface archaeological preservation potential. Existing environmental conditions conducive to long-term or repeated occupation. Subsurface occupation deposits of high archaeological complexity and significance expected.

Table 9.11 - Archaeological sensitivity rating scheme

9.7.3 Results

9.7.3.1 Survey Coverage and Effective Coverage

As indicated in Section 9.7.2 and shown on Figure 9.20, a total of 23 pedestrian transects were completed over the course of the survey. Completed transects ranged from 62 to 793 m in length, with individual transect widths (1-20 m) conditioned largely by the width of pre-existing vehicle tracks and easements. Recorded transect data indicate that a total survey coverage of approximately 2.8 ha was achieved. Excluding those portions of transects falling outside of the Project area provides a revised total survey coverage of approximately 2.7 ha, representing around 5.2% of the total Project area. A breakdown of survey coverage by landform is provided in Table 9.12. As previously noted, although visually inspected from Marsh Road, the estuarine landform unit was not subject to pedestrian survey owing to very poor GSV conditions (Plate 9.3) and the unit's low Aboriginal archaeological potential.

Effective coverage is an estimate of the area in which archaeological materials are 'detectable'. Calculation of the total effective coverage obtained for the current survey indicates that approximately 0.9 ha of land within the Project area was effectively surveyed for Aboriginal archaeological materials. This equates to around 1.7% of the total Project area and 32.1% of the total area surveyed (2.8 ha).

Tabulated estimates of the effective coverage achieved for each of the 23 pedestrian transects completed during survey are provided in Table H1, Annex C. As indicated, levels of effective coverage during survey were generally quite low, with the majority (n = 14, 60.9%) of transects exhibiting values under 10%. GSV along the vehicle tracks that criss-cross the elevated Ridge I

dune field was typically poor to fair (c.10-50%) owing to a dense to relatively dense surface cover of fallen leaf litter (Plate 9.4 and Plate 9.5). However, parts of some tracks, presumably higher-use sections, were characterised by very good to excellent (c.70-100%) GSV (Plate 9.6 and Plate 9.7). Vehicle tracks running into and along the peripheries of the olive orchard on Lot 254 of DP753204 were likewise characterised by very good to excellent GSV (Plate 9.8 and Plate 9.9). Non-grossly disturbed portions of the cleared electricity easement in the southwestern portion of the Project area, in contrast, were characterised by fair GSV (c.40%).

Consideration of levels of effective survey coverage by landform, refer Table 9.13 reveals comparable values for the elevated Ridge I dune field and adjoining low relief sand plain. However, landform-based site count data reveal a different pattern, with all identified sites occurring within the elevated Ridge I dune field unit.

Landform unit	Area (ha)	%
Elevated Ridge I dune field	1.9	69.4
Low relief sand plain	0.8	30.6
Estuarine plain	0	0
Total	**2.7**	**100**

Table 9.12 - Survey coverage by landform unit

Landform unit	Effective coverage (ha)	% of total effective coverage	Number of surface sites	% of total sites
Elevated Ridge I dune field	0.5	55.6	5	100
Low relief sand plain	0.4	44.4	0	0
Estuarine plain	0	0	0	0
Total	**0.9**	**100**	**5**	**100**

Table 9.13 - Effective coverage by landform unit

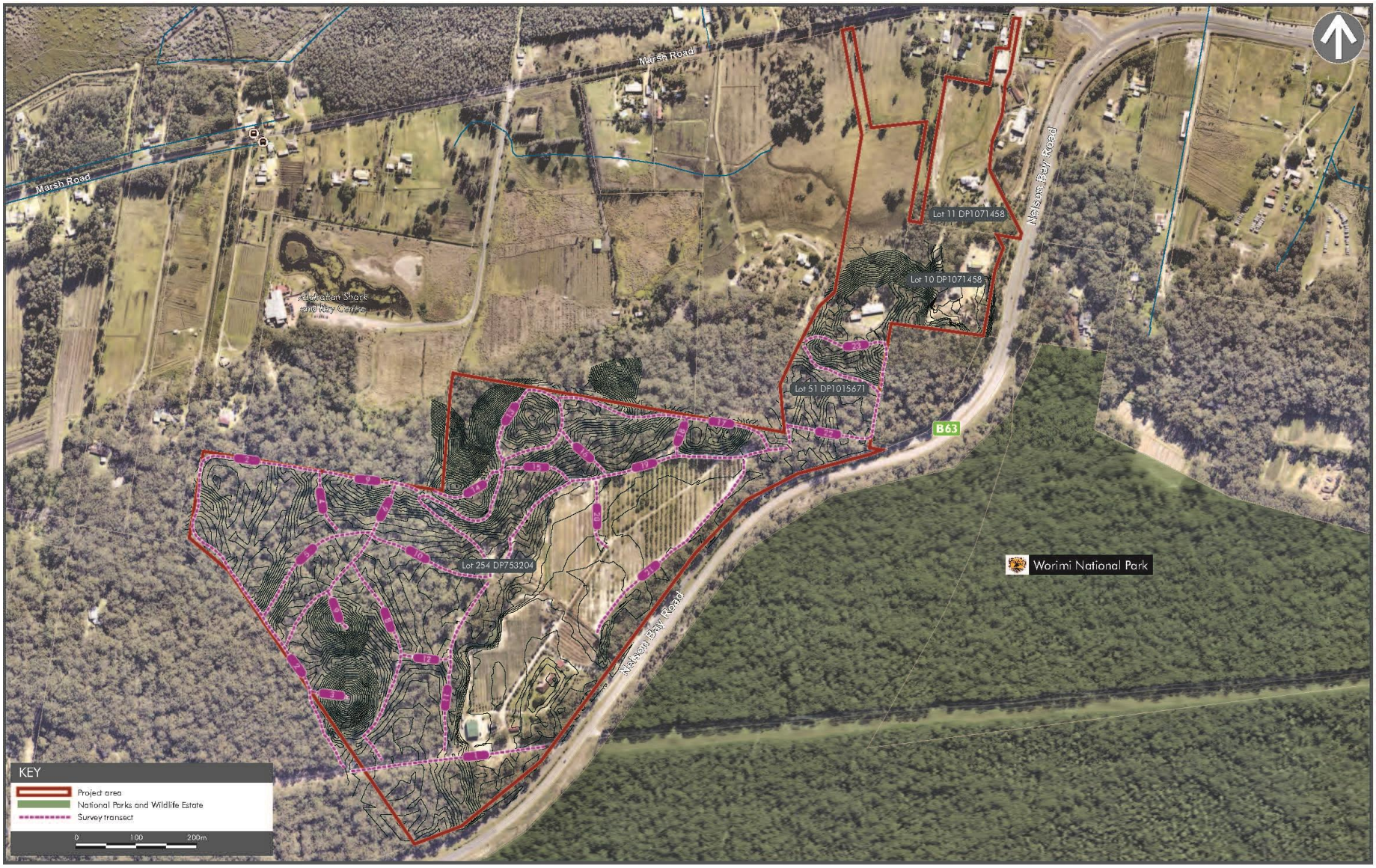


Figure 9.20 - Survey Transects



Pla **.**
No

Plate 9-4 - View along part of Transect 2. Note poor GSV due to fallen leaf matter.



Plate 9-5 - View along part of Transect 17. Note very poor GSV due to heavy surface cover of fallen leaf litter



Plate 9-6 - View along part of Transect 13. Note enhanced on-track GSV



Plate 9-7 - View along part of Transect 2. Note enhanced on-track GSV



Plate 9-8 - View along part of Transect 19. Note excellent GSV



Plate 9-9 - View along Transect 20. Note excellent GSV on-track



Plate 9-10 - View along part of Transect 1 (cleared powerline easement in southwestern portion of the Project area). GSV off-track recorded in the field as 'fair' (40%)

9.7.4 Results

9.7.4.1 Surface Sites

As indicated in Table 9.14, a total of five Aboriginal archaeological sites were identified during the current survey. These consisted exclusively of low density surface scatters of marine and/or estuarine midden shell within the elevated Ridge I dune field landform unit. All five sites are located on unsealed light vehicle tracks. However, it is noted that one site (BF-SC4-14) incorporates (in two places) remnant land surfaces outside of the track. No finds other than shell (e.g., flaked stone artefacts, mammal bone) were identified at any site nor were any compact, in-situ lenses of shell observed. All identified sites are interpreted as disturbed surface manifestations of former subsurface shell midden deposits.

Summary information on identified sites, including basic location and composition data, is provided in **Table 9.14**. Site locations are shown on **Figure 9.21**. AHIMS site cards for newly identified sites are attached in the main report in Annex C.

Site name	Site type	Centroid coordinates		Approx. site area (m^2)	Landform context / elevation	Shellfish species & counts	Plate(s)
		MGA E	MGA N				
BF-SC1-14	Shell scatter	406361	6373319	32	Gently-inclined lower slope / 16 m AHD	Pipi (*Plebidonax deltoides*) (9 fragments)	Plate 9.11
BF-SC2-14	Shell scatter	406491	6373266	75	Low dune crest / 12 m AHD	Pipi (*Plebidonax deltoides*) (16 fragments) Oyster (*Ostrea angasi/ Saccostrea glomerata*) (1 fragment)	Plate 9.12
BF-SC3-14	Shell scatter	406549	6373306	100	Gently-inclined lower slope / 13-15 m AHD	Pipi (*Plebidonax deltoides*) (14 fragments)	Plate 9.13 & Plate 9.14
BF-SC4-14	Shell scatter	406592	6373521	2050	High dune crests and intervening saddle overlooking Interbarrier Depression / 20-24 m AHD	Pipi (*Plebidonax deltoides*) (56 fragments) Oyster (*Ostrea angasi/ Saccostrea glomerata*) (25 fragments) Mud whelk (*Pyrazus ebeninus*) (3 complete shells & 58 fragments) Cockle (*Anadara trapezia*) (45 complete shells & 300 fragments)	Plate 9.15, Plate 9.16 & Plate 9.17
BF-SC5-14	Shell scatter	406919	6373526	0.15	Low dune crest / 11 m AHD	Pipi (*Plebidonax deltoides*) (2 fragments) Oyster (*Ostrea angasi/ Saccostrea glomerata*) (6 fragments) Mud whelk (*Pyrazus ebeninus*) (3 fragments) Cockle (*Anadara trapezia*) (3 complete shells & 3 fragments)	Plate 9.18 & Plate 9.19

Table 9.14 - Aboriginal archaeological sites identified during survey

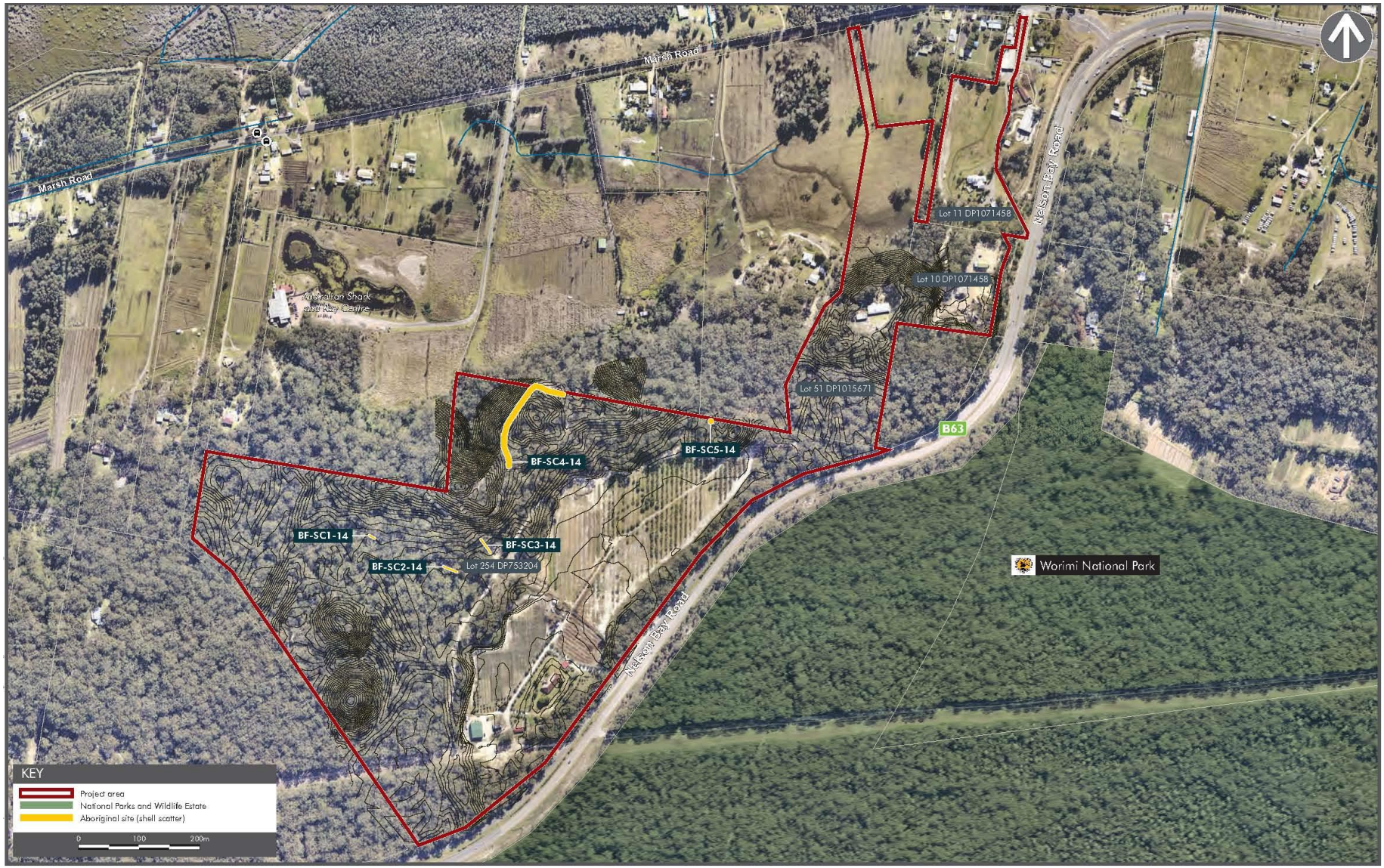


Figure 9.21 - Aboriginal Sites



Plate 9-11 - View across newly identified shell scatter BF-SC1-14, facing west



Plate 9-12 - View across newly identified shell scatter BF-SC2-14, facing west. Note cluster of flags on-track to left of bag



Plate 9-13 - Close-up of incomplete pipi (Plebidonax deltoides) shell within BF-SC3-14



Plate 9-14 - View across southern extent of newly identified shell scatter BF-SC4-14. Note strip of remnant, actively-eroding land surface on right



Plate 9-15 - View across central portion of BF-SC4-14, facing north (intervening saddle between dune crests)

9.7.4.2 Discussion

Effective coverage data for the current survey undertaken indicate that generally poor exposure and GSV conditions did constraint its effectiveness with regards to the identification of surface evidence of past Aboriginal occupation/activity. Nonetheless, observations made during survey suggest that the majority of exposed ground within the Project area was physically inspected for Aboriginal objects. Identified sites within the Project area consist exclusively of low-density surface scatters of marine and/or estuarine midden shell. All are located in contexts consistent with their exposure from subsurface contexts and, as such, are best conceived of as disturbed surface manifestations of former subsurface shell midden deposits. No finds other than shell (e.g., flaked stone artefacts, mammal bone) were identified in any site nor were any compact, in situ lenses of shell observed. Regardless, identified sites attest to the use of the Project area by Aboriginal people in the past and indicate the exploitation of both marine (i.e., beach) and estuarine resources.

Reference to the results of previous Aboriginal archaeological investigations within the greater Bobs Farm area and Newcastle Bight embayment more broadly indicates that the character of identified sites within the Project area is consistent with those identified in similar landform contexts across the Outer Barrier sand mass. As highlighted in Section 9.5.2.2, previous investigations (e.g., Dean Jones 1990, 1992; ERM 2003b, 2005; Umwelt 2010) have shown that the largest and most complex Aboriginal archaeological sites within the body of the stabilised Ridge I dune sequence occur on low elevation, low gradient ridgelines immediately adjacent to and between pockets of freshwater swamp forest. Low ridgelines appear to have been favoured over high ridgelines, presumably due to ease of access, better protection from the elements and, where applicable, proximity to resource-rich pockets of freshwater swamp forest (ERM 2005). On the landward margin of the stabilised Ridge I dune front, large, archaeologically complex sites comparable to those identified within the body of dune field in association with freshwater swamp forest have

been identified on low elevation, low gradient dune spurs protruding into the Interbarrier Depression (e.g., Umwelt 2010). In common with 'internal' freshwater swamps, available archaeological data indicate that the Interbarrier Depression functioned as a focal resource zone for Aboriginal people occupying the Outer Barrier sand mass throughout the mid-to-late Holocene.

Alongside marine and/or estuarine shell, previously identified Aboriginal sites on low elevation, low gradient landform elements immediately adjacent to estuarine and freshwater swamp environments have tended to contain large quantities of flaked stone, as well as the remains of a range of other fauna types (see, for example, ERM 2003b, 2005; Umwelt 2010). In addition, observed surface and subsurface artefact densities at these sites have typically been quite high and, together with site contents, have been cited as evidence for sustained or repeated occupation. In contrast, sites outside of these specific landform contexts (i.e., on high dune crests and low dune ridgelines not associated with freshwater swamps) have tended to consist of small surface and subsurface deposits of marine and/or estuarine midden shell, with few, if any, flaked stone artefacts. Collectively, these sites are suggestive of transient or short-term occupation events.

As with those identified in similar landform contexts across the Outer Barrier sand mass, the character of the shell scatter sites identified within the Project area are interpreted as products of transient or short-term occupation events. Although their presence cannot be ruled out, large, archaeologically complex sites indicative of intensive, long-term or repeated occupation are not expected to occur within the aeolian landform units of the Project area. Low ridgelines similar to those identified in other portions of the stabilised Ridge I dune sequence are present within these units. However, pockets of freshwater swamp forest, which will have facilitated and encouraged sustained or repeated occupation, are not. Low elevation, low gradient dune spurs which extend into the former estuarine swamp environment of the Interbarrier Depression are likewise absent (cf. Umwelt 2010).

In the absence of absolute dates obtained through controlled archaeological excavation and/or a detailed geomorphological dating program, detailed comment on the antiquity of the Aboriginal archaeological materials identified within the Project area is not possible. Nonetheless, a maximum age of c.4,500 BP is inferred on the basis of their geomorphological context (Thom et al. 1992). As indicated in Section 9.4.2, formation of the elevated Ridge I dune field has been linked to a period of aeolian instability prior to this time, with Thom et al. (1992: 364) proposing the development of vegetative cover across Ridge I "around 3,000 to 3,500 years BP".

9.7.4.3 Archaeological Predictions

In Section 9.5.3, a series of predictions regarding the Aboriginal archaeological record of the Project area were made. Table 9.15 compares the predictions made with the results of the archaeological survey undertaken as basis for informing future archaeological investigations within and around the Project area.

Prediction	Assessment
Surface evidence of past Aboriginal activity within the Project area is likely to be restricted to disturbed shell midden/scatter sites. However, there remains reasonable potential for the presence of open artefact sites and scarred trees	The results of the current survey support this prediction. Identified sites consist exclusively of shell scatters in disturbed contexts. As far as was feasible, all mature trees encountered during survey were inspected for cultural scarring. However, no scarred trees were identified.
Aboriginal burials may be present within the Project area. However, it is highly unlikely that this type of site will be identified via surface survey.	No burials were identified during the current survey. However, consideration of the landform context of the Project area suggests that these features may be present in subsurface contexts. Burials are a locally and regionally rare site type.
Most, if not all, surface shell midden/scatter sites within the Project area will contain only shell.	The results of the current survey support this prediction. No flaked stone artefacts or faunal materials other than shell were identified during survey.
Large, archaeologically complex sites/deposits indicative of sustained or repeated occupation are unlikely to occur within Project area's aeolian landform units owing to an absence of pockets/areas of freshwater swamp forest	The results of the current survey support this prediction. Identified sites consist exclusively of a low-density surface scatters of marine and/or estuarine shell.
Identified surface shell midden/scatter sites will contain of mixture of estuarine and marine (i.e., beach) shellfish species, with the former predominating	The results of the current survey provide some support for this prediction. Of the five shell scatter sites identified during survey, three contain a mixture of estuarine and marine (i.e., beach) shellfish species. Estuarine species are dominant in two of these sites. The remaining two scatter sites identified during survey are characterised by a single marine species (i.e., pipi).
The largest shell midden/scatter sites within the Project area will occur on elevated, low gradient dune surfaces overlooking the Interbarrier Depression	The results of the current survey provide some support for this prediction. Newly identified shell scatter BF-SC4-14, which overlooks the Interbarrier Depression, is considerably larger than the other sites identified during survey. However, test excavation would be required to adequately test this prediction.
Aboriginal archaeological sites are highly unlikely to occur within the estuarine plain landform unit (i.e., Interbarrier Depression) owing to unfavourable occupation conditions	The validity of this prediction cannot be assessed on the basis of the survey undertaken. However, it is noted that the existing archaeological data for the Newcastle Bight embayment as a whole supports it.
Flaked stone assemblages, if present, will be dominated by flake debitage (sensu Andrefsky 2005), with formed objects (i.e., cores and retouched flakes) comparatively poorly represented;	Not applicable. No flaked stone artefacts were identified during survey.
The dominant raw material for flaked stone artefact production within the Project area will be a cream and/or grey coloured volcanic tuff, with silcrete the second most common material;	Not applicable. No flaked stone artefacts were identified during survey.
Tool types of demonstrated temporal significance, if present, will be limited to edge-ground hatchet heads and backed artefacts.	Not applicable. No flaked stone artefacts were identified during survey.

Table 9.15 - Evaluation of archaeological predictions

9.7.4.4 Archaeological Sensitivity

Figure 9.22 presents AECOM's assessment of the archaeological sensitivity of land within the Project area using the rating scheme provided in Table 9.11 in Section 9.7.2.1.

As shown on Figure 9.22, the majority of land within the Project area has been assessed as being of moderate archaeological sensitivity. A moderate sensitivity rating for all non-grossly disturbed

portions of the Project area's two aeolian landform units is predicated on the proposition that although these areas retain high subsurface archaeological preservation potential (see Fanning 2014, Appendix A, Annex C), extant subsurface occupation deposits are not expected to be of high archaeological complexity or significance. As discussed in Section 9.7.4.2, previous Aboriginal archaeological investigations within the stabilised Ridge I dune field of the Outer Barrier sand mass (e.g., Dean Jones 1992; ERM 2003b, 2005; Umwelt 2010) have demonstrated an occupational emphasis on low elevation, low gradient ridgelines bordering pockets of freshwater swamp forest as well as low, elevated dune spurs extending into the former estuarine swamp environment of the Interbarrier Depression. In view of the absence of these specific landscape features from the Project area, subsurface deposits indicative of long term or repeated occupation are not anticipated. In keeping with the results of the archaeological survey undertaken, subsurface evidence for past Aboriginal use of the Project area is expected to be consistent with transient or short-term occupation events.

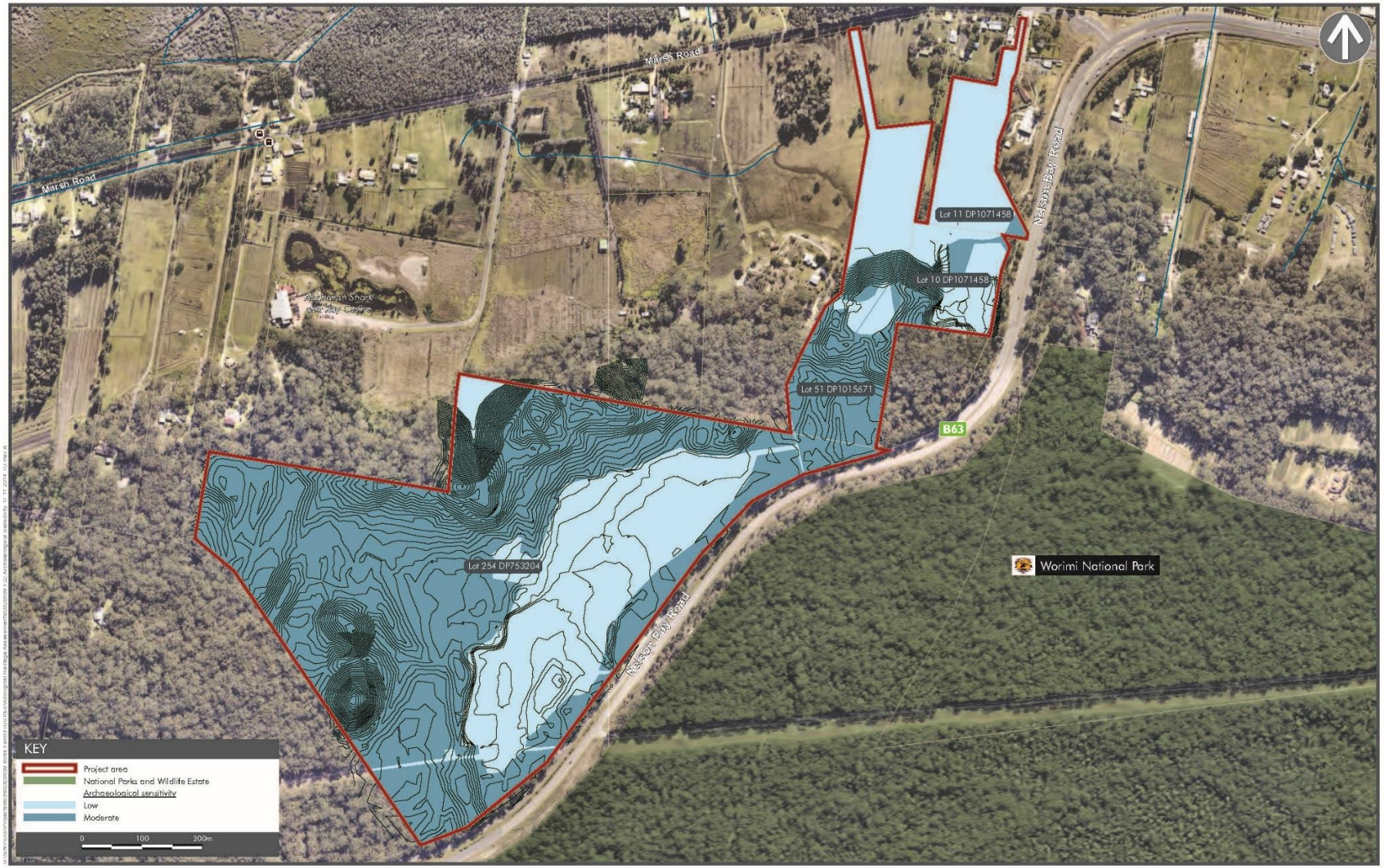


Figure 9.22 - Archaeological Sensitivity

Areas of low archaeological sensitivity within the Project area comprise areas of grossly disturbed terrain and the former estuarine swamp environment of the Interbarrier Depression (i.e., the estuarine plain landform unit). Although their presence cannot be ruled out, subsurface archaeological deposits are unlikely to occur in the highly disturbed portions of the Project area owing to the severity of the ground disturbances that have occurred in these areas. Similarly, while a highly attractive resource zone for Aboriginal people occupying the Outer Barrier sand mass throughout the mid-to-late Holocene, subsurface archaeological deposits are not anticipated within the estuarine plain landform unit owing to unfavourable occupation conditions.

No areas of high archaeological sensitivity have been identified within the Project area.

9.8 SIGNIFICANCE ASSESSMENT

9.8.1 Principles of Assessment

Heritage sites hold value for different communities in a variety of different ways. All sites are not equally significant and thus not equally worthy of conservation and management (Pearson & Sullivan 1995: 17). One of the primary responsibilities of cultural heritage practitioners, therefore, is to determine which sites are worthy of preservation and management (and why) and, conversely, which are not (and why) (Smith & Burke 2007: 227). This process is known as the assessment of cultural significance and, as highlighted by Pearson and Sullivan (1995: 127), incorporates two interrelated and interdependent components. The first involves identifying, through documentary, physical or oral evidence, the elements that make a heritage site significant, as well as the type(s) of significance it manifests. The second involves determining the degree of value that the site holds for society (i.e., its cultural significance) (Pearson & Sullivan 1995: 126)

In Australia, the primary guide to the assessment of cultural significance is the Australian ICOMOS Charter for Places of Cultural Significance (1999), informally known as The Burra Charter, which defines cultural significance as the "aesthetic, historic, scientific, social or spiritual value for past, present or future generations" of a site or place (ICOMOS 1999: 2). Under the Burra Charter model, the cultural significance of a heritage site or place is assessed in terms of its aesthetic, historic, scientific and social values, none of which are mutually exclusive (Table 9.16 - Values relevant to determining cultural significance, as defined by The Burra Charter (1999)16). Establishing cultural significance under the Burra Charter model involves assessing all information relevant to an understanding of the site and its fabric (i.e., its physical make-up) (ICOMOS 1999: 12). The assessment of cultural significance and the preparation of a statement of cultural significance are critical prerequisites to making decisions about the management of any heritage site or place (ICOMOS 1999: 11).

With respect to Aboriginal sites and places, it is possible to identify two major streams in the overall significance assessment process: the assessment of scientific value(s) by archaeologists and the assessment of social (or cultural) value(s) by Aboriginal people. These values are discussed in Sections 9.8.2 and 9.8.4.

Value	Definition
Aesthetic	"Aesthetic value includes aspects of sensory perception for which criteria can and should be stated. Such criteria may include consideration of the form, scale, colour, texture and material of the fabric; the smells and sounds associated with the place and its use" (ICOMOS 1999: 12).
Historic	"Historic value encompasses the history of aesthetics, science and society...[a] place may have historic value because it has influenced, or has been influenced by, an historic figure, event, phase or activity. It may have historic value as the site of an important event" (ICOMOS 1999: 12).
Scientific	"The scientific or research value of a place will depend on the importance of the data involved, on its rarity, quality or representativeness, and on the degree to which the place may contribute further substantial information" (ICOMOS 1999:12).
Social	"Social value embraces the qualities for which a place has become a focus of spiritual, political, national or other cultural sentiment to a majority or minority group" (ICOMOS 1999: 12).

Table 9.16 - Values relevant to determining cultural significance, as defined by The Burra Charter (1999)

9.8.2 Scientific (Archaeological) Significance

The scientific (or archaeological) significance of Aboriginal archaeological sites relates primarily to their potential for providing information about past Aboriginal culture and is commonly assessed on the basis of their research potential, representativeness and rarity. Other criteria, such as aesthetic value and education potential, may also be relevant.

9.8.2.1 Research Potential

Research potential can be defined as the potential of an archaeological site to address what Bowdler (1981: 129) has referred to as "timely and specific research questions". These questions may relate to any number of issues concerning past human lifeways and environments and, as suggested by Bowdler's quote, will inevitably reflect current trends or problems in academic research (Burke & Smith 2004: 249). For their part, Bowdler and Bickford (1984: 23-4) suggest that the research potential of an archaeological site can be determined by answering the following series of questions:

1. Can the site contribute knowledge which no other resource can?
2. Can the site contribute knowledge which no other such site can?
3. Is this knowledge relevant to general questions about human history or other substantiative subjects?

Several criteria can be used to assess the research potential of an archaeological site. Particularly important in the context of Aboriginal archaeology are the intactness or integrity of the site in question, its complexity and its potential for archaeological deposit (NPWS 1997: 7). The connectedness of the site to other sites or natural landscape features may also be relevant.

Integrity refers to the extent to which a site has been disturbed by natural and/or anthropogenic phenomena and includes both the state of preservation of particular remains (e.g., animal bones, plant remains) and, where applicable, stratigraphic integrity. Assessments of archaeological integrity are predicated on the notion that undisturbed or minimally disturbed sites are likely to yield higher quality archaeological and/or environmental data than those whose integrity has been significantly compromised by natural and/or anthropogenic phenomena. Establishing levels of preservation or integrity in the context of a surface survey is difficult. Nonetheless, useful rating schemes are available for 'open' sites (Coutts & Witter 1977: 34) and scarred trees (Long 2003).

The complexity of a site refers primarily to the nature or character of the artefactual materials or features that constitute it but also includes site structure (e.g., the physical size of the site, spatial

patterning in observed cultural materials). In the case of open artefact sites, for example, the principal criteria used to assess complexity are the site's size (i.e., number of artefacts and/or spatial extent), the presence, range and frequency of artefact and raw material types, and the presence of features such as hearths.

Potential for archaeological deposit refers to the potential of a site to contain subsurface archaeological evidence which may, through controlled excavation and analysis, assist in answering questions that are of contemporary archaeological interest. Assessing subsurface potential in the absence of subsurface investigation is difficult. Nonetheless, consideration of a range of factors, including the integrity of the site, the complexity of extant surface evidence, the nature of the local geomorphology (as established through surface observations and documentary research) and the results of previous archaeological excavations in the area, will help inform assessment of this criterion.

Connectedness concerns the relationship between archaeological sites within a given area and may be expressed through a combination of factors such as site location, type and contents. It may, for example, be possible to establish a connection between a stone quarry and hatchet found nearby. Demonstrating connectedness archaeologically, however, is far from straightforward, especially when dealing with surface evidence alone. Ultimately, this difficulty rests with the need to demonstrate contemporaneity between sites that may have been created hundreds, if not thousands, of years apart. As Shiner (2008: 13) has observed, "much of the surface archaeological record documents the accumulation of materials from multiple behavioural episodes occurring over long periods of discontinuous time". Contemporaneity, then, needs to be demonstrated and not assumed.

9.8.2.2 Rarity and Representativeness

Rarity and representativeness are related concepts. Rarity refers to the relative uniqueness of a site within its local and regional context. The scientific significance of a site is assessed as higher if it is unique or rare within either context; conversely, it is considered to be of lower significance if it is common in one or both. The concept of representativeness, meanwhile, refers to the question of whether or not a site is "a good example of its type, illustrating clearly the attributes of its significance" (Burke & Smith 2004: 247). Representativeness is an important criterion as one of the primary goals of cultural heritage management is to preserve for future generations a representative sample of all archaeological site types in their full range of environmental contexts.

In common with rarity, assessments of representativeness within a region are dependent on the state of current knowledge concerning the number and type of archaeological sites present within that region[9]. This is a critical point, for as suggested by Kuskie (2000) and others (e.g., Bowdler 1981; Godwin 2011; Pearson & Sullivan 1995), the absence across most of Australia of regional-scale quantitative data for Aboriginal sites and places represents a major constraint in assessments of representativeness and rarity. As stressed by Bowdler (1981) some 30 years ago, detailed regional-scale assessments of the Aboriginal archaeological record of Australia are required to address this issue.

[9] There is, of course, a temporal fluidity to this criterion (i.e., as knowledge of the Aboriginal archaeology of a region increases, assessed levels of representativeness may change, a point of equal relevance to rarity).

9.8.3 Assessment of Scientific Significance

9.8.3.1 Identified Surface Sites

An assessment of the scientific significance of the five Aboriginal archaeological sites identified during survey is presented in Table 9.17 - Scientific significance assessment for identified surface sites[9]. Significance ratings are offered on the basis of the assessed research potential, rarity and representativeness of each site on a local and regional scale.

Site name	Site type	Significance rating	Rationale
BF-SC1-14	Shell scatter	Low	BF-SC1-14 is highly unlikely to contribute knowledge not available from another resource or site. It is a poor example of a locally and regionally common site type. Better examples of this type of site exist locally and regionally and offer comparable/greater research opportunities. Site condition is poor due to vehicle track construction and use. The potential for subsurface archaeological deposit(s) within the mapped boundaries of this site is considered to be low.
BF-SC2-14	Shell scatter	Low	BF-SC2-14 is highly unlikely to contribute knowledge not available from another resource or site. It is a poor example of a locally and regionally common site type. Better examples of this type of site exist locally and regionally and offer comparable/greater research opportunities. Site condition is poor due to vehicle track construction and use. The potential for subsurface archaeological deposit(s) within the mapped boundaries of this site is considered to be low.
BF-SC3-14	Shell scatter	Low	BF-SC3-14 is highly unlikely to contribute knowledge not available from another resource or site. It is a poor example of a locally and regionally common site type. Better examples of this type of site exist locally and regionally and offer comparable/greater research opportunities. Site condition is poor due to vehicle track construction and use. The potential for subsurface archaeological deposit(s) within the mapped boundaries of this site is considered to be low.
BF-SC4-14	Shell scatter	Moderate	BF-SC4-14 has some potential to contribute knowledge not available from another resource or site. The site overlooks the Interbarrier Depression and contains a range of shellfish species (both estuarine and marine). BF-SC4-14 is a reasonable example of a locally and regionally common site type. Overall site condition is poor due to vehicle track construction and use. However, sections of the site (i.e., remnant land surfaces adjacent to the vehicle track that cuts through it) retain high subsurface archaeological preservation potential.
BF-SC5-14	Shell scatter	Moderate	BF-SC5-14 has some potential to contribute knowledge not available from another resource or site. Although small, the scatter contains a range of shellfish species (both estuarine and marine). BF-SC5-14 is a reasonable example of a locally and regionally common site type. The potential for intact subsurface archaeological deposit(s) within the immediate vicinity of the site is considered is very high.

Table 9.17 - Scientific significance assessment for identified surface sites

9.8.3.2 Subsurface Resource

As indicted in Section 9.7.4.2, all newly identified Aboriginal sites within the Project are located in contexts consistent with their exposure from subsurface contexts and, as such, are best conceived of as disturbed surface manifestations of former subsurface shell midden deposits. Accordingly, it is prudent to consider the archaeological significance of the Project area's potential subsurface Aboriginal archaeological resource.

AECOM's assessment of the archaeological sensitivity of land within the Project area was presented on Figure 9.22 and discussed in Section 9.7.4.4. As shown on Figure 9.22, the majority of

land within the Project area has been assessed as being of moderate archaeological sensitivity. A moderate sensitivity rating for all non-grossly disturbed portions of the Project area's two aeolian landform units is predicated on the proposition that although these areas retain high subsurface archaeological preservation potential (see Fanning 2014, Appendix A, Annex C), extant subsurface occupation deposits are not expected to be of high archaeological complexity or significance. In keeping with the results of the archaeological survey undertaken, subsurface evidence for past Aboriginal use of the Project area is expected to be consistent with transient or short-term occupation events. Such evidence is likely to be of low to moderate archaeological significance.

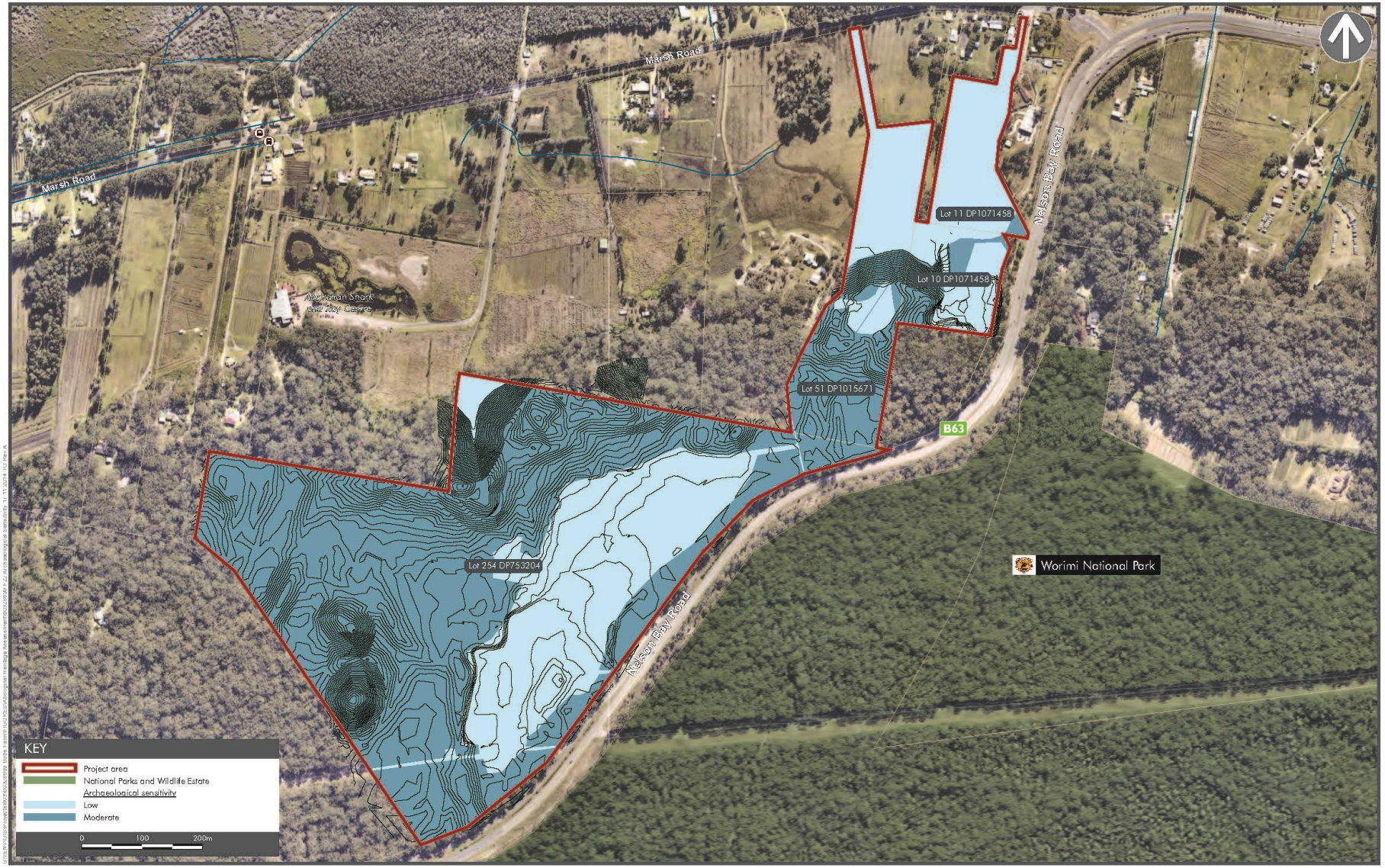
Areas of low archaeological sensitivity within the Project area comprise areas of grossly disturbed terrain and the former estuarine swamp environment of the Interbarrier Depression (i.e., the estuarine plain landform unit). Although their presence cannot be ruled out, subsurface archaeological deposits are unlikely to occur in the highly disturbed portions of the Project area owing to the severity of the ground disturbances that have occurred in these areas. Similarly, while a highly attractive resource zone for Aboriginal people occupying the Outer Barrier sand mass throughout the mid-to-late Holocene, subsurface archaeological deposits are not anticipated within the estuarine plain landform unit owing to unfavourable occupation conditions.

9.8.4 Social/Cultural Values

Social or cultural values refer to the spiritual, traditional, historical and contemporary associations and attachments a place or area has for Aboriginal people. As such, these values and their social significance can only be identified through consultation with Aboriginal people. Accordingly, throughout the assessment process, AECOM have actively sought the opinions of RAPs on this matter, both verbally and in writing. Opportunities for the provision of cultural information have been provided at all stages of the assessment process.

Throughout the assessment process, RAPs have identified the following social or cultural values for the Project area and its associated Aboriginal archaeological record:

- The Interbarrier Depression landward of the elevated Ridge I dune field would have been a focal resource area for Aboriginal people camping within or passing through the Project area. However, this area would have been unsuitable for camping;
- The elevated dunes overlooking the Interbarrier Depression are likely to have been favoured for occupation owing to their proximity to this important resource area;
- The lack of freshwater sources within the Project area's elevated Ridge I dune field and adjoining sand plain landform units means that these areas would not have been suitable for long-term occupation;
- Identified surface sites within the Project area are typical of those encountered locally in terms of containing a mixture of estuarine and marine shellfish species;
- Local flaked stone artefact assemblages, including those from sites excavated as part of recent upgrades to Nelson Bay Road, are dominated by artefacts manufactured out of tuff;
- Dune crests associated with the two prominent conical-shaped dunes in the southwestern portion of the Project area are likely to have functioned as lookouts and may have been used as campsites; and
- The elevated Ridge I dune field that dominates that topography of the Project area form parts of culturally significant songline for local Worimi people.



AECOM

ARCHAEOLOGICAL SENSITIVITY

Figure 9.23 - Archaeological Significance

9.9 IMPACT ASSESSMENT

9.9.1 Summary of Proposed Impacts

As outlined in Section 9.1.4 and shown on Figure 9.3, Ammos Resource Management propose to develop a sand mining operation within the Project area, with mining-related activities likely to result in the disturbance of around 74% (39 ha) of the site. Key project activities would include:

- construction of extractive materials processing and transport infrastructure;
- bulk handling of sand material using front end loaders and trucks;
- staged vegetation clearance employing logging and mulching;
- screening and sizing of extracted sand material;
- washing of selected extracted sand material;
- dredging of sand material below the economic reach of mechanical equipment. Approximately 50% of the recoverable resource would be dredged;
- transportation of extractive materials off-site via roads; and
- site rehabilitation.

An assessment of the potential impacts of the Project on the known and potential Aboriginal heritage resource of the Project area is provided in the following sections.

9.9.2 Impacts to Known Surface Resource

Proposed sand mining activities within the Project area are expected to directly impact all five Aboriginal archaeological sites identified within it. Consideration of the location of identified surface sites in relation to the project layout (Figure 9.24) indicates that four out of five sites (or parts thereof) are located within the Project's proposed extraction area. As shown on Figure 9.23, sites BF-SC1-14, BF-SC2-14 and BF-SC3-14 are located wholly within this area. BF-SC4-14 extends outside of the extraction area into a proposed vegetation buffer area. However, given that over 90% of the site falls within the extraction area, a complete loss of value is anticipated. Site BF-SC5-14 is located within a proposed vegetation buffer area approximately 10 m outside of the Project's proposed extraction area. However, given the character and landform context of this site, it is considered likely that subsurface archaeological deposits associated with this site extend into the extraction area. Attention is also drawn to the proximity of BF-SC5-14 to the extraction area and the high likelihood of ancillary impacts (e.g., vehicle movements, vegetation management works) throughout the operational life of the Project.

9.9.3 Impacts to Potential Subsurface Resource

Alongside impacts to identified surface sites, it is considered highly likely that a body of subsurface Aboriginal archaeological material will be impacted by the Project. As indicated in Section 9.8.3.2, subsurface evidence for past Aboriginal use of the Project area is expected to be consistent with transient or short-term occupation and to be of low to moderate archaeological significance. Nonetheless, the potential for impacts to subsurface features of high scientific and cultural significance, namely Aboriginal burials, is recognised.



Figure 9.24 - Impact Assessment

9.9.4 Impacts to Previously Unidentified Scarred Trees

No scarred trees were identified during the archaeological survey undertaken for this assessment, which concentrated on areas of enhanced exposure and visibility across the Project area. Nonetheless, areas of remnant bushland within the Project area, including those within the Project's proposed extraction area, contain mature native trees that may retain cultural scars. In the absence of appropriate management protocols, it is expected that any Aboriginal scarred trees located with Project's proposed extraction area would be destroyed as a result of sand mining activities within this area.

9.9.5 Cumulative Impact Assessment

9.9.5.1 Assessment of Ecologically Sustainable Development (ESD)

In NSW, the NPW Act provides the legislative framework for the protection of Aboriginal objects and places. Section 2A(2) of the NPW Act stipulates that such protection is to be achieved by applying the principles of Ecologically Sustainable Development (ESD). ESD requires the integration of economic and environmental considerations (including cultural heritage) in decision-making processes and, in the context of Aboriginal cultural heritage, can be achieved through the implementation of two key principles: intergenerational equity and the precautionary principle.

Intergenerational equity is the principle whereby the present generation should ensure the health, diversity and productivity of the environment for the benefit of future generations. With regards to Aboriginal heritage, intergenerational equity can be assessed in terms of cumulative impacts to Aboriginal objects and places in a region. Central to any assessment of intergenerational equity is the proposition that regions with fewer Aboriginal objects and places necessarily retain fewer opportunities for future generations of Aboriginal people to enjoy their cultural heritage. Accordingly, information regarding the known and potential Aboriginal heritage resource of a given region is critical to any assessment of intergenerational equity.

The precautionary principle holds that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing cost-effective measures to prevent environmental degradation. In NSW, the precautionary principle is relevant to OEH's consideration of potential impacts to Aboriginal cultural heritage in situations where:

- the proposed development involves a risk of serious or irreversible damage to Aboriginal objects or places or to the value of those objects or places; and
- there is uncertainty about the Aboriginal cultural heritage values or scientific or archaeological values, including in relation to the integrity, rarity or representativeness of the Aboriginal objects or places proposed to be impacted.

In these instances, OEH has indicated that a precautionary approach should be taken and all cost-effective measures implemented to prevent or reduce damage to Aboriginal objects and/or places. In addition to these measures, a cumulative impact assessment should be undertaken to gain an understanding and appreciation of the impacts development will have on NSW's Aboriginal cultural heritage resource.

It should be noted that the results of cumulative impact assessments undertaken for cultural heritage sites and places, Aboriginal or otherwise, must be interpreted with caution, not least because they are based (in part) on heritage datasets that are inevitably incomplete and contain various inconsistencies and errors. Godwin (2011), in particular, has questioned the value of

cumulative impact assessments to cultural heritage management in Australia, arguing that the 'fundamentals' necessary for undertaking such assessments simply do not exist. The 'fundamentals' Godwin is referring are robust regional and national data sets for measuring proposed impacts and the determination of acceptable scientific and cultural impact thresholds. While recognising the validity of the issues raised by Godwin (2011), current OEH guidelines necessitate that a cumulative impact assessment be undertaken as part of any Aboriginal cultural heritage assessment in NSW.

9.9.5.2 Intergenerational Equity - Cumulative Impact Assessment

Two avenues for assessing the cumulative impact of the Project on Aboriginal heritage can be pursued:

1) A comparison, using the results of an AHIMS search, of the identified Aboriginal archaeological resource of the Project area with that of the surrounding region, defined here as an arbitrary 40 (E-W) x 20 (N-S) km area centred on the Project area; and
2) The use of existing environmental data sources (e.g., digital land use data and topographic maps) to identify the *potential shell midden resource* of the study region as a whole.

9.9.5.3 Known Resource

Alongside those identified within the Project area, existing shell midden[10] sites in the study region offer opportunities for future research, conservation and education. Accordingly, it is necessary to quantify the impacts of the Project on this joint resource. As indicated, a total of five shell midden sites have been identified within the Project area, all of which are expected to be directly impacted by the Project. AHIMS data indicate that these sites represent 1.8% of the existing shell midden resource of the study region, with searches of the AHIMS database on 14 November 2014 returning 267 'Valid' midden[11] entries, eight 'Partially Destroyed' midden entries and three 'Destroyed' midden entries for this area.

While acknowledging the limitations of the AHIMS database with respect to the validity of listed site statuses, on the basis of current AHIMS data, it seems reasonable to conclude that the loss of the five shell midden sites identified within the Project area would not constitute a significant adverse impact to the existing shell midden resource of the study region. Consideration of the character of these sites, which consist exclusively of low-density surface scatters of midden shell, provides further support this suggestion as does the observation that, while a large number of Aboriginal archaeological investigations incorporating survey and/or excavation have been undertaken within the study region, the majority of land within this area has not been physically inspected for Aboriginal sites.

9.9.5.4 Potential Resource

Based as they are on the results of archaeological investigations covering only a fraction of the total study region, the AHIMS-derived figures cited in Section 9.5.2.1 provide an insufficient picture of the cumulative impact of the Project on the shell midden resource of the study region. Accordingly, an assessment of the potential midden resource of this area is also required. For the present analysis, digital land use data and relevant topographic maps have been used to prepare a provisional assessment of this resource.

As a starting point, it is necessary to quantify the amount of land within the study region that has the potential to retain to shell midden sites/deposits similar to those identified within the Project

[10] For the purposes of this cumulative impact assessment, no distinction is drawn between 'shell scatters' and 'shell middens'. Both are referred to here as 'shell midden sites'.
[11] AHIMS listing includes 'Shell' as a site feature

area[12]. A basic assumption here is that grossly disturbed terrain is unlikely to retain such sites whereas undisturbed/minimally disturbed terrain is likely to retain them. Analysis of available digital land use data for the study region (Table 9.18) indicates that grossly modified or disturbed terrain accounts for approximately 19% of the c.37,757 ha terrestrial component of the study region. Outside of these areas, native forests and shrublands, both within and outside of formal conservation areas (i.e., National Parks, State Forests and Conservation Areas), are particularly well represented, making up around 57% of the total. Other natural features, including wetlands (i.e., coastal marshes, swamps, mangroves and mudflats) and the region's mobile dune sheet, which includes the five morphological units described by Thom et al. (1992), are also well represented, accounting for c.13% of land within the region. Grazing land, meanwhile, makes up just over 10% of land within the region.

Viewed from an Aboriginal archaeological perspective, the land use data presented in Table 9.17 suggest that approximately 80% of the terrestrial component of the coastal study region investigated here can reasonably be considered to comprise a potential shell midden resource. As indicated, land upon which shell midden deposits are unlikely to survive accounts for around 19% of the total resource area. This figure increases to around 30% if grazing land is included. However, as indicated by the results of numerous Aboriginal archaeological investigations, both within and outside of the study region, grazed areas can and frequently do retain such sites. It can, therefore, be concluded that around 80% of land within the study region has the potential to retain shell midden sites in surface and subsurface contexts. While acknowledging the fact that the character and distribution of such sites will vary markedly in relation to a range of environmental variables, analysis of available land use data does help to quantify the extent of the region's potential Aboriginal shell midden resource. Moreover, it provides a basis from which assess the cumulative impact of the proposed development on this resource.

With regards to the existence, outside of the Project area, of environmental contexts that have the potential to contain sites comparable to those identified within it, examination of relevant topographic maps for the study region indicates that many such contexts exist. The Worimi National Park, for example, which borders Nelson Bay Road to the south of Project area, incorporates a large component of the Ridge I transgressive dune sheet. Landform elements comparable to those present within the Project area, namely elevated dune crests (with steep side slopes) and low dunes and swales, abound in this park, which forms part of the broader Worimi Conservation Lands (WCL). Comparable landform elements are also present in areas of native bushland to the west of the Project area, north of Nelson Bay Road.

[12] Note that open water bodies and rivers/constructed drainage channels, which make up approximately 53% of the study region (as defined here), have been excluded from this analysis.

Land Use	Ha	%
Conservation area	12081	32.00
Native forest and shrublands	9357	24.78
Urban	5159	13.66
Grazing	4044	10.71
Wetland	2493	6.60
Beach, foredune and sand spit/estuarine sand island	2487	6.59
Mining & quarrying	846	2.24
Defense facility	608	1.61
Transportation corridors and facilities	474	1.26
Horticulture	170	0.45
Plantation	23	0.06
Intensive animal production	12	0.03
Power generation	3	0.01
Total	**37757**	**100**

Source: NSW Landuse data, 2013.

Table 9.18 - Land use analysis

9.9.5.5 The Precautionary Principle

As indicated in Section 9.9.5.1, the precautionary principle holds that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

In the context of the current investigation, it can be stated that AECOM has adopted a precautionary approach in our assessment of the impacts of the proposed development on the Aboriginal archaeological resource of the Project area and that this approach is reflected in our proposed management strategy.

9.10 MANAGEMENT STRATEGY

9.10.1 Statutory Requirements

As indicated in Section 9.1.1, this Aboriginal cultural heritage assessment forms part of an ea being prepared by Tattersall Lander to support Ammos Resource Management's application for State Significant Development Consent under Division 4.1 of Part 4 of the EP&A Act.

DP&E's draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation (DEC 2005) detail the relevant statutory requirements for Aboriginal cultural heritage assessments conducted under Division 4.1 of Part 4 of the EP&A Act. Although not statutorily binding for Division 4.1 assessments, OEH's Code of Practice for Archaeological Investigation of

Aboriginal Objects in New South Wales (DECCW 2010a) and Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in NSW (OEH 2011) provide 'best practice' documents for Aboriginal Cultural Heritage Impact Assessments in NSW. Both documents have been used in the formulation of the management strategy detailed in the following section.

9.10.2 Management Strategy

As detailed in Section 9.9, all five Aboriginal archaeological sites identified within the Project area are anticipated to be directly impacted by the Project. At the same time, it is considered highly likely that a body of subsurface Aboriginal archaeological material will also be impacted by the Project. The potential for impacts to previously unidentified scarred trees in areas of remnant native vegetation within Project's proposed extraction area is also recognised.

A management strategy to address the potential impacts of the Project on the known and potential Aboriginal heritage resource of the Project area is provided as follows. It is recommended that this strategy be detailed in an Aboriginal Cultural Heritage Management Plan (ACHMP) for the Project, which should be prepared in consultation with RAPs, OEH and DP&E. Subject to Division 4.1 Development Consent and ACHMP approval by DP&E, this document will guide the management of Aboriginal cultural heritage within the Project area.

9.10.2.1 Archaeological Salvage Program

A comprehensive archaeological salvage program should be undertaken within the Project area prior to the commencement of any Project-related ground clearance works. Should Ammos Resource Management wish to proceed with the salvage of any identified sites prior to Project and ACHMP approval, an Aboriginal Heritage Impact Permit (AHIP) will need to be applied for and granted by OEH.

The archaeological salvage program for the Project should incorporate the following components:

1. Surface collection of newly identified shell scatter sites BF-SC1-14, BF-SC2-14 and BF-SC3-14, all of which have been assessed as being of low scientific significance. Surface collection is considered an appropriate and effective mitigation option for these sites given their contents and significance. Surface collection should occur prior to the commencement of ground disturbance works in their vicinity.

2. Surface collections and archaeological excavations at newly identified shell scatter sites BF-SC4-14 and BF-SC5-14, which have been assessed as being of moderate scientific significance. Archaeological excavations at both sites should initially involve test excavations. Salvage (i.e., open area) excavations should only be undertaken if high density concentrations of archaeological materials (i.e., shell, flaked stone artefacts or animal bone) and/or suspected/definitive archaeological features such as hearths are identified during test excavations.

The ACHMP for the Project should include a detailed research design and methodology for the surface collection and excavation components of the salvage program.

All archaeological salvage works should be undertaken by a combined field team of archaeologists and RAP field representatives. Post-salvage work for the surface collection and excavation components of the archaeological salvage program should, at minimum, include:

- the analysis and cataloguing of all recovered Aboriginal objects by a suitably qualified specialist or specialists;

- the submission, where deemed appropriate by a qualified archaeologist and/or geomorphologist, of excavated charcoal and/or shell samples for conventional or Accelerator Mass Spectrometry (AMS) radiocarbon dating. No more than three samples will be submitted for analysis from each site;

- the submission, where deemed appropriate by a qualified archaeologist and/or geomorphologist, of excavated sediment samples for Optically Stimulated Luminescence (OSL) dating. No more than three samples will be submitted for analysis from each site;

All Aboriginal objects salvaged as part of the archaeological salvage program should be curated in an appropriate manner, as determined through consultation with RAPs, OEH and DP&E during preparation of the ACHMP. Temporary off-site storage of salvaged objects should be allowed for the purposes of analysis and recording.

Aboriginal Site Impact Recording (ASIR) forms for all salvaged sites should be submitted to OEH at the completion of the salvage program.

9.10.2.2 RAP monitoring of vegetation clearance activities

Sand mining operations within the Project area cannot be undertaken without impacting stabilised soil profiles associated with the Ridge I transgressive dune sheet. In view of the demonstrated archaeological sensitivity of these soil profiles, both on a local and regional scale, a program of archaeological monitoring by RAPs should be undertaken during vegetation clearance activities. RAPs should be provided with the opportunity to visually inspect all areas selected for vegetation clearance throughout the life of the Project. For occupational health and safety reasons, inspections in each area should be completed upon cessation of undergrowth clearance activities.

Any surface archaeological materials identified during visual inspections should be collected in accordance the research design and methodology developed for the archaeological salvage program. In addition, if high density concentrations of archaeological materials (i.e., shell, flaked stone artefacts or animal bone) and/or suspected/definitive archaeological features such as hearths are identified, test excavations should be undertaken to characterise the identified materials/feature(s) and to determine the requirement for salvage excavations. Archaeological excavations, in all instances, should be carried in accordance with the research design and methodology developed for the archaeological salvage program. Criteria for the commencement of salvage excavations at test-excavated locations should be incorporated into the ACHMP.

9.10.2.3 Inspection of Stockpiled Samples of Reject Screen Material

Ammos Resource Management should ensure that RAPs are provided with the opportunity to inspect stockpiled samples of reject screen material from sand mining operations within the Project area. Inspections of stockpiled samples should occur on a monthly basis for the first 12 months of active operations. Should RAPs identify significant quantities of Aboriginal archaeological materials (i.e., flaked stone artefacts, shell, animal bone) within inspected samples (as determined by RAPs in consultation with a qualified archaeologist), Ammos Resource Management should facilitate, as soon as practicable, a RAP inspection of the source area(s) of this material. If high density concentrations of archaeological materials and/or suspected/definitive archaeological features (e.g., hearths) are identified in these areas, the requirement for salvage (surface and/or subsurface) of these materials/features should be discussed between Ammos Resource Management, RAPs and a qualified archaeologist. If salvage is deemed warranted, salvage activities should be completed in accordance the research design and methodology developed for the archaeological salvage program.

9.10.2.4 AHIMS site cards

AHIMS site cards should be submitted to OEH in a timely fashion for all newly recorded Aboriginal archaeological sites within the Project area. In the event that a previously unidentified Aboriginal site is discovered within the Project area at any point during the life of the Project, an AHIMS site card for that site should be submitted to OEH as promptly as possible. Timing protocols for the submission of AHIMS site cards should be included in the ACHMP for the Project.

9.10.2.5 Previously unrecorded Aboriginal archaeological sites/materials

Provisions regarding the appropriate management action(s) for any previously unrecorded Aboriginal archaeological sites/materials identified within the Project area throughout the life of the Project should be incorporated into the ACHMP. Management action(s) will vary according to the type of evidence identified, its significance (both scientific and cultural) and the nature of potential impacts.

9.10.2.6 Human Skeletal Remains

In the event that potential human skeletal remains are identified within the Project area during the development and operational phases of the Project, the following standard procedure, to be detailed in the ACHMP for the Project, should be followed.

1) All work in the vicinity of the remains should cease immediately;
2) The location should be cordoned off and the appropriate authorities notified; and
3) A physical or forensic anthropologist should be commissioned to inspect the remains *in situ* and make a determination of ancestry (Aboriginal or non-Aboriginal) and antiquity (pre-contact, historic or modern).

Subsequent management actions will be dependent on the findings of the inspection undertaken under Point 3.

- If the remains are identified as modern and human, the area will become a crime scene under the jurisdiction of the NSW Police;
- If the remains are identified as pre-contact or historic Aboriginal, the site will be secured and OEH and all RAPs notified in writing. Where impacts to exposed Aboriginal skeletal remains cannot be avoided, remains will be retrieved via controlled archaeological excavation and reburied outside of the Disturbance Boundary in a manner and location determined by RAPs;
- If the remains are identified as historic non-Aboriginal, the site is to be secured and the NSW Heritage Branch contacted; and
- If the remains are identified as non-human, work can recommence immediately.

9.10.2.7 Aboriginal Cultural Heritage Awareness Training

An Aboriginal cultural heritage awareness training package should be developed for use throughout the life of the Project. This package should be developed in consultation with RAPs and completed prior to the commencement any ground disturbance works within the Project area. A register of all persons having completed the training package should be maintained throughout the life of the Project.

Aboriginal cultural awareness training should be mandatory for all staff and contractors whose roles may reasonably bring them into contact with Aboriginal sites and/or involve consultation with local Aboriginal community members. Training should also be offered on a voluntary basis to all other mine staff and contractors.

Ammos Resource Management should ensure that as part of all standard site inductions, an Aboriginal cultural heritage component is included. At a minimum, this should outline current protocols and responsibilities with respect to the management of Aboriginal cultural heritage within the Project area, provide an overview of the diagnostic features of potential Aboriginal site types (e.g., scarred trees) and procedures for reporting the identification of Aboriginal archaeological sites.

9.10.2.8 Reporting under the ACHMP

All Aboriginal heritage management and mitigation works carried out under the ACHMP for the Project should be documented to a standard comparable to that required by the Code of Practice for Archaeological Investigation of Aboriginal Objects 2010 (DECCW 2010a). Printed and/or digital copies of all archaeological salvage reports (plain English and technical) should be made available to RAPs upon request.

9.10.2.9 Periodic Review of ACHMP

The ACHMP for the Project should be subject to periodic review to ensure that all management policies are being adhered to and are working effectively. Periodic reviews will also provide an opportunity to make modifications to existing policies and to add, where appropriate, new policies.

10 HISTORIC HERITAGE ASSESSMENT

Chapter 10 provides a summary of a detailed Historic Cultural Heritage Assessment undertaken by Aecom archaeologists to assess the impacts of the proposed sand extraction mine on items of historical heritage. The heritage report is provided separately in Annex D.

10.1 INTRODUCTION AND BACKGROUND

10.1.1 Introduction

AECOM Australia Pty Ltd (AECOM) was commissioned by Tattersall Lander Pty Ltd (Tattersall Lander), on behalf of Ammos Resource Management Pty Ltd (Ammos Resource Management), to undertake an historic heritage impact assessment for the Bobs Farm Sand Project (the Project), off Nelson Bay Road, at Bobs Farm, NSW. This assessment is to form part of an Environmental Impact Statement (ea) being prepared by Tattersall Lander to support an application for State Significant Development Consent under Division 4.1 of Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act) for the Project, which will involve the establishment of a sand quarry with an estimated extraction and processing rate of approximately 750,000 tonnes per annum. This report documents the results of AECOM's historic heritage assessment.

10.1.2 Assessment Objectives

The overarching objectives of this assessment were as follows:

- to identify the historic heritage values of the Project area through background research and archaeological survey;
- to assess the potential impact(s) of the Project on these values;
- to provide an appropriate management strategy for avoiding and/or mitigating potential harm to identified values; and
- to compile an historic heritage assessment report that will assist the Director General of the DP&E in his/her assessment of the Project application.

10.1.3 Project Area

The Project area for this assessment, shown on **Figure 10.1** and **Figure 10.2**, is an irregularly-shaped 53ha parcel of land located in the sparsely populated rural suburb of Bobs Farm, approximately 25 km east-northeast of the City of Newcastle and 7 km west-northwest of the township of Anna Bay on the Hunter Valley's Coastal Plain.

Situated between MGA grid coordinates 406060 and 407440 east and 6372810 and 6374190 north on the Morna Point (9332-3) 1:50,000 topographic map sheet, the Project area is located within the Newcastle Bight embayment, the largest sedimentary basin of Quaternary age in the greater Port Stephens-Myall Lakes area (Thom et al. 1992). Aeolian sand dunes within the Project area form part of the Outer Barrier of the Newcastle Bight Sand Dune System, an intensively investigated geomorphological complex consisting of an inner Pleatocene barrier (the 'Inner Barrier'), an outer Holocene barrier (the 'Outer Barrier') and a broad interbarrier depression filled with Holocene estuarine swamp deposits (the 'Interbarrier Depression') (Thom et al. 1981, 1992).

Largely vegetated, the Project area is bounded to the south and east by Nelson Bay Road, to the north by Marsh Road and rural residential allotments and to the west by native bushland. Surrounding suburbs include Anna Bay to the east, Oyster Cove and Tanilba Bay to the north and Salt Ash to the west. Parks and reserves in the local area, meanwhile, include Worimi National Park,

which borders Nelson Bay Road to the immediate south of the Project area, Worimi Regional Park, which adjoins Worimi National Park to the east and like it, comprises part of the broader Worimi Conservation Lands (WCL), Tilligerry National Park to the west, Tilligerry State Conservation Area to the northwest and Tilligerry Nature Reserve to the northeast.

Topographically, the Project area is dominated by steep stabilised aeolian sand dunes associated with the oldest of the Outer Barrier's three transgressive long-walled 'ridges' (i.e., Ridge I). In the northeastern portion of the Project area, Thom et al.'s (1992) stabilised Ridge I dunes abruptly give way to flat, low-lying and formerly swampy terrain associated with the Interbarrier Depression's now heavily drained Holocene estuarine plain. A similarly abrupt topographic transition occurs in the central and western portions of the Project area, with the Ridge I dune field rapidly transitioning, towards Nelson Bay Road, into a low relief sand plain now largely occupied by an orchard and associated buildings.

Reference to the Geographical Names Register of NSW indicates that the Project area falls wholly within the boundaries of the Port Stephens Local Government Area (Port Stephens LGA) and is situated in the Parish of Tomaree in the County of Gloucester. Land within the Project area has been registered as Lots 10 and 11 on DP1071458, Lot 254 on DP753204 and Lot 51 on DP1015671.

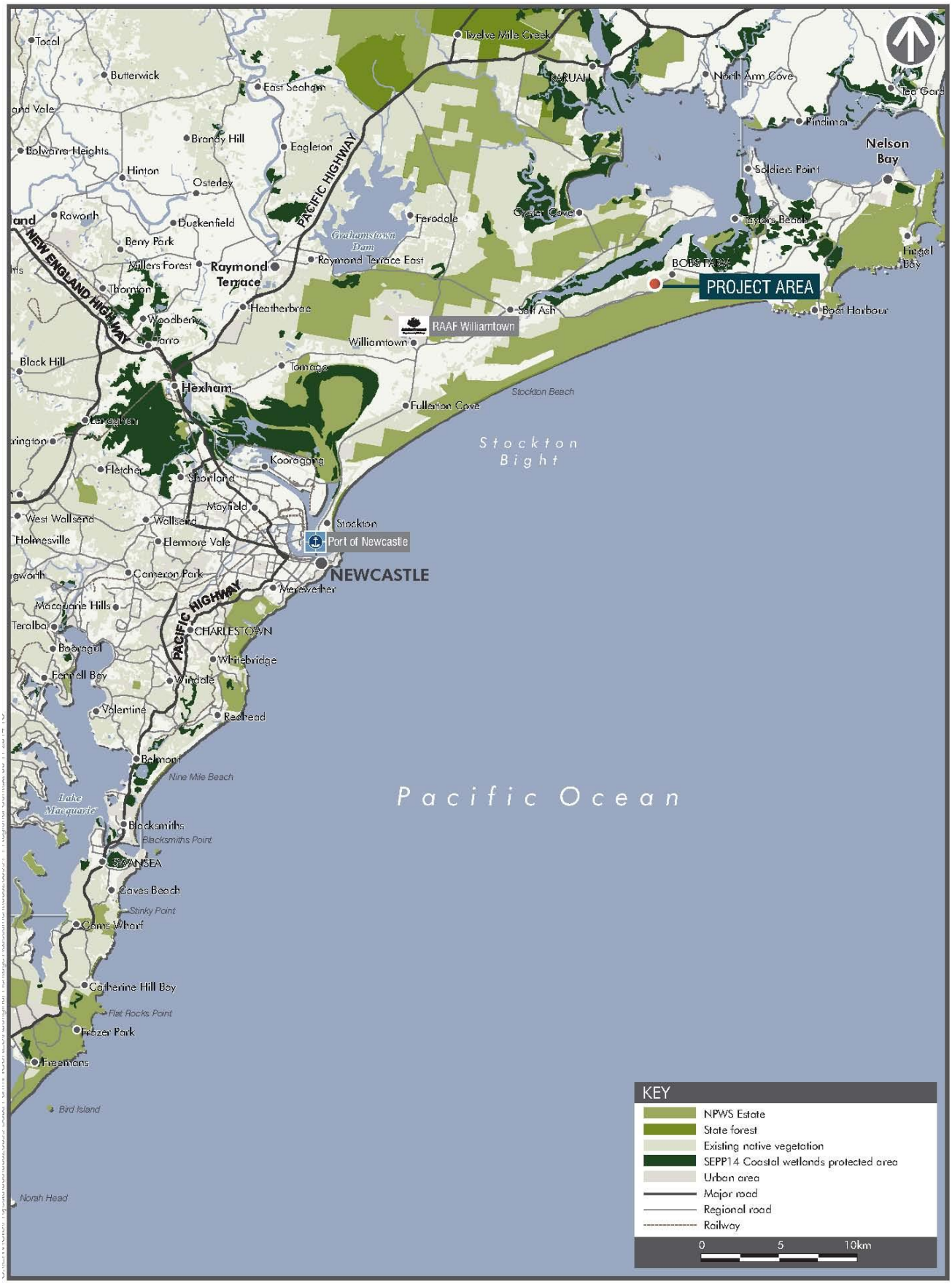


Figure 10.1 - Regional Context

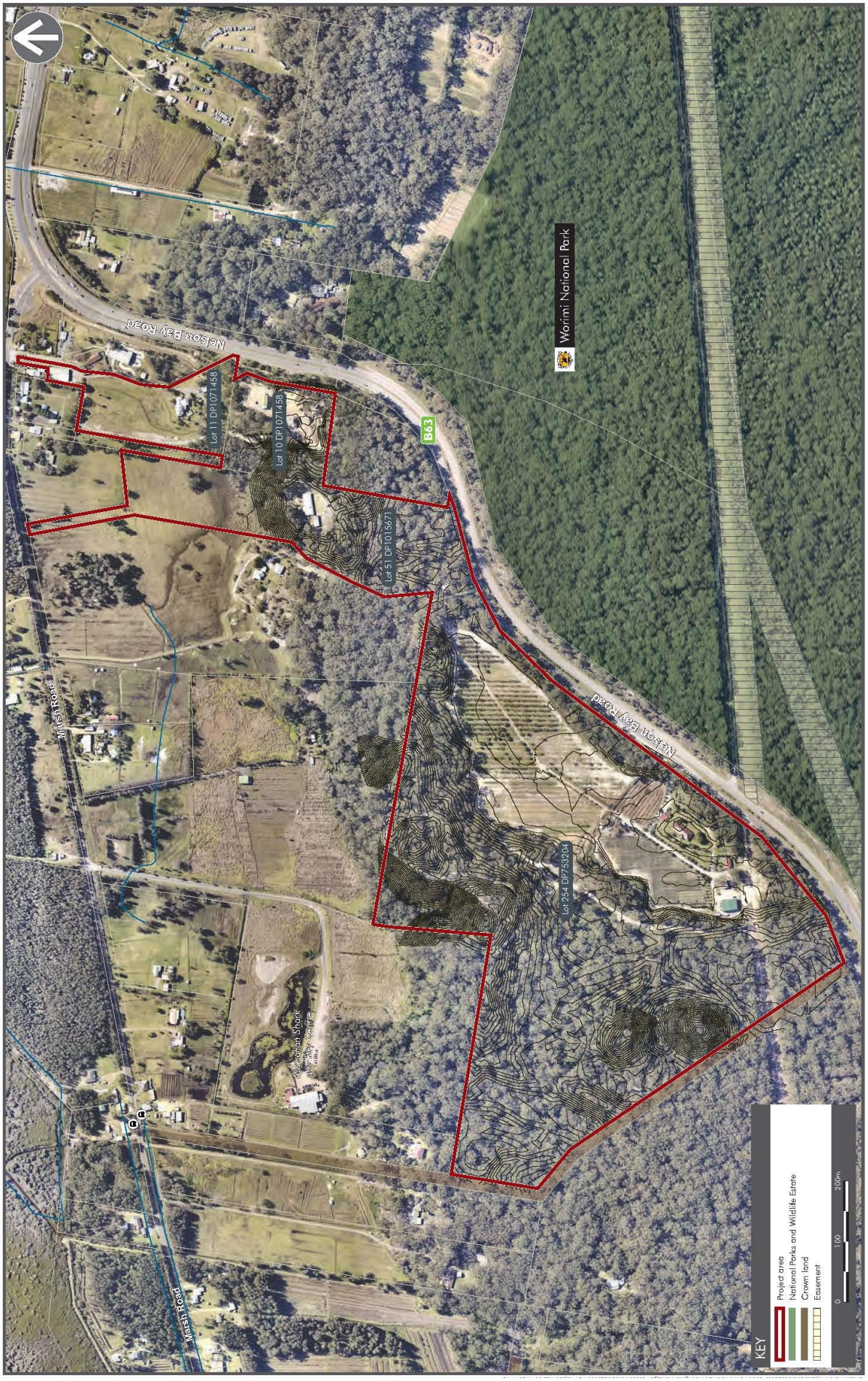


Figure 10.2 - Site Context

10.1.4 The Project

Ammos Resource Management is seeking State Significant Development Consent under Division 4.1 of Part 4 of the EP&A Act for the Project, which would involve:

- The establishment of a sand quarry to extract and process sand at a rate of approximately 750,000 tonnes per annum, from a total sand resource of 10 million tonnes;
- Construction of extractive materials processing and transport infrastructure;
- Transportation of extractive materials off-site via roads; and
- Site rehabilitation.

The conceptual layout of the Project is shown on Figure 10.3 and is outlined in further detail in Section 10.6.2.



Figure 10.3 - Proposed Layout

10.1.5 Director-General's Requirements

The Director-General of the NSW Planning and Environment (DP&E) issued the Director-General's Environmental Assessment Requirements (DGRs) for the Project on 21 March 2014. For historic heritage, the DGRs require the completion of an historic heritage assessment (including archaeology) which must:

- Include a statement of heritage impact (including significance assessment) for any State significant or locally significant historic heritage items; and
- Outline any proposed impact mitigation and management measures (including an evaluation of the effectiveness and reliability of the measures).

Attachment 1 (Technical and Policy Guidelines) of the DGRs lists the NSW Heritage Manual (NSW Heritage Office & NSW Department of Urban Affairs and Planning 1996) and The Burra Charter (ICOMOS (Australia) 2013) as the relevant guidelines for the historic heritage component of the Project's ea.

10.1.6 Limitations

A summary of the statutory requirements regarding historical heritage is provided in Section 10.3. This is provided based on experience with the heritage system in NSW and does not purport to be legal advice. It should be noted that legislation, regulations and guidelines change over time and users of the report should satisfy themselves that the statutory requirements have not changed since the report was written.

10.2 METHODOLOGY

This chapter describes the methodology used in preparing this historic heritage assessment, including heritage register searches, field survey of the Project area and significance assessment criteria.

10.2.1 Heritage Register Search

The following method was used to determine the listed heritage items within and adjacent to the Project area. A search was undertaken of the heritage schedules below through the Australian Heritage Database, the NSW State Heritage Inventory, maintained by the NSW Heritage Division, and the Port Stephens Local Environment Plan 2013 (Port Stephens LEP) Environmental Heritage Schedule:

- World Heritage List;
- National Heritage List;
- Commonwealth Heritage List;
- Register of the National Estate (non-statutory);
- State Heritage Register;
- Section 170 Registers of relevant Government Agencies; and
- Schedule 5 of the Port Stephens LEP.

10.2.2 Field Survey Methodology

The field survey was undertaken on the 1st and 2nd October 2014 in conjunction with the Aboriginal heritage survey. The historical context did not indicate any areas of potential

archaeological or historical significance and a general survey of the Project area was therefore considered to be appropriate.

Archaeological survey of Project area was undertaken over two days by a combined field team of two AECOM archaeologists and three Registered Aboriginal Parties field representatives per day. The survey focussed on enhanced areas of ground surface visibility, specifically, the light vehicle tracks that dissect the elevated ridge dune field area, the cleared power-line easement in the south western portion of the site and the heavily modified orchard area. The estuarine flat was visually inspected from Marsh Road. However, in view of universally poor ground surface visibility conditions (owing to a thick cover of native and introduced grasses) and the area's low archaeological potential, this area was not subject to pedestrian survey.

All survey was conducted on foot, with a total of 23 transects completed over the course of the survey. The location of each transect completed during survey, including start and end points, was recorded using one of two handheld differential GPS units, with associated transect data (e.g., levels of visibility and exposure) entered directly into the same unit upon the completion of each transect.

Completed transects ranged from 62 to 793 m in length, with individual transect widths (1-20 m) conditioned largely by the width of pre-existing vehicle tracks and easements. Recorded transect data indicate that a total survey coverage of approximately 2.8 ha was achieved. Excluding those portions of transects falling outside of the Project area provides a revised total survey coverage of approximately 2.7 ha, representing around 5.2% of the total Project area.

10.2.3 Significance Assessment Criteria

In order to understand how a development will impact on a heritage item it is essential to understand why that item is significant. An assessment of significance is undertaken to explain why a particular item is important and to enable the appropriate site management and curtilage to be determined. Cultural significance is defined in the Australia International Council on Monuments and Sites Charter for the conservation of places of Cultural Significance (the Burra Charter) as meaning "aesthetic, historic, scientific or social value for past, present or future generations" (Article 1.2). Cultural significance may be derived from a place's fabric, association with a person or event, or for its research potential. The significance of a place is not fixed for all time, and what is of significance to us now may change as similar sites are located, more historical research is undertaken and community tastes change.

The process of linking this assessment with an item's historical context has been developed through the NSW Heritage Management System and is outlined in the guideline Assessing Heritage Significance (NSW Heritage Office 2001), part of the NSW Heritage Manual (NSW Heritage Office & NSW Department of Urban Affairs and Planning 1996). The Assessing Heritage Significance guidelines establish seven evaluation criteria (which reflect four categories of significance and whether an item is rare or representative) under which a place can be evaluated in the context of State or local historical themes. Similarly, a heritage item can be significant at a local level (i.e. to the people living in the vicinity of the site), at a State level (i.e. to all people living within NSW) or be significant to the country as a whole and be of National or Commonwealth significance.

In accordance with in the guideline Assessing Heritage Significance (NSW Heritage Office 2001) and the Heritage Act 1977, an item will be considered to be of State significance if it meets two or more of the assessment criteria at a State level. An item is assessed as being of local heritage significance if it meets one or more of the following criteria:

Criterion (a) *– an item is important in the course, or pattern, of NSW's cultural or natural history (or the cultural or natural history of the local area).*

The item must show evidence of significant human activity or maintain or show the continuity of historical process or activity. An item is excluded if it has been so altered that it can no longer provide evidence of association.

Criterion (b) *– an item has strong or special association with the life or works of a person, or group of persons, of importance in NSW's cultural or natural history (or the cultural or natural history of the local to area).*

The site must show evidence of significant human occupation. An item is excluded if it has been so altered that it can no longer provide evidence of association.

Criterion (c) *– an item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in NSW (or the local area).*

An item can be excluded on the grounds that it has lost its design or technical integrity or its landmark qualities have been more than temporarily degraded.

Criterion (d) *– an item has strong or special association with a particular community or cultural group in NSW (or the local area) for social, cultural or spiritual reasons.*

This criterion does not cover importance for reasons of amenity or retention in preference to proposed alternative.

Criterion (e) *– an item has potential to yield information that will contribute to an understanding of NSW's cultural or natural history (or the cultural or natural history of the local area). Significance under this criterion must have the potential to yield new or further substantial information.*

Under the guideline, an item can be excluded if the information would be irrelevant or only contains information available in other sources.

Criterion (f) *– an item possesses uncommon, rare or endangered aspects of NSW's cultural or natural history (or the cultural or natural history of the local area). The site must show evidence of the element/function etc proposed to be rare.*

Criterion (g) *– an item is important in demonstrating the principal characteristics of a class of NSW's (or local area's):*

- *Cultural or natural places; or*
- *Cultural or natural environments.*

An item is excluded under this criterion if it is a poor example or has lost the range of characteristics of a type.

The Heritage Council require the summation of the significance assessment into a succinct paragraph, known as a Statement of Significance. The Statement of Significance is the foundation for future management and impact assessment.

10.2.4 Statements of Heritage Impact

The objective of a Statement of Heritage Impact (SoHI) is to evaluate and explain how the proposed development, rehabilitation or land use change will affect the value of an historic heritage item. A Statement of Heritage Impact should also address how the heritage value of the site/place can be conserved or maintained, or preferably enhanced by the proposed works.

This report has been prepared in accordance with the NSW Heritage Office and Department of Urban Affairs and Planning's NSW Heritage Manual (1996) and the NSW Heritage Office Statements of Heritage Impact (NSW Heritage Office 2002). These guidelines pose a series of questions as prompts to aid in the consideration of impacts to identified historic heritage items. The questions vary in the guideline, depending on the nature of proposed impacts.

10.3 LEGISLATIVE CONTEXT

10.3.1 Introduction

A number of planning and legislative documents govern how heritage is managed in NSW and Australia. The following section provides an overview of the requirements under each as they apply to the project.

10.3.2 Federal Controls

10.3.2.1 Environment Protection and Biodiversity Conservation Act 1999

The Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) took effect on 16 July 2000.

Under Part 9 of the EPBC Act, any action that is likely to have a significant impact on a matter of National Environmental Significance (known as a controlled action under the Act), may only progress with approval of the Commonwealth Minister for the Department of the Environment. An action is defined as a project, development, undertaking, activity (or series of activities), or alteration. An action will also require approval if:

- It is undertaken on Commonwealth land and will have or is likely to have a significant impact on the environment on Commonwealth land; and

- It is undertaken by the Commonwealth and will have or is likely to have a significant impact.

The EPBC Act defines 'environment' as both natural and cultural environments and therefore includes Aboriginal and non-Aboriginal heritage items. Under the Act protected heritage items are listed on the National Heritage List (items of significance to the nation) or the Commonwealth Heritage List (items belonging to the Commonwealth or its agencies). These two lists replaced the Register of the National Estate (RNE). The RNE has been suspended and is no longer a statutory list, however it remains as an archive.

The statutory registers mandated by the EPBC Act have been searched and there are no items listed within or adjacent to the Project area. The 'Newcastle Bight Coastal Area, Nelson Bay Rd, Fern Bay, NSW, Australia' is listed as an Indicative Place on the non-statutory RNE (ID #19510). The Indicative Place status indicates the item was under consideration for listing when the RNE was suspended. The item does not result in any statutory obligations for the Project.

10.3.3 State Controls

10.3.3.1 Environmental Planning and Assessment Act 1979

The EP&A Act allows for the preparation of planning instruments to direct development within NSW. This includes Local Environment Plans (LEP), which are administered by local government, and principally determine land use and the process for development applications. LEPs usually include clauses requiring that heritage be considered during development applications and a schedule of identified heritage sites be provided. The Port Stephens LEP 2013 applies to the project and is discussed further in Section 10.3.4.

Upon repeal of Part 3A of the EP&A Act on 1 October 2011, the Environmental Planning and Assessment Amendment (Part 3A Repeal) Act 2011 inserted a new Division 4.1 in Part 4 of the EP&A Act. Division 4.1 provides for a new planning assessment and determination regime for State Significant Development (SSD). Section 89C of the EP&A Act stipulates that a development will be

considered SSD if it declared to be such by the new State Environmental Planning Policy (State and Regional Development) 2011 (SEPP SRD).

Under Clause 8(1) of SEPP SRD, a development is declared to be SSD if:

- The development on the land concerned is, by the operation of an environmental planning instrument, is permissible only with development consent under Part 4 of the EP&A Act, and

- The development is specified in Schedule 1 or 2 of the SEPP SRD.

The Project was declared to be a SSD as it meets both of these criteria.

Section 89J of the EP&A Act provides that an approval under Part 4, or an excavation permit under Section 139, of the Heritage Act 1977, is not required for the project as it is an approved SSD.

10.3.3.2 The Heritage Act 1977

The NSW Heritage Act 1977 (as amended) was enacted to conserve the environmental heritage of NSW. Under Section 32, places, buildings, works, relics, moveable objects or precincts of heritage significance are protected by means of either Interim Heritage Orders or by listing on the NSW State Heritage Register (SHR). Sites that are assessed as having State heritage significance can be listed on the SHR by the Minister on the recommendation of the NSW Heritage Council.

Archaeological relics (any relics that are buried) are protected by the provisions of Section 139. Under this section it is illegal to disturb or excavate any land knowing or suspecting that the disturbance or excavation will or is likely to result in a relic being discovered, exposed, moved, damaged or destroyed. In such cases an excavation permit under Section 140 is required. Note that no formal listing is required for archaeological relics; they are automatically protected if they are of local significance or higher.

Proposals to alter, damage, move or destroy places, buildings, works, relics, moveable objects or precincts protected by an IHO or listed on the SHR require an approval under Section 60. Demolition of whole buildings will not normally be approved except under certain conditions (Section 63). Some of the sites listed on the SHR or on LEPs may either be 'relics' or have relics associated with them. In such cases, a Section 60 approval is also required for any disturbance to relics associated with a listed site.

Under Section 170 of the Heritage Act 1977, NSW Government agencies are required to maintain a register of heritage assets. The Register places obligations on the agencies, but not on non-government proponents, beyond their responsibility to assess the impact on surrounding heritage sites. AECOM searched Section 170 registers to determine whether there are listed sites within the Project area.

No items listed on the SHR or an agency Section 170 Register were identified within or adjacent to the Project area.

10.3.4 Local Controls

10.3.4.1 Port Stephens Local Environmental Plan 2013

Clause 5.10 of the Port Stephens LEP 2013 provides specific provisions for the protection of heritage items, heritage conservation areas, Aboriginal objects and Aboriginal places of heritage significance within the Port Stephens LGA. These are defined in the LEP as:

- A *heritage item* means a building, work, place, relic, tree, object or archaeological site, the location and nature of which is described in Schedule 5 of the LEP;
- A *heritage conservation area* means an area of land of heritage significance:
    - shown on the Heritage Map as a heritage conservation area, and
    - the location and nature of which is described in Schedule 5 of the LEP,
    - and includes any heritage items situated on or within that area.

Under the Port Stephens LEP, development consent is required for any of the following:

- demolishing or moving any of the following or altering the exterior of any of the following (including, in the case of a building, making changes to its detail, fabric, finish or appearance):
    - a heritage item,
    - an Aboriginal object,
    - a building, work, relic or tree within a heritage conservation area,
- altering a heritage item that is a building by making structural changes to its interior or by making changes to anything inside the item that is specified in Schedule 5 in relation to the item,
- disturbing or excavating an archaeological site while knowing, or having reasonable cause to suspect, that the disturbance or excavation will or is likely to result in a relic being discovered, exposed, moved, damaged or destroyed,
- disturbing or excavating an Aboriginal place of heritage significance,
- erecting a building on land:
    - on which a heritage item is located or that is within a heritage conservation area, or
    - on which an Aboriginal object is located or that is within an Aboriginal place of heritage significance,
- subdividing land:
    - on which a heritage item is located or that is within a heritage conservation area, or
    - on which an Aboriginal object is located or that is within an Aboriginal place of heritage significance.

Schedule 5 of the Port Stephens LEP 2013 provides a list of heritage items, heritage conservation areas and archaeological sites within the Port Stephens LGA. An examination of Schedule 5 indicated that no listed items are within the Project area. The southern and eastern boundary of the Project area is formed by Nelson Bay Road. The Road forms the northern boundary of the 'Stockton Beach Dune System, including Aboriginal site and shell middens, ship wrecks, WWII ramparts, tank traps, proofing range, rifle range and tin huts' listing (#I34). The Project area is therefore separated from the item by the Road.

While the requirements of the Port Stephens LEP are not statutorily binding on the Project by virtue of the operation of Part 4 of the EP&A Act, the heritage-related provisions of the LEP have been considered as part of this assessment, where relevant.

10.3.5 Summary

Table 10.1 - Heritage items Identified on heritage inventories summarises the historic heritage register listings within and adjacent to the Project area.

Register	Items within the Project area	Items in vicinity of Project area
World Heritage List	0	0

Register	Items within the Project area	Items in vicinity of Project area
Commonwealth Heritage List	0	0
National Heritage List	0	0
Register of the National Estate	0	Newcastle Bight Coastal Area, Nelson Bay Rd, Fern Bay, NSW, Australia (ID #19510).
State Heritage Register	0	0
Section 170 Registers	0	0
Port Stephens LEP 2013	0	Stockton Beach Dune System, including Aboriginal site and shell middens, ship wrecks, WWII ramparts, tank traps, proofing range, rifle range and tin huts (#I34).

Table 10.1 - Heritage items Identified on heritage inventories

10.4 HISTORICAL CONTEXT

10.4.1 Introduction

The following sections provide an overview of the historical development of the locality in order to provide an indication of the probably type and location of historic sites that may be present in the Project area.

10.4.2 Aboriginal Land Use

The Project area is located within the traditional country of the Worimi people, who spoke the Kattang (also spelt Kutthung, Kuttang, Gadhang, Gadang and Gathang) language described by Enright (1900). Tindale (1974) describes the territory of the Worimi as a 3,900 km2 area extending from the Hunter River to Forster, near Cape Hawke, inland to near Gresford and south to Maitland, although other sources (e.g., Enright 1933 ; Elkin 1932) provide different boundaries.

In common with other regions of New South Wales (e.g., Attenbrow, 2010) and Australia more broadly (Peterson, 1976), available historical records suggest that the primary units of social organisation amongst the Aboriginal language groups present in the Lower Hunter at contact were the clan and band. Although these terms are often used interchangeably (e.g., Kohen, 1993), following Attenbrow (2010), a distinction can, in fact, be drawn between the two, with clans comprising local descent groups and bands, land-using groups who, though not necessarily all of the same clan[13], camped together and cooperated daily in hunting, fishing and gathering activities. Individual bands will have habitually occupied and exploited the resources of particular tracts of land within the overall territory of their clan. However, the territorial boundaries of each band will have been permeable or elastic in the sense of complex kinship ties facilitating inter-band territorial movements and the reciprocal use and/or exchange of resources (Brayshaw, 1987: 36).

The size of the individual bands occupying the lower Hunter at contact appears to have varied considerably and was no doubt activity and season dependent (Brayshaw 1987). However, an upper limit of around 70 individuals, consisting of several families, is suggested by available

[13] Some individuals may have been related through marriage.

historical records (see, in particular, Table B in Brayshaw, 1987). Individual band sizes notwithstanding, much larger groups of Aboriginal people, numbering in the hundreds, are known to have come together for events such as corroborees, ritual combats and feasts (e.g., Scott 1929: 32;Threlkeld in Gunson 1974: 55).

For the Worimi, Elkin (1932) and Enright (1932) report the existence of four 'named local groups', two of which - the Garugal and Maiangal - were 'salt-water' groups and two - the Gamipingal and Buraigal - 'inland' groups. Following Attenbrow (2010), it is possible that these named groups comprised bands. However, it is noted that they are commonly referred to as clans or "nurras". Regardless, Elkin (1932: 360) notes that each occupied "a definite area" within the overall territory of the Worimi. Reference to Elkin (1932) and Enright (Enright 1936) indicates that the current Project area falls within the territory of the Maiangal nurra, which extended from the Hunter River/Fullerton Cove in the south, to Tomaree Head in the north and eastward from the Pacific Ocean to Tilligerry Creek.

Available historical records attest to exploitation, for food and other resources (e.g., skins for clothing), of a large and diverse range of terrestrial, avian and aquatic fauna by Aboriginal peoples occupying the Lower Hunter Valley at contact. A broad economic division between 'coastal' and 'inland' groups is also evidenced, with the subsistence regimes of those living along the coast geared principally towards the exploitation of marine foods.

10.4.3 European Discovery

The first European sighting of Port Stephens occurred on 11 May of 1770, when Captain James Cook noted:

> *Wind southerly in the day and in the night westerly, a gentle breeze and clear weather. At 4p.m. past at the distance of 1 mile a low rocky point which I named Point Stephens … on the north side of this point is an inlet which I called Port Stephens that appears from the masthead to be sheltered from all winds.*
>
> (Bartlett, 1980:5)

Following the establishment of European penal settlement on Norfolk Island, the ship Salamander entered and explored the Port in 1791 after returning from a visit to the penal colony. The next exploration occurred in 1795 when Deputy Surveyor Charles Grimes entered Port Stephens in the Francis. Grimes landed and made what is now understood to be an inaccurate map of the Port. His report back to Lieutenant Governor Captain Paterson was unfavourable and it was concluded that no further time was to be spend investigating the area. On 23 August 1795, Captain W.R. Broughton in the HMS Providence encountered bad weather and was forced to take shelter in the Port. The Captain discovered four convicts who had escaped from Parramatta four years earlier. It appeared as though the convicts were living with or were aided by local Aboriginal people (Wilkinson 2000).

Searching for escaped convicts, Lieutenant Shortland landed at the mouth of the Hunter River in 1797 and identified coal, which was to lead to increased European visitation to the area and the establishment of penal settlements at Newcastle in 1801 and 1804

From the early 1800s, Chinese fishermen are reported to have sporadically used Fly Point, Nelson Bay as a base from which to catch and process fish and lobsters for local and Chinese markets (Wilkinson, 2000). Cedar getters frequented the northern side of Port Stephens to extract timber from around 1816 (Browne et al., 1986)

10.4.4 Early Settlement

The first permanent European settler in the area was Captain William Cromarty. Cromarty was granted 300 acres of land at Salamander Bay in 1824. This grant was located to the north of the Project area, on Soldiers Point (Wilkinson, 2000).

According to Bartlett (1980:45) the name Bobs Farm remembers a convict servant of a landholder called "Gentleman Smith". Bob apparently had his eye on a piece of land, which he was determined to acquire once his sentence had expired. Bob reportedly died before his dreams could be fulfilled. Bartlett reports that Magnus Cromarty, William's son, took over Smith's herd of sheep. Magnus was granted land in the Bobs Farm area to the south of Fenningham's Island and fronting onto Bob's Creek in the 1850s, apparently the land Bob had coveted. Magnus reportedly grew wheat and arrowroot and kept sheep, pigs and poultry.

Fourteen-year-old Elizabeth Cromarty, presumably Magnus's daughter, wrote to Dame Durden's Post Office, a column in the Town and Country Journal that invited young readers to send in letters with interesting tid-bits. Elizabeth's letter was published in 1894 and described Bob's Farm thus:

> *"Dear Dame Durden, - I will tell you a little about the place where I live; it is called Bob's Farm. Bob's Farm consists of 361 acres. It is situated about 20 miles from Newcastle, which is the nearest town. The chief occupation of the people is dairy farming. There are two ways of taking the produce to market. One way is taking it down the beach, and the other down the road. The chief kind of trees that grow here are oak, eucalyptus, wattle, and many other different kinds. There are many pretty kinds of flowers also…"*
>
> (Cromarty, 1894:33e)

The *Raymond Terrace Examiner and Lower Hunter and Port Stephens Advertiser* reports on the erection of a public hall at Bob's Farm in 1922 stating:

> *"The building will fill a most needful purpose, and will enable residents to meet in public, and so more openly ventilate their wants and wishes. A concert and dance will be held soon to obtain funds to help wipe off the debt cost of erecting. The hall is erected close to the school, and Bob's Farm is assuming quite an air of importance. There are about 30 children attending the school."*
>
> (Raymond Terrace Examiner and Lower Hunter and Port Stephens Advertiser 1922:3d)

From this date on, the above newspaper frequently reported on social events held at the hall, including children's picnics, concerts, dances and cricket games. The school mentioned had been opened in 1918 as the Anna Bay Lower School. The school was rebadged as the Bobs Farm Provisional School in 1919 (Plate 10.1). It remains an active school community to the present (NSW Department of Education and Communities, 2014). The Bobs Farm Hall and Bobs Farm School are located on Marsh Road, near the northern portion of the Project area.



Plate 10-1 - Bobs Farm School, no date. Source Bobs Farm School website.

The first parish plan for the Tomaree parish was published in 1926. It is therefore difficult to determine how much activity was in the area prior to this time. The early newspaper reports do not provide a sense of how densely populated the area was. However, Elizabeth Cromarty's letter to Dame Durden indicates there were a sufficient number of dairy farmers operating within her sphere to rate a mention.

10.4.5 Bobs Farm Cadre Camp

During WWII, some Portuguese Timorese and local Timorese assisted Australian soldiers by providing information, food, acting as guides and sometimes fighting alongside them. The Dutch Timorese, on the other hand, had largely aligned themselves with the Japanese force and following directives from the Japanese, began killing and torturing Portuguese Timorese. Given the service of the locals, the Australian Army determined to evacuate some people to Australia in advance of the fall of Timor to the Japanese in late 1942. The first evacuation of Portuguese officials and Timorese is difficult to determine, but evacuations had commenced by September 1942. Australian led evacuations continued throughout the later months of 1942, with the final operation occurring on the night of 9 January 1943. A month later, on 10 February 1943 the remainder of Australian forces who had stayed behind to gather intelligence, and some Portuguese officials were evacuated in the US submarine Gudgeon (Fraser 2014). In all, around 600 evacuees were taken from Timor.

Initially, the evacuated Timorese were held in quarantine, many suffering from malaria and worms or were sent to various refugee camps in Brisbane, Melbourne and elsewhere. However, there was a strong desire to keep Timorese refugees with knowledge of the Allied operations isolated from the media and the general community. A partially completed Cadre Camp (a camp used by those with the highest skill to train subsequent recruits to form commando companies) at Bobs Farm was seen as an ideal location.

Prior to the evacuations, the Department of Defence had commenced construction of the Camp at Bob's Farm for the 41st Battalion. The camp was established on 69 acres of crown land, but also encroached on Henry Upton's free-hold of Portions 4 and 5 (Figure 10.4). Upton's land had been secured by November of 1941, with Upton waving his right to compensation for the use of the land for the duration of the war (Fraser 2014:17-18). The sum of £13,481 was approved on 29 June 1943 for the construction of the necessary buildings and services. Works commenced and the sullage, treatment works and water reticulation systems were completed, as were 18 or 19 huts. However, it seems that the majority of the work was not carried out as it had already been commandeered to house the Timorese.

The first group of refugees travelled by train from Brisbane to the camp on 10 January 1943[14], accompanied by four Army nurses, 12 Roman Catholic priests and 20 Sisters of the Daughters of Charity (Fraser 2014:19). The majority of other Timorese housed in other facilities around the country were transferred to Bobs Farm during January 1943, with the last group arriving in September of the same year following their evacuation earlier that month.

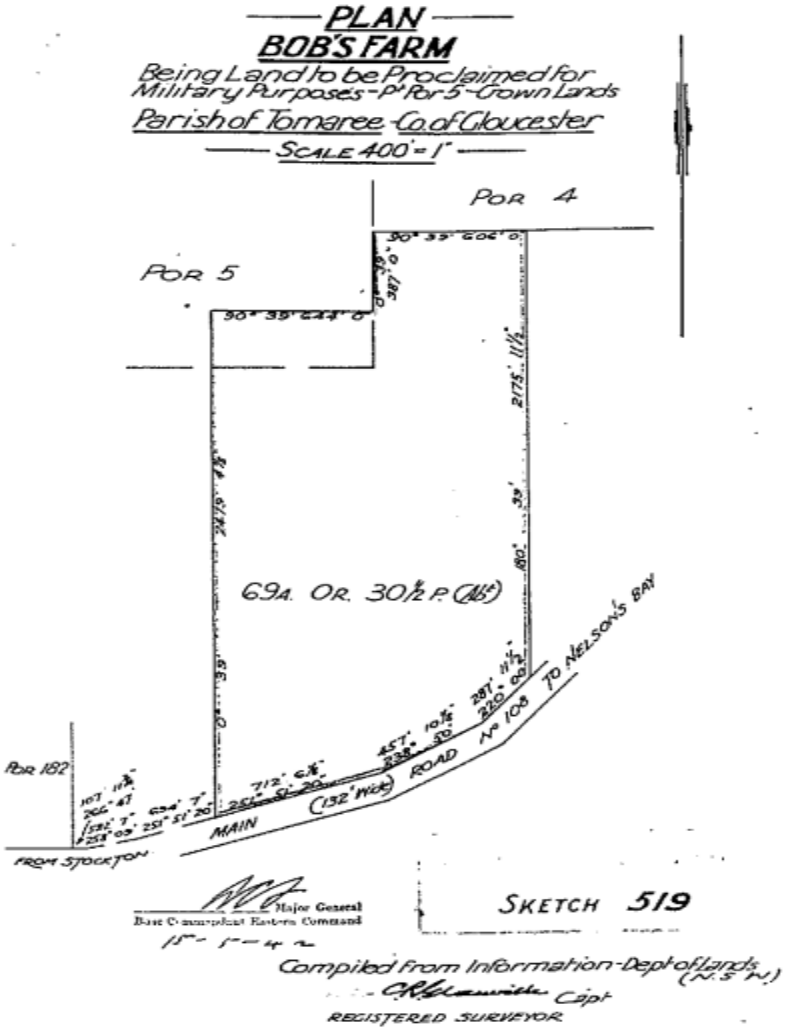


Figure 10.4 - Plan indicating the land proposed for the Bob's Farm Cadre Camp. Source: National Archives of Australia SP857/6 PH1862 in Fraser 2014:17

The Local Army Staff Camp Office at Raymond Terrace was initially charged with the responsibility for the Camp and Mr Symonds from the Department of Labour was appointed Camp Commandant. In March 1943 this responsibility was given to William V. Crothers. Crothers did not reside in the camp, but kept the hours of 11am to 5pm Monday to Friday. Other personnel included a Hygiene Sergeant, a butcher, cook and canteen steward. The Raymond Terrace Camp Quartermaster, Lieutenant Behets, was tasked with ensuring the safety of Army property in the Camp. The cook's duties as such were short-lived, with the evacuees taking over this task by April 1943 – probably due to a preference for more traditional fare than was provided by the Australian cook (Fraser 2014:20).

The standard number of huts provided for a Cadre Camp was 18 and these were originally intended to be used as school rooms, recreation huts and hospital facilities. Despite being ordered

[14] The funds for the works were approved after the first group of refugees arrived in the camp. The reason for this inconsistency in the records is not clear.

to treat all the evacuees equally, Mr Symonds assigned the huts to Portuguese senior officials and army personnel, who were also provided with beds and bedding, which was issued as hospital equipment. The remainder of the evacuees were accommodated in tents with straw mattresses, a bucket, basin and kerosene lamps (the huts having electric lights and tables and chairs). This preferential treatment caused considerable discontent amongst the evacuees.

Clothing was provided to the evacuees by the Red Cross and the Civilian Aid Services established a hospital of 16 beds. The funding for the hospital seems to have been supplied by the Portuguese government, who initially had been indignant that its Government representatives and Army officers had left Timor, believing they should have stayed at their posts despite the Japanese invasion. Their position was that the officials should be redeployed to what is now Mozambique, another Portuguese colony; however, this plan was dropped when it became apparent that there was no suitable means of transportation.

Tension in the camp between the evacuees due to racial and class distinctions was a continuing problem. While some groups refused to cook for themselves, other groups refused to cook for them. There was several outbreaks of violence arising from these tensions. From May 1943 some of the families were found employment in Armidale, several locations in Victoria or locally. Still others went to commando or other military training facilities before being deployed back to Timor on secret missions (Fraser 2014:33-34).

The racial and class differences also compounded the health and hygiene issues experienced in the Camp. While the sandy nature of the area, together with the climate, was causing some illness, this was exacerbated by unwillingness amongst the evacuees to clean or properly dispose of waste. The officials refused to do this work themselves, while others considered it no longer their job, as they were guests of the Australian Government. Refuse disposal was a constant issue, as the incinerator was not up to the task. Mr Upton was employed to collect the refuse, but this service was suspended for a short time as his facilities did not meet the National Security Regulations. In the interval, four work parties were formed. They were to bury the rubbish in kerosene tins to suppress the insects "over the hill from the camp" (Fraser 2014:23). Mr Upton's service was resumed to supplement the efforts of the work parties.

By May 1943 options to remove the remaining 300 evacuees from Bobs Farm were being assessed. Rental accommodation for 95 evacuees was found in Narrabri. This was followed by further accommodation being found in Narrabri and Glen Innes for the remaining evacuees in February 1944. The accommodation in Narrabri included Coleman's Private Hotel and the Imperial Hotel. Arrangements had been made that the Camp would be handed back to the Army on 5 March 1944, but an inspection on the 28 February determined that there was still 16 evacuees in residence tasked with cleaning the facilities. The Camp was eventually handed back on 22 March.

In November 1944, Henry Upton wrote to the Army indicating he was willing to buy one of the water tanks still located on his property and that the Raymond Terrace Methodist Church was interested in one of the smaller huts. In January of the following year the 5th Australian Maintenance Platoon dismantled the electrical wiring, insulators, cross arms and poles, together with the buildings. In June 1945, the components of the Camp's water system were offered for sale. By the end of July 1945, the land was back in the possession of the Crown.

10.4.6 Project Area

The first Parish Plan was published in 1926 and indicates majority of the Project area remaining the property of the Crown, with an early unsealed incarnation of the current Nelson Bay Road being marked to the south (Figure 10.5). The northern sections of the Project area had been purchased by T.R. Upton. An obituary for his wife, who passed away in 1943, indicated she had been in the

area for 64 years (Dungog Chronicle, 1943:3a). This would place the Upton's land grant to around 1879.

The Deposited Plan for Lot 254 indicates that following the closure of the Cadre Camp, the land was granted to Harold James Upton under a Special Lease in 1948 (Figure 10.7). The 1943 Parish Plan (Figure 10.6) has had a later annotation, indicating the Lot was under the ownership of H.R. Upton. It would appear that the parish plan references ownership by Henry Raymond Phillip Upton, who subsequently took over the property. The relationship between T.R. and Harold and Henry is unclear, but the parish plans, together with the newspaper reports on Bob's Farm indicate the family was prominent in the local community.

The earliest aerial photography for the project area was flown in 1951 (Figure 10.8). It shows the Project area as vegetated, the exception being the northern extents, which had been cleared. The Bob's Farm School and Bob's Farm Hall can be seen on Marsh Road, adjacent to the Project area. Based on this evidence, it would appear that Upton did not proceed with whole-sale land clearance. The 1973 Parish Plan (Figure 10.9) provides the owner of the southern portion of the site as the Worimi Local Aboriginal Land Council (LALC). The aerial photography from 1975 indicates that the vegetation was denser than in 1951 (Figure 10.10). This probably indicates there was regeneration of the vegetation following the removal of the evacuees. The area is likely to have been selectively cleared for firewood and the undergrowth reduced during the use of the area by the Timorese.

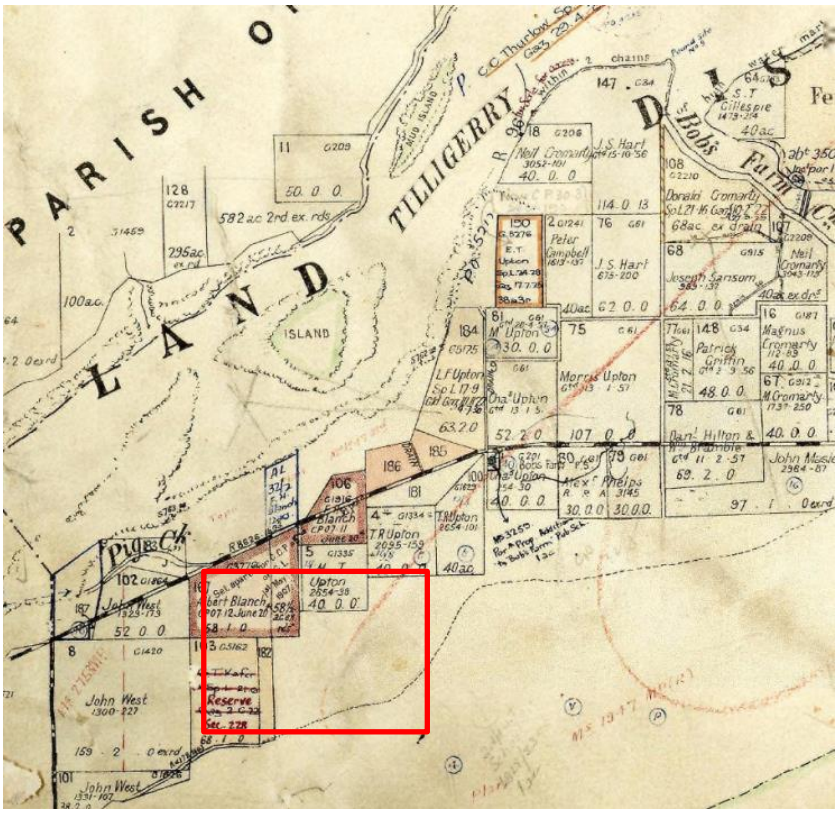


Figure 10.5 - Tomaree Parish Plan 1926. Approximate Project area highlighted. (Source: Land & Property Information NSW)

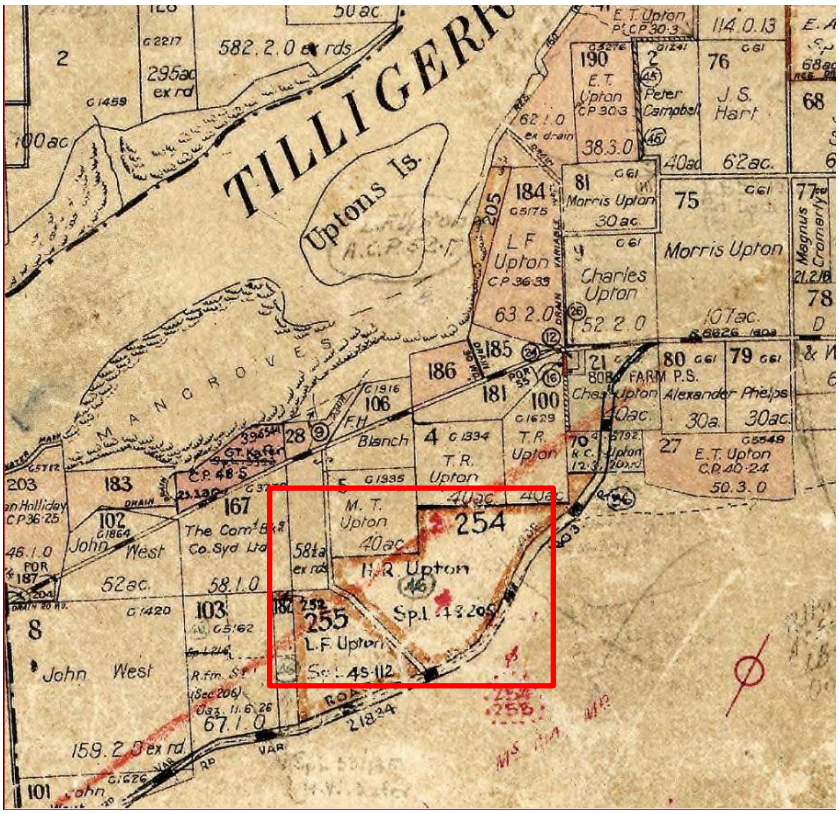


Figure 10.6 - Tomaree Parish Plan 1943. Approximate Project area highlighted (Source: Land & Property Information NSW)

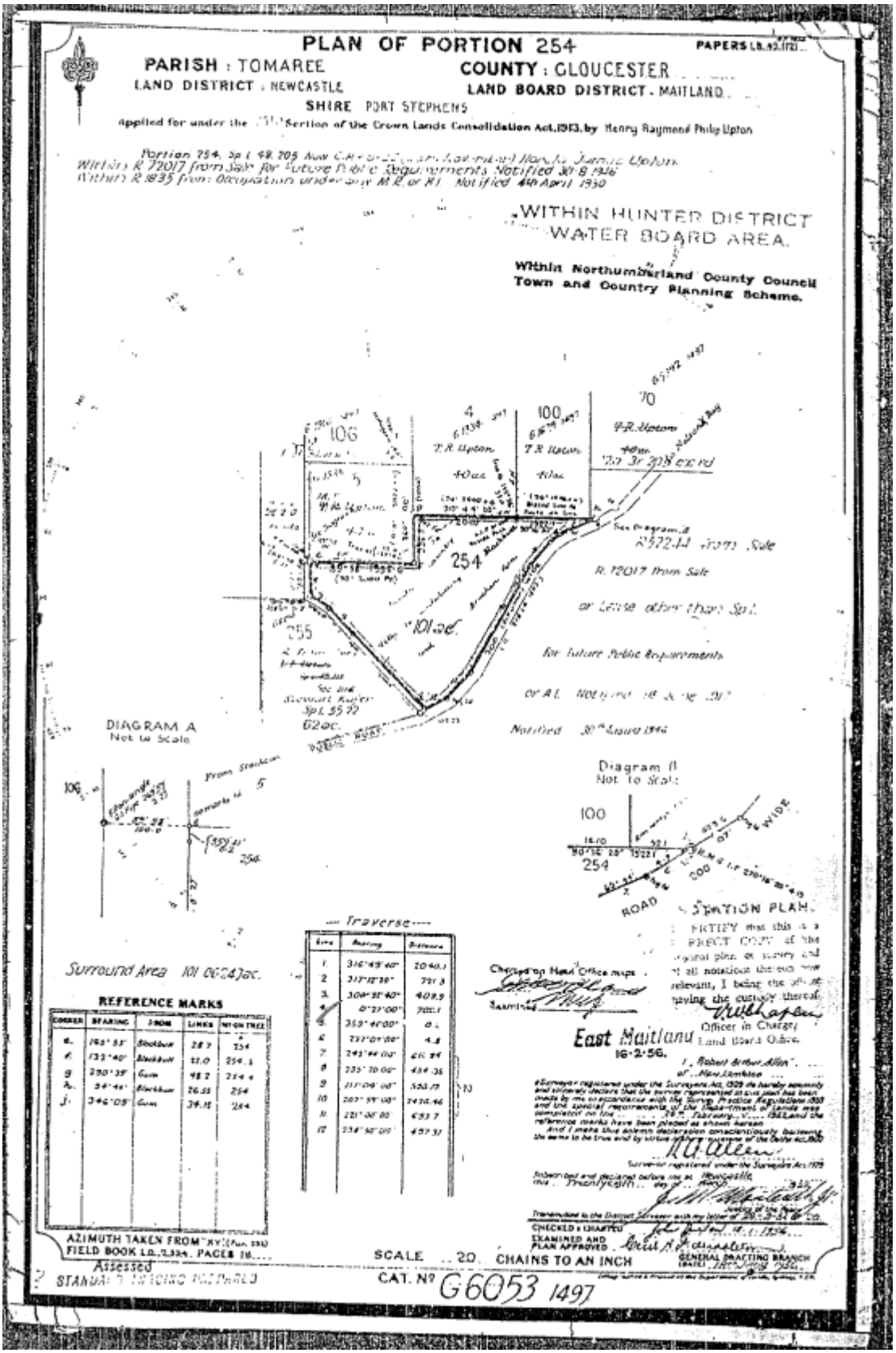


Figure 10.7 - Excerpt from Deposited Plan for Lot 254. **(Source: Lands & Property Information NSW. Ref:G6053-1497)**

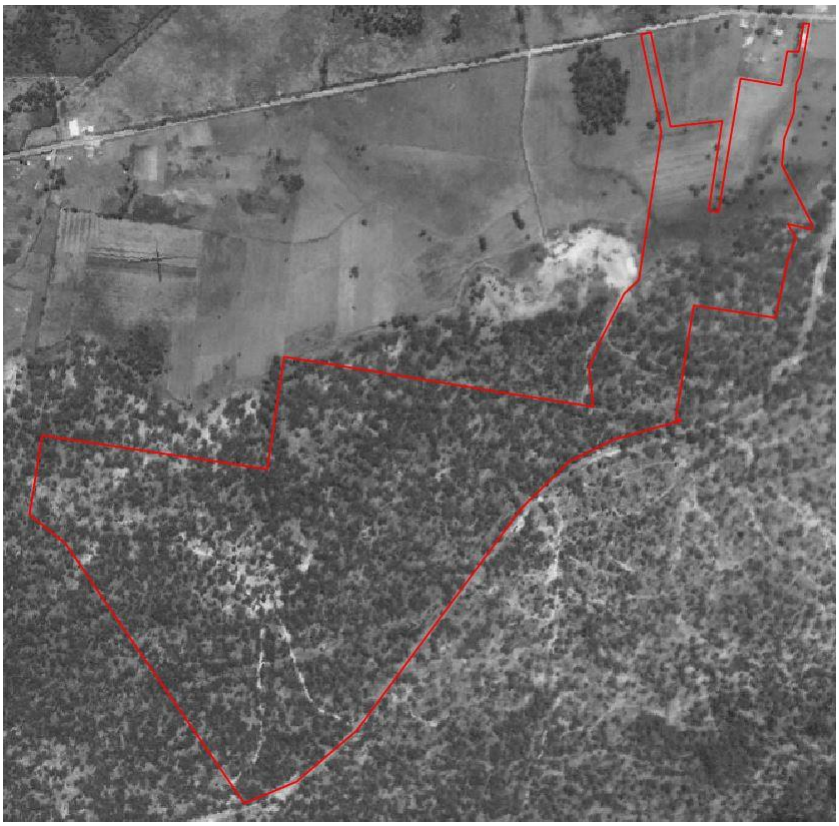


Figure 10.8 - Aerial photograph of Project area, 1951 **(Source: Land & Property Information NSW)**

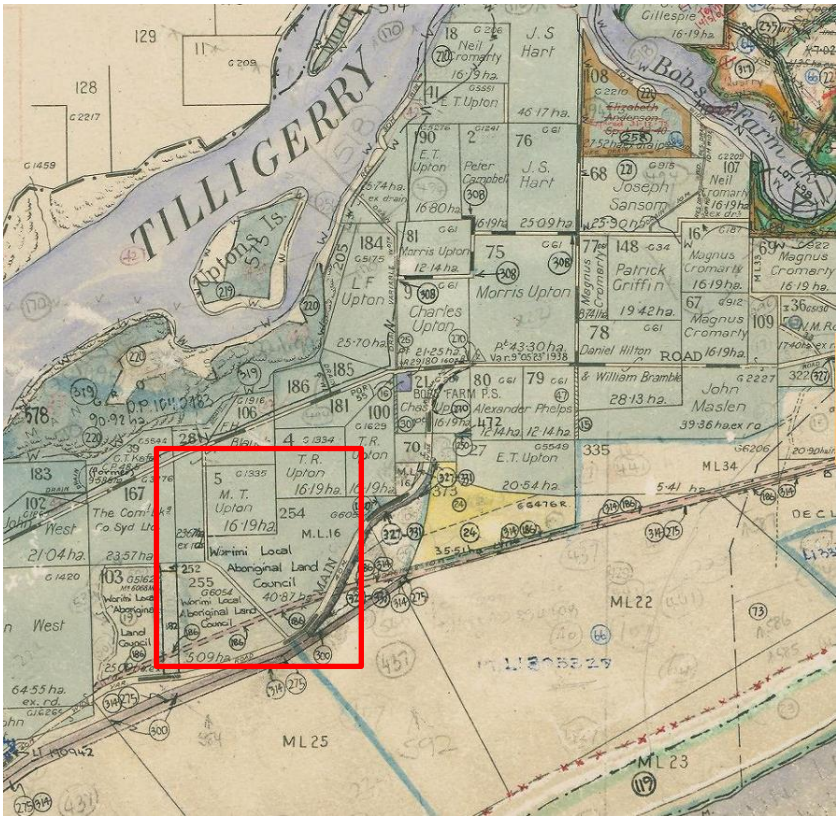


Figure 10.9 - Tomaree Parish Plan 1973 Approximate Project area highlighted. **(Source: Land & Property Information NSW)**



Figure 10.10 - Aerial photograph of Project area, 1975 (Source: Land & Property Information NSW)

The aerial photography from 1992 indicates that between 1975 and 1992, four residential structures were constructed in the northern portion of the Project area (Figure 10.11).

Prior to 2000, the Worimi LALC sold the land to Patra Holdings, who developed an olive farm and associated house on the southern portion of the Project area. The olive farm was extended in the early 2000s.

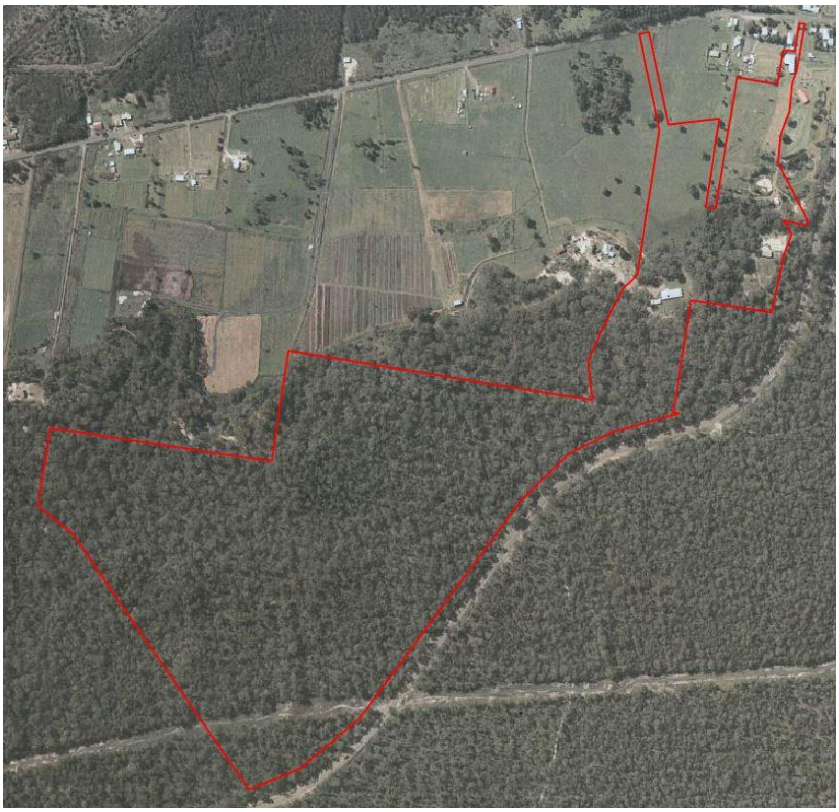


Figure 10.11 - Aerial photograph of Project area, 1992 (Source: Land & Property Information NSW)

10.4.7 Summary

While there were European settlers in the Bob's Farm area from the 1820s, the northern portion of the Project area was not granted until the late 1870s or early 1880s. The southern portion of the Project area was not sold until 1948, following its use during World War II as a camp for Portuguese and Timorese evacuated from Timor before its fall to the Japanese. The Camp is likely to have been located towards the northern boundary of this grant, close to T.R. Upton's land and within the Project boundary. While some vegetation and farming occurred in the northern portion, it would appear that the southern section of the Project area was never cleared and the thickening of the vegetation indicated on the aerial photography is probably indicative of regeneration following the closure of the Bobs Farm Cadre Camp.

The above account of the Bobs Farm Cadre Camp has been summarised from a secondary source (Fraser 2014), which was largely based on inter-departmental correspondence and some oral history. There is no known plan of the Camp during its operation. The location of the huts, tents and refuse disposal area (which may have archaeological potential and significance) can therefore not be identified with any certainty. However, as Henry Upton offered to buy one of the water tanks associated with the Camp, which was located on his land, it can be presumed that the huts are likely to have been located in the northern section of the site. Photographs included in the report provide some indication of the physical form of the huts. They were demountable weatherboard structures, which were placed on brick piers, as indicated in Plate 10.2. Another image of the Camp (Plate 10.3) shows the tent accommodation and also indicates that the site was not cleared of vegetation, tents instead being placed between the trees.



Plate 10-2 - L to R: Unknown nurse, unknown nurse, Dr. Elvira Correia Teles, Nurse Sally Blain, Dr Ron Bonnette, Nurse Dorothy Mills, 1943. From Fraser 2014:23. Note the weatherboard structure on brick piers behind



Plate 10-3 - Australian Army Nurses Sally Blain (left) and Dorothy Mills at Bob's Farm Camp, 1943. From Fraser 2014:19. Note tents and vegetation behind

10.5 EXISTING ENVIRONMENT

10.5.1 Introduction

The field survey was undertaken on 1st and 2nd October 2014, using the methodology outlined in Section 10.2. No sites were identified within the Project area, while four items were identified in the vicinity.

10.5.2 Project Area

The western portion of the Project area is covered in native vegetation, through which various unsealed tracks have been created (Plate 10.4). Part of Lot 254 has been developed into a commercial olive and fig orchard, with associated sheds and a residence (Plate 10.5). This operation was established in the early 2000s and is not of heritage significance.

The northern portion of the Project area has been partially cleared and contains four residences and some sheds (Plate 10.6). Aerial imagery (see Section 10.4.5) indicates these residences were constructed between 1975 and 1992 and are not considered to be of heritage significance.

The survey of the Project area identified that the structures within the boundary are recent and hold no heritage significance when assessed against the NSW Heritage Division guidelines (NSW Heritage Office, 2001).



Plate 10-4 - Indicative view of area of native vegetation and an unsealed track in the west of the Project area



Plate 10-5 - Olive grove (on left in foreground) and fig plantation (on right at rear) on Lot 254 on DP753204



Plate 10-6 - Example of residence the northern portion of the Project area

10.5.3 Bobs Farm Cadre Camp

Despite extensive survey of the Project area, no evidence associated with the Bobs Farm Cadre Camp could be identified. Any evidence of the Camp is likely to consist of artefact scatters across the area where the huts and tents were erected, plus possibly some of the brick piers associated with the huts. Additionally, the area used to dispose of refuse is likely to retain sub-surface archaeological deposits. Section 10.4.5 identified that there is no known plan of the Camp that indicates the layout and location of the huts. It is possible that the huts were located towards the north of the Project area, within the tree line. Figure 10.12 indicates the area considered most likely to have contained the Camp and therefore have potential to contain archaeological deposits or relics associated with the use of the Camp. Table 10.2 provides an assessment of the potential archaeological deposits against the NSW heritage significance criteria. The archaeological deposits, should they exist, would be of local historic, research and rarity significance. The potential impact of the Project on the potential archaeological deposits is discussed in **Section 10.6.4** and a management strategy provided in **Section 10.7.1.**

APPLICATION OF CRITERIA	
Historical significance NSW criterion (a)	The Bobs Farm Cadre Camp is of local historical significance, having played a little-known role in World War II. The Camp was commandeered to meet a need to house refugees evacuated from Timor prior to its fall to Japan. The loss of the majority of the physical evidence associated with the Camp has diminished the Camp's significance under this criterion.
Historical association significance NSW criterion (b)	The Bobs Farm Cadre Camp is not of historical associative significance on a state or local level as it does not have a strong or special association with the life or works of a person, or group of persons, of importance in state or local cultural history. This is demonstrated by the almost total lack of local knowledge regarding the Camp.
Aesthetic significance NSW criterion (c)	The Bobs Farm Cadre Camp is not of aesthetic significance on a state or local level as it does not demonstrate aesthetic characteristics and/or a high degree of technical achievement in the state or the local area.
Social significance NSW criterion (d)	The Bobs Farm Cadre Camp may be of social significance to the Timorese and their descendants, as well as those who worked at the Camp. Confirmation of the significance of the site under this criterion would require further research with the local community should evidence of the site be uncovered.
Technical/Research significance NSW criterion (e)	The Bobs Farm Cadre Camp is of local research significance. The potential archaeological deposits associated with the Camp could provide evidence of the location and use of the Camp not available from other sources. The exact location of the Camp is not located on any map located to date and local knowledge places the Camp only within a general area. Archaeological evidence may provide a more exact location. The deposits themselves may provide an insight into the lives of the evacuees in the Camp, including how they adapted to their surroundings. This may be particularly evident in the preparation of food as indicated by faunal remains.
Rarity NSW criterion (f)	The Bobs Farm Cadre Camp is of local significance under this criterion. It is the only refugee camp specifically housing Timorese evacuated during World War II in Australia. The loss of physical fabric demonstrating the use of the Camp has diminished the Camp's significance under this criterion.
Representativeness NSW criterion (g)	The Bobs Farm Cadre Camp is not of representative significance as it does not demonstrate the principal characteristics of a class of state or local places or environments due to the loss of the physical of the buildings and associated infrastructure.

Table 10.2 - Bobs Farm Cadre Camp potential archaeological site – application of heritage significance criteria



Figure 10.12 - Area of archaeological potential

10.5.4 Project Area Vicinity

One item of heritage significance was identified from the heritage registers adjacent to the Project area. The Stockton Beach Dune System, including Aboriginal site and shell middens, ship wrecks, WWII ramparts, tank traps, proofing range, rifle range and tin huts (#I34) is listed on the Port Stephens LEP. The same area also has a non-statutory listing on the RNE as the 'Newcastle Bight Coastal Area, Nelson Bay Rd, Fern Bay, NSW, Australia' (ID #19510). The listed area extends from Birubi Point in the north to Fern Bay in the south (Figure 10.13). The WWII ramparts, tank traps, proofing range, rifle range and tin huts are located near Fern Bay, approximately 15 km to the south of the Project area. No assessment against the heritage significance criteria was available for either listing.

The historical context (**Section 10.4.5**) identified two items of local interest: Bobs Farm Primary School and Bobs Farm Hall. The school is located on Marsh Road, approximately 25 m west of the proposed egress point for the Project onto Marsh Road (Figure 10.13). The school could not be inspected due to restricted access to operational schools for the protection of the students. It was not considered necessary to obtain access as there will be no direct impacts to the school as a result of the Project. It is also considered unlikely that the original school building (Plate 10.7), or evidence of it, is retained on the site. AECOM currently has insufficient information with which to assess the heritage significance of the school against Heritage Division guidelines.

The Bobs Farm Hall is located to the west of the School on Marsh Road (Figure 10.13). The rectangular building is covered with metal weatherboard cladding and has a pitched, corrugated iron roof. The roof and cladding appear to be replacements of earlier fabric. The northern and western elevations contain aluminium framed windows, which are also not original to the Hall. An amenities block has been added to the western elevation (Plate 10.7). On the eastern side of the building, a skillion roofed verandah has been appended, the southern portion of which has been enclosed and provides kitchen facilities for the hall. The interior space is open, with a stage area at the southern end (Plate 10.8). The heritage significance of the Hall has been assessed in Table 10.3 using the Heritage Division guidelines as outlined in **Section 10.2.3**.

APPLICATION OF CRITERIA	
Historical significance NSW criteria (a)	The Bobs Farm Hall is of local historical significance as it demonstrates the growth of the local Bobs Farm community. The Hall was the scene of local social gatherings that solidified the local community spirit.
Historical association significance NSW criteria (b)	The Bobs Farm Hall is not of historical associative significance on a state or local level as it does not have a strong or special association with the life or works of a person, or group of persons, of importance in state or local cultural history.
Aesthetic significance NSW criteria (c)	The Bobs Farm Hall is not of aesthetic significance on a state or local level as it does not demonstrate aesthetic characteristics and/or a high degree of technical achievement in the state or the local area.
Social significance NSW criteria (d)	The Bobs Farm Hall is likely to be of local social significance to the residents of Bobs Farm. Confirmation of this significance would need to be confirmed through consultation with the local community.
Technical/Research significance NSW criteria (e)	The Bobs Farm Hall is not of technical or research significance as it is unlikely to yield information that will contribute to an understanding of NSW's cultural or natural history at a local or State level.
Rarity NSW criteria (f)	The Bobs Farm Hall does not possess uncommon, rare, or endangered aspects of state or local cultural history and so does not qualify as significant under this criterion.
Representativeness NSW criteria (g)	The Bobs Farm Hall is not of representative significance as it does not demonstrate the principal characteristics of a class of state or local places or environments due to the significant intervention into the fabric of the building.

Table 10.3 - Bobs Farm Hall – application of heritage significance criteria

Statement of Significance:

The Bobs Farm Hall is of local historical significance as it demonstrates the growth of the local Bobs Farm community from the 1920s onwards. The Hall was the scene of local social gatherings that solidified the local community spirit. The Hall may also have local social significance to the present community.



Plate 10-7 - Bobs Farm Hall – Exterior



Plate 10-8 - Bobs Farm Hall - Interior



Figure 10.13 - Items of local interest

10.5.5 Summary

No items of heritage significance were identified within the Project area, however, there is potential for archaeological deposits associated with the Bobs Farm Cadre Camp to be retained within the Project area. The area of highest potential is indicated on Figure 10.12. One listed heritage item was identified to the south of the Project area: the 'Stockton Beach Dune System', which is listed on the Port Stephens LEP and the non-statutory RNE. A further two items of local interest, the Bobs Farm School and Hall are located on Marsh Road to the west of the Project's proposed egress point onto Marsh Road.

10.6 IMPACT ASSESSMENT

10.6.1 Introduction

The following section assesses the potential impacts to historic heritage and archaeology arising from the Project. The Project is first outlined and then the potential impacts assessed.

10.6.2 The Project

Ammos Resource Management is seeking approval for:

- The establishment of a sand quarry to extract and process sand at a rate of approximately 750,000 tonnes per annum, from a total sand resource of 10 million tonnes;
- Construction of extractive materials processing and transport infrastructure;
- Transportation of extractive materials off-site via roads; and
- Site rehabilitation.

Ammos Resource Management proposes to stage the development and operation of the Project as follows:

1. Development Stage - involving the installation of an access location on Nelson Bay Road, initial clearing of the quarry site, the setting up of screening operations and the construction of a loading ramp, storage shed and main exit road;
2. Operational Stage 1 - involving the clearing and stockpiling of topsoil and production of initial sand material that is likely to be processed into landscape soil base and sports field top-dress material;
3. Operational Stage 2 - involving the processing of extracted blonde sand material for various product uses; and
4. Operational Stage 3 - involving the setting up of dredging operations and winning of sand material for various product uses.

Site access throughout the life of the Project would be off Nelson Bay Road with egress via Marsh Road and then back onto Nelson Bay Road.

Key project activities would include:

- Construction of extractive materials processing and transport infrastructure;
- Bulk handling of sand material using front end loaders and trucks;
- Staged vegetation clearance employing logging and mulching;
- Screening and sizing of extracted sand material;
- Washing of selected extracted sand material;

- Dredging of sand material below the economic reach of mechanical equipment. Approximately 50% of the recoverable resource would be dredged;
- Transportation of extractive materials off-site via roads; and
- Site rehabilitation.

The conceptual layout of the Project is shown on Figure 10.3.

10.6.3 Identified Sites

The heritage register searches, historical research and field survey did not identify any items of historic heritage significance within the Project area. However, the area has potential to contain archaeological deposits associated with the Bobs Farm Cadre Camp, which have been assessed as holding historic, research and rarity values.

One listed item has been identified to the south of the Project area, across Nelson Bay Road – 'Stockton Beach Dune System' listed on the Port Stephens LEP and the non-statutory RNE. The Bobs Farm Primary School, which was established in 1918, and the Bobs Farm Hall constructed in 1922 are in proximity to the northern portion of the Project area. The location of the Bobs Farm School and Bobs Farm Hall in relation to the Project area is indicated in Figure 10.13. There was insufficient information to assess the heritage significance of the school, however the Bobs Farm Hall was assessed as being of local significance, holding historic and possibly social significance.

10.6.4 Potential Direct Impacts

No sites were identified within the Project area, however, there is potential for archaeological deposits or relics associated with the Bobs Farm Cadre Camp to be preserved within the Project area. The extent and nature of these deposits are unknown, as no surface expression has been located. Should deposits be located within the Project area, the Project would result in direct impacts to the deposits. A management strategy is provided in Section 10.7.1. As the preservation and extent of the potential archaeological deposits cannot be determined at this time, it is difficult to assess the potential impacts formerly within a Statement of Heritage Impact, as required by the Director-General's Requirements (refer Section 10.1.5).

10.6.5 Potential Indirect Impacts

The Stockton Beach Dune System, Bobs Farm School and Bobs Farm Hall are located near the Project area; however, the Project is unlikely to result in any indirect impacts to these items. The Project will not be using blasting as an extraction method and the items will therefore not be subject to additional vibration as a result of the Project.

The Stockton Beach Dune System will not be subject to indirect visual impacts as a result of the Project. Nelson Bay Road and the 15 m vegetation buffer will ensure the extraction area is not visible from the Stockton Beach Dune System.

There will be no indirect visual impacts to the items. The Bobs Farm School and Bobs Farm Hall are oriented towards Marsh Road, facing away from the Project area. In addition, the Project area will not be visible to or from the items as there is an existing vegetation screen. In addition, the Project proposes to maintain a 15 m vegetation buffer between the Project area boundary and the extraction area.

10.6.6 Summary

No items have been identified within the Project area but there remains potential for archaeological deposits to be preserved within the Project area. The location, extent and preservation of these deposits are currently unknown, making it difficult to assess the impact. As outlined in Section 10.7.1, it is recommended that the potential impacts be managed through a program of archaeological monitoring. Archaeological testing and salvage excavation may also be required if large and/or intact deposits are uncovered.

The two items of local interest are located to the north of the Project area and will not be directly or indirectly impacted by the Project. There will be no increased vibrations as a result of the Project and there will be no visual impacts as there are no view-lines between the items and the Project area. Likewise, the historic heritage significance of the one statutory listed item in the vicinity of the Project area, the Stockton Beach Dune System, will not be directly or indirectly impacted by the Project as there are no view-lines or increase in vibrations.

10.7 MANAGEMENT STRATEGY

No direct or indirect impacts to historic heritage items have been identified, however there is potential for archaeological deposits associated with the Cadre Camp to exist within the Project area. Recommendations to deal with this possibility are provided in Section 10.7.1. Historic Heritage Management Plan (HHMP) is not warranted as there are no standing structures that will require on-going maintenance and consideration. It is, however, recommended that the Project's Environmental Management Plan (EMP) include contingency policies for the management of unexpected historic heritage finds and skeletal remains. Suggested policies are detailed in Sections 10.7.2 and 10.7.3 below.

10.7.1 Bobs Farm Cadre Camp

As the nature and extent of the potential archaeological deposits associated with Bobs Farm Cadre Camp are unknown, it is recommended that archaeological monitoring be undertaken during the clearing of vegetation within areas marked as of high archaeological potential on Figure 10.12. Ammos Resources should engage a suitably qualified archaeologist to prepare an Archaeological Research Design and Methodology, which should be approved by the Heritage Council of NSW prior to ground disturbance works. The methodology should include provision for archaeological testing or salvage should deposits or relics be uncovered during works. Evaluation of the proposed mitigation measures is required by the Director-General's Requirements (refer Section 10.1.5). This is considered to be an effective mitigation measure, as it will enable the identification of the location of the Camp as well as it's archaeological investigation once it is identified.

10.7.2 Suggested Unexpected Finds Policy

The following procedure guides the management of any unexpected historic heritage finds encountered the course of sand mining operations outside of the scope of works covered by the Bobs Farm Cadre Camp. Finds include artefact scatters (glass, animal bone, ceramic, brick, metal etc), building foundations and earthworks of unknown origin (i.e. not associated with mining operations):

- All work in the area is to cease immediately;
- Alert the Environmental Manager to the find;
- If necessary, protect the area with fencing;

- Engage a suitably qualified archaeologist to undertake an assessment of the finds;
- The assessment should be undertaken using the guidelines Assessing Significance for Historical Archaeological Sites and 'Relics' (NSW Heritage Branch 2009);
- On the advice of the archaeologist, if necessary, prepare an Impact Assessment and Research design and methodology to submit to the Heritage Branch for a Section 140 excavation permit or exception;
- Undertake the archaeological mitigation in accordance with the prepared documents and the permit/exception issued by the Heritage Division; and
- Once the site has been mitigated to the satisfaction of the archaeologist and the Heritage Branch, works may resume in the area.

10.7.3 Suggested Management of Human Remains Policy

This section outlines the procedure proposed for inclusion in the EMP in the event that human remains are discovered during sand mining operations. The procedure takes into account the following documents:

- Burials - Exhumation of Human Remains NSW Health Policy Directive PD2008_022 (NSW Health 2008) available at : http://www.health.nsw.gov.au/policies/pd/2008/pdf/PD2008_022.pdf
- *Manual for the Identification of Aboriginal Remains* (NSW Department of Environment & Conservation 2006);
- Skeletal Remains – *Guidelines for the management of human skeletal remains* under the *Heritage Act 1977* (NSW Heritage Office 1998); and
- The *Aboriginal Cultural Heritage Standards and Guidelines Kit* (NSW National Parks and Wildlife Service 1997).

In the event that development or operations reveal possible human skeletal material (remains), the following procedure is to be followed:

- When suspected human remains are exposed, all construction work is to cease immediately in the near vicinity of the find location and the General Manager on site is to be immediately notified. The General Manager will contact the Police at the earliest reasonable time;
- An area of 5 m radius is to be cordoned off by temporary fencing around the exposed human remains site - work can continue outside of this area as long as there is no risk of interference to the human remains or the assessment of human remains. Assessment of risk may utilise the risk matrix provided within the NSW Health Policy directive on the exhumation of human burials;
- Contact the OEH Environment line on 131 555 and the Heritage Division on 02 9873 8500; and
- A physical or forensic anthropologist should be commissioned by Ammos Resource Management to inspect the remains in situ (unless otherwise directed by the police), and make a determination of ancestry (Aboriginal or non-Aboriginal) and antiquity (pre-contact, historic or modern);
    - if the remains are identified as modern the area is deemed as crime scene; or
    - if the remains are identified as Aboriginal, the Environmental Specialist will notify OEH and representatives of the local Aboriginal community and appropriate management measures will be determined through consultation with them.

Representatives of the Aboriginal community will be present during all investigations of Aboriginal remains; or

- if the remains are as non-Aboriginal (historical) remains, the site is to be secured and the Heritage Division is to be contacted.

This process functions only to appropriately identify the remains and secure the site. From this time, the management of the area and remains are to be determined through one of the following means:

- If the remains are identified as a modern matter, liaise with the police and/or the Coroner's Office and/or NSW Health with respect to the exhumation of the remains;
- If the remains are identified as Aboriginal, liaise with OEH and Aboriginal stakeholders;
- If the remains are identified as non-Aboriginal (historical), liaise with the Heritage Division; and
- If the remains are identified as not being human, then work can recommence without delay.

10.8 CONCLUSION

While there were European settlers in the Bob's Farm area from the 1820s, the northern portion of the Project area was not granted until the late 1870s or early 1880s to T.R Upton, later being transferred to Henry Upton. The southern portion of the Project area was not sold until 1948, following its use during World War II as a camp for Portuguese and Timorese evacuated from Timor before its fall to the Japanese. The Camp was almost certainly located towards the northern boundary of this grant, close to T.R. Upton's land and within the Project boundary. It is known that the Camp disposed of some waste off-site, however some was buried within walking distance. Archaeological deposits associated with the Camp therefore have the potential to be preserved within the Project area. These potential archaeological deposits have been assessed as holding historic, research and rarity values. There is no known plan of the Camp during its operation. The location of the huts, tents and refuse disposal area (which may have archaeological potential and significance) can therefore not be identified with any certainty. However, as Henry Upton offered to buy one of the water tanks associated with the Camp, which was located on his land, it can be presumed that the huts are likely to have been located in the northern section of the site.

A search of the relevant heritage registers was undertaken. No statutory listed sites were identified within the Project area. One item, the 'Stockton Beach Dune System', listed on the statutory Port Stephens LEP and the non-statutory RNE, is located directly adjacent to the Project area. Two further items of local interest were identified to the north of the Project area. The Bobs Farm School and the Bobs Farm Hall, which held a pivotal place in the local community, are located near the northern egress of the Project area.

An impact assessment was undertaken, which determined that no direct impacts have been identified as a result of the Project. No indirect impacts, as a result of increased vibrations or visual alterations, have been identified to items in the vicinity of the Project. This is because the Project will not use blasting as an extraction method and the mine layout retains an adequate vegetation screen to ensure the mine is not visible from public space, including the LEP item, the 'Stockton Beach Dune System'.

No Statements of Heritage Impact (SoHIs) are required as no quantifiable impacts have been determined. A Historic Heritage Management Plan (HHMP) is also not warranted. It is therefore considered that the Project's Environmental Management Plan (EMP) will be able to adequately manage and protect the heritage values of the Project area. It is recommended

that the EMP include contingency policies for the management of unexpected historic heritage finds and skeletal remains. Suggested policies have been included in **Section 10.7**. It is also recommended that a suitably qualified archaeologist be engaged to prepare an Archaeological Research Design and Methodology prior to undertaking a watching brief with test and salvage excavation, if warranted, during vegetation clearance within areas of high archaeological potential.

11 NOISE IMPACT ASSESSMENT

Chapter 11 provides a summary of detailed Vibration, Construction Noise and Operational Noise Assessments undertaken by Vipac to assess the likely acoustic and vibration impacts of the proposed sand extraction mine operations and traffic. The assessment includes the results of background noise logging and models predicted noise levels due to sand extraction. Results are assessed against industry standards and the detailed report is contained in Annex J. In addition, Vipac have provided an individual response to the DoPE issues for the original report. This individual response is contained in Annex J

11.1 INTRODUCTION

Vipac Engineers and Scientists Ltd (Vipac) was commissioned by Tattersall Lander Pty Ltd to conduct a Noise and Vibration Impact Assessment of the proposed Sand Farm located on Deposited Plans DP753204 (40.9ha) and DP1015671 (6.63ha) with associated land at DP1071458 (2.53ha), Bob's Farm NSW. The location of the proposed development site is illustrated in ***Figure 11.1***.

11.2 GLOSSARY OF TERMS

A list of commonly used acoustical terms (and their definition) used in this report is provided below in **Table 11.1**, as an aid to readers of the report.

Term	Definition
$L_{eq,1hr}$	Equivalent Continuous Noise Level - which, lasting for as long as a given noise event, has the same amount of acoustic energy as the given event for the period of one hour.
$L_{A10,1\ hr}$	The noise level, which is equalled or exceeded for 10% of the measurement period of one hour.
$L_{A90,T}$	The noise level, which is equalled or exceeded for 90% of a given measurement period, T. $L_{A90,T}$ is used in Australia as the descriptor for background noise.
$L_{Aeq,T}$	The equivalent continuous A-weighted sound pressure level that has the same mean square pressure level as a sound that varies over time, for a given time period. It can be considered as the average sound pressure level over the measurement period and is commonly used as a descriptor for ambient noise.
L_n	The Sound Pressure levels that is equalled or exceeded for n% of the interval time period. Commonly used noise intervals are L_1, L_{10}, L_{90} and L_{99}%
$L_{A10,18hrs}$	The L_{10} noise level for the time period extending from 6am to midnight.

Table 11.1 - Definition of Acoustical Terms

11.3 PROJECT DESCRIPTION

11.3.1 Site Location

The Bobs Farm site deposit is situated on the northern end of the Stockton Bight Dunal system, approximately 200 km north of Sydney, near Bobs Farm, NSW. The surrounding area is predominately zoned as rural with minimal primary production.

The site is located in Bob's Farm approximately 27 km north-east of Newcastle and approximately 14 km south-west of Nelsons Bay. The site is bounded to the south by Nelson Bay Road and to the north by Marsh Road.

11.3.2 Proposed Operations

The proposed Bobs Farm Sand Mine project comprises:

- The establishment of a quarry to extract and process sand at a rate of approximately 750,000 tonnes per annum, from a total sand resource of approximately 8-10 million tonnes. The estimated life of the extraction process is 13 years;
- The construction of extractive materials processing and transport infrastructure;
- The transportation of extractive materials off-site via roads; and
- The rehabilitation of the site.

Sand will be extracted from the site by two main mining methods:

- Dry mining utilising excavator and haul trucks to remove dry sand products from the pit areas above the water table for processing prior to export, and
- Wet mining utilising a dredge and pump line system to pump wet raw sand materials for processing prior to export.

A graphical display of the Deposited Plan is presented below in **Figure 11.1** also showing the outline of the mine boundary.

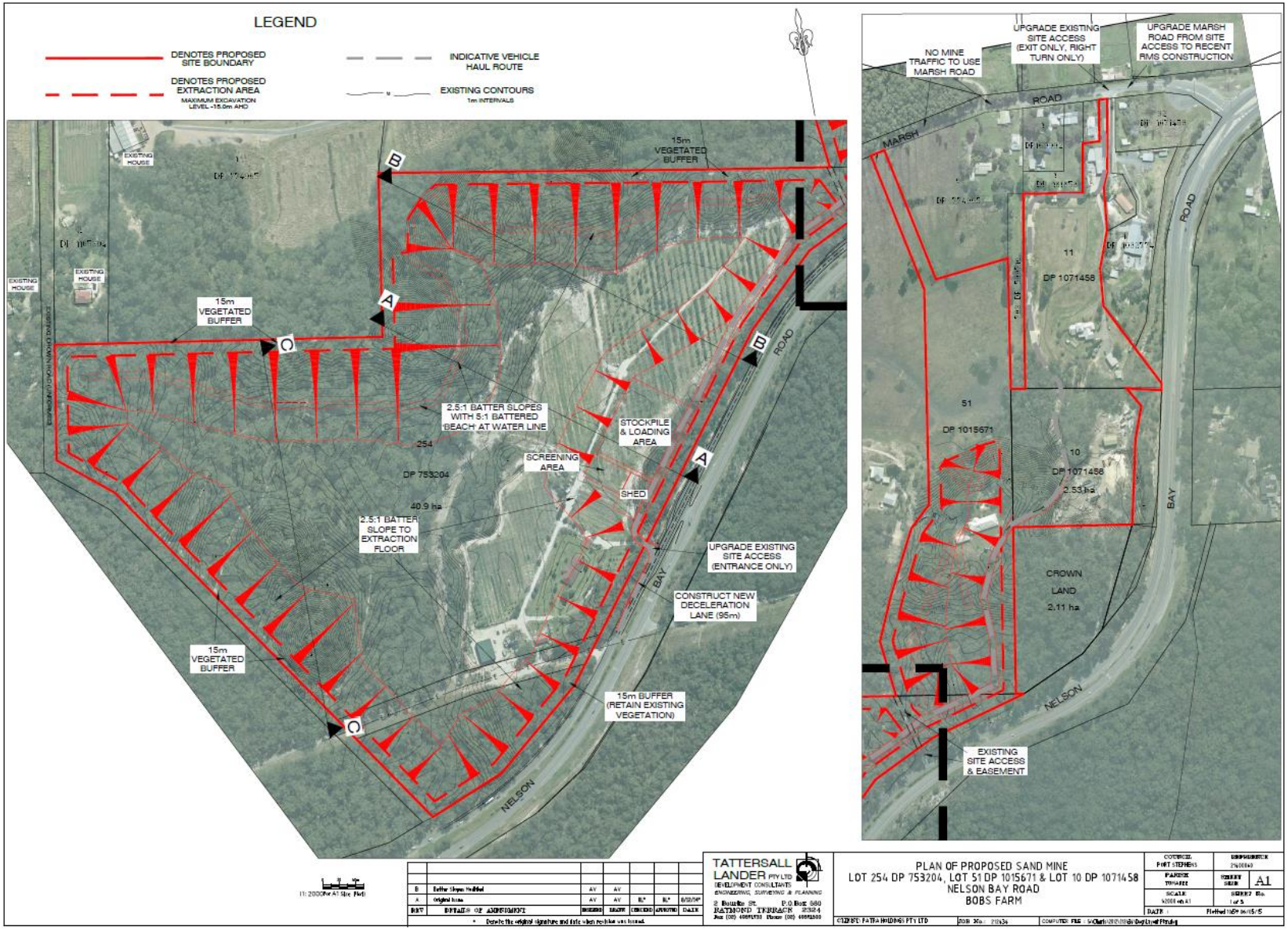


Figure 11.1 - Site Location – Deposited Plans

An overview of the developmental stages during the Project life is provided in ***Table 11.2***. A cross-section of the proposed sand mine presents the extent of each production stage in relation to the water table (between the blue and green lines), as shown in ***Figure 11.2***.

Phase	Operational Year	Annual Throughput (tonnes)	Method	Location in Relation to Water Table
Phase1	Year 1	150,000	Stripping of topsoil and dry mining (Stripping Phase)	Above (***Figure 2***)
Phase 2	Year 2	250,000	Dry mining Construction Stage and Year 1 Extraction/Production)	Above (***Figure 2***)
Phase 3	Year 3	450,000	Dry mining (Initial Extraction Stage down to water-table)	Above and below (***Figure 2***)
Phase 4	Years 4 - 13	700,000	Wet production (Final Extraction – production below the water-table down to a depth of -15m below the water-table)	Below (***Figure 2***)

Table 11.2 - Overview of Proposed Operations

The main activities of the Project will be the bulk handling of sand material, utilising mobile plant, general truck movements for the transport of the material to the plant where the sand is screened and washed before being de-watered and stockpiled. The final product will be transported, when necessary from site using trucks.

Entrance to the proposed sand mine will be via a left hand turn off Nelson Bay road at the southern end of the site entering into a sales area where road lorries will fill be filled by two sales loaders.

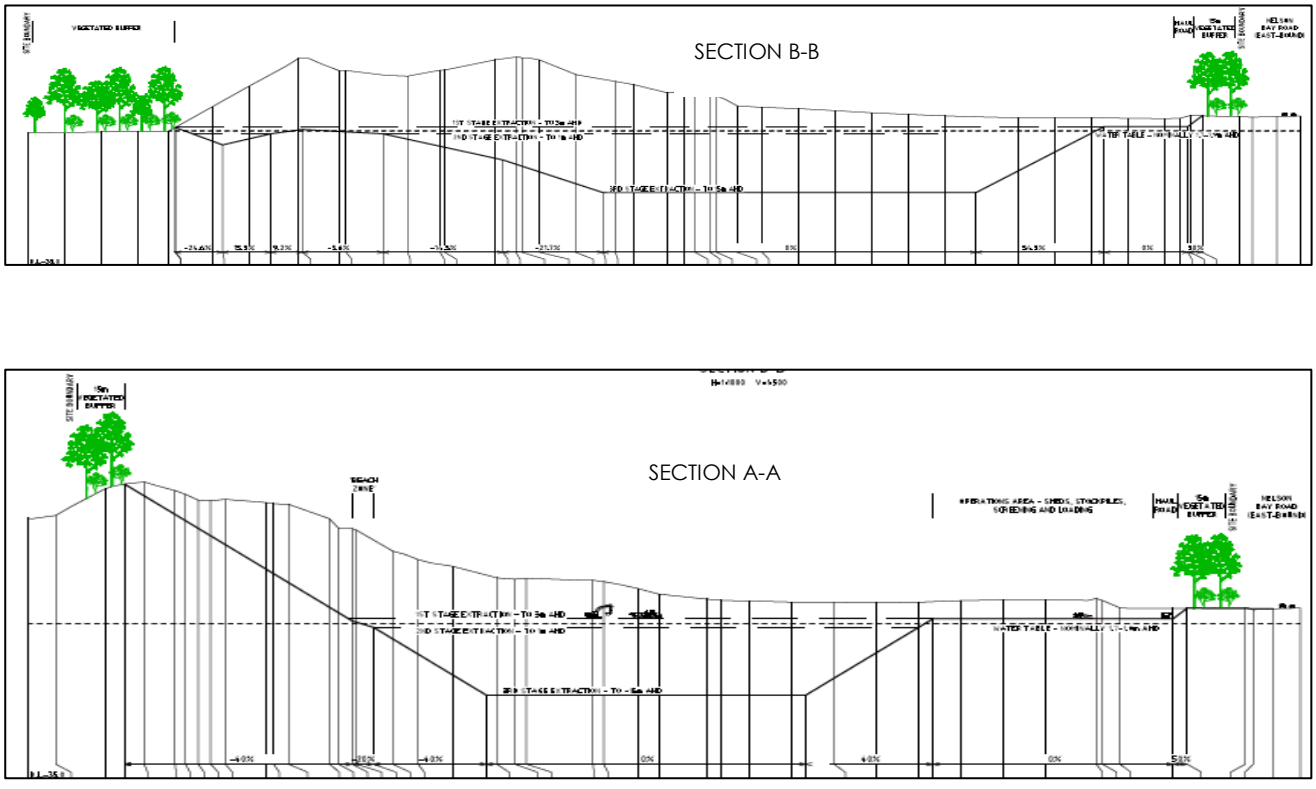


Figure 11.2 - Production Stages (Section B-B and Section A-A) **[Tattersall Lander]**

11.3.3 Operational Hours

During construction of the proposed sand mine the proposed operating hours will be for 10 hours per day from 07:00 to 17:00.

During initial operation of the proposed sand mine the operating hours will commence as a single shift of 10 hours, from 06:00 – 16:00, with provision for an additional 10-hour shift if production and or sales demands require it. Production is based upon 11 months per year, 19 days per month and 8 hours per day.

Operational hours for both extractions, loading of vehicles and transportation of material are proposed to be Monday to Saturday – 06:00 to 18:00 only.

11.3.4 Equipment

The proposed equipment for the Project will comprise of core mobile plant which will change in quantity to reflect the product throughput and ancillary equipment. The proposed equipment includes:

- Excavators;
- Articulated dump truck (44 tonne capacity);
- Front end loaders;
- Conveyor;
- Screens and hoppers;
- Wash / recovery plant;
- Dredge (Phase 3 only); and
- Road trucks.

The proposed concept design is provided below in **Figure 11.3.**

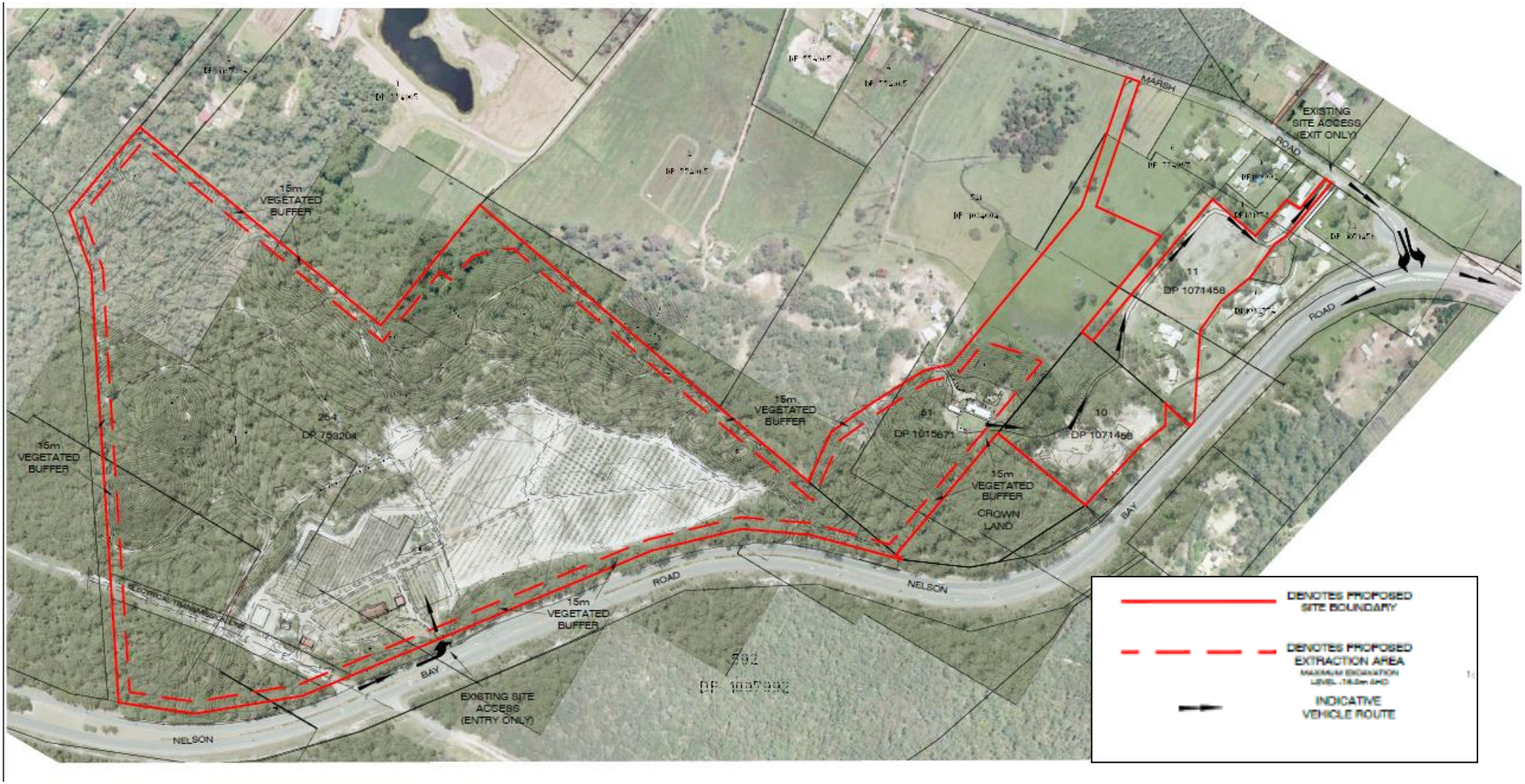


Figure 11.3 - Proposed Mine Design and Configuration

11.3.5 Noise Sensitive Receivers

The closest dwellings to the site are located approximately 10m to west of the Haul Road at the exit end of the haul road at Marsh Road, approximately 45m to the north-west of the site boundary at the eastern end of the proposed extraction area and approximately 53m to the west of the site boundary at the western end of the extraction area of the proposed mine. The sensitive receptors considered in this assessment are presented in **Table 11.3** below and illustrated in **Figure 11.4** and **Figure 11.5.**

Reference	Description	Distance from Site Boundary (approx.)	UTM Coordinates	
			Easting	Northing
R1	724 Marsh Road - Residential	45m	407080	6373782
R2	776 Marsh Road - Residential	10m	407432	6374056
R3	772 Marsh Road - Residential	10m	407410	6374157
R4	764 Marsh Road (Marsh Road Public School)	8m	407377	6374169
R5	762 Marsh Road - Residential	30m	407313	6374153
R6	760 Marsh Road (Marsh Road Public Hall)	95m	407306	6374183
R7	756 Marsh Road - Residential	65m	407270	6374128
R8	710 & 712 Marsh Road - Residential	500m	406822	6374040
R9	698 Marsh Road - Residential	160m	406807	6373689
R10	666 Marsh Road - Residential	330m	406409	6373926
R11	650 Marsh Road - Residential	365m	406345	6373915
R12	686 Marsh Road (Shark and Ray Centre)	240m	406209	6373694
R13	644 Marsh Road - Residential	53m	406123	6373508
R14	640 Marsh Road - Residential	103m	406016	6373514
R15	630 Marsh Road - Residential	154m	405912	6373456
R16	3551 Nelson Bay Road - Residential	485m	405906	6373182
R17	3515 Nelson Bay Road - Residential	235m	405758	6372941
R18	723 Marsh Road - Residential	650m	406868	6374185
R19	731 Marsh Road - Residential	500m	407003	6374232
R20	761 Marsh Road - Residential	150m	407322	6374277
R21	767 Marsh Road - Residential	100m	407385	6374280
R22	781 Marsh Road - Residential	80m	407503	6374223
R23	3780 Nelson Bay Road - Residential	215m	407631	6374081
R24	3724 Nelson Bay Road - Residential	180m	407629	6373758
R25	3790 Nelson Bay Road - Residential	300m	407547	6373678

Table 11.3 - Noise Sensitive Receptors

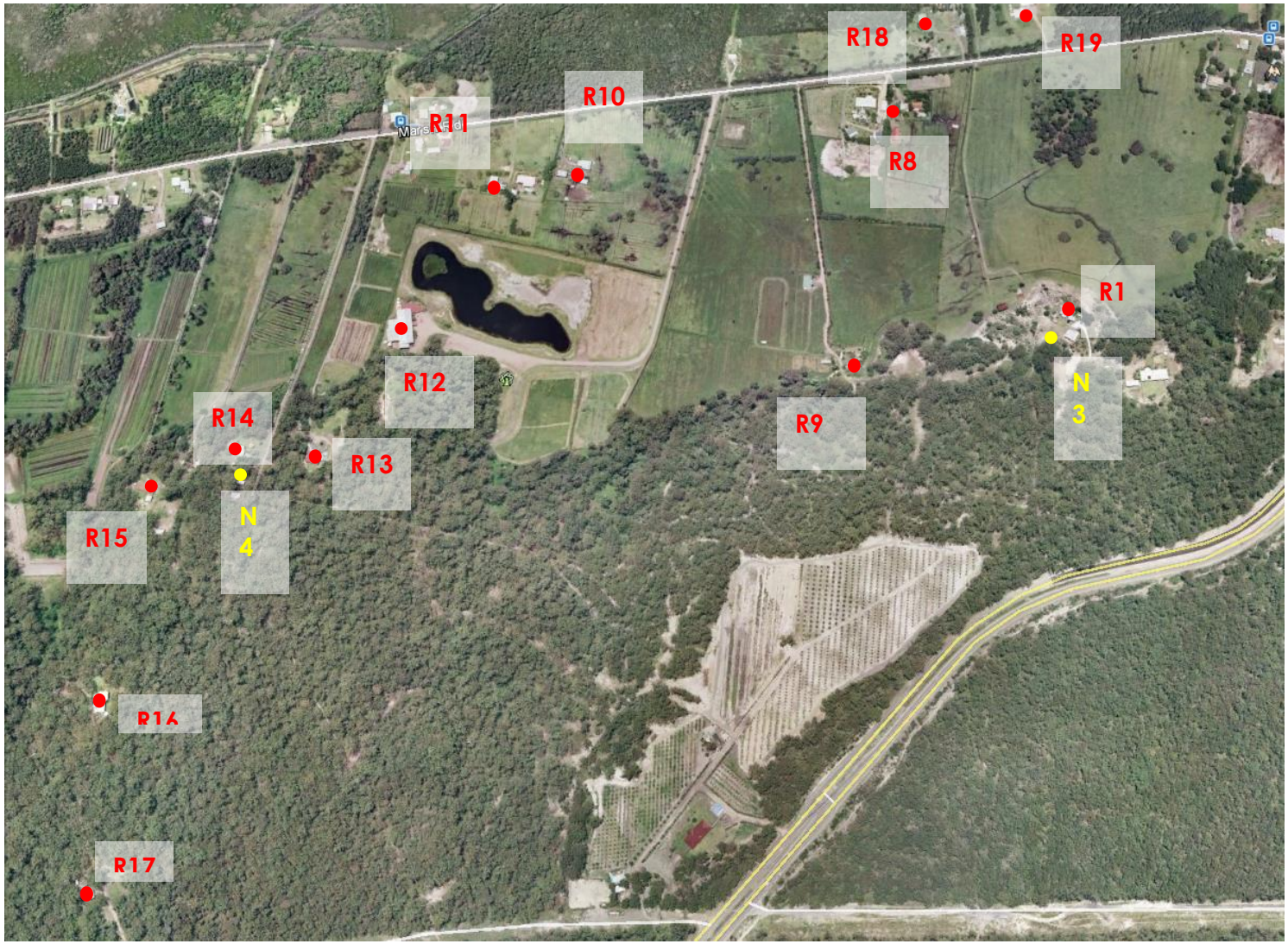


Figure 11.4 - Noise Sensitive Receivers (R1 and R8 - R19) and Noise Monitoring Locations (N3 – N4)

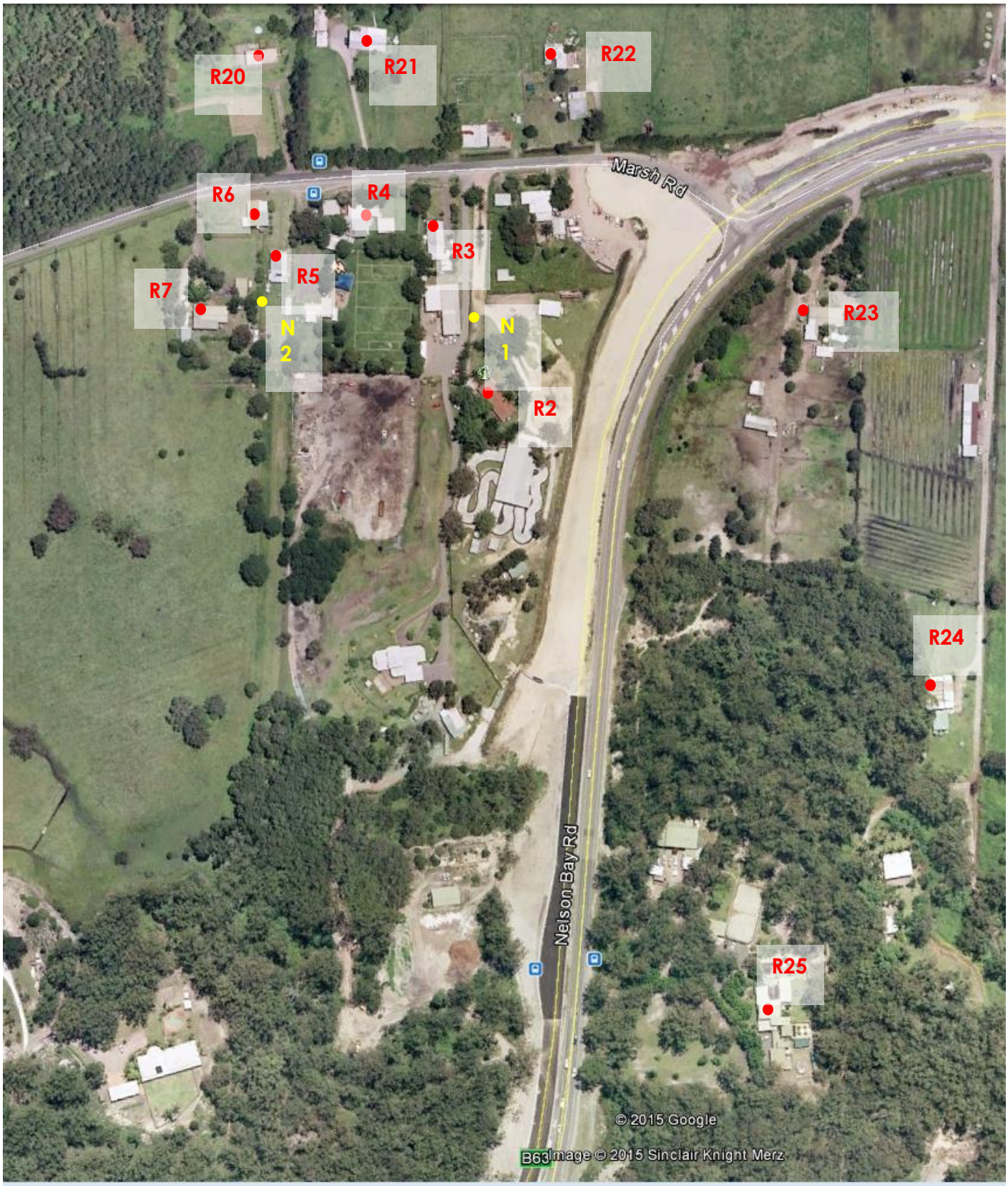


Figure 11.5 - Noise Sensitive Receivers R2-R7 and R20-R25 and Noise Monitoring Locations N1 and N2

11.4 EXISTING NOISE ENVIRONMENT

11.4.1 Unattended Noise Measurements

Vipac installed noise logging equipment at four locations to measure baseline environmental noise levels at representative noise sensitive receptor locations in the vicinity of the proposed sand mine site. The location of the monitoring points are listed in

Loc.	Noise Survey Dates	Location / Address	Instrument	Serial No.
N1	02nd- 06th Sept 2014	776 Marsh Road	Larson Davis 824	A2597
N2	12th-25th Aug 2014	762 Marsh Road	Larson Davis 870	1466
N3	12th-25th Aug 2014	724 Marsh Road	Larson Davis 870	1461
N4	12th-18th Aug 2014	640 Marsh Road	Larson Davis 870	1459

Table ***11.4*** and shown in ***Figure 11.4*** and ***Figure 11.5***.

The primary aim of the noise logging survey was to determine the existing environmental noise levels of the potentially affected area and to enable an assessment of the potential noise impacts on the receiving environment. Logger Location 1 (N1) represented receivers along Nelson Bay Road, Logger Location 2 (N2) represents receivers in the vicinity of Marsh Road Public School and Public Hall, Logger Location 3 (N3) represents receivers R1 and R11 and Logger Location 4 (N4) represents the receivers R14- R19 to the west of the proposed sand mine site.

Loc.	Noise Survey Dates	Location / Address	Instrument	Serial No.
N1	02nd- 06th Sept 2014	776 Marsh Road	Larson Davis 824	A2597
N2	12th-25th Aug 2014	762 Marsh Road	Larson Davis 870	1466
N3	12th-25th Aug 2014	724 Marsh Road	Larson Davis 870	1461
N4	12th-18th Aug 2014	640 Marsh Road	Larson Davis 870	1459

Table 11.4 - Monitoring Locations

The instruments were programmed to accumulate noise data continuously over sampling periods of 15-minutes for the entire monitoring period. Internal software then calculates and stores the Ln percentile noise levels for each sampling period, which can later be retrieved for detailed analysis.

The instruments were calibrated using a Rion NC-73 calibrator immediately before and after monitoring and showed a maximum error of 0.5 dB.

Loc.	Period	LAeq	LA90	RBL
N1	Day	70	52	52
	Evening	60	49	48
	Night	68	51	49
N2	Day	61	43	43
	Evening	69	43	41
	Night	48	41	47
N3	Day	47	40	40
	Evening	46	40	39
	Night	45	38	36
N4	Day	47	40	40

	Evening	40	37	36
	Night	41	39	38

Table **Table11.5** presents a summary of the current ambient noise levels at the monitoring locations.

Loc.	Period	L_{Aeq}	L_{A90}	RBL[15]
N1	Day	70	52	52
	Evening	60	49	48
	Night	68	51	49
N2	Day	61	43	43
	Evening	69	43	41
	Night	48	41	47
N3	Day	47	40	40
	Evening	46	40	39
	Night	45	38	36
N4	Day	47	40	40
	Evening	40	37	36
	Night	41	39	38

Table 11.5 - Summary of current ambient noise levels (dB (A))

[15] RBL is the median of the overall assessment background noise level calculated using OEH Industrial Noise Policy methodology as defined in the glossary of acoustic term

11.5 ASSESSMENT METHDOLOGY, NOISE AND VIBRATION CRITERIA

11.5.1 NSW EPA Industrial Noise Policy (INP)

THE EPA (OEH) INP sets limits on the noise that may be generated by a wide array of facilities and includes guidance applicable for the assessment potential noise impacts from developments such as the proposed sand mine, during the operational stage. These limits are dependent upon the existing noise levels at the site and are designed to ensure changes to the existing noise environment are minimised and deal with the intrusiveness of the noise and the amenity of the environment. The most stringent of the limits is taken as the limiting criterion for the noise source.

The intrusiveness noise criterion requires that the $L_{Aeq,15minutes}$ for the noise source, measured at the most sensitive receiver under worst-case conditions, should not exceed the Rated Background Level (RBL) by more than 5dB, represented as follows:

- $L_{Aeq,15minutes}$ < RBL+ 5dB

Noise levels at nearby noise sensitive receptors (located in the surrounding area), associated with the proposed sand mine should not exceed the Project Specific Noise Levels detailed in **Table 11.6**, which have been determined on the basis of the results of the baseline noise surveys. It should be noted that there are no existing noise sensitive receptors located near the rear of the proposed development site, represented by the baseline noise monitoring location N4.

Location	Period	L_{Aeq}	RBL	Recommended Acceptable L_{Aeq}[1]	Intrusiveness Criteria Level	Project Specific Noise Level
N1 R2, R3, R22-R25	Day	70	52	50	57	50
	Evening	60	48	45	53	45
	Night	68	49	40	54	40
N2 R5, R7, R8, R10, R11, R18-R21	Day	61	43	50	48	48
	Evening	69	41	45	46	45
	Night	48	37	40	52	40
N3 R1 and R9	Day	47	40	50	45	45
	Evening	46	39	45	44	44
	Night	45	36	40	41	40
N4 R13-R17	Day	47	40	50	45	45
	Evening	40	36	45	41	41
	Night	41	38	40	43	40

Table 11.6 - Project Specific Noise Levels at Noise Sensitive Receptors dB(A) - Residential

[1] Recommended Acceptable L_{Aeq} noise level for residence in Rural and Suburban area from Table 2.1 in OEH Industrial Noise Policy.

Loc.	Period	Recommended L_{Aeq} - Acceptable Levels (Noisiest 1-hour period)
R4 - Marsh Road Public School	When in Use	40
R6 - Marsh Road Public Hall	When in Use	55
R12 - Shark and Ray Centre	When in Use	55

Table 11.7 - Project Specific Noise Levels for Non - Residential - dB(A)

11.5.2 Sleep Disturbance Assessment Approach

Guidance indicating the potential for sleep disturbance is set out in the NSW Environmental Criteria for Road and Traffic Noise (EPA 1999), and is summarised as follows:

OEH reviewed research on sleep disturbance in the NSW Environmental Criteria for Road Traffic Noise (ECRTN) (EPA, 1999). This review concluded that the range of results is sufficiently diverse that it was not reasonable to issue new noise criteria for sleep disturbance.

From the research, OEH recognised that current sleep disturbance criterion of an $L_{A1, (1\ minute)}$ not exceeding the L_{A90}, (15 minute) by more than 15 dB(A) is not ideal. Nevertheless, as there is insufficient evidence to determine what should replace it, OEH will continue to use it as a guide to identify the likelihood of sleep disturbance.

This means that where the criterion is met, sleep disturbance is not likely, but where it is not met, a more detailed analysis is required.

The detailed analysis should cover the maximum noise level or $L_{A1, (1\ minute)}$, that is, the extent to which the maximum noise level exceeds the background level and the number of times this happens during the night-time period. Some guidance on possible impact is contained in the review of research results in the appendices to the ECRTN. Other factors that may be important in assessing the extent of impacts on sleep include:

- How often high noise events will occur
- Time of day (normally between 10pm and 7am)
- Whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods).

The $L_{A1, (1\ minute)}$ descriptor is meant to represent a maximum noise level measured under 'fast' time response. DECCW will accept analysis based on either $L_{A1, (1\ minute)}$ or $L_{A(Max)}$.

It should be noted that the OEH refers to the Office of Environment and Heritage, and DECCW refers to the Department of Environment, Climate Change and Water.

Table 11.8 details the criteria for sleep disturbance for each of the individual noise receiver locations.

Location	Period	L_{A90}	Criteria (L_{A90} +15)
N1 R2, R3, R22-R25	Day	52	67
	Evening	49	64
	Night	51	66
N2 R5, R7, R8, R10, R11, R18-R21	Day	43	58
	Evening	43	58
	Night	41	56
N3 R1 and R9	Day	40	55
	Evening	40	55
	Night	38	53
N4 R13-R17	Day	40	55
	Evening	37	52
	Night	39	54

Table 11.8 - Sleep Disturbance Noise Criteria at Noise Sensitive Receptors dB(A) - Residential

11.5.3 NSW Road Noise Policy (RNP)

The requirements of the NSW Road Noise Policy (RNP) published by the Department of Environment, Climate Change and Water (DECCW) are also applicable to this assessment. ***Table 11.9*** summarises the road category to establish the noise assessment criteria based on the type of road and the land use developments. The proposed development has the potential to generate additional traffic on the arterial/local roads that can potentially impact on the nearby noise sensitive receivers.

Road Category	Type of project / land use	Assessment Criteria/ Target Noise Level, dB(A)	
		Day (7am-10pm)	Night (10pm-7am)
Freeway/arterial/sub-arterial Road (Nelson Bay Road)	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments.	$L_{Aeq,\ (15hour)}$ 60 (external)	$L_{Aeq,\ (9\ hour)}$ 55 (external)
Local Roads (Marsh Road)	Existing residences affected by additional traffic on existing local roads generated by land use developments	$L_{Aeq,\ (1\ hour)}$ 55 (external)	$L_{Aeq,\ (1\ hour)}$ 50 (external)

Note: These criteria are for assessment against façade- corrected noise levels when measured in front of a building façade. Hence, a correction factor of 2.5 dB is added to the predicted noise levels

Table 11.9 - Road Traffic Noise Assessment Criteria for Residential Land Uses

As stated in Section 3.4 of the Road Noise Policy, with regard to existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use development, any increase in total traffic noise level should be limited to 2dB above that of the corresponding 'no build option'.

The noise assessment criterion for non-residential land use is listed in **Table 11.10**. This criterion is applied when assessing the impact and determining mitigation measures in the following situations:

- When there is a new road or road development;
- When there is a land use development with the potential to generate additional traffic on local, sub-arterial or arterial roads.

Existing sensitive land use	Assessment criteria- dB(A)		Additional Consideration
	Day (7am – 10pm)	Night (10pm – 7am)	
School classrooms	$L_{Aeq,1hr}$ 40 (Internal) When in use	-	In the case of a building used for education or health care, noise level criteria for spaces other than classrooms and wards may be obtained by interpolation from the 'maximum' levels shown in Australian Standard 2107:2000 (Standards Australia 2000).
Places of worship	$L_{Aeq,1hr}$ 40 (Internal)	$L_{Aeq,1hr}$ 40 (Internal)	The criteria are internal, i.e. the inside of a Church. Areas outside the place of worship, such as Churchyard or Cemetery, may also be a place of worship. Therefore, in determining appropriate criteria for such external areas, it should be established what in these areas may be affected by road traffic noise.

Table 11.10 - Road traffic noise assessment criteria for non-residential land uses affected by proposed road projects and traffic generating developments (Sheet 1 of 2)

Existing sensitive land use	Assessment criteria- dB(A)		Additional Consideration
	Day (7am – 10pm)	Night (10pm – 7am)	
Childcare facilities	Sleeping rooms $L_{Aeq,1hr}$ 35 (Internal) Indoor Play areas $L_{Aeq,1hr}$ 40 (Internal) Outdoor Play areas $L_{Aeq,1hr}$ 55 (External)	-	Multi-purpose spaces, e.g. shared indoor play/sleeping rooms should meet the lower of the respective criteria. Measurements for sleeping rooms should be taken during designated sleeping times for the facility or if these are not known, during the highest hourly traffic noise level during the opening hours of the facility.

Commercial and Industrial Premises	Shopping Mall L_{Aeq},45-55 (Internal) Small Retail Stores (general) L_{Aeq} 45-50 (Internal) Hotels and motels (sleeping areas) L_{Aeq} 35-40 (Internal)	Shopping Mall L_{Aeq},45-55 (Internal) Small Retail Stores (general) L_{Aeq} 45-50 (Internal) Hotels and motels (sleeping areas) L_{Aeq} 35-40 (Internal)	Information on desirable internal noise levels is contained in Australian Standard 2107:2000.

Table 11.11 - Road traffic noise assessment criteria for non-residential land uses affected by proposed road projects and traffic generating developments (Sheet 2 of 2)

Where internal noise levels were specified for the applicable criteria outlined in ***Table 11.10*** above, +10dB was added to approximate to an external noise level, for the purposes of the traffic noise assessment which is undertaken to assess noise levels externally to noise sensitive properties.

11.5.3.1 Practice Note 3 (Sleep Disturbance Impact)

A substantial portion of the DECC NSW Road Noise Policy (RNP) discusses a review of international research on the subject of sleep disturbance associated with noise. The guidance outlined with regard to road traffic noise and potential impacts on sleep disturbance expands on previous guidance set out in the RTA Environmental Noise Management Manual (ENMM) and earlier guidance set out in the Environmental Protection Authority Environmental Criteria for Road Traffic Noise (ECRTN).

The most recent guidance set out in the RNP states that "*there appears to be insufficient evidence to set new indicators for potential sleep disturbance due to road traffic noise*". The RNP refers to the RTA Practice Note 3 protocol as the method for assessing and reporting on maximum noise levels that may cause sleep disturbance. The guidelines indicate that:

- Maximum internal noise levels below 50-55 dB(A) are unlikely to cause awakening reactions, and
- One or two noise events per night with maximum internal noise levels of 65-70 dB(A) are not likely to significantly affect health and well-being.

11.5.4 Vibration Criteria – Human Response to Vibration

The effects of construction vibration upon buildings can be separated into three main categories:

- Perceptibility of the occupants to the vibration, and the possibility of them being disturbed or annoyed;
- Vulnerability of the building structures to vibration induced damaged;
- Vulnerability of the contents of the building that includes types of equipment, activities and processes.

Humans are very sensitive to vibration, and they can be disturbed, annoyed, and have their work activities interfered with if the levels are too high. The DECC "Assessing Vibration –

Technical Guideline" (2006) and British Standard 6472-1:2008 Guide to evaluation of human exposure to vibration in buildings, Part 1 – Vibration sources other than blasting provides guidance on human response to vibration in buildings. The guidelines set down base vibration levels at which there would be minimal interference to occupants.

BS6841:1987 Guide to measurement and evaluation of human exposure to whole-body mechanical vibration and repeated shock also sets out guidance on the effects of physical health from sustained exposure to vibration. However, it is unlikely that such levels would be encountered from construction, demolition or sand mining activities. The frequency weighting to be applied to the vibration levels are obtained from BS6841.

The criteria and guidelines relating to human response are summarised below.

11.5.4.1 DECC Assessing Vibration: A Technical Guideline

The DECC "*Assessing Vibration – Technical Guideline*" (2006) provides evaluation methods to assess the human response from continuous, impulsive and intermittent vibration in buildings from 1Hz to 80Hz which is based on British Standards 6472:1992 "*Evaluation of the Human Exposure to Vibration in Building (1Hz to 80Hz)*".

For continuous and impulsive vibration, assessment of impact should be considered on the basis of weighted RMS acceleration values. For intermittent vibration, assessment of impact should be considered on the basis of vibration dose values (VDV).

The DECC guidelines also include a section on mitigation when the predicted vibration value exceeds the criteria. Vibration mitigation may be achieved by way of:

- Controlling the vibration at the source, using the application of Best Management Practice (BMP) and Best Available Technology Economically Achievable (BATea).
- Controlling the transmission of vibration.
- Controlling the vibration at the receiver

11.5.4.2 British Standard 6472:2008- Evaluation of Human Exposure to Vibration in Buildings

BS6472:1992 was updated in 2008 by BS6472:2008 Parts 1 and 2. BS6472:2008 Part 1 sets out vibration levels at which minimal comment is likely to be provoked from the occupants of a building subject to vibration (BS6472:2008 Part 2 relates to Blast-induced vibration). BS 6472 takes into account the fact that humans perceive vertical vibrations to a greater extent than horizontal vibrations, although the effect is reversed at very low frequencies, below 4 Hz.

The evaluation of building vibration with respect to annoyance and comfort for occupants, over all weighted values of vibration is the preferred method of evaluation.

Continuous vibration would be generated for typical construction work. The curves in **Figure 11.6** represent the magnitudes of continuous vibration in buildings for Z-axis acceleration, below which adverse comments or complaints are rare. Multiplication factors are applied to the base level curve to define criteria for residential or office spaces. There are similar curves for x and y-axes.

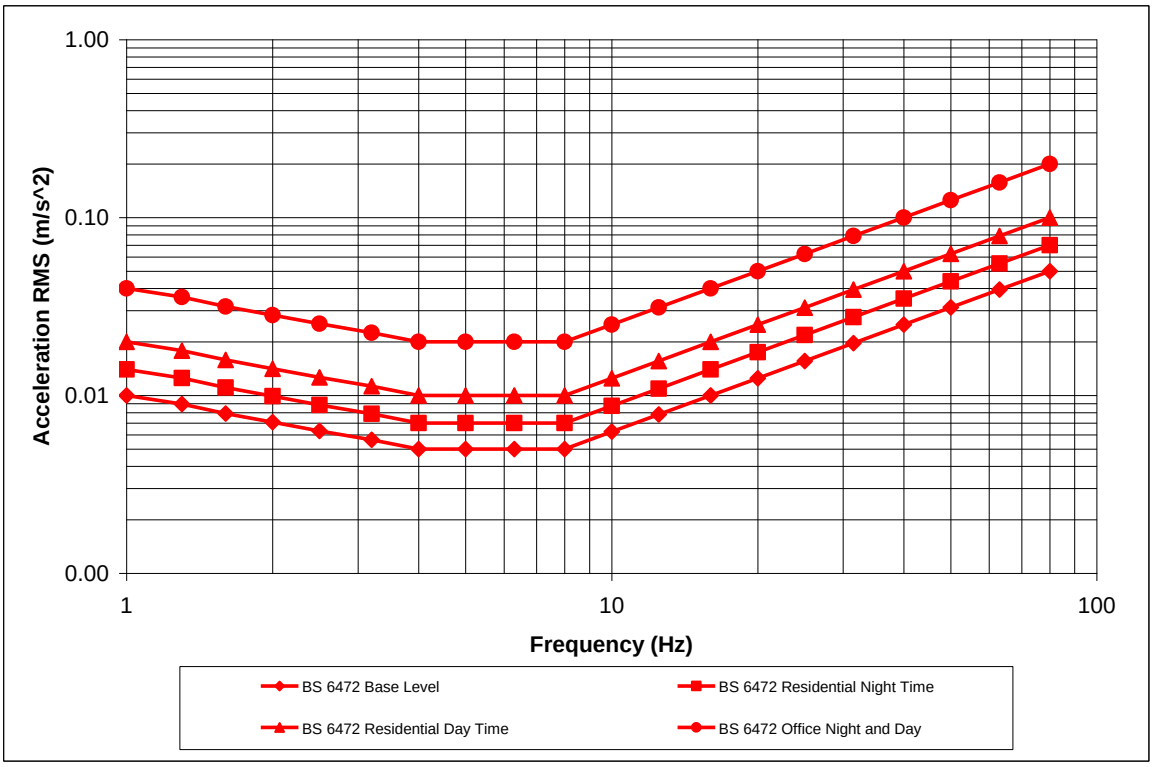


Figure 11.6 - BS 6472 building vibration levels. Z-axis

The Vibration Dose Value in BS 6472 is a concept used to evaluate the cumulative effects of bursts of both intermittent vibration and impulsive vibrations. Vibration Dose Value or the VDV represents a single value amount used to quantify the level of vibration.

The recommended VDV levels outlined in the OEH Vibration Guidelines (based on the BS6472:1992 Standard) which specifies levels of VDV expressed in daytime, night-time and typical human response are presented in **Table 11.1** presents levels of VDV expressed in daytime, night-time and typical human response, based on the updated BS6472:2008 Part 1.

Location	Daytime[1]		Night-time	
	Preferred Value $m/s^{1.75}$	Maximum Value $m/s^{1.75}$	Preferred Value $m/s^{1.75}$	Maximum Value $m/s^{1.75}$
Critical areas[2]	0.1	0.2	0.1	0.2
Residences	0.2	0.4	0.13	0.26
Offices, schools, educational institutions and places of worship	0.4	0.8	0.4	0.8
Workshops	0.8	1.6	0.8	1.6

Note 1: Daytime is 07:00 am to 10:00 pm and night-time is 10:00 pm to 07:00 am.

Note 2: Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous or impulsive criteria for critical cases.

Table 11.12 - Acceptable vibration dose values for intermittent vibration in various buildings ($m/s^{1.75}$)

Place and time	Low probability of adverse comment $m/s^{1.75}$ Note 1	Adverse comment possible $m/s^{1.75}$	Adverse comment probable $m/s^{1.75}$ Note 2
Residential buildings 16h day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8h night	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8
Office buildings 16h day	0.4 to 0.8	0.8 to 1.6	1.6 to 3.2
Workshop buildings 16h day	0.8 to 1.6	1.6 to 3.2	3.2 to 6.4

Note 1: Below these ranges, adverse comment is not expected.

Note 2: Above these ranges, adverse comment is very likely.

Table 11.13 - Vibration dose value ranges which might result in various probabilities of adverse comment within various buildings ($m/s^{1.75}$)

Vibration frequency was assessed in a range from 8Hz - 80 Hz, as predominant frequencies are known to be above 8Hz. Vibration levels below the low probability of adverse comment range presented in **Table 11.1** correspond to a low probability of disturbance to building occupants. Adverse comment or complaints may be expected when the VDV approaches the higher range levels in the possible and probable categories. Values up to the maximum level in **Table 11.1** can only be used where all reasonable and feasible measures have been implemented and they can be justified.

Criteria for exposure to continuous and impulsive vibration with regard to PPV levels expressed in daytime and night-time (outlined in the OEH Vibration Guidelines) is provided in **Table 11.14**.

Place	Time	Peak Particle velocity (mm/s) for z-axis vibration - Frequency range 8Hz-80Hz	
		Exposure to continuous vibration (16h day, 8h night)	Impulsive vibration excitation with up to three occurrences
Critical working areas (e.g. hospital operating theatres, precision laboratories)	Day Night	0.14 to 0.28 0.14 to 0.28	0.14 to 0.28 0.14 to 0.28
Residential	Day Night	0.28 to 0.56 0.2 to 0.4	8.6 to 17.0 2.8 to 5.6
Office	Day Night	0.56 to 1.1 0.56 to 1.1	18.0 to 36.0 18.0 to 36.0
Workshops	Day Night	1.1 to 2.2 1.1 to 2.2	18.0 to 36.0 18.0 to 36.0

Table 11.14 - Peak Particle velocity for z-axis

11.5.5 Structural Response to Vibration

The response of a building to vibration is affected by several factors that include its type of foundation; the underlying ground conditions, its construction and the state of the building.

BS 7385: Part 2-1993 *Evaluation and measurement for vibration in buildings - Part 2: Guide to damage levels from ground borne vibration* provides guidance values for building damage, as well as guidance on vibration measurement and data analysis. The German Standard DIN 4150: Part 3-1999 *Structural vibration - Effects of vibration on structures* also provides guidelines for evaluating the effects of vibration on structures.

11.5.5.1 German Standard DIN 4150-3:1999 – Structural Vibration – Effects of Vibration on Structures

The German Standard DIN 4150: Part 3-1999 *Structural Vibration Part 3: Effects on buildings and structures* is commonly used in Australia to evaluate the effects of vibration on structures primarily used for static loading.

Short-term vibration is defined as vibration which does not occur often enough to cause structural fatigue and which does not produce resonance in the structure being evaluated.

Table 11.15 provides guideline limits for short-term vibration to ensure that damage reducing the serviceability of a building will not occur provided vibration levels do not exceed these limits. This is also shown graphically in ***Figure 11.7*** Vibration at the foundation is taken as the maximum absolute value in the x, y, and z directions, and vibration at the highest floor is the maximum of the in-plane components.

Type of structure	Guideline values for velocity in mm/s			
	Vibration at the foundation at a frequency of			Vibration at horizontal plane of highest floor at all frequencies
	1Hz to 10Hz	10 to 50Hz	50 to 100Hz (and above)	
Buildings for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
Dwellings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20	15
Structures that because of their particular sensitivity to vibration, cannot be classified as above and are of great intrinsic value (e.g. listed buildings under preservation order)	3	3 to 8	8 to 10	8

Table 11.15 - DIN4150-3 Vibration Limits

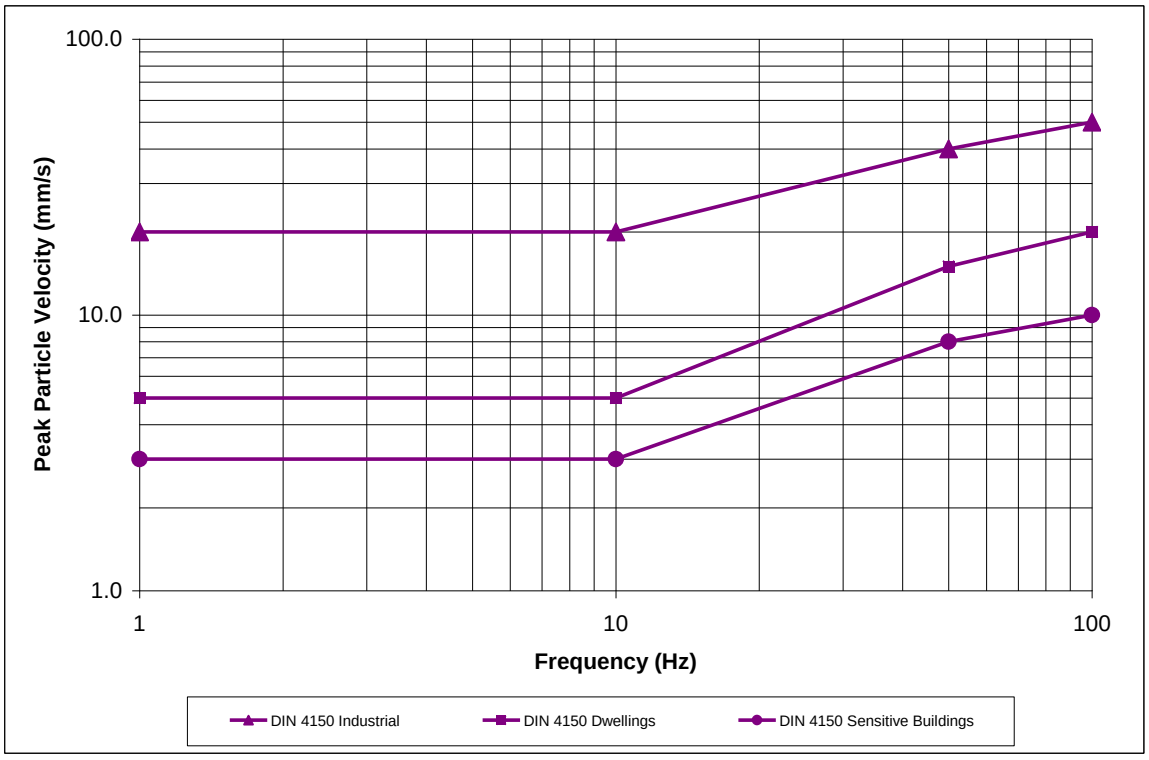


Figure 11.7 - DIN 4150-3 Vibration Limits

11.5.5.2 British Standard 7385 Part 2 – 1993 Guide to damage levels from groundborne vibration

The limits for transient vibration, above which cosmetic damage could occur to buildings, are given in **Table 11.16** and shown graphically in ***Figure 11.8***.

These guide values however relate predominantly to transient vibration that does not give rise to resonant responses in structures. The guide values in **Table 11.16** should be reduced by up to 50%, in the case of dynamic loading caused by continuous vibration. The values presented in BS 7385-2 are frequency dependant levels that are judged to give a minimal risk of vibration-induced damage.

Type of building	Peak component particle velocity in frequency range of predominant pulse	
	4 Hz to 15 Hz	15 Hz and above
Reinforced framed structures, Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
Un-reinforced or light framed structures, Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above
Note 1: Values referred to are at the base of the building Note 2: For the residential buildings group, at frequencies below 4 Hz, a maximum displacement of 0.6mm (zero to peak) should not be exceeded		

Table 11.16 - Transient vibration guide values for cosmetic damage

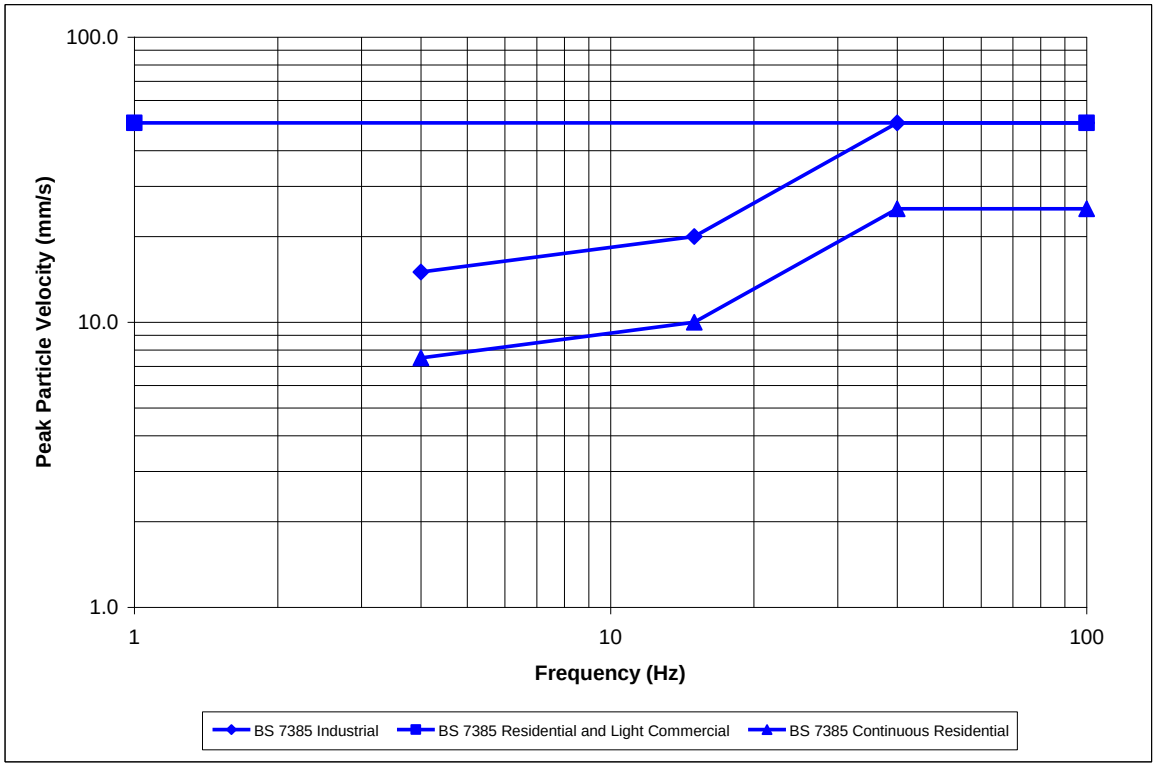


Figure 11.8 - Transient Vibration Guide for Cosmetic Damage

11.5.5.3 Construction Vibration Assessment Criteria Summary

A comparison to the above criteria is shown in ***Figure 11.9***. PPV values have been used for the human disturbance values, in order to compare against building damage guide values.

The human disturbance criterion from BS 6472 for continuous vibration is significantly lower than the various threshold damage levels from DIN 4150 and BS 7385. This is due to humans being able to perceive vibration levels that are well below those that could cause any risk to damage to a building or its contents.

The values in DIN 4150 are levels that if complied with, damage will not occur. If levels are exceeded damage will not necessarily occur, however if they are significantly exceeded, then further investigations will be required.

The vales in BS 7385 are the lowest vibration levels above which damage has been credibly demonstrated. This is the basis on which the values are much higher than those of DIN 4150. Based on the above, the following criterion is deemed most appropriate and is recommended for use in this assessment:

- When the adjacent building subject to vibration is being occupied, continuous vibration levels from BS 6472 will be used to assess human perception. Human perception occurs at lower thresholds than that for building damage and during occupied periods will be the limiting criteria.
- When it is un-occupied, vibration levels from DIN 4150 will be used to protect the building from cosmetic damage.

Type	Human Perception and cosmetic damage criteria	
	Human Perception (mm/s)	Cosmetic Damage (mm/s)
Residential	0.28-0.56	5

Table 11.1**Table 11.17** provides a summary of vibration management levels criterion at the sensitive receivers (which have been determined in accordance with the *Interim Construction Noise Guideline*).

Type	Human Perception and cosmetic damage criteria	
	Human Perception (mm/s)	Cosmetic Damage (mm/s)
Residential	0.28-0.56	5

Table 11.17 - Human perception and cosmetic damage criteria (minimum value)

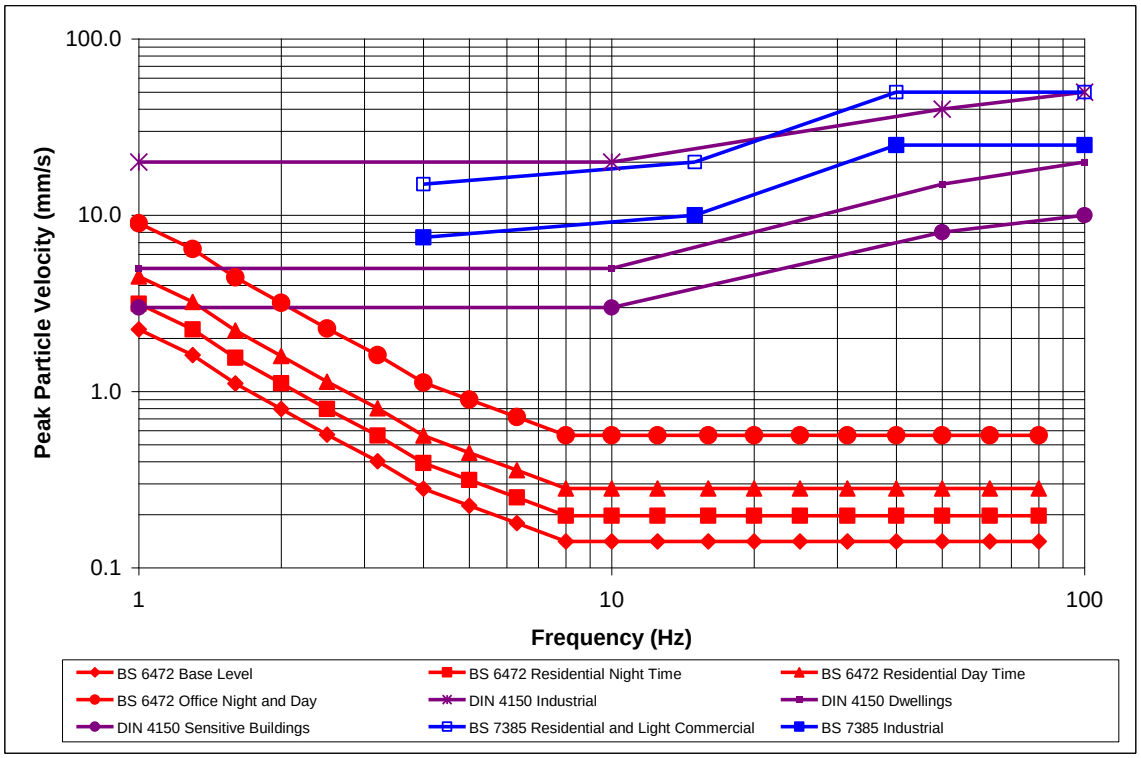


Figure 11.9 - Human Disturbance and Building Damage Guide Values

11.6 NOISE MODELLING

Noise modelling has been undertaken using the SoundPLAN® computational noise modelling software package. The use of the SoundPLAN® software and referenced modelling methodology is accepted for use in the state of NSW by the EPA (OEH) for environmental noise modelling purposes. Vipac have undertaken numerous noise modelling and impact assessments previously for a range of projects, including infrastructure development and industrial projects using SoundPLAN®.

11.6.1 Geographical Data

Tattersall Lander supplied topographical details of the area to Vipac and **Table 11.18** below lists the drawings received and used in the noise prediction model.

Drawing Title	Description	Date
Existing Surface Survey dxf	Current Terrain Layout	11/08/2014
3m Design Surface dxf	3m pit proposed design	11/08/2014
1m Design Surface dxf	1m pit proposed design	11/08/2014
-15m Design Surface dxf	-15m proposed pit design	11/08/2014
Sand Mine Plan (Rev B)	Proposed Mine Layout	06/05/2015

Table 11.18 - Drawings used

11.6.2 Operational Phases

11.6.2.1 Noise Sources

Vipac has been advised by Tattersall Lander that the main noise contributor associated with the proposed sand mine will be the operation of the mobile plant and export lorries utilised in the mining process. A list of mobile plant for use in the noise modelling has been compiled in

conjunction with Tattersall Lander and with details of the mining process and plant as outlined in the QMS mining plan.

Details of the plant and equipment that will be used during the operational phase of the proposed sand mine and associated sound power levels (i.e. noise emission levels associated with the equipment) are listed in **Table 11.19**.

Description	Sound Power levels, L_w (dB(A))	Sound Power Reference Source
22 Tonne Excavator	106	BS5228-1-2009
35 Tonne Excavator	109	BS5228-1-2009
44 tonne Haul Truck	118	BS5228-1-2009
Sales Loader	112	BS5228-1-2009
Conveyor System Head Drive	97	BS5228-1-2009
Screens	109	BS5228-1-2009
Pump	100	BS5228-1-2009
Export lorry 32 tonne	110	BS5228-1-2009
Pump on Dredge	108	BS5228-1-2009

Table 11.19 - Sound Power Levels (L_w).

11.6.2.2 Noise Modelling Scenario

Vipac understands that the proposed sand mine will operate from 6am to 4pm once the mine is operational. A site layout plan of the proposed facility is provided as ***Figure 11.3***.

The mine will progress in phases with Dry mining from current terrain down to the water table and then wet mining commencing by way of dredge down to a final depth of -15m AHD. Vipac has, as worst-case, conservatively modelled at the beginning of each phase. Dry mining at the current terrain levels, at the 3m terrain level provided and wet mining commencing at the 1m terrain level and -15m terrain level provided.

11.6.2.3 Weather Conditions

Four acoustic modelling scenarios were assessed for the operational phase of the proposed sand mine within the SoundPLAN program using CONCAWE algorithms under both neutral and worst-case weather conditions for the day and night periods. It should be noted that sound will propagate further through the atmosphere under certain weather conditions dependent on-air pressure variations, wind speed and direction variations, temperature inversions etc. The 'worst-case' weather conditions chosen were those highly conducive to the propagation of sound.

Table 11.20 presents the weather parameters used in the CONCAWE calculations based on annual data from the Bureau of Meteorology (BoM) Weather Station at Nelson Bay.

Parameter	Day		Evening/Night	
	Neutral	Worst-case	Neutral	Worst-case
Pasquill Stability Category	B	D	D	F
Wind Speed (m/s)	0	3	0	3
Humidity (%)	57	57	75	75
Temperature (deg Celsius)	16	16	10	10
Met Category	3	5	4	6

Table 11.20 - Sound Plan Weather Parameters

11.6.3 Noise Impact from Generated Traffic

The Calculation of Road Traffic Noise (CoRTN) method of traffic noise prediction was used, which is a method approved by the EPA (OEH). The traffic data presented in the "Bobs Farm Sand Quarry Traffic Impact Assessment" (by Seca Solution, dated 24th October 2014) and augmented with automatic traffic counts which were obtained on Nelson Bay Road between Marsh Road and Port Stephens Road in September 2014.

Traffic will enter the site via the entrance off Nelson Bay Road at the southern end of the site. Vehicles will travel along the private road in the southern and eastern areas of the site and exit turning right onto to Marsh Road near the junction of Marsh Road and Nelson Bay Road.

The Seca Solutions report assumes the site will generate 200 trucks per day during peak periods, increasing the AADT west of the site by 360 vehicles per day, raising it from 15,311 to 15,671 vehicles per day representing an increase of 2.3%.

Vipac has also conducted noise modelling for the four phases of operation, as outlined in the Quarry Mining System reports, based on projected export tonnage specified in the report and an average export load of 30 tonnes per shipment to assess the traffic outside peak times. The increased number of trucks utilising the road is outlined below in **Table 11.21.**

Phase	Truck movements
1	24
2	40
3	72
4	112
Peak	200

Table 11.21 - Estimated Truck Movements

Table 11.22 and **Table 11.23** provide the following increase of traffic travelling eastbound to the west of the site on Nelson Bay Road and exiting along Marsh Road and turning right westbound onto Nelson Bay Road.

Traffic Details	Nelson Bay Road					
	Base Traffic	Base Traffic + Phase 1	Base Traffic + Phase 2	Base Traffic + Phase 3	Base Traffic + Phase 4	Base Traffic + Proposed Peak
Average Daily Traffic	15311	15335	15351	15383	15433	15511
15 hour traffic flows (Day Period)	14323	14343	14358	14390	14430	14518
% Percentage Heavy Vehicles (15 hours)	4	4.4	4.5	4.7	5.0	5.5
9 hour traffic flows (Night Period)	988	992	993	993	933	933
% Percentage Heavy Vehicles (9 hours)	4.6	5.0	5.0	5.0	5.0	5.0
Speed Limit (km/h)	80					

Table 11.22 - Traffic Volumes – Nelson Bay Road

Traffic Details	Marsh Road					
	Base Traffic	Base Traffic + Phase 1	Base Traffic + Phase 2	Base Traffic + Phase 3	Base Traffic + Phase 4	Base Traffic + Proposed Peak
Average Daily Traffic	708	732	748	780	820	908
15 hour traffic flows (Day Period)	680	700	715	747	787	875
% Percentage Heavy Vehicles (15 hours)	4.55	7.28	9.2	13.1	13.6	15.8
9 hour traffic flows (Night Period)	28	32	33	33	33	33
% Percentage Heavy Vehicles (9 hours)	0	12.5	15.1	15.1	15.1	15.1
Speed Limit (km/h)	60					

Table 11.23 - Traffic Volumes – Marsh Road

11.7 RESULTS

11.7.1 Modelled Noise – Operational Phases (L_{Aeq})

Noise prediction modelling has been carried out to assess the potential impact associated with the proposed sand mine on the existing noise environment at the nearest noise sensitive receptors located in proximity to the site. Due to the layout of the proposed mine Vipac has approached the modelling by breaking the mine up into two sides, the western end of the mine pit close to Receivers R13-17 and the eastern end of the mine pit close to receivers R1 and R9

with an operational scenario being conducted for each of the phases of operation. The haul road accessing the site from Nelson Bay Road and exiting onto Marsh Road has also been modelled to assess the impact on the receivers in Marsh Road Village from the private haul road. Noise emissions associated with operations on the haul road has been incorporated into each of the models undertaken for the western end of the pit and the eastern end of the pit operations with regard to the sand mine operational scenarios.

The predicted noise levels representative of each of the operational phases for Phase 1, Phase 4 and Peak onsite truck operations for both neutral conditions and worst-case conditions during day and evening/night-time are presented in ***Tables 11.23 – 11.27***. The results for Phase 2 and Phase 3 are presented in ***Annex J***.

11.7.2 Sand Mine Operations (OPERATIONAL NOISE ASSESSMENT) – Daytime Operations

The results of the noise modelling show that there are exceedances predicted for Receivers R2, R3, R5 and R7 for the worst-case weather conditions during the sand mine operations from Phase 1 operations (i.e. initial phase of sand mine site development and commencement of extraction operations) onwards. Additionally, at Receiver R2 for both neutral and worst-case conditions exceedances are predicted from Phase 2 operations onwards and Receivers R3, R5 and R7 from Phase 3 onwards for both neutral and worst conditions for the operation of the sand mine. These exceedances are largely attributed to the operation of the export lorries along the private haul road.

To mitigate these exceedances Vipac proposes a 4m high acoustic barrier be installed along both sides of the private haul road at the Marsh Road exit, with the western barrier to be an absorbent barrier and the last 50m of the barrier on both sides (i.e. the western and eastern barrier) at the Marsh Road end to be transparent on both sides to provide visibility of sight lines for export lorries in both directions. The approximate length of the western barrier overall should be 490m and the approximately length of the eastern barrier overall should be 320m. Additional measures have also been taken into consideration including lowering the private haul road, by excavating a haul path through the hill at the eastern end of the pit, which will reduce the potential impact on receivers at the eastern area of the pit operation. Modelling conducted with the mitigation in place shows compliance with the noise criteria for Phase 1 to Phase 4 operations based on the required truck movements.

A 6m high noise bund, approximately 440m in length is proposed to be constructed along the north-eastern (corner) boundary of the pit, as shown in ***Figure 11.10*** to mitigate the impact on Receiver R1 which will be required from Phase 2 operations onwards. This bund is required primarily due to the operation of the private haul road associated with lorries operating at the site in conjunction with Phase 2 operations. However should the demand for export lorries increase during Phase 1 this bund will be need to constructed prior to Phase 2 operations commencing. With the implementation of these mitigation measures the predicted noise levels at R1, are compliant with the daytime noise criteria for all phases of operation.

The results of noise modelling for Phase 1 operations in the western area of the pit show compliance with the criteria at receivers at this end of the pit. Compliance is predicted to be achieved through the effective excavation practices and utilises the current topography which will screen the noise sources in the sand mine (i.e. excavators and haul trucks) from sensitive receptors in the surrounding area. As operations progress to Phase 2 and increased operations develop, the topography will provide less effective screening of the noise sources from the sensitive receptors R13 - R16 due to earlier stages of extraction, which will have changed the topographical profile of the site.

The results of the noise modelling show that there are exceedances predicted at R13 for Phase 2 operations under worst-case conditions in the western end of the sand mine operation. Additionally once dredging operations commence during Phase 3 and continue into Phase 4, the predicted noise levels indicate potential exceedances during worst-case conditions may be experienced at R13. In order to mitigate these noise levels Vipac proposes a 6m high bund 400m in length should be constructed along the boundary at the north-western (corner) boundary of the pit as shown in ***Figure 11.10*** to mitigate the potential noise impact associated with operations during Phase 2 to Phase 4 in the western end of the pit.

These noise mitigation measures are predicted to reduce the noise levels at R13 to below the criteria for Phase 2 to Phase 4 during worst-case weather conditions. As this noise bund is only required for the operations where plant is operating in the western end of the pit, once dredging operations extend into the area of the pit near the plant area toward the eastern end of the mine, the bund at the western end of the pit can be removed. Therefore, as the dredging operations progress through the pit reaching the plant area and progress eastwards, moving away from the western end of the pit the western bund could be removed as noise levels are predicted to be below the noise criteria at the Receiver R13 at this stage.

An additional noise prediction model has also been undertaken to assess the proposed peak 200 export lorry movements during demand as outlined in the Seca Traffic Impact Assessment. The results of this model, presented in ***Table 11.27***, show that even with the mitigation measures of the acoustic barriers in place, exceedances for worst-case conditions were predicted for receiver R2 due to the higher number of export lorries utilising the private haul road and exiting from the mine. Vipac has conducted additional modelling to determine the maximum number of export lorries that can access the site and exit along Marsh Road during the daytime period under worst-case conditions and ensure compliance with the noise criteria, as presented in ***Table 11.28***. This noise modelling has shown that the maximum number of trucks that can exit the private haul road is 180 truck movements per day exiting at the Marsh Road exit.

Rec #	Predicted Noise Levels dB(A)																	
	Criteria	Day Period No Mitigation				Day Period Mitigation applied				Criteria	Night Period No Mitigation				Night Period Mitigation applied			
		Neutral	Worst-case	Compliant		Neutral	Worst-case	Compliant			Neutral	Worst-case	Compliant		Neutral	Worst-case	Compliant	
R1	45	33	41	✓	✓	32	41	✓	✓	40	37	42	✓	✗	36	41	✓	✗
R2	50	49	52	✓	✗	40	43	✓	✓	40	50	52	✗	✗	42	42	✗	✗
R3	50	49	52	✓	✗	36	38	✓	✓	40	50	51	✗	✗	37	38	✓	✓
R4	40 (when in use)	35	38	✓	✓	26	30	✓	✓	40 (when in use)	36	38	✓	✓	26	30	✓	✓
R5	48	48	50	✓	✗	37	40	✓	✓	40	49	50	✗	✗	38	40	✓	✓
R6	55 (when in use)	39	44	✓	✓	30	36	✓	✓	55 (when in use)	41	44	✓	✓	33	36	✓	✓
R7	48	45	48	✓	✓	34	39	✓	✓	40	46	48	✗	✗	36	39	✓	✓
R8	48	24	32	✓	✓	20	27	✓	✓	40	28	32	✓	✓	27	31	✓	✓
R9	45	24	32	✓	✓	23	30	✓	✓	40	28	32	✓	✓	26	30	✓	✓
R10	48	30	39	✓	✓	30	39	✓	✓	40	35	40	✓	✓	35	40	✓	✓
R11	48	30	39	✓	✓	30	39	✓	✓	40	35	40	✓	✓	35	40	✓	✓
R12	55 (when in use)	22	29	✓	✓	21	28	✓	✓	55 (when in use)	25	29	✓	✓	24	28	✓	✓
R13	45	35	44	✓	✓	33	42	✓	✓	40	39	44	✓	✗	38	42	✓	✗
R14	45	33	42	✓	✓	31	40	✓	✓	40	37	42	✓	✗	36	41	✓	✗
R15	45	33	42	✓	✓	31	41	✓	✓	40	37	42	✓	✗	36	41	✓	✗
R16	45	31	40	✓	✓	31	40	✓	✓	40	35	40	✓	✓	35	40	✓	✓
R17	45	27	37	✓	✓	27	37	✓	✓	40	32	37	✓	✓	32	37	✓	✓
R18	48	24	33	✓	✓	21	30	✓	✓	40	29	33	✓	✓	25	30	✓	✓
R19	48	29	38	✓	✓	26	36	✓	✓	40	33	38	✓	✓	31	36	✓	✓
R20	48	35	42	✓	✓	29	37	✓	✓	40	38	42	✓	✗	33	37	✓	✓
R21	48	39	43	✓	✓	32	39	✓	✓	40	41	44	✗	✗	35	39	✓	✓
R22	50	41	44	✓	✓	29	34	✓	✓	40	42	44	✗	✗	37	40	✓	✓
R23	50	34	41	✓	✓	29	37	✓	✓	40	38	42	✓	✗	36	40	✓	✓
R24	50	32	40	✓	✓	32	40	✓	✓	40	36	40	✓	✓	32	37	✓	✓
R25	50	31	40	✓	✓	30	39	✓	✓	40	35	40	✓	✓	33	38	✓	✓

Table 11.24 - Phase 1 Operation – Western end of Mine Working Scenario – Predicted Noise Impact (L_{Aeq})

Rec #	Predicted Noise Levels dB(A)																	
	Criteria	Day Period No Mitigation				Day Period Mitigation applied				Criteria	Night Period No Mitigation				Night Period Mitigation applied			
		Neutral	Worst-case	Compliant		Neutral	Worst-case	Compliant			Neutral	Worst-case	Compliant		Neutral	Worst-case	Compliant	
R1	45	37	45	✓	✓	35	43	✓	✓	40	41	45	✗	✗	39	44	✓	✗
R2	50	49	52	✓	✗	40	43	✓	✓	40	50	52	✗	✗	42	42	✗	✗
R3	50	49	52	✓	✗	36	38	✓	✓	40	50	51	✗	✗	37	38	✓	✓
R4	40 (when in use)	35	38	✓	✓	26	31	✓	✓	40 (when in use)	36	38	✓	✓	26	30	✓	✓
R5	48	48	50	✓	✗	37	41	✓	✓	40	49	50	✗	✗	39	42	✓	✗
R6	55 (when in use)	39	44	✓	✓	31	37	✓	✓	55 (when in use)	41	44	✓	✓	34	38	✓	✓
R7	48	45	49	✓	✗	35	41	✓	✓	40	47	49	✗	✗	37	41	✓	✗
R8	48	24	32	✓	✓	21	28	✓	✓	40	28	33	✓	✓	24	28	✓	✓
R9	45	27	34	✓	✓	26	33	✓	✓	40	30	34	✓	✓	29	33	✓	✓
R10	48	30	40	✓	✓	31	40	✓	✓	40	35	40	✓	✓	35	40	✓	✓
R11	48	30	40	✓	✓	31	40	✓	✓	40	35	40	✓	✓	35	40	✓	✓
R12	55 (when in use)	30	38	✓	✓	30	38	✓	✓	55 (when in use)	34	39	✓	✓	34	38	✓	✓
R13	45	32	41	✓	✓	31	41	✓	✓	40	36	41	✓	✗	36	41	✓	✗
R14	45	30	40	✓	✓	30	40	✓	✓	40	35	40	✓	✓	35	40	✓	✓
R15	45	30	39	✓	✓	30	39	✓	✓	40	35	40	✓	✓	34	39	✓	✓
R16	45	30	40	✓	✓	30	40	✓	✓	40	35	40	✓	✓	35	40	✓	✓
R17	45	28	37	✓	✓	28	37	✓	✓	40	33	38	✓	✓	33	38	✓	✓
R18	48	25	34	✓	✓	22	30	✓	✓	40	29	34	✓	✓	26	30	✓	✓
R19	48	29	38	✓	✓	26	36	✓	✓	40	34	38	✓	✓	31	36	✓	✓
R20	48	35	42	✓	✓	30	37	✓	✓	40	38	42	✓	✗	33	37	✓	✓
R21	48	40	44	✓	✓	32	40	✓	✓	40	41	44	✗	✗	36	40	✓	✓
R22	50	41	44	✓	✓	29	36	✓	✓	40	42	44	✗	✗	38	41	✓	✗
R23	50	34	42	✓	✓	30	38	✓	✓	40	38	42	✓	✗	36	41	✓	✗
R24	50	33	41	✓	✓	32	40	✓	✓	40	37	41	✓	✗	32	37	✓	✓
R25	50	32	41	✓	✓	31	40	✓	✓	40	36	41	✓	✗	34	39	✓	✓

Table 11.25 - Phase 1 Operation – Eastern end of Mine Working Scenario – Predicted Noise Impact (L_{Aeq})

Rec #	Predicted Noise Levels dB(A)																	
	Criteria	Day Period No Mitigation				Day Period Mitigation applied				Criteria	Night Period No Mitigation				Night Period Mitigation applied			
		Neutral	Worst-case	Compliant		Neutral	Worst-case	Compliant			Neutral	Worst-case	Compliant		Neutral	Worst-case	Compliant	
R1	45	41	48	✓	✗	35	44	✓	✓	40	44	48	✗	✗	39	44	✓	✗
R2	50	55	58	✗	✗	42	46	✓	✓	40	56	58	✗	✗	44	46	✗	✗
R3	50	54	57	✗	✗	41	43	✓	✓	40	55	57	✗	✗	42	43	✗	✗
R4	40 (when in use)	38	41	✓	✗	31	35	✓	✓	40 (when in use)	39	41	✓	✗	33	35	✓	✓
R5	48	50	53	✗	✗	39	43	✓	✓	40	52	53	✗	✗	41	43	✗	✗
R6	55 (when in use)	44	49	✓	✓	35	40	✓	✓	55 (when in use)	46	49	✓	✓	37	40	✓	✓
R7	48	50	53	✗	✗	38	42	✓	✓	40	52	53	✗	✗	39	42	✓	✗
R8	48	28	36	✓	✓	23	30	✓	✓	40	32	36	✓	✓	26	31	✓	✓
R9	45	28	35	✓	✓	27	34	✓	✓	40	31	36	✓	✓	30	34	✓	✓
R10	48	31	41	✓	✓	31	40	✓	✓	40	36	41	✓	✗	36	41	✓	✗
R11	48	31	41	✓	✓	31	40	✓	✓	40	36	41	✓	✗	36	41	✓	✗
R12	55 (when in use)	27	35	✓	✓	26	35	✓	✓	55 (when in use)	31	35	✓	✓	30	35	✓	✓
R13	45	38	47	✓	✗	32	41	✓	✓	40	42	47	✗	✗	37	41	✓	✗
R14	45	31	41	✓	✓	31	41	✓	✓	40	36	41	✓	✗	36	41	✓	✗
R15	45	31	40	✓	✓	31	40	✓	✓	40	35	40	✓	✓	35	40	✓	✓
R16	45	31	40	✓	✓	30	40	✓	✓	40	35	40	✓	✗	35	40	✓	✓
R17	45	28	38	✓	✓	28	37	✓	✓	40	33	38	✓	✓	33	38	✓	✓
R18	48	28	37	✓	✓	23	32	✓	✓	40	32	37	✓	✓	27	32	✓	✓
R19	48	32	41	✓	✓	27	36	✓	✓	40	36	41	✓	✗	32	37	✓	✓
R20	48	41	47	✓	✓	35	41	✓	✓	40	44	47	✗	✗	38	41	✓	✗
R21	48	46	49	✓	✗	41	45	✓	✓	40	47	49	✗	✗	42	45	✗	✗
R22	50	48	51	✓	✗	42	45	✓	✓	40	49	51	✗	✗	43	45	✗	✗
R23	50	39	47	✓	✓	33	41	✓	✓	40	43	47	✗	✗	37	41	✓	✗
R24	50	33	42	✓	✓	33	42	✓	✓	40	38	43	✓	✗	37	42	✓	✗
R25	50	29	37	✓	✓	29	37	✓	✓	40	32	37	✓	✓	32	37	✓	✓

Table 11.26 - Phase 4 Operation - Western End of Mine Working Scenario – Predicted Noise Impact (L_{Aeq})

Rec#	Predicted Noise Levels dB(A)				
	Criteria	Day Period No Mitigation	Day Period Mitigation applied	Criteria	Night Period No Mitigation	Night Period Mitigation applied

		Neutral	Worst-case	Compliant		Neutral	Worst-case	Compliant			Neutral	Worst-case	Compliant		Neutral	Worst-case	Compliant	
R1	45	41	48	✓	✗	35	44	✓	✓	40	44	48	✗	✗	39	44	✓	✗
R2	50	55	58	✗	✗	42	46	✓	✓	40	56	58	✗	✗	44	46	✗	✗
R3	50	54	57	✗	✗	41	43	✓	✓	40	55	57	✗	✗	42	43	✗	✗
R4	40 (when in use)	38	41	✓	✗	31	35	✓	✓	40 (when in use)	39	41	✓	✗	33	35	✓	✓
R5	48	50	53	✗	✗	39	43	✓	✓	40	52	53	✗	✗	41	43	✗	✗
R6	55 (when in use)	44	49	✓	✓	35	40	✓	✓	55 (when in use)	46	49	✓	✓	37	40	✓	✓
R7	48	50	53	✗	✗	38	42	✓	✓	40	52	53	✗	✗	39	42	✓	✗
R8	48	28	36	✓	✓	23	31	✓	✓	40	32	37	✓	✓	27	31	✓	✓
R9	45	29	36	✓	✓	27	34	✓	✓	40	32	36	✓	✓	30	34	✓	✓
R10	48	31	41	✓	✓	31	40	✓	✓	40	36	41	✓	✗	36	41	✓	✗
R11	48	31	41	✓	✓	31	40	✓	✓	40	36	41	✓	✗	36	41	✓	✗
R12	55 (when in use)	27	36	✓	✓	27	35	✓	✓	55 (when in use)	31	36	✓	✓	31	35	✓	✓
R13	45	32	42	✓	✓	32	42	✓	✓	40	37	42	✓	✗	37	42	✓	✗
R14	45	30	40	✓	✓	30	40	✓	✓	40	35	40	✓	✓	35	40	✓	✓
R15	45	30	40	✓	✓	30	40	✓	✓	40	35	40	✓	✓	35	40	✓	✓
R16	45	31	40	✓	✓	31	40	✓	✓	40	35	40	✓	✓	35	40	✓	✓
R17	45	28	38	✓	✓	28	38	✓	✓	40	33	38	✓	✓	33	38	✓	✓
R18	48	28	37	✓	✓	23	32	✓	✓	40	32	37	✓	✓	27	32	✓	✓
R19	48	32	41	✓	✓	27	36	✓	✓	40	36	41	✓	✗	32	36	✓	✓
R20	48	41	47	✓	✓	35	41	✓	✓	40	44	47	✗	✗	38	41	✓	✗
R21	48	46	49	✓	✗	41	45	✓	✓	40	47	49	✗	✗	42	45	✗	✗
R22	50	48	51	✓	✗	42	45	✓	✓	40	49	51	✗	✗	43	45	✗	✗
R23	50	39	47	✓	✓	33	41	✓	✓	40	43	47	✗	✗	37	41	✓	✗
R24	50	33	42	✓	✓	33	42	✓	✓	40	38	43	✓	✗	37	42	✓	✗
R25	50	29	37	✓	✓	29	36	✓	✓	40	32	37	✓	✓	32	37	✓	✓

Table 11.27 - Phase 4 Operation - eastern End of Mine Working Scenario – Predicted Noise Impact (L_{Aeq})

Rec#	Predicted Noise Levels dB(A)																
	Criteria	Day Period No Mitigation				Day Period Mitigation applied				Criteria	Night Period No Mitigation				Night Period Mitigation applied			
		Neutral	Worst-case	Compliant		Neutral	Worst-case	Compliant			Neutral	Worst-case	Compliant		Neutral	Worst-case	Compliant	
R1	45	44	50	✓	✗	37	45	✓	✓	40	46	50	✗	✗	41	45	✗	✗
R2	50	58	61	✗	✗	47	51	✓	✗	40	59	61	✗	✗	49	51	✗	✗
R3	50	57	60	✗	✗	44	46	✓	✓	40	58	60	✗	✗	45	46	✗	✗
R4	40 (when in use)	40	43	✓	✗	33	38	✓	✓	40 (when in use)	42	43	✗	✗	35	38	✓	✓
R5	48	53	56	✗	✗	42	45	✓	✓	40	54	56	✗	✗	43	45	✗	✗
R6	55 (when in use)	47	52	✓	✓	38	43	✓	✓	55 (when in use)	49	52	✓	✓	40	43	✓	✓
R7	48	53	56	✗	✗	40	44	✓	✓	40	54	56	✗	✗	42	44	✗	✗
R8	48	30	39	✓	✓	25	32	✓	✓	40	34	39	✓	✓	28	33	✓	✓
R9	45	30	38	✓	✓	29	35	✓	✓	40	34	38	✓	✓	31	35	✓	✓
R10	48	32	41	✓	✓	31	41	✓	✓	40	36	41	✓	✗	36	41	✓	✗
R11	48	32	41	✓	✓	31	41	✓	✓	40	36	41	✓	✗	36	41	✓	✗
R12	55 (when in use)	29	37	✓	✓	28	37	✓	✓	55 (when in use)	33	38	✓	✓	32	37	✓	✓
R13	45	33	42	✓	✓	33	42	✓	✓	40	37	42	✓	✗	37	42	✓	✗
R14	45	31	40	✓	✓	31	40	✓	✓	40	36	41	✓	✗	35	41	✓	✗
R15	45	31	40	✓	✓	31	40	✓	✓	40	36	41	✓	✗	35	40	✓	✓
R16	45	31	41	✓	✓	31	41	✓	✓	40	36	41	✓	✗	36	41	✓	✗
R17	45	29	38	✓	✓	29	38	✓	✓	40	34	39	✓	✓	34	39	✓	✓
R18	48	31	39	✓	✓	26	34	✓	✓	40	35	40	✓	✓	29	34	✓	✓
R19	48	34	43	✓	✓	28	37	✓	✓	40	38	43	✓	✗	33	37	✓	✓
R20	48	44	49	✓	✗	38	44	✓	✓	40	46	50	✗	✗	41	44	✗	✗
R21	48	49	52	✗	✗	44	47	✓	✓	40	50	52	✗	✗	45	47	✗	✗
R22	50	51	54	✗	✗	45	47	✓	✓	40	52	54	✗	✗	46	48	✗	✗
R23	50	42	49	✓	✓	36	43	✓	✓	40	46	49	✗	✗	39	43	✓	✗
R24	50	36	45	✓	✓	35	44	✓	✓	40	40	45	✗	✗	40	44	✓	✓
R25	50	31	38	✓	✓	31	38	✓	✓	40	34	38	✓	✓	34	38	✓	✓

Table 11.28 - Proposed Peak Truck Requirement (200 trucks per day) Scenario – Predicted Noise Impact (L_{Aeq})

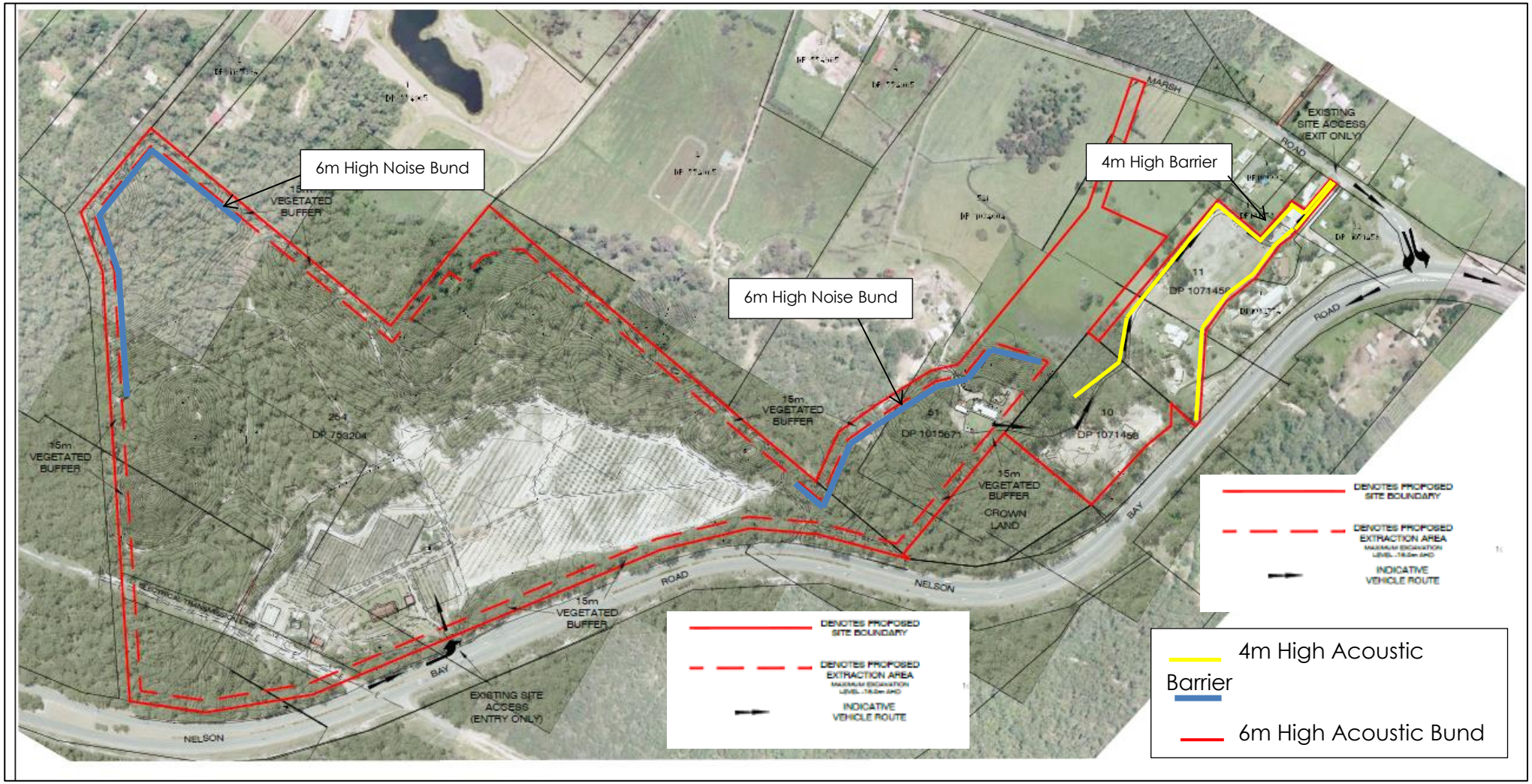


Figure 11.10 - Proposed Noise Bund and Barrier Location

Location	Criteria	Predicted Noise Levels dB(A) - Day Period No Mitigation			
		Neutral	Worst-case	Compliant	
R1	45	37	45	✓	✓
R2	50	46	50	✓	✓
R3	50	43	45	✓	✓
R4	40 (when in use)	33	37	✓	✓
R5	48	41	45	✓	✓
R6	55 (when in use)	38	43	✓	✓
R7	48	40	44	✓	✓
R8	48	25	32	✓	✓
R9	45	28	35	✓	✓
R10	48	31	41	✓	✓
R11	48	31	41	✓	✓
R12	55 (when in use)	28	36	✓	✓
R13	45	33	42	✓	✓
R14	45	31	40	✓	✓
R15	45	31	40	✓	✓
R16	45	31	40	✓	✓
R17	45	29	38	✓	✓
R18	48	25	33	✓	✓
R19	48	28	37	✓	✓
R20	48	38	43	✓	✓
R21	48	43	47	✓	✓
R22	50	44	47	✓	✓
R23	50	35	43	✓	✓
R24	50	35	44	✓	✓
R25	50	30	38	✓	✓

Table 11.29 - Maximum Trucks allowable (180 trucks per day) Scenario – Predicted Noise Impact (L_{Aeq})

11.7.3 Sand Mine operations (OPERATIONAL NOISE ASSESSMENT) – Night-Time Operations

For night-time operations (6am-7am there are exceedances predicted at Receivers R2, R3, R5, R7, R21 and R22 during neutral conditions and additionally Receivers R1, R13, R15, R20, R23 and R24 during worst-case conditions during Phase 1 operations. These exceedances are attributed to the operation of the haul road accessing the sand mine from Marsh Road and export lorries on the road. Vipac has also conducted modelling with mitigation measures in place and found that during neutral conditions receiver R2; and receivers R1, R2, R13, R14 and R15 during worst-case conditions were still exceeding the noise criteria.

The number of exceedances even with the implementation of mitigation measures increases for each of the phases up to Phase 4 operations where during neutral conditions Receivers R2, R3, R5, R21 and R22; and Receivers R1, R2, R3, R5, R7, R10, R11, R13, R14 and R20 to R24 during worst-case conditions exceeded the noise criteria at the receivers. Vipac again also conducted modelling to ascertain the maximum number of trucks permissible in this night-time period (6am-7am) without exceeding the noise criteria at this point and the predicted maximum number of trucks permissible on the haul road during this period is a single truck.

11.7.4 Sand Mine operations (OPERATIONAL NOISE ASSESSMENT) – Sleep Disturbance

Noise prediction modelling has been carried out to assess the potential sleep disturbance impact associated with the proposed sand mine on the existing noise environment at the nearest noise sensitive receptors located in proximity to the site during the night period. The predicted noise levels representative of the operational phase for both neutral conditions and worst-case conditions during the night-time are presented in ***Annex J***. The predicted noise

impact associated with the proposed development of the sand mine on the noise sensitive receivers range between 35 to 63dB(A) at the façade of the noise sensitive receptors.

The predicted noise levels are raised above the sleep disturbance criteria during the sand mine operations at receivers R1 during Phase 1; at the receivers R1, R13, R14 and R15 during Phase 2; at receivers R1, R5, R7, R13, R14, R15 and R21 during Phase 3; and at receivers R1, R5 and R21 during Phase 4 operations. The exceedances range from 1dB exceedance to 5dB. The Marsh Road receivers at the exit of the Haul Road are the most effected experiencing exceedances of 4-5dB(A) during the operation of the sand mine. Due to the predicted exceedances of the sleep disturbance criteria at receivers R1, R5, R7, R13, R14, R15, R20 and R21 during the varied phases of operation and the exceedance of the operational L_{Aeq} criteria for any more than a single truck at the Marsh Road exit of the sand mine site during the night-time period of 6am-7am it is not recommended for the mine to operate during this period.

11.7.5 Undeveloped Land Noise Assessment

Vipac has conducted an assessment of the undeveloped land surrounding the proposed Sand Mine to assess if the predicted noise emissions from the proposed operation of the mine would exceed the noise criteria on more than 25% of the undeveloped land in the surrounding area. To assess this scenario, Vipac has generated a 45dB(A) noise contour map for the operations of Year 1 east, Year 1 West, Year 4 east and Year 4 West, as these are deemed the worst-case scenarios with regard to potential noise impacts associated with operations on-site and noise emissions associated with export trucks.

Receivers R1 & R8 – R17 are the properties with large undeveloped areas of land, located outside the discrete dwelling receivers located on the lands.

As receivers R1, R9 & R13-R17 have a 45dB(A) criteria as outlined in Section 5.1, Vipac has as a conservative approach, generated noise contour maps with a 45dB(A) contour line showing the areas which exceed the 45dB(A) noise level for the proposed operation of the sand mine. By ensuring that undeveloped properties with a 48dB(A) criteria do not have an area in excess of 25% of their total area above a 45dB(A) criteria it will also ensure that these properties will not have an area in excess of 25% of their total area above 48dB(A). The noise contour maps are provided in ***Annex J***.

The noise prediction contour maps show that receivers R1, R9 and R12 all have areas which are predicted to be above the 45dB(A) noise level. These are highlighted in red for receiver R9, green for receiver R12 and yellow for receiver R13 in **Figures 11.11 – 11.14** provided in ***Annex J***. The contour maps show that the proposed operation of the sand mine does not exceed the 45dB(A) criteria on more than 25% of the land for all receivers for all four scenarios modelled with the exception of receiver R1 during Year 1 east operations (highlighted in ***Figure 11.11*** in red, refer to ***Annex J***), where an area in excess of 25% of the property area exceeds the 45dB(A) criteria.

This exceedance is only during the short period of the proposed Year 1 east operations. As the operations progress down to the full depth of the pit and as the proposed noise bund is constructed, during Year 2 operations, the noise levels are predicted not to exceed the 45dB(A) on 25% of Receiver R1, as shown in the Year 4 east Contour map provided in ***Annex J***.

The predicted affected land at Receiver R1 is dense bushland to the rear of the property, adjacent to the proposed sand mine boundary with no buildings or dwelling located in the area of affected land. The main dwelling on the property, the results of which are listed in the discrete receivers in ***Section 11.7.2***, is predicted to comply with the noise criteria during all phases of the

proposed sand mine operations with the applied mitigation measures from Phase 1 Operation onwards.

Thus, although there is a short-term exceedance on more than 25% of the land on the undeveloped land at Receiver 1, it is for a short period during the commencement stages of the proposed sand mine operations, with mitigation measures proposed during Year 2 Operation to mitigate any impact on undeveloped land at receiver R1 to below 25% of the property overall holding.

11.7.6 Traffic Noise Assessment

Noise modelling has also been undertaken to assess the potential noise impacts associated with the additional vehicle movements on Nelson Bay Road and the eastern end of Marsh Road. The noise model has taken into account all the sources (Nelson Bay Road and Marsh Road) associated with traffic that will be generated by the proposed sand mine as outlined in ***Section 11.6.3*** to determine the cumulative noise levels in the area. As Receivers 9-15 are situated along Marsh Road where no additional traffic flow is proposed to be generated by the sand mine they have not been assessed as part of the traffic noise impact assessment.

Additionally, as night-time operations are not recommended due to the exceedances of the noise criteria as outlined in ***Section 11.7.1*** and ***Section 11.7.2*** no traffic noise modelling has been conducted for the night-time period (6am-7am). The results of the traffic noise predictions associated with the proposed sand mine development are presented in ***Tables11. 29 – 11.33***.

Rec #	Location	Day Period ($L_{Aeq,15hr}$)			
		Base Traffic Flow	Base Traffic Flow + Phase 1 Development Flow	Criteria	Difference
1	724 Marsh Road	45.8	45.9	55	0.1
2	776 Marsh Road	57.9	57.9	60	0.0
3	772 Marsh Road	55.5	55.6	55	0.1
4	764 Marsh Road - Public School	53.6	53.7	55	0.1
5	762 Marsh Road	49.2	49.2	55	0.0
6	760 Marsh Road - Public Hall	58.3	58.3	55	0.0
7	756 Marsh Road	48.2	48.2	55	0.0
8	712 Marsh Road	46.9	47.0	55	0.1
16	3551 Nelson Bay Road	48.3	48.4	60	0.1
17	3515 Nelson Bay Road	52.2	52.3	60	0.1
18	723 Marsh Road	48.1	48.1	55	0.0
19	731 Marsh Road	48.9	49.0	55	0.1
20	761 Marsh Road	52.4	52.5	55	0.1
21	767 Marsh Road	54.2	54.2	55	0.0
22	781 Marsh Road	59.4	59.7	60	0.3
23	3780 Nelson Bay Road	58.8	58.8	60	0.0
24	3724 Nelson Bay Road	54.7	54.8	60	0.1
25	3790 Nelson Bay Road	59.9	60.0	60	0.1

Table 11.30 - Cumulative Traffic Noise Impact (dB(A)) – Phase 1 Operation

Rec #	Location	Day Period ($L_{Aeq,15hr}$)			
		Base Traffic Flow	Base Traffic Flow + Phase 2 development Flow	Criteria	Difference
1	724 Marsh Road	45.8	45.9	55	0.1
2	776 Marsh Road	57.9	57.9	60	0.0
3	772 Marsh Road	55.5	55.7	55	0.2
4	764 Marsh Road - Public School	53.6	53.8	55	0.2
5	762 Marsh Road	49.2	49.2	55	0.0
6	760 Marsh Road - Public Hall	58.3	58.4	55	0.1
7	756 Marsh Road	48.2	48.2	55	0.0
8	712 Marsh Road	46.9	47.0	55	0.1
16	3551 Nelson Bay Road	48.3	48.4	60	0.1
17	3515 Nelson Bay Road	52.2	52.4	60	0.2
18	723 Marsh Road	48.1	48.1	55	0.0
19	731 Marsh Road	48.9	49.0	55	0.1
20	761 Marsh Road	52.4	52.5	55	0.1
21	767 Marsh Road	54.2	54.2	55	0.0
22	781 Marsh Road	59.4	59.8	60	0.4
23	3780 Nelson Bay Road	58.8	58.9	60	0.1
24	3724 Nelson Bay Road	54.7	54.8	60	0.1
25	3790 Nelson Bay Road	59.9	60.0	60	0.1

Table 11.31 - Cumulative Traffic Noise Impact (dB(A)) – Phase 2 Operation

Rec #	Location	Day Period ($L_{Aeq,15hr}$)			
		Base Traffic Flow	Base Traffic Flow + Phase 3 development Flow	Criteria	Difference
1	724 Marsh Road	45.8	46.0	55	0.2
2	776 Marsh Road	57.9	58.0	60	0.1
3	772 Marsh Road	55.5	55.8	55	0.3
4	764 Marsh Road - Public School	53.6	53.9	55	0.3
5	762 Marsh Road	49.2	49.2	55	0.0
6	760 Marsh Road - Public Hall	58.3	58.4	55	0.1
7	756 Marsh Road	48.2	48.2	55	0.0
8	712 Marsh Road	46.9	47.0	55	0.1
16	3551 Nelson Bay Road	48.3	48.5	60	0.2
17	3515 Nelson Bay Road	52.2	52.5	60	0.3
18	723 Marsh Road	48.1	48.1	55	0.0
19	731 Marsh Road	48.9	49.0	55	0.1
20	761 Marsh Road	52.4	52.5	55	0.1
21	767 Marsh Road	54.2	54.3	55	0.1
22	781 Marsh Road	59.4	60.1	60	0.7
23	3780 Nelson Bay Road	58.8	58.9	60	0.1
24	3724 Nelson Bay Road	54.7	54.9	60	0.2
25	3790 Nelson Bay Road	59.9	60.1	60	0.2

Table 11.32 - Cumulative Traffic Noise Impact (dB(A)) – Phase 3 Operation

Rec #	Location	Day Period ($L_{Aeq,15hr}$)			
		Base Traffic Flow	Base Traffic Flow + Phase 4 development Flow	Criteria	Difference
1	724 Marsh Road	45.8	46.3	55	0.5
2	776 Marsh Road	57.9	58.1	60	0.0
3	772 Marsh Road	55.5	55.9	55	0.4
4	764 Marsh Road - Public School	53.6	54.1	55	0.5
5	762 Marsh Road	49.2	49.3	55	0.1
6	760 Marsh Road - Public Hall	58.3	58.4	55	0.1
7	756 Marsh Road	48.2	48.3	55	0.1
8	712 Marsh Road	46.9	47.0	55	0.1
16	3551 Nelson Bay Road	48.3	48.5	60	0.2
17	3515 Nelson Bay Road	52.2	52.6	60	0.4
18	723 Marsh Road	48.1	48.1	55	0.0
19	731 Marsh Road	48.9	49.0	55	0.1
20	761 Marsh Road	52.4	52.5	55	0.1
21	767 Marsh Road	54.2	54.3	55	0.1
22	781 Marsh Road	59.4	60.3	60	0.9
23	3780 Nelson Bay Road	58.8	58.9	60	0.1
24	3724 Nelson Bay Road	54.7	55.0	60	0.3
25	3790 Nelson Bay Road	59.9	60.2	60	0.3

Table 11.33 - Cumulative Traffic Noise Impact (dB(A)) – Phase 4 Operation

Rec #	Location	Day Period ($L_{Aeq,15hr}$)			
		Base Traffic Flow	Base Traffic Flow + peak development Flow	Criteria	Difference
1	724 Marsh Road	45.8	46.4	55	0.6
2	776 Marsh Road	57.9	58.3	60	0.4
3	772 Marsh Road	55.5	56.2	55	0.7
4	764 Marsh Road - Public School	53.6	54.4	55	0.8
5	762 Marsh Road	49.2	49.3	55	0.1
6	760 Marsh Road - Public Hall	58.3	58.4	55	0.1
7	756 Marsh Road	48.2	48.3	55	0.1
8	712 Marsh Road	46.9	47.1	55	0.2
16	3551 Nelson Bay Road	48.3	48.8	60	0.5
17	3515 Nelson Bay Road	52.2	52.9	60	0.7
18	723 Marsh Road	48.1	48.2	55	0.1
19	731 Marsh Road	48.9	49.0	55	0.1
20	761 Marsh Road	52.4	52.6	55	0.2
21	767 Marsh Road	54.2	54.4	55	0.2
22	781 Marsh Road	59.4	61.0	60	1.6
23	3780 Nelson Bay Road	58.8	59.1	60	0.3
24	3724 Nelson Bay Road	54.7	55.2	60	0.5
25	3790 Nelson Bay Road	59.9	60.4	60	0.5

Table 11.34 - Cumulative Traffic Noise Impact (dB(A)) – Peak Truck Operation (200 Trucks)

The predicted existing traffic levels at receivers R3 and R6 are slightly raised above the daytime noise criteria for the current traffic flows on the road. As stated in Section 3.4 of the Road Noise Policy, with regard to existing residences and other sensitive land uses affected by additional traffic on existing roads, generated by land use development, any increase in total traffic noise level should be limited to 2dB above that of the corresponding existing noise level at any residential property.

As seen from ***Table 11.29*** to ***Table 11.33*** there is an acceptable increase in the predicted traffic noise at all locations for Phase 1 to Phase 4 with the maximum increase being 0.9 dB.

Modelling was also conducted for the peak lorries outlined in the Seca Traffic Impact Assessment of 200 lorries and the maximum increase is predicted to be an increase of 1.6dB at receiver R22, located at 781 Marsh Road. As the predicted increases in traffic noise levels are

within +2dB of the existing road traffic noise levels at the sensitive receivers, the increase in traffic volumes on Marsh Road and Nelson Bay Road are deemed to be acceptable.

Although the peak number of 200 export lorries is acceptable along Nelson Bay Road and Marsh Road, the maximum number of lorries permitted to utilise the private haul road remains 180 for the worst-case weather conditions, as outlined in ***Section 11.7.1***.

11.7.7 Construction Vibration Assessment

Vibration may be generated as a result of the sand extraction works and transport of sand to the processing plant. Vibration has been considered both in respect of potential damage of buildings and potential annoyance to the occupants. This section provides guidance on the vibration impacts that may be expected from the activities associated construction and operation of the sand mine.

In many cases, it is the occupants/residents fear of building damage that enhances the potential annoyance. The most common form of vibration measurement is peak particle velocity (PPV) in mm/s. In respect to building damage, a vibration level limit and frequency is normally specified, however, in respect of potential annoyance to receivers, a combination of vibration level frequency and duration is more appropriate. This is normally termed as a dose value.

Table 11.34 summarises the anticipated level of vibration associated with the plant and equipment that is likely to be used. It should be noted that the vibration levels presented in **Table 11.35** are indicative levels only. The actual vibration levels that may impact upon properties located in the vicinity of the proposed sand mine may vary. This is due to the fact that vibration magnitudes will dissipate at varying levels dependent on ground conditions and source level variations associated with operational conditions of the plant and equipment.

Activity	Description	Typical Ground vibration level
Clearing and grubbing	Clearing of vegetation, trunk and root removal, processing of timber waste	In general, the activities carried out during this stage of works generate low levels of vibration and areas close to residences are generally already cleared. Vibration impact is considered unlikely.
	Bulldozers ripping	1mm/s to 2mm/s at distances of approximately 5 metres. At distances greater than 20 metres, vibration is usually below 0.2mm/s.
earthworks	Backhoe- Excavator	<1mm/s at distances of approximately 10 metres
	Truck traffic (on normal smooth road)	0.01mm/s to 0.2mm/s at the footings of buildings located 10m-20 metres from a roadway (note that very large surface irregularities can cause levels up to five to ten times higher).

Table 11.35 - Vibration levels of equipment

The nearest receivers to the proposed sand mine are located approximately 120 metres to the north-west of the site, at the western end of the pit and approximately 60 metres to the north-east of the site, at the eastern end of the pit. Based on the vibration levels provided in ***Table 11.34***, it is unlikely that there would be any vibration impacts generated by the excavation plant that would give rise to annoyance or structural damage at any of the nearest receivers.

Vibration monitoring would be undertaken in the unlikely event that any works were to be carried out within 50 metres of residences where vibration may be generated by equipment, beyond 100 metres there is a low probability of annoyance for all activities.

11.8 CONCLUSION

A noise impact assessment has been undertaken to determine the potential noise impact of the proposed sand mine at Bobs Farm on noise sensitive receptors in the surrounding area of the proposed development site.

11.8.1 Sand Mine Operations (OPERATIONAL NOISE ASSESSMENT) - Daytime Operations

Vipac has assessed the potential operational phase noise impacts on the 25 identified receivers surrounding the proposed sand mine for each of the four phases of operation down to the maximum pit depth. The predicted noise levels and the findings of the potential noise impact assessment presented in Section 7 have identified a number of receptors that may potentially be impacted by the proposed sand mine operational activities for different phases of the proposed operation.

In order to mitigate these exceedances Vipac proposes a 4m high acoustic barrier be installed along both sides of the private haul road at the Marsh Road exit, with the western barrier to be an absorbent barrier and the last 50m of the barrier on both sides (i.e. the western and eastern barrier) at the Marsh Road end to be transparent on both sides to provide visibility of sight lines for export lorries in both directions. The approximate length of the western barrier overall should be 490m and the approximately length of the eastern barrier overall should be 320m. Additionally, the haul road is to be excavated down into the hill located at the north-eastern area of the pit to reduce the impact on receivers at this end of the mine operations. With the implementation of these mitigation measures the predicted noise levels at the nearest potentially affected receivers are compliant with the daytime noise criteria for all phases of operation.

A 6m high noise bund, approximately 440m in length is proposed to be constructed along the north-eastern (corner) boundary of the pit as shown in ***Figure 10*** to mitigate the impact on Receiver R1 which will be required during the Phase 2 operations onwards. This bund is required primarily due to the operation of the private haul road associated with lorries operating at the site in conjunction with Phase 2 operations. However, should the demand for export lorries increase during Phase 1 this bund will be need to constructed prior to Phase 2 operations commencing. With the implementation of these mitigation measures the predicted noise levels at Receiver R1, are compliant with the daytime noise criteria for all phases of operation.

A 6m high noise bund, approximately 400m in length is also proposed to be constructed along the north-western (corner) boundary of the pit as shown in ***Figure 10*** to mitigate the potential impact on Receiver R13 associated with operations during Phase 2 to Phase 4 in the western end of the pit. These noise mitigation measures are predicted to reduce the noise levels to below the criteria for Phase 2 to Phase 4 operations at Receiver 13. As this noise bund is only required for the operations where plant is operating in the western end of the pit, once dredging operations extend into the area of the pit near the plant area toward the eastern end of the mine, the bund at the western end of the pit can be removed. Therefore, as the dredging operations progress through the pit reaching the plant area and progress eastwards, moving away from the western end of the pit the western bund could be removed as noise levels are predicted to be below the noise criteria at the Receiver R13 at this stage.

Vipac has also conducted noise modelling to assess the impact to the receivers for the proposed peak of 200 export lorries utilising the private haul road during peak production. The

results show that with the proposed mitigation measures in place, the peak 200 trucks are predicted to comply with the criteria at all receiver locations for both neutral and worst-case conditions with the exception R2 during worst-case conditions. Vipac has conducted additional noise modelling to assess the maximum number of export lorries permissible to utilise the private haul road under worst-case weather conditions and comply with the noise criteria at R2 and found the maximum number of lorries to be 180 lorries.

11.8.2 Sand Mine Operations (OPERATIONAL NOISE ASSESSMENT) - Night Time Operations

Noise modelling was conducted to assess the night-time operations (6am-7am) for the proposed sand mine and there are exceedances predicted at up to five noise sensitive receivers located in the vicinity of the site during neutral conditions. There are also exceedances predicted at up to six noise sensitive receivers during worst-case conditions during Phase 1 operations, as outlined in ***Section 11.7.3***.

These exceedances are attributed to the operation of the haul road accessing the sand mine from Marsh Road and export lorries on the road. Vipac has also conducted modelling with mitigation measures in place and found that during neutral conditions noise levels at one receiver; and that during worst-case conditions noise levels at up to five receivers were still exceeding the noise criteria, as outlined in ***Section 11.7.3***.

The number of exceedances even with the implementation of mitigation measures increases for each of the phases up to Phase 4 operations where during neutral conditions up to five receivers, and during worst-case conditions up to eleven receivers are predicted to experience noise levels in excess of the applicable noise criteria.

Vipac again also conducted modelling to ascertain the maximum number of trucks permissible in this night-time period (6am-7am) without exceeding the noise criteria at this point and the predicted maximum number of trucks permissible on the haul road during this period is a single truck.

11.8.3 Sand Mine Operations (OPERATIONAL NOISE ASSESSMENT) – Sleep Disturbance

Noise prediction modelling has been carried out to assess the potential sleep disturbance impact associated with the proposed sand mine on the existing noise environment at the nearest noise sensitive receptors located in proximity to the site during the night period. The predicted noise impact associated with the proposed development of the sand mine on the noise sensitive receivers' range between 35 to 63dB(A) at the façade of the noise sensitive receptors.

The predicted noise levels are raised above the sleep disturbance criteria during the sand mine operations at receivers one receiver during Phase 1 operations; at up to four receivers during Phase 2; at up to seven receivers during Phase 3; and at up to three receivers during Phase 4 operations. The exceedances range from 1dB exceedance to 5dB. The Marsh Road receivers at the exit of the Haul Road are the most effected experiencing exceedances of 4-5dB(A) during the operation of the sand mine.

Due to the predicted exceedances of the sleep disturbance criteria at eight receivers (R1, R5, R7, R13, R14, R15, R20 and R21) during the varied phases of operation and the exceedance of the operational L_{Aeq} criteria for any more than a single truck at the Marsh Road exit of the sand mine site during the night-time period of 6am-7am it is not recommended for the mine to operate during this period.

11.8.4 Traffic Noise Assessment

Noise modelling has also been undertaken to assess the potential noise impacts associated with the additional vehicle movements on Nelson Bay Road and the eastern end of Marsh Road. The noise model has taken into account all the sources (Nelson Bay Road and Marsh Road) associated with traffic that will be generated by the proposed sand mine as outlined in ***Section 11.6.3*** to determine the cumulative noise levels in the area.

As Receivers 9-15 are situated along Marsh Road where no additional traffic flow is proposed to be generated by the sand mine they have not been assessed as part of the traffic noise impact assessment. Additionally, as night-time operations are not recommended due to the exceedances of the noise criteria as outlined above, no traffic noise modelling has been conducted for the night-time period (6am-7am).
There is an acceptable increase in the predicted traffic noise at all of the potentially affected noise sensitive receptor locations for Phases 1 to 4 with the maximum increase being 0.9 dB.

Modelling was also conducted for the peak lorries outlined in the Seca Traffic Impact Assessment of 200 lorries and the maximum increase is predicted to be an increase of 1.6dB at receiver R22, located at 781 Marsh Road. As the predicted increases in traffic noise levels are within +2dB of the existing road traffic noise levels at the sensitive receivers, the increase in traffic volumes on Marsh Road and Nelson Bay Road are deemed to be acceptable.

Although the peak number of 200 export lorries is acceptable along Nelson Bay Road and Marsh Road, the maximum number of lorries permitted to utilise the private haul road remains 180 for the worst-case weather conditions, as outlined in ***Section 11.7.5***.

11.8.5 Vibration Assessment

Activities associated with the initial development phase of the sand mine and operational activities associated with sand mine have the potential to generate measureable vibration levels on-site. However, the nearest potentially affected receptors are located approximately 120 metres to the north-west of the site, at the western end of the pit and approximately 60 metres to the north-east of the site, at the eastern end of the pit, and it is unlikely that there would be any vibration impacts generated by the plant and machinery that will be utilised at the site, that would give rise to annoyance or structural damage at any of the nearest receivers.

12 AIR QUALITY ASSESSMENT

Chapter 12 provides a detailed air quality assessment to identify potential impacts of the proposed sand extraction operations. The chapter provides the results of an investigation by Vipac Engineers and Scientists of meteorological investigations and detailed air quality modelling, estimates emissions, and compares the likely impacts on air quality against relevant industry standards and the detailed report is contained in Annexure L.

Additional matters raised by the Department of Planning & Environment in relation to the VIPAC report are contained in Annexure L.

12.1 INTRODUCTION

Vipac Engineers and Scientists Ltd (Vipac) was commissioned by Tattersall Lander (Tattersall) to prepare an Air Quality Impact Assessment for the proposed sand mine (the 'Project') located near Bobs Farm, near Newcastle, New South Wales.

The purpose of this assessment is to evaluate the potential impacts of air pollutants generated from the construction and operational stages of the project and to provide recommendations to mitigate any potential impacts that might have an effect on nearby sensitive receptors.

12.2 PROJECT DESCRIPTION

12.2.1 Site Location

The Bobs Farm site deposit is situated on the northern end of the Stockton Bight Dunal system, approximately 200 km north of Sydney, near Bobs Farm, NSW. The surrounding area is predominately zoned as rural with minimal primary production.

12.2.2 Proposed Operations

Bobs Farm Sand Project comprises:

- The establishment of a quarry to extract and process sand at a rate of approximately 750,000 tonnes per annum, from a total sand resource of approximately 8-10 million tonnes. The estimated life of the extraction process is 13 years;
- The construction of extractive materials processing and transport infrastructure;
- The transportation of extractive materials off-site via roads; and
- The rehabilitation of the site.

Phase	Operational Year	Annual Throughput (tonnes)	Method	Location in Relation to Water Table
Phase1	Year 1	150,000	Stripping of topsoil and dry mining (Stripping Phase)	Above (***Figure 2***)
Phase 2	Year 2	250,000	Dry mining Construction Stage and Year 1 Extraction/Production)	Above (***Figure 2***)
Phase 3	Year 3	450,000	Dry mining (Initial Extraction Stage down to water-table)	Above and below (***Figure 2***)

Phase 4	Years 4 - 13	700,000	Wet production (Final Extraction – production below the water-table down to a depth of -15m below the water-table)	Below (***Figure 2***)

Table provides an overview of the developmental stages during the Project life. A cross-section of the proposed Sand Mine presents the extent of each production stage in relation to the water table (between the blue and green lines), as shown in ***Figure*** .

Stage	Operational Year	Annual Throughput (tonnes)	Method	Location in Relation to Water Table
Initial Stage	**Year 1**	**150,000**	**Stripping of topsoil & dry mining**	**Above**
Production Stage 1	**Year 2**	**250,000**	**Dry mining**	**Above (blue line in *Figure*)**
Production Stage 2	**Year 3**	**450,000**	**Dry mining**	**Above and below (green line in *Figure*)**
Production Stage 3	**Years 4 - 13**	**700,000**	**Wet production**	**Below (red line in *Figure*)**

Table 112-1 - Overview of Proposed Operations

The main activities of the Project will be the bulk handling of sand material, utilising mobile plant, general truck movements for the transport of the material to the plant where the sand is screened and washed before being de-watered and stockpiled. The final product will be transported, when necessary from site using trucks.

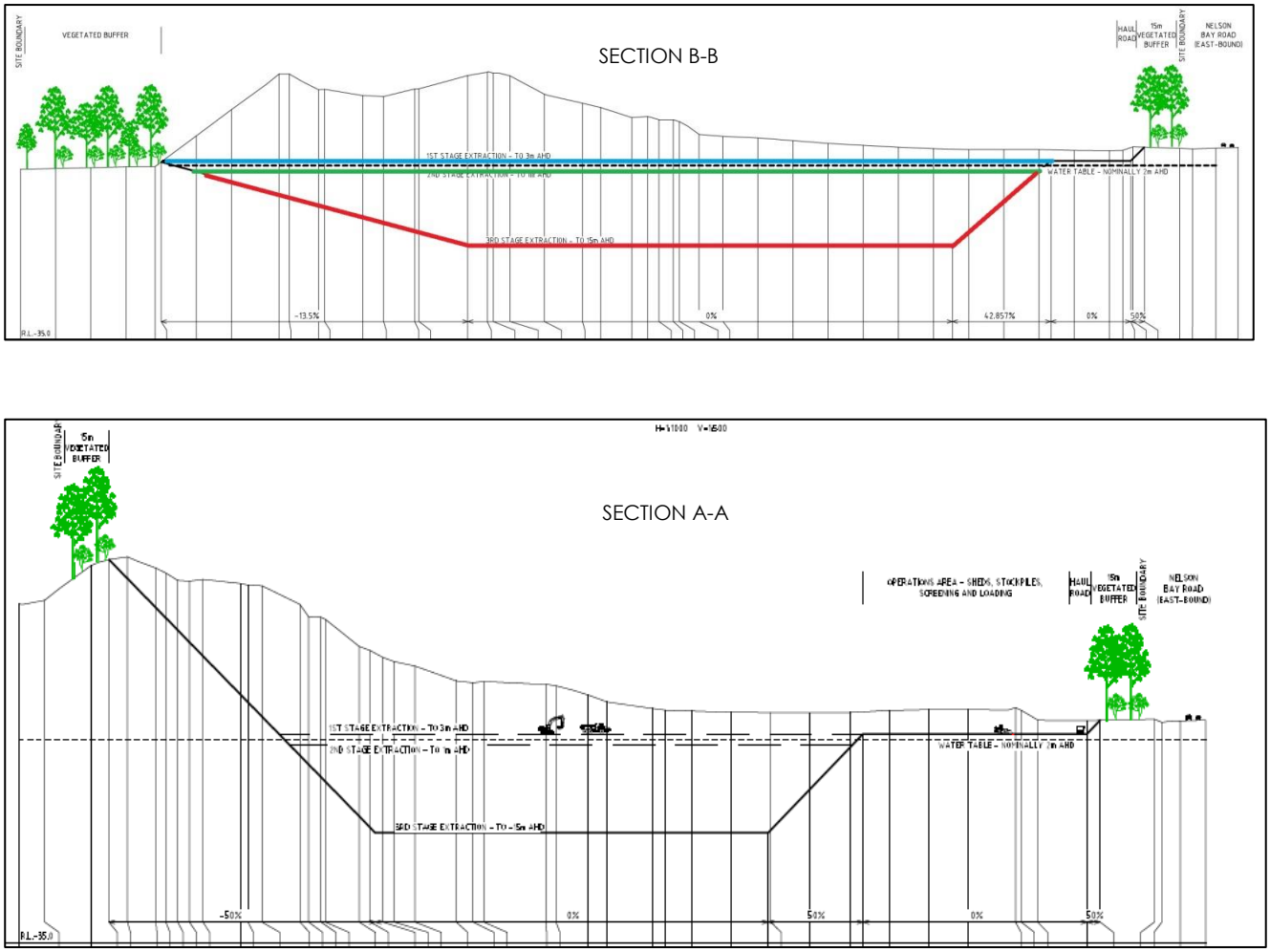


Figure 112-1 - Production Stages (Section B-B and Section A-A) [Tattersall Lander]

12.2.3 Operational Hours

During construction of the proposed Sand Mine the proposed operating hours will be for 10 hours per day from 07:00 to 17:00.

During initial operation of the proposed Sand Mine the operating hours will commence as a single shift of 10 hours, from 06:00 – 16:00, with provision for an additional 10 hour shift if production and or

sales demands require it. Production is based upon 11 months per year, 19 days per month and 8 hours per day.

Operational hours for both extraction, loading of vehicles and transportation of material are proposed to be Monday to Saturday – 06:00 to 18:00 only.

12.2.4 Equipment

The proposed equipment for the Project will comprise of core mobile plant which will change in quantity to reflect the product throughput and ancillary equipment. The proposed equipment includes:

- Excavators;
- Articulated dump truck (44 tonne capacity);
- Front end loaders;
- Conveyor;
- Screens and hoppers;
- Wash / recovery plant;
- Dredge (stage 3 only); and
- Road trucks.

12.2.5 Sensitive Receptors

A review of the area has identified several sensitive receptors within the locality of the Project. The approximate geographic coordinates of the closest sensitive receptors are presented in ***Table 112-2*** and ***Figure 112-2.***

ID	Description	Universal Transverse Mercator Location (m)	
		X	Y
R1	**756 Marsh Road**	**407267**	**6374127**
R2	**760 Marsh Road**	**407312**	**6374149**
R3	**774 Marsh Road**	**407345**	**6373909**
R4	**780 Marsh Road**	**407471**	**6374162**
R5	**Primary School**	**407332**	**6374083**
R6	**3679 Nelson Bay Road**	**407078**	**6373773**
R7	**698 Marsh Road**	**406802**	**6373679**
R8	**640 Marsh Road**	**406129**	**6373507**
R9	**614A Marsh Road**	**405905**	**6373164**
R10	**Port Stephens Avocado Farm**	**405930**	**6372951**

Table 112-2 - Sensitive Receptor Details

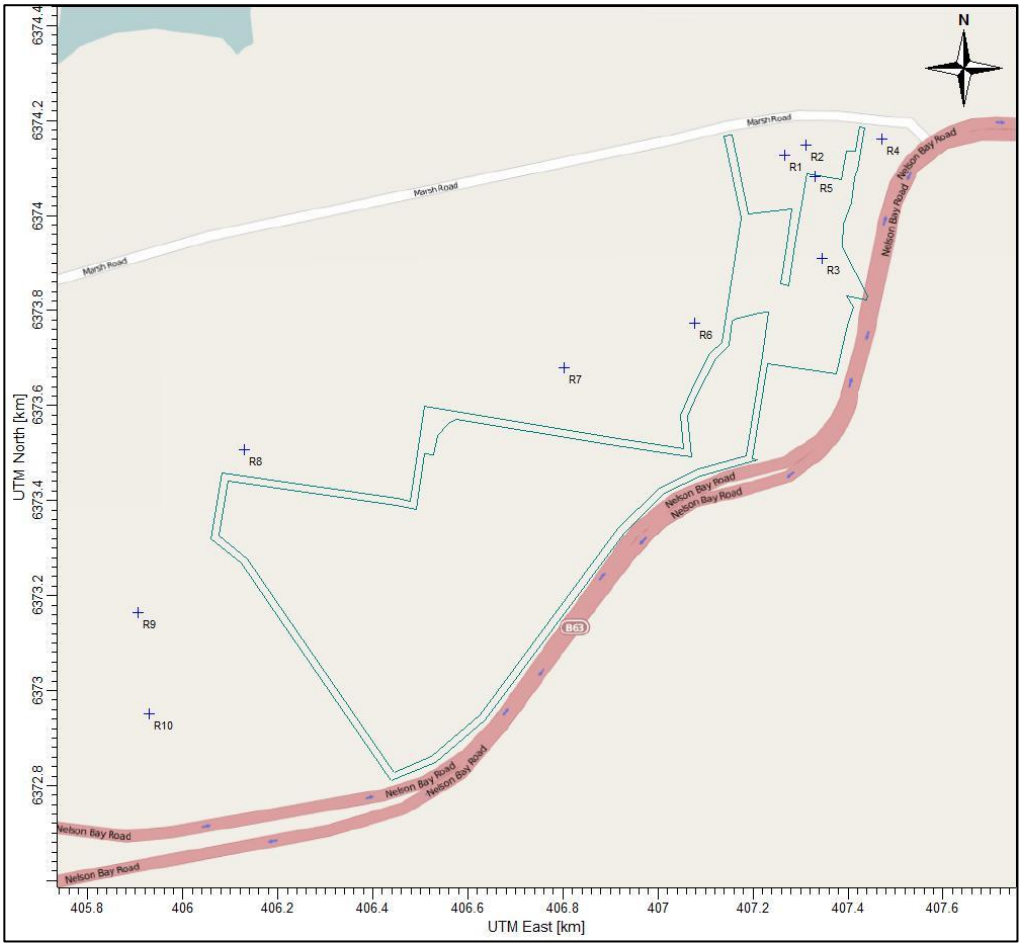


Figure 112-2 - Sensitive Receptor Locations as Modelled

12.2.6 Local Topography

The Project is situated is approximately 2 km from Nelson Bay. The local topography as modelled is presented in ***Figure 112-3***.

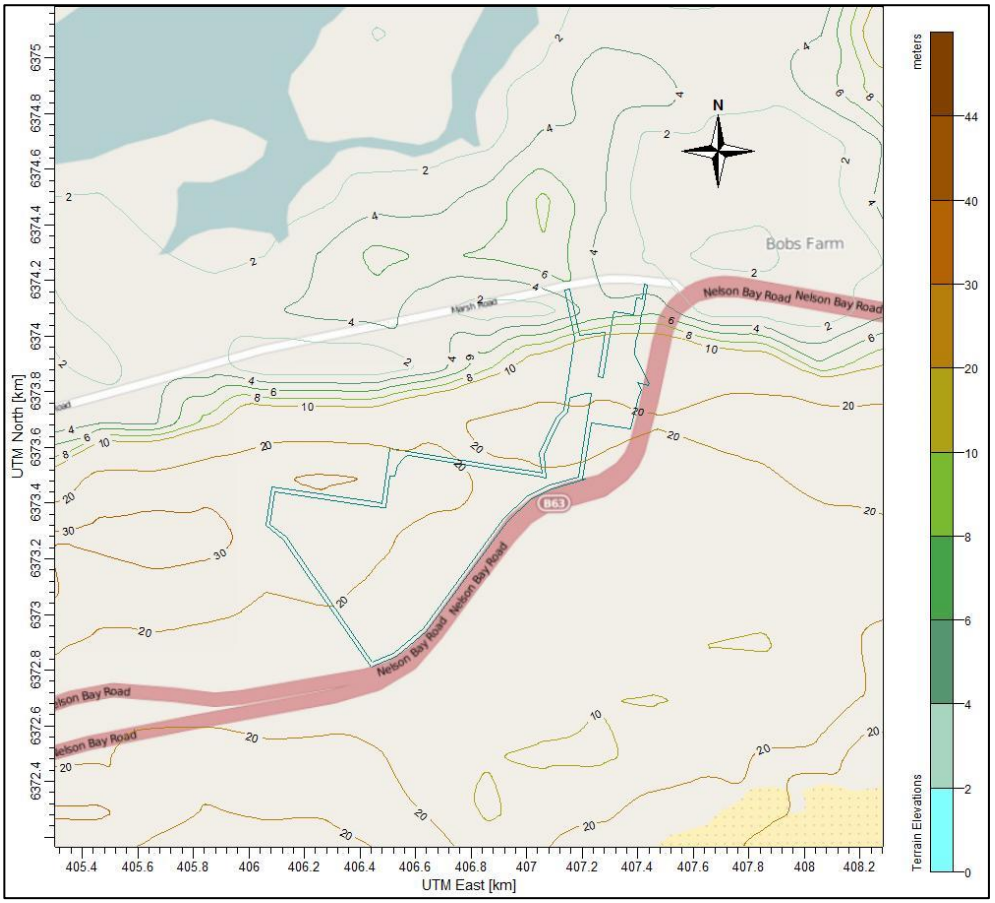


Figure 112-3 - Local Topography

12.3 REGULATORY FRAMEWORK

12.3.1 National Legislation

12.3.1.1 National Environment Protection Measure for Ambient Air Quality

Australia's first national ambient air quality standards were outlined in 1998 as part of the National Environment Protection Measure for Ambient Air Quality (National Environment Protection Council , 1998).

The Ambient Air Measure (referred to as Air NEPM) sets national standards for the key air pollutants; carbon monoxide, ozone, sulfur dioxide, nitrogen dioxide, lead and particles (PM_{10} and $PM_{2.5}$). The Air NEPM requires the State's governments to monitor air quality and to identify potential air quality problems.

12.3.2 State Legislation and Guidelines

12.3.2.1 Department of Environment and Conservations (NSW) Approved Methods

The *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (2016) detail both the assessment methodology and criteria for air quality assessments. Due to the type of industry and proximity to sensitive receptors, the requirements for a Level 2 assessment have been followed.

While the most recent update of the Approved Methods (2016) was published in January 2017 after the original air quality impact assessment was issued, the criteria within the updated Approved Methods have been used for this amended assessment.

12.3.2.2 Protection of the Environment Operations (Clean Air) Regulation 2010

The *Protection of the Environment Operations (Clean Air) Regulation 2010 (Clean Air Regulation)* (NSW Government) provides regulatory measures to control emissions from wood heaters, open burning, motor vehicles and fuels and industry. The operation of Project does not trigger any regulatory emissions relating to industry; however the emission requirements for goods vehicles must be adhered to.

12.3.2.3 Action for Air

Action for Air (Environmental Protection Authority, 1998) seeks to provide long-term ongoing emission reductions, however it does not target acute and extreme exceedances from events such as bushfires. The aim of Action for Air includes:

- Meeting the national air quality standards for six pollutants as identified in the Ambient Air-NEPM; and
- Reducing the population's exposure to air pollution and the associated health costs.

The six pollutants in the Ambient Air-NEPM are CO, NO_2, SO_2, lead, ozone and PM_{10}. The pollutant from the Project that is relevant to the Action for Air is PM_{10}. Action for Air aims to reduce air emissions to enable compliance with the Ambient Air-NEPM targets to achieve the aims described above, with a focus on motor vehicle emissions. The Project would address the aims of the Action for Air Plan by implementing reasonable and feasible mitigation measures to reduce dust (e.g. PM_{10}) emissions and continue to implement an air quality monitoring plan to assess the Project against the Ambient Air-NEPM goals.

12.3.3 Pollutants of Concern

The main emissions to air from mining operations caused by wind-borne dust, vehicle usage, materials handling and transfers. Fugitive air emissions can be estimated using emission factors combined with site-specific information such as the silt and moisture content of material being handled.

The Director General's Requirements (DGRs) for this Project were to assess:

- Total Suspended Particles (TSP) - Particulate matter with a diameter up to 50 microns;
- PM_{10} - Particulate matter less than 10 microns in size;
- $PM_{2.5}$ - Particulate matter less than 2.5 microns in size; and
- Dust Deposition – deposited matter that falls out of the atmosphere.

12.3.4 Project Criteria

The DGRs for this Project requested that the "*cumulative impact does not result in an annual level greater than 30 µg/m³ of PM_{10} for private dwellings*". As discussed in Section 12.12.3.2.1, the criteria specified in the Approved Methods have been updated since the original air quality impact assessment was issued. This includes the criteria for annual PM_{10} which is more stringent than the DGRs (i.e. 25 µg/m³ compared with 30 µg/m³). The criteria specified within the updated Approved Methods have therefore been used for this amended assessment.

From all of the regulations the strictest applicable criteria have been selected for this assessment and are presented in ***Table*** .

Pollutant	Basis	Criteria	Averaging Time	Source
TSP	**Human Health**	**90 µg/m³**	**Annual**	**Approved Methods**
PM_{10}	**Human Health**	**50 µg/m³**	**24-hour**	**Approved Methods**
	Human Health	**25 µg/m³**	**Annual**	**Approved Methods**
$PM_{2.5}$	**Human Health**	**25 µg/m³**	**24-hour**	**Approved Methods**
	Human Health	**8 µg/m³**	**Annual**	**Approved Methods**
Dust deposition	**Amenity**	**Maximum incremental increase of 2 g/m²/month**	**Annual**	**Approved Methods**
	Amenity	**Maximum total of 4 g/m²/month**	**Annual**	**Approved Methods**

Table 12.3 - Project Air Quality Goals

12.4 METHODOLOGY

Computational modelling of air dispersion is used to predict the maximum levels of air pollutants based on the local topography, weather conditions and emission rates for the various sources of pollutants. The maximum levels are compared with criteria provided in ***Table*** . Air quality controls are applied to reduce emission rates when non-compliance is predicted.

12.4.1 Emission Estimation

The emission rates for individual activities were obtained from the National Pollutant Inventory (NPI) - *Emissions Estimation Technique (EET) Manual for Mining.* (Department of Sustainability, Environment, Water, Population and Communities, 2012). The NPI emission factors are derived from the USEPA AP-42.

Emission factors can be used to estimate emissions of TSP and PM_{10} to the air from various sources. Emission factors relate the quantity of a substance emitted from a source to some measure of activity associated with the source. Common measures of activity include distance travelled, quantity of material handled, or the duration of the activity (Department of Sustainability, Environment, Water, Population and Communities, 2012).

Emission factors are used to estimate a facility's emissions by the general equation:

$$E_{i\,(kg/yr)} = \left[A_{(t/h)} \times OP_{(h/yr)} \right] \times EF_{i\,l(kg/t)} \times \left[1 - \frac{CE_i}{100} \right]$$

Where:

$E_{i\,(kg/yr)}$ = Emission rate of pollutant
$A_{(t/h)}$ = Activity rate
$OP_{(h/yr)}$ = operating hours
$EF_{i\,l(kg/t)}$ = uncontrolled emission factor of pollutant
CE_i = overall control efficiency for pollutant

The equations and activity rates are presented in ***Annexure L***.

12.4.2 Air Dispersion Modelling

12.4.2.1 TAPM

A 3-dimensional dispersion wind field model, CALPUFF, has been used to simulate the impacts from Project. CALPUFF is an advanced non-steady-state meteorological and air quality modelling system developed and distributed by Earth Tech, Inc. The model has been approved for use in the '*Guideline on Air Quality Models*' (United States Environmental Protection Agency, 2005) as a preferred model for assessing applications involving complex meteorological conditions such as calm conditions.

To generate the broad scale meteorological inputs to run CALPUFF, this study has used the model The Air Pollution Model (TAPM), which is a 3-dimensional prognostic model developed and verified for air pollution studies by the CSIRO. The output from TAPM will be used to generate the appropriate meteorological data for the CALPUFF modelling system.

TAPM was configured as follows:-

- Centre coordinates – 32˚ 47.0 S, 152˚ 0.5 E;
- Dates modelled – 1st January 2013 to 31st December 2013;
- Four nested grid domains of 30 km, 10 km, 3 km and 1 km;
- 25 x 25 grid points for all modelling domains;
- 20 vertical levels from 10 m to an altitude of 8000 m above sea level;
- The default TAPM databases for terrain, land use and meteorology were used in the model; and
- Wind data from Bureau of Meteorology weather station at Nelson Bay was assimilated into the model.

12.4.2.2 CALMET

CALMET is an advanced non-steady-state diagnostic three-dimensional meteorological model with micro-meteorological modules for overwater and overland boundary layers. The model is the meteorological pre-processor for the CALPUFF modelling system.

The CALMET simulation was run as No-Obs simulation with the gridded TAPM three-dimensional wind field data from the innermost grid. CALMET then adjusts the prognostic data for the kinematic effects of terrain, slope flows, blocking effects and three-dimensional divergence minimisation.

12.4.2.3 CALPUFF

CALPUFF is a non-steady-state Lagrangian Gaussian puff model. CALPUFF employs the three-dimensional meteorological fields generated from the CALMET model by simulating the effects of time and space varying meteorological conditions on pollutant transport, transformation and removal.

Emission sources can be characterised as arbitrarily-varying point, area, volume and lines or any combination of those sources within the modelling domain.

The radius of influence of terrain features was set at 3 km while the minimum radius of influence was set as 0.1 km. The terrain data had a resolution of 3 arc-seconds (approximately 90 m). Most CALPUFF options remained at their default recommended values.

12.5 EXISTING CONDITIONS

12.5.1 Ambient Particulate Monitoring - PM_{10}

PM_{10} is not currently monitored for compliance in the vicinity of the proposed Sand Mine site. As a substitute, data is available from the Office of Environment and Heritage's (OEH) monitoring stations. Available data for 2013 has shown that the Newcastle monitoring station, located at Smith Street, approximately 29 km south west of the proposed Sand Mine was considered more representative than the other OEH monitoring stations.

In order to obtain an indication of likely PM_{10} concentrations in the region of the Project site, the daily-varying (24-hour average) PM_{10} concentrations recorded at this station in 2013 has been analysed;

- The highest 24-hour concentration was 69 µg/m^3 on 17th October 2013, with four exceedances of the criteria during the year. The sixth highest value was 49.1 µg/m^3;

- The annual average excluding the exceedances was 22.3 µg/m^3; and
- The 90th percentile was 37.2 µg/m^3 and the 70th percentile was 26.3 µg/m^3.

Level 2 air quality assessments require ambient monitoring data for at least one year of continuous measurements should be used in the dispersion modelling process (Department of Environment & Conservation, 2005). The 24-hour average PM_{10} concentrations recorded at the Newcastle monitoring station for the period 1st January 2013 to 31st December 2013 are presented in ***Figure*** .

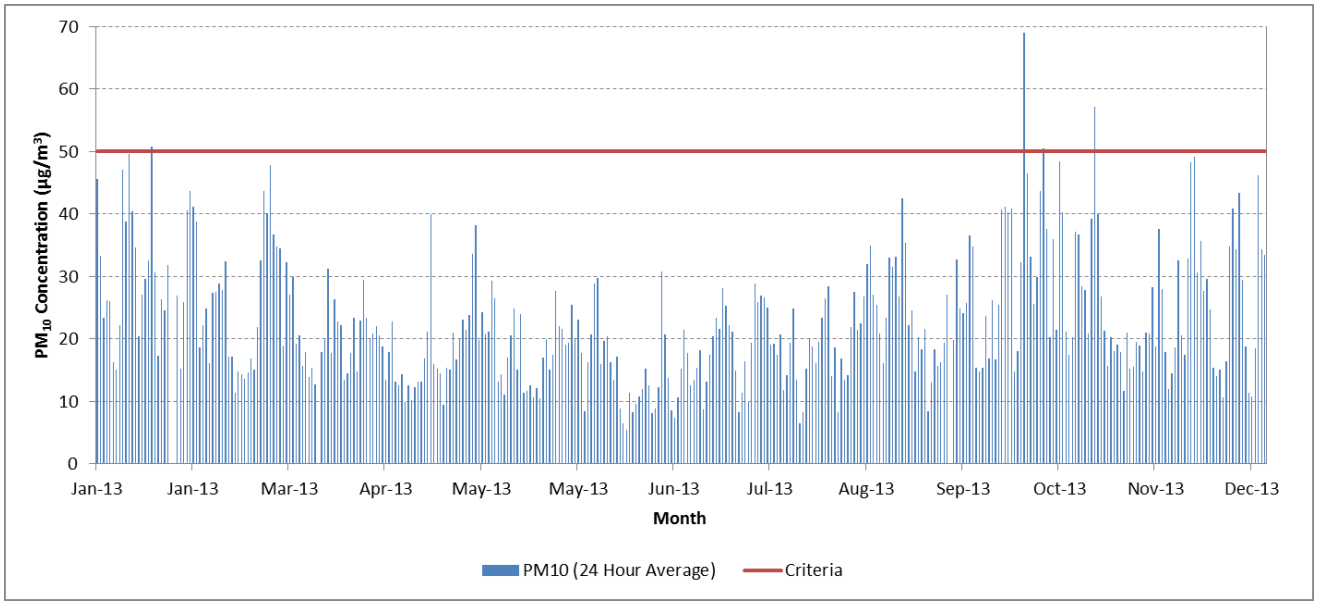


Figure 12.4 - PM_{10} Concentrations at Newcastle [DECCW, 2013]

Figure shows the distribution of the 24-hour PM_{10} concentration monitoring data. It can be seen that the 24% of PM_{10} 24-hour concentrations range 20-25 µg/m^3.

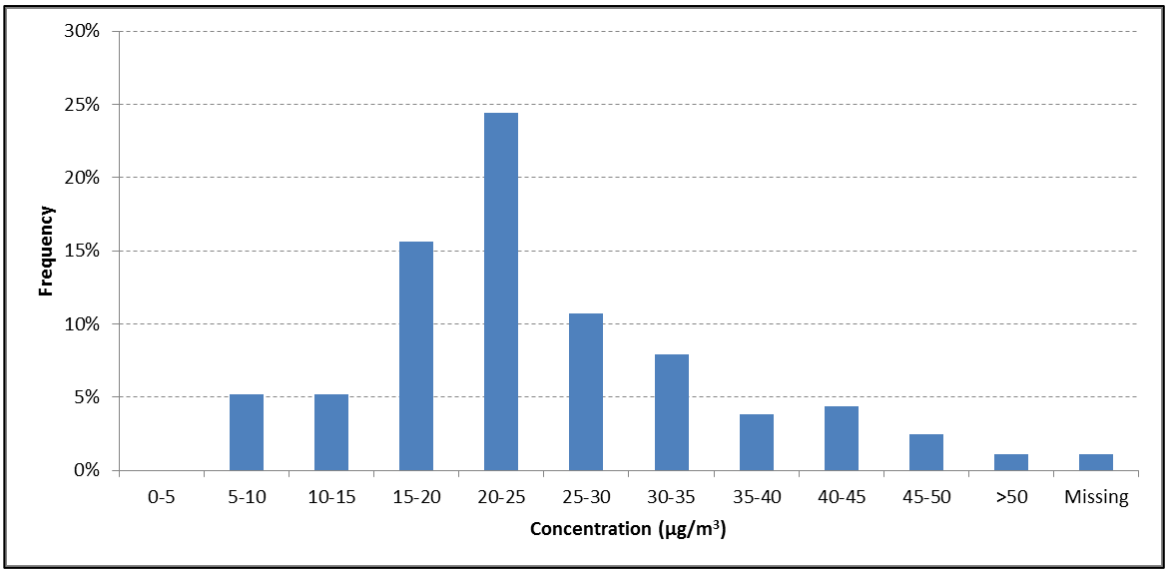


Figure 12.5 - 24-Hour Average PM_{10} Concentration Distribution at Newcastle [DECCW, 2013]

12.5.2 Ambient Particulate Monitoring - $PM_{2.5}$

As with PM_{10}, $PM_{2.5}$ is not monitored in the vicinity of the Mine site, additionally $PM_{2.5}$ data was not available for the Newcastle monitoring station. As a substitute, data from the Wallsend monitoring

station was used, this monitoring station is located 34 km south west of the site. In order to obtain an indication of likely $PM_{2.5}$ concentrations in the region of the Mine, the daily-varying (24-hour average) $PM_{2.5}$ concentrations recorded at this station in 2013 has been analysed;

- The highest 24-hour concentration was 37 µg/m^3 on the 19th October 2013, with six exceedances of the criteria during the year. The second highest 24-hour concentration was 31.3 µg/m^3;
- The annual average excluding the one exceedance was 7.7 µg/m^3; and
- The 90th percentile was 12.3 µg/m^3 and the 70th percentile was 8.5 µg/m^3.

The 24-hour average $PM_{2.5}$ concentrations recorded at the Wallsend monitoring station for the period 1st January 2013 to 31st December 2013 are presented in Figure .

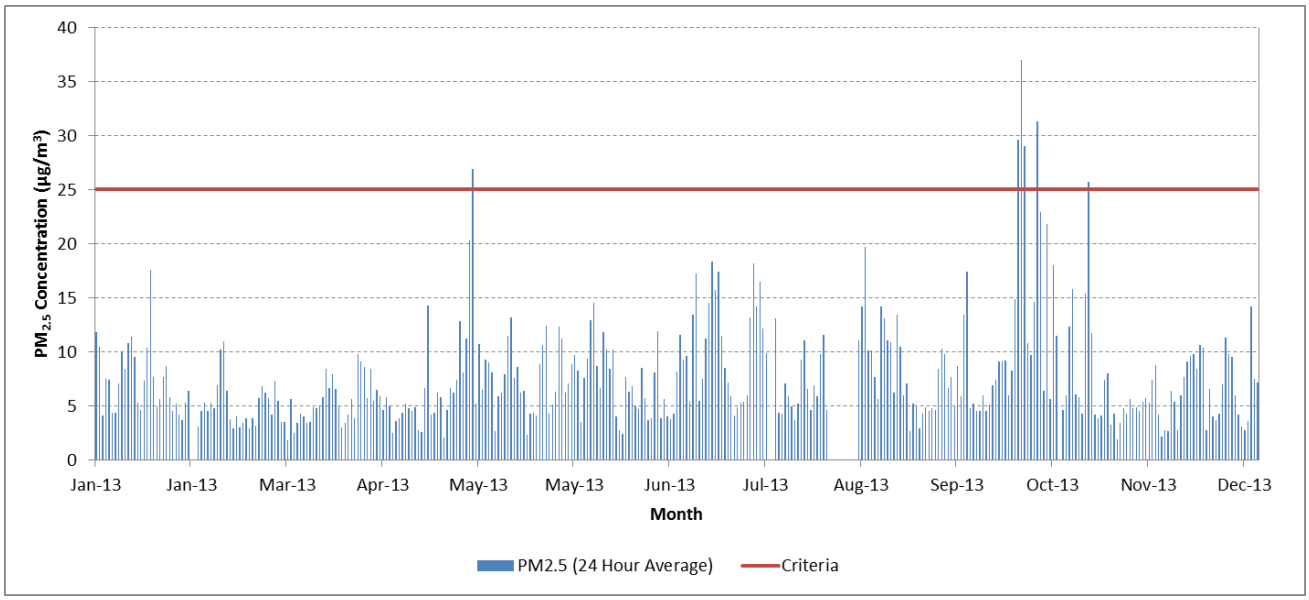


Figure 12.6 - PM2.5 Concentrations at Wallsend [DECCW, 2013]

12.5.2.1 TSP

TSP is not currently monitored in the vicinity of the proposed Sand Mine site. In this instance, TSP concentrations have been assumed to be twice those of the measured PM_{10} concentrations at Newcastle. It is noted that the PM_{10} sub-set is typically 50% of TSP mass in regions where road traffic is not the dominant particulate source (NSW Minerals Council, 2000).

12.5.3 Project Assigned Background Concentrations

A summary of the assigned background concentrations used in this study are presented in

. These background concentrations will be used to add to the predicted incremental impact from the Project to derive total concentrations:

- Individual 24-hour average predicted PM_{10} and $PM_{2.5}$ concentration will be paired in time with the corresponding 24-hour concentration within the adopted 2013 monitoring dataset to obtain total impact at each receptor; and
- Annual average PM_{10}, $PM_{2.5}$, TSP and monthly dust deposition will be assessed through the addition of the dataset average concentrations.

Parameter	Air Quality Objective	Period	Applied Background	Comments
TSP	**90 µg/m³**	Annual	**44.6 µg/m³**	**Double annual average PM_{10}**
PM_{10}	**50 µg/m³**	24-Hour	**Varies**	**Daily Newcastle Data for 2013**
	25 µg/m³	Annual	**22.3 µg/m³**	**Annual Average Newcastle Data**
$PM_{2.5}$	**25 µg/m³**	24 Hour	**Varies**	**Daily Wallsend Data for 2013**
	8 µg/m³	Annual	**7.7 µg/m³**	**Annual Average Wallsend Data**
Dust Deposition	**4 g/m²/month**	Month	**2.1 g/m²/month**	**Typical Values**

Table 12.4 - Assigned Project Background Concentrations

12.6 METEOROLOGY

At the time this assessment was undertaken, there was no site-specific meteorological data available for consideration.

Long term weather data has been obtained from the Bureau of Meteorology Nelson Bay Automatic Weather Station [AWS] Street (Site number 061054). The mean temperature range is between 8.9° and 27.3° with the coldest month being July and the hottest being January. The Rainfall in the region is variable, with most rainfall in the cooler months. On average, most of the annual rainfall is received between May and August. Rainfall is lowest between October and January, with a mean annual rainfall of 1,350 mm. The mean long-term weather data for the Bureau of Meteorology (BOM) Weather station at Nelson Bay is presented in ***Table 12.5.***

Month	Temperature		Rainfall (mm)	9 am Conditions			3 pm Conditions		
	Max (°C)	Min (°C)		Temp (°C)	Cloud Cover (oktas)	Wind Speed (km/h)	Temp (°C)	Cloud Cover (oktas)	Wind Speed (km/h)
Jan	**27.3**	**18.7**	**99.3**	**22.8**	**4.3**	**12.8**	**25.5**	**4.0**	**21.7**
Feb	**27.0**	**18.8**	**113.2**	**22.7**	**4.8**	**12.7**	**25.3**	**4.4**	**20.5**
Mar	**25.9**	**17.5**	**116.4**	**21.1**	**4.3**	**11.6**	**24.2**	**4.0**	**17.5**
Apr	**23.6**	**15.1**	**127.9**	**18.8**	**3.7**	**12.0**	**22.0**	**3.8**	**15.3**
May	**20.7**	**12.2**	**152.9**	**15.3**	**3.6**	**15.0**	**19.0**	**4.0**	**15.2**
Jun	**18.3**	**10.0**	**154.6**	**13.0**	**4.2**	**15.9**	**16.9**	**4.2**	**14.8**
Jul	**17.4**	**8.9**	**140.1**	**11.8**	**3.3**	**14.6**	**16.3**	**3.7**	**15.4**
Aug	**18.9**	**9.7**	**103.4**	**13.3**	**3.4**	**14.6**	**17.4**	**3.4**	**17.5**
Sep	**21.5**	**11.8**	**89.0**	**16.1**	**3.3**	**13.9**	**19.3**	**3.6**	**18.2**
Oct	**23.2**	**13.9**	**78.5**	**18.7**	**3.8**	**13.3**	**21.1**	**4.0**	**20.8**
Nov	**24.7**	**15.8**	**81.1**	**20.1**	**4.5**	**13.4**	**22.3**	**4.4**	**21.2**
Dec	**26.1**	**17.5**	**94.3**	**21.6**	**4.6**	**12.5**	**24.1**	**4.4**	**20.9**
Annual	22.9	14.2	1,350.7	17.9	4.0	13.5	21.1	4.0	18.2

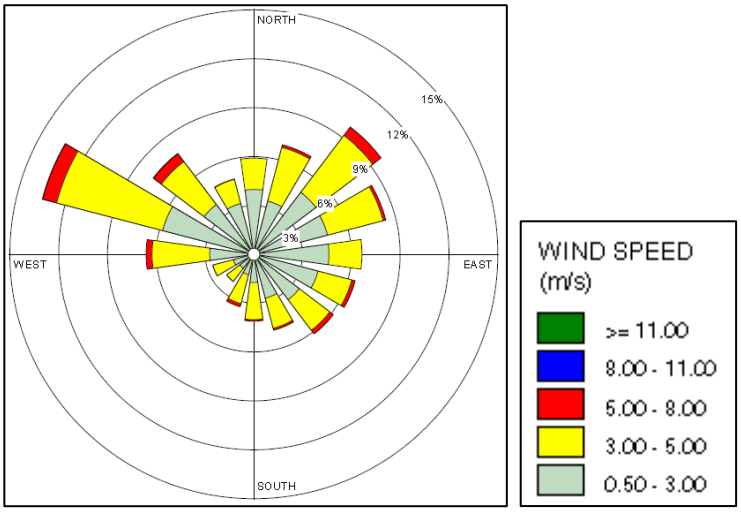
Table 12.5 - Mean Long-term Weather Data for Nelson Bay [BOM 1968-2010]

12.6.1 TAPM Meteorological Data

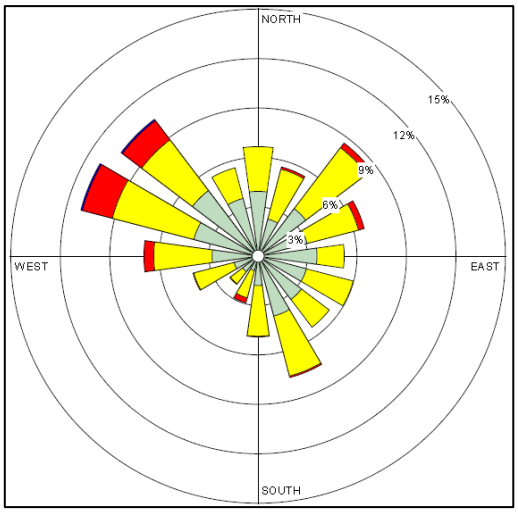
Meteorological data for the site was generated using meteorological data using The Air Pollution Model (TAPM) at the site for 2013, as discussed in ***Section 12.4***.

The wind roses are presented in ***Figure*** and show that winds blowing from the north-west are dominant in Spring, Autumn and Winter. These winds will carry the pollutants away from sensitive receptors, whilst during the summer months, the receptors R9 and R10 are likely to be affected due to north easterly winds.

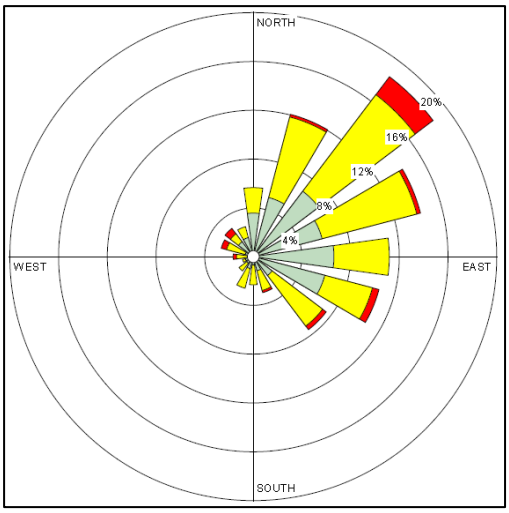
A comparison of the BOM wind roses and the TAPM generated wind roses at the BOM location are presented in ***Annexure L***.



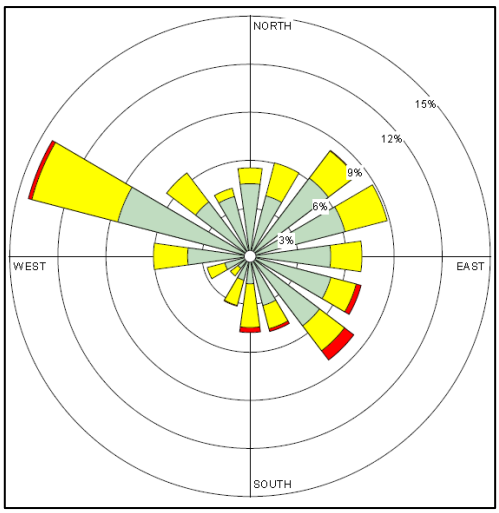
Annual (Calm – 0.39%)



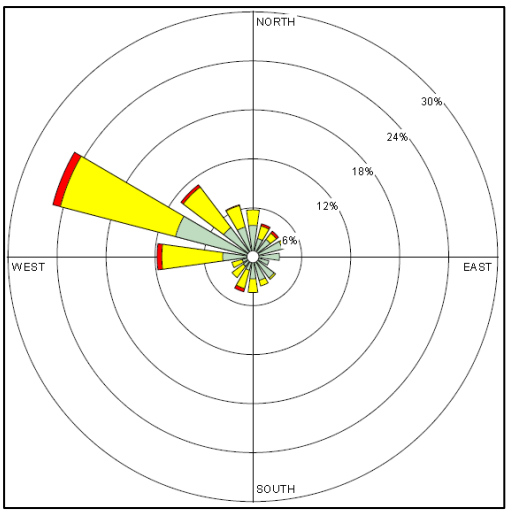
Spring (Calm – 0.37%)



Summer (Calm – 0.05%)



Autumn (Calm – 0.77%)



Winter (Calm – 0.36%)

Figure 12.7 - Site-Specific Wind Roses by Season for 2013 [TAPM]

12.7 MIXING HEIGHT

Mixing height is defined as the height of the layer adjacent to the ground over which an emitted or entrained inert non-buoyant tracer will be mixed (by turbulence) within a time scale of about one hour or less.

Diurnal variations in mixing depths are illustrated in ***Figure 12.6***. As would be expected, an increase in the mixing depth during the morning is apparent, arising due to the onset of vertical mixing following sunrise. Maximum mixing heights occur in the mid to late afternoon, due to the dissipation of ground-based temperature inversions and the growth of convective mixing layer.

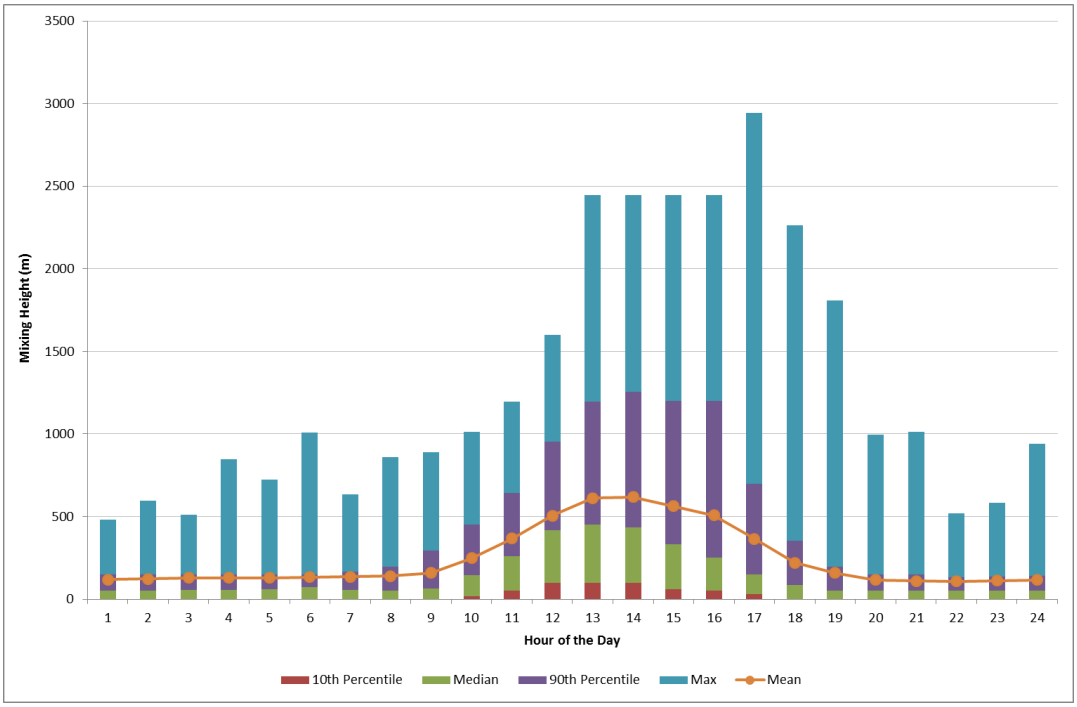


Figure 12.8 - Mixing Height [TAPM, 2013]

12.8 SOURCES AND EMISSION ESTIMATION

This section provides information upon which the emission rates were derived using the equations and parameters detailed in ***Annexure L***.

12.8.1 Atmospheric Stability

Atmospheric stability refers to the tendency of the atmosphere to resist or enhance vertical motion. The Pasquill-Turner assignment scheme identifies six Stability Classes (Stability Classes A to F), to categorise the degree of atmospheric stability. These classes indicate the characteristics of the prevailing meteorological conditions and are used as input into various air dispersion models. The frequency of occurrence for each stability class and the associated average wind speed for proposed development site for 2013 is detailed in ***Table*** . The data identifies that Stability Class D is most common; this stability class is indicative of neutral conditions neither enhancing nor impeding pollutant dispersion.

Stability Class	Description	Frequency of Occurrence (%)	Average Wind Speed (m/s)
A	**Very unstable low wind, clear skies, hot daytime conditions**	**9.58%**	**2.3**
B	**Unstable clear skies, daytime conditions**	**15.55%**	**3.3**

C	**Moderately unstable moderate wind, slightly overcast daytime conditions**	**9.10%**	**3.6**
D	**Neutral high winds or cloudy days and nights**	**19.75%**	**3.0**
E	**Stable moderate wind, slightly overcast night-time conditions**	**13.68%**	**3.6**
F	**Very stable low winds, clear skies, cold night-time conditions**	32.35%	**2.6**

Table 12.6 - Annual Stability Class Distribution Predicted [TAPM, 2013]

12.8.2 Modelling Scenarios

Modelling for each stage has been undertaken for this assessment, as detailed in ***Section 12.2***:

- Initial Stage (Year 1) – due to the short duration of stripping of topsoil, the dry mining above the water table and processing activities (150,000 tonnes per annum) during this stage have been modelled;
- Production Stage 1 (Year 2) – dry mining above the water table and processing activities (250,000 tonnes per annum) during this stage have been modelled.
- Production Stage 2 (Year 3) – dry mining above and below the water table and processing activities (450,000 tonnes per annum) during this stage have been modelled; and
- Production Stage 3 (Years 4 onwards) – setting up of dredge operations, wet production and processing activities (700,000 tonnes per annum) have been modelled.

Each modelling scenario incorporates the following activities:

- Mining operations (mobile plant and truck loading);
- Haul road movements to processing area;
- Processing operations (vehicle movements, material unloading, screening, material transfers, stockpiling of materials);
- Wind generated emissions from stockpiles and pit floors; and
- Product loading to trucks.

The following assumptions have been made:

- Continuous 24-hour plant operation, 365 days per year. In reality this situation is unlikely to occur;
- One haul road will be paved and the remaining two haul roads will be covered with gravel; and
- Screens are enclosed.

Additional assumptions and equations are presented in ***Annexure L***.

12.8.3 Location of Sources

Figure presents the proposed locations of the pits, stockpiles, and processing area. The location of sources remains constant throughput the life of the Project.

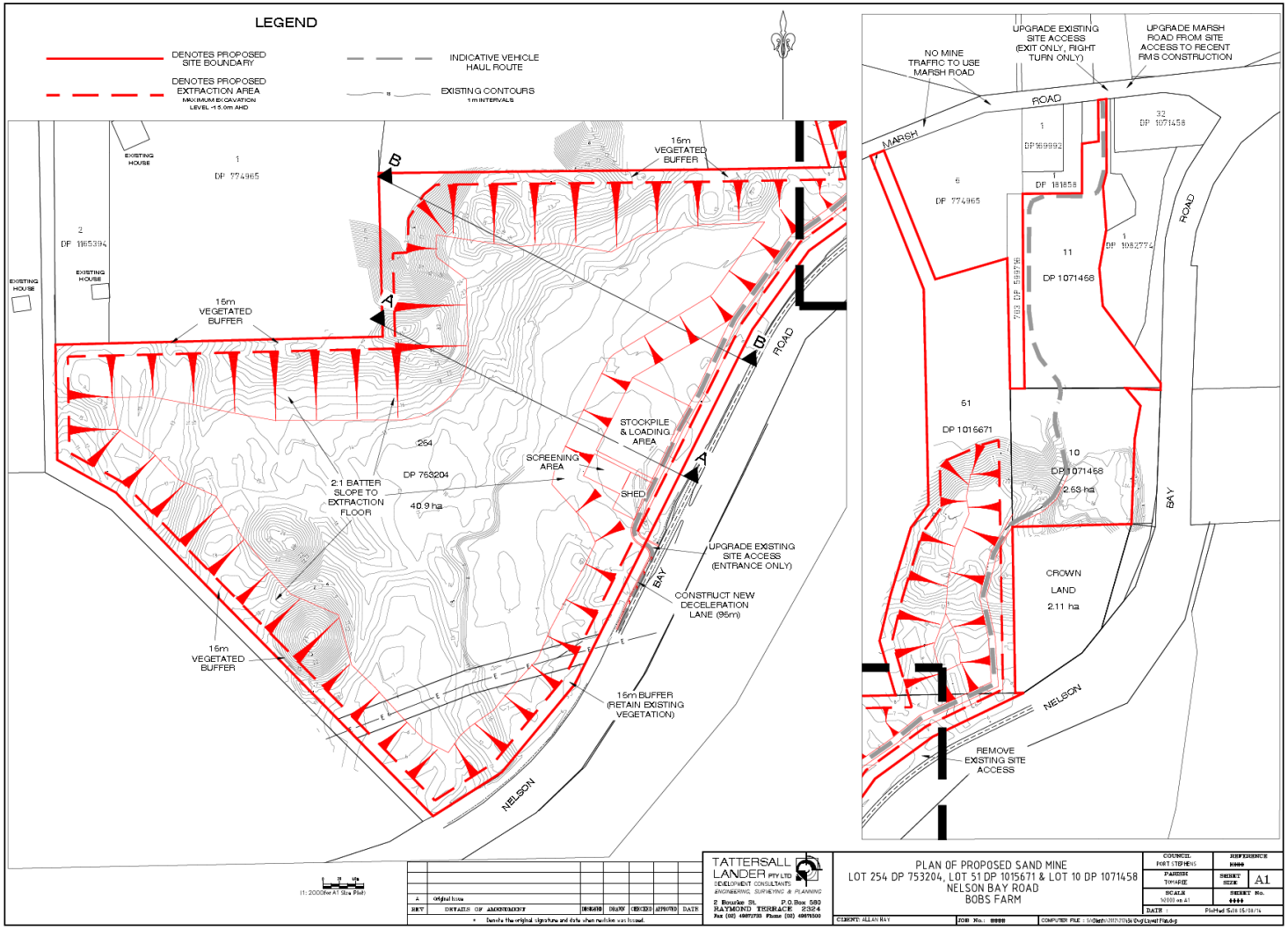


Figure 12.9 - Location of Sources [Tattersall Lander]

12.8.4 Emissions by Source

As discussed in ***Section 12.5.1***, the emission estimation for individual activities has been derived from NPI Emission Estimation Technique manuals and US EPA AP42 documentation. Where calculation methods require site-specific parameters, these have been provided by Tattersall Lander, as detailed in ***Annexure L***.

The annual calculated emissions for TSP, PM_{10} and $PM_{2.5}$ are presented in ***Table*** , ***Table*** and ***Table*** for each source type and assessment stage. It should be noted that all sources are classed as fugitive and there are no point sources associated with this project.

Fugitive Activities	Initial Stage	Production Stage 1	Production Stage 2	Production Stage 3
Mining	**6.65**	**11.10**	**9.99**	**1.58**
Wind Erosion (pits)	**1.17**	**1.17**	**0.59**	**0.12**
Haul Truck Movements	**15.54**	**25.91**	**46.65**	**0**
Material Handling & Screening	**0.08**	**0.14**	**0.25**	**0.39**
Stockpiles	**0.09**	**0.11**	**0.14**	**0.19**
Product Movements	**0.13**	**0.22**	**0.39**	**0.61**

Table 12.7 - Calculated Annual TSP Emissions by Source for Each Assessment Stage (t/year)

Fugitive Activities	Initial Stage	Production Stage 1	Production Stage 2	Production Stage 3
Mining	**3.19**	**5.32**	**4.79**	**0.75**
Wind Erosion (pits)	**0.59**	**0.59**	**0.29**	**0.06**
Haul Truck Movements	**3.96**	**6.60**	**11.89**	**0.00**
Material Handling & Screening	**0.04**	**0.07**	**0.12**	**0.18**
Stockpiles	**0.05**	**0.05**	**0.07**	**0.09**
Product Movements	**0.06**	**0.10**	**0.17**	**0.27**

Table 12.8 - Calculated Annual PM_{10} Emissions by Source for Each Assessment Stage (t/year)

Fugitive Activities	Initial Stage	Production Stage 1	Production Stage 2	Production Stage 3
Mining	**0.70**	**1.17**	**1.05**	**0.17**
Wind Erosion (pits)	**0.09**	**0.09**	**0.04**	**0.01**
Haul Truck Movements	**0.40**	**0.66**	**1.19**	**0.00**
Material Handling & Screening	**0.002**	**0.003**	**0.005**	**0.01**
Stockpiles	**0.01**	**0.01**	**0.01**	**0.01**
Product Movements	**0.01**	**0.02**	**0.04**	**0.06**

Table 12.9 - Calculated Annual $PM_{2.5}$ Emissions by Source for Each Assessment Stage (t/year)

Table , ***Table*** and ***Table*** show an increase in emissions in relation to the increase in throughput for each stage. The emissions during Production Stage 2 clearly show the influence of the water table during mining and material handling activities. It is clear that the highest emission source is from the haul roads, until the dredge operations begin.

The efficiency controls applied are presented in ***Annexure L***.

12.9 IMPACT ASSESSMENT

This section presents the results of the air quality impact assessment for predicted ground level concentrations of TSP, PM_{10}, $PM_{2.5}$, and dust deposition for the proposed operations at varying Stages.

The results of the dispersion modelling include individual sensitive receptor and contour plots that are indicative of ground-level concentrations.

This Level 2 impact assessment requires the predictions to be presented as follows:

- The incremental impact of each pollutant as per the criterion units and time periods;
- The total impact (incremental plus background) for the 100th percentile (i.e. maximum value) in units as per the criterion and time periods. For 24-hour average PM_{10} and $PM_{2.5}$ predictions, the contemporaneous concentrations are the predicted pollutant concentrations added to the daily monitoring results from Newcastle and Wallsend, as discussed in ***Section 12.6.3***.

12.9.1 TSP

The predicted incremental increase in annual average TSP is presented in ***Table*** for each assessment stage. It can be seen from ***Table*** that the incremental increase in annual average TSP will be less than 8 µg/m^3 at all sensitive receptor locations. The highest incremental increases will occur at Port Stephens Avocado Farm during Production Stage 2.

Receptor	Predicted Annual Average Incremental TSP Concentrations (µg/m^3)			
	Initial Stage	Production Stage 1	Production Stage 2	Production Stage 3

756 Marsh Road	**0.2**	**0.4**	**0.6**	**0.0**
760 Marsh Road	**0.2**	**0.3**	**0.5**	**0.0**
774 Marsh Road	**0.3**	**0.5**	**0.8**	**0.0**
780 Marsh Road	**0.2**	**0.3**	**0.4**	**0.0**
Primary School	**0.2**	**0.3**	**0.6**	**0.0**
3679 Nelson Bay Road	**0.7**	**1.2**	**2.0**	**0.1**
698 Marsh Road	**2.5**	**4.1**	**7.1**	**0.2**
640 Marsh Road	**1.9**	**3.0**	**4.8**	**0.3**
614A Marsh Road	**2.3**	**3.8**	**6.3**	**0.2**
Port Stephens Avocado Farm	**2.8**	**4.7**	**7.9**	**0.2**

Table 12.10 - Predicted Annual Average Incremental TSP Concentrations (µg/m³)

When the annual average background concentration of 44.6 µg/m³ is applied to the model productions, the total annual average TSP is predicted to be less than 53 µg/m³, which is below the criterion of 90 µg/m³. As such the TSP emissions from the Project are not predicted to adversely impact upon the sensitive receptors. A contour plot is presented in ***Annexure L***.

12.9.2 PM_{10}

12.9.2.1 24-Hour Average Concentrations

The daily PM_{10} results have been analysis in the following manner:

- Maximum total concentrations – these results are the overall maximum 24-hour concentrations at each receptor and associated number of exceedances of the criteria;
- Maximum incremental contemporaneous concentrations – these results are reviewed based on the highest impact from the Project. The daily results are added to the corresponding background concentrations as detailed in ***Section 12.5.1***.

Maximum Concentrations

Analysis of the daily predictions has identified the maximum 24-hour concentration at each receptor and the number of daily exceedances of the criteria. The maximum predicted 24-hour average PM_{10} is presented in ***Table*** for each assessment stage.

The results show that Port Stephens Avocado Farm will exceed the 50 µg/m³ criteria for one day during all Stages of the Project. During Production Stage 2 (Year 3) 640 Marsh Road will also experience and exceedance.

Receptor	Predicted Max 24-Hour Average Contemporaneous PM_{10} Concentrations ($\mu g/m^3$) with Background Concentrations in Brackets			
	Initial Stage	Production Stage 1	Production Stage 2	Production Stage 3
756 Marsh Road	**49.6 (0)**	**49.6 (0)**	**49.6 (0)**	**49.6 (0)**
760 Marsh Road	**49.6 (0)**	**49.6 (0)**	**49.6 (0)**	**49.6 (0)**
774 Marsh Road	**49.6 (0)**	**49.6 (0)**	**49.6 (0)**	**49.6 (0)**
780 Marsh Road	**49.6 (0)**	**49.6 (0)**	**49.6 (0)**	**49.6 (0)**
Primary School	**49.6 (0)**	**49.6 (0)**	**49.6 (0)**	**49.6 (0)**
3679 Nelson Bay Road	**49.6 (0)**	**49.6 (0)**	**49.6 (0)**	**49.6 (0)**
698 Marsh Road	**49.6 (0)**	**49.6 (0)**	**49.6 (0)**	**49.6 (0)**
640 Marsh Road	**49.6 (0)**	**49.6 (0)**	50.1 (1)	**49.6 (0)**
614A Marsh Road	**49.7 (0)**	**49.7 (0)**	**49.7 (0)**	**49.6 (0)**
Port Stephens Avocado Farm	**50.1 (1)**	**50.5 (1)**	**50.9 (1)**	**49.7 (0)**

Table 12.11 - Predicted Maximum Contemporaneous 24-Hour Average PM_{10} Concentrations ($\mu g/m^3$)

Figure presents a graph of the number of exceedances per Stage at each sensitive receptor.

The maximum background concentration with exceedances removed (as discussed in ***Section 5.1***) was 49.6 $\mu g/m^3$, which occurred on 11/01/2013. As this high value is close to the criteria, a review of the incremental increases on this date has been undertaken:

- During the Initial Stage (Year 1) one receptor, Port Stephens Avocado Farm, is predicted to exceed the criteria, this exceedance occurs on 11/01/2013;
- During Production Stage 1 (Year 2) one receptor, Port Stephens Avocado Farm, will exceed the criteria as a result of this high background concentration on 11/01/2013;
- During Production Stage 2 (Year 3) two receptors will exceed the criteria as a result of this high background concentration on 11/01/2013; and
- During Production Stage 3 (Year 4 onwards) no receptors will exceed the criteria.

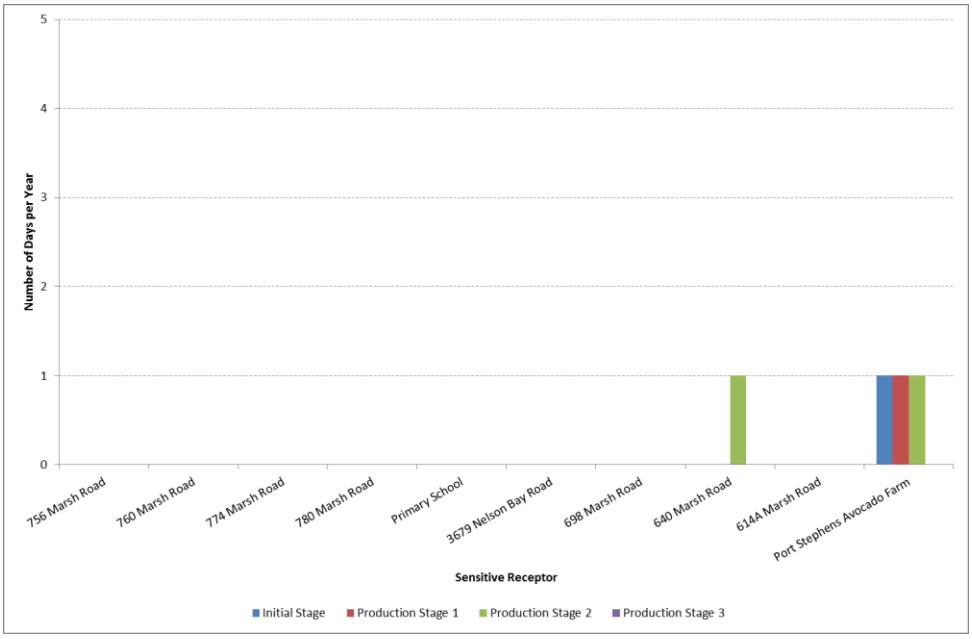


Figure 12.10 - Number of Days the 24-Hour Average Contemporaneous Predictions Exceed the PM_{10} Criteria

Maximum Incremental Concentrations

The predicted contemporaneous 24-hour average PM_{10} is presented in ***Table*** for each assessment stage. The contemporaneous concentrations are the predicted pollutant concentrations added to the daily monitoring results from Newcastle as discussed in ***Section 12.5.1***. For each receptor location, the highest predicted incremental concentration occurs at different times, therefore the background concentrations vary. The incremental increase for each sensitive receptor is presented in ***Table*** .

Receptor	Predicted Max 24-Hour Average Contemporaneous PM_{10} Concentrations ($\mu g/m^3$) with Background Concentrations in Brackets			
	Initial Stage	Production Stage 1	Production Stage 2	Production Stage 3
756 Marsh Road	**16.6 (15.2)**	**17.6 (15.2)**	**19.1 (15.2)**	**15.4 (15.2)**
760 Marsh Road	**13.3 (11.9)**	**14.2 (11.9)**	**15.6 (11.9)**	**12.1 (11.9)**
774 Marsh Road	**12.4 (10.2)**	**13.8 (10.2)**	**16.3 (10.2)**	**10.6 (10.2)**
780 Marsh Road	**16.4 (15.2)**	**17.2 (15.2)**	**18.6 (15.2)**	**15.4 (15.2)**
Primary School	**13.5 (11.9)**	**14.5 (11.9)**	**16.3 (11.9)**	**12.2 (11.9)**
3679 Nelson Bay Road	**15.6 (11.9)**	**18.0 (11.9)**	**22.2 (11.9)**	**12.5 (11.9)**
698 Marsh Road	**18.5 (10.6)**	**23.7 (10.6)**	**33.2 (10.6)**	**12.0 (10.6)**
640 Marsh Road	**18.6 (13.2)**	**22.1 (13.2)**	**27.2 (13.2)**	**12.8 (11.7)**
614A Marsh Road	**18.4 (13.6)**	**21.5 (13.6)**	**27.1 (13.6)**	**16.8 (16.1)**
Port Stephens Avocado Farm	**20.4 (13.7)**	**24.8 (13.7)**	**32.0 (13.7)**	**14.6 (13.7)**

Table 12.12 - Maximum Incremental Contemporaneous 24-Hour Average PM_{10} Concentrations ($\mu g/m^3$)

It can be seen from ***Table*** that:

- The increases in concentrations during each Stage of the Project reflect in the increase in throughput of the Mine, which the exception of Production Stage 3, where dredging operations commence;
- During all Stages of the Project, this highest incremental increases occur at 698 Marsh Road, with the maximum 24-hour increase of 22.6 µg/m^3 occurring during Production Stage 2 (Year 3); and
- During Production Stage 3 (Year 4 onwards) will have the lowest incremental increases due to the reduction in emissions as a result of the dredging operations.
-

Receptor	Predicted 24-Hour Average Incremental PM_{10} Concentrations (µg/m^3)			
	Initial Stage	Production Stage 1	Production Stage 2	Production Stage 3
756 Marsh Road	**1.4**	**2.4**	**3.9**	**0.2**
760 Marsh Road	**1.4**	**2.3**	**3.7**	**0.2**
774 Marsh Road	**2.2**	**3.6**	**6.1**	**0.4**
780 Marsh Road	**1.2**	**2.0**	**3.4**	**0.2**
Primary School	**1.6**	**2.6**	**4.4**	**0.3**
3679 Nelson Bay Road	**3.7**	**6.1**	**10.3**	**0.6**
698 Marsh Road	**7.9**	**13.1**	**22.6**	**1.4**
640 Marsh Road	**5.4**	**8.9**	**14.0**	**1.1**
614A Marsh Road	**4.8**	**7.9**	**13.5**	**0.7**
Port Stephens Avocado Farm	**6.7**	**11.1**	**18.3**	**0.9**

Table 12.13 - Predicted Max 24-Hour Incremental PM_{10} Concentrations (µg/m^3)

12.9.2.2 Annual Average

The PM_{10} annual average criterion of 25 µg/m^3 has been adopted for this assessment. ***Table*** presents the predicted total PM_{10} concentrations at sensitive receptors for each assessment stage. Background PM_{10} concentration of 22.3 µg/m^3 are included in the predictions.

Receptor	Predicted Total Annual Average PM_{10} Concentrations with Background Concentrations in Brackets ($\mu g/m^3$)			
	Initial Stage	Production Stage 1	Production Stage 2	Production Stage 3
756 Marsh Road	**22.4 (22.3)**	**22.5 (22.3)**	**22.5 (22.3)**	**22.5 (22.3)**
760 Marsh Road	**22.4 (22.3)**	**22.4 (22.3)**	**22.4 (22.3)**	**22.4 (22.3)**
774 Marsh Road	**22.4 (22.3)**	**22.5 (22.3)**	**22.5 (22.3)**	**22.5 (22.3)**
780 Marsh Road	**22.3 (22.3)**	**22.4 (22.3)**	**22.4 (22.3)**	**22.4 (22.3)**
Primary School	**22.4 (22.3)**	**22.4 (22.3)**	**22.4 (22.3)**	**22.4 (22.3)**
3679 Nelson Bay Road	**22.5 (22.3)**	**22.8 (22.3)**	**22.8 (22.3)**	**22.8 (22.3)**
698 Marsh Road	**22.9 (22.3)**	**24.1 (22.3)**	**24.1 (22.3)**	**24.1 (22.3)**
640 Marsh Road	**22.8 (22.3)**	**23.6 (22.3)**	**23.6 (22.3)**	**23.6 (22.3)**
614A Marsh Road	**22.9 (22.3)**	**24.0 (22.3)**	**24.0 (22.3)**	**24.0 (22.3)**
Port Stephens Avocado Farm	**23.0 (22.3)**	**24.3 (22.3)**	**24.3 (22.3)**	**24.3 (22.3)**

Table 12.14 - Predicted Total Annual Average PM_{10} Concentrations ($\mu g/m^3$)

It can be seen from ***Table*** that the total PM_{10} concentration will be less than the 25 $\mu g/m^3$ criterion at all sensitive receptor locations. The highest annual average PM_{10} concentration is 24.3 $\mu g/m^3$ which will occur at Port Stephens Avocado Farm during all Production Stages. As such the annual PM_{10} emissions from the Project are not predicted to adversely impact upon the sensitive receptors. A contour plot is presented in ***Annexure L***.

12.9.3 $PM_{2.5}$

12.9.3.1 24-Hour Average Concentrations

The daily $PM_{2.5}$ results have been analysed based on maximum total concentrations – these results are the overall maximum 24-hour concentrations at each receptor and associated number of exceedances of the criteria.

Maximum Concentrations

Analysis of the daily predictions has identified the maximum 24-hour concentration at each receptor and the number of daily exceedances of the criteria. The maximum predicted 24-hour average $PM_{2.5}$ is presented in ***Table*** for each assessment stage.

The results show that there are no exceedances of the 24-hour $PM_{2.5}$ criteria (25 $\mu g/m^3$) predicted at any modelled receptor.

Receptor	Predicted Max 24-Hour Average Contemporaneous $PM_{2.5}$ Concentrations ($\mu g/m^3$) with number of exceedances in Brackets			
	Initial Stage	Production Stage 1	Production Stage 2	Production Stage 3
756 Marsh Road	**21.5 (0)**	**21.5 (0)**	**21.5 (0)**	**21.5 (0)**
760 Marsh Road	**21.5 (0)**	**21.5 (0)**	**21.5 (0)**	**21.5 (0)**
774 Marsh Road	**21.5 (0)**	**21.5 (0)**	**21.6 (0)**	**21.6 (0)**
780 Marsh Road	**21.5 (0)**	**21.5 (0)**	**21.5 (0)**	**21.5 (0)**
Primary School	**21.5 (0)**	**21.5 (0)**	**21.5 (0)**	**21.5 (0)**
3679 Nelson Bay Road	**21.5 (0)**	**21.6 (0)**	**21.6 (0)**	**21.5 (0)**
698 Marsh Road	**21.5 (0)**	**21.9 (0)**	**22.1 (0)**	**21.6 (0)**
640 Marsh Road	**21.5 (0)**	**21.5 (0)**	**21.5 (0)**	**21.5 (0)**
614A Marsh Road	**21.5 (0)**	**21.5 (0)**	**21.5 (0)**	**21.5 (0)**
Port Stephens Avocado Farm	**21.5 (0)**	**21.5 (0)**	**21.5 (0)**	**21.5(0)**

Table 12.15 - Predicted Maximum Contemporaneous 24-Hour Average $PM_{2.5}$ Concentrations ($\mu g/m^3$)

12.9.3.2 Annual Average

The $PM_{2.5}$ annual average criterion of 8 $\mu g/m^3$ has been adopted for this assessment. ***Table*** presents the predicted total $PM_{2.5}$ concentrations at sensitive receptors for each assessment stage. Background PM_{10} concentration of 7.7 $\mu g/m^3$ are included in the predictions.

Receptor	Predicted Total Annual Average PM_{10} Concentrations with Background Concentrations in Brackets ($\mu g/m^3$)			
	Initial Stage	Production Stage 1	Production Stage 2	Production Stage 3
756 Marsh Road	**7.71 (7.7)**	**7.71 (7.7)**	**7.72 (7.7)**	**7.70 (7.7)**
760 Marsh Road	**7.71 (7.7)**	**7.71 (7.7)**	**7.72 (7.7)**	**7.70 (7.7)**
774 Marsh Road	**7.71 (7.7)**	**7.72 (7.7)**	**7.73 (7.7)**	**7.70 (7.7)**
780 Marsh Road	**7.71 (7.7)**	**7.71 (7.7)**	**7.71 (7.7)**	**7.70 (7.7)**
Primary School	**7.71 (7.7)**	**7.71 (7.7)**	**7.72 (7.7)**	**7.70 (7.7)**
3679 Nelson Bay Road	**7.73 (7.7)**	**7.74 (7.7)**	**7.77 (7.7)**	**7.71 (7.7)**
698 Marsh Road	**7.78 (7.7)**	**7.83 (7.7)**	**7.91 (7.7)**	**7.71 (7.7)**
640 Marsh Road	**7.78 (7.7)**	**7.82 (7.7)**	**7.87 (7.7)**	**7.72 (7.7)**
614A Marsh Road	**7.79 (7.7)**	**7.84 (7.7)**	**7.91 (7.7)**	**7.71 (7.7)**
Port Stephens Avocado Farm	**7.80 (7.7)**	**7.87 (7.7)**	**7.95 (7.7)**	**7.71 (7.7)**

Table 12.16 - Predicted Total Annual Average PM_{10} Concentrations ($\mu g/m^3$)

It can be seen from ***Table*** that the total $PM_{2.5}$ concentration will be less than the 8 $\mu g/m^3$ criterion at all sensitive receptor locations. The highest annual average $PM_{2.5}$ concentration is 7.95 $\mu g/m^3$ which will occur at Port Stephens Avocado Farm during Production Stage 2. As such the annual $PM_{2.5}$ emissions from the Project are not predicted to adversely impact upon the sensitive receptors. A contour plot is presented in ***Annexure L***.

12.9.4 Dust Deposition

The predicted incremental increase in monthly average dust deposition is presented in ***Table*** for each assessment stage. The assessment criterion for dust deposition is a maximum incremental increase of 2 g/m^2/month. It can be seen from ***Table*** that the highest incremental increase in dust deposition is 0.3 g/m^2/month, which will occur at 698 and 614A Marsh Road during Production Stage 2.

When the background dust deposition level of 2.1 g/m^2/month is applied to the predictions detailed in ***Table*** , the highest dust deposition monthly average is 2.4 g/m^2/month, which complies with the total dust deposition criterion of 4 g/m^2/month.

Overall, the predicted levels comply with the incremental increase and the total dust deposition criteria and therefore dust is not expected to be a nuisance for sensitive receptors.

Receptor	Predicted Annual Average Incremental Dust Deposition (g/m²/month)			
	Initial Stage	Production Stage 1	Production Stage 2	Production Stage 3
756 Marsh Road	**0.01**	**0.02**	**0.04**	**0.00**
760 Marsh Road	**0.01**	**0.02**	**0.03**	**0.00**
774 Marsh Road	**0.01**	**0.01**	**0.02**	**0.00**
780 Marsh Road	**0.01**	**0.01**	**0.02**	**0.00**
Primary School	**0.01**	**0.02**	**0.03**	**0.00**
3679 Nelson Bay Road	**0.04**	**0.06**	**0.10**	**0.01**
698 Marsh Road	**0.10**	**0.17**	**0.30**	**0.01**
640 Marsh Road	**0.06**	**0.10**	**0.15**	**0.01**
614A Marsh Road	**0.11**	**0.18**	**0.30**	**0.01**
Port Stephens Avocado Farm	**0.09**	**0.15**	**0.24**	**0.01**

Table 12.17 - Predicted Monthly Average Incremental Dust Deposition (g/m²/month)

12.9.5 Discussion of Results

The results of the modelling have shown that during all Stages, the TSP, PM_{10} (annual), $PM_{2.5}$ (24 hour and annual) and dust deposition predictions comply with the relevant criteria, as requested in the DGRs.

For most sensitive receptors the maximum 24-hour PM_{10} concentrations are driven by the background concentrations obtained from Newcastle monitoring station. The results have shown that the highest predicted concentrations will occur during Production Stage 2 (Year 3) for most sensitive receptors. This is a result of the increased throughput with dry mining.

Frequency analysis has identified that the highest number of days the PM_{10} 24-hour criteria will be exceeded is 1 day per annum at two receptors during all Stages except Production Stage 3 (Year 4 onwards).

12.10 MITIGATION & MONITORING

12.10.1 General Dust Control Measures

General dust control measures include:

- Minimise the potential for dust emissions from the product stockpile by either watering or screening, where practical;
- Minimise the potential for dust emissions from the haul roads by paving haul road three and applying low silt gravel to the remaining two haul roads. Water the haul roads when dust is visible especially during dry conditions;

- Maintain a wheel wash at the exit of Mine to remove dust from vehicle wheels. This will reduce the likelihood of dust visibly accumulating on the road.

An Air Quality Management Plan is provided in ***Annexure L*** this Management Plan outlines general practices which will reduce dust emissions from the operation of Project.

12.10.2 Air Monitoring Network

In the Director General Requirements (DGR's) for this Project, the EPA state that they are moving away from dust deposition monitoring due to a more proactive real-time data collection methods for PM_{10}. A cost/benefit analysis of Hi-Volume Sampling and Tapered Element Oscillating Microbalance (TEOM) is undertaken, as shown in ***Table*** . Additionally, dust deposition monitoring has also been included to outline the differences in measurement techniques.

Measurement Technique	Benefits	Disadvantages	Australian Standard
Hi-Volume Sampler	The particulate concentration is calculated at a laboratory based on the total mass of the sample divided by the volume of air drawn through the filter paper.	Time resolution is limited to 24 hour and the results are only available several days after the measurement. Estimated precision - ±2 µg/m^3	AS/NZS 3580.9.6:2003
TEOM	Provide real-time data with short resolution (<1 hour) that can be used for proactive particulate control. Estimated precision - ±0.5 µg/m^3	High capital costs.	AS/NZS 3580.9.8-2001

Table 12.18 - PM_{10} Measurement Technique Cost Benefit Analysis

Based on this assessment, consideration should be given to install and maintain a TEOM machine at the fence-line of the proposed Sand Mine. Additionally, the installation of a meteorological station would be beneficial to provide more accurate wind conditions.

The installation of a TEOM and weather station will allow proactive dust management techniques to be employed to reduce the likelihood of complaints and exceedances. Any equipment must be installed, maintained and sited in accordance with (Department of Environment & Conservation, 2007).

12.11 CONCLUSION

The purpose of this air quality assessment is to evaluate the potential impacts of pollutants generated from the stages of the proposed Bobs Farm Sand Mine and to provide recommendations to mitigate and minimise any potential impacts that might have an effect on nearby sensitive receptors.

The main air emissions from the proposed Sand Mine operations are caused by vehicle usage, materials handling and transfers associated with the haul roads, until the dredge operations begin.

In order to assess the impact of the proposed Sand Mine on the receiving environment, the incremental impact is quantified and added to existing background pollutant concentrations.

Vipac has used daily particulate monitoring data from NSW EPA site at Newcastle (Smith Street) in the PM_{10} predictions. For the purposes of accurate predictions, the modelling simulated different Stages of the project as outlined in ***Section 12.7***.

The results of the modelling have shown that during all Stages, the TSP, PM_{10} (annual), $PM_{2.5}$ (24 hour and annual) and dust deposition predictions comply with the relevant criteria, as requested in the DGRs.

For most sensitive receptors the maximum 24-hour PM_{10} concentrations are driven by the background concentrations obtained from Newcastle monitoring station. The results have shown that the highest predicted concentrations will occur during Production Stage 2 (Year 3) for most sensitive receptors. This is a result of the increased throughput with dry mining.

Frequency analysis has identified that the highest number of days the PM_{10} 24-hour criteria will be exceeded is 1 day per annum at two receptors during all Stages except Production Stage 3 (Year 4 onwards).

Overall, the predicted levels comply with the incremental increase and the total dust deposition criteria and therefore dust is not expected to be a nuisance for sensitive receptors.

Recommendations for the installation of a TEOM machine and weather station at the site have been outlined in ***Section 12.9***. This would allow proactive dust controls measures to be enforced to reduce the likelihood of exceedances and complaints.

13 GREENHOUSE GAS ASSESSMENT

Chapter 13 provides a Greenhouse Gas Assessment to identify the annual emissions and the expected impacts for the life of the mining operation. The chapter provides the results of an investigation by Vipac Engineers and Scientists the detailed report is contained in Annex M.

13.1 INTRODUCTION

The purpose of this report is to calculate the greenhouse gas emissions of the construction and operation of the new facility over the 13-year life of the Project.

Greenhouse gases (GHG's) are a natural part of the atmosphere; they absorb and re-radiate the sun's warmth and maintain the earth's surface temperature at a level necessary to support life. Human actions, particularly burning fossil fuels (coal, oil and natural gas), agriculture and land clearing are increasing the concentrations of the greenhouse gases. This is the enhanced greenhouse effect, which is contributing to warming of the earth.

Greenhouse gases include water vapour, carbon dioxide (CO_2), methane, nitrous oxide and some artificial chemicals such as chlorofluorocarbons (CFCs). Water vapour is the most abundant greenhouse gas. These gases vary in effect and longevity in the atmosphere, but scientists have developed a system called Global Warming Potential to allow them to be described in equivalent terms to CO_2 (the most prevalent greenhouse gas) called equivalent carbon dioxide emissions (CO_2-e). A unit of one tonne of CO_2-e (t CO_2-e) is the basic unit used in carbon accounting. An emissions inventory, or 'carbon footprint', is calculated as the sum of the emission rate of each greenhouse gas multiplied by the global warming potential.

Technical Considerations

Climate change is a change in the average pattern of weather over a long period of time. There is evidence that our climate is changing, largely due to human activities. The Fourth Assessment Report, produced by the Intergovernmental Panel on Climate Change (IPCC) in 2007, states global warming is 'unequivocal' and 'most of the observed increase in globally-averaged temperatures since the mid-20th century is very likely due to the observed increase in greenhouse gas concentrations'.

There are multiple lines of evidence that show the earth's climate system is warming. These include increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level. Climate change, however, is not just about global warming; the science indicates that the climate will be altered in many other ways. For example, there will be changes in rainfall patterns and ocean currents, changes to the intensity and frequency of extreme events such as storms, droughts and floods, rising global sea level and ocean acidification.

Greenhouse Gases & Global Warming Potential

Greenhouse gases are a natural part of the atmosphere; they absorb and re-radiate the Sun's warmth and maintain the earth's surface temperature at a level necessary to support life. Human actions, particularly burning fossil fuels (coal, oil and natural gas), agriculture and land clearing, are increasing the concentrations of the gases that trap heat. This is the enhanced greenhouse effect, which is contributing to warming of the earth.

Greenhouse gases include water vapour, carbon dioxide CO2, methane, nitrous oxide and some artificial chemicals such as chlorofluorocarbons (CFCs). Water vapour is the most abundant greenhouse gas. Its concentration is highly variable and human activities do not directly impact on its amount in the atmosphere. The concentrations of the other greenhouse gases in the atmosphere are directly influenced by human activities. Once released into the atmosphere, many of these gases remain there for a long time.

Standard units of measurement are prescribed for the standard reportable items; emissions of each greenhouse gas are be estimated and reported in tonnes of CO2-equivalent. Conversion factors from tonnes of emissions of each greenhouse gas to tonnes of emissions of carbon dioxide equivalent for that gas are called Global Warming Potentials (GWP) and are listed in Table 13.1.

Greenhouse Gas		Chemical Formula	Global Warming Potential
Carbon dioxide		CO_2	1
Methane		CH_4	21
Nitrous oxide		N_2O	310
Sulphur hexafluoride		SF_6	23,900
Hydrofluorocarbons	HFC-23	CHF_3	11,700
	HFC-32	CH_2F_2	650
	HFC-41	CH_3F	150
	HFC-43-10mee	$C_5H_2F_{10}$	1,300
	HFC-125	C_2HF_5	2,800
	HFC-134	$C_2H_2F_4$ (CHF_2CHF_2)	1,000
	HFC-134a	$C_2H_2F_4$ (CH_2FCF_3)	1,300
	HFC-143	$C_2H_3F_3$ (CHF_2CH_2F)	300
	HFC-143a	$C_2H_3F_3$ (CF_3CH_3)	3,800
	HFC-152a	$C_2H_4F_2$ (CH_3CHF_2)	140
	HFC-227ea	C_3HF_7	2,900
	HFC-236fa	$C_3H_2F_6$	6,300
	HFC-245ca	$C_3H_3F_5$	560
Perfluorocarbons	Perfluoromethane	CH_4	6,500
	Perfluoroethane	C_2F_6	9,200
	Perfluoropropane	C_3F_8	7,000
	Perfluorobutane	C_4F_{10}	7,000
	Perfluorocyclobutane	c-C_4F_8	8,700
	Perfluoropentane	C_5F_{12}	7,500
	Perfluorohexane	C_6F_{14}	7,400

The Global Warming Potential figures in the above table are the figures published by the Intergovernmental Panel on Climate Change in Climate Change 1995: The Science of Climate Change (Cambridge, UK: Cambridge University Press, 1996).

Table 13.1 - Global Warming Potentials

Direct & Indirect Emissions

Direct emissions are produced from sources within the boundary of an organisation and as a result of the organisation's activities. These emissions mainly arise from the following activities:

- Generation of energy, heat, steam and electricity, including carbon dioxide and products of incomplete combustion (methane and nitrous oxide);
- Manufacturing processes that produce emissions (for example, cement, aluminium and ammonia production);
- Transportation of materials, products, waste and people; for example, use of vehicles owned and operated by the reporting organisation;
- Fugitive emissions: intentional or unintentional GHG releases (such as methane emissions from coal mines, natural gas leaks from joints and seals); and
- On-site waste management, such as emissions from landfill sites.

Indirect emissions are emissions generated in the wider economy as a consequence of an organisation's activities, but which are physically produced by the activities of another organisation. The most important category of indirect emissions is from the consumption of electricity.

13.1 PROJECT DESCRIPTION

The proposed Bobs Farm Sand Mine project comprises:

- The establishment of a quarry/pit to extract and process sand at a rate of approximately 750,000 tonnes per annum, from a total sand resource of approximately 8-10 million tonnes. The estimated life of the extraction process is 13 years;
- The construction of extractive materials processing and transport infrastructure;
- The transportation of extractive materials off-site via roads; and
- The rehabilitation of the site.

Sand will be extracted from the site by two main mining methods:

- Dry mining utilising excavator and haul trucks to remove dry sand products from the pit areas above the water table for processing prior to export, and
- Wet mining utilising a dredge and pump line system to pump wet raw sand materials for processing prior to export.
- An overview of the developmental stages during the Project life is provided in ***Table 13.2***.

Phase	Operational Year	Annual Throughput (tonnes)	Method	Equipment
Phase1	Year 1	150,000	Stripping of topsoil and dry mining (Stripping Phase)	1x 35 tonne excavator 1x 22 tonne excavator 2x 44 tonne dump trucks 2x 23 tonne loaders
Phase 2	Year 2	250,000	Dry mining Construction Stage and Year 1 Extraction/Production)	1x 12/10 suction cutter dredge 1x 22 tonne excavator 1x 44 tonne dump trucks 2x 23 tonne loaders
Phase 3	Year 3	450,000	Dry mining (Initial Extraction Stage down to water-table)	1x 12/10 suction cutter dredge 1x 22 tonne excavator 1x 44 tonne dump trucks 2x 23 tonne loaders
Phase 4	Years 4 - 13	700,000	Wet production (Final Extraction – production below the water-table down to a depth of -15m below the water-table)	1x 12/10 suction cutter dredge 1x 22 tonne excavator 1x 44 tonne dump trucks 2x 23 tonne loaders

Table 13.2 - Overview of Proposed Operations

The main activities of the Project will be the bulk handling of sand material, utilising mobile plant, general truck movements for the transport of the material to the plant where the sand is screened and washed before being de-watered and stockpiled. The final product will be transported, when necessary from site using trucks.

13.2 REGULATORY FRAMEWORK

The *Commonwealth National Greenhouse and Energy Reporting Act 2007* (NGER Act) established a national framework for corporations to report greenhouse gas emissions and energy consumption. The NGER Act requires corporations to submit an annual report in energy consumption, energy production and greenhouse gas emissions, if any of the following thresholds are met:

- The facility consumes more than 100 terajoules of energy in a financial year or emits greenhouse gases above 25,000 tonnes CO_2-e (facility threshold); and
- All Australian facilities collectively consume more than 200 terajoules of energy in a financial year or emit greenhouse gases above 50,000 tonnes CO_2-e (corporate threshold).

A facility is defined as an activity, or a series of activities (including ancillary activities), if it involves the production of greenhouse gas emissions, the production of energy or the consumption of energy; and forms a single undertaking or enterprise and meets the requirements of the regulations.

Tattersall Lander will not be required to report under the NGER Act as the Project is not expected to emit more than 25,000 tonnes of CO_2-e per year.

13.3 METHODOLOGY

The Department of the Environment (DOE) monitors and compiles databases on anthropogenic activities that produce greenhouse gases in Australia. The DOE has published greenhouse gas emission factors for a range of anthropogenic activities. The DOE methodology for calculating greenhouse gas emissions is published in the National Greenhouse Accounts (NGA) Factors workbook (Department of Environment, 2015). This

workbook is updated regularly to reflect current compositions in fuel mixes and evolving information on emission sources.

The scope that emissions are reported, as defined by the NGA Factors Workbook is determined by whether the activity is within the organisation's boundary (Scope 1 – Direct Emissions) or outside the organisation's boundary (Scopes 2 and 3 – Indirect Emissions). The scopes are described below:

- Scope 1 Emissions: Direct (or point-source) emission factors give the kilograms of carbon dioxide equivalent (CO_2-e) emitted per unit of activity at the point of emission release (i.e. fuel use, energy use, manufacturing process activity, mining activity, on-site waste disposal, etc.);
- Scope 2 Emissions: Indirect emissions from the generation of the electricity purchased and consumed by an organisation as kilograms of CO_2-e per unit of electricity consumed; and
- Scope 3 Emissions: Indirect emissions for organisations that:
    a. Burn fossil fuels: to estimate their indirect emissions attributable to the extraction, production and transport of those fuels; or
    b. Consume purchased electricity: to estimate their indirect emissions from the extraction, production and transport of fuel burned at generation and the indirect emissions attributable to the electricity lost in delivery in the transmission and distribution network.

Scope 1 emissions include those from fuel use by vehicles, coal burnt in boilers and methane from wastewater systems. Scope 2 emissions are from any purchased electricity. Scope 3 emissions are from the emissions resulting from the energy required to manufacture products such as diesel and equipment.

Emission factors used in this assessment have been derived from either the Department of Environment, site-specific information or from operational details obtained from similar emission sources.

The majority of the emission factors used in this report has been sourced from the NGA Factors Workbook (Department of Environment, 2015) as indicated in ***Table*** 13.3 - Emission Factor***13.3***. The carbon emissions for the embodied energy of materials have been derived from the *Inventory of Carbon and Energy* (Hammond, Professor Geoff and Jones, Craig, 2008).

Scope	Emission Source	Emission Factor	Source
1	Combustion emissions from diesel (stationary)	2.71 t CO_2-e / kL	NGA Factors Workbook, 2015
	Combustion for transport (general)	2.29 t CO_2-e / kL	NGA Factors Workbook, 2015
2	Electricity (purchased in NSW)	0.84 kg CO_2-e / kWh	NGA Factors Workbook, 2015
3	Combustion for transport (general)	0.18 t CO_2-e / kL	NGA Factors Workbook, 2015
	Electricity (purchased in NSW)	0.12 kg CO_2-e / kWh	NGA Factors Workbook, 2015
	Diesel consumption	0.139 t CO_2-e / kL	NGA Factors Workbook, 2015
	Embodied energy for concrete	0.13 kg CO_2-e/kg	Hammond and Jones, 2008
	Embodied energy for steel (general)	1.77 kg CO_2-e/kg	Hammond and Jones, 2008

Table 13.3 - Emission Factor

For this assessment Scope 1, Scope 2 and Scope 3 emissions have been calculated in accordance with the NGA Factors Workbook methodology.

13.4 QUANTIFICATION OF EMISSIONS

This section will quantify the carbon dioxide equivalent emissions associated with the annual CO_2-e emissions and Life of the Project CO_2-e emissions are presented.

Embodied Energy of Construction Materials

The upstream emissions have been identified the embodied energy associated with the production of construction materials. The quantities of materials have been provided by Quarry Mining Systems and are shown in ***Table 13.4*** - Quantity of Construction Materials. The associated emissions are shown in ***Table 13.5*** - Construction Material Embodied Energy Emissions (CO2-e tonnes). The total emissions during the construction phase are 199.3 tonnes CO_2-e.

Item	Concrete (m^3)	Steel (kg)
Weighbridge	60	500
Work Shop	80	600
Admin & carpark	80	400
Screen (18 x 5)	60	600
Wash plant	40	28,000
Cyclone Pad	25	200
Cyclone Tower	-	15,000
Electricity transformer pad	10	100
Total	**355 m^3 (852 tonnes)**	**45,400 kg (50 tonnes assumed)**

Table 13.4 - Quantity of Construction Materials

Emission Source	Scope	Amount of Material (tonnes)	Emissions (t CO_2-e)
Embodied energy of concrete	3 (Embodied)	852	110.8
Embodied energy of steel	3 (Embodied)	50	88.5
		Total CO_2-e Emissions (tonnes)	**199.3**

Table 13.5 - Construction Material Embodied Energy Emissions (CO2-e tonnes)

Purchased Power

The proposed mine will use electricity from the grid. At present the expected amount of electricity is unknown, however cost estimates allow $3,500 per month. For the purposes of this assessment, a usage of 10,000 kWh per month consumption has been assumed. The emissions are presented in Table 13.6.

Emission Source	Scope	Annual Usage (kL)	Annual Emissions (t CO_2-e)
Purchased Electricity	2	120,000	100.8
	3 (embodied)	120,000	14.4
		Total CO_2-e Emissions (tonnes) per Annum	**115.2**
		Project Total CO_2-e Emissions (tonnes)	**1,497.6**

Table 13.6 - Electricity Consumption (CO2-e tonnes)

Mining Equipment Fuel

The equipment list and associated fuel consumption for each mobile plant has been provided by Quarry Mining Systems. The calculations in **Table 13.7** are based on operational activity of eight-hour operation per day for 209 days per annum.

Emission Source	Scope	Diesel Consumption (L/hour)	Emissions (t CO_2-e)			
			Phase 1	Phase 2	Phase 3	Phase 4 (per annum)
Excavator (35 tonne)	1 (Direct)	35	158.6	-	-	-
	3 (Embodied)	35	8.1	-	-	-
Excavator (22 tonne)	1 (Direct)	25	113.3	226.6	226.6	226.6
	3 (Embodied)	25	5.8	11.6	11.6	11.6
Loaders (23 tonne)	1 (Direct)	26	235.6	235.6	235.6	235.6
	3 (Embodied)	26	12.1	12.1	12.1	12.1
Haul Trucks (44 tonne)	1 (Direct)	36	326.2	163.1	163.1	163.1
	3 (Embodied)	36	16.7	8.4	8.4	8.4
Suction Cutter Dredge	1 (Direct)	60	-	271.9	271.9	271.9
	3 (Embodied)	60	-	13.9	13.9	13.9
Total CO_2-e Emissions (tonnes) per Annum			**876.5**	**943.2**	**943.2**	**943.2**
Total CO_2-e Emissions (tonnes) per Phase			**876.5**	**943.2**	**943.2**	**9,431.5**
Project Total CO_2-e Emissions (tonnes)			**12,194.3**			

Table 13.7 - Mining Equipment Fuel Emissions (CO2-e tonnes)

Transport Fuel Emissions (Staff Movements)

The transport fuel emissions have been calculated for staff transport to and fro, from work. It has been confirmed that seven staff will be employed at the sand mine. The following assumptions have been made for this assessment:

- Average fuel consumption per vehicle is 10 litres per 100 km travelled; and
- Average distance is 40 km round trip per day for 209 days per annum.

Table 13.8 presents the estimated CO_2-e emissions from staff movements.

Emission Source	Scope	Annual Usage (kL)	Annual Emissions (t CO_2-e)
Staff Movements	1 (direct)	5.85	13.43
	3 (embodied)	5.85	1.06
Total CO_2-e Emissions (tonnes) per Annum			**14.49**
Project Total CO_2-e Emissions (tonnes)			**188.39**

Table 13.8 - Transport Fuel Emissions from Staff Movements (CO2-e tonnes)

Haulage Fuel (from Mine to Customers)

Haul trucks with a payload of 44 tonnes will transport the material from the mine to customers located in the Newcastle or Sydney areas. Some material will be exported out of Australia; these emissions have not been calculated.

The following assumptions have been made for this assessment:

- Average fuel consumption per vehicle is 36 litres per 100 km travelled;
- Average distance is 235 km round trip (assumes average distance between Newcastle and Sydney); and,
- Operational days per year are 209 days.

Table 13.9 presents the estimated CO_2-e emissions from staff movements.

Emission Source	Scope	Diesel Consumption (L/100 km)	Emissions (t CO_2-e)			
			Phase 1	Phase 2	Phase 3	Phase 4 (per annum)
Haul Truck	1 (Direct)	36	773.0	1,289.4	2,321.2	3,610.7
	3 (Embodied)	36	58.9	98.3	177.0	275.3
Total CO_2-e Emissions (tonnes) per Annum			**832.0**	**1,387.8**	**2,498.2**	**3,886.0**
Total CO_2-e Emissions (tonnes) per Phase			**832.0**	**1,387.8**	**2,498.2**	**38,860.2**
Project Total CO_2-e Emissions (tonnes)			**43,578.2**			

Table 13.9 - Haulage Truck Emissions (CO2-e tonnes)

13.5 SUMMARY OF EMISSIONS

The purpose of this report is to evaluate the greenhouse gas emissions from the operation of the facility. Table 13.10 presents the annual emissions during each phase of the project and the life of project emissions.

The following can be determined:

- The highest annual emissions is 4,958.9 tonnes CO_2-e during Phase 4. This is below the 25,000 tonnes CO_2-e threshold and therefore emissions do not need to be reported.
- The Life of Project emissions are estimated to be 57,657.7 tonnes CO_2-e; and
- When compared to Australia's reported greenhouse gas emissions for 2012 (558.8 million tonnes), the highest annual emissions during Phase 4 is approximately 0.00088% of Australia's total emissions.

Activity	Annual Emission (t CO_2-e)				Life of Project Emissions (t CO_2-e)
	Phase 1	Phase 2	Phase 3	Phase 4 (per Annum)	
Construction Materials	199.3	-	-	-	199.3
Equipment Fuel	876.5	943.2	943.2	943.2	12,194.3
Transport Fuel (Staff)	14.5	14.5	14.5	14.5	188.4
Electricity	115.2	115.2	115.2	115.2	1,497.6
Haulage	832.0	1,387.8	2,498.2	3886.0	43,578.2
Total	**2,037.4**	**2,460.6**	**3,571.1**	**4,958.9**	**57,657.7**

Table 13.10 - Summary of Annual Emissions

14 ECOLOGICAL ASSESSMENT

Chapter 14 summarises flora and fauna investigations within the proposed sand extraction area and surrounds under a Biodiversity Assessment Report (BAR). A detailed description of existing flora and fauna and impacts of the mining operation is provided separately at Annex N. The impacts of the proposal on threatened species and ecological communities listed under State and Commonwealth legislation have been assessed.

14.1 INTRODUCTION

This Biodiversity Assessment Report (BAR) has been undertaken to seek approval for a proposed sand mine within Lots 10 & 11 DP 1071458, Lot 51 DP 1015671 and Lot 245 DP 753204 Nelson Bay Road, Bobs Farm NSW. This BAR addresses the specific matters raised in the Secretary's Environmental Assessment Requirements (SEARs) that are relevant to biodiversity. In accordance with the SEARs, the BAR uses the Framework for Biodiversity Assessment (FBA) to quantify the project's impacts and the BioBanking Assessment Methodology (BBAM) to determine suitable offsets in accordance with the NSW Biodiversity Offsets Policy for Major Projects. Considerations have also been given to the Fisheries Management Act 1994 (FM Act), Port Stephens Comprehensive Koala Plan of Management 2002 (CKPoM) and the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). This report forms part of the Environmental Impact Statement (EIS) undertaken for this proposal.

Definition of the Study Area

The 50.06 ha irregularly shaped study area was composed of four parcels of land:

- Lot 10 DP 1071458 (2.53ha);
- Lot 11 DP 1071458 (2.9ha);
- Lot 51 DP 1015671 (6.63ha);
- Lot 254 DP 753204 (40.9ha).

Location of Study Area

The study area was located at Bobs Farm NSW within the Port Stephens LGA approximately 27km north-east of Newcastle and 14km south-west of Nelson Bay (Figures 1 & 2). The study area was situated between Nelson Bay Road and Marsh Road. Nelson Bay Road formed the southern boundary of the study area.

Topography and Soils

The majority of the study area occurs on stable, often steep sided Aeolian Holocene transgressive dunes composed of quartz sands. Soils consisted of deep, very well drained, weakly developed Podzols (Murphy, 1995). Lower ground in the far north-west of the study area consisted of a flat, swampy, Holocene estuarine plain. Soils within this lower area consisted of very poorly drained Humic Gleys (Murphy, 1995). A detailed plan showing the topography of the study area is shown in Figure 3.

Drainage

No watercourses or drainage features were noted onsite. Lower lying poorly drained areas of ground in the far north of the study area contained some surface water, particularly after heavy rains. These poorly drained regions of surface water were associated with areas of Swamp Forest and Freshwater

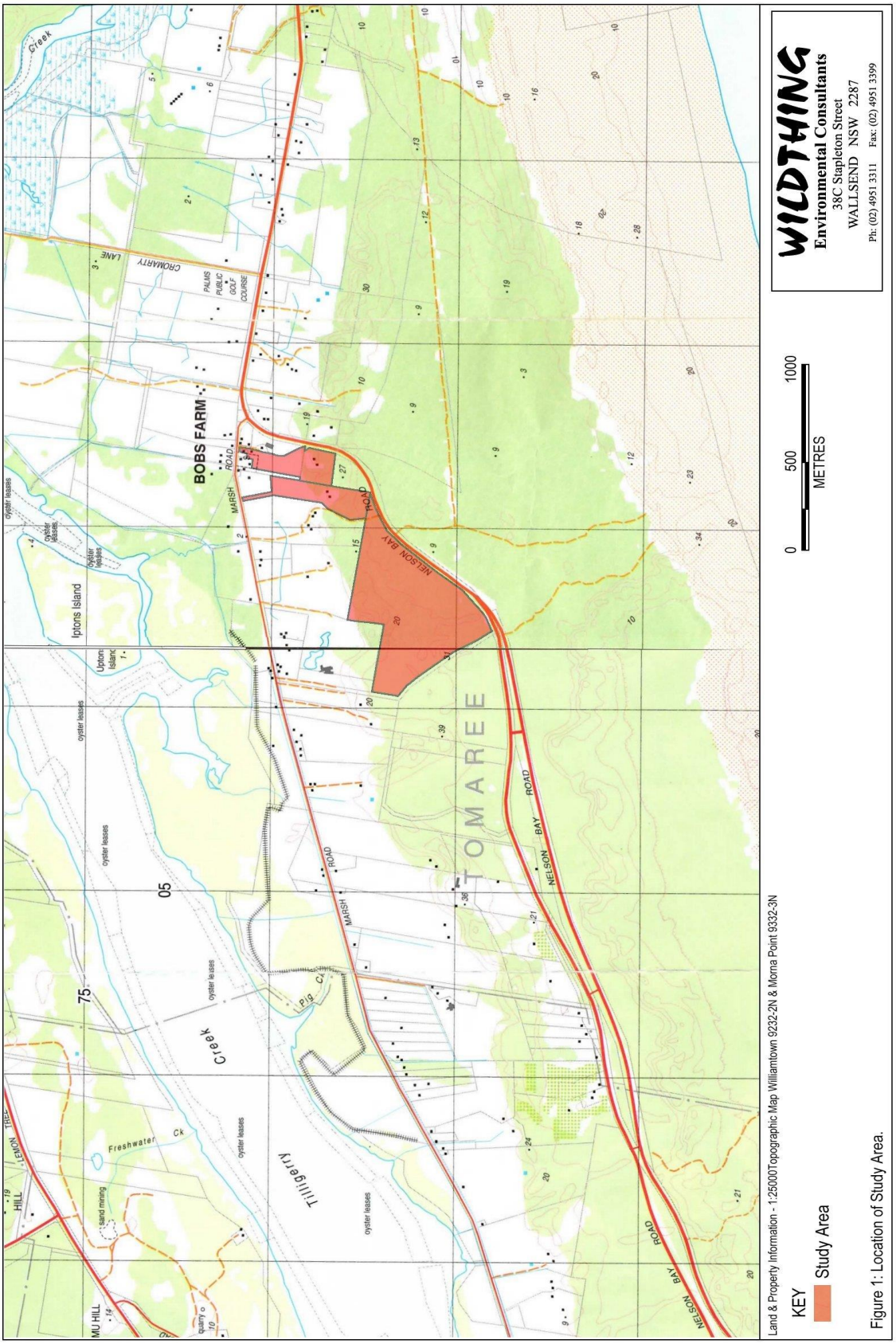


Figure 14.1 - Location of Study Area

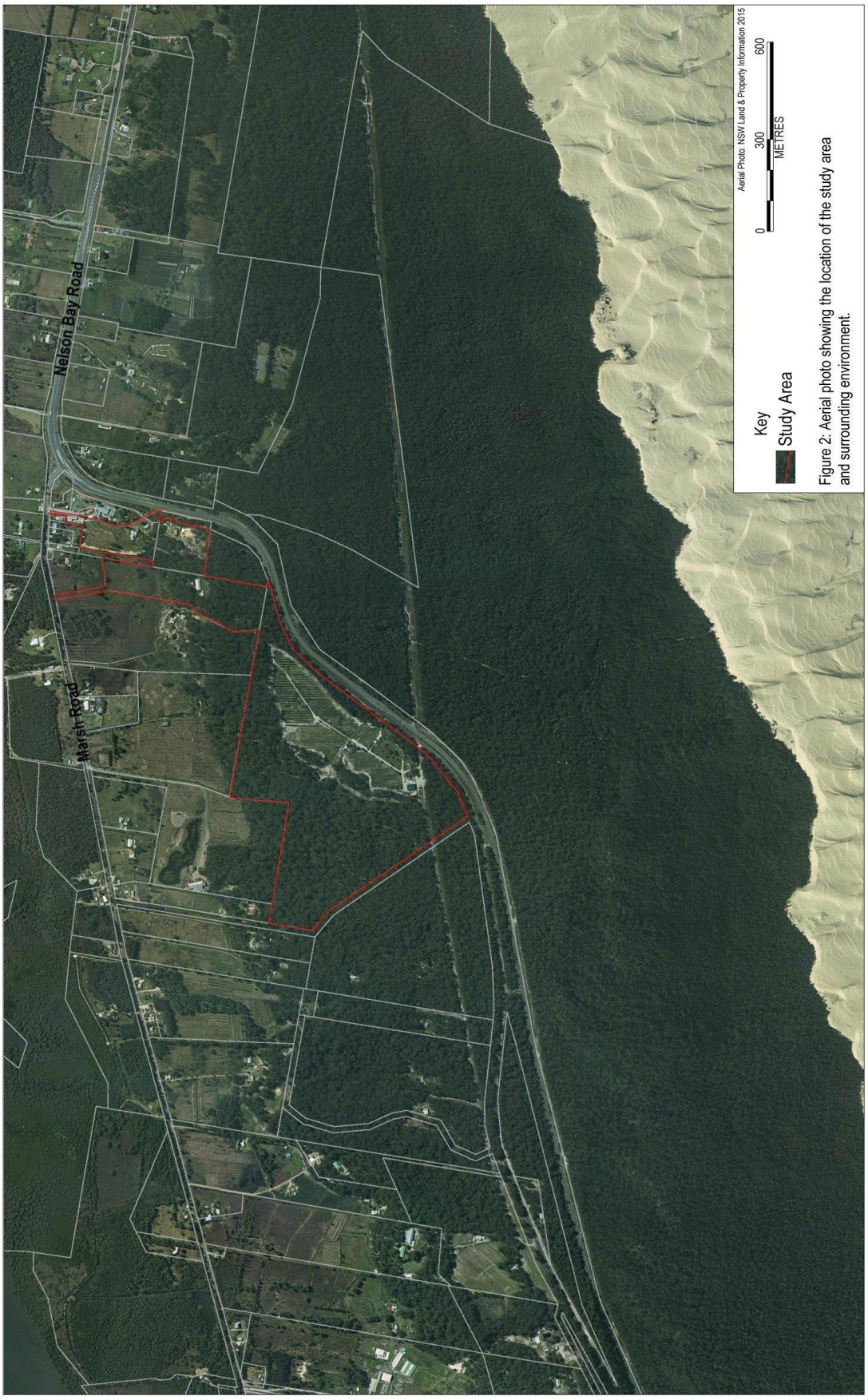


Figure 14.2 - Location of Study Area

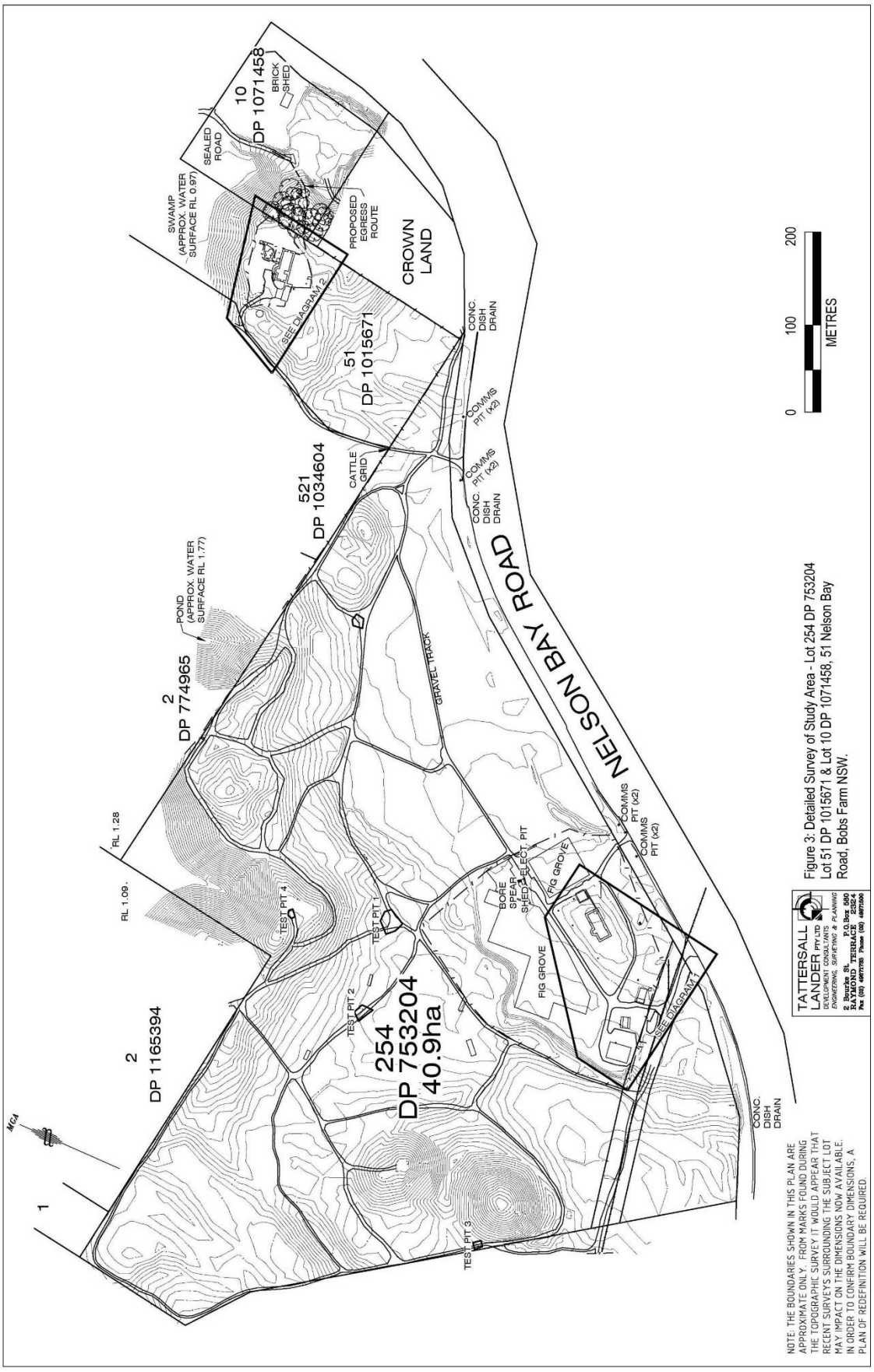


Figure 14.3 - Topography of Study Area

Wetland. The majority of the site drains east into Worimi National Park. The north-west portion drains north-west into a large dam on the neighbouring Shark and Ray Centre property or into the drainage network of Tilligerry Creek, located approximately 1km north-west of the study area (Martens, 2015).

Vegetation

A large portion of Lots 51, 254 and to a lesser extent Lot 10 occurring on Aeolian Holocene transgressive dunes was undeveloped and consisted of uncleared tall dry open sclerophyll forest dominated by the canopy species Eucalyptus pilularis (Blackbutt) and Angophora costata (Smooth-barked Apple). Coastal Sand Apple Blackbutt Forest composed of E. pilularis and A. costata was the dominant vegetation community on the Holocene sand dunes along Stockton Bight from Fern Bay to Anna Bay. Approximately 10ha within Lot 254 had been cleared and was occupied by an Olive and Fig Orchard. The cleared orchard area also contained a residence and maintained gardens. The lower-lying flat ground in the north of Lots 10, 11 & 51 has had a long history of disturbance and largely consisted of grassland/pasture. Two smaller areas of Swamp Forest dominated by Melaleuca quinquenervia (Broad-leaved Paperbark) were present in the far north and west of the study area. An area of Freshwater wetland dominated by sedges was also present in the far north of the study area.

Zoning of Study Area Under the Port Stephens LEP (2013)

The entire study area is zoned RU2 Rural Landscape. The objective of this direction is to protect the agricultural production value of rural land.

Land Tenure Information

The study area consisted of a number of parcels of land under a number of tenures. Lot 254 DP 753204 and Lot 51 DP 1015671 which made up the majority of the study area is owned by the proponent. The remaining two lots were also in private ownership. Table 1 below shows the land tenure across the study area.

Table 14.1 - Land tenure within the Study Area.

Land Parcel	Land Holder
Lot 10 DP 1071458 (2.53ha)	Allan Hay
Lot 11 DP 1071458	Allan Hay
Lot 51 DP 1015671 (6.63ha)	Ammos Resource Management Pty Ltd
Lot 254 DP 753204 (40.9ha)	Ammos Resource Management Pty Ltd

14.2 PROPOSAL

The proposed Sand Mine will have a disturbance zone whole area including vegetation of 38ha (Figure 4). The proposed sand mining operations will have several stages of development and operations. These are likely to be:

a. Development Stage – installation of Nelson Bay access location, initial part-clearing of mine site, setting up screening operations, loading ramp and storage shed and the construction of the main exit road onto the existing bitumen sealed road within Lot 10 DP 1071458.

b. Operational Stage 1 – Part Staged clearing and stockpiling of topsoil and production of initial sand material that is likely to be processed into landscape soil base and sports field top-dress material.

c. Operational Stage 2 – Part staged clearing and processing of the blonde sand material for all products range.

d. Operational Stage 3 – Part staged clearing and setting up of dredge operations and winning of sand material for the processing of all products range.

Within all operational stages the main activities will be the bulk handling of sand material, utilising front end loaders and trucks and dogs for the transport of the material to the required markets. Operational hours for extraction, loading of vehicles and transportation of materials out of the site area requested to be 6.00am – 6.00pm Monday to Saturday. No work on Sundays or Public Holidays.

With regards to the processing of the site material for the various applications that could be commercially supplied, the following processes are expected to be undertaken:

1. Vegetation Clearing – logging and mulching. This process would be undertaken in a staged or incremental fashion that would be tailored to specific commercial markets. Large scale clearing would not be undertaken.

2. Screening – This process involves the separating of the sand into certified material and would be undertaken throughout the whole mining process. The extent of the activity will be dependent on the product specification that will be required.

3. Washing – It is expected that some of the sand material will require washing to clean the material for a certification that will be required.

4. Sizing – Sand material will need to be sized. This process is essential for the production of fracking sand, glass, construction sand and high-end sports field top dress materials.

5. Separating of non-silica material - process undertaken generally for the production of glass and sand specification.

6. Dredging – process is for the recovery of material that is below the economic reach of mechanical equipment. Approximately 50% of the recoverable resource would be dredged.

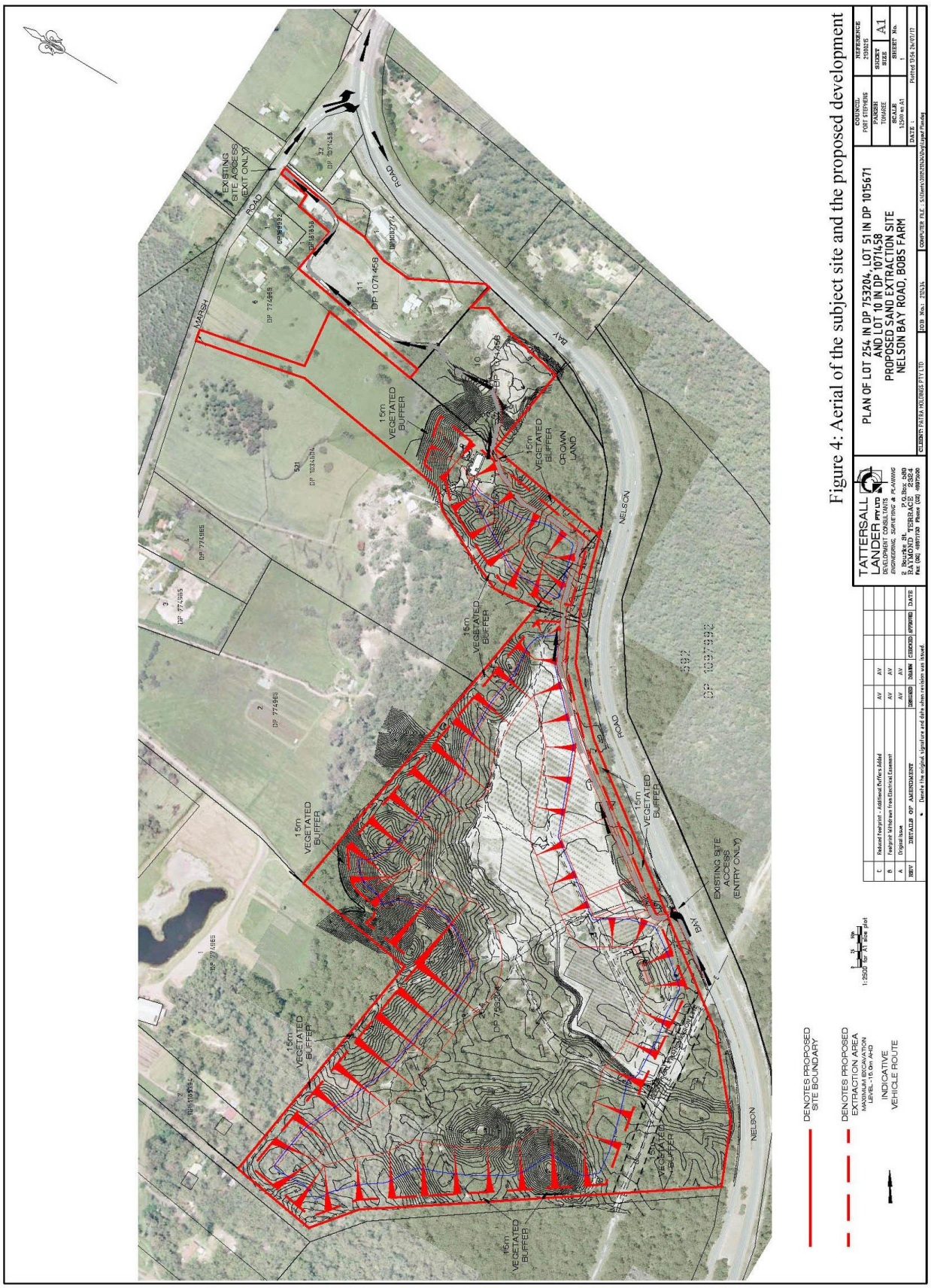


Figure 14.4 - Proposed Sand Mine

Wastes from these processes are expected to be:

1. All organic material processed on the site would be either used for rehabilitation of the land or sold to local garden suppliers. It would also be expected that some of the trees would be processed for saw logs. Tub ground mulch would also be stockpiled and used in local rehabilitation projects.

2. Heavy Metals – this product has been identified in very low concentrations of 0.18 to 2% within the 5 boreholes that have been undertaken. It would be initially proposed that this material would be stockpiled and then relocated to a heavy earth processor.

3. Water – sourced from site bores, this water would be returned to the groundwater via infiltration and settlement ponds.

4. Organic Soils – the current boreholes have indicated that organic soils are banded at layers of around 1-2 metres and located around the current site water table. It would be expected that these materials would be processed as landscaping supplies.

Approximately 12ha extraction area will be rehabilitated back to forest. The remaining 24.8ha of the extraction area will become an artificial lake.

14.3 LEGISLATIVE REQUIREMENTS

Legislative Context & SEARs

Environmental impact statements (EIS's) are prepared to assess the impacts of major projects, including State Significant Development (SSD) projects, under Part 5.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). This Biodiversity Assessment Report (BAR) forms part of the EIS being prepared for the Bobs Farm Sand Mine and assesses the biodiversity impacts of the project.

Secretary's Environmental Assessment Requirements (SEARS)

EIS's are subject to a range of legislative and policy requirements as set out in the Secretary's Environmental Assessment Requirements (SEARs) (issued 12 April 2017).

The SEARs require the BAR to address the following:

- The likely biodiversity impacts of the development, having regard to OEH's requirements.

- Details of the biodiversity offsets to compensate for significant residual impacts required to offset the development in accordance with the Framework for Biodiversity Assessment (FBA) (OEH 2014).

A copy of the SEARs for the Bobs Farm Sand Mine are contained in Appendix A. In accordance with the SEARs, this BAR has been prepared to quantify the project's impacts and to determine suitable offsets in accordance with the NSW Biodiversity Offsets Policy for Major Projects and Framework for Biodiversity Assessment.

Taking the Biodiversity Conservation (Savings and Transitional) Regulation 2017 - Major projects (state significant development/state significant infrastructure) - Other development applications (or modification applications) can be considered under the previous legislation if:

- environmental assessment requirements were issued before 25 August 2017 and the application is made before 25 February 2019. If the environmental assessment requirements are reissued, the application must instead be made within 18 months of the reissue, but no later than 24 August 2020.

Matters For Further Consideration

The NSW OEH provided project specific SEARs (Attachment B to the SEARs) which outlined 'Project Specific Requirements' in addition to the project SEARs. The following additional requirements were made by OEH in respect to the project:

"Impacts on the following species will require further consideration and provision of the information specified in section 9.2 of the Framework for Biodiversity Assessment:

- ***Pterostylis chaetophora*** **(Tall Rustyhood)** - given its known habitat preferences and known occurrence within the LGA, OEH is of the opinion this species has the potential to occur on the proposed development site. As such OEH expects appropriately targeted sampling to be undertaken during its known flowering period (September to November) (Bishop, 2000) and samples sent to the NSW Herbarium for identification and/or confirmation. OEH will provide assistance with details of the nearby location to assist with the targeted sampling.
- ***Uperoleia mahonyi*** **(Mahoney's Toadlet)** – as suitable habitat exists on the subject site, OEH considers any potential loss of known habitat could significantly reduce the viability and genetic diversity of this species, and therefore OEH specifically requires that this species is considered (in accordance Section 9 of the FBA)."

Detailed Project Specific Requirements' in addition to the project SEARs is contained in Annex N.

14.4 ADDITIONAL LEGISLATIVE REQUIREMENTS

This Report has taken into consideration the following additional legislation, Acts and Policies:

- Commonwealth Environment Protection and Biodiversity Conservation Act 1999) (EPBC Act);
- Environmental Planning and Assessment Act 1979 (EP&A Act);
- Threatened Species Conservation Act 1995 (TSC Act);

- Biodiversity Conservation Act 2016 (BC Act);
- Biodiversity Conservation (Savings and Transitional) Regulation 2017
- Water Management Act 2000 (WM Act);
- Biosecurity Act 2015 (BS Act);
- Fisheries Management Act 1994 (FM Act);
- Coastal Management SEPP
- State Environmental Planning Policy 44 (SEPP 44) Koala Habitat Protection;
- Port Stephens Comprehensive Koala Plan of Management 2002 (CKPoM);
- NSW Biodiversity Offsets Policy for Major Projects (Biobanking);
- NSW Groundwater Dependent Ecosystem Policy.

Commonwealth Environment Protection And Biodiversity Conservation Act 1999 (EPBC Act)

The Commonwealth Environment Protection and Biodiversity Conservation Act 1999 provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places which are defined in the EPBC Act as matters of national environmental significance. The EPBC Act comes into play when a proposal has the potential to have a significant impact on a matter of national environmental significance. The nine matters of national environmental significance to which the EPBC Act applies are:

- world heritage properties;
- national heritage places;
- wetlands of international importance (often called 'Ramsar' wetlands after the international treaty under which such wetlands are listed);
- nationally threatened species and ecological communities;
- migratory species;
- Commonwealth marine areas;
- the Great Barrier Reef Marine Park;
- nuclear actions (including uranium mining);
- a water resource, in relation to coal seam gas development and large coal mining development.

In addition, the EPBC Act confers jurisdiction over actions that have a significant impact on the environment where the actions affect, or are taken on, Commonwealth land, or are carried out by a Commonwealth agency (even if that significant impact is not on one of the nine matters of 'national environmental significance'). Matters under the EPBC Act are addressed in Section 14.11 of the report.

Environmental Planning and Assessment Act 1979 (EP&A Act)

The provisions of the EP&A Act enable the preparation of local environmental plans, development control plans, regional environmental plans and State Environmental Planning

Polices (SEPP's) to control development at the local, regional and state level. The proposed sand mine is being assessed as State Significant Development (SSD). The SSD assessment system has been established to guide planning decisions on large-scale industrial, resource and other proposals which the proposed sand mine is classed. Considerations of the effects of the proposal on threatened species, endangered populations and communities under the guidelines of Section 5A of the Environmental Planning and Assessment Act (1995) are addressed in Sections 14.7 and Annex N of this report.

Threatened Species Conservation Act 1995 (TSC Act)

The TSC Act provides for the conservation of threatened species, populations and ecological communities of animals and plants. The Act sets out a number of specific objectives relating to the conservation of biological diversity and the promotion of ecologically sustainable development. Schedules 1 & 2 of the TSC Act contain lists of flora and fauna species, population and communities that have been determined by the NSW Scientific Community. These species have been determined as being under threat of serious decline that could ultimately lead to extinction. Schedule 3 of the Act also contains a list of "Key Threatening Processes" which have been determined to have a detrimental impact on threatened species, populations or communities. Under Section 5A of the EP&A Act an assessment of significance (Seven Part Test) is applied to species, populations and ecological communities listed on Schedules 1, 1A and 2 of the TSC Act which may be affected directly or indirectly by the proposed action (Section 14.7 and Annex N of the report).

Biodiversity Conservation Act 2016

The Biodiversity Conservation Act replaces the Threatened Species Conservation Act 1995, Nature Conservation Trust Act 2001, and parts of the National Parks & Wildlife Act 1974. The BC Act and supporting regulations establish a modern and integrated legislative framework for land management and conservation in NSW. The purpose of the BC Act is to establish a pathway to avoid, minimise and offset the impacts of proposed development and land use change on biodiversity and to establish a scientific method for assessing the likely impacts on biodiversity values of proposed development and land use change, for calculating measures to offset those impacts and for assessing improvements in biodiversity values.

Under the Biodiversity Conservation (Savings and Transitional) Regulation 2017 - Major projects (state significant development/state significant infrastructure) - development applications (or modification applications) the proposal is to be submitted under the previous legislation.

Local Land Services Act 2013

The LLS Act repeals the Native Vegetation Act 2003 (NSW). The amendments to the LLS Act have resulted in a change to the criteria for native vegetation clearing. A Native Vegetation Regulatory Map (Regulatory Map) will identify three different land categories for clearing on rural land:

Category 1 – 'Exempt land' which will not be subject to clearing approval;

Category 2 – 'Regulated Land' on which clearing of native vegetation may be carried out with or without approval in accordance with an 'allowable activity' or 'code' under the LLS

Act, and

'Excluded Land' – Land not categorised in the Regulatory Maps and to which the LLS Act does not apply.

The Regulatory Map will not apply to land urban land, national parks or state forestry land. As the proposal is assessed as State Significant Development an authorisation under the LLS Act is not required.

Water Management Act 2000 (WM Act)

The objectives of this Act are to provide for the sustainable and integrated management of the water sources of the state for the benefit of both present and future generations. The NSW Office of Water administers the WM Act and is required to assess the impact of any proposed controlled activity to ensure that no more than minimal harm will be done to waterfront land as a consequence of carrying out the controlled activity. Waterfront land includes the bed and bank of any river, lake or estuary and all land within 40 metres of the highest bank of the river, lake or estuary. No area of Waterfront Land occurs within proximity to the study area therefore an assessment under the WM Act is not required.

Biosecurity Act 2015

The primary object of the Biosecurity Act is to provide a framework for the prevention, elimination and minimisation of biosecurity risks posed by biosecurity matter, dealing with biosecurity matter, carriers and potential carriers, and other activities that involve biosecurity matter, carriers or potential carriers. The broad objectives for biosecurity in NSW are to manage biosecurity risks from animal and plant pests and diseases, weeds and contaminants by:

- preventing their entry into NSW;
- quickly finding, containing and eradicating any new entries;
- effectively minimising the impacts of those pests, diseases, weeds and contaminants that cannot be eradicated through robust management arrangements.

The Biosecurity Act has been addressed in Section 14.6.1.4.

Fisheries Management Act 1994 (FM Act)

The FM Act aims 'to conserve, develop and share the fishery resources of the State for the benefit of present and future generations and, in particular to:

- conserve fish stocks and key fish habitats;
- conserve threatened species, populations and ecological communities of fish and marine vegetation;
- promote ecologically sustainable development, including the conservation of biological diversity, and, consistently with those objectives;
- promote viable commercial fishing and aquaculture industries;
- promote quality recreational fishing opportunities;

- appropriately share fisheries resources between the users of those resources;
- provide social and economic benefits for the wider community of New South Wales.

To meet these objectives, Part 7 of the FM Act outlines legislative provisions to protect fish habitat and Part 7A outlines provisions to conserve threatened species of fish and marine vegetation and their habitat. Aquatic habitat within the study area would likely be defined as intermittent wetlands filled from localised runoff and not otherwise hydrologically connected to other permanent habitats such as rivers, creeks, estuaries and ocean. An assessment of the development under the FM Act is contained within Section 14.10 of the report.

Coastal Management SEPP

The State Environmental Planning Policy (Coastal Management) 2018 (CM SEPP) updates and consolidates into one integrated policy SEPP 14 (Coastal Wetlands), SEPP 26 (Littoral Rainforests) and SEPP 71 (Coastal Protection), including clause 5.5. of the Standard Instrument – Principal Local Environmental Plan. These policies are now repealed.

The aim of this Policy is to promote an integrated and co-ordinated approach to land use planning in the coastal zone in a manner consistent with the objects of the Coastal Management Act 2016, including the management objectives for each coastal management area, by:

- managing development in the coastal zone and protecting the environmental assets of the coast, and
- establishing a framework for land use planning to guide decision-making in the coastal zone, and
- mapping the 4 coastal management areas that comprise the NSW coastal zone for the purpose of the definitions in the Coastal Management Act 2016.

These coastal management areas are:

- the coastal wetlands and littoral rainforests area,
- the coastal vulnerability area,
- the coastal environment area, and
- the coastal use area.

The study area was not located within littoral rainforests/coastal wetlands, coastal vulnerability or coastal use management areas however the study area is located within a mapped coastal environment area. Further information on this matter is provided in Section 14.9.0 of this report.

SEPP 44 - Koala Habitat Protection

The aims of SEPP 44 are: "to encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas, to ensure permanent free-living populations over their present range and to reverse the current trend of population decline:

(a) by requiring the preparation of plans of management before development consent can be granted in relation to areas of core koala habitat;

(b) by encouraging the identification of areas of core koala habitat;

(c) by encouraging the inclusion of areas of core koala habitat in environment protection zones.

State Environmental Planning Policy No.44 – Koala Habitat Protection (SEPP 44) applies to the proposed development. The Port Stephens Comprehensive Koala Plan of Management (CKPoM) operates under the provisions of SEPP 44.

Port Stephens Comphrehensive Koala Plan of Management CKPoM

The Port Stephens Comprehensive Koala Plan of Management (CKPoM) has been prepared for the Port Stephens LGA in accordance with SEPP 44 - 'Koala Habitat Protection'. The aim of the CKPoM is to encourage the proper conservation and management of areas of natural vegetation that provide habitat for Koalas, to ensure permanent free-living populations over their present range and to reverse the current trend of population decline. An assessment under the Port Stephens CKPoM has been undertaken in Section 14.8.0 of the report.

NSW Biodivisity Offsets Policy for Major Projects

An offsetting strategy will be undertaken using the Biobanking Assessment Methodology (DECC, 2009). A biobank site will be created with the resultant credit generation/retirement. As the project is a SSD the assessment process will follow the Framework for Biodiversity Assessment – NSW Biodiversity Offsets Policy for Major Projects. A provision for compensatory habitat (Offsetting) is contained in Section 14.15.0.

NSW Groundwater Dependent Ecosystem Policy

The state Groundwater Dependent Ecosystems Policy supports the requirements of the Water Management Act 2000 and is specifically designed to protect valuable ecosystems which rely on groundwater for survival so that, wherever possible the ecological processes and biodiversity of these dependent systems are maintained or restored, for the benefit of present and future generations. An assessment under the NSW Groundwater Dependent Ecosystem Policy is contained in Section 14.6.1.2.

14.5 LICENCING

Fieldwork undertaken by Wildthing Environmental Consultants was carried out under NPWS Scientific Investigation Licence S10475 and under Animal Care and Ethics Approval: Animal Research Authority Issue by the Director General of NSW Agriculture (File No. 13 – 251) for the Fauna Survey for Biodiversity and Impact Assessment. The Biobanking Assessment was undertaken by Daryl Harman – BioBanking Assessor Accreditation Number – 159.

14.6 INITIAL ASSESSMENT

The flora and fauna within the study area and adjacent land has been subject to a small number of previous ecological investigations (Table 14.2). These past studies are considered to be the initial assessment.

Table 14.2 - Previous Ecological studies undertaken within the study area and adjacent lands.

Environmental Consultant	Area Surveyed	Survey/Study Type
Wildthing Environmental Consultants (2005).	Lot 10 DP 1071458 Nelson Bay Road, Bobs Farm NSW (northern portion of study area).	Targeted Flora Survey Targeted Fauna searches including fauna trapping.
ERM (2003). Environmental Impact Statement for the Electricity Supply Upgrade from Tomago to Tomaree. Energy Australia.	Areas of habitat within the vicinity of the electrical easement.	Targeted Flora Survey Targeted Fauna searches including fauna trapping.
Ecotone (2008).	Vertebrate Fauna Survey Worimi Conservation Lands. EEC Project No. 0583CW. Prepared for NSW Department of Environment and Climate Change.	Targeted Fauna searches including fauna trapping.
Bell, S.A.J. & Driscoll (2010).	Vegetation of the Worimi Conservation Lands Port Stephens, New South Wales: Worimi NP, Worimi SCA & Worimi RP. Report to Department of Environment, Climate Change & Water, Hunter Regional Parks & Wildlife Group.	Vegetation and targeted Flora Survey.

14.7 INDENTIFYING SUBJECT SPECIES AND ENDANGERED ECOLOGICAL COMMUNITIES

The following threatened species, endangered populations and communities listed in Table 14.3 have been recorded on the Atlas of NSW Wildlife (OEH, 2017) and the Department of the Environment and Energy (DoEE) databases for within 10km of the study area.

Table 14.3 - Threatened species, endangered populations and ecological communities considered.

Scientific Name	Common Name	TSC Act 1995	EPBC Act 1999
Flora			
Corybas dowlingii	Red Helmet Orchid	E	
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V
Diuris arenaria	Tomaree Doubletail	E	
Diuris praecox	Newcastle Doubletail	V	V
Genoplesium baueri	Bauer's Midge Orchid	V	
Phaius australis	Lesser Swamp Orchid	E	E
Rhizanthella slateri	Eastern Underground Orchid	E	E
Pterostylis chaetophora	Tall Rustyhood	V	
Grevillea parviflora subsp. *parviflora*	Small-flowered Grevillea	V	V
Allocasuarina defungens	Dwarf Heath Casuarina	E	E
Allocasuarina simulans	Nabiac Casuarina	V	V
Angophora inopina	Charmhaven Apple	V	V
Callistemon linearifolius	Netted Bottle Brush	V	
Eucalyptus camfieldii	Camfield's Stringybark	V	
**Eucalyptus glaucina*	Slaty Red Gum	V	V
Eucalyptus parramattensis subsp. *decadens*	Drooping Red Gum	V	V
Melaleuca biconvexa	Biconvex Paperbark	V	
Melaleuca groveana	Grove's Paperbark	V	
Syzygium paniculatum	Magenta Lillypilly	E	V
Tetratheca juncea	Black-eyed Susan	V	V
Prostanthera densa	Villous Mintbush	V	
Asperula asthenes	Trailing Woodruff	V	
Galium australe	Tangled Bedstraw	E	
Lindernia alsinoides	Noah's False Chickweed	E	
Chamaesyce psammogeton	Sand Spurge	E	
Senecio spathulatus	Coastal Fireweed	E	

Scientific Name	Common Name	TSC Act 1995	EPBC Act 1999
Streblus pendulinus	Siah's Backbone		E
Maundia triglochinoides		V	
Cynanchum elegans	White-flowered Wax Plant	E	E
Persicaria elatior	Tall Knotweed	V	V
Zannichellia palustris		E	
Invertebrates			
Petalura gigantea	Giant Dragonfly	E	
Amphibians			
Crinia tinnula	Wallum Froglet	V	
Uperoleia mahonyi	Mahony's Toadlet	E	
Litoria aurea	Green and Golden Bell Frog	E	V
Litoria brevipalmata	Green-thighed Frog	V	
Mixophyes balbus	Stuttering Frog	V	V
Mixophyes iteratus	Giant Barred Frog	E	E
Reptiles			
Caretta caretta	Loggerhead Turtle	V	M
Chelonia mydas	Green Turtle	V	M
Dermochelys coriacea	Leatherback Turtle	E	E
Eretmochelys imbricata	Hawksbill Turtle		V
Natator depressus	Flatback Turtle		V
Hoplocephalus bitorquatus	Pale-headed Snake	V	
Hoplocephalus stephensii	Stephen's Banded Snake	V	
Birds			
Macronectes giganteus	Southern Giant Petrel	E	E & M
Macronectes halli	Northern Giant Petrel	E	M
Pterodroma leucoptera leucoptera	Gould's Petrel	E	
Pterodroma neglecta	Kermadec Petrel	V	
Fregetta grallaria grallaria	White-bellied Storm Petrel	V	V
Pterodroma nigripennis	Black-winged Petrel	V	

Scientific Name	Common Name	TSC Act 1995	EPBC Act 1999
Pterodroma solandri	Providence Petrel	V	
Calonectris leucomelas	Streaked Shearwater		M
Puffinus carneipes	Flesh-footed Shearwater	V	
Puffinus tenuirostris	Short-tailed Shearwater		M
Limicola falcinellus	Broad-billed Sandpiper	V	
Limosa lapponica	Bar-tailed Godwit		M
Limosa limosa	Black-tailed Godwit	V	M
Arenaria interpres	Ruddy Turnstone		M
Xenus cinereus	Terek Sandpiper	V	M
Heteroscelus brevipes	Grey-tailed Tattler		M
Sterna albifrons	Little Tern	E	M
Onychopriom fuscata	Sooty Tern	V	
Actitis hypoleucos	Common Sandpiper		M
Calidris acuminata	Sharp-tailed Sandpiper		M
Calidris canutus	Red Knot		M
Calidris ferruginea	Curlew Sandpiper	E	M
Calidris ruficollis	Red-necked Stint		M
Calidris tenuirostris	Great Knot	V	M
Tringa stagnatilis	Marsh Sandpiper		M
Numenius madagascariensis	Eastern Curlew		M
Numenius minutus	Little Curlew		M
Numenius phaeopus	Whimbrel		M
Charadrius bicinctus	Double-banded Plover		M
Charadrius leschenaultii	Greater Sand-plover	V	
Charadrius mongolus	Lesser Sand-plover	V	M
Pluvialis fulva	Pacific Golden Plover		M
Pluvialis squatarola	Grey Plover		M
Diomedea antipodensis	Antipodeam Albatross	V	V & M
Diomedea gibsoni	Gibson's Albatross	V	V & M

Scientific Name	Common Name	TSC Act 1995	EPBC Act 1999
Thalassarche bulleri	Buller's Albatross		V & M
Thalassarche cauta cauta	Shy Albatross	V	V & M
Thalassarche cauta salvini	Salvin's Albatross		V & M
Thalassarche cauta steadi	White-capped Albatross	V	V & M
Thalassarche melanophris impavida	Campbell Albatross		V & M
Haematopus fuliginosus	Sooty Oystercatcher	V	
Haematopus longirostris	Pied Oystercatcher	E	
Esacus neglectus	Beach Stone-curlew	E4A	
Gallinago hardwickii	Latham's Snipe		M
Rostratula benghalensis australis	Australian Painted Snipe	E	V & M
Botaurus poiciloptilus	Australian Bittern	E	E
Ixobrychus flavicollis	Black Bittern	V	
Ardea alba	Great Egret		M
Ardea ibis	Cattle Egret		M
Ephippiorhynchus asiaticus	Black-necked Stork	E	
Irediparra gallinacea	Comb-crested Jacana	V	
Turnix maculosa	Red-backed Button-quail	V	
Burhinus grallarius	Bush Stone-curlew	E	
Ptilinopus magnificus	Wompoo Fruit-Dove	V	
Ptilinopus regina	Rose-crowned Fruit-Dove	V	
Ptilinopus superbus	Superb Fruit-Dove	V	
Lathamus discolor	Swift Parrot	E	E
Neophema pulchella	Turquoise Parrot	V	
Glossopsitta pusilla	Little Lorikeet	V	
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	
Callocephalon fimbriatum	Gang Gang Cockatoo	V	
Apus pacificus	Fork-tailed Swift		M
Hirundapus caudacutus	White-throated Needletail		M
Monarcha melanopsis	Black-faced Monarch		M

Scientific Name	Common Name	TSC Act 1995	EPBC Act 1999
Monarcha trivirgatus	Spectacled Monarch		M
Merops ornatus	Rainbow Bee-eater		M
Rhipidura rufifrons	Rufous Fantail		M
Epthianura albifrons	White-fronted Chat	V	
Petroica boodang	Scarlet Robin	V	
Petroica phoenicea	Flame Robin	V	
Climacteris picumnus victoriae	Brown Treecreeper	V	
Anthochaera phrygia	Regent Honeyeater	E4A	E & M
Daphoenositta chrysoptera	Varied Sittella	V	
Melithreptus gularis gularis	Black-chinned Honeyeater	V	
Pomatostomus temporalis temporalis	Grey-crowned Babbler	V	
Dasyornis brachypterus	Eastern Bristlebird	E1	E
Circus assimilis	Spotted Harrier	V	
Pandion cristatus	Eastern Osprey	V	
Lophoictinia isura	Square-tailed Kite	V	
Erythrotriorchis radiatus	Red Goshawk	E4A	V
Hieraaetus morphnoides	Little Eagle	V	
Haliaeetus leucogaster	White-bellied Sea Eagle		M
Ninox connivens	Barking Owl	V	
Ninox strenua	Powerful Owl	V	
Tyto longimembris	Eastern Grass Owl	V	
Tyto novaehollandiae	Masked Owl	V	
Tyto tenebricosa	Sooty Owl	V	
Mammals			
Planigale maculata	Common Planigale	V	
Dasyurus maculatus maculatus	Tiger Quoll	V	V
Phascogale tapoatafa	Brush-tailed Phascogale	V	
Phascolarctos cinereus	Koala	V	
Macropus parma	Parma Wallaby	V	

Scientific Name	Common Name	TSC Act 1995	EPBC Act 1999
Petrogale penicillata	Brush-tailed Rock-wallaby	E1	V
Potorous tridactylus tridactylus SE Mainland	Long-nosed Potoroo	V	V
Aepyprymnus rufescens	Rufous Bettong	E1	
Cercartetus nanus	Eastern Pygmy-possum	V	
Petaurus australis	Yellow-bellied Glider	V	
Petaurus norfolcensis	Squirrel Glider	V	
Pseudomys gracilicaudatus	Eastern Chestnut Mouse	V	
Psuedomys novaehollandiae	New Holland Mouse		V
Pteropus poliocephalus	Grey-headed Flying-fox	V	V
Syconycteris australis	Common Blossom-bat	V	
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	
Mormopterus norfolkensis	Eastern Freetail-bat	V	
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	
Miniopterus australis	Little Bentwing-bat	V	
Miniopterus schreibersii oceanensis	Large Bentwing-bat	V	
Kerivoula papuensis	Golden-tipped Bat	V	
Myotis macropus	Southern Myotis	V	
Scoteanax rueppellii	Greater Broad-nosed Bat	V	
Chalinolobus dwyeri	Large Pied Bat	V	V
Vespadelus troughtoni	Eastern Cave Bat	V	
Endangered Populations			
Dromaius novaehollandiae (Emu) – population in the NSW North Coast Bioregion and Port Stephens LGA.			
Hawks Nest and Tea Gardens Endangered Koala (*Phascolarctos cinereus*) Population			
Endangered Ecological Communities			
Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South-East Corner Bioregions.			
Littoral Rainforest in the NSW North Coast, Sydney Basin and South-East Corner Bioregions.			
River Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions.			

Scientific Name	Common Name	TSC Act 1995	EPBC Act 1999
Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions.			
Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions.			
Freshwater wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions.			

E=Endangered Species V=Vulnerable Species E4A=Critically Endangered M=Migratory Species

14.8 SURVEY TECHNIQUES

The survey techniques employed in the production of this flora and fauna report are discussed below. Details of the survey effort including dates, times on site and hours of survey effort are presented in tabular form in Appendix E.

14.9 VEGETATION SURVEY METHODOLOGY

Surveys were conducted from February 2013 to November 2017. The initial determination of the basic vegetation community boundaries was undertaken through the review of an orthophoto covering the study area. Random meander searches were conducted in areas of native vegetation to determine the plant species present. Data on geology, dominant canopy species, native diversity, vegetation structure and condition were collected across the study area to determine the classification as Plant Community Types (PCTs) required to be used by BioBanking Assessment Methodology (BBAM). The plot/transect based surveys were conducted in accordance with the BioBanking Assessment Methodology (BBAM) (Office of Environment and Heritage 2014a).

Biobanking Plot/Transect Surveys

Eight quantitative (plot/transect) site surveys were completed within the study area as outlined in the methodology contained in the BioBanking Assessment Methodology (Office of Environment and Heritage 2014a) and described below Figure 14.5 illustrates the plot layout that was used at each site.

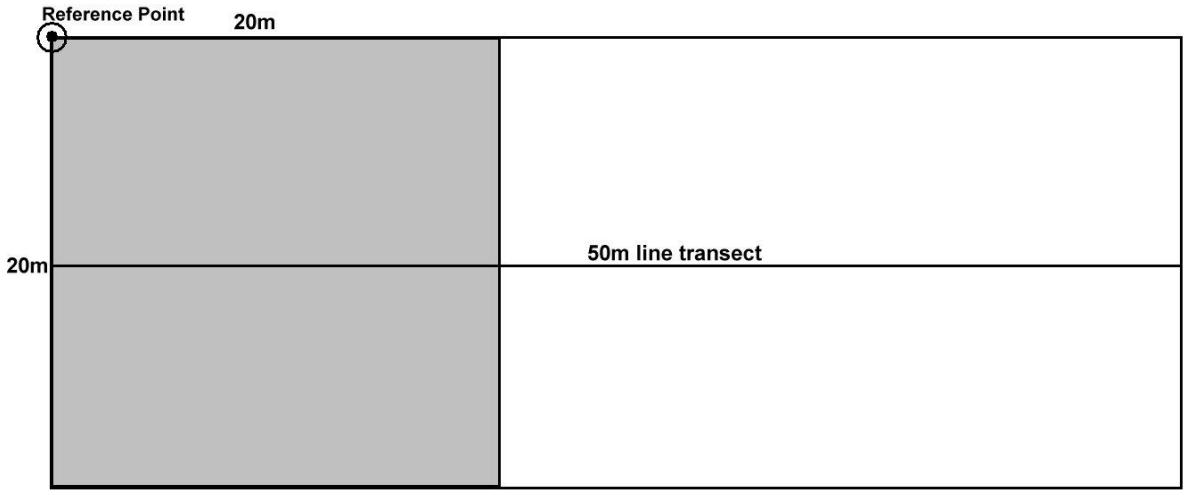


Figure 14.5 - Diagram illustrating the layout of the nested 20 m x 50 m and 20 m x 20 m quadrants used for the assessment of condition attributes at each site

The following site attributes were recorded at each site:

- Location (easting – northing grid type MGA 94, Zone 56).
- Vegetation structure and dominant species and vegetation condition.
- Native and exotic species richness (within a 400 m^2 quadrat): this consisted of recording all species by systematically walking through each 20m x 20m quadrat. The cover abundance of each species was estimated.
- Number of trees with hollows (1,000 m2 quadrat): this was the frequency of hollows within living and dead trees within each 50m x 20m quadrat. A hollow was only recorded if:
    - the entrance could be seen;
    - the estimated entrance width was at least 5 cm across;
    - the hollow appeared to have depth;
    - the centre of the tree was located within the sampled quadrat.
- Total length of fallen logs (1,000 m^2 quadrat): this was the cumulative total of logs within each 50m x 20 m quadrat with a diameter of at least 10 cm and a length of at least 0.5 m.
- Native over-storey cover: this consisted of estimating the percentage cover of the tallest woody stratum present (>1 m and including emergents). The woody stratum included species that were native to NSW and not necessarily those that were locally endemic;
- Native mid-storey cover: this involved estimating the cover of vegetation between the over-storey stratum and a height of one m (i.e. tall shrubs, under-storey trees and tree regeneration).
- Ground cover: this comprised estimating the cover of plants below 1 m in height. The following categories of plants were recorded:
    - native ground cover (grasses): native grasses (Poaceae family native to NSW);
    - native ground cover (shrubs): all woody vegetation below one m in height and native to NSW
    - native ground cover (other): non-woody vegetation (i.e. vascular plants–ferns and herbs) below one m in height and native to NSW
    - exotic plant cover: vascular plants not native to Australia.
    - Evaluation of regeneration: this was estimated as the proportion of over-storey species present at the site that was regenerating (i.e. saplings with a diameter at breast height ≤5 cm). The maximum value for this measure was one.

Targeted Threatened Flora Surveys

The objective of the targeted threatened-flora surveys is to establish, with a high level of confidence, the presence or absence of a threatened flora species within the study area. If any threatened flora species are recorded then data including number of individuals and the habitat area is also to be determined. Flora species targeted included those threatened species identified in Table 14.3 as having potential habitat within the study area as a result of the Assessment of Significant Species within Table 10 of this report. All 'species credit' flora

species were also subject to targeted searches (See Section 14.12.1 for list of flora species which are classed as species credit species requiring targeted surveys with an accompanying survey time matrix).

Targeted surveys were used in accordance with the NSW Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (Working Draft) (Department of Environment and Conservation 2004), NSW Guide to Surveying Threatened Plants State of New South Wales (OEH, 2016a) and the Draft survey guidelines for Australia's threatened orchids (DoEE, 2013). Each target threatened flora species was allocated areas of potential habitat. All vegetation communities considered to be habitat for the target species were searched. Due to the relatively large size of the study area, areas of potential habitat were broken up into smaller sections such as the internal network of vehicle tracks. A parallel field traverse (i.e. parallel transects, as used by Cropper 1993) was undertaken within each of these smaller sections. Surveys were conducted along parallel line transects approximately 10 metres apart. Transects were conducted along a straight path using the tracks on a GPS to guide the surveyors.

Threatened flora species such as trees and shrubs that could be identified by for example from their leaves were not subject to specific survey timings. Species such as terrestrial orchids were surveyed during their flowering period as the presence of flowers makes the species easier to locate and the flowers also enable positive identification. Optimal flowering times were determined by BBAM and FBA (section 14.6.6.1.4), publications such as A Complete Guide to Native Orchids of Australia including the Island Territories (Jones, 2006) and online Threatened Biodiversity Profile Searches. The most reliable way to demonstrate that the surveys were conducted at an appropriate time included visiting nearby known populations (Done for *Diuris arenaria* and *Diuris praecox* (Newcastle Doubletail) and *Corybas dowlingi* (Red Helmet Orchid) and/or getting first-hand knowledge from experts (Done for *Pterostylis chaetophora* – OEH) to ascertain if they were flowering.

The survey effort and times of the targeted threatened flora species are shown in Table 14.4. Remaining threatened flora species were also surveyed opportunistically during incidental and targeted and surveys within the study area.

Table 14.4 - Targeted surveys for subject threatened flora species.

SURVEY TECHNIQUE	TARGET SPECIES	SURVEY TYPE	SURVEY EFFORT	DATE CARRIED OUT	IDEAL SURVEY DETECTION PERIOD
Targeted Threatened Flora Surveys	*Corybas dowlingii* Red Helmet Orchid	Random meander surveys	4 person hours	28/06/13	June - August
	Cryptostylis hunteriana Leafless Tongue Orchid	Walking parallel transects across the entire study area, spaced at approximately 15m intervals	18 person hours	04/02/13, 06/02/13, 13/11/14	November - February
	Diuris arenaria Tomaree Doubletail	Walking parallel transects across the entire study area, spaced at approximately 15m intervals	46 person hours	13/08/13, 21/08/13, 13/09/13, 25/09/13, 05/09/16	August - September
	Diuris praecox Newcastle Doubletail			13/08/13, 21/08/13, 13/09/13, 05/09/16	July - August
	Genoplesium baueri Bauer's Midge Orchid	Walking parallel transects across the entire study area, spaced at approximately 15m intervals	18 person hours	04/02/13, 06/02/13	February- March

SURVEY TECHNIQUE	TARGET SPECIES	SURVEY TYPE	SURVEY EFFORT	DATE CARRIED OUT	IDEAL SURVEY DETECTION PERIOD
	Phaius australis Lesser Swamp Orchid	Random meander surveys	28 person hours	04/02/13, 06/02/13, 13/11/13	Spring
	Pterostylis chaetophora Tall Rustyhood	Walking parallel transects across the entire study area, spaced at approximately 15m intervals	28 person hours	10/10/17, 11/10/17 & 13/10/17	September - November
	Callistemon linearifolius Netted Bottle Brush	Random meander surveys	20 person hours	04/02/13, 06/02/13, 13/11/13	All year
	Eucalyptus parramattensis subsp. *decadens* Drooping Red Gum				All year
	Melaleuca biconvexa Biconvex Paperbark				All year
	Syzygium paniculatum Magenta Lilly Pilly				All year
	Grevillea parviflora subsp. *parviflora* Small-flowered Grevillea				All year

SURVEY TECHNIQUE	TARGET SPECIES	SURVEY TYPE	SURVEY EFFORT	DATE CARRIED OUT	IDEAL SURVEY DETECTION PERIOD
	Lindernia aslinoides Noah's False Chickweed				November to February
	Allocasuarina defungens Dwarf Heath Casuarina				All year
	Allocasuarina simulans Nabiac Casuarina				All year
	Angophora inopina Charmhaven Apple				All year
	Eucalyptus camfieldii Camfield's Stringybark				All year
	Eucalyptus glaucina Slaty Red Gum				All year
	Melaleuca groveana Grove's Paperbark				All year
	Prostanthera densa *Villous Mintbush*				All year
	Rhizanthella slateri Eastern Underground Orchid	Walking parallel transects across the entire study area, spaced at approximately 15m intervals	46 person hours	13/08/13, 21/08/13, 13/09/13, 25/09/13, 05/09/16	September October November

SURVEY TECHNIQUE	TARGET SPECIES	SURVEY TYPE	SURVEY EFFORT	DATE CARRIED OUT	IDEAL SURVEY DETECTION PERIOD
	Tetratheca juncea Black-eyed Susan	Walking parallel transects across the entire study area, spaced at approximately 15m intervals	46 person hours	13/08/13, 21/08/13, 13/09/13, 25/09/13, 05/09/16	August to November
	Maundia triglochinoides Maundia	Random meander surveys	4.5 person hours	04/02/13, 06/02/13, 13/11/13	November to March
	Cynanchum elegans White-flowered Wax Plant	Random meander surveys	20 person hours	04/02/13, 06/02/13, 13/11/13	All year
	Persicaria elatior Tall Knotweed	Random meander surveys	4.5 person hours	17-04-15	December to June
	Zannichellia palustris	Random meander surveys	4.5 person hours	17-04-15	March to November
	Asperula asthenes Trailing Woodruff	Random meander surveys	20 person hours	04/02/13, 06/02/13, 13/11/13	All year

14.10 HABITAT APPRAISAL METHODOLOGY

Habitat may be defined as the physical and biological environment required for the survival of a specific population of a species. In modern usage habitat has also come to be regarded as an association of landform and plant life, which provides sustenance and shelter for a particular fauna assemblage.

The methodology of the habitat appraisal used the vegetation community data combined, where relevant, with geomorphological features and the occurrence of particular plant species or forms (i.e. tree hollows) to provide a basis for a subjective habitat assessment aimed at placing the ecological status of the site within a local perspective.

General Habitat for Native Species

From the vegetation appraisal and a general inspection of the study area and surrounds, a subjective assessment of the general habitat value of this site was made. Considered in this assessment were:

- occurrence of that habitat type in the general vicinity;
- degree of disturbance and degradation;
- area occupied by that habitat on site;
- continuity with similar habitat adjacent to the site, or connection with similar habitat off site by way of corridors; and
- structural and floral diversity.

Inventory of Hollow Bearing Trees

A hollow-bearing tree survey was conducted over the entire study area. The ground-based survey recorded the details of each hollow-bearing tree within the study area including height, diameter at breast height (dbh), hand held GPS coordinates and fauna habitat attributes such as hollows. The presence of activity in the form of scratches, scats on the trunks of trees and scats around the base were also noted. Each of the trees were tagged and numbered with yellow cattle tags. It must be noted that observations made from ground level may fail to record a small number of hollows that are obscured. Some entrances may also not lead to a cavity. The internal dimensions of the hollows are also impossible in many cases to determine from the ground.

Habitat for Significant Species

This study area was evaluated as potential habitat for each of the threatened species reported on the Office of Environment and Heritage (OEH), the federal Department of the Environment (DoEE) and Sydney Botanic Gardens databases from within 10km of the site. This evaluation was based on home-range, feeding, roosting, breeding, movement patterns and corridor requirements for fauna and hydrology, soil types, aspect and structural formation for flora species.

14.11 FAUNA SURVEY METHODOLOGY

The fauna survey was initiated with an assessment of the potential use of the study area by any threatened species identified in the OEH and DoEE database searches. Subsequently, the confirmation of the fauna species list, by way of on-site observation, trapping and recording, was carried out as described below. The survey was carried out using the Department of Environment and Conservation's (NSW) Threatened Biodiversity Survey and Assessment Guidelines – Working Draft (Department of Environment and Conservation, 2004).

Small Terrestrial Mammal Trapping

Small terrestrial mammal trapping was undertaken using 90 Elliott Type A traps (8x10x33cm) within the study area in April 2013 (40 traps) and May 2014 (50 Traps). The traps were left in place for four consecutive nights during April 2013 and May 2014 giving a total of 360 small terrestrial trap nights. The traps were hidden in thick grass, under shrubs or near fallen logs and were camouflaged with vegetation where the ground cover was sparse. The baits used for the traps were a mixture of rolled oats and honey, Good-O's (dry dog food) and peanut butter. The traps were checked early each morning and, where necessary, reset and rebaited. The location of the small terrestrial traps lines is shown in Figure 14.6.

A small terrestrial mammal trapping program had also been previously undertaken within Lot 10 DP 1071458 in the far north of the study area (Wildthing Environmental Consultants, 2008).

Medium Terrestrial Mammal Trapping

Medium terrestrial mammal trapping was undertaken using 40 cage traps (60×35×40cm) within the study area in April 2013 (20 traps) and May 2014 (20 Traps). The traps were left in place for four consecutive nights during April 2013 and May 2014 giving a total of 160 medium terrestrial trap nights. The traps were hidden in thick grass, under shrubs or near fallen logs and were camouflaged with vegetation where the ground cover was sparse. The bait used for the traps were raw chicken wings. The traps were checked early each morning and where necessary, reset and rebaited. The traps were checked early each morning and, where necessary, reset and rebaited. The location of the medium terrestrial trap lines is shown in Figure 14.6.

A medium terrestrial mammal trapping program had also been previously undertaken within Lot 10 DP 1071458 in the far north of the study area (Wildthing Environmental Consultants, 2008).

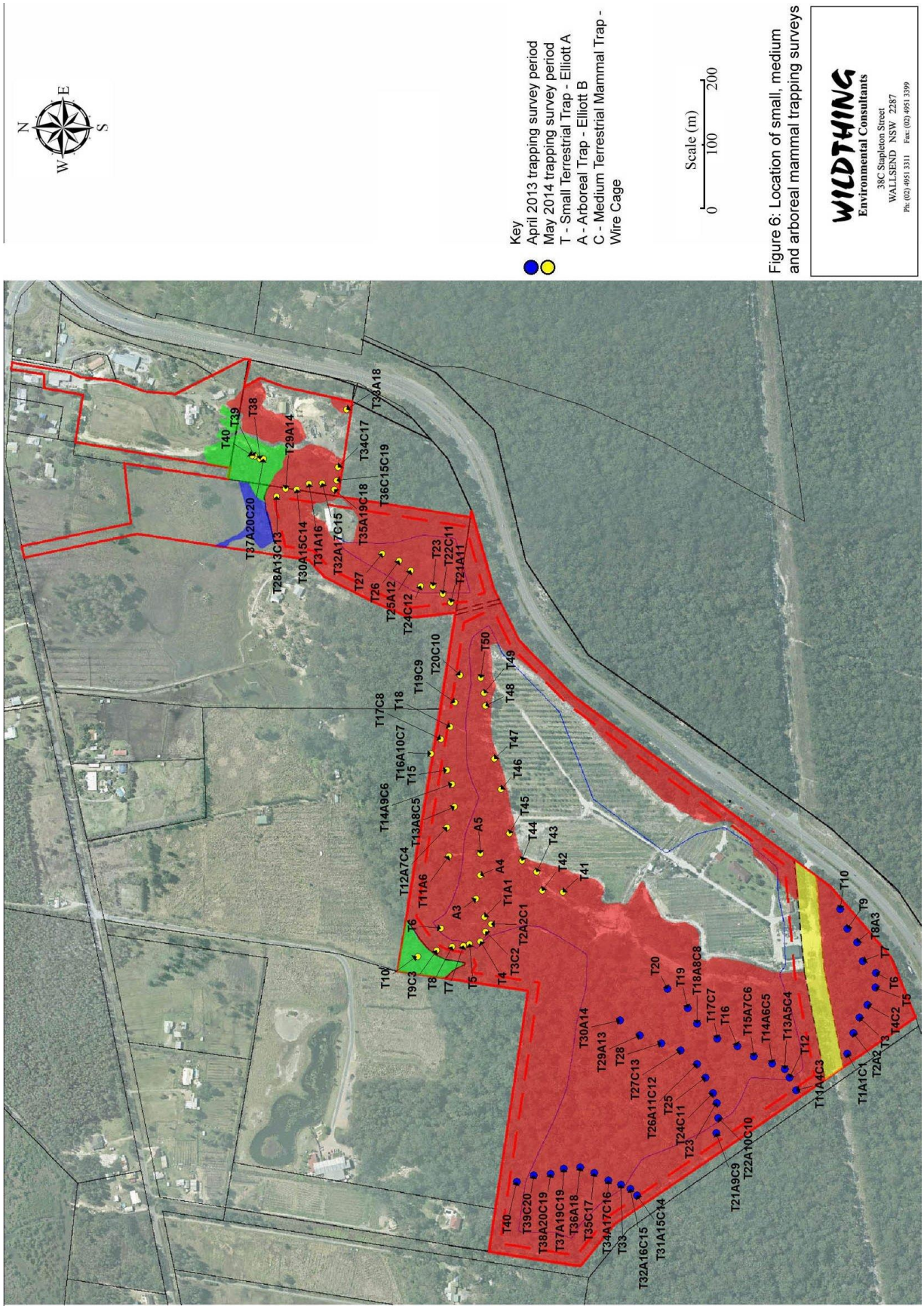


Figure 14.6 - Location of Medium Terrestial Traps

Arboreal Mammal Trapping

Arboreal mammal trapping was undertaken using 40 Elliott Type B traps (15 × 15 × 46cm) within the study area in April 2013 (20 traps) and May 2014 (20 Traps) to determine the presence of arboreal mammals, particularly *Petaurus norfolcensis* (Squirrel Glider) which is known to occur in similar habitats in the local area (OEH, 2015). The traps were left in place for four consecutive nights during April 2013 and May 2014 giving a total of 160 arboreal trap nights. The traps were placed around 3 - 4 metres above the ground on platforms mounted on tree trunks. The targeted trees contained hollows, were flowering or had scratches present on the boles. The baits used consisted of a rolled oats and honey mixture, peanut butter and an aniseed ring (sugar coated sweet). The traps were sprayed with honey mixed in water before being placed in the trees to attract fauna and mask the smell of humans. The tree trunks were also sprayed with this mixture each day. In all cases the traps were checked early each morning and, where necessary, reset and rebaited. The position of the arboreal traps within the study area can be seen in Figure 14.6.

An arboreal mammal trapping program had also been previously undertaken within Lot 10 DP 1071458 in the far north of the study area (Wildthing Environmental Consultants, 2008).

Microchiropteran Bat Harp Trapping

Two monofilament harp traps were set over 5 nights within the study area on 21 May & 13 November 2013, 29 April & 27 November 2014 and 27 January 2015 giving a total of 10 harp trap nights within the study area. The harp trapping was undertaken in order to sample the use of the site by sub-canopy microchiropteran bat species. Traps were positioned in potential flyways and were checked early each morning, with any captures being identified. Harp Trap locations are shown in Figure 14.7.

Harp trapping program had also been previously undertaken within Lot 10 DP 1071458 in the far north of the study area (Wildthing Environmental Consultants, 2008).

Microchiropteran Bat Call Survey

Bat echo-location calls were recorded using an Anabat detector in areas which were considered likely to be used by bats. These positions were selected to sample potential hunting sites for bats, including flyways, clearings and ecotones. Echolocation surveys used a combination of stationary and hand-held mobile surveys. Hand-held surveys were undertaken during spotlighting. Stationary call activated microchiropteran bat detection was undertaken from dawn to dusk for six nights.

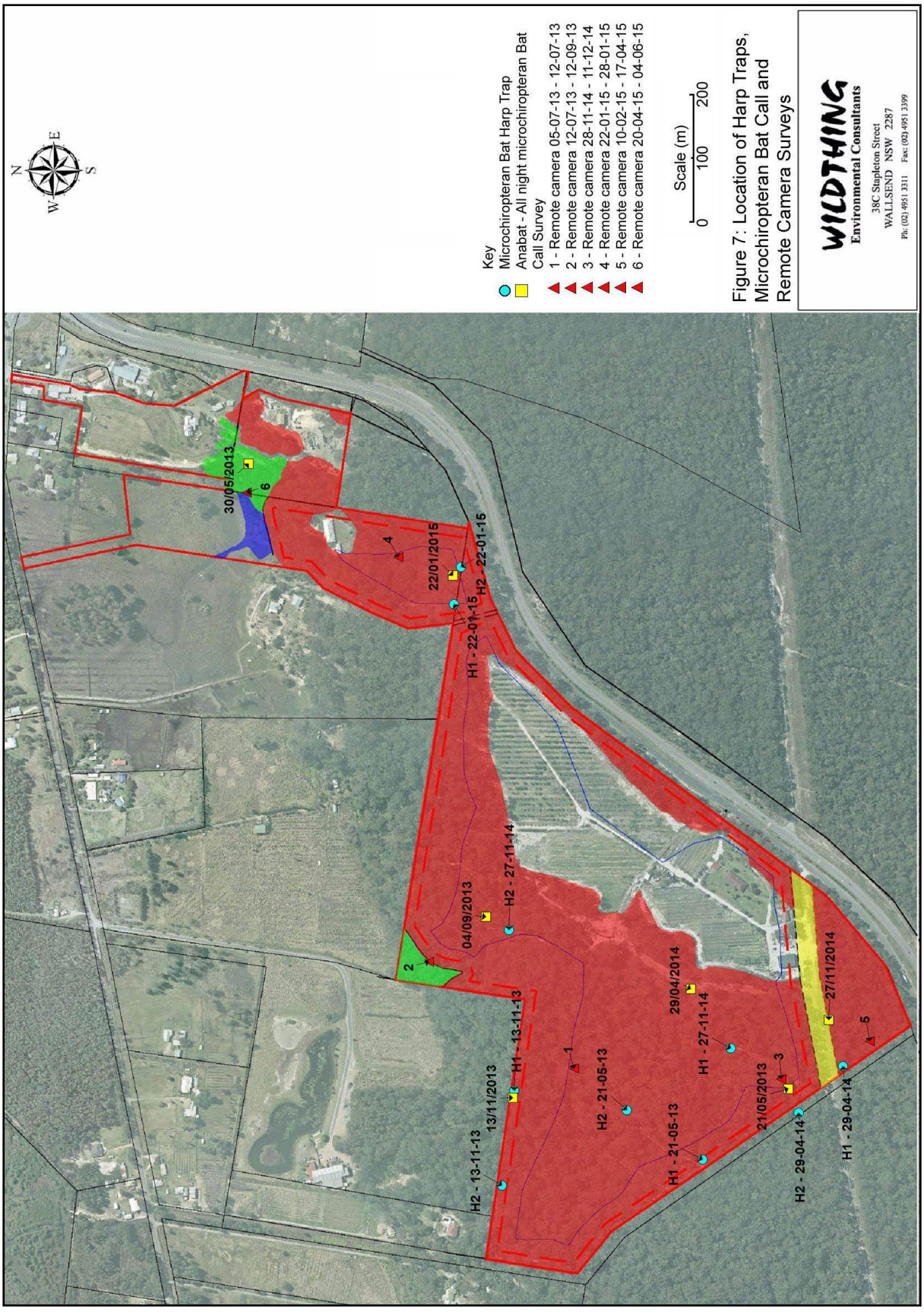


Figure 14.7 - Harp Trap Locations

The bat calls recorded by Wildthing Environmental Consultants were analysed in-house by Mungo Worth. The locations of the bat call surveys are shown in Figure 14.7. A microchiropteran bat call survey had also been previously undertaken within Lot 10 DP 1071458 within the far north of the study area (Wildthing Environmental Consultants, 2008).

Amphibian Survey

The amphibian survey included a combination of diurnal and nocturnal census methods. Diurnal searches involved systematic searches within appropriate habitat for basking or sheltering individuals. Any appropriate cover such as logs were turned over for resting individuals.

Nocturnal surveys were undertaken within areas of suitable habitat (lower lying poorly drained area in the north and west of the study area) and involved listening for the characteristic call of male frogs. Playback of frog calls was undertaken in an attempt to elicit a response from threatened amphibian species in particular *Crinia tinnula* (Wallum Froglet) and *Litoria aurea* (Green and Golden Bell Frog).

Calls broadcast included:

- *Litoria aurea* (Green and Golden Bell Frog)
- *Crinia tinnula* (Wallum Froglet)
- *Litoria brevipalmata* (Green-thighed Frog)

In accordance with the Matters for Further Consideration within the updated SEARS additional targeted surveys were conducted for the recently described *Uperoleia mahonyi* (Mahony's Toadlet). The surveys were undertaken by Dr Simon Clulow from Newcastle University who discovered and described the species (Clulow *et al.* 2016). The survey involved an initial visit to the site to ascertain suitable survey locations. Nocturnal surveys were undertaken in November 2017 following rain over two nights for three hours duration and were located within areas of Freshwater Wetland and Swamp Sclerophyll Forest in the north-east of the site which were considered to be the most likely habitat. The survey involved a visit to a reference site at Oyster Cove (type locality for *U. mahonyi*) on both nights to ascertain if *U. mahonyi* was calling at the time.

The location of the frog census conducted is shown in Figures 14.8 & 14.9.

Reptile Survey

Searches for reptiles involved a combination of diurnal and nocturnal searches. Diurnal searches for reptiles involved searching in likely habitat (i.e. leaf litter, dead logs and long grass) during the morning and afternoon survey period. Nocturnal searches were conducted for reptile species active at night such as geckos and some species of snakes and involved searching in likely habitats with the aid of a spotlight. The location of the reptile surveys is shown in Figure 14.8.

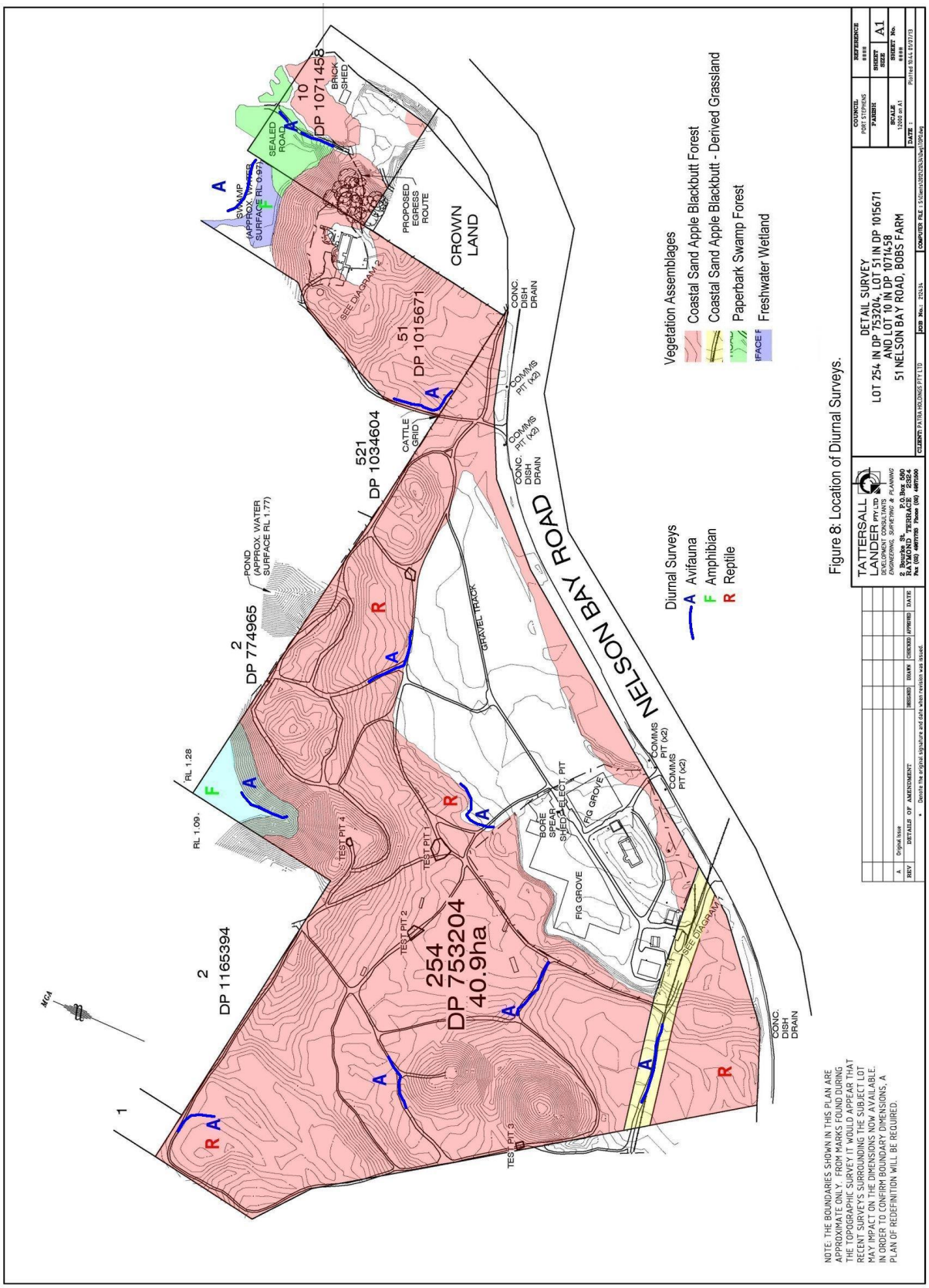


Figure 14.8 - Location of Diurnal Surveys

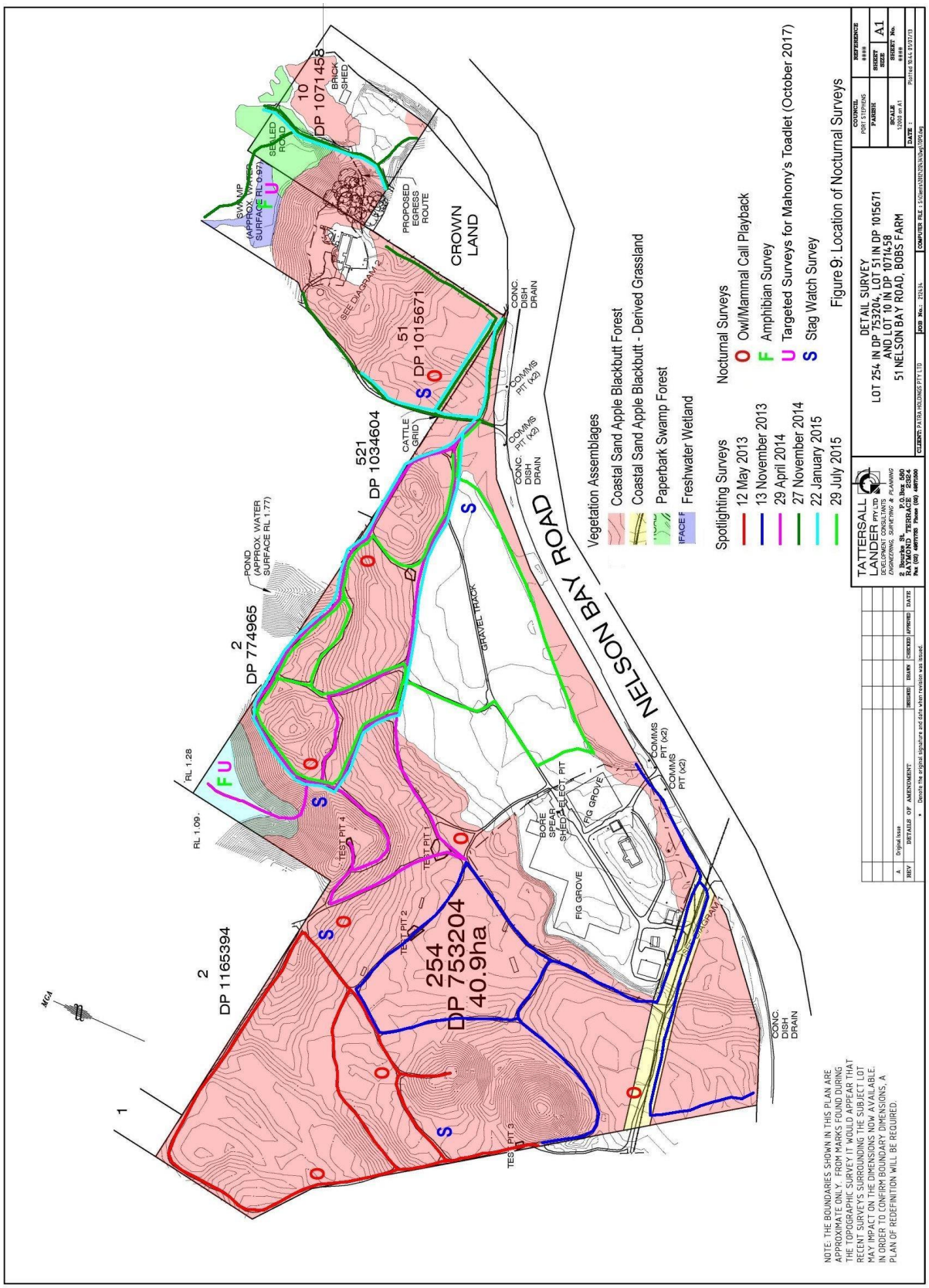


Figure 14.9 - Location of Nocturnal Surveys

Diurnal Avifauna Survey

The diurnal avifauna survey involved walking along a pre-determined 100m transect for 30 minutes. Every 20m a point survey was undertaken which involved observation and listening for calls. Birds targeted included species such as *Daphoenositta chrysoptera* (Varied Sittella). Surveys were conducted at peak activity periods (i.e. dawn and dusk). A total of 5.0 hours of targeted diurnal bird surveys were undertaken. A number of incidental observations of avifauna were also made as a result of a relatively long time spent within the study area conducting other surveys. Observations were also made of secondary indications (i.e. distinctive feathers and nests) of avifauna were also recorded. The location of the diurnal avifauna surveys are shown in Figure 14.8.

Nocturnal Avifauna and Mammal Call Playback Survey

During the nocturnal avifauna and mammal survey pre-recorded calls of *Ninox connivens* (Barking Owl), *Ninox strenua* (Powerful Owl), *Tyto novaehollandiae* (Masked Owl), *Tyto tenebricosa* (Sooty Owl), *Tyto capensis* (Grass Owl), *Petaurus australis* (Yellow-bellied Glider), *Petaurus norfolcensis* (Squirrel Glider) and *Phascolarctos cinereus* (Koala) were broadcast through an amplification system designed to project the sound for at least 1km under still night conditions. An initial listening period of 10 minutes was undertaken, followed by 5 minutes of calls (repeated in four different directions). A period of two minutes of quiet listening was then employed after each 5-minute bracket of calls. At the conclusion of the call playback survey, spotlighting was carried out in the vicinity of the call playback site. The locations of the call playback are shown in Figure 14.9.

Spotlighting Survey

Spotlighting was undertaken on foot using 100watt hand-held spotlights. The spotlighting undertaken was completed by at least two persons and involved walking at a slow pace around the study area and stopping every 2 minutes, allowing the observer to hear movements of animals. A total of 18-person hours of spotlighting was conducted during the survey. The spotlight routes are shown in Figure 14.9.

Stag Watching Survey

The stag watching survey involved watching significant hollow-bearing trees, 20 minutes prior to sunset and continuing until 20 minutes after sunset. The person was in a position to allow a good view of the tree to be obtained, preferably with the tree silhouetted against the sky. The required listening period and stag watching were undertaken concurrently. Hollow trees targeted were those suitable for *Petaurus norfolcensis* (Squirrel Glider) and owl species such as *Tyto novaehollandiae* (Masked Owl) and *Ninox strenua* (Powerful Owl). The location of the watched stag trees is shown in Figure 14.9.

Remote Camera Survey

A remote camera was set up in six different locations within the study area from 2013 - 2015 to survey for threatened fauna species, particularly the threatened *Dasyurus maculatus* (Tiger Quoll). The remote camera was set up along tracks and areas of high animal usage. Bait

such as chicken necks was placed in front of the camera to lure animals into range. The locations of the remote camera surveys within the study area are shown in Figure 14.6.

Summary of Fauna Survey Effort

The survey effort and times of the targeted threatened fauna species are shown in Table 14.5.

Table 14.5 - Targeted surveys for subject threatened fauna species.

SURVEY TECHNIQUE	TARGET SPECIES	SURVEY TYPE	SURVEY EFFORT	DATE CARRIED OUT	IDEAL SURVEY DETECTION PERIOD
Targeted Threatened Fauna Surveys	*Petalura gigantea* Giant Dragonfly	Random meander surveys around swampy areas Observation for flying/perching adults Searching for diagnostic nymphal skins from emerged adults.	Targeted and incidental surveys.	13/11/13,	October – February
	Crinia tinnula Wallum Froglet	Targeted nocturnal Spotlighting searches wetland areas and vegetation, frog call detection and frog call playback.	Four nights for two hours.	13/11/13, 03-06-14, 17-04-15, 28-04-15,	Autumn
	Litoria aurea Green and Golden Bell Frog				Spring, Summer
	Litoria brevipalmata Green-thighed Frog				Spring, Summer
	Uperoleia mahonyi Mahony's Toadlet	Targeted nocturnal Spotlighting searches wetland areas and vegetation, frog call	Two nights one for three and one four hours duration following rain.	07-11-17 & 09-11-17	October - November

SURVEY TECHNIQUE	TARGET SPECIES	SURVEY TYPE	SURVEY EFFORT	DATE CARRIED OUT	IDEAL SURVEY DETECTION PERIOD
		detection and frog call playback.			
	Xenus cinereus Terek Sandpiper	Point Surveys over wetland.	Two nights for half hour duration.	03-06-14, 17-04-15,	All year
	Limicola falcinellus Broad-billed Sandpiper				
	Ephippiorhynchus asiaticus Black-necked Stork				
	Ixobrychus flavicollis Black Bittern				
	Rostratula benghalensis australis *Australian Painted Snipe*				
	Anthochaera phrygia Regent Honeyeater	Winter surveys targeting flowering trees particularly		27/05/14, 29/07/15	Winter
	Lathamus discolor				

SURVEY TECHNIQUE	TARGET SPECIES	SURVEY TYPE	SURVEY EFFORT	DATE CARRIED OUT	IDEAL SURVEY DETECTION PERIOD
	Swift Parrot	specimens of Swamp Mahogany.			
	Turnix maculosa Red-backed Button-quail	Point surveys Incidental Observations	5 - person hours	18/04/13, 21/05/13, 22/05/13, 04/09/13, 29/04/14, 27/05/14, 27/11/14, 28/11/14, 28/04/15, 29/07/15	All year
	Neophema pulchella Turquoise Parrot				
	Glossopsitta pusilla Little Lorikeet				
	Calyptorhynchus lathami Glossy Black-Cockatoo				
	Callocephalon fimbriatum Gang-gang Cockatoo				
	Epthianura albifrons White-fronted Chat				
	Petroica boodang Scarlet Robin				
	Petroica phoenicea				

SURVEY TECHNIQUE	TARGET SPECIES	SURVEY TYPE	SURVEY EFFORT	DATE CARRIED OUT	IDEAL SURVEY DETECTION PERIOD
	Flame Robin				
	Climacteris picumnus victoriae Brown Treecreeper				
	Daphoenositta chrysoptera Varied Sittella				
	Melithreptus gularis gularis Black-chinned Honeyeater				
	Pomatostomus temporalis temporalis Grey-crowned Babbler				
	Circus assimilis Spotted Harrier				
	Pandion cristatus Eastern Osprey				
	Hieraaetus morphnoides				

SURVEY TECHNIQUE	TARGET SPECIES	SURVEY TYPE	SURVEY EFFORT	DATE CARRIED OUT	IDEAL SURVEY DETECTION PERIOD
	Little Eagle				
	Ninox connivens Barking Owl	Call playback, Listening, Spotlight surveys	12 - person hours	21/05/13, 13/11/13, 29/04/14, 12/06/14, 22/01/15, 29/07/15.	All year
	Ninox strenua Powerful Owl				
	Tyto longimembris Eastern Grass Owl				
	Tyto novaehollandiae Masked Owl				
	Tyto tenebricosa Sooty Owl				
	Planigale maculata Common Planigale	Spotlight surveys Mammal Trapping Motion sensitive camera.	Trapping 4 nights over two-week periods (2013 & 2014). Spotlighting At least 20 hours of spotlighting.	Trapping 4 nights over two periods (2013 & 2014). Spotlighting. 21/05/13, 13/11/13,	All year
	Dasyurus maculatus maculatus Tiger Quoll				
	Phascogale tapoatafa				

SURVEY TECHNIQUE	TARGET SPECIES	SURVEY TYPE	SURVEY EFFORT	DATE CARRIED OUT	IDEAL SURVEY DETECTION PERIOD
	Brush-tailed Phascogale			29/04/14, 12/06/14, 22/01/15, 29/07/15 Motion sensitive camera. 05-07-13 – 12-07-13 12-07-13 – 12-09-13 28-11-14 – 11-12-14 22-01-15 – 28-01-15 10-02-15 – 17-04-15 30-04-15 – 04-06-15	
	Aepyprymnus rufescens Rufous Bettong				
	Potorous tridactylus tridactylus Long-nosed Potoroo				
	Cercartetus nanus Eastern Pygmy-possum				
	Petaurus australis Yellow-Bellied Glider				
	Petaurus norfolcensis Squirrel Glider				
	Pseudomys gracilicaudatus Eastern Chestnut Mouse				
	Phascolarctos cinereus Koala	Spotlighting.	Spotlighting At least 20 hours of spotlighting.	Spotlighting.	All year

SURVEY TECHNIQUE	TARGET SPECIES	SURVEY TYPE	SURVEY EFFORT	DATE CARRIED OUT	IDEAL SURVEY DETECTION PERIOD
		Mapping Preferred Feed Trees under CKPoM (Thorough search of these trees for secondary indications of Koalas such as scats & scratches on tree trunks). Habitat tree surveys (All habitat trees were inspected for presence of Koalas & secondary indications).	Habitat tree survey conducted over nine days.	21/05/13, 13/11/13, 29/04/14, 12/06/14, 22/01/15, 29/07/15 Searches 20/10/15, 03/06/14, 17/04/15, 20/10/16.	
	Syconycteris australis Common Blossom-bat *Kerivoula papuensis* Golden-tipped Bat *Saccolaimus flaviventris* Yellow-bellied Sheathtail-bat	Harp Trapping Bat Call Survey	Harp Trapping 10 Harp Trapping Nights Bat Call Survey 7 Nights	Harp Trapping 21/05/13, 13/11/13, 29/04/14, 27/11/14, 22/01/15. Bat Call Survey	

SURVEY TECHNIQUE	TARGET SPECIES	SURVEY TYPE	SURVEY EFFORT	DATE CARRIED OUT	IDEAL SURVEY DETECTION PERIOD
	Mormopterus norfolkensis East Coast Freetail-bat			21/05/13, 30/05/13, 03/09/13, 13/11/13, 29/04/14, 7/11/14, 22/01/15.	
	Falsistrellus tasmaniensis Eastern False Pipistrelle				
	Miniopterus australis Little Bentwing-bat				
	Miniopterus schreibersii oceanensis Large Bentwing-bat				
	Myotis macropus Eastern Myotis				
	Scoteanax rueppellii Greater Broad-nosed Bat				
	Chalinolobus dwyeri Large-eared Pied Bat				
	Vespadelus troughtoni *Eastern Cave Bat*				

SURVEY TECHNIQUE	TARGET SPECIES	SURVEY TYPE	SURVEY EFFORT	DATE CARRIED OUT	IDEAL SURVEY DETECTION PERIOD
	Pteropus poliocephalus Grey-headed Flying-Fox	Spotlighting, Listening	Spotlighting At least 20 hours of spotlighting.	Spotlighting. 21/05/13, 13/11/13, 29/04/14, 12/06/14, 22/01/15, 29/07/15	All year, Tree flowering periods.
	Emu population in the NSW North Coast Bioregion and Port Stephens LGA.	Incidental observations.			All year

14.12 RESULTS

Vegetation Survey

A large portion of the study area occurring on Aeolian Holocene transgressive dunes was undeveloped and consisted of uncleared tall dry open sclerophyll forest dominated by the canopy species *Eucalyptus pilularis* (Blackbutt) and *Angophora costata* (Smooth-barked Apple). An area of aeolian sand within Lot 254 contained an Olive and Fig Orchard plus a residence, gardens and associated buildings. Other cleared areas occurring on aeolian sands included a residence on Lot 51 and an Earthmoving Business within Lot 10. The lower flat ground in the north of Lot 51 has had a long history of disturbance and largely consisted of grassland/pasture. One smaller area of Swamp Forest and an area of Freshwater Wetland was present in this NE region of the study area. An additional area of swamp forest was also present on lower ground in the far north-west of Lot 254.

Vegetation types were classified based on the 'best fit' vegetation type listed in the Plant Communities Types (PCT's) Database (OEH 2009). Parameters used to choose the 'best fit' Vegetation Type included over-storey and understorey floristics, soil landscape, location and topographic position. A total of three vegetation types were delineated within the study area:

- **Vegetation Type 1 -** HU860 – Smooth-barked Apple - Blackbutt - Old Man Banksia woodland on coastal sands of the Central and Lower North Coast (Moderate/Good High Condition)(35.41ha);

- **Vegetation Type 2 –** HU938 – Broad-leaved Paperbark - Swamp Oak - Saw Sedge swamp forest on coastal lowlands of the Central Coast and Lower North Coast(Moderate/Good)(1.15ha);

- **Vegetation Type 3** – HU533 - Coastal freshwater lagoons of the Sydney Basin Bioregion and South East Corner Bioregion Moderate/Good Poor)(0.32ha).

Two additional vegetated areas were highly altered and could not be assigned a community Vegetation Type:

- Orchard, Cleared/Modified (9.6ha);
- Grassland/Pasture (4.0ha).

A description of the three PCT's is shown below. A vegetation map of the study area showing the location of the quadrat/transect surveys is shown in Figure 14.9. A full list of the flora species recorded during the fieldwork is listed in Annex N. The results of the plot/transect based surveys can be seen in Annex N.

*Note on Vegetation Community Distribution Map. A map of vegetation of any area seeks to describe the distribution of the plant species in that area by defining a number of vegetation units (assemblages or communities), which are relatively internally homogenous. Whilst such mapping is a convenient tool, it greatly oversimplifies the real situation. Plants rarely occur in defined communities with distinct boundaries. Accordingly vegetation units used for the accompanying map should be viewed as indicative of their extent rather than being precise edges of communities.

Figure 14.10 - Study Area Vegetation Types

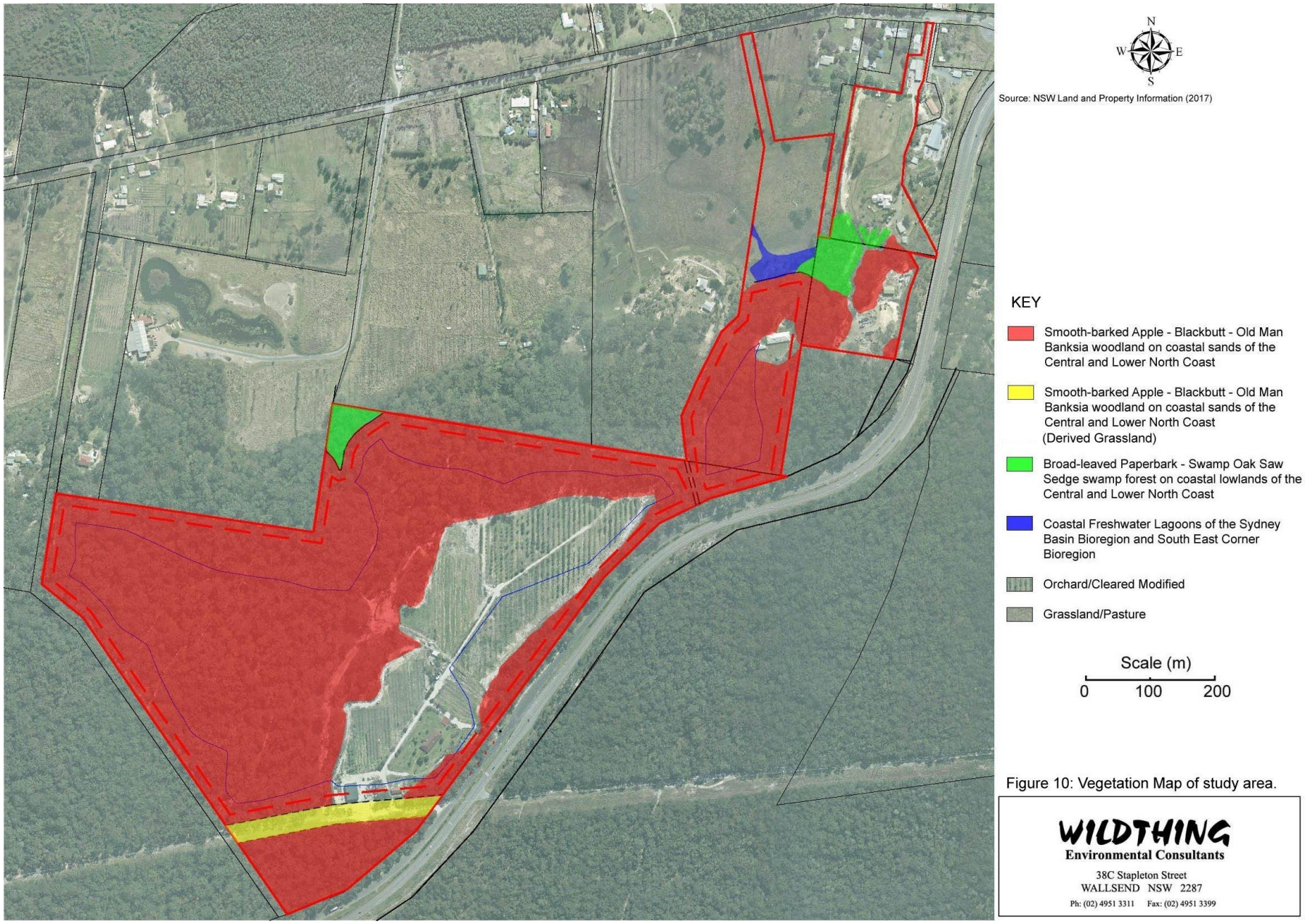


Figure 10: Vegetation Map of study area.

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Vegetation Type 1 – PCT 1646 HU860 – Smooth-barked Apple - Blackbutt - Old Man Banksia woodland on coastal sands of the Central and Lower North Coast

Smooth-barked Apple - Blackbutt - Old Man Banksia woodland on coastal sands of the Central and Lower North Coast occupied 35.41ha of the study area and was located on the well-drained Holocene sand dunes (Plates 14.1 – 14.5). This community was dominated by the canopy species *Eucalyptus pilularis* (Blackbutt) and *Angophora costata* (Smooth-barked Apple). The majority of this community was present within Lot 254, although adjoining areas of this community were also present within Lots 10 and 51. Coastal Sand Apple Blackbutt Open Forest within the study area was found to be generally intact. The main disturbances to this community were from the construction of internal access roads and weed incursion primarily from *Chrysanthemoides monilifera* subsp. *rotundata* (Bitou Bush) and *Lantana camara* (Lantana). Ongoing Cattle grazing has also had a minor impact on the understorey of Coastal Sand Apple Blackbutt Open Forest within Lot 51.

More sheltered (associated with steep-sided dunes) occurrences of Smooth-barked Apple - Blackbutt - Old Man Banksia woodland occupied small areas of the study area. These areas contained species adapted to more moist areas such as *Livistona australis* (Cabbage Tree Palm), *Glochidion ferdinandi* (Cheese Tree), *Synoum glandulosum* (Scentless Rosewood) and *Myrsine howittiana* (Brush Muttonwood). The canopy species *Eucalyptus grandis* (Flooded Gum) was also noted in one of these areas in the far north-west (Plate 14.6).

Coastal Sand Apple Blackbutt Open Forest within the study area formed part of a much larger area of this assemblage located on Holocene sand dunes along Stockton Bight from Fern Bay to Anna Bay. 1924.1ha of Coastal Sand Apple Blackbutt Open Forest has been mapped within the nearby Worimi Conservation Lands (Bell & Driscoll, 2010).

Similar Vegetation Types

NPWS, (2000)	Map Unit 33 – Coastal Sand Apple – Blackbutt Forest
Bell & Driscoll (2010)	Map Unit 3 - Frontal Dune Blackbutt-Apple Forest.

Structure

Stratum	**Height Range**	**Canopy Cover**
Canopy	20 - 35m	20-35%
Small Tree	10 - 20m	5-40%
Shrub	1.5 – 4m	10-30%
Ground	<1m	5 – 60%



Plate 14-1 - Smooth-barked Apple - Blackbutt - Old Man Banksia woodland within Lot 254.



Plate 14-2 - Smooth-barked Apple - Blackbutt - Old Man Banksia woodland within Lot 254.



Plate 14-3 - Smooth-barked Apple - Blackbutt - Old Man Banksia woodland within Lot 254.



Plate 14-4 - Smooth-barked Apple - Blackbutt - Old Man Banksia woodland on higher sand hill - Lot 254.



Plate 14-5 - Smooth-barked Apple - Blackbutt - Old Man Banksia woodland within Lot 51.



Plate 14-6 - Area of more sheltered Smooth-barked Apple-Blackbutt-Old Man Banksia woodland Lot 254.



Plate 14-7 - Coastal Sand Apple Blackbutt (Derived Grassland) within electrical easement.

Species Composition

Canopy - *Eucalyptus pilularis* (Blackbutt), *Angophora costata* (Smooth-barked Apple).

Mid -storey

Banksia serrata (Old Man Banksia), *Endiandra sieberi* (Corkwood), *Monotoca elliptica* (Tree Broom-heath).

Shrub Layer

Leucopogon margarodes, Leucopogon lanceolatus (Lance Beard-heath), *Acacia longifolia* (Sydney Golden Wattle), *Acacia suaveolens* (Sweet Scented Wattle), *Breynia oblongifolia* (Breynia), *Dodonaea triquetra* (Common Hop Bush), *Monotoca elliptica* (Tree Broom-heath), *Pimelea linifolia* (Rice Flower), *Ricinocarpus pinifolius* (Wedding Bush), *Leucopogon margarodes*.

Ground Layer

Pteridium esculentum (Bracken Fern), *Themeda triandra* (Kangaroo Grass), *Imperata cylindrica* var. *major* (Blady Grass), *Lomandra longifolia* (Spiny Mat Rush), *Dianella caerulea* var. *producta* (Blue Flax Lily), *Gonocarpus teucrioides* (Germander Raspwort).

Climbers

Parsonsia straminea (Common Silkpod), *Kennedia rubicunda* (Kennedia) *Pandorea pandorana* (Wonga Wonga Vine).

A Derived Grassland form of Smooth-barked Apple - Blackbutt - Old Man Banksia woodland on coastal sands of the Central and Lower North Coast was mapped within the electricity easement in the south of the study area (Plate 6). This easement area had been previously cleared of trees and shrubs and is maintained as a lower ground cover by Ausgrid. The most common native groundcovers within this community were *Themeda australis* (Kangaroo Grass) and *Pteridium esculentum* (Bracken Fern). Other species noted within this vegetation type included *Pimelea linifolia* (Rice Flower). A number of orchid species were found to be present within this area including the threatened *Diuris arenaria* (Tomaree Doubletail). Introduced species, particularly perennial grasses such as *Andropogon virginicus* (Whisky Grass), *Melinis repens* (Red Natal Grass) and *Eragrostis curvula* (African Love Grass) were also becoming prevalent within parts of the easement.

Species Composition

Native Ground Layer

Pteridium esculentum (Bracken Fern), *Themeda triandra* (Kangaroo Grass), *Imperata cylindrica* var. *major* (Blady Grass), *Lomandra longifolia* (Spiny Mat Rush), *Dianella caerulea* var. *producta* (Blue Flax Lily), *Gonocarpus teucrioides* (Germander Raspwort).

Vegetation Type 2 – HU938 – Broad-leaved Paperbark - Swamp Oak - Saw Sedge swamp forest on coastal lowlands of the Central Coast and Lower North Coast

Broad-leaved Paperbark - Swamp Oak - Saw Sedge swamp forest on coastal lowlands of the Central Coast and Lower North Coast occupied 1.15ha of the lower lying poorly drained land within the study area. Based on canopy species two variations of Broad-leaved Paperbark - Swamp Oak - Saw Sedge swamp forest on coastal lowlands of the Central Coast and Lower North Coast were found to be present. They were:

- 0.8ha of Swamp Forest dominated by a canopy of *Melaleuca quinquenervia* (Broad-leaved Paperbark) in the north of the study area. Other canopy species were *Eucalyptus robusta* (Swamp Mahogany) and *Casuarina glauca* (Swamp Oak). The ground layer was generally dominated by fern and sedge species (Plates 14.7 & 14.8).
- 0.35ha of Swamp Forest dominated by a canopy of *Melaleuca quinquenervia* (Broad-leaved Paperbark) with a number of specimens of *Eucalyptus grandis* (Flooded Gum) in the north-west of the study area (Plates 14.9 & 14.10). This community also had some similarities to the Wet Sclerophyll Forests Vegetation Type PCT 1569 Flooded Gum - Brush Box - Tallowwood mesic tall open forest on ranges of the lower North Coast. Due to the dominance of *M. quinquenervia* this community was more aligned with a forested wetland structure.



Plate 14-8 - Swamp Forest within north-east of study area (Lot 10).



Plate 14-9 - Swamp Forest within north-east of study area (Lot 10).



Plate 14-10 - Swamp Forest with Broad-leaved Paperbark & Flooded Gum (Lot 254).



Plate 14-11 - Swamp Forest with Broad-leaved Paperbark & Flooded Gum (Lot 254).

Similar Vegetation Types

NPWS, (2000) Forest	Map Unit 37 - Swamp Mahogany – Paperbark
Bell & Driscoll (2006)	Map Unit 17. - Paperbark Swamp Forest
Bell & Driscoll (2010) Forest	Map Unit 6 – Paperbark-Mahogany Wet Swamp

Structure

Stratum	**Height Range**	**Canopy Cover**
Canopy	15 - 25m	15-45%
Small Tree	10 - 15m	40-85%
Shrub	1.5 – 4m	5-20%
Ground	<1m	5 – 40%

Species Composition

Canopy

Melaleuca quinquenervia (Broad-leaved Paperbark), *Eucalyptus robusta* (Swamp Mahogany), *Eucalyptus grandis* (Flooded Gum), *Livistona australis* (Cabbage Tree Palm), *Casuarina glauca* (Swamp Oak).

Mid-storey Layer

Livistona australis (Cabbage Tree Palm), *Glochidion ferdinandi* (Cheese Tree),

Shrub Layer

Breynia oblongifolia (Breynia), *Omalanthus populifolius* (Bleeding Heart).

Ground Layer

Gahnia clarkei (Sword Grass), *Histiopteris incisa* (Batswing Fern), *Cyclosorus interruptus*, *Enydra fluctuans.*

Climbers

Parsonsia straminea (Common Silkpod).

Vegetation Type 3 – HU533 - Coastal freshwater lagoons of the Sydney Basin Bioregion and South-East Corner Bioregion

Approximately 0.32ha of Coastal freshwater lagoons of the Sydney Basin Bioregion and South-East Corner Bioregion occupied a lower lying poorly drained area in the north of the study area (Lot 51) (Plates 14.13 & 14.14). This wetland assemblage may have been derived from the past removal of Paperbark Swamp Forest which occurs adjacent to this area. The area of wetland has been subject to disturbance from ongoing grazing and trampling by cattle. The edges of the wetland were found to have been subject to the greater disturbance. Common flora species noted included *Schoenoplectus validus* and *Eleocharis equiseta*. Common introduced flora species were *Paspalum urvillei* (Vasey Grass) and *Hydrocotyle bonariensis* (Kurnell Curse).

Similar Vegetation Types

NPWS, (2000)	Map Unit 46 – Freshwater Wetland Complex
HU533 - Coastal freshwater lagoons of the Sydney Basin Bioregion and South East Corner Bioregion	



Plate 14-12 - Freshwater Wetland within the north of the study area (Lot 51).



Plate 14-13 - Freshwater Wetland within the north of the study area (Lot 51).

Structure

Stratum	Height Range	Canopy Cover
Canopy	<10m	<5%
Ground	<1m	60 - 100%

Species Composition

Canopy

Melaleuca quinquenervia (Broad-leaved Paperbark).

Ground Layer

Schoenoplectus validus, Ludwigia peploides subsp. *montevidensis* (Water Primrose), *Eleocharis equiseta*, *Paspalum distichum* (Water Couch), *Philydrum lanuginosum* (Woolly Frogmouth), *Persicaria decipens* (Slender Knotweed), *Persicaria strigosa* (Spotted Knotweed), *Ranunculus inundatus* (River Buttercup), *Cyperus polystachyos, *Paspalum urvillei* (Vasey Grass), *******Hydrocotyle bonariensis* (Kurnell Curse).

Orchard, Cleared Modified Vegetation

Approximately 9.6ha of the study area consisted of Orchards and Cleared/Modified Vegetation (Plates 14.15 & 14.16). The largest area was located in the south-eastern area of Lot 254 where the area contains fruit trees. Fruit trees largely consisted of *Olea europaea* subsp. *europaea* (Common Olive) and *Ficus carica* (Fig). The ground cover within the orchards were largely dominated by introduced grasses particularly *Anthoxanthum odoratum* (Sweet Vernal Grass), *Melinis repens* (Red Natal Grass) and *Eragrostis curvula* (African Love Grass). Other common introduced species included *Bidens pilosa* (Cobblers Pegs) and *Solanum nigrum* (Blackberry Nightshade).

Grassland/Pasture

Approximately 4ha of Grassland/Pasture was present on lower lying ground within Lots 10, 11 and 51 in the north of the study area (Plates 14.17 & 14.18). Within Lots 10 & 11 this assemblage was maintained by regular mowing. Ongoing cattle grazing within Lot 51 has also kept this assemblage close to the ground. The dominant flora species within the Grassland/Pasture assemblage were exotic grasses such as *Axonopus fissifolius* (Narrow-leaved Carpet Grass), *Paspalum dilatatum* (Paspalum) and *Pennisetum clandestinum* (Kikuyu). Other common introduced flora species included *Senecio madagascariensis* (Fireweed), *Hypochaeris radicata* (Flatweed) and *Trifolium repens* (White Clover). The few native species within this assemblage included *Cynodon dactylon* (Couch Grass) and *Commelina cyanea* (Scurvy Weed). A number of scattered remnant and planted trees were present within this assemblage. Trees within Lot 10 & 11 tended to be largely planted and introduced and included *Pinus elliotii* (Slash Pine), *Phoenix*

canariensis (Canary Island Date Palm) and *Cinnamomum camphora* (Camphor Laurel). Within Lot 51 *Melaleuca quinquenervia* (Broad-leaved Paperbark) was present as a remnant trees.



Plate 14-14 - Orchard/Cleared Modified Vegetation within the study area (Lot 254).



Plate 14-15 - Orchard/Cleared Modified Vegetation within the study area (Lot 254).



Plate 14-16 - Grassland/Pasture within Lot 11.



Plate 14-17 - Grassland/Pasture within Lot 51.

Endangered Ecological Communities

Seven Endangered Ecological Communities are known to occur within the local area:

- Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner Bioregions;
- Littoral Rainforest in the NSW North Coast, Sydney Basin and South-East Corner Bioregions;
- River Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner Bioregions;
- Subtropical Coastal Floodplain Forest of the NSW North Coast, Sydney Basin and South-East Corner bioregions (SCFF);
- Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South-East Corner Bioregions;
- Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South-East Corner Bioregions;
- Freshwater wetlands on coastal floodplains of the NSW North Coast, Sydney Basin and South-East Corner bioregions.

Two areas of Broad-leaved Paperbark - Swamp Oak - Saw Sedge swamp forest on coastal lowlands of the Central Coast and Lower North Coast were found to be consistent with the Endangered Ecological Community Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner Bioregions (NPWS, 2001). The 0.35ha area identified as Swamp Sclerophyll Forest in the north-west of the study area containing specimens of the canopy species *Eucalyptus grandis* (Flooded Gum) was found to have some similarities to the EEC River Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner Bioregions. As a result of the drainage, position in the landscape, understorey species and dominance of the canopy species *Melaleuca quinquenervia* (Broad-leaved Paperbark) it was considered to be closer to Swamp Sclerophyll Forest.

The area mapped as Freshwater Wetland was also considered to be a representation of Freshwater wetlands on coastal floodplains of the NSW North Coast, Sydney Basin and South-East Corner bioregions.

The impact of the proposal on these Endangered Ecological Communities has been detailed in Section 14.7 and Annex N.

Groundwater Dependent Ecosystems

Groundwater Dependent Ecosystems (GDE's) are ecosystems that are fully or partially dependent on groundwater to maintain ecosystem function. These ecosystems occur across both surface and subsurface landscapes and are highly variable.

Groundwater Dependent Ecosystems present in the Study Area

The groundwater dependency of the native vegetation of the Tomago and Tomaree Sandbeds has been previously determined and mapped (Driscoll & Bell, 2006). Although the study area lies outside the assessed areas contained within the Driscoll & Bell (2006) report the vegetation assemblages and landform were largely consistent with those considered in the report.

A number of GDE's were found to be present within the study area and ranged from those which contain species that rely exclusively on groundwater to survive to those which have no reliance on groundwater reserves. A list of GDE's present in the study area and there groundwater dependency is shown in Table 14.6.

Identified vegetation communities within the study area that are exclusively reliant on groundwater; Swamp Sclerophyll Forest and Freshwater Wetland are located outside the proposed mining footprint (Figure 14.9 vegetation map). Coastal Sand Apple Blackbutt Forest contains species which obtain groundwater in the capillary fringe. Approximately 25.90ha of Coastal Sand Apple Blackbutt Forest will be required to be removed for the sand mine. Areas of Coastal Sand Apple Blackbutt Forest will remain around the edge of the mining footprint and to the west below the easement.

Table 14.6 - Groundwater Dependent Ecosystems present in the study area.

Ecosystem	Ecosystem Type	Groundwater System	Groundwater Dependency
Broad-leaved Paperbark - Swamp Oak - Saw Sedge swamp forest	Terrestrial Vegetation	Coastal Sandbed	Obligate
Freshwater Wetland	Terrestrial Vegetation	Coastal Sandbed	Obligate
Coastal Sand Apple Blackbutt Forest	Terrestrial Vegetation	Coastal Sandbed	Facultative
Derived Grassland - Coastal Sand Apple Blackbutt Forest	Terrestrial Vegetation	Coastal Sandbed	Facultative (likely)

Key to Groundwater Dependency

Obligate - Contain species which rely exclusively on groundwater to survive

Facultative - Contain species which retrieve groundwater located in the capillary fringe or area above the saturated zone

Non Groundwater Dependent - Have no reliance on groundwater reserves

The proposed sand mine will require excavation below the groundwater level within the study area. An assessment undertaken (Martins, 2015) found drawdown of the permanent groundwater system at this vegetation communities is modelled to be a maximum of approximately 0.07 m. Based on the NSW Aquifer Interference Policy (Department of Primary Industries Office of Water, 2012) and the post Water Sharing Plan the local groundwater natural level range is of the order of 3 m (or more). The adopted permissible drawdown at a 40m buffer from the GDEs is 0.30 m (i.e. 10% x 3.00). This drawdown threshold is met for vegetation communities exclusively reliant on groundwater. Consequently, based on modelling results, the proposed development does not exceed the drawdown impact criterion set out in the NSW Aquifer Interference Policy (NOW, 2012).

Threatened and Rare Flora Species

Field surveys identified 191 plant species occurring within the Study Area. Thirty threatened and rare plant species (ROTAP - Briggs & Leigh, 1996) were considered to have potential habitat as a result of a 10km search of the study area of the OEH Wildlife Atlas and the Department of the Environment & Energy (DoEE) databases (Table 14.7).

Table 14.7 - Threatened and Rare Flora species recorded within the locality.

FLORA SPECIES	TSC	EPBC	ROTAP
Corybas dowlingii (Red Helmet Orchid)	E		
**Cryptostylis hunteriana* (Leafless Tongue Orchid)	E	V	3VC-
Diuris arenaria (Tomaree Doubletail)	E		Recommend 2VC
Diuris praecox (Newcastle Doubletail)	V	V	2VC-
Genoplesium baueri (Bauer's Midge Orchid)	V		3RC-
Rhizanthella slateri (Eastern Underground Orchid)	E	E	3KC-
Phaius australis (Lesser Swamp Orchid)	E	E	3VCa
Pterostylis chaetophora (Taree Rustyhood)	V		
**Persicaria elatior* (Tall Knotweed)	V	V	3V
Zannichellia palustris	E		
Grevillea parviflora subsp. *parviflora* (Small-flowered Grevillea)	V	V	
Allocasuarina defungens (Dwarf Heath Casuarina)	E	E	2E
Allocasuarina simulans (Nabiac Casuarina)	V	V	
Angophora inopina (Charmhaven Apple)	V	V	2R-
Callistemon linearifolius (Netted Bottle Brush)	V		2RCi
Eucalyptus fergusonii subsp. *fergusonii* (Ferguson's Ironbark)			3KC-
Eucalyptus glaucina (Slaty Red Gum)	V	V	3VCa
Eucalyptus parramattensis subsp. *decadens* (Drooping Red Gum)	V	V	2V
Eucalyptus rudderi (Rudder's Box)			3RC
Melaleuca biconvexa (Biconvex Paperbark)	V		
Melaleuca groveana (Grove's Paperbark)	V		3RC-
Syzygium paniculatum (Magenta Lillypilly)	E	V	3VCi
**Tetratheca juncea* (Black-eyed Susan)	V	V	3VCa
Prostanthera densa (Villous Mintbush)	V	V	3VC-
Cynanchum elegans (White-flowered Wax Plant)	V	V	3ECi

FLORA SPECIES	TSC	EPBC	ROTAP
Asperula asthenes (Trailing Woodruff)		V	3VC-
Galium australe (Tangled Bedstraw)	E		
Lindernia alsinoides (Noah's False Chickweed)	E		
Streblus pendulinus (Siah's Backbone)		E	
Maundia triglochinoides	V		
Chamaesyce psammogeton (Sand Spurge)	E		
Senecio spathulatus (Coastal Fireweed)	E		
Macrozamia flexuosa			2K

Of the abovementioned threatened flora species one species *Diuris arenaria* (Tomaree Doubletail) was recorded within the study area during targeted surveys. A total of 108 specimens of *D. arenaria* were found within the study area (Figures 14.11 & 14.12). With the exception of one individual plant (No. 14) all of the specimens of *D. arenaria* were found to be present within the electricity easement in the far south-west of the study area. Specimens of *D. arenaria* as well as *Diuris praecox* (Newcastle Doubletail) were also found to occur outside the study area to the west within the same electricity easement (Figure 14.11).

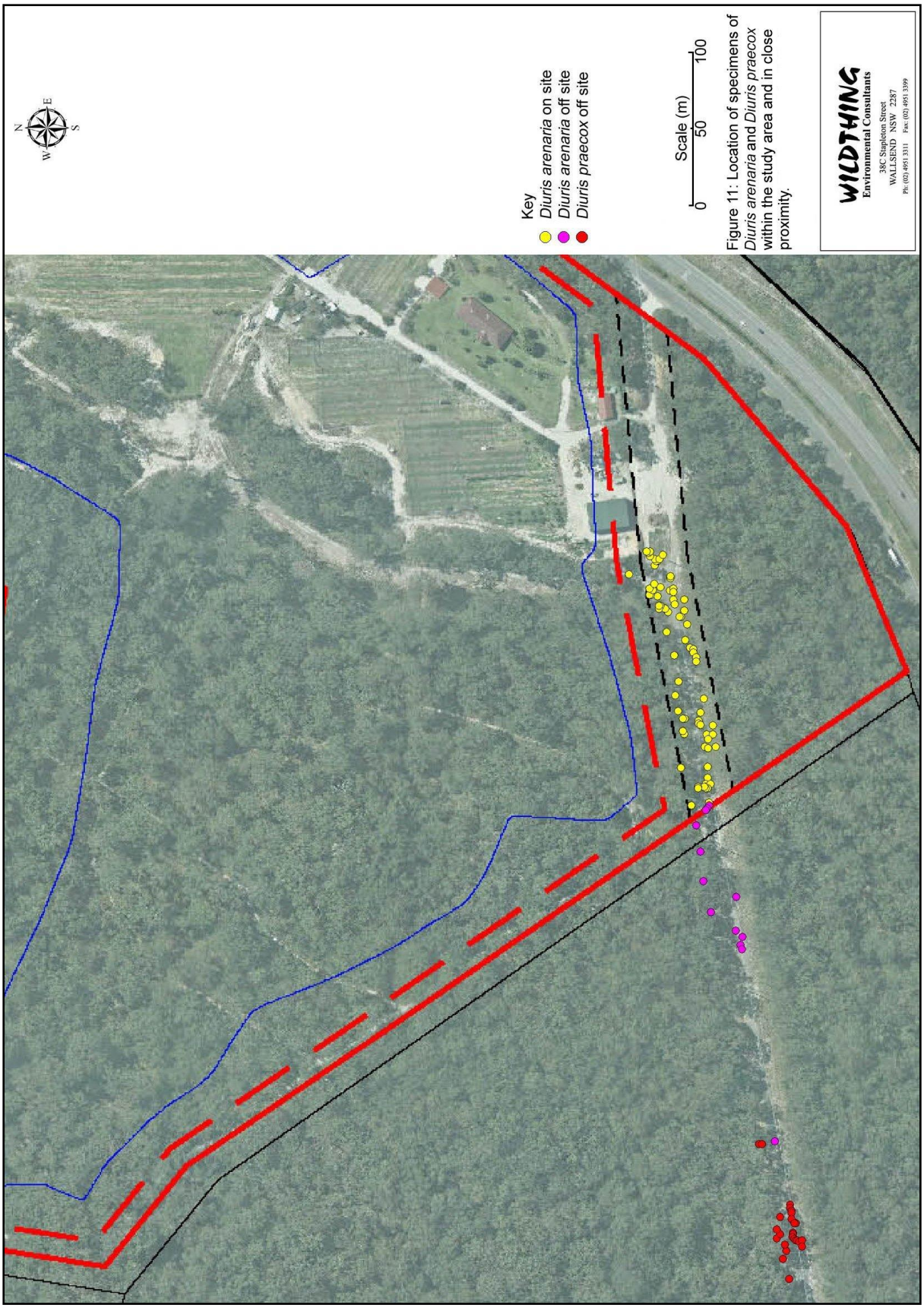


Figure 14.11 - Locations of Orchids

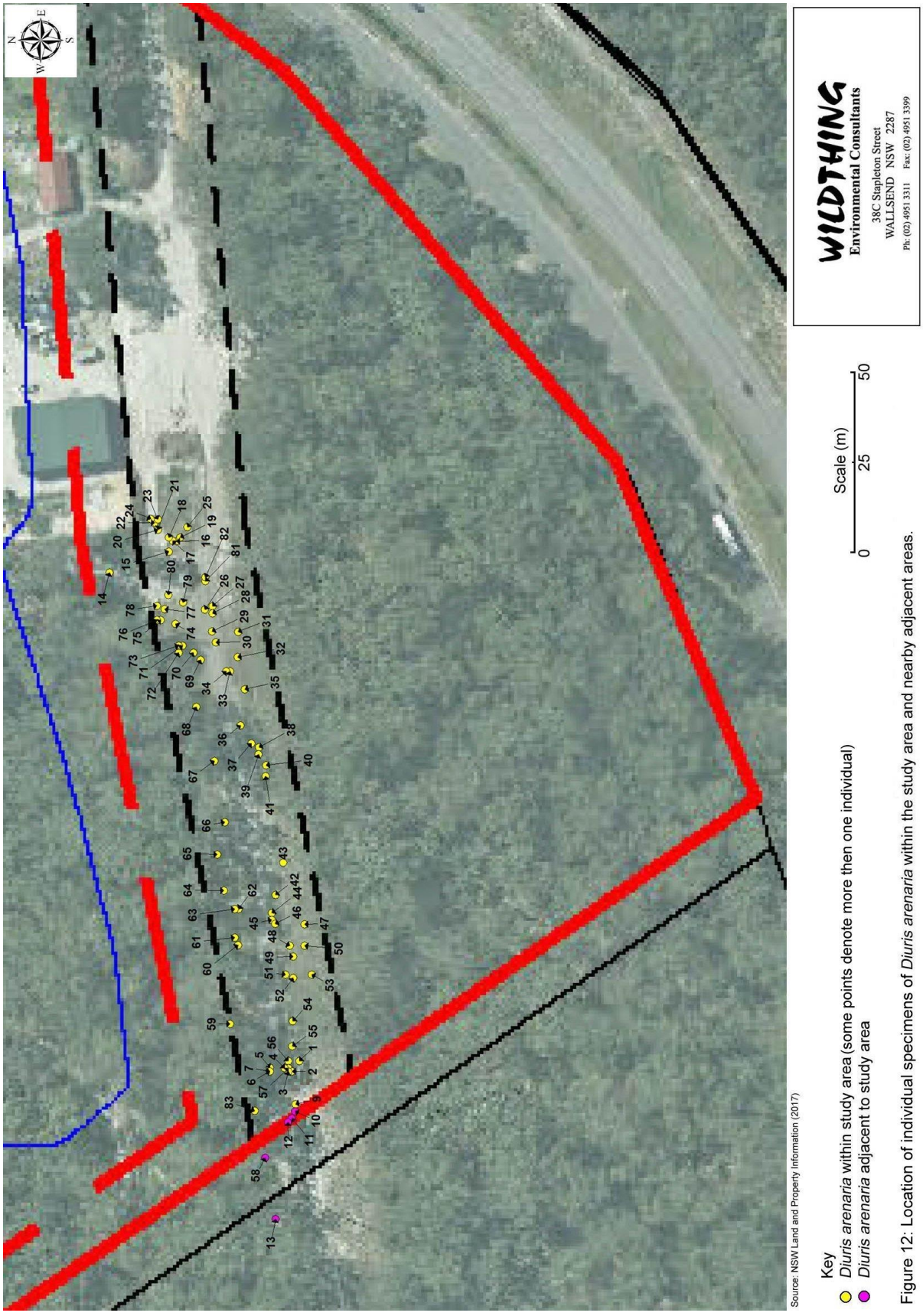


Figure 12: Location of individual specimens of *Diuris arenaria* within the study area and nearby adjacent areas.

Figure 14.12 - Locations of Individual Orchid Specimens

The nearest specimens of *D. praecox* were approximately 200m away from the study area boundary (Wildthing Environmental Consultants, 2018). The occurrence of these two threatened orchid species were largely consistent with the mapping completed for the Electricity Supply Upgrade from Tomago to Tomaree (ERM, 2003). The mapping contained within the ERM, 2003 report showed populations of *D. arenaria* and *D. praecox* occurring within the electricity easement to the west of the study area and within the easement on the southern side of Nelson Bay Road to the south-east.

No additional threatened flora species were recorded within the study area during fieldwork. The study area was considered to contain low quality habitat for *C. dowlingii, C. hunteriana, P. chaetophora, P. elatior, Z. palustris C. linearifolius, E. parramattensis subsp. decadens, M. biconvexa, S. paniculatum, M. triglochinoides, C. elegans* and *L. alsinoides.*

A species-specific habitat assessment for the addressed threatened flora species has been provided in Section 14.5.2.4 of this report.

No ROTAP species were recorded within the study area.

Biosecurity Act 2015

Two priority weed species listed under the Biosecurity Act 2015 were identified on site and are listed below in Table 8. The site lies within the Hunter Regional Weed Committee (HRWC).

Table 14.8 - Priority Weed species found within the subject site.

WEED SPECIES	LEGAL REQUIREMENTS	ADDITIONAL SIGNIFICANCE
Senecio madagascariensis Fireweed	General Biosecurity Duty Prohibition on dealings	N
Rubus fruticosa Blackberry	General Biosecurity Duty Prohibition on dealings Regional Recommended Measure	N
Lantana camara Lantana	General Biosecurity Duty Prohibition on dealings	T, N
Chrysanthemoides monilifera subsp. *rotundata* Bitou Bush	Prohibition on dealings, General Biosecurity Duty Biosecurity Zone	T, N

T – Listed as a Threatening Process under the NSW BC Act 2016.
N –Weed of National Significance.

***Priorities under the Biosecurity Act 2015**
General Biosecurity Duty - any person dealing with plant matter must take measures to prevent, minimise or eliminate the biosecurity risk (as far as is reasonably practicable).
Prohibition on dealings - Must not be imported into the State or sold.
Regional Recommended Measure - Land managers mitigate the risk of the plant being introduced to their land. Land managers reduce impacts from the plant on priority assets. Land managers prevent spread from their land where feasible. The plant or parts of the plant are not traded, carried, grown or released into the environment.

Another weed species *Alternanthera philoxeroides* (Alligator Weed) which has the potential to invade low lying poorly drained parts of the study area has been recorded nearby to the within low table drains alongside Nelson Bay Road to the nearby east. The control of listed noxious and other invasive weeds within the study area is to be included within the Vegetation Management Plan recommended for the proposal.

14.13 HABITAT APPRAISAL

Habitat Description and Distribution in the Vicinity

The vegetation and landforms present within the study area offered habitat for a variety of native species. The main habitat types within the study area were Dry Sclerophyll Forest, Swamp Forest, Freshwater Wetland, Orchard and Cleared open areas.

Dry Sclerophyll Forest

Dry Sclerophyll Forest in the form of Coastal Sand Smooth-barked Apple Blackbutt Forest occupied 35.83ha of the study area and was the largest habitat class present. Coastal Sand Apple Blackbutt Forest is also the dominant habitat type along the dunal forests of Stockton Bight. Dry Sclerophyll Forest occurring within the study area would provide suitable habitat opportunities for a variety of species. Frugivorous, nectivorous, granivorous and insectivorous birds and microchiropteran bat species would all find potential foraging resources within this complex. The large number of hollow-bearing trees would provide nesting and roosting sites for a variety of avifauna and other hollow dependant species such as arboreal mammals and tree-roosting bats. Hunting opportunities exist for birds of prey, given that the variable tree coverage and understorey vegetation has created a myriad of ecotones and habitat densities. Such habitat is suitable for terrestrial species including small and medium sized mammals, macropods, reptiles and potentially for some frog species adapted to drier areas. No preferred species of Koala feed trees listed under the Port Stephens CKPoM were recorded within this area of habitat.

Swamp Sclerophyll Forest

Swamp Sclerophyll Forest habitat totalling 1.15ha occupied two areas of the poorly drained lower lying regions of the study area. These areas provided suitable habitat opportunities for a variety of species. Frugivorous, nectivorous, granivorous and insectivorous birds and microchiropteran bat species would all find potential foraging resources within this complex. Flowering specimens of *Melaleuca quinquenervia* (Broad-leaved Paperbark), *Eucalyptus robusta* (Swamp Mahogany) and *Eucalyptus grandis* (Flooded Gum) would provide a seasonal food source for Flying-Foxes and nectivorous bird species. Due to the lack of hollow-bearing trees only limited nesting and roosting opportunities were present for hollow dependent species such as arboreal mammals, tree-roosting bats and nesting avifauna. Water within the low-lying areas of swamp forest was found to be ephemeral in nature and would dry out during extended periods of low rainfall. This area contained habitat for amphibians and limited habitat for waterbird species. *Eucalyptus robusta* is listed as a preferred feed tree species under the Port Stephens CKPoM and was present within this area of habitat.

Freshwater Wetland

Freshwater Wetland habitat composed of sedges, rushes and other flora adapted to periods of inundation occupied 0.32ha of poorly drained land in the north of the study area. Surface water within this area was found to be ephemeral in nature and would be absent during extended periods of low rainfall. This area contained preferred habitat for a number of amphibian species although only marginal habitat was likely to be present for a few species of freshwater fish. Suitable habitat was present for a number of reptile and waterbird species. Periodic surface water would act as a water source for other native animals such as macropods and offer limited habitat for bats that prefer to hunt above or around water bodies.

Cleared Open Areas

The cleared highly disturbed open areas of habitat provide opportunity for a variety of avifauna, including predominantly terrestrial species preferring open spaces, seed eating birds and several birds of prey, which may hunt over this area in search of potential prey species. Macropods may also frequent such areas whilst grazing. Some species of bats may also forage over this cleared area for insects. However, the lack of vegetative cover often limits the value of such areas as this for many species, particularly reptiles and small mammals which are vulnerable to predation in open spaces.

In general, the habitats within the study area offer a wide range of habitat opportunities for a range of native species. The habitats proposed to be affected by the proposal range from less ecologically significant areas such as orchards to relatively intact Dry Sclerophyll Forest that is capable of offering suitable resources to both resident and transitory species.

Inventory of Hollow Bearing Trees

A total of 1217 habitat (hollow-bearing) trees were identified within the study area as a result of a hollow-bearing tree survey. A summary of the significant tree survey is shown in Table 9 and the locations of each tree are shown in Figure 13. Detailed results of the significant tree survey are contained in Appendix F.

Table 14.9 - Summary of Hollow-bearing Tree Survey

	Hollow-bearing Tree No.	Class 1 Hollow No.	Class 2 Hollow No.	Class 3 Hollow No.	Class 4 Hollow No.	Total Hollows
Lot 254	1058	411	705	976	944	3035
Lot 51	118	18	53	136	183	390
Lot 10	40	36	45	73	55	209
Lot 11	1	0	0	0	2	2
Study Area	1217	465	803	1184	1184	3636

The classification system employed involved three classes:

Class 1 –very large sized hollow openings (i.e. >20cm) suitable for species such as Owls

Class 2 – large sized hollow openings (i.e. 15-20cm) suitable for species such as Possums

Class 3 – medium sized hollow-openings (i.e. 5-15cm) suitable for species such as Gliders and Possums

Class 4 – small sized hollow openings (i.e. <5cm) suitable for species such as microchiropteran bats

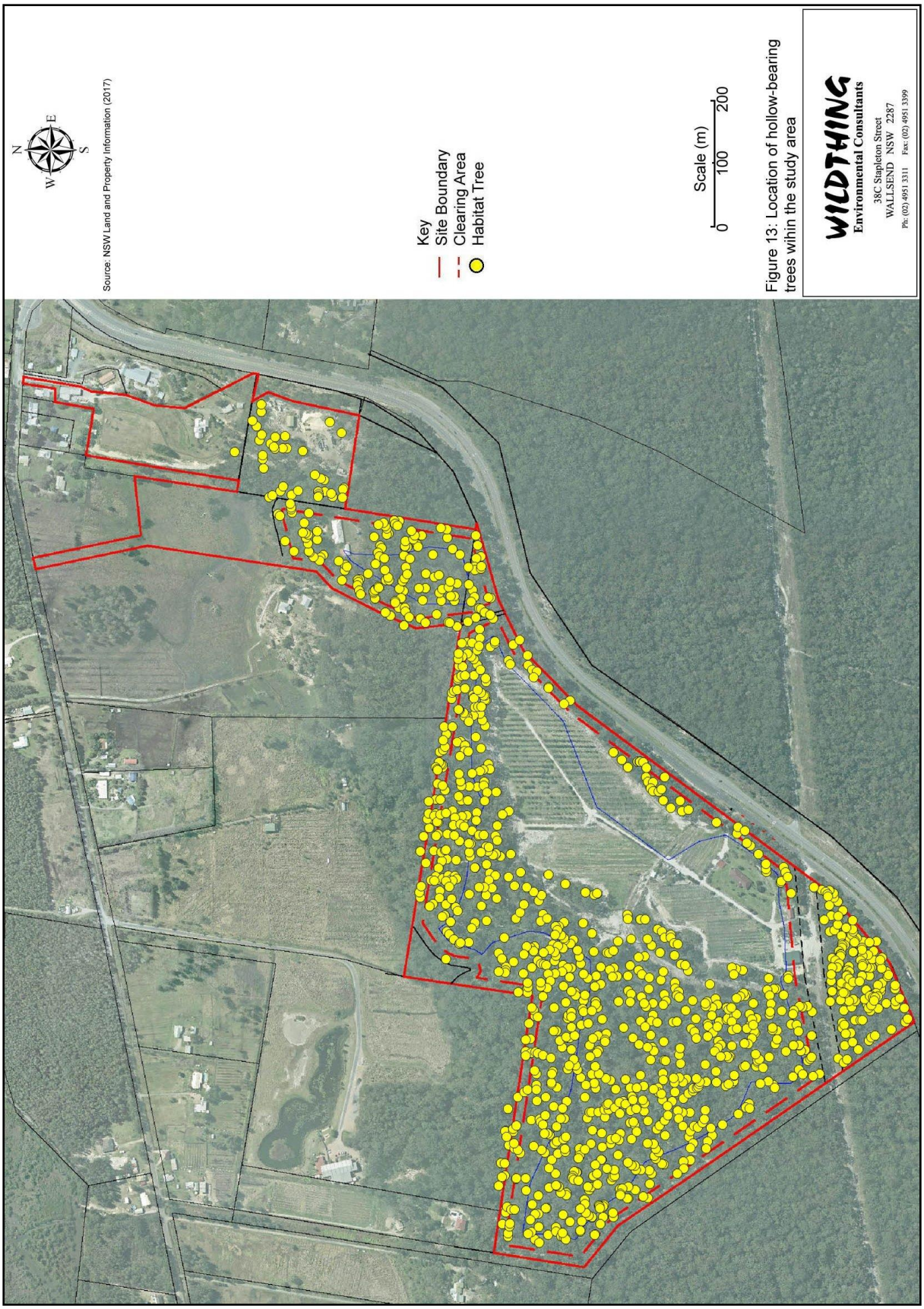


Figure 14.13 - Location of Hollow Bearing Trees

The proposed sand mine will result in the removal of approximately 877 of the 1217 hollow-bearing trees from within the study area. The vast majority of hollow-bearing trees were present within Coastal Sand Apple Blackbutt Forest assemblage. Many of these trees where considered to be significant as a result of their very large size, the variety and number of hollows they contained. Hollows were available for roosting or nesting avifauna species, arboreal mammals, reptiles and tree roosting microchiropteran bat species. A number of potential roost trees for large owls such as the threatened *Ninox strenua* (Powerful Owl) were also present. Six hollow-bearing trees were found to contain introduced *Apis mellifera* (Feral Honey Bee) hives. Competition from the Feral Honey Bees is a threatening process under Schedule 3 of the TSC Act 1995.

The loss of hollow-bearing trees is a Key Threatening Process under Schedule 3 of the TSC Act 1995. The removal of 877 hollow-bearing trees would be a significant loss of this resource in the local area. It would be likely that similar densities and sizes of hollows occurring within the study area would be present within adjoining areas of Coastal Sand Apple Blackbutt Forest which is the dominant vegetation assemblage along the sand dunes of Stockton Bight from Fern Bay to Anna Bay. Hollow-bearing tree frequency however would be expected to be lower within the more exposed stunted form of Coastal Sand Apple Blackbutt Forest closer to the waters of Stockton Bight.

Habitat Fragmentation & Corridors

The study area forms part of a significant ecological corridor that runs down the coast from the Tomago Sandbeds in the south along the Stockton Bight to the Tomaree Peninsula in the north. The ecological corridor occurring along Stockton Bight is restricted by the bare shifting sand dunes to the east and largely cleared agricultural land to the west. The Lower Hunter Regional Strategy (Planning 2006) identifies this area as part of a key green corridor linking large vegetated areas, allowing the movement and dispersal of biodiversity within the region. This corridor links the Watagans and Yengo National Parks with the coastal plains of the Tomago Sand beds, Stockton Bight and Port Stephens. The Lower Hunter and Central Coast Regional Biodiversity Conservation Strategy (House, 2003) also identifies the Coastal Sand Apple – Blackbutt Forest occurring along the Stockton Bight dune system as a regionally significant habitat linkage. The Hunter Regional Plan 2036 (NSW Government, 2016) also shows the site to occur within a Biodiversity Corridor.

The fragment of vegetation that the study area is situated has also been mapped as a key habitat (NPWS 2002). Key habitats define areas identified as centres of high native species diversity for a range of fauna assemblages (NPWS 2002). The proposal will result in the removal of approximately 25.90ha of key habitat largely consisting of Coastal Sand Apple Blackbutt Forest from the north-east section of the corridor. The section of the corridor where the study area is located is approximately 1.5km wide. The proposal will result in the reduction in the width of the corridor on the western side of the dual carriage way of Nelson Bay Road by approximately 540m at its widest point (not taking planted orchard into account). The wider southern portion of the regional corridor occurring east of Nelson Bay Road is located on the protected Worimi Conservation Lands. An aerial photo of the surrounding habitat is shown in Figure 14.14.

The dual carriage way is approximately 40 to 50m (without a treed traffic island) wide and would create a significant barrier for the movement of a number of native fauna species such as arboreal mammals. Taking into consideration the presence of the dual carriage way the proposal will result in a reduction in the width of connectivity to the east of the study area to open forest areas within Lot 10 and the adjoining crown reserve (Lot 7374). A 15m vegetated buffer zone around the proposal together with adjoining habitat within the road reserve along Nelson Bay Road (varying between 10m & 15m) will still provide connectivity to these areas of habitat. Considering the current presence of a planted orchard within the study area this constriction is already present along parts of the eastern boundary.

Cleared agricultural land also bordered parts of the north-west boundary. The proposal will narrow the connectivity to adjoining areas of native open forest habitat contained within Lot 2 DP774965, Lot 251 DP 1034604 and Lot 1 DP 774965 on the north-western side of the study area to a minimum of 15m in the far north (Lot 51 – small section) and 170m in the west (Lot 1).

The existing electrical easement within the far west of the study area was approximately 30m wide. This area was composed of derived native groundcovers and would unlikely currently pose a significant movement barrier for any native species.

The connectivity to these areas will improve after the mine site has been progressively revegetated to the edge of a resulting permanent artificial lake. Proposed revegetation of Swamp Forest within the northern portion of Lot 51 within the study area towards Marsh Road will also greatly increase the width of the resulting 15m corridor in the north.

The artificial lake will remain permanently within the ecological corridor and will be approximately 680m at its widest point. The proposal will result in a reduction in the function and quality of the ecological corridor. Taking into consideration revegetation of impacted areas to the resulting artificial lakes edge and further revegetation within the northern portion of Lot 51 the proposal is unlikely to significantly impact the integrity of the ecological corridor. A plan of the study area showing the proposal, surrounding habitat and artificial lake is shown in Figure 14.15.



Figure 14.14 - Aerial Photograph of Study Area and Surrounds

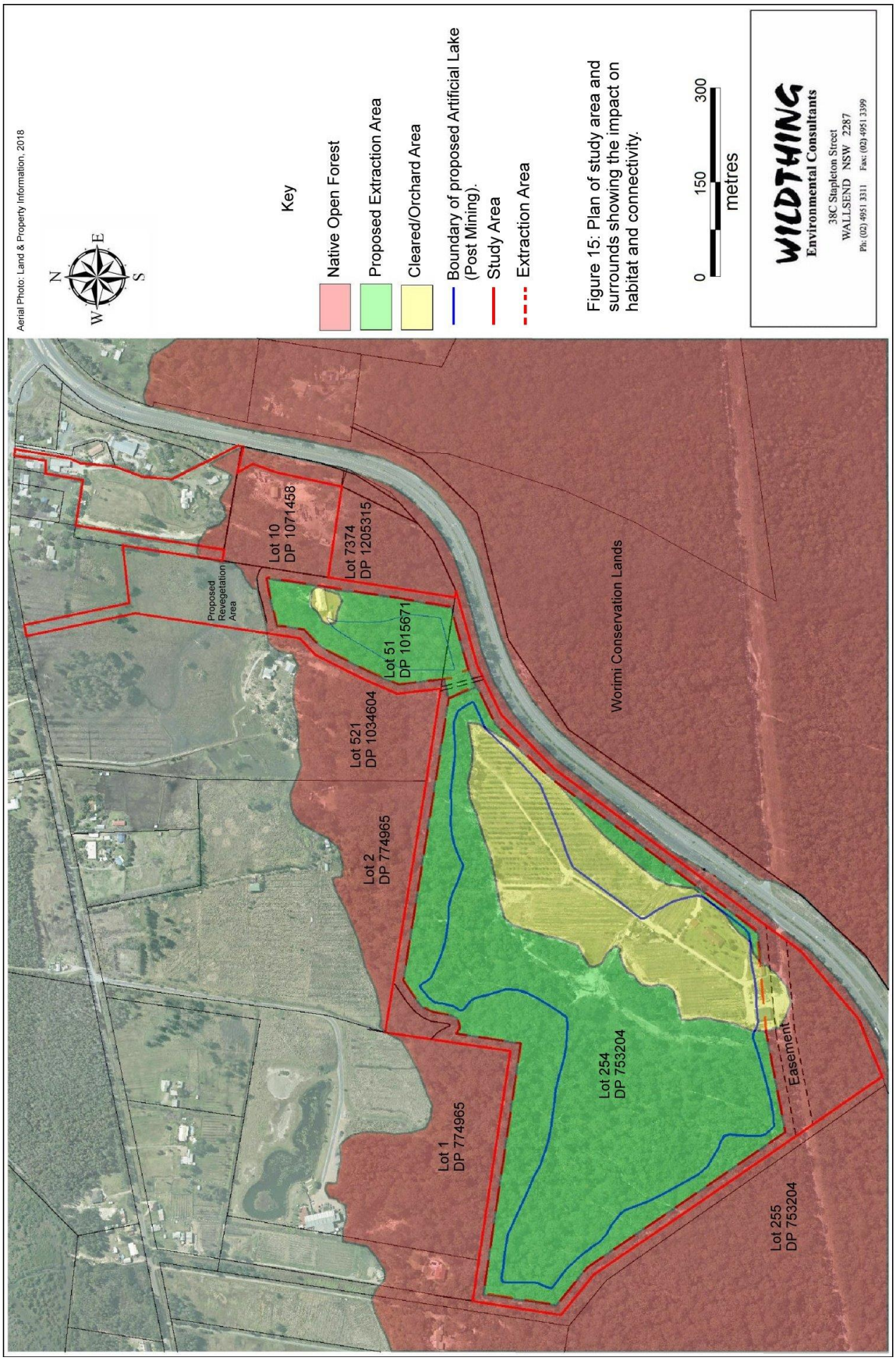


Figure 14.15 - Study Area and Habitat Connectivity

Habitat for Significant Species

An assessment of habitat attributes on site has been undertaken for the threatened species listed in Section 14.3.5. The results of the assessment are displayed in Table 14.8. Those species identified in this assessment as having potential habitat available on site have been considered further under Section 5A of the EPA Act in Section 14.7.0 of this report. The description of the ecology of each species is contained in Annex N.

Table 14.10 - Habitat Assessment for Significant Species

SPECIES	STATUS	HABITAT DESCRIPTION AND LOCALLY KNOWN POPULATIONS	LIKELYHOOD OF OCCURRENCE WITHIN THE STUDY AREA	7-PART TEST REQUIRED
Corybas dowlingii Red Helmet Orchid	TSC Act-E	Forms colonies and typically grows in gullies in tall open forest on well-drained gravelly soil at elevations of 10-200m. Is restricted to New South Wales where it is currently known from 4 localities including Port Stephens (2 localities), Bulahdelah and Freemans Waterhole south of Newcastle. A population is known from Stoney Ridge Reserve on Soldiers Point on the southern shore of Port Stephens.	**Low** No preferred habitat in the form of areas of well drained gravelly soil was present within the sandy study area.	**Yes**
Cryptostylis hunteriana Leafless Tongue Orchid	TSC Act-E EPBC Act-E ROTAP – 3VC-	This species is a saprophyte, which grows in small, localised colonies on flat plains close to the coast. This species has also been recorded in mountainous areas growing in moist depressions as well as in swampy habitats.	**Low** Suitable habitat was considered to be present within the study area.	**Yes**
Diuris arenaria Tomaree Doubletail	TSC Act – E ROTAP – Recommend 2VC	Coastal heath, Dry Sclerophyll Forest with patches of *Themeda australis* (Kangaroo Grass) on sandy flats (Bishop, 1996). This species is only known from the Tomaree Peninsula on the southern side of Port Stephens.	**High-Recorded within the study area.** Suitable habitat was considered to be present over the majority of the study area.	**Yes**
Diuris praecox Newcastle Doubletail	TSC Act - V EPBC Act – V ROTAP – 2VC-	Found in eucalypt forests on hilltops or slopes and is widespread in grassy habitats. Large populations have been recorded within power line easements at Anna Bay and Bobs Farm (ERM, 2003).	**High** Suitable habitat was considered to be present over the majority of the study area. Recorded a	**Yes**

SPECIES	STATUS	HABITAT DESCRIPTION AND LOCALLY KNOWN POPULATIONS	LIKELYHOOD OF OCCURRENCE WITHIN THE STUDY AREA	7-PART TEST REQUIRED
			short distance outside the study area.	
Genoplesium baueri Bauer's Midge Orchid	TSC Act – V ROTAP – 3RC-	Grows in sparse sclerophyll forest and moss gardens over sandstone.	**Unlikely** No suitable habitat was considered to be present for this orchid species. No local records exist for this species.	**No**
Phaius australis Lesser Swamp Orchid	TSC Act - E EPBC Act – E ROTAP – 3VCa	Swampy grassland or swampy forest including rainforest, eucalypt or paperbark forest, mostly in coastal areas. Occurs in Queensland and north-east NSW as far south as Coffs Harbour. Historically, it extended farther south, to Port Macquarie.	**Unlikely** Suitable habitat was present within the two areas of Swamp Sclerophyll Forest. However, the study area occurs well south of known distribution of the orchid species.	**No**
Rhizanthella slateri Eastern Underground Orchid	TSC Act - E EPBC Act – E ROTAP – 3KC-	Habitat requirements are poorly understood and no particular vegetation type has been associated with this species, although it is known to occur in sclerophyll forest. This species is highly cryptic as it grows almost completely below the soil. It flowers from September to November. This orchid species has not been recorded on the Tomaree Peninsula. The nearest known local record of this species is Bulahdelah (Jones, 2006).	**Low** Only marginal habitat was present.	**Yes**

SPECIES	STATUS	HABITAT DESCRIPTION AND LOCALLY KNOWN POPULATIONS	LIKELYHOOD OF OCCURRENCE WITHIN THE STUDY AREA	7-PART TEST REQUIRED
Pterostylis chaetophora Taree Rustyhood	TSC Act-V	The preferred habitat is seasonally moist, dry sclerophyll forest with a grass and shrub understorey. In NSW, it is currently known from 18 scattered locations in a relatively small area between Taree and Kurri Kurri, extending to the south-east towards Tea Gardens and west into the Upper Hunter, with additional records near Denman and Wingen. This species has also been recorded near Grahamstown Dam near Medowie (Pers.com. Steve Lewer OEH).	**Low** Suitable habitat was found to be present over a large portion of the study area containing Dry Sclerophyll Forest.	**Yes**
Grevillea parviflora subsp. *parviflora* Small-flowered Grevillea	TSC Act-V EPBC Act-V	This species of Grevillea occurs in light clayey soils in woodlands. This species grows chiefly in south-western Sydney. Disjunct populations occur near Cessnock, Putty and Cooranbong (Fairley, 2004). A record from Oyster Bay was present on the OEH BioNet database (OEH, 2017).	**Unlikely** No known soil types or associated flora species were present. The study area is not composed of older Pleistocene-aged sands.	**No**
Allocasuarina defungens Dwarf Heath Casuarina	TSC Act-E EPBC Act-E ROTAP – 2E	A small erect shrub occurring on sand in the Nabiac area and farther north in the NSW North Coast Region. Grows mainly in tall heath on sand, but can also occur on clay soils and sandstone (DEC, 2005). It is found in coastal areas of wet to dry, dense, low, closed heath land growing on Pleistocene-aged marine aeolian derived soils (Wilson & Johnson, 1989).	**Unlikely** The study area is not composed of Pleistocene-aged sands. The study area is also located outside the know distribution of this species.	**No**
Allocasuarina simulans *Nabiac Casuarina*	TSC Act-V EPBC Act-V	The Nabiac Casuarina is restricted to the mid-north coast of NSW, from Nabiac to Forster and is very rare. The Nabiac Casuarina grows in heathland on coastal sands.	**Unlikely**	**No**

SPECIES	STATUS	HABITAT DESCRIPTION AND LOCALLY KNOWN POPULATIONS	LIKELYHOOD OF OCCURRENCE WITHIN THE STUDY AREA	7-PART TEST REQUIRED
			The study area is also located outside the know distribution of this species.	
Angophora inopina Charmhaven Apple	TSC Act-V EPBC Act-V ROTAP – 2R-	Found in shallow sandy soils within open woodland/forest assemblages in co-dominant distribution with *Eucalyptus haemastoma* (Scribbly Gum), *Corymbia gummifera* (Red Bloodwood) and *Eucalyptus capitellata* (Brown Stringybark), as well as within wet-dry heath, and swamp forest communities. The main occurrences of this species are in the Wyong and Lake Macquarie LGA. Disjunct populations have also been found south of Karuah in the Port Stephens LGA and north of Karuah in the Great Lakes LGA.	**Unlikely** No associated woodland/forest assemblages were present.	**No**
Callistemon linearifolius Netted Bottle Brush	TSC Act-V ROTAP – 2RCi	Grows in dry sclerophyll forest on the coast and adjacent ranges from the Georges River to the Hawkesbury River in the Sydney area, and north to Nelson Bay. This species is known to occur within Stoney Ridge Reserve at Soldiers Point.	**Low** Suitable habitat was found to be present over a large portion of the study area containing Dry Sclerophyll Forest.	**Yes**
Eucalyptus camfieldii Camfield's Stringybark	TSC Act – V EPBC Act – V	Records from Tanilba Bay on Shrubby Wallum Heath on a ridge with sandy soil with *Corymbia gummifera* and *Eucalyptus piperita.*	**Unlikely** The site lacks Wallum Heath.	**No**
Eucalyptus glaucina	TSC Act – V	The Slaty Red Gum principally occurs in the Casino area in northern NSW and from Gloucester to Broke, in	**Unlikely**	**No**

SPECIES	STATUS	HABITAT DESCRIPTION AND LOCALLY KNOWN POPULATIONS	LIKELYHOOD OF OCCURRENCE WITHIN THE STUDY AREA	7-PART TEST REQUIRED
Slaty Red Gum	EPBC Act – V ROTAP – 3VCa	mid-northern NSW. It grows mostly on gentle slopes near drainage lines in alluvial and clayey soils, in open forest.	No suitable habitat was present.	
Eucalyptus parramattensis subsp. *decadens* Drooping Red Gum	TSC Act - V EPBC Act – V ROTAP – 2V	Occurs in woodland on sandy soils in wet sites. In the Port Stephens area, the Drooping Red Gum occurs in open wet sclerophyll woodland on heavy, often waterlogged, inter-barrier depression soils. This species is present within Mambo Swamp on the southern shore of Port Stephens.	**Low** Marginal habitat was considered to be present on lower areas of ground in the far north of the study area.	**Yes**
Melaleuca biconvexa Biconvex Paperbark	TSC Act - V	May occur in dense stands adjacent to watercourses, in association with other *Melaleuca* species or as an understorey species in wet forest.	**Low** No suitable habitat was considered to be present. No nearly local records.	**Yes**
Melaleuca groveana Grove's Paperbark	TSC Act-V ROTAP – 3RC-	This species is generally found in north eastern NSW and South East Queensland in heath, often in exposed sites and mainly at higher altitude. In Tomaree National Park, *Melaleuca groveana* occurs in closed heath communities on rhyodacite volcanic rock.	**Unlikely** The study area lacked associated geology, soil and vegetation types.	**No**
Syzygium paniculatum Magenta Lilly Pilly	TSC Act - E EPBC Act – V	Occurs in coastal rainforests on sandy soils or stabilised coastal dunes from Jervis Bay to Bulahdelah in NSW.	**Low** Suitable habitat was considered to be present in	**Yes**

SPECIES	STATUS	HABITAT DESCRIPTION AND LOCALLY KNOWN POPULATIONS	LIKELYHOOD OF OCCURRENCE WITHIN THE STUDY AREA	7-PART TEST REQUIRED
	ROTAP 3VCi		the more sheltered areas of sclerophyll forest.	
Tetratheca juncea Black-eyed Susan	TSC Act-V EPBC Act-V ROTAP - 3VCa	Heath and Dry Sclerophyll Forests on low nutrient soil with a dense understorey of grasses. Is most commonly found associated with species including, *Angophora costata* (Smooth-barked Apple), *Eucalyptus globoidea* (White Stringybark), *Corymbia gummifera* (Red Bloodwood) and *Acacia myrtifolia* (Myrtle Wattle).	**Unlikely** The study area lacked associated soil and vegetation types. No nearby local records (OEH, 2017).	**No**
Prostanthera densa Villous Mintbush	TSC Act - V EPBC Act – V ROTAP – 3VC-	This species is known to occur on clay soils on volcanic hills and on sandy soils occurring as a shallow mantle over volcanic hills. It has been reported generally from sclerophyll forest and shrubland on coastal headlands and near-coastal ranges, chiefly on sandstone. The closest records are likely to occur on Gang Gang Hill, Nelson Bay well to the north of the study area.	**Unlikely** The study area lacked associated geology, soil and vegetation types.	**No**
Asperula asthenes Trailing Woodruff	TSC Act - V ROTAP – 3VC-	Damp Sites, often along riverbanks (DEC, 2006). The major portion of the distribution of this species occurs in the Great Lakes LGA. Populations are known from North Karuah and The Branch areas (Great Lakes Council, 2003).	**Unlikely** The study area lacked associated drainage lines and vegetation types.	**No**
Galium australe Tangled Bedstraw	TSC Act-E	Found in moist gullies of tall forest, *Eucalyptus tereticornis* (Forest Red Gum) forest, coastal Banksia shrubland, and *Allocasuarina nana* heathland.	**Unlikely** This species is unlikely to be present due to the lack of associated vegetation and local records.	**No**

SPECIES	STATUS	HABITAT DESCRIPTION AND LOCALLY KNOWN POPULATIONS	LIKELYHOOD OF OCCURRENCE WITHIN THE STUDY AREA	7-PART TEST REQUIRED
Lindernia alsinoides Noah's False Chickweed	TSC Act-E	Grows in swampy sites in sclerophyll forests and coastal heath.	**Low** Suitable habitat was considered to be present in the south of the study area on the edges of the Swamp Mahogany/Paperbark Forest assemblage. The study area would be considered to be south of the known distribution of this species.	**Yes**
Chamaesyce psammogeton Sand Spurge	TSC Act-E	This prostrate perennial herb grows on foredunes and exposed sites on headlands.	**Unlikely** No suitable habitat was present.	**No**
Senecio spathulatus Coastal Fireweed	TSC Act-E	Confined to areas of unstabilised sand on coastal dunes.	**Unlikely** No suitable habitat was present.	**No**

SPECIES	STATUS	HABITAT DESCRIPTION AND LOCALLY KNOWN POPULATIONS	LIKELYHOOD OF OCCURRENCE WITHIN THE STUDY AREA	7-PART TEST REQUIRED
Streblus pendulinus Siah's Backbone	EPBC Act - E	Siah's Backbone is found in warmer rainforests, chiefly along watercourses. The altitudinal range is from near sea level to 800 m above sea level. The species grows in well-developed rainforest, gallery forest and drier, more seasonal rainforest.	**Unlikely** No suitable habitat was present.	**No**
Maundia triglochinoides	TSC Act - V	Grows in swamps, creeks or shallow freshwater 30-60cm deep on heavy clay with low nutrients. Is known to occur within drainage channels around Williamtown to the south of the study area.	**Low** The area of wetland contains suitable habitat.	**Yes**
Cynanchum elegans White-flowered Wax Plant	TSC Act – E1 EPBC Act – E ROTAP 3ECi	This species occurs in scattered coastal localities from the QLD-NSW border south to Wollongong. Found in dry, littoral or subtropical rainforest, and occasionally in scrub and woodland from sea level to about 600m ASL. Records are known from Ash Island, Kooragang Wetlands.	**Low** Marginal habitat would be confined to the more sheltered areas of the study area.	**Yes**
Persicaria elatior Tall Knotweed	TSC Act - V EPBC Act – V ROTAP – 3V	Grows in damp sites, especially beside streams, lakes, margins of dams and occasionally in swamp forest.	**Low** Habitat was considered to be present within the lower lying areas of ground containing wetland in the north of the study area. The occurrence of this species is marginalised by the lack of nearby local records.	**Yes**

SPECIES	STATUS	HABITAT DESCRIPTION AND LOCALLY KNOWN POPULATIONS	LIKELYHOOD OF OCCURRENCE WITHIN THE STUDY AREA	7-PART TEST REQUIRED
Zannichellia palustris	TSC Act-E1	Grows in fresh or slightly saline stationary or slowly flowing water.	**Low** Habitat was considered to be present within the lower lying areas of ground containing wetland in the north of the study area. The occurrence of this species is marginalised by the lack of nearby local records.	**Yes**
Petalura gigantea Giant Dragonfly	TSC Act-E	Permanent wetlands both coastal and upland. Larvae occupy permanent long chambered burrows built under swamps. According to the OEH database this Dragonfly has been recorded within Mambo Swamp on the southern side of Port Stephens in 2006 (OEH, 2017).	**Low-Moderate** Swamps and wetland within the study area contain suitable habitat for this Dragonfly species.	**Yes**
Crinia tinnula Wallum Froglet	TSC Act-V	Shallow acid swamps (temporary / semi-permanent) and associated connecting channels and deeper water holes (permanent) consisting of hard-leafed heaths, shrubs and woodland on coastal plains and dunes and associated sedgelands and swamps in low lying areas collectively known as wallum.	**Moderate** Suitable habitat was found to occur within the area of wetland and swamp forest within the north of the study area.	**Yes**
Uperoleia mahonyi	TSC Act-E	Inhabits ephemeral and semi-permanent swamps and swales on the coastal fringe of its range. Records occur	**High**	**Yes**

SPECIES	STATUS	HABITAT DESCRIPTION AND LOCALLY KNOWN POPULATIONS	LIKELYHOOD OF OCCURRENCE WITHIN THE STUDY AREA	7-PART TEST REQUIRED
Mahony's Toadlet		in heath or wallum habitats almost exclusively associated with leached (highly nutrient impoverished) white sand. This species has also been recorded on more recent Holocene Dunes (Dr Simon Clulow *pers.com*). Commonly associated with acid paperbark swamps, is also known to occur in wallum heath, swamp mahogany-paperbark swamp forest, heath shrubland and Sydney red gum woodland. Recent studies suggest intact vegetation adjacent to and within water bodies is an important habitat feature for this species. Endemic to the mid-north coast of New South Wales (NSW) and to date has been found between Kangy Angy and Seal Rocks.	Suitable habitat was found to occur within the area of wetland and swamp forest within the north of the study area.	
Litoria aurea Green and Golden Bell Frog	TSC Act-E EPBC Act-E	This frog species inhabits swamps, lagoons, streams and ponds as well as dams, drains and storm water basins.	**Low** Suitable habitat was found to occur within the area of lower lying wetland within the north of the study area. No nearby local records (OEH, 2017).	**Yes**
Litoria brevipalmata Green-thighed Frog	TSC Act-V	Open Forest, rainforest bordering cleared areas.	**Low** Only marginal habitat was present within the study area for this frog species. No nearby local records (OEH, 2017).	**Yes**
Mixophyes balbus	TSC Act-V	Occurs in wet forest regions of south-eastern Queensland, Eastern NSW and Victoria. In late spring,	**Unlikely**	**No**

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Stuttering Frog	EPBC Act-V	eggs are deposited among leaf litter on the banks of streams and subsequently are washed into the water during heavy rain.	No suitable habitat was present.	
Mixophyes iteratus Great Barred Frog	TSC Act-E EPBC Act-E	Occurs on forest slopes of the Great Dividing Range, generally between 20-800m A.S.L. It appears to prefer riparian vegetation or other moist vegetation communities, generally on rich organic soils. Deep leaf litter and/or thick cover is necessary for this species. Water quality must be of a high standard, and the species occurs in 1st to 3rd order streams (i.e. 'young' streams), and is absent from ponds and ephemeral pools. Graded banks with undercuts and steep edges are favourable haunts of this frog.	**Unlikely** No suitable habitat was present.	**No**
Caretta caretta Loggerhead Turtle	TSC Act-E EPBC Act-E	Ocean dwellers foraging in deeper water for fish, jellyfish and bottom dwelling animals. The female comes ashore to layer her eggs in a hole dug on the beach in tropical regions during the warmer months.	**Unlikely** No habitat was present.	**No**
Chelonia mydas Green Turtle	TSC Act-V EPBC Act-V	Occurs in shallow seas where there is sufficient light to ensure an abundant growth of marine grasses. When resting this species searches out an appropriate rest area i.e. rock overhang, rocky pothole, which gives some protection from predators.	**Unlikely** No habitat was present.	**No**
Dermochelys coriacea Leatherback Turtle	TSC Act-V EPBC Act-E	The Leatherback Turtle is a pelagic feeder, found in tropical, subtropical and temperate waters throughout the world. It has been recorded feeding in the coastal waters of all Australian States.	**Unlikely** No habitat was present.	**No**
Eretmochelys imbricata	EPBC Act-V	Hawksbill turtles typically occur in tidal and sub-tidal coral and rocky reef habitats throughout tropical	**Unlikely**	**No**

SPECIES	STATUS	HABITAT DESCRIPTION AND LOCALLY KNOWN POPULATIONS	LIKELYHOOD OF OCCURRENCE WITHIN THE STUDY AREA	7-PART TEST REQUIRED
Hawksbill Turtle		waters, extending into warm temperate areas as far south as northern New South Wales.	No habitat was present.	
Natator depressus Flatback Turtle	EPBC Act-V	Although found in open seas, they prefer inshore waters and bays where their feeding ground is the shallow, soft-bottomed seabed.	**Unlikely** No habitat was present.	**No**
Hoplocephalus bitorquatus Pale-headed Snake	TSC Act-V	Rainforest to the drier sclerophyll forests.	**Low** Suitable habitat was considered to be present within the study area. There was a lack of local records for this species (OEH, 2017).	**Yes**
Hoplocephalus stephensii Stephen's Banded Snake	TSC Act-V	Partly arboreal found in wet sclerophyll forest or rainforest.	**Low** Suitable habitat was considered to be present within the study area. There was a lack of local records for this species (OEH, 2017).	**Yes**
Macronectes giganteus Southern Giant Petrel	TSC Act – E EPBC Act-E	The Southern Giant Petrel ranges from deep circumpolar waters from Antarctica across the entire length of the New South Wales coast.	**Unlikely** No suitable habitat was present.	**No**

SPECIES	STATUS	HABITAT DESCRIPTION AND LOCALLY KNOWN POPULATIONS	LIKELYHOOD OF OCCURRENCE WITHIN THE STUDY AREA	7-PART TEST REQUIRED
Macronectes halli Northern Giant Petrel	TSC Act - E	Inhabits subtropical waters in winter and early spring. Potential foraging resources in N.S.W. are regarded as significant during the winter months although representing a small proportion of the total foraging area for this species.	**Unlikely** No suitable habitat was present.	**No**
Pterodroma leucoptera leucoptera Gould's Petrel	TSC Act - E	Lives pelagic life, nests on Cabbage Tree Island.	**Unlikely** No suitable habitat was present.	**No**
Pterodroma neglecta Kermadec Petrel	TSC Act-V	It is a pelagic species inhabiting the subtropical and tropical waters of the Pacific Ocean, rarely reaching mainland.	**Unlikely** No suitable habitat was present.	**No**
Pterodroma nigripennis Black-winged Petrel	TSC Act-V	Pelagic species	**Unlikely** No suitable habitat was present.	**No**
Pterodroma solandri Providence Petrel	TSC Act-V	Pelagic species	**Unlikely** No suitable habitat was present.	**No**
Calonectris leucomelas Streaked Shearwater	EPBC-Migratory	Pelagic species	**Unlikely** No suitable habitat was present.	**No**
Ardenna carneipes	TSC Act-V	Lives pelagic life, nests on Lord Howe Island.	**Unlikely**	**No**

SPECIES	STATUS	HABITAT DESCRIPTION AND LOCALLY KNOWN POPULATIONS	LIKELYHOOD OF OCCURRENCE WITHIN THE STUDY AREA	7-PART TEST REQUIRED
Flesh-footed Shearwater			No suitable habitat was present.	
Puffinus tenuirostris Short-tailed Shearwater	EPBC-Migratory	Pelagic species	**Unlikely** No suitable habitat was present.	**No**
Limicola falcinellus Broad-billed Sandpiper	TSC Act-V	Habitat utilised by this species includes tidal mudflats, reefs, salt marshes, freshwater wetlands and sewage farms. Favours muddy ooze.	**Unlikely** No suitable habitat was present.	**No**
Limosa lapponica Bar-tailed Godwit	EPBC-Migratory	Tidal mudflats, estuaries, sewerage ponds, shallow river margins, brackish or saline inland lakes and flooded pastures (Pizzey & Knight, 2001).	**Unlikely** No suitable habitat was present.	**No**
Limosa limosa Black-tailed Godwit	TSC Act-V	Habitat utilised by this species includes tidal mudflats, river edges, sandy beaches, brackish swamps as well as the shallows of lakes, reservoirs and sewage farms.	**Unlikely** No suitable habitat was present.	**No**
Arenaria interpres Ruddy Turnstone	EPBC-Migratory	Tidal reefs and pools; weed-covered rocks; pebbly, shelly and sandy shores with stranded seaweed; mudflats; occasionally inland shallow waters; sewage ponds and open or ploughed ground.	**Unlikely** No suitable habitat was present.	**No**
Xenus cinereus Terek Sandpiper	TSC Act-V	Tidal Mudflats, estuaries, shores, reefs and coastal swamps.	**Unlikely** No suitable habitat was present.	**No**

SPECIES	STATUS	HABITAT DESCRIPTION AND LOCALLY KNOWN POPULATIONS	LIKELYHOOD OF OCCURRENCE WITHIN THE STUDY AREA	7-PART TEST REQUIRED
Heteroscelus brevipes Grey-tailed Tattler	EPBC-Migratory	Estuaries, tidal mudflats, mangroves, wave-washed rocks, and reefs; shallow river margins, coastal and inland.	**Unlikely** No suitable habitat was present.	**No**
Sterna albifrons Little Tern	TSC Act - E	Little Terns nest only on or near the coast in N.S.W. The typical features of the nesting area are a sandy substrate, flat or gently sloping topography, abundant shells and pebbles and little vegetation.	**Unlikely** No suitable habitat was present.	**No**
Sterna fuscata Sooty Tern	TSC Act-V	A pelagic species, does not nest in the area.	**Unlikely** No suitable habitat was present.	**No**
Actitis hypoleucos Common Sandpiper	EPBC-Migratory	Shallow pebbly, muddy or sandy edges of rivers and streams, coastal and inland; dams, lakes, sewage ponds, margins of tidal rivers, waterways in mangroves or saltmarsh; mudflats; rocky or sandy beaches.	**Unlikely** No suitable habitat was present.	**No**
Calidris acuminata Sharp-tailed Sandpiper	EPBC-Migratory	Tidal mudflats, saltmarshes, mangroves; shallow fresh, brackish or saline inland wetlands; sewage ponds and irrigated pastures.	**Unlikely** No suitable habitat was present.	**No**
Calidris canutus Red Knot	EPBC-Migratory	Tidal mudflats, sandflats, beaches, saltmarshes, flooded pastures, ploughed lands.	**Unlikely** No suitable habitat was present.	**No**
Calidris ferruginea Curlew Sandpiper	TSC Act-E EPBC-Migratory	Tidal mudflats; saltmarsh; fresh, brackish or saline wetlands; sewage ponds.	**Unlikely**	**No**

SPECIES	STATUS	HABITAT DESCRIPTION AND LOCALLY KNOWN POPULATIONS	LIKELYHOOD OF OCCURRENCE WITHIN THE STUDY AREA	7-PART TEST REQUIRED
			No suitable habitat was present.	
Calidris ruficollis Red-necked Stint	EPBC-Migratory	Tidal mudflats; saltmarsh; fresh, brackish or saline wetlands; sewage ponds.	**Unlikely** No suitable habitat was present.	**No**
Calidris tenuirostris Great Knot	TSC Act-V	Inhabits beaches, coastal mudflats, bay shores, estuarine environments; sometimes freshwater wetlands.	**Unlikely** No suitable habitat was present.	**No**
Tringa stagnatilis Marsh Sandpiper	EPBC-Migratory	Salt; fresh, brackish or saline wetlands; sewage ponds, mangroves, tidal flats and estuaries.	**Unlikely** No suitable habitat was present.	**No**
Numenius madagascariensis Eastern Curlew	EPBC-Migratory	Estuaries, tidal mudflats, sandspits, saltmarshes, mangroves; occasionally fresh or brackish lakes.	**Unlikely** No suitable habitat was present.	**No**
Numenius minutus Little Curlew	EPBC-Migratory	Dry grasslands, floodplains, margins of drying swamps; tidal mudflats, crops and sewage ponds.	**Unlikely** No suitable habitat was present.	**No**
Numenius phaeopus Whimbrel	EPBC-Migratory	Estuaries, tidal flats, coral cays, exposed reefs, flooded paddocks, sewage ponds and lawns.	**Unlikely** No suitable habitat was present.	**No**

SPECIES	STATUS	HABITAT DESCRIPTION AND LOCALLY KNOWN POPULATIONS	LIKELYHOOD OF OCCURRENCE WITHIN THE STUDY AREA	7-PART TEST REQUIRED
Charadrius bicinctus Double-banded Plover	EPBC-Migratory	Wide beaches, tidal mudflats, saltmarsh, sparsely vegetated margins of shallow saline and freshwater.	**Unlikely** No suitable habitat was present.	**No**
Charadrius leschenaultii Greater Sand-plover	TSC Act-V	Inhabits sheltered bays, harbours and estuaries with large intertidal sandflats mudflats or bare paddocks.	**Unlikely** No suitable habitat was present.	**No**
Charadrius mongolus Lesser Sand-plover	TSC Act-V	Inhabits sheltered bays, harbours and estuaries with large intertidal sandflats or mudflats.	**Unlikely** No suitable habitat was present.	**No**
Pluvialis fulva Pacific Golden Plover	EPBC-Migratory	Estuaries, tidal mudflats, saltmarshes, mangroves; rocky reefs, margins of shallow open inland swamps, sewage ponds.	**Unlikely** No suitable habitat was present.	**No**
Pluvialis squatarola Grey Plover	EPBC-Migratory	Mudflats, saltmarsh, tidal reefs and estuaries.	**Unlikely** No suitable habitat was present.	**No**
Diomedea antipodensis Antipodeam Albatross	TSC Act-V EPBC Act-V & M	Lives a pelagic life.	**Unlikely** No suitable habitat was present.	**No**
Diomedea gibsoni Gibson's Albatross	TSC Act-V	Lives a pelagic life.	**Unlikely**	**No**

SPECIES	STATUS	HABITAT DESCRIPTION AND LOCALLY KNOWN POPULATIONS	LIKELYHOOD OF OCCURRENCE WITHIN THE STUDY AREA	7-PART TEST REQUIRED
	EPBC Act-V & M		No suitable habitat was present.	
Thalassarche bulleri Buller's Albatross	EPBC Act-V EPBC Act-V & M	Lives a pelagic life.	**Unlikely** No suitable habitat was present.	**No**
Thalassarche cauta cauta Shy Albatross	TSC Act-V EPBC Act-V & M	Lives a pelagic life.	**Unlikely** No suitable habitat was present.	**No**
Thalassarche cauta salvini Salvin's Albatross	EPBC Act-V & M	Lives a pelagic life.	**Unlikely** No suitable habitat was present.	**No**
Thalassarche cauta steadi White-capped Albatross	TSC Act-V EPBC Act-V & M	Lives a pelagic life.	**Unlikely** No suitable habitat was present.	**No**
Thalassarche melanophris impavida Campbell Albatross	EPBC Act-V & M	Lives a pelagic life.	**Unlikely** No suitable habitat was present.	**No**
Haematopus fuliginosus Sooty Oystercatcher	TSC Act-V	Prefer rocky intertidal shorelines and sandy beaches.	**Unlikely**	**No**

SPECIES	STATUS	HABITAT DESCRIPTION AND LOCALLY KNOWN POPULATIONS	LIKELYHOOD OF OCCURRENCE WITHIN THE STUDY AREA	7-PART TEST REQUIRED
			No suitable habitat was present.	
Haematopus longirostris Pied Oystercatcher	TSC Act-E	Prefer rocky intertidal shorelines and sandy beaches.	**Unlikely** No suitable habitat was present.	**No**
Esacus neglectus Beach Stone-Curlew	TSC Act–E4A	Inhabits undisturbed sandy beaches, especially those with extensive mangrove-backed sandflats, mudflats or reefs exposed at low tide. It has also been recorded utilising cane fields that are located in proximity to tidal areas.	**Unlikely** No suitable habitat was present.	**No**
Gallinago hardwickii Latham's Snipe	EPBC Act-M	Utilises a variety of habitats, such as soft wet ground or shallow water with tussock and other green and dead vegetation, and scrub or open wetland from sea-level to alpine bogs (Pizzey & Knight, 2001).	**Low** Suitable habitat was present within areas of freshwater wetlands in the north of the study area.	**Yes**
Rostratula benghalensis australis Australian Painted Snipe	TSC Act-E EPBC Act-V & M	Margins of swamps and streams, chiefly those covered with low and stunted vegetation.	**Low** Suitable habitat was present within areas of freshwater wetlands in the north of the study area.	**Yes**
Botaurus poiciloptilus Australasian Bittern	TSC Act-E EPBC Act-E	Favours permanent fresh-waters dominated by sedges, rushes, reeds or cutting grasses (eg. Phragmites, Scirpus, Eleocharis, Juncus, Typha, Baumea and Gahnia).	**Low - Moderate** Suitable habitat was present within areas of	**Yes**

SPECIES	STATUS	HABITAT DESCRIPTION AND LOCALLY KNOWN POPULATIONS	LIKELYHOOD OF OCCURRENCE WITHIN THE STUDY AREA	7-PART TEST REQUIRED
			freshwater wetlands in the north of the study area.	
Ixobrychus flavicollis Black Bittern	TSC Act-V	Near water in mangroves and other trees, often forming only a narrow fringe of cover.	**Low** Suitable habitat was present around areas of freshwater wetlands in the east of the study area.	**Yes**
Ardea alba Great Egret	EPBC Act-M	Inhabits shallows of rivers, larger dams, freshwater wetlands and irrigation areas.	**Low - Moderate** Suitable habitat was present around areas of freshwater wetlands in the east of the study area.	**Yes**
Ardea ibis Cattle Egret	EPBC Act-M	Inhabits stock paddocks, pastures, croplands, wetlands and drains.	**High – Recorded within the study area.** Suitable habitat was present for this species within the area of pasture/Grassland in the north of the study area.	**No – Not listed under TSC Act. Assessed in Section 11.**
Ephippiorhynchus asiaticus Black-necked Stork	TSC Act-E	Inhabits swamps associated with river systems and large permanent pools but sometimes appears on the coast or in estuaries. It has also been recorded on farm dams and sewage treatment ponds.	**Unlikely** No habitat was considered to be present due to the	**No**

SPECIES	STATUS	HABITAT DESCRIPTION AND LOCALLY KNOWN POPULATIONS	LIKELYHOOD OF OCCURRENCE WITHIN THE STUDY AREA	7-PART TEST REQUIRED
			lack of larger areas of permanent waterbodies.	
Irediparra gallinacea Comb-crested Jacana	TSC Act-V	Inhabits mostly deep permanent freshwater wetlands, which are abundant with floating aquatic vegetation that forms dense mats or rafts on the surface of the water (eg. *Nymphaeaceae, Myriophyllum lacifolium, Marsilea* and *Riccia*).	**Unlikely** No habitat was considered to be present due to the lack of deep freshwater and floating aquatic vegetation.	**No**
Turnix maculosa Red-backed Button-quail	TSC Act-V	Grasses, sedges near water, grassy woodlands, rainforest edges; black soil plains, spinifex, cereal crops and gardens.	**Unlikely** Study area occurs below the known distribution of this species.	**No**
Burhinus grallarius Bush Stone-curlew	TSC Act-E	This species inhabits dry open forest and woodland with an open grassy understorey that has not been overgrazed. It prefers woodland with many fallen branches where it roosts during the day. It has also been known to utilise coastal scrub, mangrove fringes, golf courses and plantations. This species has been recorded within the adjoining property (Lot 3) to the east (NPWS, 2011).	**Low-moderate** Suitable habitat was present for this species within the more open areas of woodland.	**Yes**
Ptilinopus magnificus Wompoo Fruit-Dove	TSC Act-V	This frugivorous Rainforest specialist inhabits the canopy of Sub-tropical, Warm-temperate and Littoral Rainforests. Favoured feed trees include Figs, Laurels, Myrtles and native Tamarind. The females lay one egg on a flimsy platform of vine tendrils on a slender horizontal branch.	**Low** Areas of secondary habitat were present within the study area.	**Yes**

SPECIES	STATUS	HABITAT DESCRIPTION AND LOCALLY KNOWN POPULATIONS	LIKELYHOOD OF OCCURRENCE WITHIN THE STUDY AREA	7-PART TEST REQUIRED
Ptilinopus regina Rose Crowned Fruit-dove	TSC Act-V	Inhabits rainforest, though it also frequents nearby drier forests as well as mangroves. It usually feeds on Figs or other fruit and berry-bearing trees.	**Low** Areas of secondary habitat were present within the study area.	**Yes**
Ptilinopus superbus Superb Fruit Dove	TSC Act-V	Lives mainly in Rainforest but will feed in adjacent Mangroves or Eucalypt forest, venturing into coastal habitats. The nest is a platform built in a small tree on a horizontal fork situated in Open Forest at the edge of scrub.	**Low** Areas of secondary habitat were present within the study area.	**Yes**
Lathamus discolor Swift Parrot	TSC Act-E EPBC Act- Crit-E & M	Open Forest to Woodland, also street trees and in parks and gardens, winter flowering eucalypts for feeding. This species nests in Tasmania during the summer months.	**Low – Moderate** Suitable foraging habitat was present in the form of winter flowering species particularly *Eucalyptus robusta* (Swamp Mahogany).	**Yes**
Neophema pulchella Turquoise Parrot	TSC Act-V	Lives on the edges of Eucalypt woodland adjoining clearings and on timbered ridges and creeks in farmland. It has also been recorded utilising roadside verges and orchards. Nests in small hollow branches of Eucalypts.	**Low** Only marginal habitat was considered to be present within the study area. This parrot would be an infrequent visitor to the local area.	**Yes**

SPECIES	STATUS	HABITAT DESCRIPTION AND LOCALLY KNOWN POPULATIONS	LIKELYHOOD OF OCCURRENCE WITHIN THE STUDY AREA	7-PART TEST REQUIRED
Glossopsitta pusilla Little Lorikeet	TSC Act-V	Tall Open Forests, woodlands, orchards, parks and street trees.	**High – recorded on site.** Suitable foraging and nesting habitat was considered to be present over much of the study area.	**Yes**
Calyptorhynchus lathami Glossy Black-Cockatoo	TSC Act-V	Lowland coastal forests, dense mountain forests, semi-arid woodland and trees bordering watercourses, with (Allo)Casuarina trees for foraging.	**Low** Only marginal transitory habitat is present within the study area. A small number of *Casuarina glauca* (Swamp Oak) trees a suitable foraging species was present.	**Yes**
Callocephalon fimbriatum Gang-gang Cockatoo	TSC Act-V	Tall montane forests and woodlands in mature wet sclerophyll forests. Requires hollows in which to breed between October and January. This Cockatoo species would be an infrequent visitor to the local area.	**Low** Suitable foraging habitat was present. This species is unlikely to nest within the local area.	**Yes**
Apus pacificus Fork-tailed Swift	EPBC Act-M	Inhabits the airspace over open country from semi deserts to coasts.	**Moderate** Due to the non-specific habitat requirements habitat was present within	**No**

SPECIES	STATUS	HABITAT DESCRIPTION AND LOCALLY KNOWN POPULATIONS	LIKELYHOOD OF OCCURRENCE WITHIN THE STUDY AREA	7-PART TEST REQUIRED
			airspace above the study area.	
Hirundapus caudacutus White-throated Needletail	EPBC Act-M	Inhabits the airspace above forests, woodlands, farmlands, plains, lakes, coasts and towns.	**Moderate** Due to the non-specific habitat requirements habitat was present within airspace above the study area.	**No**
Monarcha melanopsis Black-faced Monarch	EPBC Act-M	Utilises a range of habitats including rainforests, eucalypt woodlands, coastal scrubs (Pizzey & Knight, 2001).	**Low-Moderate** Suitable habitat was present over the majority of the study area.	**No**
Monarcha trivirgatus Spectacled Monarch	EPBC Act-M	Wet forests, thickly wooded gullies, waterside vegetation and mangroves.	**Moderate** Suitable habitat was present within more thickly wooded parts of the study area.	**No**
Merops ornatus Rainbow Bee-eater	EPBC Act-M	Inhabits areas such as open woodlands with sandy soils, sand ridges, riverbanks, beaches, dunes, cliffs and rainforests.	**Low-Moderate** Suitable foraging habitat was present over the majority of the study area. No preferred nesting habitat was present.	**No**

SPECIES	STATUS	HABITAT DESCRIPTION AND LOCALLY KNOWN POPULATIONS	LIKELYHOOD OF OCCURRENCE WITHIN THE STUDY AREA	7-PART TEST REQUIRED
Rhipidura rufifrons Rufous Fantail	EPBC Act-M	Utilises a range of habitats including rainforests, wet sclerophyll forests, monsoon forests, scrubs, mangroves, watercourses, parks and gardens. During migration this species also utilises farms, street trees and buildings (Pizzey & Knight, 2001).	**High – recorded within study area.** Suitable foraging and nesting habitat was considered to be present.	**No**
Epthianura albifrons White-fronted Chat	TSC Act-V	Occurs mostly in the southern half of NSW, occurring in damp open habitats along the coast, and near waterways in the western part of the state	**Low** Marginal habitat was present within the north of the study area.	**Yes**
Petroica boodang Scarlet Robin	TSC Act-V	The Scarlet Robin breeds in drier eucalypt forests and temperate woodlands, often on ridges and slopes, within an open understorey of shrubs and grasses and sometimes in open areas. Abundant logs and coarse woody debris are important structural components of its habitat. In autumn and winter it migrates to more open habitats such as grassy open woodland or paddocks with scattered trees.	**Low** Only marginal habitat was considered to be present within areas of open forest. This species is more commonly found inland from the coast.	**Yes**
Petroica phoenicea Flame Robin	TSC Act-V	Breeds in upland tall moist eucalypt forests and woodlands, often on ridges and slopes and prefers clearings or areas with open understoreys. In winter, birds migrate to drier more open habitats in the lowlands including dry forests, open woodlands and in	**Low** Only marginal habitat was considered to be present within areas of open forest. This species is more	**Yes**

SPECIES	STATUS	HABITAT DESCRIPTION AND LOCALLY KNOWN POPULATIONS	LIKELYHOOD OF OCCURRENCE WITHIN THE STUDY AREA	7-PART TEST REQUIRED
		pastures and native grasslands, with or without scattered trees.	commonly found inland from the coast.	
Climacteris picumnus victoriae Brown Treecreeper	TSC Act-V	Occupies Eucalypt woodlands, particularly open woodlands lacking a dense understorey, River Red Gums on watercourses and around lakeshores. It is sedentary and nests in tree hollows within permanent territories.	**Unlikely** This Treecreeper species is more commonly found inland from the coast and would be unlikely to be present within the study area.	**No**
Anthochaera phrygia Regent Honeyeater	TSC Act-Crit-E EPBC Act- Crit-E & M	Temperate woodlands and open forest, including forest edges, preferring to forage on large-flowered Eucalypts. Was recorded in June 2014 feeding on flowering specimens of *Eucalyptus robusta* (Swamp Mahogany) at Tanilba Bay Sailing Club (Port Stephens Examiner, 2014).	**Low-Moderate** Suitable foraging habitat was present in the form of flowering myrtaceous species particularly the winter flowering *Eucalyptus robusta* (Swamp Mahogany).	**Yes**
Daphoenositta chrysoptera Varied Sittella	TSC Act-V	Open eucalypt woodland/forest, mallee, inland acacia, coastal tea-tree scrubs, golf courses, orchards and parks.	**High** Suitable foraging habitat and nesting habitat was present.	**Yes**

SPECIES	STATUS	HABITAT DESCRIPTION AND LOCALLY KNOWN POPULATIONS	LIKELYHOOD OF OCCURRENCE WITHIN THE STUDY AREA	7-PART TEST REQUIRED
Melithreptus gularis gularis Black-chinned Honeyeater	TSC Act-V	Usually found on the western side of the Great Dividing Range in dry sclerophyll forests and woodlands containing box-ironbark associations and River Red Gum. In the Hunter Valley this species is known to utilise drier coastal woodlands. Usually found in open woodlands.	**Low** Only marginal habitat was considered to be present for this woodland bird.	**Yes**
Pomatostomus temporalis temporalis Grey-crowned Babbler	TSC Act-V	Open forest, woodland, scrubland, farmland and outer suburbs. Prefers woodlands with regenerating trees, tall shrubs, and an intact ground cover of grass and forbs. One old record from 1978 exists within the Worimi Conservation Areas in the vicinity of Boyces Track.	**Low** Marginal habitat occurs within the cleared grassy area with scattered trees in the far north-east of the study area.	**Yes**
Dasyornis brachypterus Eastern Bristlebird	TSC Act-E EPBC Act-E	Habitat is characterised by dense, low vegetation including heath and open woodland with a heathy understorey; in northern NSW occurs in open forest with tussocky grass understorey.	**Unlikely** No known local records.	**No**
Circus assimilis	TSC Act-V	Occurs throughout the Australian mainland, except in densely forested or wooded habitats of the coast, escarpment and ranges. Occurs in grassy open	**Unlikely**	**No**

SPECIES	STATUS	HABITAT DESCRIPTION AND LOCALLY KNOWN POPULATIONS	LIKELYHOOD OF OCCURRENCE WITHIN THE STUDY AREA	7-PART TEST REQUIRED
Spotted Harrier		woodland including acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe. It is found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands.	This species is not usually associated with forested habitat of the coast.	
Pandion cristatus Eastern Osprey	TSC Act-V	Open and swamp forest adjacent to the coast or estuaries, fishing mainly in brackish or salt water. This species is known to inhabit the Port Stephens area.	**Low** Hunting habitat was absent. Large trees within the study area may provide suitable nesting habitat.	**Yes**
Lophoictinia isura Square-tailed Kite	TSC Act-V	The Square-tailed Kite inhabits Open Forests and Woodlands, particularly those on fertile soils with abundant passerines. They may also range into nearby open habitats but not into extensive treeless regions.	**Moderate** Due to the generalist habitat requirements of this species habitat was considered to be present.	**Yes**
Erythrotriorchis radiatus Red Goshawk	TSC Act-E4A EPBC Act - V	In NSW, preferred habitats include mixed subtropical rainforest, *Melaleuca* swamp forest and riparian *Eucalyptus* forest of coastal rivers.	**Low** Suitable habitat was present.	**Yes**
Hieraaetus morphnoides Little Eagle	TSC Act-V	The Little Eagle occupies habitats rich in prey within open eucalypt forest, woodland or open woodland. Sheoak or acacia woodlands and riparian woodlands of interior NSW are also used (Marchant and Higgins 1993; Aumann 2001a). For nest sites it requires a tall living tree within a remnant patch, where pairs build a large stick nest in winter and lay in early spring.	**Moderate** Due to the generalist requirements of this species habitat was considered to be present within the site.	**Yes**

SPECIES	STATUS	HABITAT DESCRIPTION AND LOCALLY KNOWN POPULATIONS	LIKELYHOOD OF OCCURRENCE WITHIN THE STUDY AREA	7-PART TEST REQUIRED
Haliaeetus leucogaster White-bellied Sea Eagle	TSC Act-V EPBC Act-M	Occupies habitat characterised by the presence of large areas of open water and feeds opportunistically on a variety of fish, birds, reptiles, mammals and crustaceans. The nests are built in a variety of sites including tall trees, bushes, mangroves, cliffs, rocky outcrops, caves, crevices, on the ground or even in artificial structures.	**High – Recorded flying over study area.** Nesting habitat was present. No preferred hunting habitat was present.	**Yes**
Ninox connivens Barking Owl	TSC Act-V	This species is found in forest and woodland, encountered most commonly in savanna and paperbark woodlands. It sometimes roosts in rainforests, but it requires the more open country for hunting and hollow Eucalypts for breeding.	**Moderate** Suitable hunting and limited roosting habitat was present within the study area.	**Yes**
Ninox strenua Powerful Owl	TSC Act-V	Inhabits a wide range of vegetation types from wet Eucalypt forests with a Rainforest understorey to Dry Open Forests and Woodlands. The species has been recorded utilising disturbed habitats such as exotic pine plantations and large trees in parks and gardens. Powerful Owls nest in a slight depression in the wood-mould on the base of a cavity in a large old tree, sometimes in excess of 25 metres above the ground.	**High – Likely pellet found within the study area.** Suitable hunting, roosting and nesting habitat was present.	**Yes**
Tyto longimembris Eastern Grass Owl	TSC Act-V	This species roost and nest on the ground, in crops or in thick grass tussock often associated with swamps.	**Low** Marginal hunting and roosting habitat was present in the north of the study area.	**Yes**

SPECIES	STATUS	HABITAT DESCRIPTION AND LOCALLY KNOWN POPULATIONS	LIKELYHOOD OF OCCURRENCE WITHIN THE STUDY AREA	7-PART TEST REQUIRED
Tyto novaehollandiae Masked Owl	TSC Act-V	A range of wooded habitats that contain mature trees with large hollows for roosting and nesting, and more open areas for hunting.	**Moderate-High** Suitable hunting, roosting and nesting habitat was present.	**Yes**
Tyto tenebricosa Sooty Owl	TSC Act-V	Prefers dense dimly-lit forests, inhabiting pockets of rainforest and wet sclerophyll forest mainly in mountainous areas, often in south-east facing gullies.	**Unlikely** Due to the lack of rainforest and tall wet sclerophyll forest the Sooty Owl would be considered unlikely to be present.	**No**
Planigale maculata Common Planigale	TSC Act-V	In NSW it is found along the coastal strip, occupying a variety of habitats ranging from rainforest, wet and dry sclerophyll forests to grasslands, marshlands and rocky areas.	**Low** Suitable habitat was present within the study area. Few records for this species are known from the locality.	**Yes**
Dasyurus maculatus maculatus Tiger Quoll	TSC Act-V	Inhabits sclerophyll forests, rainforests and coastal woodlands. Nests are made in rock caves and hollow logs or trees, and basking sites are usually found nearby.	**Moderate - High** Suitable habitat was present over a large portion of the study area.	**Yes**
Phascogale tapoatafa Brush-tailed Phascogale	TSC Act-V	Sparsely distributed outside the semi-arid zone in dry sclerophyll forest and monsoonal forest and woodland.	**Low** Foraging and nesting habitat was present over	**Yes**

SPECIES	STATUS	HABITAT DESCRIPTION AND LOCALLY KNOWN POPULATIONS	LIKELYHOOD OF OCCURRENCE WITHIN THE STUDY AREA	7-PART TEST REQUIRED
			much of the study area. Locally this species prefers rough barked (Woodland containing Ironbark species).	
Phascolarctos cinereus Koala	TSC Act-V EPBC Act – V (NSW & Qld)	Coastal woodland and open forest containing suitable food trees.	**High – Some evidence of Koala activity.** Preferred feed tree, *Eucalyptus robusta* (Swamp Mahogany) was present within the north of the study area.	**Yes**
Macropus parma Parma Wallaby	TSC Act-V	Preferred habitat is moist eucalypt forest with thick, shrubby understorey, often with nearby grassy areas, rainforest margins and occasionally drier eucalypt forest.	**Unlikely** Suitable habitat was considered to be present, however due to the lack of local records this species would be unlikely to be present.	**No**
Petrogale penicillata Brush-tailed Rock-wallaby	TSC Act – E1 EPBC Act – E	Found in steep rocky sites in sclerophyll forests with a grassy understorey.	**Unlikely** No suitable habitat was present.	**No**
Aepyprymnus rufescens	TSC Act-V	Occupies a variety of habitats ranging from coastal Eucalypt forests to tall Wet Sclerophyll Forests along the	**Low**	**Yes**

SPECIES	STATUS	HABITAT DESCRIPTION AND LOCALLY KNOWN POPULATIONS	LIKELYHOOD OF OCCURRENCE WITHIN THE STUDY AREA	7-PART TEST REQUIRED
Rufous Bettong		east coast of Australia. West of the Great Dividing Range it occupies Low Open Woodland. It tends to favour those areas where there is a sparse or grassy understorey.	Suitable habitat was considered to be present. Due to the absence of local records the occurrence of this species would be low.	
Potorous tridactylus tridactylus Long-nosed Potoroo	TSC Act-V	This species is known from a variety of habitats, including Rainforest, Open Forests and Woodlands with dense groundcover, and dense, wet coastal heathlands. Soft (often sandy) substrates are preferred by this species.	**Low - Moderate** Suitable habitat was available within the study area. Records known from Williamtown (RPS Harper Somers O'Sullivan, 2009).	**Yes**
Cercartetus nanus Eastern Pygmy-possum	TSC Act-V	Feeds mostly on the pollen and nectar from banksias, eucalypts and understorey plants and will also eat insects, seeds and fruit. Hollow bearing trees are favoured for shelter and nesting although spherical nests constructed of short shredded bark have been found between the wood and bark of eucalypts. This species has been recorded north of Fern Bay within Coastal Sand Blackbutt Forest (Umwelt, 2004).	**Low - Moderate** Foraging and nesting habitat was present.	**Yes**

SPECIES	STATUS	HABITAT DESCRIPTION AND LOCALLY KNOWN POPULATIONS	LIKELYHOOD OF OCCURRENCE WITHIN THE STUDY AREA	7-PART TEST REQUIRED
Petaurus australis Yellow-Bellied Glider	TSC Act-V	This species occupies tall, mature wet eucalypt forest.	**Low** Foraging and nesting habitat was present. No known local records.	**Yes**
Petaurus norfolcensis Squirrel Glider	TSC Act-V	Dry sclerophyll forests and woodlands with exudates for foraging and hollows for nesting.	**High – Recorded within Study Area.** Foraging and nesting habitat was present over a large portion of the study area.	**Yes**
Pseudomys gracilicaudatus Eastern Chestnut Mouse	TSC Act-V	Found in heathland, wet heathland and swamps.	**Low** Only marginal habitat was present. No known local records.	**Yes**
Psuedomys novaehollandiae New Holland Mouse	EPBC Act – E	Known to inhabit open heathlands, open woodlands with a heathland understorey and vegetated sand dunes.	**Moderate - High** Suitable habitat was present within the more open sandy vegetated parts of the study area.	**No – Not listed under TSC Act. Assessed in Section 11.**
Pteropus poliocephalus Grey-headed Flying-Fox	TSC Act-V EPBC Act-V	Wet and Dry Sclerophyll Forests, Rainforest, Mangroves and Paperbark swamps and Banksia Woodlands.	**High – Recorded within study area.** Seasonal foraging habitat was present over the	**Yes**

SPECIES	STATUS	HABITAT DESCRIPTION AND LOCALLY KNOWN POPULATIONS	LIKELYHOOD OF OCCURRENCE WITHIN THE STUDY AREA	7-PART TEST REQUIRED
			majority of the study area. Roosting habitat was also likely to be present.	
Syconycteris australis Common Blossom-bat	TSC Act-V	Occurs within coastal areas of northeast NSW and eastern Queensland. Often roost in littoral rainforest and feed on flowers in adjacent heathland and paperbark swamps. Has been recorded just north of Hawks Nest (Wildthing Environmental Consultants, 2012).	**Low** Suitable habitat was present within the study area. The study area would be considered to be outside the southern limit of the distribution of this species.	**Yes**
Kerivoula papuensis Golden-tipped Bat	TSC Act-V	Found in rainforest and adjacent wet and dry sclerophyll forest up to 1000m. It is also recorded in tall open forest. This species roosts mainly in abandoned hanging Yellow-throated Scrubwren and Brown Gerygone nests, also in tree hollows, dense foliage and epiphytes; located in rainforest gullies on small first and second-order streams. There is a paucity of local record of this species.	**Low** Suitable hunting and roosting habitat was present.	**Yes**
Saccolaimus flaviventris Yellow-bellied Sheathtail-bat	TSC Act-V	This microchiropteran bat species occupies a range of habitats including eucalypt forests, Mallee or open country. Roosts in tree hollows, animal burrows, dry clay cracks, under rock slabs and in abandoned Sugar Glider nests.	**Moderate** Suitable hunting and roosting habitat was present.	**Yes**

SPECIES	STATUS	HABITAT DESCRIPTION AND LOCALLY KNOWN POPULATIONS	LIKELYHOOD OF OCCURRENCE WITHIN THE STUDY AREA	7-PART TEST REQUIRED
Mormopterus norfolkensis East Coast Freetail-bat	TSC Act-V	This species appears to live in Sclerophyll Forests and Woodland. Roosts in tree hollows or under loose bark.	**High** Suitable hunting and roosting habitat was present.	**Yes**
Falsistrellus tasmaniensis Eastern False Pipistrelle	TSC Act-V	Inhabits sclerophyll forests from the Great Divide to the east coast. A preference has been noted for wet habitats where trees are more than 20m high. It has been observed roosting in holes and hollow trunks of Eucalypts.	**High – Recorded within the study area.** Suitable hunting and roosting habitat was present.	**Yes**
Miniopterus australis Little Bentwing-bat	TSC Act-V	Tropical Rainforest to warm-temperate Wet and Dry Sclerophyll Forest; caves or similar structures for roosting.	**High – recorded within the study area.** Suitable hunting habitat was present. The study area lacked preferred roosting habitat.	**Yes**
Miniopterus schreibersii oceanensis Large Bentwing-bat	TSC Act-V	Wet and Dry Tall Open Forest, Rainforest, Monsoon Forest, Open Woodland, Paperbark Forests and Open Grasslands; caves or similar structures for roosting. It occasionally uses tree hollows.	**High – recorded within the study area.** Suitable hunting habitat was present. No preferred roosting habitat was present.	**Yes**

SPECIES	STATUS	HABITAT DESCRIPTION AND LOCALLY KNOWN POPULATIONS	LIKELYHOOD OF OCCURRENCE WITHIN THE STUDY AREA	7-PART TEST REQUIRED
Myotis macropus Eastern Myotis	TSC Act-V	Various habitats of the coast and adjacent ranges with suitable waterbodies for hunting; caves or similar structures for roosting. It occasionally uses tree hollows.	**Moderate** Suitable hunting habitat was present on site.	**Yes**
Scoteanax rueppellii Greater Broad-nosed Bat	TSC Act-V	Tree-lined creeks, woodland/clearing ecotones and rainforest creeks, roosting mainly in tree hollows.	**High – Possible calls recorded during bat call survey.** Suitable hunting and roosting habitat was present.	**Yes**
Chalinolobus dwyeri Large-eared Pied Bat	TSC Act-V	This species has been found occupying Dry Sclerophyll Forest and Woodland. Roosts in caves, abandoned mud-nests of Fairy Martins and mine tunnels.	**Low** Suitable hunting habitat was present. No roosting habitat was available.	**Yes**
Vespadelus troughtoni Eastern Cave Bat	TSC Act-V	The Eastern Cave Bat roosts in caves and occurs in wet/dry sclerophyll forests to the semi-arid zone. It has been found roosting in small groups in sandstone overhangs, in mine tunnels and occasionally buildings.	**Low** Suitable hunting habitat was present. No roosting habitat was available.	**Yes**
Emu population in the NSW North Coast Bioregion and Port Stephens LGA.		Predominantly open habitats, including plains, grasslands, woodlands and scrubs, and may occur occasionally in forest.	**Low** Suitable habitat was present. Few local records.	**Yes**

14.14 FAUNA APPRAISAL RESULTS

A full list of fauna species observed during the survey is contained in Appendix D.

Small Terrestrial Mammal Trapping

During this component of the survey four species of mammal, *Antechinus stuartii* (Brown Antechinus), *Rattus lutreolus* (Swamp Rat), *Rattus rattus* (Black Rat) and *Mus musculus* (House Mouse) were captured. Both *R. rattus* and *M. musculus* are introduced species. No specimens of the expected native *Rattus fuscipes* (Bush Rat) were captured during either trapping period. Specimens of *R. fuscipes* were captured in 2017 during a fauna survey with the adjoining Lot 255 (Wildthing Environmental Consultants, 2017). The results of the small terrestrial mammal survey are shown in Table 14.11.

Table 14.11 - Small Terrestrial Mammal Trapping Results.

DATE	TRAP NO	SPECIES	SEX
Trapping period 15 – 19 April 2013			
Tuesday	T7	*Antechinus stuartii* (Brown Antechinus)	Male
16/04/13	T14	*A. stuartii*	Male
	T15	*A. stuartii*	Male
Wednesday	T7	*A. stuartii*	Male
17/04/13	T9	*A. stuartii*	Male
	T11	*A. stuartii*	Male
	T12	*A. stuartii*	Female
	T14	*A. stuartii*	Male
	T28	*A. stuartii*	Male
	T32	*A. stuartii*	Male
Thursday	T2	*A. stuartii*	Male
18/04/13	T11	*A. stuartii*	Female
	T23	*A. stuartii*	Female
	T25	*A. stuartii*	Male
	T29	*A. stuartii*	Female
	T33	*A. stuartii*	Male
	T35	*A. stuartii*	Male
Friday	T1	*A. stuartii*	Female
19/04/13	T3	*A. stuartii*	Male

DATE	TRAP NO	SPECIES	SEX
	T9	*A. stuartii*	Male
	T25	*A. stuartii*	Male
	T29	*A. stuartii*	Male
	T33	*A. stuartii*	Male
Trapping period 26 – 30 May 2014			
Tuesday	T13	*A. stuartii*	Female
27/05/14	T21	*A. stuartii*	Male
	T23	*A. stuartii*	Female
	T29	*A. stuartii*	Male
	T33	*A. stuartii*	Male
	T37	*A. stuartii*	Male
Wednesday	T19	*A. stuartii*	Female
28/05/14	T23	*A. stuartii*	Male
	T24	*A. stuartii*	Female
	T35	*A. stuartii*	Male
	T40	*Rattus lutreolus* (Swamp Rat)	Male
	T42	*A. stuartii*	Male
Thursday	T37	*A. stuartii*	Male
29/05/14	T39	*Rattus rattus* (Black Rat)	Male
	T48	*A. stuartii*	Male
	T50	*A. stuartii*	Male
		Mus musculus (House Mouse)	
Friday	T11	*A. stuartii*	Female
30/05/14	T12	*A. stuartii*	Male
	T14	*A. stuartii*	Female
	T24	*A. stuartii*	Female
	T26	*A. stuartii*	Male
	T29	*A. stuartii*	Female
	T37	*R. rattus*	Male

DATE	TRAP NO	SPECIES	SEX
	T39	*A. stuartii*	Male
	T41	*M. musculus*	Male
	T42	*A. stuartii*	Male
	T50	*A. stuartii*	Male

Medium Terrestrial Mammal Trapping

During this component of the survey no fauna species were captured. A small number of cages had been disturbed. The disturbance would likely be attributed to the European Red Fox, Feral Dogs or the Common Brushtail Possum.

Arboreal Mammal Trapping

During this component of the survey two species of mammal *Petaurus norfolcensis* (Squirrel Glider) and *Antechinus stuartii* (Brown Antechinus) were captured. *Petaurus norfolcensis* is listed as vulnerable under the TSC Act (1995) and has been further assessed within Section 7 and Appendix E of this report. The results of the arboreal mammal trapping survey are shown in Table 14.12. The locations of the trapped Squirrel Gliders are shown in Figure 14.16.

Table 14.12 - Arboreal Mammal Trapping Results.

DATE	TRAP NO	SPECIES	SEX
Trapping period 15 – 19 April 2013			
Tuesday 16/04/13		No captures	
Wednesday 17/04/13	A7	*Antechinus stuartii* (Brown Antechinus)	Female
Thursday 18/04/13	A10	*A. stuartii*	Male
Friday 19/04/13		*A. stuartii*	Male
Trapping period 26 – 30 May 2014			
Tuesday 27/05/14	A2	*Petaurus norfolcensis* (Squirrel Glider)	Male
Wednesday 28/05/14	A4	*P. norfolcensis*	Male
Thursday 29/05/14	A2	*P. norfolcensis* *P. norfolcensis*	Male Male
Friday 30/05/14		No captures	

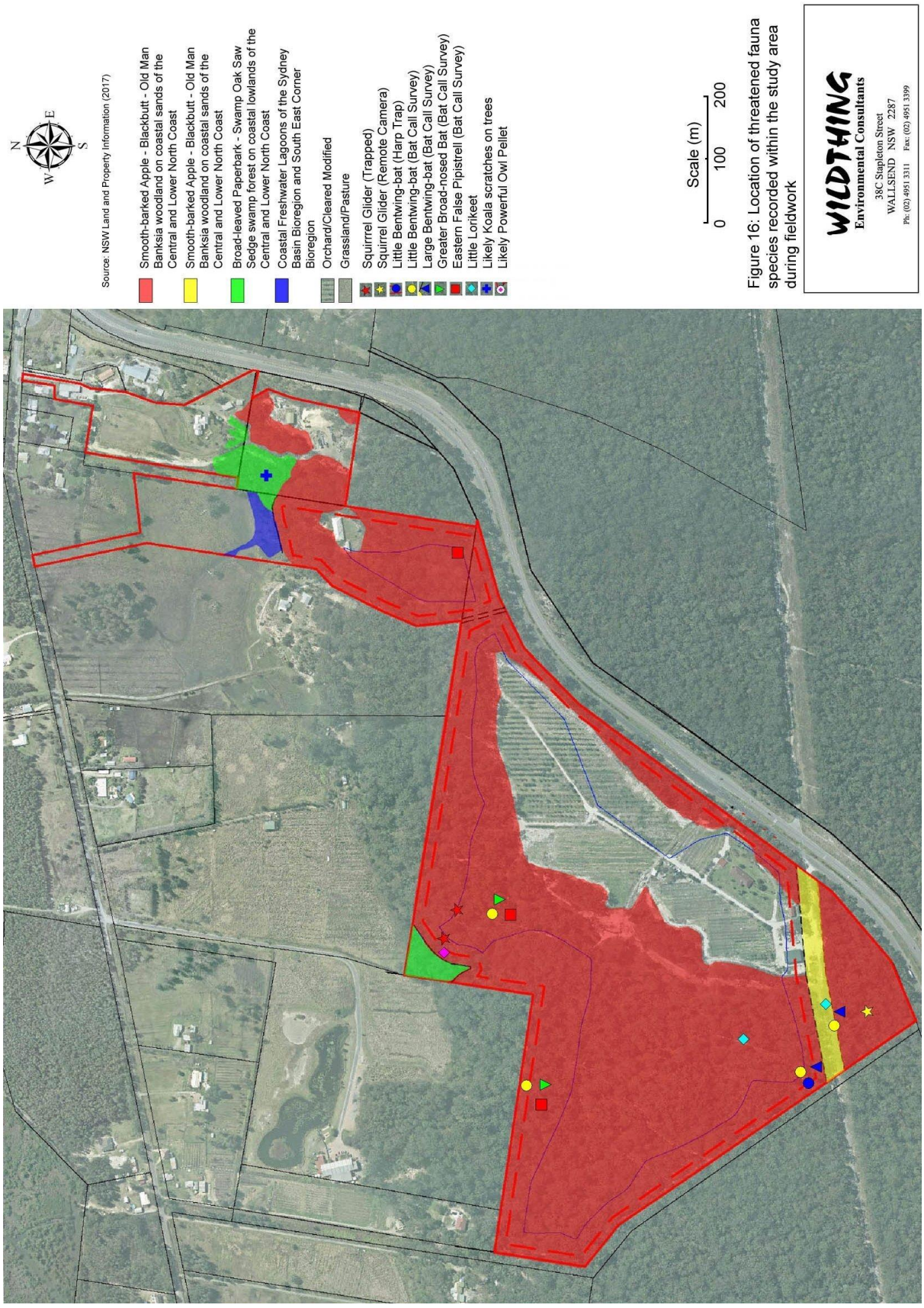


Figure 14-16 - Location of Recorded Threatened Fauna

Harp Trapping

During the harp trapping component of the survey two species of microchiropteran bat; *Vespadelus vulturnus* (Little Forest Bat) and *Miniopterus australis* (Little Bentwing-bat) were captured. *Miniopterus australis* is listed as a Vulnerable species under the TSC Act 1995 and has been further assessed in Section 14.7.0 and Appendix E. The results of the harp trapping survey are shown in Table 14.13. The location of this threatened microchiropteran bat species is shown in Figure 14.16.

Table 14.13 - Harp Trapping Results.

DATE	TRAP NO.	SPECIES	SEX
21/05/13	Trap 1	No captures	
	Trap 2	No captures	
13/11/13	Trap 1	No captures	
	Trap 2	No captures	
29/04/14	Trap 1	No captures	
	Trap 2	No captures	
27/11/14	Trap 1	No captures	
	Trap 2	*Vespadelus vulturnus* (Little Forest Bat) *V. vulturnus* *Miniopterus australis* (Little Bentwing-bat)	Female Male Female
22/01/15	Trap 1	No captures	
	Trap 2	No captures	

Microchiropteran Bat Call Detection

Seven species of microchiropteran bat, *Chalinolobus gouldii* (Gould's Wattled Bat), *Chalinolobus morio* (Chocolate Wattled Bat), *Miniopterus australis* (Little Bentwing-bat), *Miniopterus schreibersii oceanensis* (Large Bentwing-bat), *Mormopterus* sp. 2, *Austronomus australis* (White-striped Freetail Bat) and *Falsistrellus tasmaniensis* (Eastern Falsistrelle) were positively identified during the bat call survey. Probable calls from *Miniopterus schreibersii*

oceanensis and possible calls from *Scoteanax rueppellii* (Greater Broad-nosed Bat) were also identified.

A number of calls attributed to the Genus *Nyctophilus* were likely to be either *N. geoffroyi* (Lesser Long-eared Bat) or *N. gouldi* (Gould's Long-eared Bat). One species, *Nyctophilus gouldii* (Gould's Long-eared Bat) was found dead within the brick building in Lot 10 during a previous survey (Wildthing Environmental Consultants, 2008). Calls attributed to the Genus Vespadelus were probably *Vespadelus vulturnus* (Little Forest Bat) which was captured during the trapping survey.

Four of these microchiropteran bat species; *F. tasmaniensis, M. australis, M. schreibersii oceanensis* and *S. rueppellii* are listed as vulnerable under the TSC Act (1995) and have been further assessed within Section 7.0 and Appendix E of this report. The results of the Bat Call Surveys survey are shown in Table 14.14. The locations of these threatened microchiropteran bat species are shown in Figure 14.16.

Table 14.14 - Microchiropteran Bat Call Survey Results.

SPECIES	NUMBER OF CALLS		
	Definite	Probable	Possible
21/05/13 E - 406343, N - 6372986			
Chalinolobus gouldii		2	
Miniopterus schreibersii oceanensis		2	
Austronomus australis	2	1	
Miniopterus australis	1	3	
Nyctophilus sp.	4	2	
Vespadelus sp.	13	11	71
Noise	36		

SPECIES	NUMBER OF CALLS		
	Definite	**Probable**	**Possible**
Unidentifiable	4		
30/05/13 E – 407298, N - 6373820			
Chalinolobus morio	6	4	
Chalinolobus gouldii	1		2
Vespadelus sp.		2	1
Nyctophilus sp.		1	
Unidentifiable	4		
Blank	1		
Noise	3		
03/09/13 E – 406600, N - 6373460			
Chalinolobus gouldii	128	12	9
Vespadelus sp.		2	
Falsistrellus tasmaniensis	10	5	

SPECIES	NUMBER OF CALLS		
	Definite	**Probable**	**Possible**
Scoteanax rueppellii			2
Nyctophilus sp.		2	
Miniopterus australis	3		
Blank	1		
Noise	7		
13/11/13 E – 406330, N - 6373409			
Falsistrellus tasmaniensis	23	14	4
Vespadelus sp.	31	16	3
Chalinolobus gouldii	14	12	1
Chalinolobus morio		5	1
Mormopterus sp. 2		5	3
Scoteanax rueppellii			1
Miniopterus australis	1		
Unidentifiable	6		

SPECIES	NUMBER OF CALLS		
	Definite	Probable	Possible
Noise	7		
29/04/14 E – 406498, N - 6373149			
Vespadelus sp.	4	8	2
Mormopterus sp. 2	1	2	
Chalinolobus gouldii	2	1	
Noise	11		
27/11/14 E – 406438, N - 6372935			
Chalinolobus gouldii	32	7	5
Miniopterus australis	4		
Miniopterus schreibersii oceanensis	1		
Nyctophilus sp.	3		
Vespadelus sp.	10	2	
Chalinolobus morio	2	2	
Unidentifiable	12		
Noise	41		

SPECIES	NUMBER OF CALLS		
	Definite	Probable	Possible
Blank	6		
22/01/15 E – 407135, N - 6373514			
Chalinolobus gouldii	22	3	
Nyctophilus sp.	4		
Vespadelus sp.	47	15	
Chalinolobus morio	3	3	
Falsistrellus tasmaniensis	2		
Unidentifiable	10		
Noise	20		
Blank	1		

Amphibian Survey

Eight species of amphibian, *Pseudophryne bibroni* (Brown Toadlet), *Crinia signifera* (Common Eastern Froglet), *Limnodynastes peronii* (Striped Marsh Frog), *Litoria fallax* (Dwarf Green Tree Frog), *Litoria peronii* (Peron's Tree Frog), *Litoria jervisiensis* (Jervis Bay Tree Frog), *Litoria tyleri* (Tyler's Tree Frog) and *Paracrinia haswelli* (Haswell's Froglet) were recorded during targeted and incidental surveys.

None of these amphibian species are regarded as threatened according to State or National legislation.

No specimens of *Uperoleia mahonyi* (Mahony's Toadlet) were recorded within the study area during targeted surveys undertaken by Dr Simon Clulow on the evenings of 7 & 9 November 2017. The surveys were conducted following rain, within areas of Freshwater Wetland and

Swamp Sclerophyll Forest in the north-east of the site, which were considered to be the most likely habitat for *U. mahonyi*. Rain was also recorded later in the evening on 7 November 2017. A visit to the reference site at Oyster Cove (type locality for *U. mahonyi*) on 7 November 2017 found no specimens of *U. mahonyi* to be calling. As a result, the second survey was conducted on the 9 November 2017 to possibly increase the chances of recording the species. A visit to the reference site at Oyster Cove on 9 November 2017 found 3-4 specimens of *U. mahonyi* to be calling intermittently. Other amphibian species recorded within the site by Dr Simon Clulow were *Limnodynastes peronii*, *C. signifera* and *L. fallax*.

Reptile Survey

Thirteen species of reptile were identified within the study area during targeted and incidental surveys: *Dendralaphis punctulata* (Green Tree Snake), *Morelia spilota spilota* (Diamond Python), *Cryptophis nigrescens* (Small-eyed Snake), *Varanus varius* (Lace Monitor), *Lampropholis delicata* (Grass Skink), *Ctenotus robustus* (Striped Skink), *Ctenotus taeniolatus* (Copper-tailed Skink), *Anomalopus swansoni* (Swanson's Legless Lizard), *Saiphos equalis* (Three-toed Skink), *Bellatorias major* (Land Mullet), *Eulamphrus tenuis* (Bar-sided Skink), *Amphibolurus muricatus* (Jacky Lizard) and *Pogona barbata* (Bearded Dragon). One specimen of *M. spilota spilota* was observed basking in the sun on a cold morning in the far north of the study area. One specimen of *C. nigrescens* was found under a log. *Varanus varius* was commonly encountered during fieldwork and was captured on the remote camera on many occasions. Large scratches on the trunks of trees would be largely attributed to *V. varius*. *Anomalopus swansoni* was found to be a relatively common burrowing reptile within the top layer of sandy soil within dry areas of sclerophyll forest. Two trapped specimens of *B. major* were rescued from an old brick structure in the far east of the site. A number of specimens of *Eulamphrus tenuis* were observed on the trunks of trees containing hollows and crevices. Two forms of *C. robustus* have been recorded within the study area, the typical striped patterned form and an atypical unmarked form. The unmarked form of *C. robustus* was recorded during the previous survey of Lot 10 (Wildthing Environmental Consultants, 2009).

Other common reptile species that would likely utilise the study area are *Pseudechis porphyriacus* (Red-bellied Black Snake) and *Tiliqua scincoides scincoides* (Eastern Blue-tongued Lizard). One deceased specimen of *T. scincoides scincoides* was found on the side of Nelson Bay Road adjacent to the study area.

None of these reptile species are regarded as threatened according to State or National legislation.

Diurnal Avifauna Survey

An array of avifauna species was found to be present within the various habitats across study area.

Within the Open Forest areas avifauna species commonly encountered included *Rhipidura fuliginosa* (Grey Fantail), *Malurus cyaneus* (Superb Fairy-wren), *Cracticus torquatus* (Grey Butcherbird), *Cormobates leucophaea* (White-throated Treecreeper), *Lichenostomus chrysops* (Yellow-faced Honeyeater), *Philemon corniculatus* (Noisy Miner), *Philemon corniculatus* (Noisy Friarbird), *Platycercus eximius* (Eastern Rosella) and *Todiramphus sancta* (Sacred Kingfisher).

Avifauna species commonly encountered within the more sheltered gullies and areas of swamp forest included *Meliphaga lewinii* (Lewin's Honeyeater), *Acanthiza pusilla* (Brown Thornbill) and *Columba leucomela* (White-headed Pigeon).

Common species observed within the open pasture/grassland areas in the north of the study area included *Ardea ibis* (Cattle Egret), *Egretta novaehollandiae* (White-faced Heron) and *Threskiornis spinicollis* (Straw-necked Ibis).

Birds of prey recorded included *Haliastur sphenurus* (Whistling Kite), *Accipiter novaehollandiae* (Grey Goshawk), *Haliaeetus leucogaster* (White-breasted Sea-Eagle), *Falco cenchroides* (Australian Kestrel) and *Aquila audax* (Wedge-tailed Eagle). An immature *H. sphenurus* was recorded on a remote camera on a number of occasions.

Glossopsitta pusilla (Little Lorikeet) listed as vulnerable under the TSC Act (1995) was observed on two occasions within open forest within the south of the study area. The recently listed *Haliaeetus leucogaster* (White-bellied Sea-eagle) was also observed flying over the study area on a number of occasions. These threatened species have been further assessed within Section 7 and Appendix E of this report. The location of the Little Lorikeet within the study area is shown in Figure 14.13.

Rhipidura rufifrons (Rufus Fantail), *Haliaeetus leucogaster* (White-bellied Sea-eagle) and *A. ibis* are recognised as Migratory Bird species under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) and have been further addressed in Section 14.11 of this report.

All birds observed within the study area during this and the previous surveys are indicated in the Total Fauna Species List contained in Annex N.

Nocturnal Avifauna Survey

Ninox boobook (Southern Boobook) was commonly heard calling during nocturnal surveys. *Podargus strigoides* (Tawny Frogmouth) was also observed and heard calling from within the site. *Podargus strigoides* was recorded within the site during a previous survey (Wildthing Environmental Consultants, 2002). There were no responses as a result of the owl calls played during the survey.

Spotlighting Survey

Four species of native mammal *Trichosurus vulpecula* (Common Brushtail Possum), *Wallabia bicolor* (Swamp Wallaby), *Acrobates pygmaeus* (Feathertail Glider) and *Pteropus poliocephalus* (Grey-headed Flying-fox) were observed within the site during the spotlighting surveys. *Trichosurus vulpecula* was found to be very common over the majority of the site. Large numbers of *P. poliocephalus* were observed to be foraging within the site during January and February 2015 when the dominant canopy species *Eucalyptus pilularis* (Blackbutt) was flowering. These Megachiropteran bats were observed to be originating from a relatively large temporary camp approximately 2km east of the study area within a heavily vegetated area near the intersection of Cromarty and Upton Lanes.

There were no responses as a result of the mammal calls played during the survey.

The Grey-headed Flying-fox is listed as 'Vulnerable' under both state and national legislation and has been further addressed in Sections 14.7, 14.11 and Annex N.

Stagwatching Survey

A number of specimens of *Trichosurus vulpecula* were observed during the stag watching survey.

Predator Scat and Owl Pellet Analysis

A small number of predator scats and owl pellets were found within the study area during the survey period. The scats were collected and sent to Barbara Triggs, an expert in the analysis of scats and their contents. The scats were found to be from a *Vulpes vulpes* (European Red Fox) and a *Canis lupus familiaris* (Wild Dog) and contained *Trichosurus vulpecula* (Common Brushtail Possum) and *Rattus lutreolus* (Swamp Rat) fur. The Owl pellets contained the remains of *R. lutreolus* and *T. vulpecula*. The state of the bone fragments containing the remains of *T. vulpecula* were indicative of a pellet likely belonging to the threatened *Ninox strenua* (Powerful Owl). The results of the predator scat and owl pellet analysis are shown in Table 14.15.

Table 14.15 - Result of the predator scat and owl pellet analysis.

Sample No.	Date	Location	Sample	Mammal ID (definite)	Mammal ID (probable)
1	13/11/2013	E-406530; N-6373530	old owl pellet	*Trichosurus vulpecula* (Brushtail Possum) Powerful Owl pellet?	
2	21/08/2013	E-406790; N-6373530	old owl pellet	*Rattus lutreolus* (Swamp Rat)	
3	21/08/2013	E-406290; N-6373310	Fox scat	*R. lutreolus*	
4	10/02/2015	E-406359; N-6372933	Dog Scat	*Wallabia bicolor* (Swamp Wallaby)	
5	02/06/15	E-406359; N-6372933	Old Scat	*Trichosurus vulpecula* (Brushtail Possum)	*Trichosurus vulpecula* (Brushtail Possum)

Sample No.	Date	Location	Sample	Mammal ID (definite)	Mammal ID (probable)
6	29/07/2015	E-406403; N-6373132	Dog? (old scat)	No hairs found	*Felis catus* (claw)

Remote Camera

A total of fourteen fauna species were positively identified within the study area during the remote camera survey conducted between July 2013 and June 2015. The most common fauna species were *Varanus varius* (Lace Monitor), *Antechinus stuartii* (Brown Antechinus), *Trichosurus vulpecula* (Common Brushtail Possum) and *Wallabia bicolor* (Swamp Wallaby). One specimen of the threatened *Petaurus norfolcensis* (Squirrel Glider) was recorded on the ground in the far west of the study area (Figure 14.15). Introduced species recorded were *Felis catus* (Feral Cat), *Vulpes vulpes* (European Red Fox), *Canis lupus familiaris* (Wild Dog) and *Lepus capensis* (European Hare). Predation by Feral Dogs and Cats and the European Red Fox is recognised as 'key threatening processes' under the TSC Act 1995. The results of the remote camera survey are shown in Table 14.16.

Incidential Observations and Secondary Indications

A number of incidental observations and secondary indications of fauna were observed during the survey and included:

- A large number of small conical diggings attributed to Bandicoot species *Perameles nasuta* (Long-nosed Bandicoot) or *Isoodon macrourus* (Northern Brown Bandicoot) were commonly found throughout the study area. Specimens of *I. macrourus* were observed within the study area during the remote camera survey;

Table 14.16 - Fauna species detected by remote camera.

Fauna species	05-07-13 12-07-13 E – 406367 N - 6373319	12-07-13 12-09-13 E – 406529 N - 6373543	28-11-14 11-12-14 E – 406360 N - 6373000	22-01-15 28-01-15 E – 407163 N - 6373578	10-02-15 17-04-15 E – 406403 N - 6372879	20-04-15 04-06-15 E – 407260 N - 6373835
Amphibolurus muricatus (Jacky Lizard)			R			
Varanus varius (Lace Monitor),			C		C	
Tachyglossus aculeatus (Echidna)			R			
Cracticus torquatus (Grey Butcherbird)	C					
Haliastur sphenurus (Whistling Kite),					O	
Antechinus stuartii (Brown Antechinus)	C		C	O	C	
Isoodon macrourus (Northern Brown Bandicoot)		O				R
Wallabia bicolor (Swamp Wallaby)		C			C	
Petaurus norfolcensis (Squirrel Glider)					R	
Trichosurus vulpecula (Common Brushtail Possum)	O			O	C	
Lepus capensis (European Hare)		O				
Felis catus (Feral Cat)	O					

Canis lupus familiaris (Wild Dog)			R			
Vulpes vulpes (European Red Fox)	C					

C – Commonly recorded (many occasions)
O - Occasionally recorded (more than once)
R – Rarely recorded (only one record)

- Scats and footprints consistent with that of a macropod were found to be common throughout the site. These Scats and prints were most likely from *Wallabia bicolor* (Swamp Wallaby) which was observed and recorded on remote camera within the study area;
- Diggings consistent with the Echidna were found on the side of some ant nests;
- Large scratches on some of the bigger hollow-bearing trees were attributed to *Varanus varius* (Lace Monitor), and
- Scratches on the trunks of a small number of specimens of *Eucalyptus robusta* (Swamp Mahogany) were found to be consistent with these of *Phascolarctos cinereus* (Koala). The Koala is listed as threatened under state and national legislation and has been assessed in Sections 14.7, 14.8, 14.11 and Annex N.

Survey Limitations

As with all reports of this type the main survey limitation for the survey is considered to be the relatively short periods of time in which the fieldwork was undertaken. Fieldwork was timed to increase the likelihood of detecting certain subject species such as threatened orchids. Limitations were generally related to the detection of species with large home ranges such as *Dasyurus maculatus* (Tiger Quoll) and Large Forest Owls. Climate variability may also affect the occurrence of some species such as *Lathamus discolor* (Swift Parrot) and *Anthochaera phrygia* (Regent Honeyeater).

Limitations have been overcome by applying the precautionary principle in all cases where the survey methodology may have given a false negative result. This precautionary principle was achieved by recognising that most threatened species are rare and therefore unlikely to be encountered during a survey even if they may utilise the study area at other times. These species have been assessed on the basis of the presence of their habitat and the likely significance of that habitat to a viable local population.

14.15 CONSIDERATIONS UNDER SECTION 5A OF THE EPA ACT

Considerations of the effects of the proposal under the guidelines of Section 5A of the Environmental Planning and Assessment Act (1995) are given in Annex N. The species, populations and communities dealt with were those species identified on site during the fieldwork and those considered to have potential habitat available within the study area as detailed in Section 14.5.2.4 of this report.

14.16 ENDANGERED ECOLOGICAL COMMUNITIES

The study area was found to contain two endangered ecological communities:

- Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner Bioregions.

- Freshwater wetlands on coastal floodplains of the NSW North Coast, Sydney Basin and South-East Corner bioregions.

Swamp Sclerophyll Forest

Swamp Forest (total area 1.15ha) occurring on lower lying poorly drained ground within the study area was found to be consistent with the Endangered Ecological Community Swamp Sclerophyll Forest on coastal floodplains of the NSW North Coast, Sydney Basin and South-East Corner bioregions. The area of Paperbark Swamp Forest (0.8ha) was largely contained within Lot 10 in the north of the study area. This assemblage also pushed into the neighbouring Lots 11 and 51. This area was in generally good condition although it had been subject to a number of disturbances from surrounding development and weed incursion. The sloping edge of the access road into the earthmoving business within Lot 10 had been slowly encroaching into this assemblage. Parts of this assemblage on the other side of the access road near the residence had a maintained understorey. The area of Swamp Sclerophyll Forest within Lot 51 had been subject to some grazing and trampling by cattle. Swamp Sclerophyll Forest (0.35ha) located within the far north-west of study area (within Lot 254) was also found to be in relatively good condition. This area of Swamp Sclerophyll Forest containing specimens of *Eucalyptus grandis* (Flooded Gum) also had similarities to another EEC River Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner Bioregions. As a result of the drainage, position in the landscape, understorey species and dominance of the canopy species *Melaleuca quinquenervia* (Broad-leaved Paperbark) it was considered to be closer to Swamp Sclerophyll Forest.

The areas of Swamp Sclerophyll Forest are located outside the proposed mining footprint (15m buffer) and as a consequence will not be directly impacted. The proposed sand mine will require excavation below the groundwater level. An assessment undertaken (Martins, 2015) found drawdown of the permanent groundwater system for this vegetation community within the study area is modelled to be a maximum of approximately 0.07m. Swamp Sclerophyll Forest is an obligate Groundwater Dependant Community which is exclusively reliant on groundwater. Based on the NSW Aquifer Interference Policy (Department of Primary Industries Office of Water, 2012) and the post Water Sharing Plan the local groundwater natural level range is in the order of 3 m (or more). The adopted permissible drawdown at a 40m buffer from the GDEs is 0.30m (i.e. 10% x 3.00). This drawdown threshold is met for vegetation communities exclusively reliant on groundwater. Consequently, based on modelling results, the proposed development does not exceed the drawdown impact criterion set out in the NSW Aquifer Interference Policy (NOW, 2012).

Strict controls will have to be applied to the proposal to prevent any future degradation to the areas of Swamp Sclerophyll Forest. Long-term monitoring of the groundwater levels around the areas of Swamp Sclerophyll Forest is to be undertaken. It is recommended that a vegetation management plan be completed for these areas to ensure the long-term viability of this Endangered Ecological Community. Taking the recommendations into consideration the proposal is unlikely to have an adverse effect on Swamp Sclerophyll Forest that its composition or local occurrence is likely to be placed at extinction.

Freshwater wetlands

Approximately 0.32ha of wetland vegetation occurring on the lower lying poorly drained area in the north of Lot 51 within the study area was found to be consistent with the Endangered Ecological Community Freshwater wetlands on coastal floodplains of the NSW North Coast,

Sydney Basin and South-East Corner bioregions. The freshwater wetland was found to intergrade with an area of Paperbark Swamp Forest which was largely contained within the adjoining Lot 10 to the east. The wetland may have originally been derived from the past clearing of Paperbark Swamp Forest. The area of wetland had been subject to disturbance from ongoing grazing and trampling by cattle, with the edges of the wetland having the most disturbance.

As with the areas of Swamp Sclerophyll Forest, the area of Freshwater Wetland is located outside the proposed mining footprint and as a consequence will not be directly impacted. The wetland will have a buffer of 15m to the proposed mining footprint. The proposal will require excavation below the groundwater level. An assessment undertaken (Martins, 2015) found drawdown of the permanent groundwater system for this vegetation community within the study area is modelled to be a maximum of approximately 0.07m. Freshwater Wetlands are an obligate Groundwater Dependant Community which are exclusively reliant on groundwater. Based on the NSW Aquifer Interference Policy (Department of Primary Industries Office of Water, 2012) and the post Water Sharing Plan local groundwater natural level range of the order of 3 m (or more), the adopted permissible drawdown at a 40m buffer from the GDEs is 0.30m (i.e. 10% x 3.00). This drawdown threshold is met for vegetation communities exclusively reliant on groundwater. Consequently, based on modelling results, the proposed development does not exceed the drawdown impact criterion set out in the NSW Aquifer Interference Policy (NOW, 2012).

Strict controls will have to be applied to the proposal to prevent any future degradation to the area of Freshwater Wetland. Long-term monitoring of the groundwater levels around the area of Wetland is to be undertaken. It is recommended that cattle be excluded from the area of wetland. A vegetation management plan to be completed for this area will help ensure the long-term viability of the Endangered Ecological Community within the study area. Given the fact that this relatively small wetland which has been subject to disturbance will not be directly affected, the proposal is unlikely to cause extinction of this endangered ecological community in the locality.

14.17 THREATENED SPECIES

Threatened Flora

One threatened flora species *Diuris arenaria* (Tomaree Doubletail) was found to be present within the study area.

Diuris arenaria (Tomaree Doubletail)

A total of 108 individual specimens of *Diuris arenaria* (Tomaree Doubletail) were recorded within the study area as a result of targeted surveys undertaken in 2013, 2014 & 2016 during the known flowering period (August/September) for this orchid species. With the exception of one plant (No. 14) occurring approximately 6m to the north of the electrical easement, the remaining specimens of *D. arenaria* were found to be confined to the maintained electrical easement in the far west of the study area. The locations of *D. arenaria* were largely consistent with those mapped for the Tomago to Tomaree Electricity Easement Upgrade (ERM, 2003). Some additional specimens may have been inadvertently buried in the past as a result of past earthworks within the easement closer to Nelson Bay Road. Outside the study area *D. arenaria* also occurs within the same electricity easement to the west and east (ERM, 2003). Within the

study area the orchids were located within native derived grassland with no canopy which has been created and maintained as an electrical easement by Ausgrid. No other occurrences of *D. arenaria* were recorded over the remainder of the study area during targeted surveys. The absence of *D. arenaria* over the remainder of the study area is likely to be attributed to the density of trees and shrubs shading suitable habitat. However, suitable habitat was considered to be present within areas of Coastal Sand Apple Blackbutt Forest with a sparse canopy cover.

Diuris arenaria is only known to occur on the Tomaree Peninsula. A study of *D. arenaria* undertaken within the 2005 flowering season (Espallargas, 2005) found the total population of *D. arenaria* to be 2840 individuals. In view of this report the population of *D. arenaria* within the study area would equate to 1.7% of the total population of this orchid species.

No specimens of *D. arenaria* are required to be removed as a result of the proposal. The 15m buffer to the north of the electrical easement to the extraction zone will also offer protection from secondary impacts such as increased weed incursion and dust. It is recommended that there is a no-go zone below the extraction zone to avoid any unintended removal/disturbance of these orchids. This will require the erection of a barrier fence on the boundary of the extraction zone. It will also be important to liaise with Ausgrid regarding maintenance of their easements to minimise impacts and support the protection of *D. arenaria*.

Of the remaining 30 assessed flora species the study area was found to contain suitable habitat for 11:

- *Diuris praecox* (Newcastle Doubletail);
- *Corybas dowlingii* (Red Helmet Orchid);
- *Cryptostylis hunteriana* (Leafless Tongue Orchid);
- *Rhizanthella slateri* (Eastern Underground Orchid);
- *Pterostylis chaetophora* (Tall Rustyhood);
- *Maundia triglochinoides* (Maundia);
- *Persicaria elatior* (Tall Knotweed);
- *Zannichellia palustris* (Horned Pondweed);
- *Eucalyptus parramattensis* subsp. *decadens* (Drooping Red Gum);
- *Melaleuca biconvexa* (Biconvex Paperbark);
- *Syzygium paniculatum* (Magenta Lilly Pilly);

Of these threatened flora species, the most likely habitat within the study area was considered to be present for *D. praecox*. Specimens of *D. praecox* are known to be present approximately 200m to the south-west within the same electrical easement which runs through the study area (Wildthing Environmental Consultants, 2018). Previous studies (ERM, 2003) also did not find any specimens of *D. praecox* in the section of the power easement within the study area. Suitable habitat was present within areas of Coastal Sand Apple Blackbutt Forest, particularly those more open areas having less shade from overhead vegetation such as the power easement in the south. The proposal will result in the removal 25.90ha of suitable habitat from within the study area. However, considering the absence of *D. praecox* within the study area during targeted surveys and the fact that no areas of preferred habitat in the form of derived grassland within the electrical easements will required removal, the proposal is unlikely to have

a significant impact on the local population of this species such that a local extinction would occur.

Corybas dowlingii (Red Helmet Orchid) is known to occur on the Tomaree Peninsula. A population of *C. dowlingii* is know from Stony Ridge Reserve at Soldiers Point and this orchid has also been recorded within bushland next to Soldiers Point Bowling Club (Wildthing Environmental Consultants, 2012). *Corybas dowlingii* typically grows in gullies in tall open forest on well-drained gravelly soils. Taking the absence of preferred habitat in the form of well-drained gravelly soils only marginal habitat was considered to be present within the study area.

Locally *Cryptostylis hunteriana* (Leafless Tongue Orchid) is known from the Gan Gan Hill and Tomaree Headland areas and Lemon Tree Passage (Bell 2001). Suitable habitat was considered to be present within areas of Coastal Sand Apple Blackbutt Forest, however as the local populations of *C. hunteriana* are found on Carboniferous sediments associated with low hills (deLacey, et al, 2012) and taking into consideration the absence of records within similar habitat to the study area along the dunal forests of the Stockton Bight the likelihood of this orchid species being present within the study area would be reduced.

As habitat requirements are poorly understood and no particular vegetation type has been associated with *Rhizanthella slateri* (Eastern Underground Orchid) areas of sclerophyll forest were considered to contain suitable habitat for this highly cryptic orchid species. The nearest known local record of this species is Bulahdelah (Jones, 2006). Taking into consideration the current absence of records of *R. slateri* on the Tomaree Peninsula and nearby areas the likelihood of this orchid species being present within the study area would be greatly reduced.

A population of *Pterostylis chaetophora* (Tall Rustyhood) is known to occur approximately 20km to the west of the study area near Grahamstown Dam within Sclerophyll Forest containing canopy species such as *Eucalyptus fibrosa* (Broad-leaved Ironbark) and *Eucalyptus tereticornis* (Forest Red Gum), with a small tree layer of *Melaleuca nodosa* (Ball Honey-Myrtle)(pers.com Steve Lewer, OEH 2017). Considering *P. chaetophora* was not recorded within the study area during targeted and incidental surveys and taking the differences in habitat type between the study area and known local locations the likelihood of this orchid species being present within the study area would be greatly reduced.

Marginal habitat for *Maundia triglochinoides* (Maundia) was present within the area of Freshwater Wetlands. *Maundia triglochinoides* is known to occur within man-made drainage canals at Williamtown, Medowie and Campvale. No areas of suitable habitat for *M. triglochinoides* will be directly impacted by the proposed sand mine.

Suitable habitat for *Persicaria elatior* (Tall Knotweed) was present within the area of Freshwater Wetlands. Locally *P. elatior* is known from the Tomago Sandbeds. No areas of suitable habitat for *P. elatior* will be directly impacted by the proposed sand mine.

Marginal habitat for *Zannichellia palustris* (Horned Pondweed) was confined to the low-lying area of ground containing wetland in the north of the study area. As a result of the lack of nearby records the occurrence of this species within the site would be considered to be low. No areas of suitable habitat for *Z. palustris* will be directly impacted by the proposed sand mine.

Within the study area marginal habitat for *Eucalyptus parramattensis* subsp. *decadens* (Drooping Red Gum) was considered to be present within the areas of Swamp Sclerophyll Forest. The nearest records of *E. parramattensis* subsp. *decadens* are at Williamtown (RPS

Harper Somers O'Sullivan, 2009), Tilligerry Peninsula and Salamander Bay (ERM, 2005). In the Port Stephens area *E. parramattensis* subsp. *decadens* occurs in open wet sclerophyll woodland on heavy, often waterlogged, inter-barrier depression soils. No areas of suitable habitat for *E. parramattensis* subsp. *decadens* will be directly impacted by the proposed sand mine.

The closest known record of *Melaleuca biconvexa* (Biconvex Paperbark) is south-east of Moffats Swamp approximately 8km to the west (NSW Wildlife Atlas, 2017). Suitable habitat for *M. biconvexa* was considered to be present on the lower-lying, poorly drained ground to the north-east.

Suitable habitat for *Syzygium paniculatum* (Magenta Lilly Pilly) was present within more sheltered areas of Coastal Sand Apple Blackbutt Forest. Few records of this Lilly Pilly species are known from the local area according to the NSW Wildlife Atlas (OEH, 2017).

Threatened Fauna

Eight threatened fauna species were recorded within the study area as a result of fieldwork:

- *Glossopsitta pusilla* (Little Lorikeet);
- *Haliaeetus leucogaster* (White-bellied Sea Eagle);
- *Petaurus norfolcensis* (Squirrel Glider);
- *Pteropus poliocephalus* (Grey-headed Flying-fox);
- *Scoteanax rueppellii* (Greater Broad-nosed Bat);
- *Falsistrellus tasmaniensis* (Eastern Falsistrelle);
- *Miniopterus australis* (Little Bentwing-bat);
- *Miniopterus schreibersii oceanensis* (Large Bentwing-bat).

As a result of secondary evidence an additional two species were also considered to utilise the study area:

- *Ninox strenua* (Powerful Owl);
- *Phascolarctos cinereus* (Koala).

Glossopsitta pusilla (Little Lorikeet)

Glossopsitta pusilla (Little Lorikeet) was recorded within the far west of study area on two occasions. Suitable foraging and nesting habitat (tree hollows) were present over a large portion of the study area. The proposed sand mine will result in the removal of approximately 25.90ha of habitat in the form of open forest largely composed of Coastal Sand Apple Blackbutt Forest. Approximately 877 hollow-bearing trees will also be required to be removed. This will result in a relatively large reduction in habitat within the local area for this parrot species. However, taking the presence of larger adjoining areas of similar habitat within the locality the proposal is considered unlikely to result in the extinction of any local population of this lorikeet species.

Haliaeetus leucogaster (White-bellied Sea Eagle);

Haliaeetus leucogaster (White-bellied Sea Eagle) was observed flying over the study area on a number of occasions. Juvenile White-bellied Sea Eagles also noted flying over the study

area would also likely indicate nesting within the locality. Due to the relatively close proximity of Tilligerry Creek and to a lesser extent the waters of Stockton Bight, large trees within the study area would offer potential nesting habitat for the White-bellied Sea Eagle. No large nests that would be attributed to this species were within the study area. No preferred hunting habitat was present within the site. The proposal will likely result in the incremental reduction of potential nesting habitat however, it is unlikely to result in the extinction of any local population of *H. leucogaster.*

Petaurus norfolcensis (Squirrel Glider)

The Squirrel Glider was recorded within the study area as a result of targeted surveys. Four gliders were captured in arboreal mammal traps during the 2014 trapping period. An individual Squirrel Glider was also recorded on the ground by remote camera in the far south-east of the study area in early 2015. No Squirrel Gliders were captured during the 2013 trapping period. No gliders were observed during spotlighting surveys or emerging during stag-watching of hollow-bearing trees.

Despite the survey effort, the capture rate of four gliders for 160 trap nights averaged 2.5 percent. This is lower than the average capture rate at Wyong (6.5 percent) (Smith & Murray 2003) and at Port Macquarie (8 to 16 percent) (Quin, 1995). However, capture rates are lower during canopy flowering due to the excess of nectar and pollen associated with flowering eucalypts (Quin, 1995). During the trapping periods *Eucalyptus pilularis* (Blackbutt) and *Eucalyptus robusta* (Swamp Mahogany) were both flowering and may have likely reduced the chances of trapping a Squirrel Glider.

The food plants *E. pilularis* and *Banksia serrata* were very common within the study area. As winter is a time of critical food shortage for the Squirrel Glider species such as *E. robusta* are an important food resource within the local area during this period. Only 19 specimens of *E. robusta* were found to be present within the study area. Known food plants of the Squirrel Glider within the study area are shown in Table 14.17.

Squirrel Gliders have been recorded in a number of locations along Stockton Bight including Fern Bay; (ERM, 2002), (Wildthing Environmental Consultants, 2011, 2012 & 2013), Salt Ash (Umwelt, 2003) and the Worimi Conservations Lands (Ecotone, 2008). The monitoring of nest boxes erected by Energy Australia along the powerline easement within the Worimi Conservation Lands showed a high level of usage by gliders with 81 of 130 glider boxes showing signs of nest material and seven glider families identified (Hollow Log Homes, 2008).

Table 14.17 - Known food plants of the Squirrel Glider within the study area

Food Plant	Food Item
Eucalyptus pilularis (Blackbutt)	Nectar
Angophora costata (Smooth-barked Apple)	Nectar
Eucalyptus robusta (Swamp Mahogany)	Nectar
Banksia serrata (Old Man Banksia)	Summer nectar & pollen
Banksia integrifolia (Coastal Silver Banksia)	Winter nectar & pollen
Melaleuca quinquenervia (Broad-leaved Paperbark)	Nectar, insect bark feed
Acacia irrorata	Gum
Acacia maideni	Gum

The study area forms part of a much larger fragment of native vegetation dominated by Coastal Sand Smooth-barked Apple Forest associated with the coastal sand dunes along Stockton Bight. This relatively large fragment (approximately 2400ha - extrapolated from The Department of Lands, 2015 Aerial Photo) is bounded by bare Holocene sand dunes to the east, cleared mostly agricultural land to the west, residential development of Fern Bay to the far south and Anna Bay to the north. The southern extent of this fragment however, occurs north of Fern Bay where shifting sand has created a barrier for the Squirrel Glider (approximately 500m wide) to a smaller fragment of known Squirrel Glider habitat (approximately 1000ha – Fern Bay Fragment) (ERM, 2005) at the southern end of Stockton Bight. The 2400ha fragment which contains the study area is comprised of both conservation lands (Worimi Conservation Lands – approximately 1750ha – extrapolated from OEH, 2013) and less secure privately-owned land (remainder of land = approximately 650ha).

The Squirrel Glider has a home range of between 1.5 and 10 hectares and a density of 0.1 to 1.9 animals per hectare, depending upon habitat quality (Smith 2002). Density of gliders in the Fern Bay fragment which contains similar habitat was estimated at 0.36 gliders per hectare (ERM, 2005). Considering the presence of approximately 36ha of suitable habitat for the Squirrel Glider within the study area at best there could be approximately 13 or more individuals utilising the study area.

Approximately 1217 hollow-bearing trees were recorded within the study area during the hollow-bearing tree survey. Many of these trees where considered to be significant as a result of their very large size and the presence of suitably sized nesting hollows for the Squirrel Glider. Large areas of adjoining and nearby open forest are likely to contain similar densities and sizes of hollows. Suitable contiguous Squirrel Glider habitat occurs on private land north of the duel carriage way (four lanes) of Nelson Bay Road to the west of the study area. Smaller areas of adjoining privately owned habitat were also present to the east and the north. The much larger Worimi Conservation Lands were present to the south over Nelson Bay Road. No trees were present within the centre strip of the dual carriage way (Nelson Bay Road) adjacent to the study area. This gap was measured at a minimum of 40m. Trees on the side of the road

should be sufficiently tall (above 25m) to allow Squirrel Gliders to glide above large trucks (~4m high) at ~6m in from a landing tree, and land ~1m above the ground to avoid predators (Ross *et al.*, 2009). Although a number of trees along the roadside would reach over 25m in height considering the frequency of vehicle movements along this road this gap would represent a considerable barrier for the Squirrel Glider. However, a long strip of remnant trees was present within the centre of the dual carriage way a short distance to the south-west of the study area which would provide a much safer link for Squirrel Gliders between habitat north and south of Nelson Bay Road.

The proposal will result in the removal of 25.90ha of Coastal Sand Apple Blackbutt Forest containing known foraging and nesting hollows. Approximately 877 hollow-bearing trees will require removal. Many of these hollow-bearing trees are significant as a result of their very large size and presence of suitably sized nesting hollows for the Squirrel Glider. The proposal will result in a reduction in connectivity smaller areas of open forest habitat contained within Lot 2 & 521 to the immediate north of the study area. Considering the presence of the dual carriageway of Nelson Bay Road (without a treed traffic island) the proposal will also result in a reduction in connectivity for open forest areas within Lot 10 and the adjoining crown reserve. An additional 15m vegetated buffer zone located around the proposal will however continue to provide connectivity to these areas of habitat for Squirrel Gliders. The connectivity to these areas will greatly improve after the mine site has been progressively revegetated. Other potential impacts include noise from the mine operation and artificial lighting.

A number of mitigation measures have been given in the report to reduce the impact of the proposed sand mine on the Squirrel Glider. These include:

- Protection of remaining habitat/vegetation;
- Rehabilitation of habitat within extraction area;
- Reduction of ongoing mine impacts such as noise and artificial lighting.
- Removal and non-use of barbed-wire within the study area;
- Protection of the Squirrel Glider during vegetation clearance;
- Provision of compensatory habitat (Offsetting);
- Feral Vertebrate Pest Control;
- Installation of compensatory nest boxes;
- Weed Control.

The proposal will result in a significant reduction in Squirrel Glider habitat occurring along the dune forests of Stockton Bight. However, considering the relatively large area of habitat the study area forms part of together with the given recommendations the proposed sand mine is unlikely to result in the extinction of any local population of the Squirrel Glider.

Pteropus poliocephalus (Grey-headed Flying-fox);

The Grey-headed Flying-fox was observed within the study area on a number of occasions. Large numbers of Grey-headed Flying-foxes were observed feeding on flowering *Eucalyptus pilularis* (Blackbutt) throughout the study area in February 2015. The Grey-headed Flying-fox was also recorded feeding within the study area on flowering specimens of *Eucalyptus robusta* (Swamp Mahogany) and *Melaleuca quinquenervia* (Broad-leaved Paperbark). One deceased specimen had been entangled within a barbed-wire fence surrounding the orchard. Although suitable camp sites were considered to be present within the study area

no roosting individuals were observed. Grey-headed Flying-foxes in 2015 were noted to be largely originating from a large temporary camp located near the corner of Cromarty and Upton Lanes approximately 2km to the east of the study area.

The study area was found to contain seasonal foraging habitat for this highly mobile species in the form of flowering trees, in particular; *Eucalyptus pilularis* (Blackbutt), *Angophora costata* (Smooth-barked Apple) and *Banksia serrata* (Old Man Banksia). Other preferred foraging species present included *Eucalyptus robusta* (Swamp Mahogany), *Eucalyptus grandis* (Flooded Gum), *Melaleuca quinquenervia* (Broad-leaved Paperbark) and *Banksia integrifolia* (Coastal Silver Banksia). The study area was considered to contain potential camp sites, particularly within denser areas of swamp forest dominated by the canopy species *M. quinquenervia*.

The proposal will involve the removal of 25.90ha of seasonal foraging habitat resulting in a substantial reduction within the local area. No areas of habitat will become isolated for this highly mobile species. A number of mitigation measures have been given to reduce the impact of the proposed sand mine on the Grey-headed Flying-fox. These include:

- Protection of remaining habitat/vegetation;
- Rehabilitation of habitat within extraction area;
- Reduction of ongoing mine impacts such as noise and artificial lighting.
- Removal and non-use of barbed-wire

Taking the presence of larger adjoining areas of similar habitat within the locality including the nearby protected Worimi Conservation Lands and absence of roosting individuals within the study area the proposal is considered unlikely to result in the extinction of any local population of the Grey-headed Flying-fox.

Hollow Dependent Microchiropteran Bats: *Scoteanax rueppellii* (Greater Broad-nosed Bat) & *Falsistrellus tasmaniensis (Eastern Falsistrelle)*

Falsistrellus tasmaniensis (Eastern Falsistrelle) was positively identified within the study area during the bat call survey. Calls not inconsistent with *Scoteanax rueppellii* (Greater Broad-nosed Bat) were also identified. The majority of the study area contains suitable hunting habitat for these microchiropteran bat species. A large amount of roosting habitat was also present with 1217 hollow-bearing trees being recorded within the study area. Many of these trees where considered to be significant as a result of their very large size and the presence of suitably sized roosting hollows for these microchiropteran bat species. Approximately 877 hollow-bearing trees are proposed to be removed to make way for the sand mine footprint. This would represent a significant loss in roosting habitat within the local area for these microchiropteran bat species. The proposal will also result in a reduction in the quality of hunting habitat within the locality. Considering the recommendations and the presence of larger areas of adjoining and nearby habitat along the vegetated sand dunes of Stockton Bight from Fern Bay to Anna Bay which contain comparable foraging and similar densities and sizes of tree hollows it is considered unlikely to result in the extinction of any local population of *S. rueppellii* or *F. tasmaniensis.*

Cave-dwelling Bats Microchiropteran Bats: *Miniopterus australis* (Little Bentwing-bat) & *Miniopterus schreibersii oceanensis* (Large Bentwing-bat)

One specimen of *Miniopterus australis* (Little Bentwing-bat) was captured within the study area during the harp trapping component of the survey. Calls not inconsistent with *M. australis* and *Miniopterus schreibersii oceanensis* (Large Bentwing-bat) were also recorded during the bat call survey. A previous bat call survey (Wildthing Environmental Consultants, 2009) conducted within Lot 10 in the far east of the study area also recorded calls not inconsistent with *M. australis.* The majority of the study area contains suitable hunting habitat for this microchiropteran bat species. However, no preferred roosting habitat in the form of caves, culverts or other similar man-made structures was found to be present. Taking into consideration the relatively large amount of suitable hunting habitat in the locality and absence of preferred roosting habitat within the study area the proposal is unlikely to disrupt the life cycle of this microchiropteran bat species such that local extinction would occur.

Ninox strenua (Powerful Owl)

According to the analysis of the bone fragments by Barbara Triggs within an owl pellet containing the remains of *Trichosurus vulpecula* (Common Brushtail Possum) the fragments were indicative of a pellet belonging to the threatened *Ninox strenua* (Powerful Owl). The Powerful Owl was not observed within the study area during targeted or incidental surveys nor any response to playback calls heard. According to the NSW Wildlife Atlas (OEH, 2015) the powerful owl has been recorded south of the study area within the Worimi Conservation Lands. Suitable hunting habitat for the powerful owl occurs within areas of Open Forest throughout the study area. The major prey item of the powerful owl is the Common Ringtail Possum and Squirrel Glider. The Squirrel Glider was recorded within the study area however the Common Ringtail Possum although likely to be present was not recorded during surveys. Considering the presence of the likely Powerful Owl Pellet containing the remains of the Common Brushtail Possum and the large number of these possums recorded within the study area the Common Brushtail Possum is a likely frequent prey species for the Powerful Owl within the local area. Nesting habitat was present in the form of large tree hollows, particularly within larger specimens of Blackbutt. The study area was likely to contain up to 200 potential nesting hollows for the Powerful Owl. Roosting habitat for this species is present within denser areas of foliage such as Swamp Sclerophyll Forest and thicker areas of Dry Sclerophyll Forest. The Powerful Owl occupies exclusive territories that can be greater than 800ha in size (Kavanagh, 2000) and would likely utilise the study area as part of a larger home range.

The proposal will result in a significant incremental reduction in habitat for the Powerful Owl. Taking into consideration the relatively large amount of suitable hunting habitat within the local area the proposal is unlikely to disrupt the life cycle of this species of owl such that local extinction would occur.

Phascolarctos cinereus (Koala)

No Koalas were directly observed within the study area during fieldwork completed for this report or previous reports (Wildthing Environmental Consultants, 2009). However, evidence of Koala activity in the form of characteristic scratches on the trunks of a very small number of specimens of *Eucalyptus robusta* (Swamp Mahogany), a preferred feed tree species under the Port Stephens Comprehensive Koala Plan of Management CKPoM, was present within the area of Swamp Forest in the far east of the study area. *Eucalyptus robusta* was the only preferred Koala Feed Tree Species recorded within the study area. No Koala faecal pellets were found within the study area despite a search beneath every individual specimen of *E. robusta* (a total of 19 trees) and searches conducted over the entire study area during the hollow-bearing tree survey.

Review of the Koala Habitat Planning Map showed the site to be largely composed of Supplementary Koala Habitat with smaller areas of mainly cleared land. However, the CKPoM assessment found although the study area was largely composed of Supplementary habitat two smaller areas of preferred Koala habitat consisting of Swamp Sclerophyll Forest were located within the north and north-east of the study area. According to the CKPoM the area of Preferred Koala Habitat will require a 50m buffer over supplementary habitat.

No records of the Koala occurring within the study area were present on either the BioNet Atlas of NSW Wildlife (OEH, 2017) or Hunter Koala Preservation Society (2015) databases. According to database records contained in the BioNet NSW Atlas (OEH, 2017) and Hunter Koala Preservation Society (Hunter Koala Preservation Society, 2015) a small number of records of Koalas occur within proximity to the study area. Relatively recent records of Koalas have been recorded from 2015 & 2016 within the vicinity of the Shark & Ray Centre approximately 200m to the north-west of the site (OEH, 2017). Koalas have also been killed on Nelson Bay Road 200m south of Marsh Road and in the front of Murrays Brewery (no dates given). The evidence suggests that the study area particularly the area of Swamp Sclerophyll Forest in the far-east is utilised infrequently by a small number of Koalas.

The proposal sand mine will require the removal of 25.90ha of native vegetation resulting in a significant reduction in Supplementary habitat within the local area. No areas of Preferred Koala Habitat will require removal. A number of recommendations have been given to reduce the impact of the proposal on the local population of Koalas in the local area. These recommendations are:

- specimens of *Eucalyptus robusta* are to be planted into the cleared areas of pasture/grasses within the far north of the study area (Lot 51) to enhance the adjoining existing area of Preferred Koala habitat within Lot 10 and to provide a better linkage to larger areas of preferred Koala to the north over Marsh Road;
- It is recommended that the sand mine disturbance area be cordoned off by the use of Koala barrier fencing to prevent any Koalas straying into the path of machinery/trucks or drowning in pools of steep banked surface water;
- It is recommended that low speed limits and Koala warning signage be placed along the internal access roads to reduce the chance of vehicle collision;
- Dogs are to be controlled within the study area;
- Protection of remaining habitat/vegetation;
- Rehabilitation of habitat within extraction area;
- Reduction of ongoing mine impacts such as noise and artificial lighting;
- Removal and non-use of barbed-wire within the study area;
- Protection of the Koala during vegetation clearance;
- Provision of compensatory habitat (Offsetting);
- Feral Vertebrate Pest Control;

- Weed Control.

The proposal will result in a significant reduction of supplementary Koala habitat within the local area. As no areas of Preferred Koala Habitat or known Preferred Koala Feed Tree Species will be removed and given the lack of Koala sightings and low level of Koala activity, plus taking the recommendations into consideration the proposed sand mine is unlikely to have an adverse effect on the life cycle of the species such that the local population of Koalas may be placed at risk of extinction.

Of the remaining 90 assessed fauna species the study area was found to contain suitable habitat for 43:

- *Petalura gigantea* (Giant Dragonfly);
- *Crinia tinnula* (Wallum Froglet);
- *Uperoleia mahonyi* (Mahony's Toadlet);
- *Litoria aurea* (Green & Golden Bell Frog);
- *Litoria brevipalmata* (Green-thighed Frog);
- *Hoplocephalus bitorquatus* (Pale-headed Snake);
- *Hoplocephalus stephensii* (Stephen's Banded Snake);
- *Rostratula benghalensis australis* (Australian Painted Snipe);
- *Botaurus poiciloptilus* (Australasian Bittern);
- *Ptilinopus magnificus* (Wompoo Fruit-dove);
- *Ptilinopus regina* (Rose-crowned Fruit-Dove);
- *Ptilinopus superbus* (Superb Fruit Dove);
- *Callocephalon fimbriatum* (Gang Gang Cockatoo);
- *Calyptorhynchus lathami* (Glossy Black- Cockatoo);
- *Lathamus discolor* (Swift Parrot);
- *Neophema pulchella* (Turquoise Parrot);
- *Melithreptus gularis gularis* (Black-chinned Honeyeater);
- *Anthochaera phrygia* (Regent Honeyeater);
- *Daphoenositta chrysoptera* (Varied Sittella);
- *Epthianura albifrons* (White-fronted Chat);
- *Petroica boodang* (Scarlet Robin);
- *Petroica phoenicea* (Flame Robin);
- *Pomatostomus temporalis temporalis* (Grey-crowned Babbler);
- *Burhinus grallarius* (Bush Stone-curlew;
- *Hieraaetus morphnoides* (Little Eagle);
- *Lophoictinia isura* (Square-tailed Kite);
- *Erythrotriorchis radiatus* (Red Goshawk);

- *Ninox connivens* (Barking Owl);
- *Tyto novaehollandiae* (Masked Owl);
- *Planigale maculata* (Common Planigale);
- *Phascogale tapoatafa* (Brush-tailed Phascogale);
- *Dasyurus maculatus maculatus* (Tiger Quoll);
- *Potorous tridactylus tridactylus* (Long-nosed Potoroo);
- *Aepyprymnus rufescens* (Rufous Bettong);
- *Cercartetus nanus* (Eastern Pigmy Possum);
- *Petaurus australis* (Yellow-bellied Glider);
- *Syconycteris australis* (Common Blossom Bat);
- *Kerivoula papuensis* (Golden-tipped Bat);
- *Saccolaimus flaviventris* (Yellow-bellied Sheathtail-bat);
- *Myotis macropus* (Southern Myotis);
- *Mormopterus norfolkensis* (Eastern Freetail-bat);
- *Vespadelus troughtoni* (Eastern Cave Bat);
- *Chalinolobus dwyeri* (Large-eared Pied Bat);

Taking the habitat and local records into consideration the most likely of these species to utilise the study area would include *Uperoleia mahonyi* (Mahony's Toadlet), *Crinia tinnula* (Wallum Froglet), *Daphoenositta chrysoptera* (Varied Sittella), *Tyto novaehollandiae* (Masked Owl), *Dasyurus maculatus maculatus* (Tiger Quoll), *Saccolaimus flaviventris* (Yellow-bellied Sheathtail Bat) and *Mormopterus norfolkensis* (Eastern Freetail-bat). The proposal will result in an incremental loss of potential habitat for these addressed threatened fauna species, however taking into consideration the relatively large amount of suitable habitat in the local area the proposal is unlikely to disrupt the life cycle the addressed threatened species such that local extinction would occur.

14.18 ENDANGERED POPULATIONS

One endangered population *Dromaius novaehollandiae* (Emu) in the NSW North Coast Bioregion and Port Stephens LGA was present on the NPWS Wildlife Atlas as occurring within 10km of the study area. The Emu was not recorded within the study area during fieldwork. The study area contains suitable habitat for the Emu however, due to the density of vegetation no preferred habitat was considered to be present. Taking into consideration the paucity of recent local records and the relatively large amount of suitable surrounding habitat it is considered unlikely to cause extinction of any local population of the Emu.

14.19 KEY THREATENING PROCESSES

The 'Key Threatening Processes' currently listed under Schedule 3 of the TSC Act that are relevant to the study area have been listed in bold below followed by an assessment of the applicability

of the threatening process in regards to the proposal and the species considered.

Clearing of Native Vegetation

The clearing of vegetation is listed as a major factor contributing to the loss of biological diversity. The proposed sand mine will result in the removal of approximately 25.90ha of Coastal Sand Apple Blackbutt Forest. Coastal Sand Apple Blackbutt Forest is the dominant vegetation assemblage along the sand dunes of Stockton Bight from Fern Bay to Anna Bay. Approximately 1924.1ha of Coastal Sand Apple Blackbutt Forest is present within the nearby Worimi Conservation Lands (Bell & Driscoll, 2010).

Loss of Hollow-bearing Trees

The proposed sand mine will result in the removal of approximately 877 of the 1217 hollow-bearing trees from within the study area. The vast majority of hollow-bearing trees were present within Coastal Sand Apple Blackbutt Forest assemblage. Many of these trees were considered to be significant as a result of their very large size and variety and number of hollows they contained. Hollows were available for roosting or nesting avifauna species, arboreal mammals, reptiles and tree roosting microchiropteran bats species. A number of potential roost trees for large owls such as *Ninox strenua* (Powerful Owl) were also present. It would be likely that similar densities and sizes of hollows occurring within the study area would be present within adjoining areas of Coastal Sand Apple Blackbutt Forest which is the dominant vegetation assemblage along the sand dunes of Stockton Bight from Fern Bay to Anna Bay.

Removal of dead wood and dead trees

The proposal will result in the removal of a considerable amount of dead wood and trees from within the study area. Many of the standing dead trees and fallen hollow logs were considered to be significant as they offer potential nesting, roosting and denning habitat for a number of fauna species such as the *Dasyurus maculatus maculatus* (Tiger Quoll).

Predation by the European Red Fox *Vulpes vulpes*

The European Red Fox was recorded within the study area a number of times as a result of the remote camera surveys. Tracks and a number of scats consistent with this species were also found over a wide area of the study area. Given the high frequency of European Red Foxes noted, the fox would likely have a significant impact on native fauna within the local area. The proposal may result in an increase in the number of this introduced species, however, it is recommended that fox control be undertaken as part of ongoing management of the sand mine site.

Predation by the Feral Cat *Felis catus*

The Feral Cat was recorded within the study area as a result of the remote camera surveys. The Feral Cat would have an impact on native fauna within the local area. The proposal may result in an increase in the number of this introduced species, however, it is recommended that Feral Cat control be undertaken as part of ongoing management of the sand mine site.

Predation and hybridisation of Feral Dogs *Canis lupis famililaris*

The Feral Dog was recorded within the study area as a result of the remote camera surveys. A number of tracks and scats consistent with the Feral Dog were also commonly observed within the study area. The proposal may result in an increase in the number of this introduced species

however, it is recommended that Feral Dog control be undertaken as part of ongoing management of the sand mine site.

Invasion of Native Plant Communities by *Chrysanthemoides monilifera* (Bitou Bush)

Chrysanthemoides monilifera (Bitou Bush)

Bitou Bush was found to be present within the study area and formed small thickets in some areas. Bitou Bush has the potential for further infestation within the study area regardless of the proposal. Given the recommendation for a vegetation management plan for this area which will include regular weed control the impact from this threatening process would be minimised.

Invasion, establishment and spread of *Lantana camara* (Lantana)

Lantana was found to be present within the study area and formed small thickets in some areas. The Lantana present has the potential for further infestation within the study area regardless of the proposal. Given the recommendation for a vegetation management plan for this area which will include regular weed control the impact from this threatening process would be minimised.

Invasion of native plant communities by exotic perennial grasses

A number of exotic perennial grasses particularly *Eragrostis curvula* (African Love Grass), *Andropogon virginicus* (Whiskey Grass), *Anthoxanthum odoratum* (Sweet Vernal Grass), *Melinis repens* (Red Natal Grass), *Paspalum urvillei* (Vasey Grass) and *Axonopus affinis* (Narrow-leaved Carpet Grass) were present within the study area. Exotic grasses pose a threat to endangered ecological communities and threatened species within the study area particularly the area of Freshwater Wetland and the threatened *Diuris arenaria* (Tomaree Doubletail) occurring within the electrical easement. Given the recommendation for a vegetation management plan for this area which will include regular weed control the impact from this threatening process would be minimised.

High frequency fire resulting in the disruption of life cycle processors in plants and animals and loss of vegetation structure and composition

Evidence of past fire such as blackened tree trunks was present within the study area. It is difficult to ascertain the disruption and structural changes, if any, past fires have caused the study area. Frequent fire has the potential to impact the ability of species to maintain life cycle processes and may result in a change in vegetation structure resulting in habitat becoming more or less favourable for some species. Fire also reduces the amount of fallen timber and hollow bearing trees. The proposal is unlikely to have any impact on the frequency of fire within the local area.

Competition from feral honeybees *Apis mellifera*

Six hollow-bearing trees were found to contain introduced *Apis mellifera* (Feral Honey Bee) hives as a result of the habitat tree survey. The Feral Honeybee competes with a number of native fauna species for nectar and tree hollows. The proposal is unlikely to have any impact on the Feral Honeybee occurrence within the local area.

Competition and grazing by the feral European Rabbit *Oryctolagus cuniculus*

The Feral European Rabbit was recorded within the study area during fieldwork. Grazing and

burrowing by rabbits can cause massive erosion problems, reduce recruitment and survival of native plants, and alter entire landscapes. The Feral European Rabbit may also have an impact on species such as *Diuris arenaria* (Tomaree Doubletail). The presence of Rabbits may also attract more introduced predators such as the European Red Fox. The proposal may result in an increase in the number of this introduced species. It is recommended that Feral European Rabbit control be undertaken as part of ongoing management of the sand mine site.

Aggressive exclusion of birds by Noisy Miners *Manorina melanocephala*

The Noisy Miner was found to be common within the study area. The proposed sand mine is unlikely to increase numbers of Noisy Miners.

Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants

Few escaped garden plants recorded within the study area. One example is the occurrence of *Zantedeschia aethiopica* (Arum Lily) within the area of Swamp Sclerophyll Forest within Lot 10. The proposal may result in an increase in the number of escaped garden plants into adjoining vegetation. Given the recommendation for a vegetation management plan for this area which will include regular weed control the impact from this threatening process would be minimised.

Bushrock Removal

As the study area was largely situated on sand dunes no areas of bush rock were found to be present.

Predation by *Gambusia holbrooki* Mosquito Fish or Plague Minnow

Specimens of *G. holbrooki* were recorded during periods of higher water levels after rain within the vicinity of the freshwater Wetland. The proposal is unlikely to increase numbers if this introduced fish species.

Forest Eucalypt dieback associated with over abundant psylids and Bell Miners

No Bell Miners were recorded within the study area during the survey period.

Invasion and establishment of exotic vines and scramblers

Few exotic vines and scramblers were recorded within the study area. Disturbance to the study area as a result of the sand mine has the potential to promote the establishment of species such as *Ipomoea indica* (Morning Glory) and *Lonicera japonica* (Japanese Honeysuckle). Given the recommendation for a vegetation management plan for this area which will include regular weed control the impact from this threatening process would be minimised.

Predation, habitat degradation, competition and disease transmission by Feral Pigs *Sus scrofa*

No evidence of Feral Pigs was recorded within the study area.

Herbivory and Environmental Degradation caused by Feral Deer

No evidence of the Feral Deer was recorded within the study area.

Competition and habitat degradation by Feral Goats *Capra hircus*

No Feral Goats were recorded within the study area during fieldwork.

Loss or degradation (or both) of sites used for hill-topping by Butterflies

A small number of low sand hills were present within the study area. These sand hills occur within the sand mine extraction area and will be removed as a result of the proposal. No currently listed threatened Butterflies are known to occur within the local area. It is difficult to ascertain the impact the removal of these sand hills will have on the local population of Butterflies, however considering the presence of other sand hills within the dunal forest of Stockton Bight the removal of these low hills is unlikely to be significant.

Invasion of native plant communities by African Olive

The African Olive was not recorded within the study area during fieldwork. This invasive plant is not known as a serious weed along the dunal forests of Stockton Bight.

Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands

The proposal is unlikely to have any impact on any rivers or streams in the area.

Infection of frogs by amphibian Chytrid causing the disease Chytridiomycosis

It is possible that this fungus has an impact on frogs in the local area. However, the proposal is unlikely to have any significant impact on this threatening process.

Infection of native plants by *Phytophthora cinnamomi*

No evidence of infection by *Phytophthora cinnamomi* was noted within the study area.

Infection by psittacine circoviral (beak & feather) disease affecting endangered psittacine species and populations

The proposal is unlikely to increase infection by this disease.

Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae

Although having the potential to infect the study area evidence of this recent fungus infection was not observed during fieldwork.

Considerations Under The Port Stephens Comprehensive Koala Plan Of Management

The Port Stephens Comprehensive Koala Plan of Management (CKPoM) has been prepared for the Port Stephens LGA in accordance with SEPP 44 – 'Koala Habitat Protection'. The principal aim of the Port Stephens CKPoM is to encourage the proper conservation and management of areas of natural vegetation that provide habitat for Koalas to ensure a permanent free-living population over their present range and to reverse the current trend of Koala population decline.

Koala Habitat Assessments under the Port Stephens CKPoM involve four stages: preliminary assessment, vegetation mapping, Koala habitat identification and assessment of the

proposal. A Koala habitat assessment has been completed below specifically for the development of this site.

14.20 PRELIMINARY ASSESSMENT

The preliminary assessment for the study area involves reviewing the Koala Habitat Planning Map for the area as contained in the CKPoM and undertaking a site inspection to determine whether the study area contains individuals of Koala trees outside areas marked as 'Preferred Koala Habitat'. Review of the Koala Habitat Planning Map (Figure 14.17) showed the site to contain two Koala habitat categories:

- 'Supplementary Koala Habitat';
- 'Mainly Cleared'

The majority of the site has been designated as 'Supplementary Koala Habitat' with a small patch designated as 'Mainly Cleared' in the north-east.

Within the CKPoM there are three species of Eucalypt identified as Koala food trees, being *Eucalyptus robusta* (Swamp Mahogany), *Eucalyptus parramattensis* subsp. *decadens* (Drooping Red Gum) and *Eucalyptus tereticornis* (Forest Red Gum). *Eucalyptus robusta* was found to be present within two smaller vegetation assemblages within the study area; Paperbark Swamp Forest and Flooded Gum – Paperbark Swamp Forest. No other feed tree species were recorded within the study area.

14.21 VEGETATION MAPPING

As the survey of the site has identified a number of Swamp Mahogany present on site the next step in the Koala Habitat Assessment is to provide a description of the vegetation assemblages present within the study area and to compare the results of the vegetation survey conducted for this report with the LGA wide vegetation map (Figure 2.5 - 'Eastern Section Vegetation' in Part 2 of the Port Stephens CKPoM).

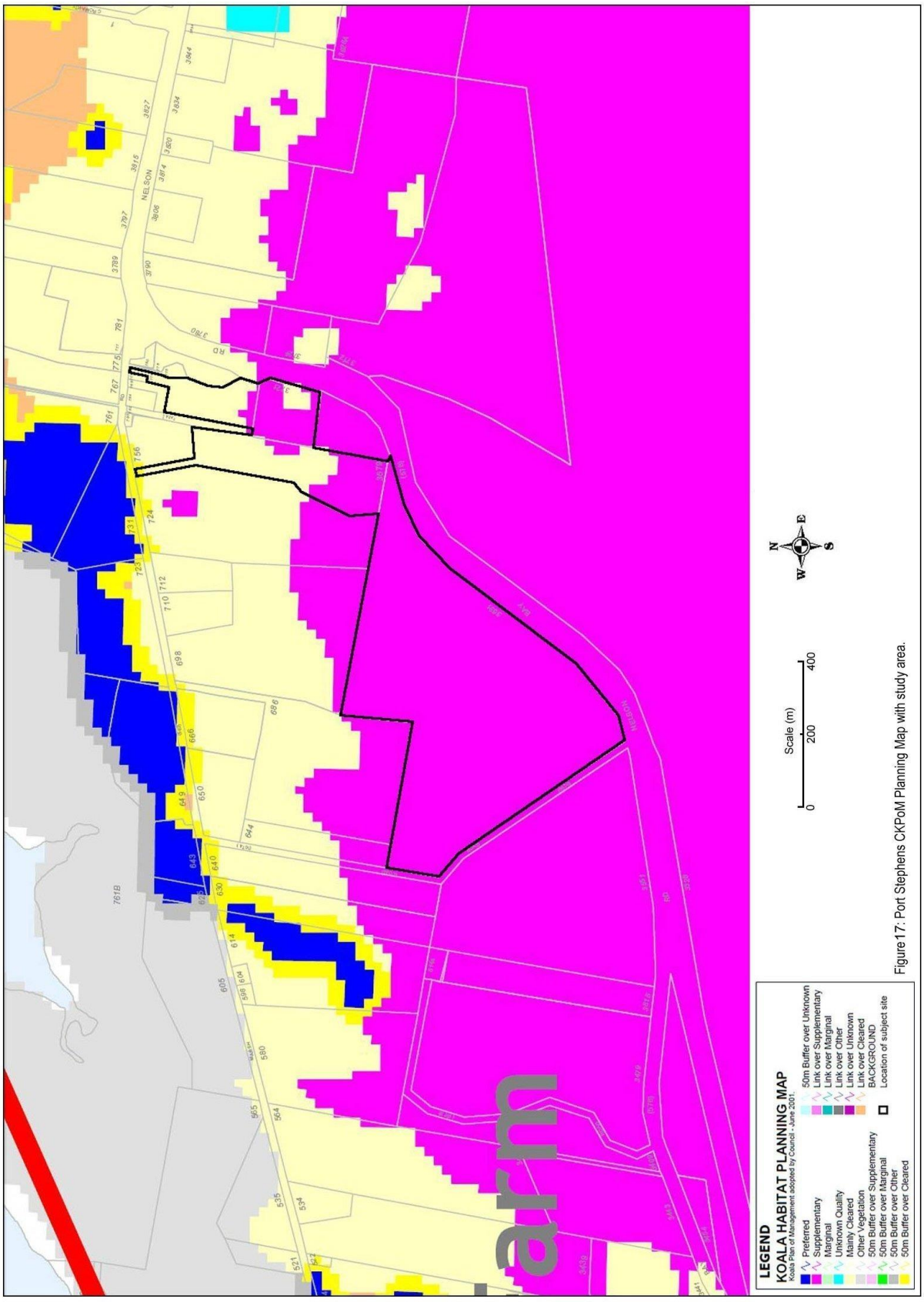


Figure 17: Port Stephens CKPoM Planning Map with study area.

Figure 14.17 - Location of Site within the Koala Habitat Planning Map

As detailed in Section 14.5.1 six vegetation assemblages were found to be present on site as a result of an on-ground assessment:

- Coastal Sand Apple Blackbutt Open Forest (34.93ha);
- Coastal Sand Apple Blackbutt Forest (Derived Grassland)(0.9ha);
- Swamp Sclerophyll Forest (1.15ha);
- Freshwater Wetland (0.32ha);
- Orchard, Cleared/Modified (9.6ha);
- Grassland/Pasture (4.0ha).

Review of the relevant LGA vegetation map (Figure 2.5 in Part 2: CKPoM Resource Document) showed vegetation on the site as being composed of two vegetation assemblages:

- 3 – Blackbutt and Smooth-barked Apple Open Forest
- 25 – Mainly cleared

Blackbutt and Smooth-barked Apple Open Forest was mapped over the majority of the study area. Smaller areas of Mainly Cleared vegetation were present in the northern areas. A large portion of the field survey map was consistent with the LGA vegetation map however the LGA map neglects the presence of two smaller areas of Swamp Sclerophyll Forest and one area of Freshwater Wetland. Figure 14.18 shows vegetation assemblages located on site and within at least 100m of the boundary.

14.22 KOALA HABITAT IDENTIFICATION

Koala Habitat Identification involves:

- the application of the definitions of Preferred and Supplementary Koala Habitat detailed by Lunney *et al.* (1998) to the study area;
- the application of Habitat Buffers to all areas of Preferred Koala Habitat; and
- approximation of Habitat Linking Areas between all patches of Preferred Koala Habitat that occur within 800m of each other.

Under the definitions provided by Lunney *et al.* (1998):

- Preferred Koala Habitat is defined as a combination of the all field survey Primary, Secondary and Community Survey category A/B (regardless of whether or not they overlap);
- Supplementary Habitat – where field survey Marginal and Community Survey Category C/D overlap;
- Marginal Koala Habitat – where field survey Marginal and Community Survey Category E overlap.

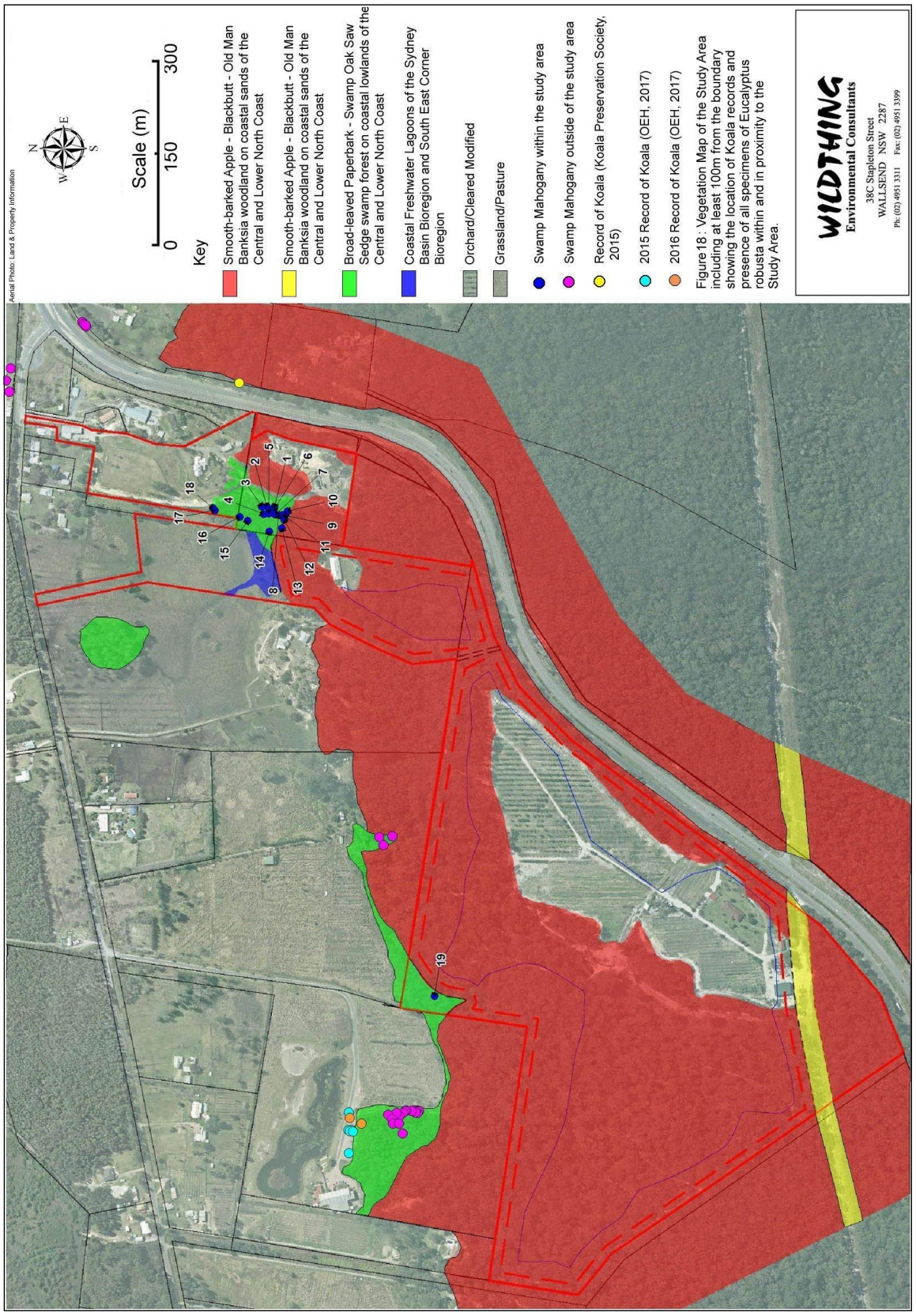


Figure 14.18 - Existing Vegetation

Field Survey

The larger area of Coastal Sand Apple Blackbutt Open Forest (34.93ha) was found to be most consistent with the Community Survey Category C - Tall Open Blackbutt and Sydney Red Gum Forest. The description of the map-based habitat category based on field work is most likely to be Marginal Koala Habitat – Vegetation associations containing low densities of species known to be preferred by Koalas. Where field survey Marginal and Community Survey Category C/D overlap Supplementary Habitat is obtained.

The smaller areas of Swamp Sclerophyll Forest were found to be most consistent with the Community Survey Category C – Open Swamp Mahogany and Swamp Oak with Paperbark. The description of the map-based habitat category based on field work is most likely to be Secondary Koala Habitat – Vegetation associations on Aeolian or Transferral Soil Landscapes of Quaternary origin supporting *E. robusta* and/or *E. parramattensis* as subdominant components of the overstorey. When the field survey Secondary and Community Survey - C overlap, under the definitions provided by Lunney *et al.* (1998), Preferred Koala Habitat is obtained.

Review of the Koala Habitat Planning Map showed the site to be largely composed of Supplementary Koala Habitat with smaller areas of mainly cleared land. However, the CKPoM assessment found although the study area was largely composed of Supplementary habitat two smaller areas of preferred Koala habitat consisting of Swamp Forest were located within the far north-east and north of the study area. According to the CKPoM the area of Preferred Koala Habitat will also require a 50m buffer over supplementary habitat.

Accordingly, an assessment was conducted in the study area to assess the level of current koala activity. *Eucalyptus robusta* was the only preferred Koala Feed Tree Species recorded within the study area. No Koala faecal pellets were found within the study area despite a search beneath every individual specimen of *E. robusta* (a total of 19 trees) and searches conducted over the entire study area during the hollow-bearing tree survey. Trees were also searched for koalas and trunks inspected for the presence of the characteristic 'pock mark' scratches made by koalas. A small number of specimens of *E. robusta* and *Melaleuca quinquenervia* (Broad-leaved Paperbark) within the northern area of Paperbark Swamp Forest (Lot 10) had scratches on the trunks consistent with those of the Koala. A small number of specimens of *E. robusta* and *M. quinquenervia* occurring outside the study area to the north-east also had scratches likely to be those of Koalas. Details of the Preferred Koala Feed Tree Species - *E. robusta* occurring within the study area are shown in Table 18. The locations of individual specimens of *E. robusta* occurring within and in proximity to the study area are shown in Figure 14.17.

Table 14.18 - Preferred Koala tree species within study area listed under the Port Stephens CKPoM.

Tree No.	Tree species	Location GDA 94 E	Location GDA 94 N	DBH (M)	Height (M)	Evidence of Koala Activity
1	*Eucalyptus robusta* Swamp Mahogany	407295	6373797	0.5	20	
2	*E. robusta*	407296	6373809	0.35	17	
3	*E. robusta*	407296	6373817	0.45	20	
4	*E. robusta*	407284	6373814	0.50	22	
5	*E. robusta*	407285	6373806	0.40	18	
6	*E. robusta*	407290	6373799	0.40	20	
7	*E. robusta*	407283	6373796	0.35	20	
8	*E. robusta*	407283	6373790	0.5	20	
9	*E. robusta*	407283	6373785	0.45	17	
10	*E. robusta*	407289	6373777	0.40	20	
11	*E. robusta*	407281	6373781	0.5	20	
12	*E. robusta*	407275	6373782	0.5	20	Scratches on trunk consistent with that of a Koala. Tree has a lean.
13	*E. robusta*	407262	6373785	0.7	20	Scratches on trunk consistent with that of a Koala.
14	*E. robusta*	407256	6373805	0.5	18	
15	*E. robusta*	407273	6373839	0.5	20	Scratches on trunk consistent with that of a Koala. Likely Koala pock marks on nearby Paperbarks.
16	*E. robusta*	407279	6373851	0.55	20	
17	*E. robusta*	407289	6373890	0.50	18	
18	*E. robusta*	407293	6373893	0.60	20	

Tree No.	Tree species	Location GDA 94 E	Location GDA 94 N	DBH (M)	Height (M)	Evidence of Koala Activity
19	*E. robusta*	406519	6373538	0.25	16	

No Koalas were recorded within the study area during the survey period. According to database records contained in the BioNet NSW Atlas (OEH, 2017) and Hunter Koala Preservation Society (Hunter Koala Preservation Society, 2015) a small number of records of Koalas occur within proximity to the study area. Relatively recent records of Koalas have been recorded from 2015 & 2016 within the vicinity of the Shark & Ray Centre approximately 200m to the north-west of the site (OEH, 2017). Koalas have also been killed on Nelson Bay Road 200m south of Marsh Road and in the front of Murrays Brewery (no dates given).

According to the CKPoM Koala Habitat Planning Map habitat within the vicinity of the Shark and Ray Centre has been mapped as Secondary Habitat, however given the presence of Swamp Sclerophyll Forest containing specimens of *E. robusta* this area should be mapped as Preferred Koala Habitat.

14.23 ASSESSMENT OF THE PROPOSAL

There are eight performance criteria applied to developments proposed on sites that contain or are adjacent to 'Preferred Koala Habitat', Supplementary Koala Habitat', 'Habitat Buffers', 'Habitat Linking Areas' or areas that contain preferred Koala feed tree species. Each criterion is displayed in italics followed by the site-specific answer.

The proposed development must:

a) Minimise the removal or degradation of native vegetation within Preferred Koala Habitat or Habitat Buffers.

Preferred Koala Habitat occupied two relatively small areas of Swamp Sclerophyll Forest within the study area. A 50m buffer over supplementary habitat would also need to be put in place around these areas of Preferred Koala Habitat. The proposed sand mine will not directly impact on these two areas of Preferred Koala Habitat. As stated in Section 14.5.1.2 the areas of preferred Koala Habitat may be subject to secondary impacts as the proposal will require excavation below the groundwater level potentially affecting the groundwater dependent Swamp Sclerophyll Forest Assemblage. An assessment undertaken (Martins, 2015) found the drawdown threshold is met for vegetation communities exclusively reliant on groundwater. Consequently, the change in groundwater levels should not significantly impact on the areas of Preferred Koala Habitat.

b) Maximise retention and minimise degradation of native vegetation within Supplementary Koala Habitat and Habitat Linking Areas;

Approximately 25.90ha of Supplementary Koala Habitat will be required to be removed for the proposed sand mine. No Habitat Linking Areas are required to be removed. Staged remediation of the impact area will over time restore areas of Supplementary Habitat lost as a result of sand mining.

c) *Minimise the removal of any individuals of preferred Koala food trees, wherever they occur on a development site. In the Port Stephens LGA these tree species are Eucalyptus robusta (Swamp Mahogany), Eucalyptus parramattensis (Parramatta Red Gum) and Eucalyptus tereticornis (Forest Red Gum);*

One species of recognised Preferred Koala Food Tree, *Eucalyptus robusta* (Swamp Mahogany) was found to be present within the study area. Areas of Swamp Sclerophyll Forest within the study area were found to contain a total of 19 specimens of *E. robusta.* None of these species are required to be removed as a result of the proposal.

d) *Make provisions, where appropriate, for restoration or rehabilitation of areas identified as Koala Habitat including Habitat Buffers and Habitat Linking Areas over Mainly Cleared Land;*

Staged remediation of the impact area will over time restore areas of Supplementary Habitat lost as a result of sand mining. Specimens of *Eucalyptus robusta* are also to be planted into the cleared areas of pasture/grasses within the far north-east of the study area (Lot 51) to enhance the adjoining area of Preferred Koala habitat within Lot 10 and to provide a better linkage to larger areas of preferred Koala to the north over Marsh Road.

e) *Make provisions for long term management and protection of Koala habitat including both existing and restored habitat;*

Native vegetation occurring outside the proposed areas of disturbance will be protected and enhanced. Weeds such as Bitou Bush and Lantana will be controlled. Staged remediation of the impact area will over time restore areas of Supplementary Habitat lost as a result of sand mining. A habitat management plan will be implemented to assist in the long-term management of areas of habitat within the study area.

f) *Not compromise the potential for safe movement of Koalas across the site. This should include maximising tree retention generally and minimising the likelihood that the proposal would result in the creation of barriers to Koala movement, such as would be imposed by certain types of fencing;*

To allow for the safe movement of Koalas it is recommended that:

- The sand mine disturbance area be cordoned off by the use of Koala barrier fencing to prevent any Koalas straying into the path of machinery or trucks;
- Removal of unwanted fences and non-use of barbed-wire within the study area;
- Weed Control.

g) Be restricted to identified envelopes which contain all buildings and infrastructure and fire fuel reduction zone;

The footprint of the proposal is to be limited to the extraction area and associated infrastructure such as access roads.

h) Include measures to effectively minimise the threat posed by Koalas by dogs, motor vehicles and swimming pools.

A number of measures will be implemented within the development to minimise the threat to Koalas. These measures will include:

- The sand mine disturbance area be cordoned off by the use of Koala barrier fencing to prevent any Koalas straying into the path of machinery/trucks or drowning in steep sided ponds;
- It is recommended that low speed limits and Koala warning signage be placed along the internal access roads to reduce the chance of vehicle collision;
- Dogs are to be restricted within the mine site;
- Feral Dogs are to be controlled within the study area (will require co-operation from surrounding landholders).

14.24 COASTAL MANAGEMENT SEPP

A key aim of the Coastal Management SEPP (CM SEPP) is to promote an integrated and co-ordinated approach to land use planning in the coastal zone in a manner consistent with the objects of the Coastal Management Act 2016, including the management objectives for each coastal management area, by:

- managing development in the coastal zone and protecting the environmental assets of the coast;
- establishing a framework for land use planning to guide decision-making in the coastal zone, and
- mapping the 4 coastal management areas that comprise the NSW coastal zone for the purpose of the definitions in the Coastal Management Act 2016.

The Coastal Management SEPP identifies four coastal management areas that comprise the coastal zone. These are:

- the coastal wetlands and littoral rainforests area,
- the coastal vulnerability area,
- the coastal environment area, and
- the coastal use area.

The CM SEPP imposes targeted development controls for these areas to guide appropriate development within the coastal zone.

The study area was not located within littoral rainforests/coastal wetlands, coastal vulnerability or coastal use management areas. However, a small portion of the highly disturbed north-west of the site (Lot 51) was located within a mapped Coastal Environment and Coastal Wetland Proximity areas (Figure 14.19).

Development on land in proximity to coastal wetlands:

(1) Development consent must not be granted to development on land identified as "proximity area for coastal wetlands" or "proximity area for littoral rainforest" on the Coastal Wetlands and Littoral Rainforests Area Map 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 littoral rainforest, or

(b) the quantity and quality of surface and ground water flows to and from the adjacent coastal wetland or littoral rainforest.

(2) This clause does not apply to land that is identified as "coastal wetlands" or "littoral rainforest" on the Coastal Wetlands and Littoral Rainforests Area Map.

Figure 14.19 - Location of SEPP (Coastal Management) areas

The portion of the study area within the north of Lot 51 was also found to contain a "Proximity Area" for coastal wetlands (No. 808a) which occurs along Tilligerry Creek to the north over Marsh Road. As this portion of the study area occurs well outside the development footprint the proposal is unlikely to impact the biophysical, hydrological or ecological integrity of the adjacent coastal wetland or effect quantity and quality of surface and ground water flows to and from the adjacent coastal wetland. The proposal to enhance this highly disturbed area though planting of native vegetation will further enhance this area.

As the study area is located within a mapped area of "Coastal Environment Area", the development controls for this area, as listed within Division 4 of the CM SEPP have been addressed below.

(1) Development consent must not be granted to development on land that is within the coastal environment area unless the consent authority has considered whether the proposed development is likely to cause an adverse impact on the following:

- the integrity and resilience of the biophysical, hydrological (surface and groundwater) and ecological environment,
- coastal environmental values and natural coastal processes,
- 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,
- marine vegetation, native vegetation and fauna and their habitats, undeveloped headlands and rock platforms,
- existing public open space and safe access to and along the foreshore, beach, headland or rock platform for members of the public, including persons with a disability,
- Aboriginal cultural heritage, practices and places; and
- the use of the surf zone.

As this portion of the study area occurs well outside the development footprint the proposal is unlikely to have an adverse impact on the above points. The proposal to enhance this highly disturbed area though planting of native vegetation will further enhance this area.

14.25 AQUATIC ECOLOGY

Aquatic Habitat Within the Study Area

No watercourses were noted onsite, however lower lying poorly drained areas of ground in the far north of the study area contained some surface water particularly after heavy rains. These poorly drained regions of surface water were associated with areas of Swamp Forest and Freshwater Wetland. The north-west portion drains to the north-west via small narrow constructed drains into a large dam on the neighbouring Shark and Ray Centre property or into the drainage network of Tilligerry Creek.

Aquatic Survey and Assessment

14.25.1.1 Water Quality

Water quality was assessed within the wetland in the north-west and a small narrow constructed drain within Swamp Sclerophyll Forest in the north of the study area. Physical water quality measurements were sampled in situ at each site on 30 May 2014. Water quality was measured using a Horiba U 50 Water Meter. Parameters measured included pH, temperature, Oxidation Reduction Potential (ORP), Dissolved Oxygen (mg/L DO), Dissolved Oxygen (DO%), Conductivity (dS/m), Turbidity TDU, Total Dissolved Solids (TDS) and Salinity. The water parameters are shown in Table 14.19.

Table 14.19 - Surface water quality measurements within the study area.

Water parameter	Wetland GDA 94 E – 407136 N - 6373899	Narrow Drain GDA 94 E – 406502 N - 6373564
Temperature 0C	16.93	16.8
pH	6.22	5.90
Oxidation Reduction Potential (ORP) pHmV	-3.9	-58
Dissolved Oxygen (mg/L DO)	7.21	0.92
Dissolved Oxygen (DO%),	74.4	9.8
Conductivity (dS/m),	0.414	0.321
Turbidity TDU	92	11
Total Dissolved Solids g/L TDS	0.269	0.212
Salinity ppt	0.2	0.2

The areas of surface water quality were found to be in relatively good condition.

14.26 FISHERIES MANAGEMENT ACT (FM Act)

The objectives of the Fisheries Management Act (FM Act) are to conserve, develop and share the fishery resources of the state for the benefit of present and future generations. Part 7A of the Fisheries Management Act 1994 (FM Act 1994) provides for the listing of threatened species,

populations and endangered ecological communities. Table 14.20 lists the threatened species and endangered populations that may occur in the local area.

Table 14.20 - Threatened Species and Populations that may occur within 10km of the proposal.

SPECIES	FM ACT 1994	HABITAT PREFERRED	HABITAT PRESENT
Macquaria australasica (Macquarie Perch)	E	Occurs naturally in western flowing drainages from the Lachlan River southward into Victoria.	No suitable habitat was present.
The Darling River Hardyhead (*Craterocephalus amniculus*) population in the Hunter River catchment	EP	They are usually found in slow flowing, clear, shallow waters or in aquatic vegetation at the edge of such waters. The species has also been recorded from the edge of fast flowing habitats such as the runs at the head of pools.	No suitable habitat was present.
Mogurnda adspersa (Purple Spotted Gudgeon)	EP	Rivers Creeks and billabongs, usually in quite or slow flowing sections over rocks or among vegetation.	No suitable habitat was present.
Carcharias taurus Greynurse Shark -	CE	Temperate waters of all oceans except the eastern Pacific. Habitat along the length of the NSW coast.	No suitable habitat was present.
Epinephelus daemelii Black Rockcod	V	Found in warm temperate and subtropical parts of the south-western Pacific.	No suitable habitat was present.
Austrocordulia leonardi Sydney Hawk Dragonfly -	V	Known only from the Hawkesbury-Nepean, Georges River and Port Hacking drainages.	No suitable habitat was present.
Archaeophya adamsi Adam's emerald dragonfly	E	Narrow, shaded riffle zones with moss and abundant riparian vegetation	No suitable habitat was present.

CE= Critically Endangere E=Endangered Species V=Vulnerable Species EP=Endangered Population

Seven-Part Test for Threatened Aquatic Species

For the purposes of the Environmental Planning and Assessment Act 1979 and, in particular, in the administration of sections 78, 79 and 112, the following factors have been taken into account in deciding whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats:

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

No suitable habitat was considered to be present for any of the currently listed threatened aquatic species. Only a small amount of freshwater habitat was present in the form of an area of freshwater wetland in the north-west and a narrow drain within swamp sclerophyll forest in the north of the study area. The proposal is not likely to have a significant impact on any listed threatened species under the FM Act.

b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

No habitat was available for any endangered populations listed under the FM Act.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.

No Endangered ecological community listed under the FM Act is likely to be impacted by the proposal.

d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and
(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

No area of aquatic habitat will be directly impacted by the proposed sand mine. No areas of aquatic habitat are considered likely to become fragmented or isolated as a result of the proposal.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

None of the site has been designated 'critical habitat'.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

No recovery or threat abatement plan is pertinent to the proposed action.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The 'Key Threatening Processes' currently listed on the schedules of the FM Act that are relevant to the site have been listed in bold below followed by an assessment of the applicability of the threatening process in regards to the proposal:

- The introduction of fish to fresh waters within a river catchment outside their natural range.

Specimens of *Gambusia holbrooki* (Plague Minnow) were recorded during periods of higher water levels after rain within the vicinity of the freshwater Wetland. The proposal is unlikely to increase numbers if this introduced fish species or result in any new introductions.

14.27 CONSIDERATIONS UNDER THE COMMONWEALTH ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999

Considerations have been made to the Commonwealth Environment Protection and Biodiversity Conservation (EPBC) Act 1999. Assessments have been made to determine whether or not the proposal or activity has, will have, or is likely to have a significant impact on a matter of National Environmental Significance. The matters of National Environmental Significance and the appropriate responses are listed below:

- *World Heritage properties;*

The proposed development is not considered to affect any World Heritage properties.

- *wetlands recognised under the Ramsar convention as having international significance;*

The Hunter Estuary Wetland Ramsar site is located approximately 18km to the south-west of Bobs Farm. There is no likely hydrological connection between the study area and the Hunter Estuary.

- *listed threatened species and communities;*

No nationally threatened communities were considered to be present within the study area. There was one EPBC Act Listed Threatened Species, *Pteropus poliocephalus* (Grey-headed Flying-fox) listed as Vulnerable, recorded within the study area. An additional species, *Phascolarctos cinereus* (Koala) also listed as Vulnerable was identified as utilising the study area from the presence of secondary evidence in the form of scratches on trees in the north-east of the study area.

- *listed as Vulnerable was recorded foraging within the site during fieldwork, and*

No other nationally threatened species were recorded on site during the survey, however 36 nationally threatened species were recorded on the DoEE database as occurring or having potential habitat available within 10km of the site, these being:

- *Cryptostylis hunteriana* (Leafless Tongue Orchid)
- *Allocasuarina defungens* (Dwarf Heath Casuarina)
- *Diuris praecox* (Newcastle Doubletail)
- *Angophora inopina* (Charmhaven Apple)
- *Eucalyptus parramattensis* subsp. *decadens* (Drooping Red Gum)
- *Melaleuca biconvexa* (Biconvex Paperbark)
- *Prostanthera densa* (Villous Mintbush)
- *Tetratheca juncea* (Black-eyed Susan)

- *Litoria aurea* (Green and Golden Bell Frog)
- *Mixophyes balbus* (Stuttering Frog)
- *Caretta caretta* (Loggerhead Turtle)
- *Chelonia mydas* (Green Turtle)
- *Dermochelys coriacea* (Leatherback Turtle)
- *Eretmochelys imbricate* (Hawksbill Turtle)
- *Natator depressus* (Flatback Turtle)
- *Diomedea antipodensis* (Antipodean Albatross)
- *Diomedea gibsoni* (Gibson's Albatross)
- *Lathamus discolor* (Swift Parrot)
- *Macronectes giganteus* (Southern Giant-Petrel)
- *Macronectes halli* (Northern Giant-Petrel)
- *Pterodroma neglecta neglecta* (Kermadec Petrel) (Western)
- *Thalassarche bulleri* (Buller's Albatross)
- *Thalassarche cauta cauta* (Shy Albatross)
- *Thalassarche salvini* (Salvin's Albatross)
- *Thalassarche steadi* (White-capped Albatross)
- *Thalassarche impavida* (Campbell Albatross)
- *Rostratula benghalensis australis* (Australian Painted Snipe)
- *Anthochaera phrygia* (Regent Honeyeater)
- *Chalinolobus dwyeri* (Large-eared Pied Bat)
- *Phascolarctos cinereus* (Koala)
- *Dasyurus maculatus maculatus* (Tiger Quoll)
- *Potorous tridactylus tridactylus* (Long-nosed Potoroo)
- *Pteropus poliocephalus* (Grey-headed Flying Fox)
- *Pseudomys novaehollandiae* (New Holland Mouse)
- *Eubalaena australis* (Southern Right Whale)
- *Megaptera novaeangliae* (Humpback Whale)

With the exception of the sea bird species, marine mammals and reptiles and the flora species *P. densa*, *A. defungens* and *T. juncea* the study area was considered to contain suitable habitat of varying quality for the remainder of the listed species. Of the remaining listed species those species most likely to occur/utilise the study area were *D. praecox*, *P. novaehollandiae* and *D. maculatus maculatus*. All nationally listed threatened species found within the site and considered most likely to occur within the site are assessed below.

14.28 *PTEROPUS POLIOCEPHALUS* (GREY-HEADED FLYING-FOX)

The Grey-headed Flying-fox was observed within the study area on a number of occasions. Large numbers of Grey-headed Flying-foxes were observed feeding on flowering *Eucalyptus pilularis* (Blackbutt) throughout the study area in February 2015. The Grey-headed Flying-fox

was also recorded feeding within the study area on flowering specimens of *Eucalyptus robusta* (Swamp Mahogany) and *Melaleuca quinquenervia* (Broad-leaved Paperbark). One deceased specimen had been entangled within a barbed-wire fence surrounding the orchard. Although suitable camp sites were considered to be present within the study area no roosting individuals were observed. Grey-headed Flying-foxes were noted to be largely originating from a large temporary camp located near the corner of Cromarty and Upton Lanes approximately 2km to the east of the study area.

An assessment in accordance with the DoEE principal significant impact guidelines is provided below for the Grey-headed Flying-fox.

Under the EPBC Act Policy Statement 1.1 – Significant Impact Guidelines (DoE, 2013) an action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- *lead to a long-term decrease in the size of an important population of a species*

The site does not support an important population of this species. Although the proposal will involve the removal of 25.90ha of seasonal foraging habitat, the proposal is unlikely to decrease the size of an important population.

- *reduce the area of occupancy of an important population*

The proposal will result in the removal of 25.90ha of seasonal foraging habitat for the Grey-headed Flying-fox resulting in a reduction within the local area. No known camp sites will be impacted. Despite the loss of seasonal foraging habitat, the proposal is unlikely to significantly reduce the area occupancy of an important population of the Grey-headed Flying-fox.

- *fragment an existing important population into two or more populations*

The study area forms part of a significant ecological corridor that runs down the coast from the Tomago Sandbeds in the south along the Stockton Bight to the Tomaree Peninsula in the north. The proposal will result in the removal of 25.90ha of seasonal foraging habitat for the Grey-headed Flying-fox resulting in a substantial reduction within the local area. However, no areas of habitat will become isolated for this highly mobile species.

- *adversely affect habitat critical to the survival of a species*

The proposal will result in the removal of 25.90ha of seasonal foraging habitat resulting in an incremental reduction within the local area. No known camp sites were noted within the study area. Whilst resulting in a loss of seasonal foraging habitat the proposal is unlikely to adversely affect habitat critical to the survival of the Grey-headed Flying-fox.

- *disrupt the breeding cycle of an important population*

The study area was not found to support camps belonging to this species, therefore proposal is not expected to result in any actions that would disrupt the breeding cycle of these species.

- *modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline*

The proposal will result in the removal of 25.90ha of seasonal foraging habitat resulting in a substantial reduction within the local area. However, the proposal is unlikely to modify, destroy,

remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

- *result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat*

The proposal is unlikely to result in an invasive species that is harmful to the Grey-headed Flying-fox from becoming established in the vulnerable species habitat.

- *introduce disease that may cause the species to decline, or*

The proposal is unlikely to result in the introduction of disease that may cause the Grey-headed Flying-fox to decline.

- *interfere substantially with the recovery of the species.*

A number of mitigation measures have been given to reduce the impact of the proposed sand mine on the Grey-headed Flying-fox. These include:

- Protection of remaining habitat/vegetation;
- Rehabilitation of habitat within extraction area;
- Reduction of ongoing mine impacts such as noise and artificial lighting.
- Removal and non-use of barbed-wire

The proposal is unlikely to interfere substantially with the recovery of the Grey-headed Flying-fox.

Conclusion

The proposal will result in the removal of seasonal foraging and areas of suitable roosting habitat for *P. poliocephalus.* Given the absence of known camp sites within the study area and relative abundance of similar food resources in the local area for this highly mobile species the proposal is unlikely to significantly impact upon *P. poliocephalus*.

14.29 PHASCOLARCTOS CINEREUS (KOALA)

No Koalas were directly observed within the study area during fieldwork completed for this report or previous reports (Wildthing Environmental Consultants, 2009). However, evidence of Koala activity in the form of characteristic scratches on the trunks of a very small number of specimens of *Eucalyptus robusta* (Swamp Mahogany), a preferred feed tree species under the Port Stephens Comprehensive Koala Plan of Management CKPoM, was present within the area of Swamp Forest in the far east of the study area. *Eucalyptus robusta* was the only preferred Koala Feed Tree Species recorded within the study area. No Koala faecal pellets were found within the study area despite a search beneath every individual specimen of *E. robusta* (a total of 19 trees) and searches conducted over the entire study area during the hollow-bearing tree survey.

An assessment in accordance with the DoEE principal significant impact guidelines is provided below for the Koala. Referral Assessment of the Koala under the EPBC Act can be found in Section 14.11.1 of this report.

Under the EPBC Act Policy Statement 1.1 – Significant Impact Guidelines (DoE, 2013) an action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

- *lead to a long-term decrease in the size of a population*

No Koalas were directly observed within the study area during fieldwork completed for this report or previous reports (Wildthing Environmental Consultants, 2009). However, evidence of Koala activity in the form of characteristic scratches on the trunks of a small number of specimens of *Eucalyptus robusta* (Swamp Mahogany) a preferred feed tree species under the Port Stephens Comprehensive Koala Plan of Management CKPoM and *Melaleuca quinquenervia* (Broad-leaved Paperbark) were present within the area of Swamp Forest in the north of the study area. Accordingly, a Koala assessment was conducted in the study area to assess the level of current koala activity. *Eucalyptus robusta* was the only preferred Koala Feed Tree Species recorded within the study area. No Koala faecal pellets were found within the study area despite a search beneath every individual specimen of *E. robusta* (a total of 19 trees) and searches conducted over the entire study area during the hollow-bearing tree survey. The proposal will result in an incremental reduction of secondary habitat within the local area, however given the fact that no Preferred Koala Feed Tree Species are required to be removed and lack of Koala sightings within the study area the development is unlikely to lead to a long-term decrease in the size of a Koala population.

- *reduce the area of occupancy of the species*

The proposal will result in the removal of approximately 25.90ha of Supplementary Koala Habitat largely resulting in an incremental reduction of secondary habitat within the local area, however given the fact that no Preferred Koala Feed Tree Species are required to be removed and lack of Koala sightings within the study area the development is unlikely to significantly reduce the area occupancy of the Koala.

- *fragment an existing population into two or more populations*

The site is part of a large, connected area of native vegetation. The proposal will result in the removal of approximately 25.90ha of Supplementary Koala Habitat largely consisting of Coastal Sand Apple Blackbutt Forest from the north-east section of the corridor. The section of the corridor where the study area is located is approximately 1.5km wide. The proposal will result in the reduction in the width of the corridor by approximately 600m (the majority of habitat occurring on the northern side of the dual carriage way of Nelson Bay Road). The wider southern portion of the regional corridor occurring south of Nelson Bay Road is located on the protected Worimi Conservation Lands. No Habitat Linking Areas under the CKPoM are required to be removed.

During all ecological surveys within the site no Koalas were observed within the site however, secondary evidence in the form of scratches on a small number of specimens of *Eucalyptus robusta* (Swamp Mahogany) were recorded in the far north-east of site outside development area. Despite targeted searches beneath every individual specimen of *E. robusta* (a total of 19 trees) and searches conducted over the entire study area during the hollow-bearing tree survey, no Koala faecal pellets were found within the study area. As a precaution any similar sized scats were sent for analysis to Barbara Triggs, but were identified as belonging to Common Brushtail Possum. The proposal will require the clearing of 25.90ha of Secondary Koala habitat. However, Preferred Koala Habitat under the definition of the CKPoM occupied two relatively small areas of Swamp Sclerophyll Forest within the study area. A 50m buffer over supplementary habitat would also need to be put in place around these areas of Preferred

Koala Habitat. The proposed sand mine will be situated within part of the buffer of these two areas. The proposal is unlikely to fragment an existing population of Koala.

- *adversely affect habitat critical to the survival of a species*

A total of 19 specimens of one Koala Food Tree Species *Eucalyptus robusta* (Swamp Mahogany) were found to be present within the smaller vegetation assemblage within the study area; Swamp Sclerophyll Forest. These 19 specimens occur outside the development footprint and will not be impacted. No habitat critical to the survival of the Koala will likely be removed.

- *disrupt the breeding cycle of a population*

The proposal is not expected to result in any actions that would disrupt the breeding cycle of the Koala.

- *modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline*

The proposal will result in the removal of approximately 25.90ha of Supplementary Koala Habitat. No Preferred Koala Habitat will be removed. Whilst resulting in a decline in secondary habitat the proposal is unlikely to significantly modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the Koala is likely to decline

- *result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat*

Due to the nature of the proposal it is unlikely that the proposal will result in an increase in harmful invasive species within the site.

- *introduce disease that may cause the species to decline, or*

Due to the nature of the proposal, it is unlikely to further facilitate the introduction or spread of disease or pathogens. If during the clearance phase a Koala is located and observed to be displaying evidence of disease then the Koala is to be taken for a thorough veterinary health examination.

- *interfere with the recovery of the species.*

A number of recommendations have been given to reduce the impact of the proposal on the local population of Koalas in the local area. These recommendations are:

- specimens of *Eucalyptus robusta* are to be planted into the cleared areas of pasture/grasses within the far east of the study area to enhance the adjoining area of Preferred Koala habitat within Lot 10 and to provide a better linkage to larger areas of preferred Koala to the north over Marsh Road.

- It is recommended that the sand mine disturbance area be cordoned off by the use of Koala barrier fencing to prevent any Koalas straying into the path of machinery or trucks.

- It is recommended that low speed limits and Koala warning signage be placed along the internal access roads to reduce the chance of vehicle collision.

- Dogs are to be controlled within the study area.

- Protection of remaining habitat/vegetation;
- Rehabilitation of habitat within extraction area;
- Reduction of ongoing mine impacts such as noise and artificial lighting.
- Removal and non-use of barbed-wire within the study area;
- Protection of the Koala during vegetation clearance;
- Provision of compensatory habitat (Offsetting);
- Feral Vertebrate Pest Control;
- Weed Control.

Conclusion

The proposal will result in the removal of 25.90ha of Coastal Sand Apple Blackbutt Forest which was identified as Supplementary Koala Habitat under the Port Stephens CKPoM. Two areas of Swamp Sclerophyll Forest identified as preferred Koala Habitat lie outside the sand mine footprint and will not be directly impacted. No preferred Koala Feed Tree Species will be removed as a result of the proposal. Taking the recommendations pertaining to the Koala into consideration the proposal is unlikely to have a significant impact on the Koala.

EPBC Act Referral Guidelines for the Vulnerable Koala

Action: Proposed sand mine within Lots 10 & 11 DP 1071458, Lot 51 DP 1015671 and Lot 245 DP 753204 Nelson Bay Road, Bobs Farm NSW.

Context: Coastal.

Associated infrastructure: Access roads.

Primary impacts: Habitat loss (clearing), habitat fragmentation, habitat degradation, vehicle strike, dog attack.

Impact area size: 25.90ha

Table 14.21 - EPBC Act Referral Guidelines - Koala Habitat Assessment Tool.

Attribute	Score	Habitat Appraisal	
Koala Occurrence	**+1 (Medium)**	Desk Top	According to database records contained in the BioNet NSW Atlas (OEH, 2017) and Hunter Koala Preservation Society (Hunter Koala Preservation Society, 2015) a small number of records of Koalas occur within proximity to the study area. Relatively recent records of Koalas have been recorded from 2015 and 2016 within the vicinity of the Shark & Ray Centre approximately 200m to the north-west of the site (OEH, 2017). Koalas have also been killed on Nelson Bay Road 200m south of Marsh Road and in the front of Murrays Brewery (no dates given).
		On Ground	Secondary evidence of Koala activity in the form of scratches on specimens of *Eucalyptus robusta* (Swamp Mahogany) were recorded in far north-east of site outside development area. However, no Koala faecal pellets were found within the study area despite a search beneath every individual specimen of *E. robusta* (a total of 19 trees) and searches conducted over the entire study area during the hollow-bearing tree survey. Potential Koala scats located within the site were sent for analysis but were identified as belonging to Common Brushtail Possum.
Vegetation Composition	**+1 (Medium)**	Desk Top	According to Port Stephens CKPoM the majority of the study area was mapped as Blackbutt and Smooth-barked Apple Open Forest (Figure 2.5 in Part 2: CKPoM Resource Document). Smaller areas of Mainly Cleared vegetation were present in the northern areas. A large portion of the field survey map was consistent with the LGA vegetation map however the LGA map neglects the presence of Swamp Sclerophyll Forest and Freshwater Wetland.
		On Ground	A total of 19 specimens of one Koala Food Tree Species *Eucalyptus robusta* (Swamp Mahogany) were found to be present within the smaller vegetation assemblage within the study area; Swamp Sclerophyll Forest. No other

Attribute	Score	Habitat Appraisal	
			feed tree species were recorded within the study area.
Habitat Connectivity	**+2 (High)**	Area is part of a contiguous ≥500ha. The study area forms part of a significant ecological corridor that runs down the coast from the Tomago Sandbeds in the south along the Stockton Bight to the Tomaree Peninsula in the north.	
Key Existing Threats	**0**	Desk Top	Ten Koala records within the vicinity of the study area were logged by Hunter Koala Preservation Society (Hunter Koala Preservation Society, 2015). Of these records four were found dead and one died within 24 hours of care from vehicle strike. Two of these Koalas were killed on Nelson Bay Road 200m south of Marsh Road and in the front of Murrays Brewery (no dates given). One Koala was killed on Nelson Bay Road about 500m East Cromarty Lane and another at 3551 Nelson Bay Road in sand hills near first u-turn bay. The koala that died in care was hit at Nelson Bay Road about 200m West Helenvale Lane. Another Koala was also hit by a vehicle on Nelson Bay Road at the junction of Cromarty Lane and recovered in care. This Koala was then released. Also, according to records from the Koala Preservation Society (2015) one Koala was located at 3819 Nelson Bay Road, Bobs Farm and relocated due to the threat of dog attack.
		On Ground	Video footage of *Canis lupus familiaris* (Wild Dog), *Felis catus* (Feral Cat) and *Vulpes vulpes* (European Red Fox) utilising the site has been recorded within the study area (Table 16). Faecal pellets have also been identified from these species within the site (Table 15). Domestic dogs are also kept within the study area.
Recovery Value	**+1 (Medium)**	The site is part of a large, connected area of native vegetation. The proposal will result in the removal of approximately 25.90ha of Supplementary Koala Habitat largely consisting of Coastal Sand Apple Blackbutt Forest from the north-east section of the corridor. The section of the corridor where the study area is located is approximately 1.5km wide. The proposal will result in the reduction in the width of the corridor by approximately 600m (the majority of habitat occurring on the northern side of the dual	

Attribute	Score	Habitat Appraisal
		carriage way of Nelson Bay Road). The wider southern portion of the regional corridor occurring south of Nelson Bay Road is located on the protected Worimi Conservation Lands. No Habitat Linking Areas under the CKPoM are required to be removed. It is therefore uncertain whether the habitat is important for achieving the interim recovery objectives.
Total	**5**	**Decision: Habitat critical to the survival of the koala—assessment of significance required (sections 14.7 and 14.8).**

Section 7 - Will your Action Adversely Affect Habitat Critical to the Survival of the Koala?

Impacts uncertain, referral decision depends on the nature of the action:

- *The score calculated for the impact area (higher score = greater risk of significant impact).* Score = 5.
- *Amount of koala habitat being cleared (more habitat cleared = greater risk of significant impact).*

Proposed amount of Secondary Koala Habitat being cleared = 25.90ha.

- *Method of clearing (i.e. clear-felling has greater risk of significant impact than selective felling with understorey and koala food tree retention).*

Method of clearing will involve clear-felling of the designated clearance zone, which will be clearly marked (no large-scale tree felling will take place). All trees to be removed will be clearly marked. Koala surveys are to be undertaken prior to any clearance within the site. If a Koala is observed within the site then a 100m radius exclusion zone is to be implemented and a spotter to be stationed observing the koala's movements. The clearance zone will firstly be underscrubbed, then all non-habitat trees will be felled. Habitat trees will be the last to be cleared with the presence of a suitably qualified ecologist inspecting all trees prior and immediately after felling of the habitat tree. Rescued fauna is to be relocated outside of the clearance zone into adjoining habitat.

- *The density or abundance of koalas (relatively high density or abundance for the region means greater risk of significant impact).*

During all ecological surveys within the site no Koalas were observed within the site however, secondary evidence in the form of scratches on specimens of *Eucalyptus robusta* (Swamp Mahogany) was recorded in the far north-east of site outside development area. Despite targeted searches beneath every individual specimen of *E. robusta* (a total of 19 trees) and searches conducted over the entire study area during the hollow-bearing tree survey, no Koala faecal pellets were found within the study area. As a precaution any similar sized scats were sent for analysis but were identified as belonging to Common Brushtail Possum. It can be assumed that the density of Koalas occurring within the locality would be low.

- *Level of fragmentation caused by the clearing (greater degree of fragmentation has greater risk of significant impact).*

The proposal will require the clearing of 25.90ha of Secondary Koala habitat. However, Preferred Koala Habitat under the definition of the CKPoM occupied two relatively small areas of Swamp Sclerophyll Forest within the study area.

DECISION: Although a score of 5 was given, the outcome of the assessment was deemed – Referral Not Recommended.

Section 8 - Could your Action Interfere Substantially with the Recovery of the Koala?

Impacts which are likely to substantially interfere with the recovery of the koala may include one or more of the following:

- *Increasing koala fatalities in habitat critical to the survival of the koala due to dog attacks to a level that is likely to result in multiple, ongoing mortalities.*

Proposed mitigating measure: It is unlikely the proposal will increase the presence of dogs within the vicinity of the sand mine. Employees of the sand mine should not be permitted to bring dogs to work.

Effectiveness = High

- *Increasing koala fatalities in habitat critical to the survival of the koala due to vehicle-strikes to a level that is likely to result in multiple, ongoing mortalities.*

Proposed mitigating measure: Low speed limits and Koala warning signage be placed along roads within the development. It is also recommended the sand mine disturbance area be cordoned off by the use of Koala proof barrier fencing to prevent any Koalas straying into the path of machinery or trucks

Effectiveness = High

- *Facilitating the introduction or spread of disease or pathogens for example Chlamydia or Phytophthora cinnamomi, to habitat critical to the survival of the koala, that are likely to significantly reduce the reproductive output of koalas or reduce the carrying capacity of the habitat.*

The proposal is unlikely to further facilitate the introduction or spread of disease or pathogens. Proposed mitigating measure: If during the clearance phase a Koala is located and observed to be displaying evidence of disease then the Koala is to be taken for a thorough veterinary health examination.

Effectiveness = High

- *Creating a barrier to movement to, between or within habitat critical to the survival of the koala that is likely to result in a long-term reduction in genetic fitness or access to habitat critical to the survival of the koala.*

Proposed mitigation measure: Planting of specimens of *Eucalyptus robusta* (Swamp Mahogany) within the northern portion of Lot 51 to enhance Koala habitat within the study area and increase the connectivity for Koalas between preferred Koala Habitat within the study area to areas of Preferred Koala Habitat over Marsh Road.

Effectiveness = Moderate

- *Changing hydrology which degrades habitat critical to the survival of the koala to the extent that the carrying capacity of the habitat is reduced in the long-term.*

As stated in Section 14.5.1.2 of this report the areas of preferred Koala Habitat may be subject to secondary impacts as the proposal will require excavation below the groundwater level potentially affecting the groundwater dependent Swamp Sclerophyll Forest Assemblage. An assessment undertaken (Martins, 2015) found the drawdown threshold is met for vegetation communities exclusively reliant on groundwater. Consequently, the change in groundwater levels should not significantly impact areas of Preferred Koala Habitat.

DECISION: Given the mitigating measures are implemented the outcome of the assessment was deemed – Referral Not Recommended.

Section 9 - Could your Action Require a Referral to the Minister for Significant Impacts on the Koala?

The decision as to whether your proposed action will have or is likely to have a significant impact on the koala will come down two key considerations outlined in these guidelines:

- *Adversely affecting habitat critical to the survival of the koala (section 7) AND/OR*

DECISION: Although a score of 5 was given, the outcome of the assessment it was deemed – Referral Not Recommended.

- *Interfering substantially with the recovery of the koala through the introduction or exacerbation of key threats in areas of habitat critical to the survival of the koala (section 14.8).*

DECISION: Given the mitigating measures are implemented the outcome of the assessment was deemed – Referral Not Recommended.

Hence referral is not recommended for adversely affecting habitat critical to the survival of the Koala.

14.30 CRITICALLY ENDANGERED SPECIES CONSIDERED TO HAVE POTENTIAL HABITAT WITHIN THE STUDY AREA

The following EPBC Act listed endangered and critically endangered species respectively are considered in this assessment:

- *Lathamus discolor* (Swift Parrot)

- *Anthochaera phrygia* (Regent Honeyeater)

The Swift Parrot is generally more commonly recorded inland from the coast, however, is known to come to the coast during drier inland periods or as a result of seasonal movements. Specimens of the large flowered *Eucalyptus robusta* (Swamp Mahogany) which were present within the study area would provide seasonal preferred coastal foraging habitat for the Swift Parrot. There is a National Recovery Plan for the Swift Parrot (Saunders & Tzaros, 2011). Overall objectives include:

- To prevent further decline of the Swift Parrot population; and to
- To achieve a demonstrable sustained improvement in the quality and quantity of Swift Parrot habitat to increase carrying capacity.

Although the Regent Honeyeater is usually recorded within inland area it is also known to come to the coast during events such as drier inland weather periods. This honeyeater has been recorded nearby to the study area at Tanilba Bay on 8 June 2014 feeding on flowering specimens of *Eucalyptus robusta* (Swamp Mahogany) (Port Stephens Examiner, 2014). There is a National Recovery Plan for the Regent Honeyeater (DoE, 2016). The Recovery plan objectives include:

- Reverse the long-term population trend of decline and increase the numbers of regent honeyeaters to a level where there is a viable, wild breeding population, even in poor breeding years; and to
- Enhance the condition of habitat across the regent honeyeaters range to maximise survival and reproductive success, and provide refugia during periods of extreme environmental fluctuation.

The strategies to achieve the recovery plan's objectives are to:

- Improve the extent and quality of regent honeyeater habitat;
- Bolster the wild population with captive-bred birds until the wild population becomes self-sustaining;
- Increase understanding of the size, structure, trajectory and viability of the wild population;
- Maintain and increase community awareness, understanding and involvement in the recovery program.

Under the EPBC Act Policy Statement 1.1 – Significant Impact Guidelines (DoE, 2013) an action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

- *lead to a long-term decrease in the size of a population*

Neither the Swift Parrot nor the Regent Honeyeater were recorded within the study area, however there is potential for these species to occur. According to the National Recovery Plan for the Swift Parrot (Saunders & Tzaros, 2011) two key foraging tree species within the Hunter-Central Rivers natural resource management region for the Swift Parrot, *Eucalyptus robusta* (Swamp Mahogany) and *Eucalyptus pilularis* (Blackbutt) are present within the site. Although the

proposal will not require the removal of any of the 19 *E. robusta* present within the site, it will result in the removal of a large number of *E. pilularis*, within 25.90ha of Coastal Sand Smooth-barked Apple Blackbutt Forest. Although this is viewed as not complying with the National Recovery Plan, given the relatively the high mobility of these birds, large amount of similar surrounding habitat the proposal is unlikely to result in the removal, modification, fragmentation or isolation of an area of habitat important to the long-term survival of the Swift Parrot.

According to the National Recovery Plan for the Regent Honeyeater (DoE, 2016) the probable major cause of long-term decline is the clearing and fragmentation of woodland and forest habitat containing the bird's preferred eucalypt species. Preferred foraging habitat within the study area would largely be confined to the small number of specimens of large flowering *Eucalyptus robusta* (Swamp Mahogany) occurring within the two areas of swamp sclerophyll forest. Although not listed as a key species utilised by the Regent Honeyeater under the National Recovery Plan, winter flowering specimens of *Eucalyptus pilularis* (Blackbutt) may also provide suitable transitory foraging habitat. No preferred foraging habitat in the form of *E. robusta* is required to be removed for the proposed sand mine. The proposal will result in a reduction in secondary seasonal foraging habitat within the local area, however it is unlikely to result in the extinction of any local population of this species.

- *reduce the area of occupancy of the species*

The proposal will result in the removal of 25.90ha of Coastal Sand Smooth-barked Apple Blackbutt Forest which contains a key foraging tree species *Eucalyptus pilularis* (Blackbutt) for the Swift Parrot and may act as seasonal transitory foraging habitat for the Regent Honeyeater. However, no Swift Parrots or Regent Honeyeaters were recorded during fieldwork undertaken within the study area.

- *fragment an existing population into two or more populations*

No areas of habitat will become isolated for these highly mobile species as a result of the proposal.

- *adversely affect habitat critical to the survival of a species*

According to the National Recovery Plan for the Swift Parrot (Saunders & Tzaros, 2011) two key foraging tree species within the Hunter-Central Rivers natural resource management region for the Swift Parrot, *Eucalyptus robusta* (Swamp Mahogany) and *Eucalyptus pilularis* (Blackbutt) are present within the site. Although the proposal will not require the removal of any of the 19 Swamp Mahogany specimens present within the site, it will result in the removal of a large number of Blackbutt, with 25.90ha of Coastal Sand Smooth-barked Apple Blackbutt Forest requiring removal. The site is also part of a large, connected area of native vegetation that contains similar floristic components to the study area, including specimens of Blackbutt that runs down the coast from the Tomago Sandbeds in the south along the Stockton Bight to the Tomaree Peninsula in the north. Therefore, although there will be an incremental loss of habitat the proposal is unlikely to result in adversely affecting habitat critical to the survival of the Swift Parrot.

According to the National Recovery Plan for the Regent Honeyeater (DoE, 2016) forest types regularly utilised by regent honeyeaters include wet lowland coastal forest dominated by *Eucalyptus robusta* (Swamp Mahogany). There are 19 Swamp Mahogany specimens located within the site. Preferred foraging habitat within the study area would largely be confined to

the small number of specimens of large flowering *Eucalyptus robusta* (Swamp Mahogany) occurring within the two areas of swamp sclerophyll forest. However, the proposal will not result in the removal of this preferred foraging habitat. The proposal will result in the removal of 25.90ha of Coastal Sand Smooth-barked Apple Blackbutt Forest which may act as seasonal transitory foraging habitat for the Regent Honeyeater. Regent honeyeaters also prefer taller and larger diameter trees for foraging, as these typically produce more nectar. Although a number of larger diameter trees (>80cm) will require removal as a result of the proposal, it is not likely to significantly affect habitat critical to the survival of the Regent Honeyeater.

- *disrupt the breeding cycle of a population*

The Swift Parrot breeds in Tasmania during the austral summer and the entire population migrates north to mainland Australia for the austral winter. The proposal is therefore unlikely to disrupt the breeding cycle of the population of Swift Parrots.

For the Regent Honeyeater, according to 'Figure 1: Regent Honeyeater Distribution' within the National Recover Plan (DoE, 2016) the study area is located within an area the species is likely to occur, but it outside of key and other breeding areas. According to the National Recovery Plan (DoE, 2016) the timing of breeding varies between regions, and appears to correspond with the flowering of key eucalypt and mistletoe species. The site contains 19 specimens of one key species being *Eucalyptus robusta* (Swamp Mahogany). The proposal will not result in the removal of any Swamp Mahogany specimens and is therefore unlikely to disrupt the breeding cycle of a population of Regent Honeyeaters.

- *modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline*

No areas of habitat will become isolated for the highly mobile Swift Parrot and Regent Honeyeater.

- *result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat*

The Regent Honeyeater also faces increased competition from larger, more aggressive nectivores, such as *Manorina melanocephala* (Noisy Miner), which is listed as a Key Threatening Process (Aggressive exclusion of birds from potential woodland and forest habitat by over-abundant noisy miners (*Manorina melanocephala*)). The proposal is not likely to increase the presence of this species.

- *introduce disease that may cause the species to decline, or*

The proposal is unlikely to result in the introduction of disease that may cause the Swift Parrot or Regent Honeyeater to decline.

- *interfere with the recovery of the species.*

A National Recovery Plan has been completed for the Swift Parrot (Saunders & Tzaros, 2011). The plan recommends the retention of foraging species such as *Eucalyptus robusta* (Swamp Mahogany) and *Eucalyptus pilularis* (Blackbutt).

A National Recovery Plan has been completed for the Regent Honeyeater (DoE, 2016). The plan recommends the retention of preferred foraging trees and Mistletoe.

A number of mitigation measures have been given to reduce the impact of the proposed sand mine on the Swift Parrot and Regent Honeyeater. These include:

- Retention of preferred foraging habitat with the retention of the 19 specimens of Swamp Mahogany.
- Protection of remaining habitat/vegetation;
- Rehabilitation of habitat within extraction area;
- Reduction of ongoing mine impacts such as noise and artificial lighting.
- Removal and non-use of barbed-wire
- Loss of habitat will be offset.

Conclusion: *Lathamus discolor* (Swift Parrot)

A National Recovery Plan has been development for the Swift Parrot (Saunders & Tzaros, 2011). The plan recommends the retention of foraging species such as *Eucalyptus robusta* (Swamp Mahogany) and *Eucalyptus pilularis* (Blackbutt). The proposal will involve the removal of specimens of *E. pilularis* however no E. *robusta* are required to be removed. The proposal although not complying with the recommendations it is unlikely to significantly compromise the recovery plan.

Conclusion: *Anthochaera phrygia* (Regent Honeyeater)

A National Recovery Plan has been completed for the Regent Honeyeater (DoE, 2016). The plan recommends the retention of preferred foraging trees and Mistletoe. As specimens of *E. robusta* a preferred foraging resource in the local will not be removed the proposal is unlikely to significantly compromise the Recovery Plan.

EPBC Act Listed Vulnerable Species considered to have potential habitat within the study area:

The following EPBC Act listed endangered and critically endangered species respectively are considered in this assessment:

- *Diuris praecox* (Newcastle Doubletail)
- *Pseudomys novaehollandiae* (New Holland Mouse)
- *Dasyurus maculatus maculatus* (Tiger Quoll)

Although not recorded within the study area a number of flowering specimens of *D. praecox* were found to occur outside the study area approximately 200m to the west within the electricity easement (Wildthing Environmental Consultants, 2018).

Records of *P. novaehollandiae* are known from the nearby Worimi Conservation Lands (Ecotone, 2008). This species has also been recorded from Salt Ash (Umwelt, 2009) and Tomago (Wildthing Environmental Consultants, 2013). Areas of Coastal Sand Apple Blackbutt Forest within the study area contained suitable habitat for this native rodent.

The Tiger Quoll was not recorded within the study area despite targeted surveys. The Atlas of NSW Wildlife database (OEH, 2015) contained a small number of local records of the Tiger Quoll within the local area. Open Forest habitat within the study area contains suitable hunting and roosting habitat for this Quoll species. A relatively large number of suitable roosts in the form of hollow logs or tree hollows were present. Spotted-tailed quolls occupy extensive home ranges which may be in excess of 580 hectares and up to 875 hectares (Watt 1993). Considering the large area of adjoining habitat along Stockton Bight it is likely that the Tiger Quoll would utilise habitat within the study area as part of a much larger home range.

An assessment in accordance with the DoEE principal significant impact guidelines is provided below for these species.

Under the EPBC Act Policy Statement 1.1 – Significant Impact Guidelines (DoE, 2013) an action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- *lead to a long-term decrease in the size of an important population of a species*

Specimens of *D. praecox* were found to occur outside the study area approximately 200m to the west within the electricity easement (Wildthing Environmental Consultants, 2018). Populations of *D. praecox* were also present within the electricity easement to the east of the study area and to the west over Nelson Bay Road (ERM, 2003). The proposed sand mine will result in the removal of areas of suitable habitat for *D. praecox*, however considering the absence of this species within the study area and during targeted searches, in particular habitat within the easement, and that the easement will be retained within the scope of the development, the proposal is unlikely to cause extinction of the local population of *D. praecox*.

Pseudomys novaehollandiae was not recorded during all surveys undertaken within the study area. However, records of *P. novaehollandiae* are known from the nearby Worimi Conservation Lands (Ecotone, 2008). This species has also been recorded from Salt Ash (Umwelt, 2009) and Tomago (Wildthing Environmental Consultants, 2013). The absence of this species during trapping may be due to the lack of preferred habitat in the form of open sandy heath. The proposal is unlikely to decrease the size of an important population of this species.

The Tiger Quoll was not recorded within the study area despite targeted surveys, which involved trapping, scat analysis, spotlighting and remote camera surveys. Considering the relatively large area of remaining habitat together with the given recommendations the proposed sand mine is unlikely to result in the extinction of any local population of the Tiger Quoll.

- *reduce the area of occupancy of an important population*

The proposed sand mine will result in the removal of areas of suitable habitat for *D. praecox*, however considering the absence of this species within the study area during targeted searches, in particular habitat within the easement, and that the easement will be retained within the scope of the development, the proposal is unlikely to cause extinction of the local population of *D. praecox*.

The proposal may result in the removal of suitable habitat for *P. novaehollandiae,* however areas of early succession revegetation after sand mining would also provide suitable habitat for this species.

The proposal will result in a significant reduction in Tiger Quoll habitat occurring along the dune forests of Stockton Bight. Considering the relatively large area of remaining habitat together with the given recommendations the proposed sand mine is unlikely to result in the extinction of any local population of the Tiger Quoll.

- *fragment an existing important population into two or more populations*

The proposal has been deigned to retain the electrical easement along the southern boundary of the study area in order to avoid isolating individuals of *D. praecox* to the west of the study area with known occurrences to the east over Nelson Bay Road. The proposal is unlikely to affect ecological processes such as pollination between sub-populations of *D. praecox*.

The New Holland Mouse and Tiger Quoll were not recorded within the study area despite targeted surveys, which involved trapping, scat analysis, spotlighting and remote camera surveys. The site is part of a large, connected area of native vegetation. The section of the corridor where the study area is located is approximately 1.5km wide. The proposal will result in the reduction in the width of the corridor by approximately 600m (the majority of habitat occurring on the northern side of the dual carriage way of Nelson Bay Road). Considering the large area of adjoining habitat along Stockton Bight the proposal is unlikely to fragment and existing population of New Holland Mouse or Tiger Quoll.

- *adversely affect habitat critical to the survival of a species*

Within the study area preferred habitat was present within open areas dominated by native grasses with no canopy or shrub layer. The area of most suitable habitat was contained within the maintained electrical easement. Habitat was also considered to be present within areas of Coastal Sand Apple Blackbutt Forest with a sparse canopy and understorey cover. The proposed sand mine will result in the removal of areas of suitable habitat for *D. praecox*.

The proposal may result in the removal of suitable habitat for *P. novaehollandiae,* however areas of early succession revegetation after mining would also provide suitable habitat for this species.

The proposal will result in the removal of 25.9ha of Coastal Sand Apple Blackbutt Forest containing likely hunting and denning habitat for the Tiger Quoll.

- *disrupt the breeding cycle of an important population*

The proposal is unlikely to affect ecological processes such as pollination between sub-populations of *D. praecox* due to the retention of the easement which will avoid isolating individuals of *D. praecox* to the west of the study area with known occurrences to the east over Nelson Bay Road.

The absence of *P. novaehollandiae* during trapping may be due to the lack of preferred habitat in the form of open sandy heath. However, areas of Coastal Sand Apple Blackbutt Forest within the study area contained suitable habitat for this native rodent. Although the proposal will result in a reduction in width of a vegetated corridor along Stockton Bight by approximately 600m, the proposal is unlikely to fragment an existing population of New Holland

Mouse. The proposal is not expected to result in any actions that would disrupt the breeding cycle of this species.

A relatively large number of suitable roosts in the form of hollow logs or tree hollows were present. Tiger quolls occupy extensive home ranges which may be in excess of 580 hectares and up to 875 hectares (Watt 1993). Considering the large area of adjoining habitat along Stockton Bight it is unlikely the proposal will disrupt the breeding cycle of an important population of Tiger Quoll.

- *modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline*

No areas of habitat are likely to become fragmented or isolated for these three species. The proposal will result in the incremental reduction in of a relatively large fragment of adjoining habitat occurring along Stockton Bight. However no area of habitat important to the long-term survival of the these species is likely to be removed, fragmented or isolated.

- *result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat*

Due to the nature of the proposal it is unlikely that the proposal will result in the colonisation of invasive species within the site.

- *introduce disease that may cause the species to decline, or*

The proposal is unlikely to result in the introduction of disease that may cause any of these three species to decline.

- *interfere substantially with the recovery of the species.*

A number of mitigation measures have been given in the report to reduce the impact of the proposed sand mine on these three species. These include:

- Protection of remaining habitat/vegetation;
- Rehabilitation of habitat within extraction area (11.74ha back to original forest type);
- Reduction of ongoing mine impacts such as noise and artificial lighting;
- Protection of these species during vegetation clearance;
- Provision of compensatory habitat (Offsetting);
- Relocation of hollow logs and tree hollows into remaining habitat;
- Feral Vertebrate Pest Control;
- Weed Control.

Conclusion: *Diuris praecox* (Newcastle Doubletail)

Considering the absence of this species within the study area during targeted searches the action is unlikely to have a significant impact on this orchid species.

Conclusion: *Pseudomys novaehollandiae* (New Holland Mouse)

The absence of this species during trapping may be due to the lack of preferred habitat in the form of open sandy heath. The proposal may result in the removal of suitable habitat for *P. novaehollandiae,* however areas of early succession revegetation after mining would also provide suitable habitat for this species. The proposed action is unlikely to have a significant impact on *P. novaehollandiae*.

Conclusion: *Dasyurus maculatus maculatus* (Tiger Quoll)

Open Forest habitat within the study area contains suitable hunting and roosting habitat for this Quoll species. A relatively large number of suitable roosts in the form of hollow logs or tree hollows were also present. Spotted-tailed quolls occupy extensive home ranges which may be in excess of 580 hectares and up to 875 hectares (Watt 1993). Considering the large area of adjoining habitat along Stockton Bight it is likely that the Tiger Quoll would utilise habitat within the study area as part of a much larger home range. The proposal will result in a reduction in Tiger Quoll habitat occurring along the dune forests of Stockton Bight. Considering the relatively large area of remaining habitat together with the given recommendations the proposed sand mine is unlikely to significantly impact on the Tiger Quoll.

- *migratory species protected under international agreements;*

Forty-two nationally listed migratory species were recorded on the DoEE on-line database as occurring or having potential habitat available within 10km of the study area, these being:

Migratory Terrestrial Species:

- *Haliaeetus leucogaster* (White-bellied Sea-Eagle)
- *Hirundapus caudacutus* (White-throated Needletail)
- *Merops ornatus* (Rainbow Bee-eater)
- *Monarcha melanopsis* (Black-faced Monarch)
- *Monarcha trivirgatus* (Spectacled Monarch)
- *Myiagra cyanoleuca* (Satin Flycatcher)
- *Rhipidura rufifrons* (Rufous Fantail)
- *Anthochaera phrygia* Regent Honeyeater

Migratory Wetland Species:

- *Actitis hypoleucos* (Common Sandpiper)
- *Ardea alba* (Great Egret)
- *Arenaria interpres* (Ruddy Turnstone)
- *Calidris canutus* (Red Knot)
- *Calidris ferruginea* (Curlew Sandpiper)
- *Calidris ruficollis* (Red-necked Stint)
- *Calidris tenuirostris* (Great Knot)
- *Charadrius bicinctus* (Double-banded Plover)
- *Charadrius mongolus* (Lesser Sand Plover)
- *Gallinago hardwickii* (Latham's Snipe)
- *Heteroscelus brevipes* (Grey-tailed Tattler)
- *Limosa limosa* (Black-tailed Godwit)
- *Numenius madagascariensis* (Eastern Curlew)
- *Numenius minutus* (Little Curlew)
- *Numenius phaeopus* (Whimbrel)
- *Pluvialis fulva* (Pacific Golden Plover)

- *Pluvialis squatarola* (Grey Plover)
- *Rostratula benghalensis* (Painted Snipe)
- *Tringa stagnatilis* (Marsh Sandpiper)
- *Xenus cinereus* (Terek Sandpiper)

Migratory Marine Birds

- *Apus pacificus* (Fork-tailed Swift)
- *Ardea alba* (Great Egret)
- *Ardea ibis* (Cattle Egret)
- *Calonectris leucomelas* (Streaked Shearwater)
- *Sterna albifrons* (Little Tern)
- *Diomedea antipodensis* (Antipodean Albatross)
- *Diomedea gibsoni* (Gibson's Albatross)
- *Macronectes giganteus* (Southern Giant-Petrel)
- *Macronectes halli* (Northern Giant-Petrel)
- *Thalassarche bulleri* (Buller's Albatross)
- *Thalassarche cauta cauta* (Shy Albatross)
- *Thalassarche salvini* (Salvin's Albatross)
- *Thalassarche steadi* (White-capped Albatross)
- *Thalassarche impavida* (Campbell Albatross)

Under the EPBC Act Policy Statement 1.1 – Significant Impact Guidelines (DoE, 2013) an action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

- *Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species.*

- *Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or*

- *Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.*

Three listed migratory species, the White-bellied Sea-Eagle, Rufous Fantail and Cattle Egret were recorded within the study area during fieldwork.

Haliaeetus leucogaster (White-bellied Sea-Eagle)

The White-bellied Sea Eagle was observed flying over the study area on a number of occasions. Juvenile White-bellied Sea Eagles noted flying over the study area would also likely indicate nesting within the area. Due to the relatively close proximity of Tilligerry Creek and to a lesser extent the waters of Stockton Bight large trees within the study area would offer potential nesting habitat for the White-bellied Sea Eagle. No large nests that would be attributed to this species were noted within the study area or in close proximity.

Rhipidura rufifrons (Rufous Fantail)

The Rufus Fantail was observed within an area of Coastal Sand Apple Blackbutt Forest on one occasion during fieldwork. The Rufous Fantail mainly inhabits wet sclerophyll forests, often in gullies dominated by eucalypts such as *Eucalyptus pilularis* (Blackbutt).

Ardea ibis (Cattle Egret)

A number of specimens of Cattle Egret were observed forging next to cattle within the area of pasture grassland in the far north-east of the study area.

Considering the relative commonality of the three-migratory species recorded within local area and the impact on habitat in the locality it is unlikely that these species or any of the listed migratory species would be significantly impacted by the proposed sand mine.

- *nuclear activities;*

The proposal does not involve any type of nuclear activity.

- *the Commonwealth marine environment;*

The proposal does not involve the modification of the Commonwealth marine environment.

14.31 BIODIVERSITY ASSESSMENT (Stage 1)

Identified Landscape Features

The FBA requires the assessment of landscape features to help describe the biodiversity values of the study area and assess the impacts of the proposed sand mine. A large portion of Lots 51, 254 and to a lesser extent Lot 10 occurring on Aeolian Holocene transgressive dunes was undeveloped and consisted of uncleared tall dry open sclerophyll forest dominated by the canopy species *Eucalyptus pilularis* (Blackbutt) and *Angophora costata* (Smooth-barked Apple). Coastal Sand Apple Blackbutt Forest composed of *E. pilularis* and *A. costata* was the dominant vegetation community on the Holocene sand dunes along Stockton Bight from Fern Bay to Anna Bay. Approximately 10ha within Lot 254 had been cleared and was occupied by an Olive and Fig Orchard. The cleared orchard area also contained a residence and maintained gardens. The lower-lying flat ground in the north of Lots 10, 11 & 51 has had a long history of disturbance and largely consisted of grassland/pasture. Two smaller areas of Swamp Forest dominated by *Melaleuca quinquenervia* (Broad-leaved Paperbark) were present in the far north and west of the study area. An area of Freshwater wetland dominated by sedges was also present in the far north of the study area.

Bioregion and IBRA Subregion

The proposed sand mine site is located within the Sydney Basin IBRA Bioregion and the Karuah-Manning IBRA Subregion (Figure 14.20). The Sydney Basin Bioregion lies on the central east coast of NSW and covers an area of about 3,624,008 hectares which includes about 4.53 per cent of NSW. The bioregion extends from north of Batemans Bay to Nelson Bay and West to Mudgee and includes a significant proportion of the catchments of the Hawkesbury- Nepean, Hunter and Shoalhaven river systems.

NSW Landscape Regions (Mitchell Landscapes)

The study area is located within the 'Sydney-Newcastle Barriers and Beaches' Mitchell Landscape. 'Sydney-Newcastle Barriers and Beaches' are composed of Quaternary coastal sediments on long recurved quartz sand beaches between rocky headlands backed by sand

dunes and intermittently closed and open lagoons. Includes areas of more extensive high dunes often located on top of the headlands. General elevation 0 to 30m, local relief 10m. Cliff top dunes may be found as high as 90m above sea level. Distinct zonation of vegetation and increasing soil development from the beach to the inland dunes. At the beach; *Spinifex hirsutus* Spinifex, *Lomandra longifolia* (Spiky mat-rush), *Acacia longifolia* subsp. *sophorae* (Coastal Wattle) and *Leptospermum laevigatum* (Coast Tea Tree) colonise the frontal dune in which there is little soil development. *Banksia integrifolia* (Coastal Banksia) and *Banksia serrata* (Old Man Banksia) are found on the second dunes and these merge with more complex forest containing *Eucalyptus pilularis* (Blackbutt), *Corymbia gummifera* (Red Bloodwood), *Xanthorrhoea* sp. (Grass Trees) and numerous understorey shrubs on deep sands that have an organic rich A horizon, a bleached A2 horizon and the initial development of weak iron or organic pans in the sandy subsoil. Well-developed, deep podsol profiles are present in cliff top dunes with swampy swales indicating that these forms are probably older than the coastal dunes. Vegetation of *Banksia aemula* heathland and open scrub of *B. integrifolia*), *Westringia fruticosa* (Coastal Rosemary), coast tea-tree and grass tree, with dwarfed *Angophora costata* (Smooth-barked Apple) and *C. gummifera*. Freshwater sedge swamps in larger areas of sand. In the lagoons, salinity varies depending on tidal flushing and they are often surrounded by *Melaleuca quinquenervia* (Broad-leaved Paperbark) and *Casuarina glauca* (Swamp Oak). Water margins are occupied by *Juncus* sp. and *Phragmites australis* (Common Reed) in fresh water areas. *Avicennia marina* (Grey mangrove) may occur in some tidal inlets.

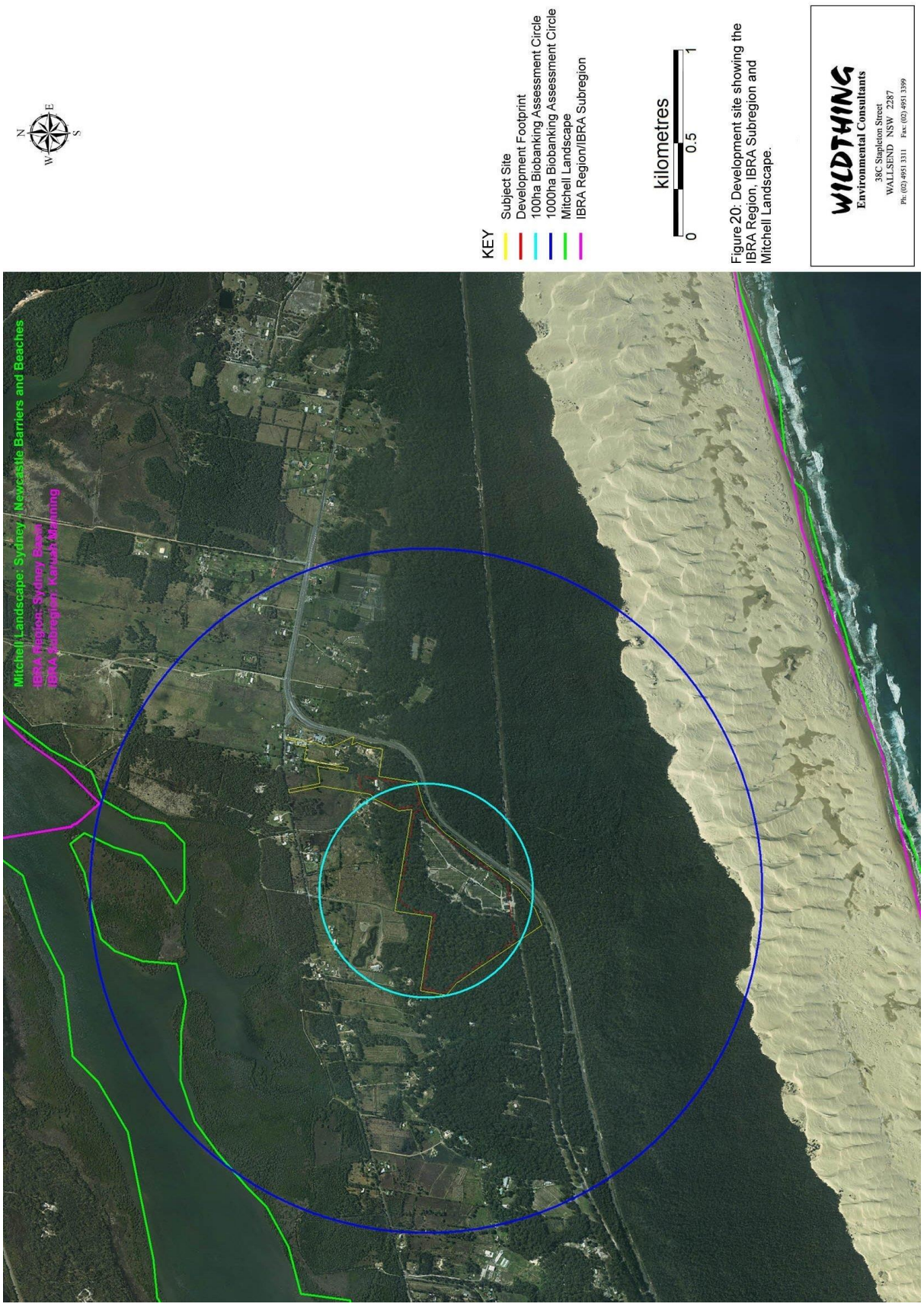


Figure 14.20 - Development Site showing IBRA Region, Subregion and Mitchell Landcape

14.32 LANDSCAPE VALUE ASSESSMENT

The Project Site Landscape Value is scored based on several variables including:

- Percentage (%) Native Vegetation Cover;
- Connectivity Values; and
- Patch Size.

Percentage Native Vegetation Cover

Two landscape assessment circles, 100ha and 1000ha were centred over the proposed mine site using an aerial photo and GIS software (Figure 14.21). The current and future percentage native vegetation cover after development was assessed for both circles. The 1000-hectare assessment circle was used to assess any loss (or negative impacts) of the proposed development on the percent native vegetation cover in the 'locality' and to identify threatened species that may occur on the Project Site. The smaller 100-hectare circle was used to assess the loss of surrounding vegetation cover at an even more local scale as a result of the proposed development.

1000ha Assessment Circle

- Before development – Approximately 705.80ha = 70.58% (71 – 75%).
- After development – Approximately *678.50ha – 67.8% (66 – 70%).

*705.80 – 27.30 = 678.50ha

After development, resulting in a downward change or 'jump' of one native vegetation cover classes.

100ha Assessment Circle

- Before development – Approximately 63.18ha = 63.18% (61 – 65%).
- After development – Approximately 37.34ha* = 37.34% (36 – 40%).

*63.18 – 27.30 – 1.46 = 37.34ha

After development, resulting in a downward change or 'jump' of five native vegetation cover classes.

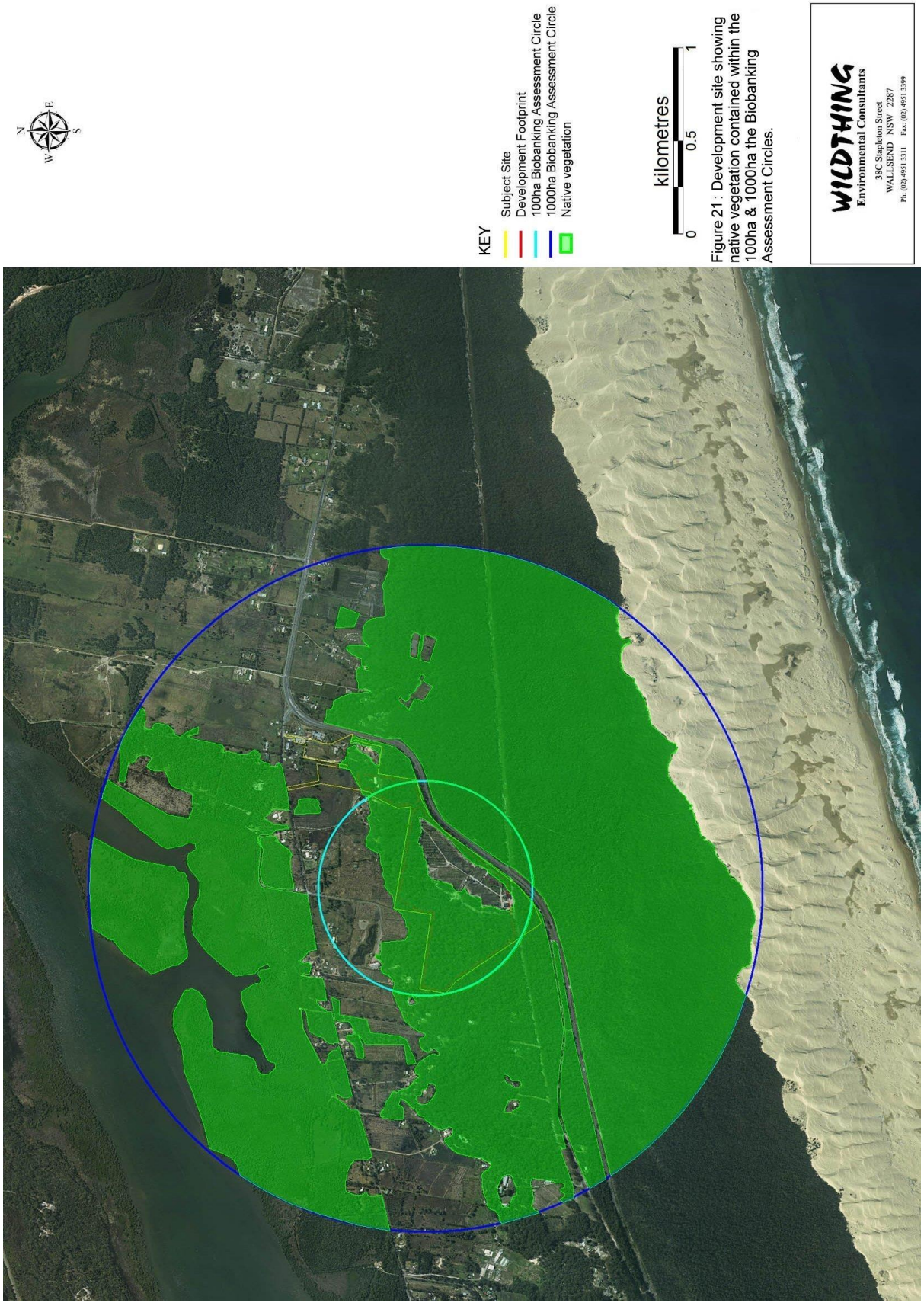


Figure 14.21 - Development Site showing Biobank Assessment Circles

Connectivity Value

A desktop Connectivity Condition assessment was undertaken by assessing the average condition of native vegetation across the Project Site's 'Primary' linkages to adjoining vegetation. Primary linkages are defined as native vegetation that:

- Is in moderate to good condition;
- Has a patch size > 1 hectare in area;
- Is separated by a distance of <100 metres; and
- Is not separated by a dual carriageway or wider highway or similar hostile link.

It is clear that the Project Site is a part of a connecting link of native vegetation. However, the site did not form part of a State Significant Biodiversity Link or Regionally Significant Biodiversity Link in a plan approved by the Chief Executive of OEH. The site did not form part of a Riparian Buffer.

Site based assessment for connectivity

Taking the dual carriageway of Nelson Bay Road into consideration the connectivity of the site only involved native vegetation occurring to the west of the duel carriageway lanes of Nelson Bay Road.

Connectivity Before Development - >100 – 500m.

Connectivity After Development - >30 – 100m.

The Development Area has connectivity score of 2.

Patch Size

To assess the Patch Size, the assessment must:

- Determine the percent native vegetation cleared in the Mitchell Landscape in which most of the development occurs. In this case the Mitchell Landscape is 'Sydney-Newcastle Barriers and Beaches' and this landscape is 50% cleared.
- Determine the Patch size class, which in this instance is 'extra-large'. Based on the above, the derived Patch Size Score is 12.

Derived Landscape Value

Data for Percentage Native Vegetation Cover, Connectivity and Patch Size is combined to give the proposed Development Area a Landscape Score of 16.40.

14.33 ASSESSING NATIVE VEGETATION

Vegetation Zones

A total of four Vegetation Zones were found to be present on the development site (Figure 22). Vegetation types were classified based on the 'best fit' vegetation type listed in the Plant Communities Types Database (OEH 2009). Parameters used to choose the 'best fit' Vegetation Type included over-storey and understorey floristics, soil landscape, location and topographic position. One vegetation zone was created for each plant community type (PCT) and broad condition state in the sand mine footprint. The area of each zone was calculated using GIS. The four native vegetation zones assessed in the credit calculator are:

Vegetation Zone 1 – HU860 – Smooth-barked Apple - Blackbutt - Old Man Banksia woodland on coastal sands of the Central and Lower North Coast (Moderate/Good_High Condition)(34.51ha);

Vegetation Zone 2 – HU860 – Smooth-barked Apple - Blackbutt - Old Man Banksia woodland on coastal sands of the Central and Lower North Coast (Moderate/Good Derived Grassland)(0.9ha);

Vegetation Zone 3 – HU938 – Broad-leaved Paperbark - Swamp Oak - Saw Sedge swamp forest on coastal lowlands of the Central Coast and Lower North Coast(Moderate/Good)(1.15ha);

Vegetation Zone 4 – HU533 - Coastal freshwater lagoons of the Sydney Basin Bioregion and South East Corner Bioregion Moderate/Good_Poor)(0.32ha).

Vegetation Zone 1

PCT - 1646

BVT - HU860 – Smooth-barked Apple - Blackbutt - Old Man Banksia woodland on coastal sands of the Central and Lower North Coast

Vegetation Formation – Dry Sclerophyll Forest (Shrubby sub-formation)

Vegetation Class – Coastal Dune Dry Sclerophyll Forest

Extent in study area – 34.51ha

Vegetation Zone 2 - HU860 – Smooth-barked Apple - Blackbutt - Old Man Banksia woodland on coastal sands of the Central and Lower North Coast (Moderate/Good Derived Grassland)

PCT - 1646

BVT - HU860 – Smooth-barked Apple - Blackbutt - Old Man Banksia woodland on coastal sands of the Central and Lower North Coast

Vegetation Formation – Dry Sclerophyll Forest (Shrubby sub-formation)

Vegetation Class – Coastal Dune Dry Sclerophyll Forest

Extent in study area – 0.9ha (occurs within electricity easement)

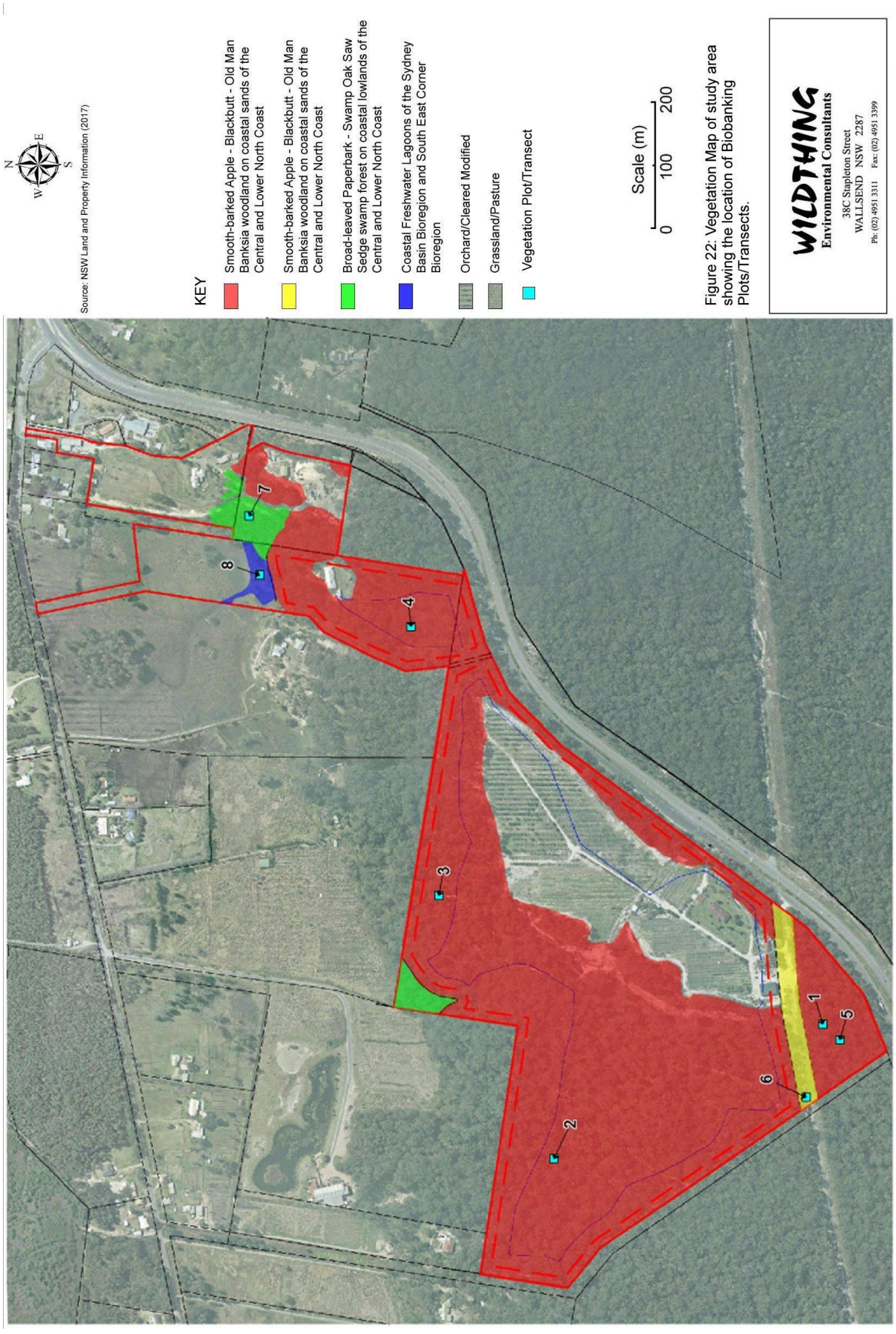


Figure 14.22 - Vegetation Map and locations of Biobank Plots/Transects

Vegetation Zone 3 – HU938 – Broad-leaved Paperbark - Swamp Oak - Saw Sedge swamp forest on coastal lowlands of the Central Coast and Lower North Coast(Moderate/Good)

PCT - 1724

BVT - HU938 – Broad-leaved Paperbark - Swamp Oak - Saw Sedge swamp forest on coastal lowlands of the Central Coast and Lower North Coast (Moderate/Good)

Vegetation Formation – Forested Wetlands

Vegetation Class – Coastal Swamp Forests

Extent in study area – 0.9ha

Vegetation Zone 4 – HU533 Coastal freshwater lagoons of the Sydney Basin Bioregion and South-East Corner Bioregion (Moderate/Good_Poor).

Vegetation Formation – Forested Wetlands

Vegetation Class – Coastal Swamp Forests

Extent in study area – 0.32ha

Full descriptions of these communities are shown in Section 14.6.1 of this report.

Endangered & Critically Endangered Ecological Communities

Final Scientific Committee Determinations under the TSC Act were reviewed to assess whether any of the Vegetation Zones were classified as Endangered or Critically Endangered Ecological Communities (EECs). Two Vegetation Zones we found to be consistent with Endangered Ecological Communities, Swamp sclerophyll forest on coastal floodplains and Freshwater wetlands on coastal floodplains (Table 202).

Table 14.22 - Endangered Ecological Communities within the subject site.

Vegetation Zone	Endangered Ecological Community
Vegetation Zone 3 - HU938 – Broad-leaved Paperbark - Swamp Oak - Saw Sedge swamp forest on coastal lowlands of the Central Coast and Lower North Coast (Moderate/Good 1.15ha)	Swamp sclerophyll forest on coastal floodplains.
Vegetation Zone 4 – HU533 - Coastal freshwater lagoons of the Sydney Basin Bioregion and South East Corner Bioregion Moderate/Good_Poor)(0.32ha).	Freshwater wetlands on coastal floodplains

Site Survey Details

Survey Time Matrix

The Credit Calculator listed a total of 38 threatened flora and fauna species which are classed as species credit species requiring targeted survey on the site with an accompanying survey time matrix (Table 14.23). All threatened species and endangered populations were surveyed during the correct time of the year. Refer to Tables 14.4 & 14.5.

Table 14.23 - Species credit species requiring targeted survey within the study area with an accompanying survey time matrix

Common name	Scientific name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Austral Toadflax	Thesium australe	Yes	Yes							Yes	Yes	Yes	Yes
Australasian Bittern	Botaurus poiciloptilus	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Biconvex Paperbark	Melaleuca biconvexa	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Black Bittern	Ixobrychus flavicollis	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Black-eyed Susan	Tetratheca juncea							Yes	Yes	Yes	Yes	Yes	Yes
Black-necked Stork	Ephippiorhynchus asiaticus	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Broad-billed Sandpiper	Limicola falcinellus	Yes	Yes	Yes						Yes	Yes	Yes	Yes
Brush-tailed Phascogale	Phascogale tapoatafa	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Camfield's Stringybark	Eucalyptus camfieldii	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Charmhaven Apple	Angophora inopina	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Common Planigale	Planigale maculata	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Eastern Australian Underground Orchid	Rhizanthella slateri									Yes	Yes	Yes	
Eastern Chestnut Mouse	Pseudomys gracilicaudatus	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Eastern Pygmy-possum	Cercartetus nanus												

Common name	Scientific name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Emu population, NSW North Coast Bioregion and Port Stephens Local Government Area	Dromaius novaehollandiae - endangered population	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Giant Dragonfly	Petalura gigantea	Yes											Yes
Golden-tipped Bat	Kerivoula papuensis	Yes	Yes	Yes							Yes	Yes	Yes
Green and Golden Bell Frog	Litoria aurea	Yes	Yes	Yes					Yes	Yes	Yes	Yes	Yes
Green-thighed Frog	Litoria brevipalmata	Yes	Yes	Yes							Yes	Yes	Yes
Grove's Paperbark	Melaleuca groveana	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Koala	Phascolarctos cinereus	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Koala population, Hawks Nest and Tea Gardens	Phascolarctos cinereus - endangered population Hawks Nest and Tea Gardens	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Leafless Tongue Orchid	Cryptostylis hunteriana	Yes	Yes									Yes	Yes
Maundia triglochinoides	Maundia triglochinoides	Yes	Yes	Yes								Yes	Yes
Nabiac Casuarina	Allocasuarina simulans	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Narrow-leaved Red Gum population, Greater Taree Local Government Area	Eucalyptus seeana - endangered population	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Netted Bottle Brush	Callistemon linearifolius	Yes	Yes	Yes						Yes	Yes	Yes	Yes
Noah's False Chickweed	Lindernia alsinoides	Yes	Yes									Yes	Yes

Common name	Scientific name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Red-backed Button-quail	Turnix maculosus	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regent Honeyeater	Anthochaera phrygia	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Rough Doubletail	Diuris praecox							Yes	Yes				
Sand Doubletail	Diuris arenaria								Yes	Yes			
Small-flower Grevillea	Grevillea parviflora subsp. parviflora	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Tall Knotweed	Persicaria elatior	Yes	Yes	Yes	Yes	Yes							Yes
Terek Sandpiper	Xenus cinereus	Yes	Yes	Yes	Yes	Yes				Yes	Yes	Yes	Yes
Trailing Woodruff	Asperula asthenes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Villous Mint-bush	Prostanthera densa	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Wallum Froglet	Crinia tinnula	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Zannichellia palustris	Zannichellia palustris			Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	

14.34 SITE VALUES

Vegetation Transects/Plots

A Biobank field survey of the Development Area was undertaken in February 2016 and November 2016 by Wildthing Environmental Consultants. A total of eight Biobank biometric plots were carried out within the Development Area where native vegetation is present (Figure 14.22). As a separate Transect/Plot was completed in the far south-west of the site (No. 5) as part of an offset for the sand mine development it was added to the development calculations.

Transect/plot data for the Development Area was entered into the 'Site Values' section of the Credit Calculator and is reproduced below in Table 14.24. The Credit Calculator requires that a minimum number of Biometric plots be carried out for each Vegetation Zone based on the Zone's extant area. The number of plots undertaken meets the Biobank assessment minimum survey effort requirements.

Table 14.24 - Vegetation Transect/Plot results.

Transect/Plot Number	Native plant No.	Over-storey Cover (%)	Mid-storey Cover (%)	Native Ground Cover (Grasses) (%)	Native Ground Cover (Shrubs)(%)	Native Ground Cover (Other)(%)	Exotic Plant Cover (%)	Number of trees with hollows	Over-storey Regeneration	Total length of fallen logs (m)	Easting	Northing
1	23	35	12	28	14	80	8	8	0.8	55.75	406478	6372909
2	26	27	7	26	42	78	0	4	0.8	27.8	406254	6373333
3	33	36	29.5	34	14	84	4	3	0.8	35	406681	6373521
4	27	36	8	10	6	94	0	6	0.8	28.1	407119	6373570
5	26	34	8.5	26	10	84	6	3	0.8	27	406453	6372882
6	23	0	0	72	6	86	8	0	0	5.6	406359	6372934
7	18	42.5	14.5	2	2	96	0	0	0.25	32.1	407295	6373830
8	13	0	1.5	0	6	100	0	0	0	0	407200	6373812

Predicted Threatened Species

The Predicted Threatened Species were modified by the selection of the *Tyto tenebricosa* Sooty Owl to not occur on site. Due to the lack of rainforest and tall wet sclerophyll forest the Sooty Owl would be considered unlikely to be present. No local records of this Owl species were found occurring along the Dunal Forests of Stockton Bight.

Vegetation Management Zones

A total of six Vegetation Management Zones were delineated and are shown in Table 14.25 and Figure 14.23.

Table 14.25 - Vegetation Management Zones.

Vegetation type listed in the Plant Communities Types Database (OEH 2009).	Management Zones
HU860 – Smooth-barked Apple - Blackbutt - Old Man Banksia woodland on coastal sands of the Central and Lower North Coast (24.38ha).	HU860 – Smooth-barked Apple - Blackbutt - Old Man Banksia woodland on coastal sands of the Central and Lower North Coast (**Clearing**) (25.90ha).
	HU860 – Smooth-barked Apple - Blackbutt - Old Man Banksia woodland on coastal sands of the Central and Lower North Coast (MZ1)(3.44ha) **MZ1 – Areas south of electricity easement, areas within Lot 10.**
	HU860 – Smooth-barked Apple - Blackbutt - Old Man Banksia woodland on coastal sands of the Central and Lower North Coast (MZ2)(5.17ha) **MZ2 – 15m Buffer around clearance line.**
HU860 – Smooth-barked Apple - Blackbutt - Old Man Banksia woodland on coastal sands of the Central and Lower North Coast (Moderate/Good – derived Grassland)(0.9ha)	HU860 – Smooth-barked Apple - Blackbutt - Old Man Banksia woodland on coastal sands of the Central and Lower North Coast (Moderate/Good – derived Grassland) **MZ3** (0.9ha).
HU938 - Broad-leaved Paperbark - Swamp Oak - Saw Sedge swamp forest on coastal lowlands of the Central Coast and Lower North Coast (1.15ha).	HU591 - Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion (**MZ4**)(1.15ha).
HU533 - Coastal freshwater lagoons of the Sydney Basin Bioregion and South East Corner Bioregion Moderate/Good_Poor)(0.32ha).	HU533 - Coastal freshwater lagoons of the Sydney Basin Bioregion and South East Corner Bioregion Moderate/Good_Poor)(0.32ha).(**MZ5**)

14.35 THREATENED SPECIES SURVEY RESULTS

Threatened Fauna

A total of eight threatened species were recorded within the study area during fieldwork:

- *Diuris arenaria* (Tomaree Doubletail)
- *Glossopsitta pusilla* (Little Lorikeet)
- *Petaurus norfolcensis* (Squirrel Glider)
- *Pteropus poliocephalus* (Grey-headed Flying-fox)

- *Scoteanax rueppellii* (Greater Broad-nosed Bat)
- *Falsistrellus tasmaniensis* (Eastern Falsistrelle)
- *Miniopterus australis* (Little Bentwing-bat)
- *Miniopterus schreibersii oceanensis* (Large Bentwing-bat)

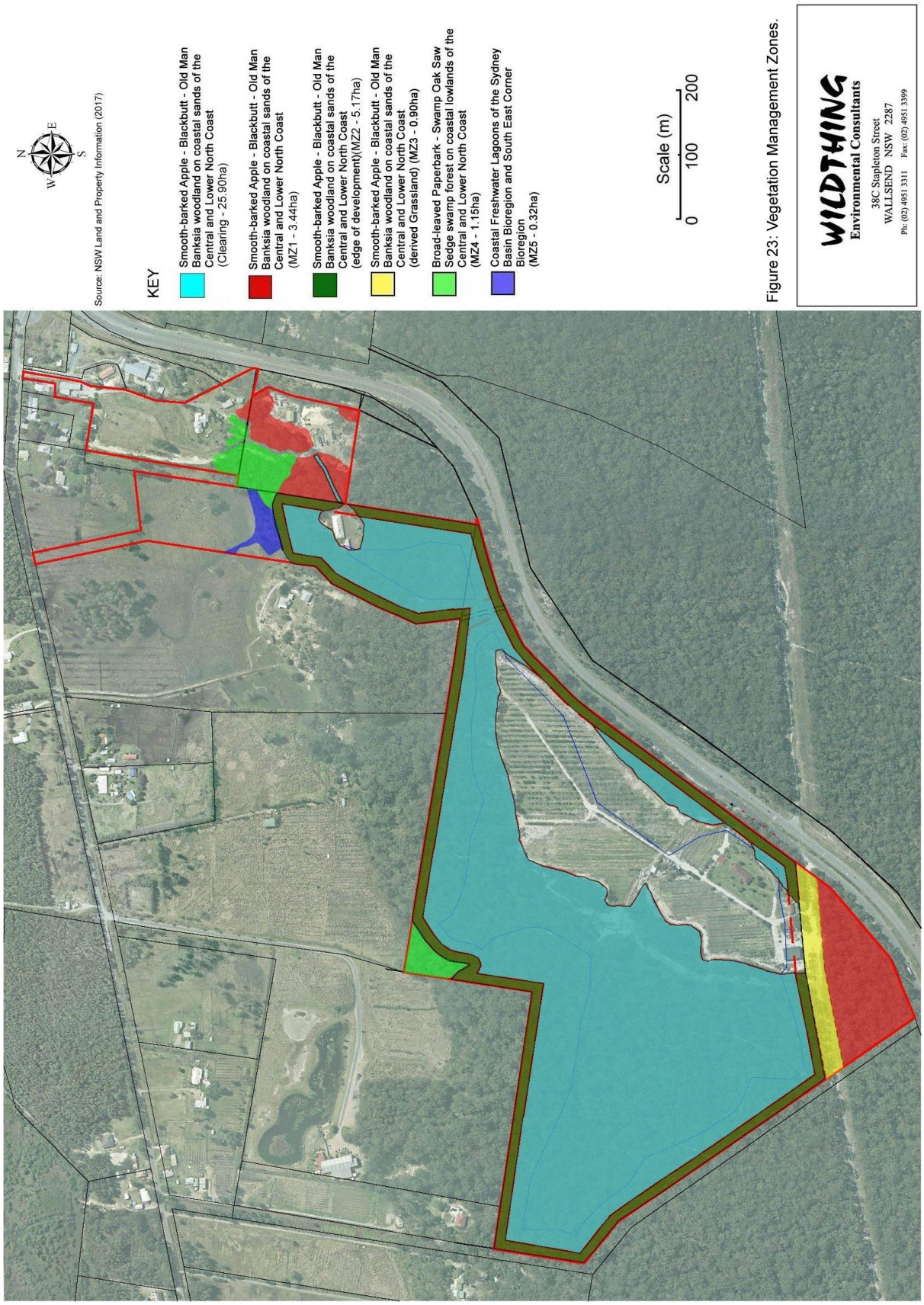


Figure 14.23 - Vegetation Management Zones

As a result of secondary evidence an additional two threatened fauna species were also noted within the study area:

- *Ninox strenua* (Powerful Owl)
- *Phascolarctos cinerea* (Koala)

The survey locations of these threatened species within the site are shown in Figures 14.12 & 14.15. Of these threatened species *Diuris arenaria* is the only species credit species.

14.36 STAGE 2 – IMPACT ASSESSMENT (BIODIVERSITY VALUES)

Potential Impacts

14.36.1.1 Avoid and Minimise ImpactS

The current development proposal has been designed to avoid directly impacting on two Endangered Ecological Communities, Swamp Sclerophyll Forest and Freshwater Wetlands in the north-east of the site. Given the need for a minimum footprint area to achieve a viable economic development, impacts on Ecological Communities have been minimised as far as possible. There is no other part of the site where the development could be feasibly sited. The conceptual sand mine plan has undergone a number of revisions since its inception. The electrical easement in the south-west containing 108 recorded specimens of the threatened *Diuris arenaria* (Tomaree Doubletail) has been subsequently removed from the development area to avoid all of these orchids. A 15m buffer between the easement and the development has also been put in place. The omission of this area has also removed an area of Coastal Sand Smooth-barked Apple Blackbutt Forest to the south of the easement outside the development plan. This area will be used as an offset as part of the mitigation measures.

Direct Impacts

The proposed Sand Mine will result in the following direct and potential impacts/losses:

- Approximately 25.90ha of Coastal Sand Smooth-barked Apple Blackbutt Forest;
- Approximately 9.5ha of Orchard;
- Approximately 25.90ha of Supplementary Koala Habitat;
- Approximately 25.90ha of known habitat for eight affected threatened fauna species; *Glossopsitta pusilla* (Little Lorikeet), *Ninox strenua* (Powerful Owl), *Petaurus norfolcensis* (Squirrel Glider), *Scoteanax rueppellii* (Greater Broad-nosed Bat), *Falsistrellus tasmaniensis* (Eastern Falsistrelle), *Miniopterus australis* (Little Bentwing-bat), *Miniopterus schreibersii oceanensis* (Large Bentwing-bat) and *Pteropus poliocephalus* (Grey-headed Flying-fox);
- Suitable habitat for a number of additional threatened and other flora and fauna species likely to utilise the study area;
- Approximately 877 hollow-bearing trees;
- Habitat Fragmentation;
- Injury/Mortality to native fauna during felling of trees.

The proposal will result in a significant incremental reduction in habitat occurring along the dune forests of Stockton Bight. However, considering the relatively large area of habitat the study area forms part of together with the given recommendations the proposed direct impacts are unlikely to result in the extinction of any Endangered Ecological Community, local population or threatened species.

Indirect Impacts

The proposed Sand Mine will result in the following indirect and potential impacts;

- Increased spread of noxious weeds;
- Increased spread of pest fauna species;
- Edge effects;
- Impact on Groundwater Dependent Ecosystems (GDE's) through changes to groundwater levels;
- Increase in noise from machinery;
- Increase in artificial lighting. Increased lighting may be the result of security lighting.

These indirect impacts have the potential to have a significant impact on the local ecology. Given recommendations the proposed indirect impacts are unlikely to result in the extinction of any Endangered Ecological Community, local population or threatened species.

Mitigation Measures

A number of mitigation measures have been specified to minimise the impact of the loss of habitat. The measures will include:

- Provision of compensatory habitat (Offsetting);
- Protection of remaining habitat/vegetation;
- Protection of fauna during vegetation removal;
- Provision of mitigation measures for affected species;
- Rehabilitation of part of the extraction area (approximately 12ha) being rehabilitated back to forest (24.8ha - remaining area of extraction area will become an artificial lake);
- Monitoring of groundwater levels and groundwater dependant ecosystems within proximity to the extraction area;
- Reduction of ongoing mine impacts such as noise and artificial lighting.

Provision of Compensatory Habitat (Offsetting)

An offsetting strategy will be undertaken using the Biobanking Assessment Methodology (DECC, 2009). Two offset sites; one site forming part of the Bobs Farm study area and adjoining

area, and two sites at Nerong are proposed to be created with the resultant credit generation/retirement.

Protection of Remaining Native Vegetation/Habitat

To protect and enhanced native vegetation occurring within the study area that occurs outside the sand mine footprint the following measures are required to be implemented:

- Clearance of native vegetation should be minimised as far as is practicable. The extent of vegetation clearing is to be clearly identified on construction plans and accurately and visibility marked on the ground. This will help to ensure areas of native vegetation occurring outside the area of disturbance will remain untouched;
- Weed Control – periodic weed control is to be undertaken within areas of remaining native vegetation;
- The electricity easement will be required to be managed by Ausgrid and be subject to their ongoing management regimes.

Protection of Fauna During Vegetation Removal

The removal of vegetation for the sand mine will be undertaken in a staged or incremental fashion. No large-scale clearing is to be carried out. The following measures are required to be implemented during vegetation clearing works:

- Vegetation clearance is to be undertaken in the non-breeding period (autumn-winter) for most native fauna species;
- Preclearance surveys will be required to be undertaken for Powerful and Masked Owl nesting sites during the breeding season. If a nesting tree is located then a 100m no go zone is to be put in place around this tree until the young have fledged the nest;
- The extent of vegetation clearing is to be accurately and clearly marked on the ground prior to the commencement of works;
- A qualified, licenced and experienced fauna ecologist is to be present during vegetation clearance operations;
- Identification of habitat (hollow-bearing) trees which require removal. These trees will be clearly marked prior to any vegetation removal (These hollow-bearing trees have been numbered and tagged;
- Immediately prior to removal the fauna ecologist is to thoroughly inspect all areas to be cleared for fauna particularly species such as Koala;
- A number of compensatory nest boxes particularly those designed for the Squirrel Glider will be installed around the clearance area to aid those Gliders that have been displaced;
- Feral animals particularly Feral Cats, Foxes and Wild Dogs are to be controlled as part of a Feral Animal Management Plan. Any Feral Animal control will be required to be

undertaken with the co-operation of neighbouring land owners including the board of the Worimi Conservation Lands.

Mitigation Measures for Affected Species

Diuris arenaria (Tomaree Doubletail)

All specimens of *Diuris arenaria* (Tomaree Doubletail) within the subject site are to be protected from unintended removal/disturbance during construction and other associated activities. This will require the erection of a barrier fence to prevent delineate and protect the 15m wide vegetated buffer zone between the development and the buffer zone. As Ausgrid are responsible for the easement it will also be important to liaise with Ausgrid regarding maintenance of the easements to minimise impacts and support the protection of *D. arenaria*.

Hollow Dependant Fauna

Affected hollow-dependant threatened fauna are *Petaurus norfolcensis* (Squirrel Glider), *Scoteanax rueppellii* (Greater Broad-nosed Bat) and *Falsistrellus tasmaniensis* (Eastern Falsistrelle). Refer to - Protection of fauna during vegetation removal.

Koala

Planting of specimens of *Eucalyptus robusta* (Swamp Mahogany) within the northern portion of Lot 51 to enhance Koala habitat within the study area and increase the connectivity for Koalas between preferred Koala Habitat within the study area to areas of Preferred Koala Habitat over Marsh Road.

Rehabilitation of extraction area

Rehabilitation within the extraction area will be undertaken in stages as the sand mine progresses. The rehabilitation will be required to conform to an approved vegetation management plan completed for the proposal.

Monitoring of Groundwater Levels and Groundwater Dependant Ecosystems within proximity to the Extraction Area

Groundwater levels are to be monitored within and around the study area. Groundwater dependent communities particularly the two areas of swamp forest will be monitored to access any changes in the health of these communities.

Ongoing Site Operation

Noise

A 4m high acoustic barrier has been proposed along both sides of the haul road at the Marsh Road exit, with the eastern barrier to be an absorbent barrier. Additionally, a 6m high noise bund is proposed to run the length of the western boundary of the sand mine, along the northern boundary and down to join the 4m noise barrier at Marsh Road. These noise bunds are proposed to be constructed prior to any other works being carried out within the study area. All of the bunds will be positioned inside the extraction footprint. The 6m barrier is a temporary feature only, needed for Phase 1 extraction only and will be removed again prior to the commencement of Phase 2. The 6m bund will be constructed out of sand and stabilised using matting and mulch. A sturdy constructed silt fence will be positioned inside the extraction footprint on the outer edge of the acoustic barriers within to avoid any sand moving past this

point. The noise bunds and silt fences will be required to be inspected regularly to ensure they are functioning property.

Artificial Lighting

Artificial lighting used to operate at night or used for security may influence nocturnal fauna. It is recommended that lighting be minimised and confined wherever possible.

Traffic

It is recommended that low speed limits be set along the haul road to help avoid collision with any native fauna.

To help ensure these mitigation measures are carried out, a vegetation management plan is to be developed to address any likely impacts during construction and ensure the long-term viability of the nearby surrounding environment.

14.37 OFFSET REQUIREMENTS

The FBA Credit Calculator generated a Credit Profile for the Development Area. The Development Biobank Credit Reports generated by the Credit Calculator are provided in Annex N. A summary of Ecosystem Credits Required is shown in Table 14.26.

Table 14.26 - Summary of Ecosystem Credits Required.

Plant Community Type	Area (ha)	Credits
HU860 – Smooth-barked Apple - Blackbutt - Old Man Banksia woodland on coastal sands of the Central and Lower North Coast	35.41	1681
HU938 - Broad-leaved Paperbark - Swamp Oak - Saw Sedge swamp forest on coastal lowlands of the Central Coast and Lower North Coast	1.15	8.17
HU533 - Coastal freshwater lagoons of the Sydney Basin Bioregion and South-East Corner Bioregion	0.32	1.31

No species credits are required.

14.38 STAGE 3 - BIODIVERSITY OFFSET STRATEGY

The Biodiversity Offset Strategy proposes to utilise three parcels of land.

- Part Lot 254 DP 753204 (forms part of the proposed Bobs Farm Sand Mine study area)
- Part Lot 255 DP 753204 (Adjoins the proposed Bobs Farm Sand Mine study area)

The other parcel of land is situated at Nerong.

- Lot 32 DP 880637 (Two sites within lot)

Biobanking Offset Sites – Bobs Farm

As previously mentioned both Part Lots 254 and 255 DP 753204 adjoin the proposed Bobs Farm Sand mine proposal. Part Lot 254 (2.33ha) also occurs within the same lot as the majority of the sand mine development and is separated from the proposal by an electricity easement which is approximately 25m wide. Part Lot 255 DP 753204 (10.55ha) occurs to the west of Part Lot 254 and is separated by a 20m unformed road. The offset area within Part Lot 255 consists of two sections of land (1.11ha & 7.06ha) separated by the 25m electrical easement. Although the landowner owns the land within the electrical easement, easements are excluded from Biobank sites due to the fact that the landowner has no control over their management (easement is managed by Ausgrid). The 1.11ha section of land has been placed along the northern section of the easement as a buffer and future protection for two threatened orchid species, *Diuris arenaria* (Tomaree Doubletail) and *Diuris praecox* (Newcastle Doubletail) which are known to occur within the easement (Wildthing Environmental Consultants, 2018). The proposed Bobs Farm offset site is located in the Sydney Basin IBRA Bioregion and the Karuah-Manning IBRA Subregion.

Biobanking Offset Sites – Nerong

The proposed Nerong offset sites were located approximately 2.5km to the south-east of the settlement of Nerong. The site was composed of two parcels of land within the 905ha Lot 32 DP 880637. Both proposed offset areas border Myall Lakes National Park. The two proposed offset sites occur within the North Coast IBRA Bioregion and the Karuah-Manning IBRA Subregion. The offset is located within the ''Newcastle Coastal Ramp' and 'Myall Foster Barrier System' Mitchell Landscapes.

15 TRAFFIC IMPACT ASSESSMENT

Chapter 15 summarises traffic and transport issues associated with the proposal. The conclusions detailed below are from a detailed traffic impact assessment conducted by Seca Solution Pty Limited to assess the impacts of the proposed sand extraction on traffic, site intersections and the surrounding road networks. Accident data, Traffic Surveys of the main intersection at Nelson Bay Road & Marsh Road and the specific Sidra Results are provided in Annex O.

15.1 INTRODUCTION

Background

Seca Solution was commissioned by Tattersall Lander Pty Ltd on behalf of Ammos Resource Management Pty Ltd to prepare a Traffic Impact Assessment for the proposed sand extraction quarry located off Nelson Bay Road, Bobs Farm.

The project is located adjacent to Nelson Bay Road which forms part of the regional road network. Whilst Council are the road authority the project will also be reviewed by the Roads and Maritime Services (RMS) and they will need to provide concurrence for the project to have access off Nelson Bay Road.

Initial discussion has been held with Council and the access proposals discussed to allow for entry off Nelson Bay Road and exit movements onto Marsh Road.

This traffic impact assessment has been prepared in accordance with Austroads Guidelines and the "RTA Guide to Traffic Generating Developments" published by the Roads and Maritime Services (RMS).

Scope of Report

The scope of this report is to review the traffic and access impacts associated with the proposed development and to assess the access arrangements for the development. The report provides advice on road network capacity, access issues and safety review.

Issues and Objectives of the study

The issues relative to the proposal are:

- Determine the future traffic generation for the development;
- Assess impact on the local road network due to the additional flows;
- Review the access arrangements for the development;
- Assess any other transport impacts associated with the development including a safety review.

The objective of the report is to document the impacts of the proposed development and provide advice on any infrastructure work required on the external road network as part of the development.

Planning Context

In preparing this document, the following guides and publications were used:

- RTA Guide to Traffic Generating Developments, Version 2.2 Dated October 2002;
- RMS TDT 2013/04 "Update Traffic surveys August 2013"

- Department of Planning EIS Guidelines, Roads and Related Facilities

Authority Requirements

The following issues were included in the DGRs issued for the development (including comments raised by the RMS) and are addressed in the following sections of this traffic impact assessment.

Comment	Report Inclusion
Accurate predictions of project-related traffic and a detailed assessment of the potential impacts of project-related traffic on the capacity, safety and efficiency of the road network	15.4.1, 15.4.1.2, 15.4.3.1, 15.4.3.2
A detailed description of the measures that would be implemented to upgrade and / or maintain the capacity, efficiency and safety of effected roads and intersections over the life of project	15.4.3.2
Identify all relevant vehicular traffic routes and intersections for access to / from the subject site	15.4.2, 15.4.2.1
Current traffic counts for all of the above traffic routes and intersections	15.2.3.1-7
The distribution on the road network of the trips generated by the proposed development. It is requested that the predicted traffic flows are shown diagrammatically to a level of detail sufficient for easy interpretation	15.4.2.1
Consideration of the traffic impacts on existing and proposed intersections and the capacity of the local and classified road network to safely and efficiently cater for the additional vehicular traffic generated by the proposed development during the construction and operational stages. The study should also give consideration to the cumulative traffic impacts of other proposed and approved developments in the area	15.4.3
Traffic analysis of any major / relevant intersection, using SIDRA or similar traffic model	15.4.3.2
Any other impacts on the regional and state road network including consideration of pedestrians, cyclists and public transport facilities and provision of service vehicles	15.3.2.3, 15.3.5, 15.4.1.5

Table 15.1 - DGRs Response

15.2 EXISTING SITUATION

Site Description and Proposed Activity

15.2.1.1 Site Location and Access

The site is located within the general locality of Bobs Farm with road frontage to both Nelson Bay Road and Marsh Road (Figure 15.1 below). Access for heavy vehicles will be provided off Nelson Bay Road with exiting heavy vehicle movements via Marsh Road. Access for light vehicles will be allowed via both of these access points.

The site is currently a fig and olive farm.

The location of the site is shown below in Figure 15.1.



Source: Google Maps

Figure 15.1 - Site Location

Existing land use adjacent to the site is a mixture of rural residential and a local primary school.

Existing Traffic Conditions

15.2.1.2 Road Hierarchy

The major road through the locality is **Nelson Bay Road** which provides an important road link between the Nelson Bay area to the east of the site and Newcastle / Newcastle airport and the Pacific Highway to the west of the site. In the locality of the subject site, it provides two lanes of travel in both directions with a sealed shoulder. There are verges to both sides and there is a central median to restrict right turn movements to intersections with a number of U turn bays provided along its length to cater for local traffic demands.

The speed limit varies along its length and in the vicinity of the subject site is 80 km/h.

Access to the site is also available via Marsh Road, a local road providing access to a number of local rural suburbs and rural residential holdings. It provides a single lane of travel in both directions and operates under the posted speed limit of 60 km/h. There is a school zone located close to the intersection with Nelson Bay Road with the normal restriction of 40 km/h during the morning and afternoon school activity periods.

15.2.1.3 Roadworks

There are currently no road works occurring within the immediate vicinity of the of the subject site. Further to the east of the site, the Roads and Maritime Services (RMS) are currently upgrading Nelson Bay Road, from the current single lane of travel to provide two lanes of travel in both directions. There will be a central median to restrict right turn movements with a number of U turn facilities provided at side roads to allow for the right turn demand movements.

15.2.1.4 Traffic Management Works

No further traffic management works are proposed along Nelson Bay Road in this locality.

15.2.1.5 Pedestrian and Cycling Facilities

There are minimal pedestrian and cycling facilities in the general locality of the site, reflective of the very low demands in this area. Pedestrians and cyclists are able to utilise the sealed shoulder provided in both directions along Nelson Bay Road. During the site work a number of cyclists were observed on Nelson Bay Road but no pedestrians. This is reflective of the relatively remote location of the area from the major centres.

Traffic Flows

15.2.1.6 Peak Hour Flows

As part of the study work, Seca Solution completed traffic surveys at the 3-way give way-controlled intersection of Marsh Road and Nelson Bay Road. These surveys were completed during both the morning and afternoon peak periods on Thursday 21st August 2014. The two-way traffic flows adjacent to the site on Nelson Bay Road (south of Marsh Road) were:

- 1,273, split 769 westbound towards Newcastle (60%) in the morning peak between 7.45 and 8.45 AM and
- 1,321, split 826 eastbound towards Nelson Bay (62%) in the afternoon peak between 3.30 and 4.30 PM

During the same periods, the two-way traffic movements on Marsh Road were much lower, at 42 in the AM peak and 110 in the PM period.

The surveyed morning and afternoon traffic flows are shown in Figure 15.2 below:

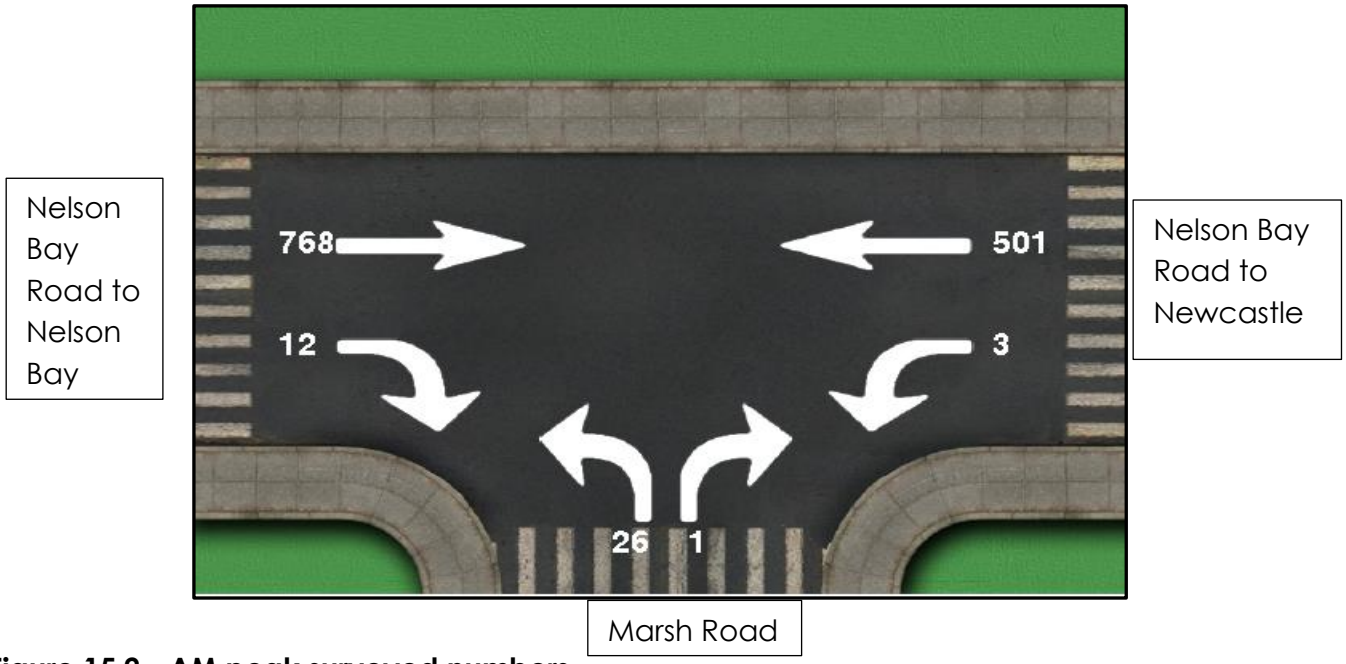


Figure 15.2 - AM peak surveyed numbers

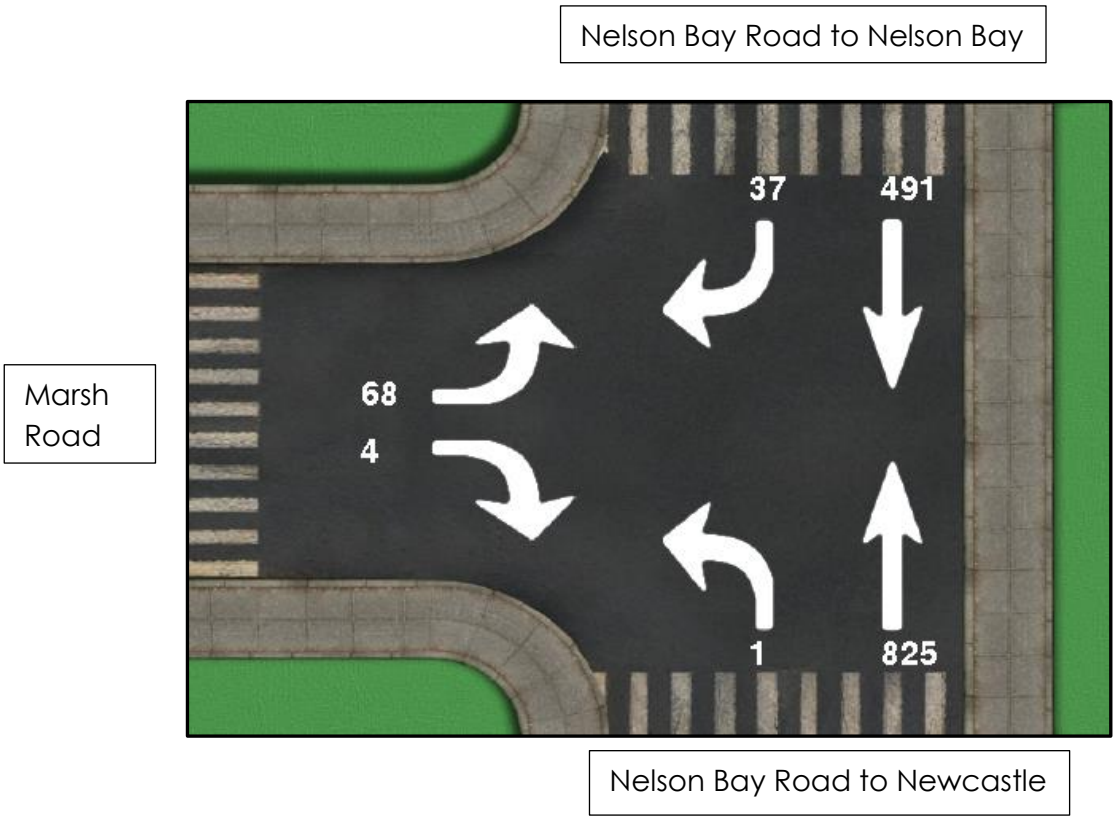


Figure 15.3 - PM peak surveyed numbers

15.2.1.7 Daily Traffic Flows

As part of the project, Seca Solution commissioned automatic tube counts to obtain current traffic volumes along both Nelson Bay Road and Marsh Road. A summary of the tube count data is provided below:

- The Marsh Road Annual Average Daily Traffic flow (AADT) was 713 vehicles per day. This was split between 412 eastbound and 301 westbound. This value is considerably lower than the value identified above (based on peak hour flows) and indicates that peak hour flows are influenced by the activities associated with student drop off and pick at the nearby school.
- The eastbound AADT on Nelson Bay Road was recorded at 7,612 vehicles per day.
- The westbound AADT on Nelson Bay Road was recorded at 7,699 vehicles per day.
- The combined two-way AADT for this section of Nelson Bay Road was 15,311 vehicles per day.

15.2.1.8 Daily Traffic Flow Distribution

The daily traffic volumes are reasonably balanced in both directions, with the above data indicating a bias in traffic movements eastbound in the morning and westbound in the afternoon. This would be reflective of the commuter demands, with commuters travelling from the Nelson Bay area towards greater Newcastle, Maitland and the Lower Hunter Valley and the reverse occurring in the afternoon period.

15.2.1.9 Vehicle Speeds

No speed surveys were completed as part of the study work. It is considered that drivers on Nelson Bay Road could travel at speeds over the posted speed limit, due to the speed limit being 100 km/h to the west of this location and there being no noticeable change in the road environment. For eastbound traffic, the road upgrades that have occurred in this area encourage drivers to speed up and as such could travel over the posted speed limit of 80 km/h. The posted speed limit increases to 100 km/h to the west of the site and it is considered that drivers speed up in anticipation of this change in speed.

The automatic tube counts provide the following data:

- 85th percentile speed on Nelson Bay Road eastbound was 91 km/h
- 85th percentile speed on Nelson Bay Road westbound was 90 km/h.

Vehicle speeds are low on Marsh Road, reflective of the road width and alignment as well as the presence of the school zone in this area. The tube count was located close to the intersection with Nelson Bay Road but west of the U-turn facility and indicates the following speeds:

- 85th percentile on Marsh Road eastbound was 65 km/h
- 85th percentile on Marsh Road westbound was 59 km/h.

15.2.1.10 Existing Site Flows

The site currently generates minimal traffic flows.

15.2.1.11 Heavy Vehicle Flows

Heavy vehicle movements in the vicinity of the subject site are relatively low, reflective of the limited through traffic movements along Nelson Bay Road. As a road that serves the Nelson Bay peninsular, there are no through traffic movements, with the only heavy vehicle movements being those associated with deliveries to the various urban centres. Heavy vehicle movements are restricted to delivery vehicles to the major shopping centres as well as some light industrial users.

During the traffic surveys, the vast majority of the traffic were light vehicles with the heavy vehicle content representing some 5% of the overall traffic movements.

15.2.1.12 Current Road Network Operation

Observations on site during the peak periods showed that the road network currently operates very well with minimal delays and congestion. The traffic movements along Nelson Bay Road flows well with no delays or congestion, and the two lanes of travel allow faster moving traffic to pass slow vehicles as appropriate. For traffic movements in and out of Marsh Road, the delays were minimal and drivers were able to determine suitable gaps for the right turn movements with very minimal delays.

Further to the west, it can be seen that the single lane of travel causes some delays, due to the volume of traffic. However, the road upgrade will allow for 2 lanes of travel and eliminate these delays.

Traffic flows along Nelson Bay Road are also influenced by seasonal demands, with summer demands increasing due to the tourist's facilities in the Nelson Bay area. Similarly, the weekend traffic demands can be relatively high, reflective of weekend and day trips to the Nelson Bay area.

Traffic Safety and Accident History

Accident data provided by the RMS for the locality shows that there have been a low number of recorded accidents in the vicinity of the intersection of Nelson Bay Road and Marsh Road, reflective of the low side road traffic flows and the good alignment of this intersection, providing good visibility in both directions for drivers entering and exiting the side road. The accidents that have occurred have been located away from the intersection and do not relate to the layout of the intersection nor its controls.

Parking Supply and Demand

15.2.1.13 On-street Parking Provision

Parking is permitted along both sides of the roads in the locality, on the verges as required with normal restricts in the immediate vicinity of the intersection and driveways.

15.2.1.14 Off-Street Parking Provision

There is parking provided within the various lots in the immediate vicinity of the subject site.

15.2.1.15 Parking Demand and Utilisation

During the site work, there were no vehicles parked on Nelson Bay Road. It is considered that any vehicles parking on this road would be associated with emergency or breakdowns only, as there is no demand to park on the road side in this location.

Vehicles associated with drop off and pick up at the local school on Marsh Road park adjacent to the school but outside of the school hours there is very little demand for parking in this location, with the local houses all allowing for off-street parking.

15.2.1.16 Set down or pick up areas

There is an indented bus drop off / pick up zone outside the entrance to the local school on Marsh Road.

Public Transport

15.2.1.17 Rail Station Locations

The subject site is not served by trains. The nearest train station is in Hexham, approximately 25kms from the subject site.

15.2.1.18 Bus Stops and Associated Facilities

There is a bus drop off zone located outside the local school on Marsh Road together with a bus stop on the opposite side of the road. There is a single shelter on Marsh Road to service these bus stops. There are bus stops located on both sides of Nelson Bay Road to both sides of

the intersection with Marsh Road, to service patron demands for buses that operate along Nelson Bay Road. The stops on Nelson Bay Road provide a sign only with no seats or shelter.

Other Proposed Developments

There are no other major developments occurring in the immediate vicinity of the subject site.

15.3 PROPOSED DEVELOPMENT

The Development

The development proposal allows for a sand mining operation, with access off Nelson Bay Road and Marsh Road. The initial stage of the proposal allows for establishing the site, clearing the site of vegetation and providing the two access points. The following stages are nominated:

a. Operational Stage 1 – Clearing and stockpiling of topsoil and production of initial sand material that is likely to be processed into landscaping soil base and sports field top-dress material.

b. Operational Stage 2- Processing of blonde sand material for all products range.

c. Operational Stage 3 – Setting up of dredging operations and winning of sand material for the processing of all products range.

Within the operational stages the main activities will be the bulk handling of sand material, utilising front end loaders and trucks and the general truck and dogs for transport of the material to the required markets.

The peak use on the site would allow for 200 trucks to enter and exit the site per day.

15.3.1.1 Phasing and Timing

The development will be established in the first phase then proceed to operations. No staging of the project has been allowed for in this assessment.

15.3.1.2 Access and Circulation Requirements

A vehicle access point is proposed to allow for direct access off Nelson Bay Road. This access will be used by both light and heavy vehicles and allow for entry movements only, with no exit movements. This access will be designed and constructed in accordance with Council and RMS design requirements. All vehicles will exit the site via the access road upgrade to Marsh Road. For heavy vehicles requiring access from the east of the site, access would be via the entry point off Nelson Bay Road. Trucks will travel along Nelson Bay Road and then complete a U-turn to then turn left into the site. There is an existing U-turn facility provided to the west of the site access, with a deceleration lane for the traffic turning off the westbound traffic lane. At this location, the opposing traffic streams are separated by some 45 metres, which allows for a safe U-turn to occur for trucks.

The access driveway on Marsh Road is located to the east of the local school and all trucks will exit and turn right out of this driveway to turn towards Nelson Bay Road. There is an existing

access at this location which will be upgraded to allow for the increased use and this access will be designed and constructed in accordance with Council design requirements.

Circulation within the site will be determined by the operational requirements of the development. All vehicles will be able to enter the site and manoeuvre as required within the site and exit in a forward direction.

Access

The new access of Nelson Bay Road and the upgraded driveway will be designed and constructed in accordance with Council and / or RMS requirements and allows for left in traffic movements only off Nelson Bay Road due to the central median. The upgraded access on Marsh Road will allow for all traffic movements, however trucks will only exit through this access and undertake a right turn. No heavy vehicles will enter the site through the Marsh Road access.

15.3.1.3 Driveway Location

The driveway access on Nelson Bay Road is located on the inside of a low angle left hand bend. In this location Nelson Bay Road provides two lanes of travel in both directions and the trucks will turn off the through lane and enter a left turn deceleration (to be constructed) before entering the site. This entry point is located 30 metres west of an existing U-turn lane on Nelson Bay Road and will only allow for left turn in traffic movements.

The driveway on Marsh Road will be an upgrade of the existing access point in this location. Marsh Road in this location offers a reasonably straight alignment to provide safe entry and exit movements. Due to the low speed limit (60 km/h) and the low traffic speeds, this access will be a simple driveway access with no left turn deceleration lane provided. All trucks exiting the site will turn right out of this driveway. All vehicles entering the site at this location will be light vehicles only associated with staffing requirements.



Plate 15-1 - View west along Marsh Road showing road alignment. Access to site is on left hand side of the photograph

15.3.1.4 Service Vehicle Access.

All service vehicle access will be via Marsh Road, with servicing levels expected to be low. There will be a requirement for a fuel truck to access the site as well as occasional maintenance vehicles for the quarry vehicles which will be located permanently on site. For the material handling trucks, servicing requirements will be completed off site.

15.3.1.5 Access to Public Transport

The site has limited access to public transport, with limited bus services provided along Nelson Bay Road and Marsh Road. While future workers could use these bus services, it is considered that the proposed development will generate no demand for public transport use.

Circulation

15.3.1.6 Pattern of circulation

All vehicles will be able to enter and exit the site in a forward direction from the local road network. All trucks will enter the site off Nelson Bay Road via the left turn slip. These trucks will then proceed through the site in a forward direction and then exit the site onto Marsh Road. All trucks will turn right when exiting the site onto Marsh Road. Light vehicles will access the site

via Marsh Road, move within the site and then exit the site onto Marsh Road in a forward direction.

15.3.1.7 Road width

The access points on Nelson Bay Road and Marsh Road will be designed and constructed in accordance with Council and RMS requirements and will allow for the movement of trucks. The internal roads will take into account the swept path requirement of a truck and trailer combination. There will not be any formal roads within the site, due to the nature of the development.

15.3.1.8 Internal Bus Movements

No internal bus movement required for this development.

15.3.1.9 Service Area Layout

No dedicated service area is provided. Trucks will be serviced off site and there will be no requirement for a dedicated service bay on the site.

Parking

The parking for the development will be provided for the staff located on site with access via the driveway off Marsh Road. This will be in an informal area close to the offices on the site.

There will be no requirement for the trucks to park on the site overnight. Equipment associated with the quarry operations will stand on site.

Pedestrian and Bicycle Facilities

The site is relatively remote and as such it is considered that there will be no demand for pedestrian or cyclists' access. The access off Marsh Road will allow for pedestrian and cyclist access should it be required. There will be no demand or provision for internal movement of pedestrians or cyclists within the site.

15.4 TRANSPORTATION ANALYSIS

Traffic Generation

Traffic associated with the development will vary based upon the market demands. Advice from the study team indicates that a peak daily demand could be 200 trucks entering and exiting the site. This is an absolute peak and at other times, there would be much lower flows and during particularly quiet periods, there would be no demand for trucks to enter and exit the site.

As a worst-case scenario, this assessment has worked on the assumption that the peak daily demand could be 200 trucks entering and exiting the site per day. The site is proposed to operate between 6.00 AM and 6.00 PM Monday to Saturday.

Based on a typical working day of 10 hours for the delivery of material off site, the development will generate some 20 inbound and 20 outbound trucks per hour on average when the site is working at maximum capacity.

15.4.1.1 Daily and Seasonal Factors

The nature of the development will lead to significant variation is daily traffic flows, dependent upon market demands. During quiet periods, it is expected that there would be no demand for trucks to enter or exit the site. Flows could be much lower on a Saturday and the site will not operate on Sundays or public holidays.

15.4.1.2 Sight Distances

The site access point on Nelson Bay Road is located within an 80 km/h speed zone. This access is an entry only and as such there is no requirement for drivers to observe vehicle movements on Nelson Bay Road to exit the site at this location. For drivers entering the site, the alignment of Nelson Bay Road ensures that the required forward visibility distance is available along the road, to allow a driver to observe the left turn slip road into the site. For the 80 km/h, the stopping sight distance requirements is 100 metres and this distance is available based upon the on-site assessment. This distance will allow a driver approaching the site access to observe the start of the left turn deceleration lane and allow for safe manoeuvring into this lane for the trucks. This will also allow drivers following the trucks to adjust their vehicle speeds or move into the right hand lane on Nelson Bay Road and ensure that the trucks can safely enter the left turn slip lane.

For the existing U-turn facility on Nelson Bay Road, for the westbound trucks turning off Nelson Bay Road, there is a deceleration lane for the U-turn bay, allowing the truck to enter this U-turn facility in a safe manner. There is good visibility available on this approach, which is greater than 100 metres. Trucks will then have to turn right out of this U-turn facility to then head east along Nelson Bay Road to then access the left turn slip into the site. At this point, the sight visibility distance exceeds 300 metres, safely exceeding the sight line distance of 160 metres for the sight distance requirements at this location.

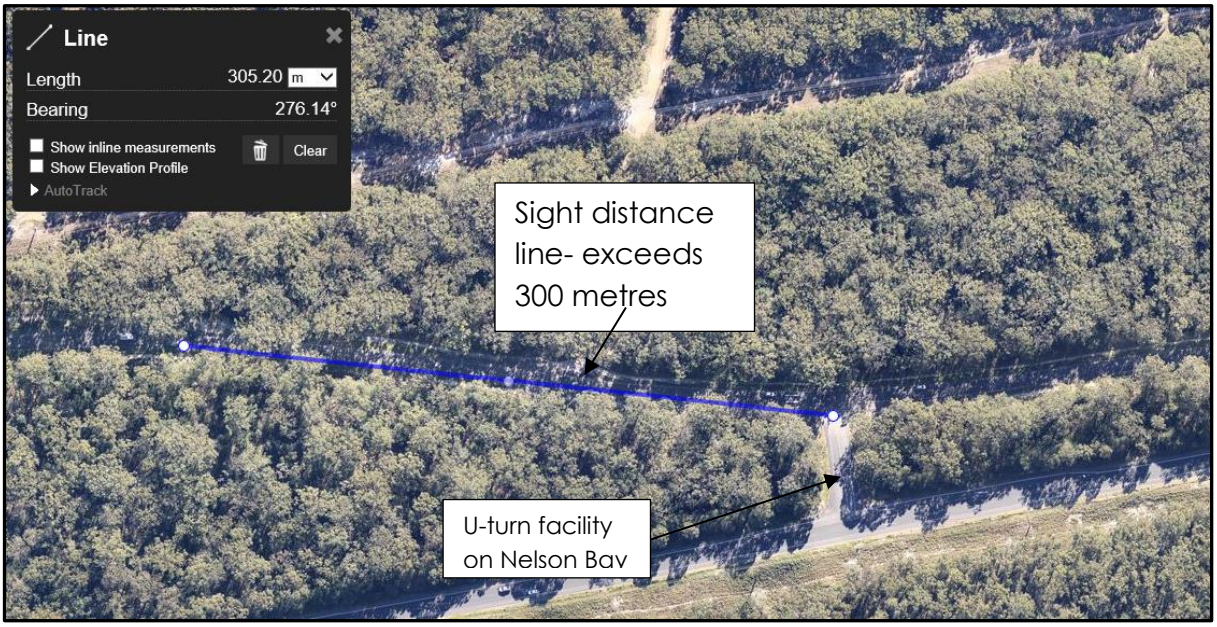


Plate 15-2 - Aerial of U-turn facility on Nelson Bay Road west of Marsh Road

The access point on Marsh Road is located within a 60 km/h speed zone, and the required sight distance for a driveway in this speed zone is 83 metres. Under Austroad requirements for an intersection in this speed zone, the safe intersection sight distance is 105 metres. For drivers exiting the site, the sight distance available to the left is 140 metres or more, as shown below.



Plate 15-3 - Aerial photo showing available sight distance left of the site access on Marsh Road

Visibility to the right is less than this distance, due to the road alignment to the east of the site (as shown in Photo 3 below). However, vehicle speeds at this point are below 60 km/h, as drivers have turned off Nelson Bay Road into Marsh Road. The distance available is 78 metres, which is some 5 metres less than the required distance of 83 metres for the posted speed zone of 60 km/h. However, it is noted that the minimum sight distance requirement for a driveway in this speed zone is 65 metres, which is less than the distance available. Further, it is noted that

for a 50 km/h zone the sight distance requirement for a driveway is 69 metres desirable (45 metres minimum) and it is considered reasonable that vehicle speeds at this point could be 50 km/h, as this distance is only 70 metres away from Nelson Bay Road.



Plate 15-4 - Aerial photo showing sight line to the right of the site access



Plate 15-5 - View to left for drivers exiting the site on Marsh Road



Plate 15-6 - View to right for drivers exiting site on Marsh Road

Overall, it is considered that the sight distances available for vehicles entering and exiting the site via Marsh Road are acceptable, given the road alignment and the vehicle speeds.

15.4.1.3 Queuing at entrance to site

There are no vehicle queues expected at site entry / exit points. Given the low overall traffic demands associated with the future development and the left in traffic arrangement on Nelson Bay Road all vehicles will be able to enter the site without delay. Any queues associated with exit movements from the site are expected to be minimal and will be contained within the site.

Light vehicle movements associated with staff are expected to be low with no delays as these vehicles turn left off Marsh Road to enter the site.

15.4.1.4 Comparison with existing site access

The site is currently used as a home business and has an access onto Marsh Road. The current use on site involves the occasional use of truck and dog combinations and these trucks operate in a safe manner with no reported issues or concerns.

15.4.1.5 Pedestrian Movements

The development is not expected to be a generator of pedestrian movements either to the site or within the site.

Traffic Distribution and Assignments

Given the location of Bobs Farm on the Nelson Bay peninsula, through traffic is limited. The markets for the quarry products are expected to be primarily to the north via Raymond Terrace or south through the greater Hunter area.

95% of all traffic is expected to have an origin/destination west of the site with all traffic using Nelson Bay Road.

15.4.1.6 Origin / Destinations Assignment

90% of traffic is expected to have an origin/destination west of the site along Nelson Bay Road. The location of the access and the raised central median on Nelson Bay Road restricts heavy vehicle access to the site to be from the west only, including any traffic initially from the east. This will be reinforced by WHS Guidelines for the site operations.

All heavy vehicles exiting the site will access Marsh Road and connect with Nelson Bay Road with the vast majority expected to want to head west from Marsh Road onto Nelson Bay Road.

The destination for deliveries will depend on market forces. Haulage routes are expected to be dispersed along existing local roads with:

- north bound deliveries travelling along Richardson Road to the Pacific Highway and Raymond Terrace
- west bound deliveries travelling along Cabbage Tree Road to Tomago and west along the New England Highway
- southbound deliveries travelling to Tomago to then travel south along the M1 Motorway
- Newcastle based deliveries travelling along Nelson Bay Road to Kooragang and connecting with the local road network as appropriate

Both Nelson Bay Road and Cabbage Tree Road are restricted access vehicle routes suitable for B-doubles and similar heavy haulage.

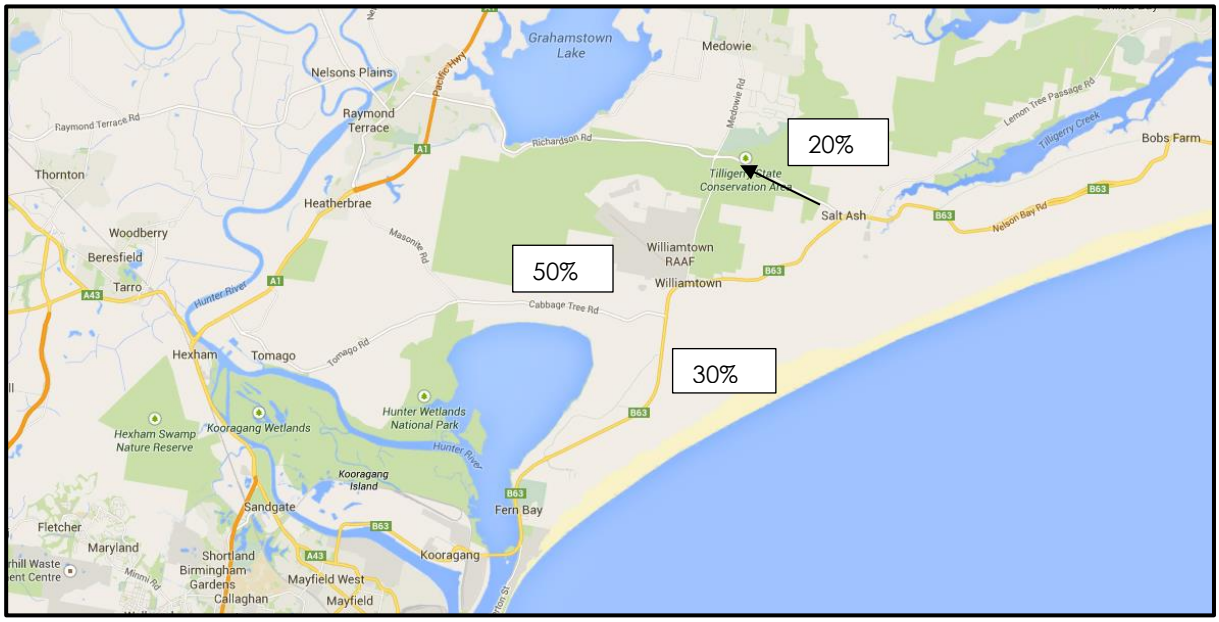


Figure 15.4 - Traffic movements associated with outbound material movements

Impact of Generated Traffic

15.4.1.7 Impact on daily Traffic Flows

It can be seen that the development will have a low impact upon the overall daily traffic movements in the general locality of the subject site. At peak operations, there will be 200 truck movements in and out of the site with 90% of these movements heading west along Nelson Bay Road. This will potentially increase flows in Nelson Bay Road to the west of the site by 360 vehicles. The current AADT for this length of Nelson Bay Road is 15,311 and this could increase to 15,671 vehicles per day, an increase of 2.3% over the existing flows.

As a major state road, under the Network Planning guidelines provided by the RTA (now RMS) the road would be classified as a Class 5R, typically providing 2 or more lanes with frequent overtaking opportunities. This guide indicates that the average daily traffic flows would be 12,000 vehicles per day. The next classification of road, 6R, with annual traffic flows greater than 12,000 vehicles per day would typically provide 4 or more traffic lanes.

Overall it is concluded that the additional traffic movements associated with the proposed development will have an acceptable impact upon daily traffic flows along Nelson Bay Road.

15.4.1.8 Peak Hour Impacts on Intersections

The peak hour traffic volumes associated with the development have been determined based upon first principals. The development, at peak operations, will generate 200 inbound and 200 outbound truck movements per day, and based on the truck movements occurring over a 10-hour day the average hourly traffic movement would be 20 inbound and 20 outbound movements per hour, which could include peak hour periods.

The key intersection that could be impacted upon by the proposed development would be the give way-controlled intersection of Nelson Bay Road and Marsh Road. The operation of this intersection has been assessed with the computer program Sidra based upon the existing traffic data collected for the project.

The automatic traffic data collected for the project shows the daily traffic flow variance along Nelson Bay Road and demonstrates the distinctive peak in traffic movements. It is noted, and confirmed with the Sidra modelling, that some delays could occur for trucks when exiting Marsh Road during the peak periods. Outside of these peak periods the delays are much lower and the intersection operates well.

The results for the intersection analysis for the morning peak period (7.45 to 8.45) and afternoon peak period (15.30 to 16.30) are shown below.

Approach	Level of Service	Delay (seconds)	Queue (metres)
Nelson Bay Road (Nelson Bay)	A / A	0.2 / 1.0	0.5 / 2.4
Marsh Road – left turn out	A / A	9.3 / 10.6	0.7 / 2.3
Marsh Road – right turn out	E / F	58.3 / 70.6	0.3 / 1.4
Nelson Bay Road (Newcastle)	A / A	0.0 / 0.0	0.0 / 0.0
Overall	A / A	0.3 / 0.9	0.6 / 2.4

Note- results for the AM / PM peak periods

Table 15.2 - Sidra results, 2014 existing situation Marsh Road and Nelson Bay Road

The above analysis shows that the intersection operates well with minimal delays, although it is noted that the right-turn out operates at a level of service of E in both the AM and F in the PM peak periods with delays of 58.3 and 70.6 seconds respectively. Observations on site show however that typically the delay for traffic turning right out of Marsh Road are low, as drivers have good visibility and can use the central turn lane to undertake the right turn out of the side road in two stages.



Plate 15-7 - View to right for drivers exiting Marsh Road onto Nelson Bay Road

It can be seen that with additional traffic added to the right turn movement out of Marsh Road, the delays will increase for drivers and could lead to frustration. It is further noted that the trucks exiting the site and using this intersection will be laden and as such, will not be able to accelerate at a significant rate.

To ensure road safety is maintained and not impact upon other traffic movements out of Marsh Road, all trucks exiting the proposed development will turn left out of Marsh Road, proceed along Nelson Bay Road to the roundabout at Nelson Bay Road / Port Stephens Drive and complete a U-turn at this location.



Plate 15-8 - View along Marsh Road showing two lane approach to Nelson Bay Road with separate left turn lane

Seca Solution has previously collected traffic data at this location in April 2014 and the results of the survey are shown in Figure 15.5 below.

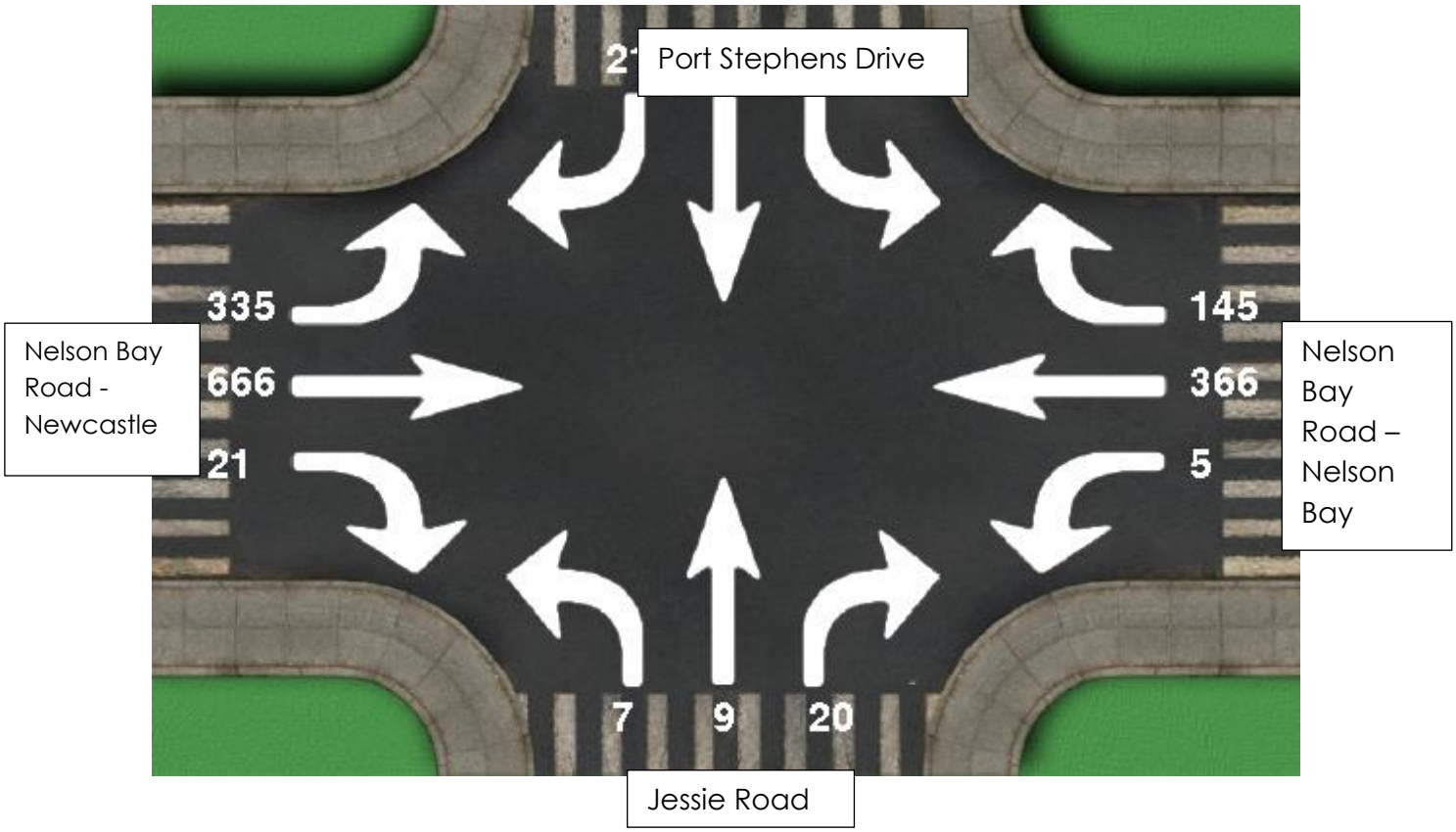


Figure 15.5 - Traffic survey results, roundabout at Nelson Bay Road and Port Stephens Drive (PM peak)

The operation of this roundabout has been assessed with Sidra and the results of the analysis are presented below in Table 15.3.

Approach	Level of service	Delay (seconds)	Queue (metres)
Jessie Road	A / A	9.2 / 9.9	1.4 / 1.9
Nelson Bay Road east	A / A	8.5 / 8.8	12.4 / 16.8
Port Stephens Road	A / A	11.6 / 12.1	7.4 / 10.5
Nelson Bay Road west	A / A	6.7 / 7.1	17.6 / 24.6

Note – results for 2014 PM existing flows / 2024 PM flows allowing for 20% growth on all movements.

Table 15.3 - Sidra modelling, roundabout of Nelson Bay Road and Port Stephens Road

The above analysis shows that the roundabout is operating well with minimal delays and congestion for all road users.

The current traffic flows through this roundabout are in the order of 1900 vehicles per hour in the PM peak, with a similar value in the AM peak. The additional traffic movements associated with the development could increase these values by some 20 vehicles per hour, representing an increase of 1% over the existing flows. It is considered that this will have a negligible impact upon the operation of the roundabout, based upon site observations and the Sidra analysis above for the peak period. Outside of the peaks, the traffic movements are much lower (20% or more) and the roundabout will operate with less delays, allowing for the movement of the trucks to occur.

For the access route through to Newcastle / Raymond Terrace and Maitland, all of the major intersections are controlled by traffic signals or roundabouts and operate well with minimal delays and congestion. It is considered that the additional 40 trucks movements per hour maximum would have an acceptable impact upon these intersections.

15.4.1.9 Background traffic and other developments

In accordance with normal RMS requirements, the impact of the additional traffic has been reviewed allowing for 10 years background growth along Nelson Bay Road. A review of the historic traffic data along Nelson Bay Road shows that the rate of background growth is very low, at less than 1.5% per annum. Allowing for 15% background growth over a 10 year timeframe it is considered that the roundabout and the road network in the locality of the subject site will continue to operate to a high level.

As part of the planning for the upgrade of Nelson Bay Road, the RMS have assessed the background growth along the road which would allow for development such as the development site and has designed the road and the connections accordingly. Therefore it is concluded that the background growth together with the traffic associated with the development will have an acceptable impact.

The Sidra results above show that the roundabout at the intersection of Nelson Bay Road and Port Stephens Drive will continue to operate with minimal delays and congestion. With all traffic movements increase by 20% the roundabout continues to operate with low overall delays and minimal queues.

15.4.1.10 Impact of Construction Traffic

There will be minimal construction activity on site associated with the proposed development, as the site set up and establishment allows for clearing of vegetation only. The major impact during the establishment of the site will be during the construction of the left turn slip into the site off Nelson Bay Road. This will require work on the site as well as work adjacent to the existing road carriageway.

As part of the construction work for the left turn slip into the site, a Traffic Management Plan will need to be developed and implemented. This will be submitted to the RMS and Council for approval prior to any works commencing on site. A Works Authorisation Deed (WAD) will also be signed with the RMS to ensure the site access is designed and constructed in accordance with the road authority requirements.

Impact on Road Safety

The additional traffic flows associated with the development of the subject site will have a relatively low impact upon traffic safety. The site entry point for the trucks is located on nelson bay Road and a left turn deceleration lane will be provided in accordance with Austroads and RMS design requirements to ensure trucks can safely enter the site. All vehicles will exit the site on Marsh Road, via the existing vehicle access point. This access is located on a relatively straight section of road offering good visibility for drivers entering and exiting the site at this location. All light vehicles will enter and exit the site via this access point. The connection to the main road network is via the stop sign controlled intersection of Marsh Road and Nelson Bay Road and this intersection provides sheltered turn lanes and good visibility. The trucks associated with the development will turn left out of this intersection, with good visibility permitting these vehicles to safely enter the traffic stream on Nelson Bay Road. These trucks will then complete a U-turn at the roundabout of Nelson Bay Road and Port Stephens Drive, which ensures road safety is maintained for all users.

Overall it is considered that the proposed development will have a negligible impact upon road safety in the general locality of the subject site.

Parking Analysis

The parking for the proposed development can all be accommodated on site. There will be an area set aside beside the office which will accommodate the staff located on site. The site will only require 1 or 2 people to operate the facility. Note that the trucks will not be parked on site and as such do not need to be provided for nor parking for the truck drivers private vehicles.

Public Transport

15.4.1.11 Options for improving services

It can be seen that the site is not well serviced by public transport and the nature of the development does not support public transport use. No improvements to public transport are considered necessary for the project.

15.5 IMPROVEMENT ANALYSIS

Improvements to Accommodate Existing Traffic

The existing road network in the immediate vicinity of the subject site is well developed and there are no road network upgrades currently occurring within the immediate vicinity of the subject site. The RMS are currently upgrading Nelson Bay Road to the east of the site to provide two lanes of travel between the subject site and Port Stephens Drive. This will benefit the trucks movements associated with the development. No further road upgrades are required to accommodate the existing traffic movements.

Improvements to Accommodate Background Traffic

The upgrade of Nelson Bay Road by the RMS is being completed to improve road safety and ensure there is adequate capacity for future increases in traffic movements. It is considered that no further road upgrades are required other than those currently being completed by the RMS on Nelson Bay Road.

Additional Improvements to Accommodate Development Traffic

Based upon the Sidra analysis, it is considered that no road upgrade works are required to accommodate the traffic movement's associated with the subject development site. Trucks will turn left out of Marsh Road and travel along Nelson Bay Road to then complete a U-turn at the roundabout controlled intersection at Port Stephens Drive. This will ensure that there are no delays for traffic at the intersection of Marsh Road and Nelson Bay Road and ensures that there will be no impact upon road safety at this location.

Alternative Improvements

No alternative improvements are put forward for the project.

15.6 SUMMARY AND RECOMMENDATIONS

Summary

The following conclusions are drawn from the investigations into the proposed sand quarry at Bobs Farm off Nelson Bay Road:

1. The proposal allows for a sand quarry with all heavy vehicle entry via a new access point off Nelson Bay Road. Light vehicle access will be via the upgraded access off Marsh Road and all vehicle exit movements will be via this access on Marsh Road.

2. The site is located within the locality of Bobs Farm with frontage to both Nelson Bay Road and Marsh Road. The major access route for outbound material will be to the west of the site along Nelson Bay Road to centres such as Newcastle, Raymond Terrace and the Lower Hunter Valley.

3. All trucks will enter the site directly off Nelson Bay Road via an upgraded access. This will require a left turn deceleration lane to be built on Nelson Bay Road and this will be designed and constructed in accordance with RMS and Council requirements. All trucks will then drive through the site and exit via the existing access point on Marsh

Road. All trucks will turn right out of the exit on Marsh Road and then proceed to the intersection of Nelson Bay Road with Marsh Road.

4. Due to potential delays for the trucks turning right out of Marsh Road and associated safety concerns, all trucks will turn left out of Marsh Road and proceed in an eastbound direction along Nelson Bay Road. The trucks will then complete a U-turn at the roundabout controlled intersection of Nelson Bay Road and Port Stephens Drive to return in a westbound direction. The trucks will then continue along Nelson Bay Road and then use Richardson Road to head towards Raymond Terrace and the Pacific Highway, or Cabbage Tree Road to head towards the New England Highway and Maitland or continue along Nelson Bay Road towards Newcastle. Both Nelson Bay Road and Cabbage Tree Road are RAV approved routes suitable for heavy haulage.

5. All light vehicles will enter and exit the site via the access point on Marsh Road. This will reduce the conflict between light and heavy vehicle and allows direct access to the site office.

6. The site access points have been reviewed on site and allow for safe vehicle movements, with adequate sight lines available based upon vehicle speeds and the posted speed limits.

7. All parking can be accommodated on site. The trucks will not be parked on site over-night and there is minimal on-site staffing levels requiring minimal on-site parking.

The overall conclusion from the investigations is that traffic and access arrangements for the development proposal are satisfactory and that there is no traffic or access impediments to the development. The trucks access routes have been reviewed based upon impacts for other road users and road safety and the proposed access routes can operate in a safe and efficient manner with minimal delays for other road users. The access point on Nelson Bay Road will be designed and constructed in accordance with RMS and Council requirements to ensure the trucks can safely enter the site. The access on Marsh Road is an existing access point and allows for a safe entry and exit movements.

16 SAND ASSESSMENT AND MINING PLAN

Chapter 16 describes the preliminary testing of the sand resource and discusses the proposed methods of sand mining. Several reports have ben completed by QMS on the resource and all three (3) stages of the report are collated in this Chapter. Full copies of these reports are available in Annex I (Stage 3), R (Stage 2 and S (Stage 1).

16.1 INTRODUCTION AND BACKGROUND

The proposed Bobs Farm deposit is situated on the northern end of the Stockton Bight Dunal system, approximately 200km north of Sydney, in Port Stephens, NSW Australia. The following scope was developed to investigate the Bobs Farm site as a potential sand deposit.

Overall Scope of Investigation

From the original Quarry Mining Systems proposal –

The overall scope of this investigation was to establish the projected viability of mining the sand deposit on this property. The work was to be completed in stages depending on the instructions of the owners and the results of the previous stage. each stage was to provide greater levels of certainty about the quantity and quality of the sand deposit.

Stage 1 (Completed)

5 test pits dug by long reach excavator to establish resource sand quantity and quality at various points on the site. Dependant on site conditions during sampling.

a. Analysis of samples from the pits.
b. Preliminary indications of sand volumes and quality available at the site.

Stage 2 (Completed)

5 boreholes were drilled up to 16 metres below the existing water table, logged and tested to confirm sand quality with depth in these locations across the site.

A comprehensive analysis of potential market applications was also undertaken to identify potential sales for the various sand lenses.

Stage 3 presented later in this report

Stage 4 is proposed to extend on work done in Stage 3 and complete the detail required for a complete quarry plant design, costing and operational budget. The site operational plan would be developed based upon site approvals and market opportunities.

Stage 5 is proposed to be the development of the overall operation, ongoing management, maintenance of the plant, product testing and quality of sand supplied to the various markets.

Review – QMS Stages 1 and 2

Previous QMS investigations, stages 1 and 2, confirmed that there were significant volumes of minable sand lenses present at different depth across the site. The Stage 1 work involved the establishment of test pits at various locations to gain an understanding of the quality and consistency of the sand with depth. Stage 2 involved further drilling and sampling of sand lenses with depth and these samples were used as a basis for further testing in this Stage 3 work

reported here. It was clear from these stages that a series of sand lenses existed and a range of potential markets also existed for these sands.

Outcomes of Stage 2

Figure 16.1 below identifies test pit and borehole location sunk onsite to date by QMS. This forms the basis of the data available for analysis.



Note: PH= Proposed Hole; TP = Test Pit

Figure 16.1 - Bore Hole and Test Pit Locations - (Extract from QMS Stage 2 Report)

Table 16.1 below details the layers thickness with depth across the Bobs Farm site.

Hole Number	Upper Grey Sand Unit (RL m)	Blonde Sand Unit (RL m)	Black Palaeosol Unit (RL m)	Lower grey Sand (RL m)	Hole Depth (m)
BH 1	5.8 – 4.8	4.8 – 2.0	2.2 – 1.3		19.00
BH 2	11.7 – 6.8	6.8 – 1.2	1.2 - -0.3	-0.3- -14.8	26.50
BH 3	15.4– 12.4	12.4 – 0.0	0.0 - -1.4	-1.4- -11.9	26.50
BH 4			2.8 – 1.9	1.9 -	24.00
BH 5					26.50

Table 16.1 - Resource Average Thickness Summary (Extract from QMS Stage 2 Report)

Table 16.2 below summarises the basis for QMS stage 2 volume estimates, when broken into three main extraction groups; Upper, Mid and Lower units. This is expected to change with Martens geotechnical report changing the maximum batter slope angles.

Resource Category	Status	Base of Extraction RL (m)	Batter angle (degrees)	Volume (BCM)	Tonnes
Upper	Dry	4.3	18	2,226,563	3,562,500
Mid	Moist	2.3	18	546,495	874,392
Lower	Wet	-13.7	42	3,830,347	6,128,555
Total				6,603,405	10,565,448

Table 16.2 - Resource Category Summary - (Extract from QMS Stage 2 Report)

Table 16.3 below represents the reserve estimates from the Stage 2 drilling program of five (5) separate drill holes that confirmed the presence of five (5) mineable sand units and a Topsoil unit for site rehabilitation, classified as:

Resource Unit	Volume	Tonnes
Top Soil	151,477	242,364
Upper Grey Sand	331,808	530,892
Blonde Sand to 4.3m RL	1,743,278	2,789,244
Blonde Sand Remaining	546,495	874,392
Black Carbonaceous	343,110	548,976
Lower Grey Sand	3,487,237	5,579,579

Note: volume estimates are based upon the available information and contain assumptions of degree of compaction within the sand as deposited and will likely be reduced when more specific mining planning is undertaken. See QMS Stage 2 Appendix 4-Borehole Logs).

Table 16.3 - Resource Unit Summary - (Extract from QMS Stage 2 Report)

Each of these sand layers were believed, based upon QMS stage 2 investigations, to have the potential to be processed into different products to satisfy different market needs; from turf sands/ sports field, cricket/golf, decorative, and construction material uses to potentially higher end uses in coloured glass, foundry and other specialist applications.

Stage 3 Scope

The investigation in stage 3 was designed to produce a number of outcomes;

1. To identify if specific sand lenses within the site could be used for higher end uses that may attract a higher selling price and hence maximise revenue for the operation.
2. Testing for process requirements into higher end markets
3. Concept process design for sand into identified markets
4. Concept process design and cost estimate for beneficiating of sand to higher value markets
5. Development of a potential mining plan based on available information

6. Market analysis on future opportunities for sales into Australian and overseas export markets.

Outcomes of Stage 3

Sampling and laboratory testing

Samples retrieved from the QMS Stage 2 (Annex R) drilling program confirmed that the different sand lenses onsite were suited to a number of different markets with blending or additional processing required in most cases. To determine if further processing of the sand would be likely to bring it to higher market uses appropriate samples from the stage 2 drilling were sent for further analysis and testing with the following outcomes;

Product quality, product types

1. Further testing in the QMS Stage 3 investigation of sand samples confirmed that the sand onsite was not suitable for Fracking sand applications as it was too soft (too low an Unconfined Compressive Strength -UCS), was too small in size and the sphericity was close but may not comply with required specification. In addition, acid testing indicated that under potentially aggressive low pH ground conditions the sand may not be suitable. See Appendix 1-5 McLanahan report (Annex I) and Table 16.4 below. The sand lenses further tested for Frac were identified in the QMS stage 2 investigation as being those most likely to comply with the relevant specifications.

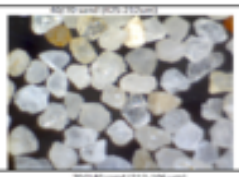
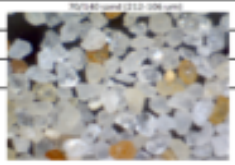
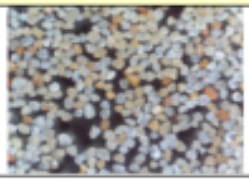
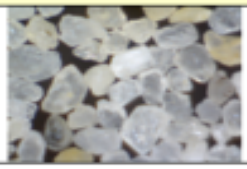
Frac Testing						
Sample Location (Borehole ID)	Primary Frac Sand Size					Images
BH2-22.5 – 23.5 – G - ML	6/12 (3350 – 1700um)	12/20 (1700 – 850um)	20/40 (850 – 425um)	40/70 (425-212um)	70/140 (212-106um)	
Roundness / Sphericity	Fail	Fail	Fail	Fail	Fail	
Acid Test	Fail	Fail	Fail	Fail	Fail	
Crush Test	N/A	N/A	N/A	Fail	N/A	
BH3- BL-B-ML	6/12 (3350 – 1700um)	12/20 (1700 – 850um)	20/40 (850 – 425um)	40/70 (425-212um)	70/140 (212-106um)	
Roundness / Sphericity	Fail	Fail	Fail	Fail	Fail	
Acid Test	Fail	Fail	Fail	Fail	Fail	
Crush Test	N/A	N/A	N/A	Fail	N/A	
BH3- BL-G-ML	6/12 (3350 – 1700um)	12/20 (1700 – 850um)	20/40 (850 – 425um)	40/70 (425-212um)	70/140 (212-106um)	
Roundness / Sphericity	Fail	Fail	Fail	Fail	Fail	
Acid Test	Fail	Fail	Fail	Fail	Fail	
Crush Test	N/A	N/A	N/A	Fail	N/A	
BH5- BL-B-ML	6/12 (3350 – 1700um)	12/20 (1700 – 850um)	20/40 (850 – 425um)	40/70 (425-212um)	70/140 (212-106um)	
Roundness / Sphericity	Fail	Fail	Fail	Fail	Fail	
Acid Test	Fail	Fail	Fail	Fail	Fail	
Crush Test	N/A	N/A	N/A	Fail	N/A	
Conclusions						
Sand lenses and size fractions tested were deemed unsuitable for Frac Applications after further specialist testing.						

Table 16.4 - Frac Testing Results Summary

2. Further testing of sand lenses within the site confirmed that, due to the high silica content and relatively low impurities of the sand lenses tested, with further processing those sand lenses may be suitable for higher end applications potentially attracting better sales revenue. See Table 16.5.

Geochempet- Chemical Property Summary and Potential Application							
Application =>	Moulding sand		Fire/ Furnace Sand		Glass		
Constituent	Spec %	Result %	Spec %	Result %	Clear Glass Spec %	Coloured Glass Spec %	Result %
Silica (SiO2)	>98	97.9	>95	97.9	>99	>98	97.9
Al2O3		-	<1.00	0.65	-	0.2-1.6	0.65
Fe2O3		-	<1.00	0.16	<0.03	<0.2	0.16
TiO2		-	-	-	<0.1	-	-
Na2O		-	-	-	-	<0.2	0.05
Cr2O3		-	-	-	<6ppm	-	-
LOI		-	-	-		<0.4	0.4
Co		-	-	-		1ppm	TBA
Cr		-	-	-		7ppm	TBA
Cu		-	-	-		3ppm	TBA
Mn		-	-	-		10ppm	TBA
Ni		-	-	-		3ppm	TBA
V		-	-	-		3ppm	TBA
Calcium Carbonate	<0.2	-	-	-			
Sodium Chloride	<0.1	-	-	-			
Other Oxides		-	<1.00	1.29			
Combustibles	<0.2	0.4		-			
Comments	Potential for Moulding Sand after washing		Potential for Fire/Furnace Sand after washing		May not be suitable for clear glass after washing	Potential for Coloured glass after washing	

Table 16.5 - Chemical Property Summary Bobs Farm Sand

3. Concept process design for sand into all markets. Based upon the sand identified and the feed properties, QMS approached a number of quarry plant suppliers to understand the best processing solutions to allow mainline products to be produced ready for sale but also to bolt on additional processing equipment required to raise some sand lenses to a higher value product where possible.

   The sand value chain hierarchy was established and was based upon maximising potential value of the sand products from the site.

   Sand Value Chain Hierarchy (In Order of Expected Sale Price- may vary):

   1. Frac sand- Not Suitable
   2. High Purity Glass Sand- LCD TVs, Silicon Computer Chips etc.

3. Optical sand glass / watches etc.
4. Glass sand (Clear- general)
5. Glass sand (Coloured)
6. Foundry/furnace sand
7. Specialist grout sand
8. Horticulture sand - propagation sands etc.
9. Landscape sand (High end)- horse sand/golf, bunker, green, fairway sands
10. Decorative sands- resorts, national / international
11. Filter sands / bio retention
12. Soft fall / sand pit sands- kindergartens, wet & wild etc..
13. Landscape sand (lower end)- top dress etc.
14. Construction sands
15. Fill sands

QMS engaged Geochempet to undertake a high level analysis of sand samples deemed most likely to yield high end products. The review was focussed on the developed hierarchy of potential market segments above.

From this analysis it was clear that with washing and potential scrubbing of sand during processing it is likely that some of the above high end market uses may be achieved. This analysis then led to the development of the proposed concept plant provided in this report.

Note: It should be made clear that a full and complete plant design is required to accurately size individual pieces of plant and equipment and as such the information provided here is for concept consideration only and may change significantly depending on the sand feed provided for processing and the demands of the market into which the sands are being sold.

The concept process design involves dry mining and wet mining of feed and as such the sand will arrive at the processing plant in different moisture conditions and hence be processed differently.

Hardness / abrasiveness of material

4. Based upon testing of samples retrieved from the QMS stage 2 (Annex R) drilling program the sand lenses within the deposit are rich in silica which is a hard and abrasive mineral. The handling and process equipment to be used onsite is expected to wear due to the nature of this material and consideration should be made to incorporate replaceable wear parts where practical. This may include specialist chute and pump liners and hard facing of loader buckets or edges etc. From the previous QMS stage 1 and 2 investigations it appears that there will be no need for crushing of oversize rock or other particles as the deposit is understood to comprise entirely of sand lenses and a single mud layer band. Should oversize rock be encountered it will be quarantined onsite for later campaign crushing using mobile crushing equipment. This is likely to be outsourced to subcontract specialists and processed offsite as required.

Processing Plant

Option 1- (Rivergum Industries).

a. Dry Mining- Option 1

- Winning of feed
- Feed delivered to processing plant by haul truck
- Haul truck tips into feed stockpile / hopper
- Loader feeds grizzly screen if oversize present then onto a feed conveyor
- Feed conveyor to double deck screen (maybe a wash screen as required by product)
- Fines to waste stream and possible treatment
- Sand screw to radial stacker and final product

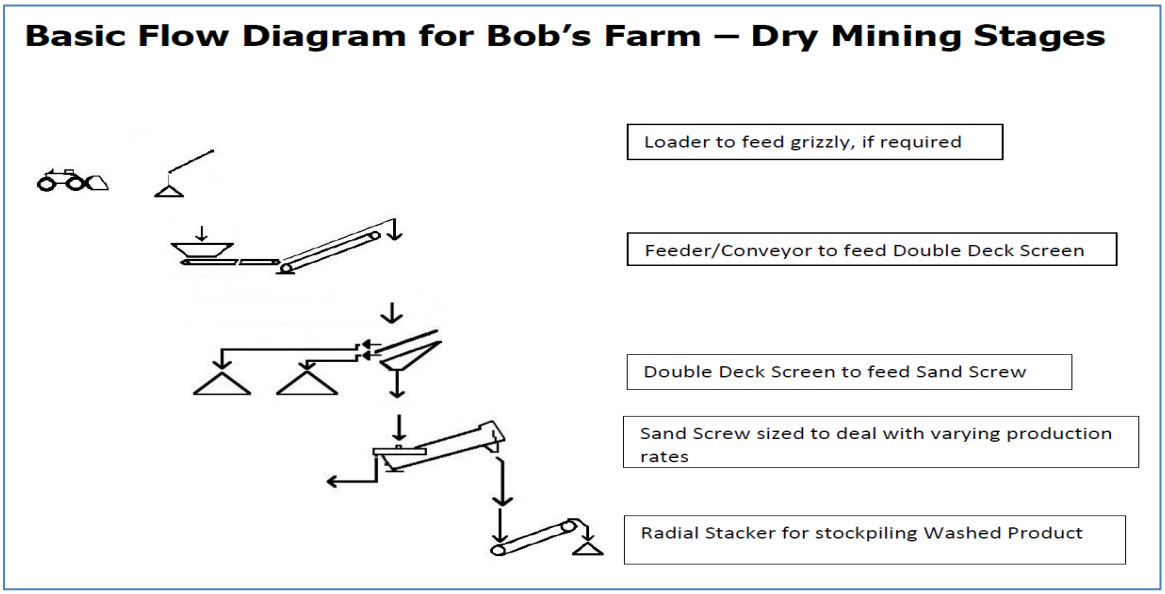


Figure 16.2 - Dry Mining Stages

b. Wet Mining Option 1

- Dredge to pump box
- Pump to double deck vibrating wet screen
- Dewatering classifying tank
- Sand screws to radial stackers and final product

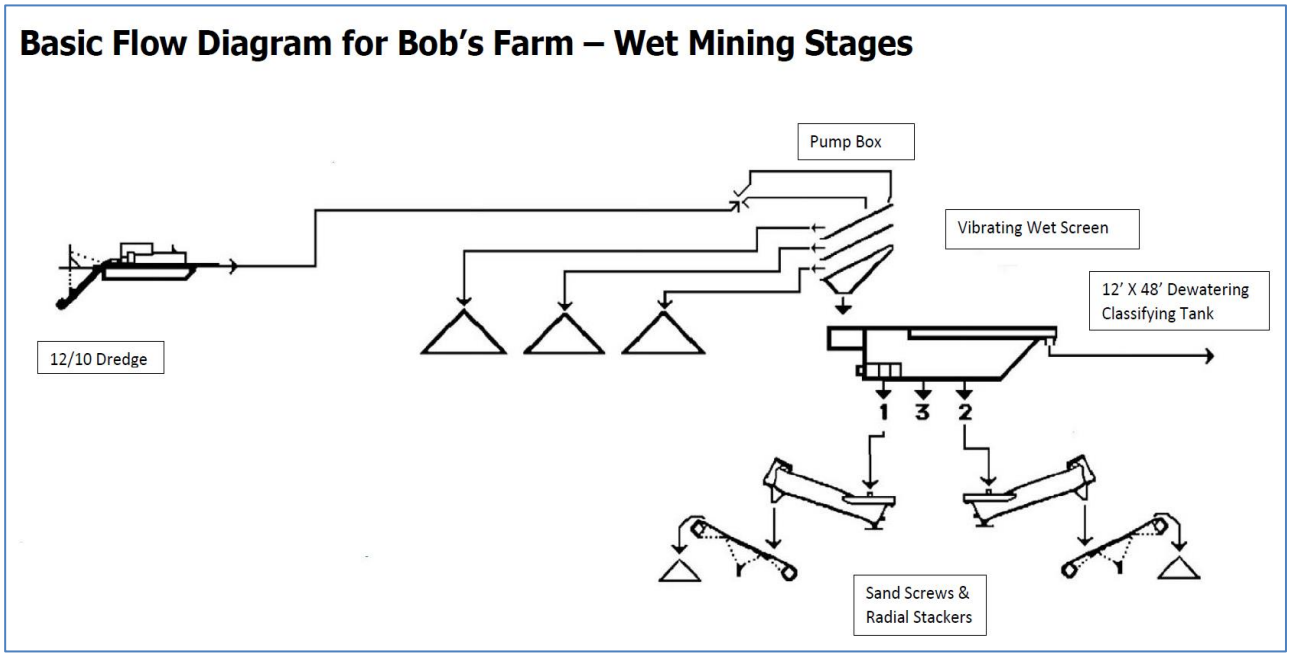


Figure 16.3 - Wet Mining Stages

c. Possible Additional Plant Option 1

- Spirals for glass sand manufacture
- Attrition cells to remove stubborn adhering contaminants if required for higher market return on products

Details to be included in QMS stage 4 as a full plant design and further testing will be required to accurately size equipment.

Option 2- (McLanahan)

a. Dry Mining- Option 2

- Winning of feed
- Feed delivered to processing plant by haul truck
- Haul truck tips into feed stockpile / hopper
- Loader feeds grizzly if oversize present then onto a feed conveyor
- Feed conveyor to double deck screen (maybe a wash screen as required by product)
- Fines to treatment sump

b. Wet Mining Option 2

i) Process 1- Physical wash screening separation (screened sand)
   - Sand feed to dump hopper via dredge
   - Pump to double deck vibrating wet screen
   - Screened oversize to ground as product

ii) Process 2- Cyclone and Hydrosizer (scrubbed and sized sand)

- Screened undersize to sump and pumped to cyclones 1 and 2 in parallel for separation
- Cyclone 1 and 2 and sump1 undersize to waste
- Cyclones 1 and 2 oversize to attrition cells 1 and 2 (to remove bonded contaminants) => then Hydrosizers 1 and 2 for particle sizing

Process 3- Sump => Cyclone (Glass Sand)

- Hydrosizer 1 and 2 undersize=> to sump=> to cyclone 3=> dewatering screen and final washed/scrubbed/dewatered fine sand
- Hydrosizer oversize to sump 2 to pump2 to Spirals1 and 2 in parallel =>to dewatering screen and final product = glass sand

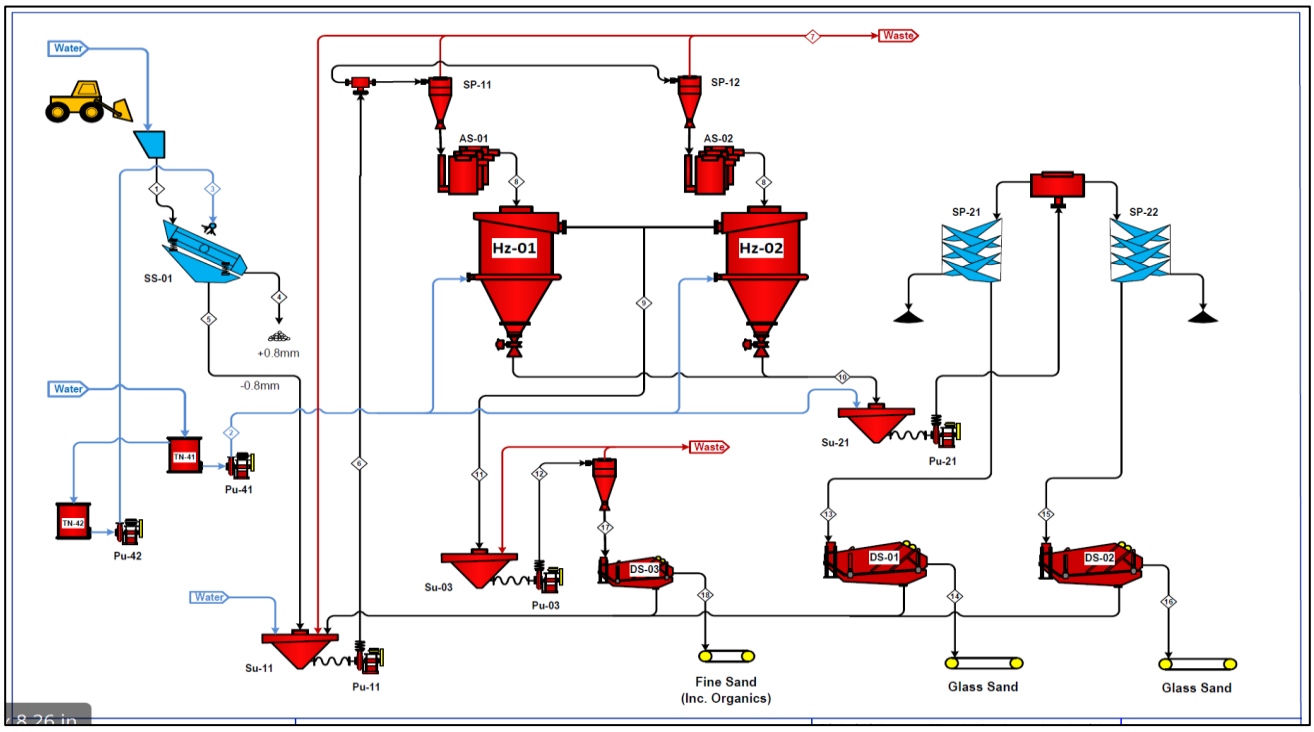


Figure 16.4 - McLanahan Complete Plant Option 2

Project B140725

Quarry Mining Systems- Glass sand Plant

Initial Equipment Supply

Equip No	Description	Model	Supplier	Qty			Ex Works UK
TBA	*Dump Hopper/ Feeder*		*Client*	*1*		*0*	*By Others*
TBA	*D ouble deck scalping screen*		*CLient*	*1*		*0*	*By Others*
TN-41	Clean water receiving		MCL	1		12,332	
TN-42	Clean water receiving		MCL	1		10,479	
PU-41	Clean Water Pump & motor		MCL	1		23,541	
PU-42	Clean Water Pump & motor		MCL	1		16,200	
SU-11/21/03	Feed regulating sumps		MCL	3		79,886	
PU-11/21/03	Slurry Pumps & motors	250/200	MCL	3		65,136	
TBA	Separator Feed Manifold		MCL	1		5,291	
SP11/12	Separators to feed Attritioners		MCL	2		41,310	
AS01/02	*2 x Attition Banks (TO be advised*		MCL	*6*	*12?*	466,560	
HZ01/02	Hydrosizers	4m round	MCL	2		123,525	
TBA	Feed manifold for Spiral banks		MCL	1		5,291	
SP21/22	*12 bank 5 turn SC21 Spirals (TBA)*		MCL	*3*	*?*	94,770	
SP03	Fines Separator		MCL	1		16,200	
DS-03	Fines dewatering screen	VD6	MCL	1		20,250	
DS-03	Underpan		MCL	1		5,670	
DS-03	Discharge chute		MCL	1		5,822	
DS-01/02	Glass sand dewatering screens	VD18	MCL	2		81,000	
DS-01/02	Underpans		MCL	2		19,440	
DS-01/02	Discharge chutes		MCL	2		15,795	
FS03/0102	*Finished product conveyors*		*Client*	*3*		*0*	*By Others*
MCC 0526	Central control cabinet complete		mcl	1		202,500	
SSTR 0526	Structural design		mcl	1		50,625	
SSTR 0526	Structure, stairways and platforms		mcl	1		202,500	
	Process pipe-work & Hoses		*Local Fabricator*	*1*		*0*	*By Others*
	Erection		*Local team*	*1*		*0*	*By Others*
			TOTAL Estimate AUD			**1,564,124**	

Table 16.6 - McLanahan Complete Plant Option 2- Budget price

It is the opinion of this report author Option 2 from McLanahan appears overly conservative and it is proposed that during stage 4 a detailed plant design be undertaken to accurately size the plant and its application.

The above option 2 plant is more likely suitable where sand feed contains high fines content or clay minerals that are required to be vigorously scrubbed and removed. Further testing will refine this process and likely the number of cyclones and Hydrosizers will be reduced.

It is the opinion of QMS that, due to the single-sized nature of the sand lenses across the site, washing and separation by hydro-cyclone may not the best option in this case, and less effective than flatbed classifiers or other methods, in separating fines from the larger sand product.

Hydro-cyclones rely on cut points within the sand and remove the fines from the cut point down by changing the vacuum pump pressures/flow and weir design at the return sump. Where the sand feed is very single sized, as in the case of Bob's farm, the cut point will be very small and narrow and there is a risk that potential final sand product volume will be lost to waste if this cannot be controlled.

The use of Attrition cells and Hydrosizers to process the sand to higher end applications should be confirmed by additional trialling in stage 4. It may well be that they are not required and classifiers and spirals may be adequate.

In addition, further plant options should be considered as a more detailed analysis in Stage 4 will lead to a more refined processing solution and a more accurate purchase price.

Estimated Concept Processing and Budget Plant Costs

1. General:
   - A new 12/10 dredge will be: $2,500,000
   - A reconditioned dredge would be $300,000*

2. **Option 1**- Estimated by *Rivergum* - plant supplier
   Dry Process
   - Dry Fixed Plant-sand wash only not high-end processing. $850,000 - $1,000,000

   1. Wet Process
   - Wet plant to match the dredge capacity: $2,200,000
   - Spiral system $1,000,000*

   Estimated Sub Total (AUS) $3,200,000

3. **Option 2**- Estimated by *McLanahan* - plant supplier
   Dry Process
   - Dry Fixed Plant-sand wash only not high-end processing. $1,200,000

   2. Wet Process
   - Wet plant to match the dredge capacity + Spirals: $1,500,000
   - US=>2,000,000AUD + feeders, chutes etc

   Estimated Sub Total (AUS) $3,000,000

16.2 MINING PLAN BACKGROUND

The proposed Bobs Farm deposit is situated on the northern end of the Stockton Bight Dunal system, approximately 200km north of Sydney, in Port Stephens, NSW Australia.

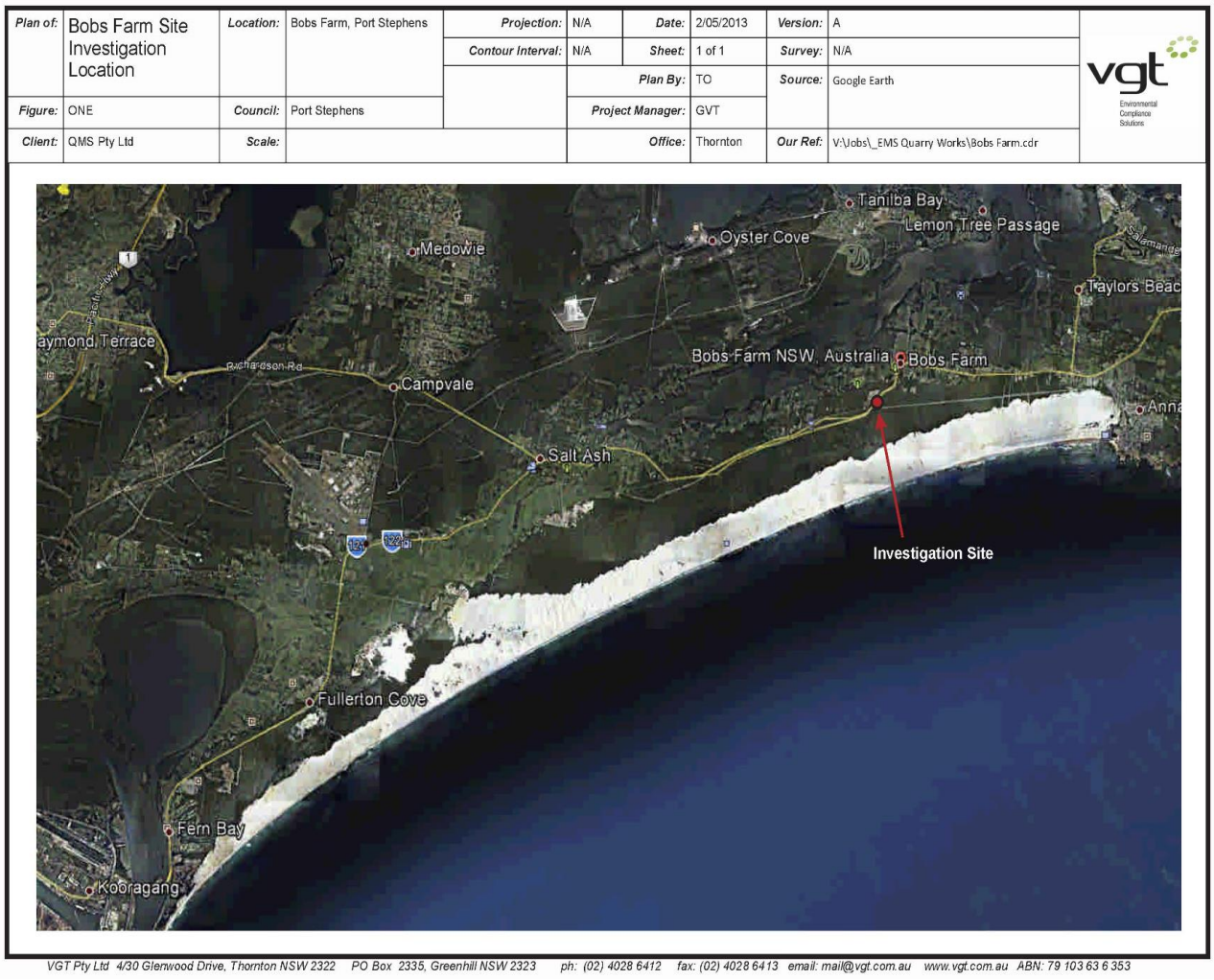


Figure 16.5 - Bobs Farm Investigation Site - Stockton Bight NSW

The Bobs Farm site is an undulating property positioned between Nelson Bay Rd on the east and Marsh Rd in the north. The proposed deposit to be mined falls entirely within Deposited Plans DP753204 (40.9ha) and DP1015671 (6.63ha) with associated land at DP1071458 (2.53ha) outside the proposed extraction limit but also available for support of site mining activities, for potential fuel storage, plant maintenance etc. See Figure 16.6.

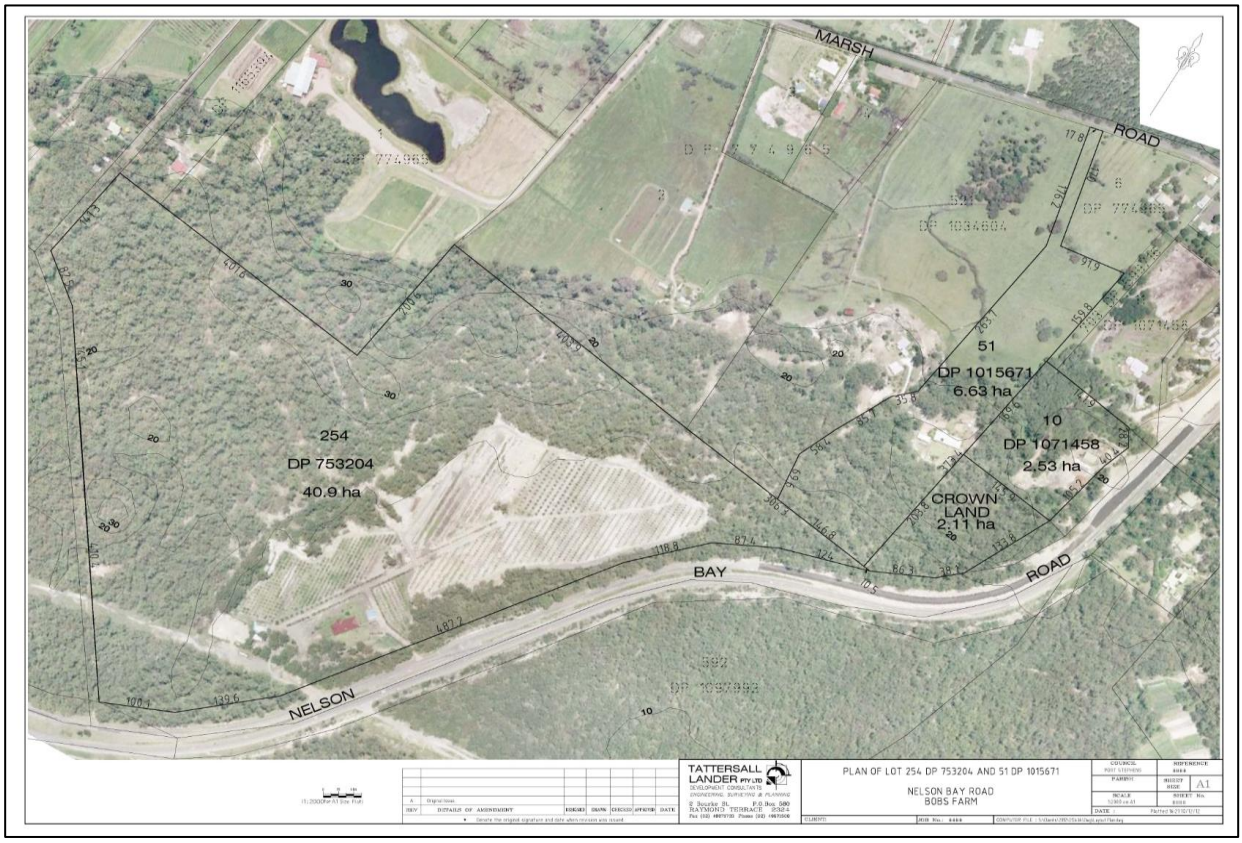


Figure 16.6 - Bobs Farm Site

Entry to the mine site is proposed to be via Nelson Bay Road via a decelerating lane and entry for road truck vehicles, truck/trailer and truck and dog configurations. Exit from site is proposed via a dedicated route to Marsh rd. see SECA Solutions transport study in Chapter 15.

As presented in the QMS stage 2 report (Annex R) the sand within the proposed Bobs Farm site area 2, Figure 16.7 is one of a number of sand deposits within the Stockton Bight region and comprises deposited dune and windblown sands found in the Holocene Epoch approx. 7000 years ago. Fanning (3) noted the two main landforms on the Bobs farm site were elevated dune ridge crest units to north and west and low relief sand plains to east with estimated formation at 4,500 to 7,000 years ago.

Note: Greg Thomson of VGT was utilised by Quarry Mining Systems as a specialist sub consultant in development of the Bobs Farm site proposed mining plan, reported here, providing advice on all aspects required for mine development. With significant experience in new mine start – ups Greg has provided significant support to this project.

Regional and Site Geology

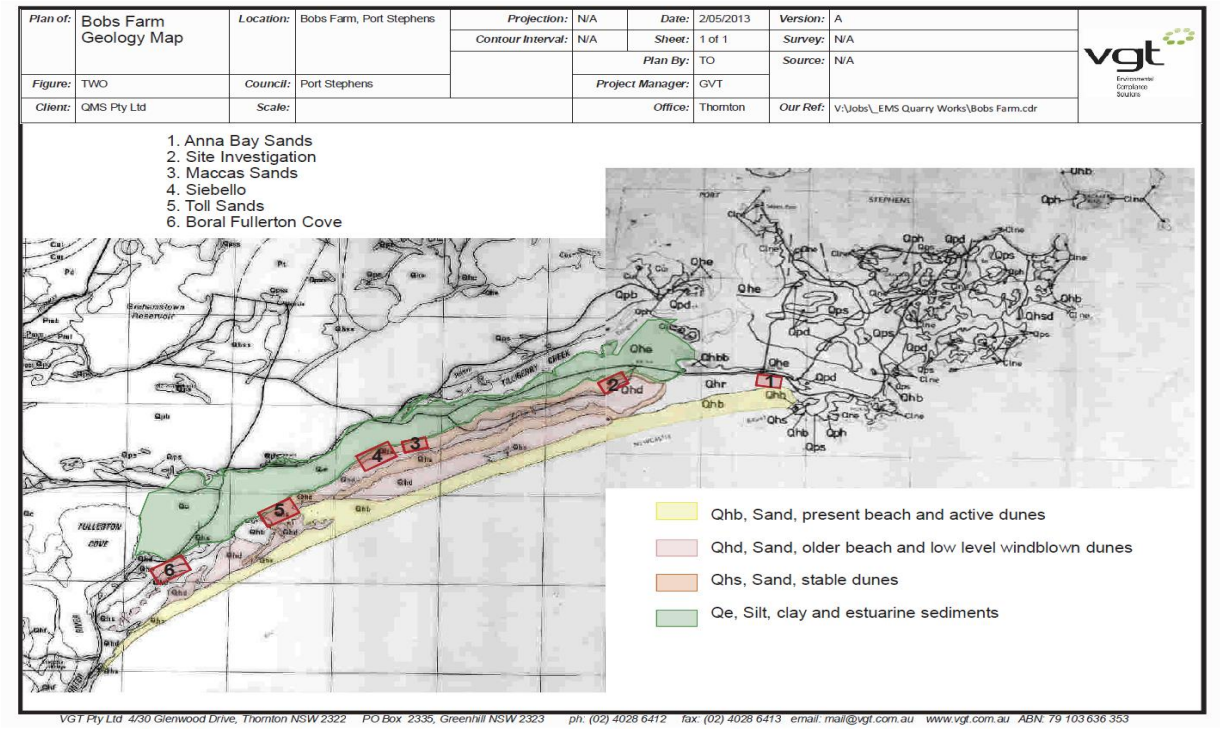


Figure 16.7 - Comparable Geology within the region

Resource Exploration Results and Reserve Estimates

The QMS stage 2 (Annex R) drilling program confirmed that from the five (5) boreholes sunk, the following sand layer thicknesses were estimated.

Bobs Farm Site Stage 2 - Sand Volume Estimates					
Resource Type	**Borehole- Hole Depth (m) / Layer Thickness (m)**				
	1	**2**	**3**	**4**	**5**
Top soil / Root zone	0 – 3.8	0 – 3.5	0 - 1	0 – 0.2	0 - 1
Sand- Mottled / Upper Grey Sand	-	3.5 – 5 (1.5)	1 – 4 (3)	0.2 – 3 (2.8)	1 – 5.5 (4.5)
Sand– Blonde	-	5 – 10.5 (5.5)	4 – 14.5 (10.5)	3 – 5.6 (2.6)	5.5 – 17.5 (12)
Black Dark Mud /Sand	3.8 – 4.5	10.5 - 12	14.5 - 16	5.6 – 6.5	17.5 -20
Water Table- Hole Depth	3.5	10.2	13.2	7.3	15.4
Coloured Grey bands	-	-	-	6.5 – 11.5	20 – 22.6
Lower Grey Sand	4.5 – 19 (14.5)	12 – 26.5 (14.5)	16 – 26.5 (10.5)	11.5 – 24 (12.5)	22.6 – 26.5 (3.9)

Table 16.7 - Sand Volume Estimates across the site

Note: Top Soil (is at or below existing surface), Dark Sand (at Orchard RL), Variable sand quality Mixed in BH2 (near Dump site), Mottled (across site, see Stage 1Test Pits), Blonde (above water table), Black Mud or sediment (normally just beneath water table), Grey sand with black fleck (deeper beneath water table)

Slope stability assessment

To ensure excavated batter slopes remain intact and safe before during and after extraction a slope stability assessment was undertaken by Martens. Based upon the Martens specified batter slopes the reserve estimates have been adjusted to 6,760,737m3 of mineable sand, (approx. 8,788,958 -10,817179 T depending on in situ compacted state between 1.3 to 1.6T/m3). This is also based upon the profile noted below in Figures 16.12 to 16.14 with a flatter beach zone located around the main deposit. See Figure 16.19.

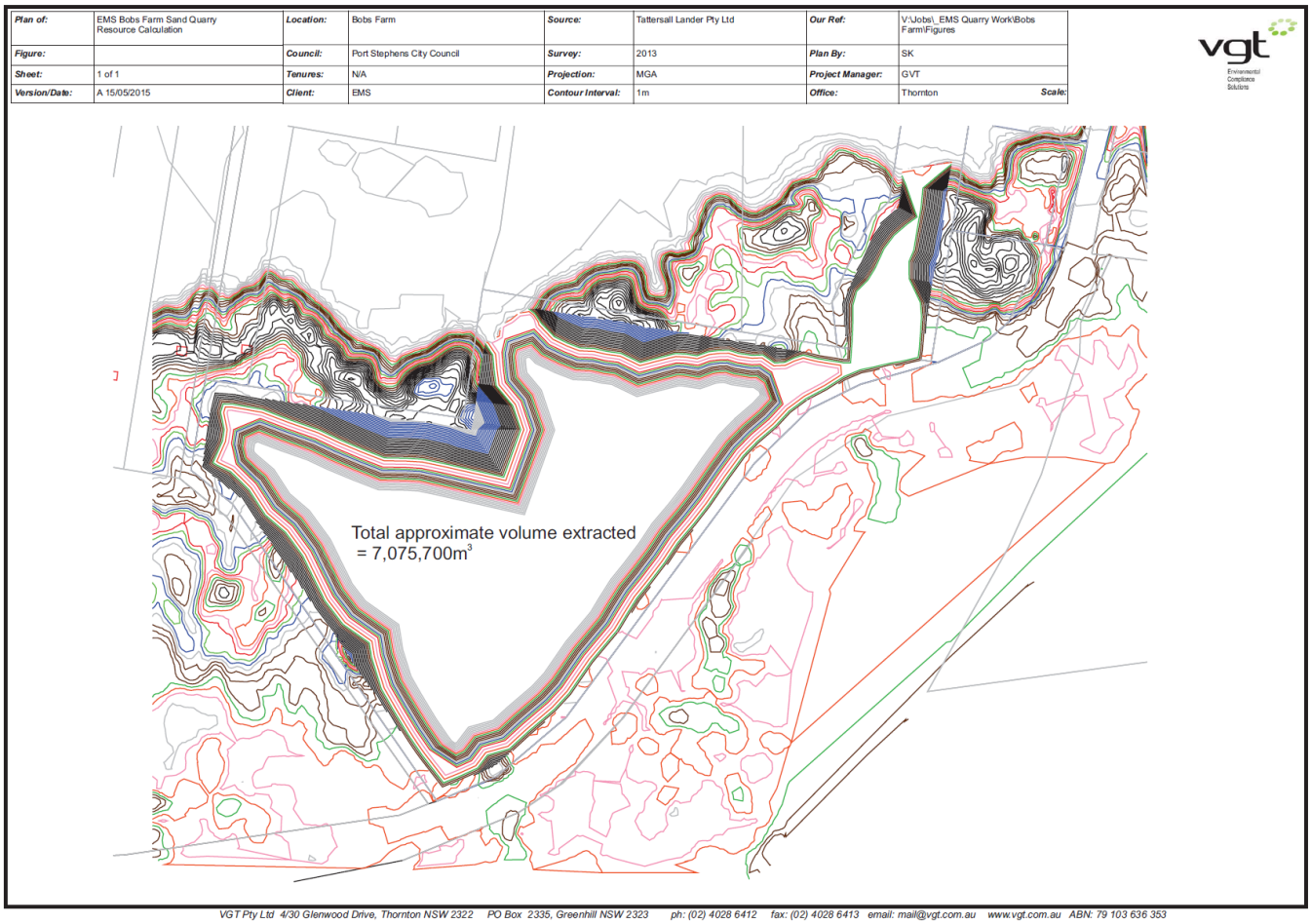


Figure 16.8 - Proposed final resource volume based upon cross-sections provided by Martens and TL

Acid sulphate soils

Within the Bobs Farm site it was identified that during formation and deposition vegetation had grown at the approximate level of the then water table later to be over-topped by new deposition of sand. This vegetated layer, between the sand layers, had broken down over time and has been identified by testing from Martens to have the potential for acid sulphate soil formation, (PASS), if untreated and allowed to freely mix with oxygen overtime (oxidise). To address this the mud layer in question will be selectively removed by excavator and treated

with lime to increase the pH to above 5 as per Martens requirements. This will be done by dosing the sand water mixture in a contained bunded area. Testing will validate the treated sand pH before any water will be returned to the site water table. In this way the PASS will be managed overtime.

The dry mining option provides an opportunity to extract the black clay layer with, a high PASS, and treat this material without potentially impacting the whole water body.

Structural features

From reported Geomorphological Assessments made (1)"The Bobs Farm site comprises two main landform units: elevated dune ridge crests to the North east and low relief sandplain to the east." The dune crests are believed to have remained stable since formation while the transgressive dune has been significantly disturbed overtime and incorporates the current orchard and residence and work areas.

Compaction characteristics of resource (in situ)

The sand on the Bobs Farm site is predominantly packed sand which has interlocked overtime to form the current deposit. Based upon the QMS Stage 1 (Annex S) and 2 (Anex R) investigations the sand appears to be easy to extract with little clay or mud layers to cause issues with soil cohesion. Induration hardening of soft sediments has not been encountered to date in the QMS Investigation Stages 1 and 2. The sand deposit is readily rippable and expected to be easy to win and transport by haul truck or later with suction/cutter dredge.

Topsoil

The sand onsite is believed to have been deposited approx. 4,500 to 7,000 years ago with podsoil profiles noted to approx. the top 2 metres of the site. It is this soil that will be reclaimed and stored as much as operationally possible to be reused for later rehabilitation of the site post mining.

Nature of Fines

Based upon the QMS stage 1 and 2 investigations the sand within the Bobs Farm deposit does not contain significant levels of clay or silt within the finer fractions and as such it is anticipated that the by-product silts produced from processing are expected to be low and easily managed within the site operations. Where fines are produced they will be regularly tested for chemical and physical properties such that they may be re-used in future saleable products or in site rehabilitation. PASS fines will be treated as per Martens specified requirements and lime dosed to ensure pH remains >4.

Overburden characteristics

From previous QMS stage 1 and 2 investigations it was clear there was little overburden present across the Bobs Farm site, up to 2 metres depth in places. The process of clearing and stripping of surface vegetation will be expected to remove most of the overburden of root zone contaminated sand; but this will be stored onsite for later reuse to save the valuable seed stock of natives. In addition this material will be important for formation and vegetation of permanent bunds and berms onsite.

Unique landforms (e.g. geodiversity, cultural significance)

Unique landforms within the site had been identified by others with the mining envelope developed by Tattersall Lander ensured mining operations do not impact on these protected areas.

Water table/ groundwater

The water balance has been developed by Martens and incorporates the water level rise and fall with season and the staged mining approaches proposed. See later in report.

Statutory Requirements, Licensing and Tenure Factors

Fuel / chemical storage

Fuel or chemicals are not to be stored within the area of extraction and any handling of fuels or re-fuelling of mobile equipment is to be done in conjunction with operational requirements for the site and all relevant legislation.

Hours of operation

During construction of the mine the proposed operating hours will be for 12 hours per day, 6am to 6pm, Monday to Saturday with no Sundays or Public Holidays.

During initial operation of the mine 12hrs will be available however it is estimated that production will commence as a single shift of 8 hours, with provision for an additional 10 hour shift if production and or sales demands require it.

Production is based upon 11 months per year, 19 days per month and 8 hours per day. This allows adequate time for plant and equipment maintenance, staff leave, shutdowns and miscellaneous unforseen stoppages etc.

Leases, easements, rights of way, encumbrances etc.

Within the Bobs Farm site there exists a 33kV (TML) Power line easement which cuts the site in the south-eastern corner of the extraction zone. It is proposed that dry mining would commence in this area no earlier than year two and the access along the easement will remain trafficable with maximum slopes of 2.5:1 to the mining face to maintain pole stability as per Martens slope stability determinations. Longer term it is proposed that the Ausgrid easement would be moved into the post-mine batter along Nelson Bay road. Upon relocation of the power poles this area will be wet mined to the final batter slope approved by Martens.

Access and right of way has been determined by SECA as part of the traffic management plan for the site outside of the extraction areas. This including entry to the site via Nelson Bay Road and egress onto Marsh road. Within the extraction zone and bunded area dedicated haul roads will be established to minimise travel times from extraction to processing plant.

Within the site there exists current dwellings and sheds which will remain as a caretakers quarters and are outside the extraction zone.

The road easement within the northern area of the site will remain to allow east-west access across this area. The area north of the road easement will be dry mined only to the final Martens approved batter slope. This is noted as Pit 3 in Figure 16.9 of this report.

Within the site there are 5 permanent wells which are located at the previous 5 boreholes sunk in the QMS stage 2 drilling. Data was collected by Martens as part of their earlier groundwater studies and the bores with the exception of BH4 will be removed during the mining operation

and will need to be relocated to become long term monitoring bores – refer Martens Groundwater Management Plan Report.

Electricity to run the fixed processing plant will be available onsite via underground cables within a controlled services area of the site.

Noise

During the construction, operation and maintenance of the mine site there will be noise generated from mobile equipment and fixed processing plant.

Dry mining above the site water table will produce noise from extraction and processing, while wet mining is to be by suction/cutter dredge and once in operation will significantly reduce overall site noise.

Noise impact across the site will be minimised by locating the processing operations close to Nelson Bay road where the existing traffic noise will lessen impacts. In addition a dedicated permanent vegetated bund will be provided to Nelson Bay road to provide an audible and visible barrier between the travelling public and the mining operation. See Vipac report (Annex I). Temporary noise bunds will be constructed in accordance with VIPAC reported requirements to the 2.5:1 slope stability design provided by Martens. These bunds will only be required for dry mining, will be made of existing sand material and when mining is finished will be removed, again under the construction activity noise guidelines. Stripped timber will be used for poles and fence posts where possible. Any remaining material will be mulched under the noise activity document requirements.

Air

Dust from mobile equipment will be minimised by sealing the main haul roads with sprayed bituminous seal and minor roads with suitable gravel etc. A water cart will ensure haul road dust levels are controlled and the use of processing water and natural dust supressing agents will be incorporated as required to minimise dust level within the processing areas. Upon commissioning and operation of the suction/cutter dredge dust levels onsite are expected to reduce significantly.

Surface and groundwater

The water balance and management cycle for site water has been designed by Martens with consideration made to the required water to wash and process the sand feed to saleable products. Upon establishment of the suction /cutter dredge the demand for water drawn from the site water table increases and the operational aspects are detailed later in this report.

Water delivered with the sand feed will be tested at the processing plant for pH and in accordance with Martens Groundwater Management Plan, water with a pH < 4 will be treated prior to discharge into the lake. This process water will not be returned to the site water table until the pH has been confirmed to be 4 or greater as per Martens requirements for PASS material.

Flooding

During construction surface water flows will be encouraged to flow into controlled drainage areas that will not negatively impact the site or its surrounds. Permanent vegetated bunds or berms are to be in place with significant freeboard to accommodate rainfall and counteract

evaporation of water from site. This forms part of the overall water balance designed by Martens. Refer Martens Surface Water Management Plan.

Waste management

Waste onsite is expected to be predominantly the silt/fines remaining after the washing and processing of the sand feed. These fines will be tested for chemical and physical properties and will be incorporated into saleable products where possible or used in site rehabilitation or if unsuitable removed from site using appropriate waste management processes.

Energy efficiency

Within the site energy efficiency will be maximised to reduce operating costs and the carbon footprint for the site. This will form part of the overall operational sustainability plan for the site.

Rehabilitation, post-mining land use

Mining of sand across the site is to develop under an active extraction cell process. Upon opening of a cell, the rehabilitation process is to commence such that the Martens approved maximum batter slopes are maintained and slope stability risk minimised. The use of soft slope stabilisation such as plants or hard stabilisation such as rock/rip rap, gabion, or larger spalls or amour stone will be directed by TL to suit final post mining landforms.

Safety – public, employees, contractors, visitors

The safety of employees, contractors, visitors and the general public will be maintained overtime by control measures implemented across the site. Controlled access to specific areas of the site along with physical separation of the public from the mining operations by bund walls, berms, gates or fences will assist in this area.

Staging plans

The development of the proposed Bob Farm site will be broken into a construction phase, operation and maintenance phase and at end of mine life a final land use phase.

each of these phases will form part of the overall use for the site and will need to be flexible enough to service the required market need, social, environmental, economic and operational requirements for the site and the region in which it is located.

Transport routes

Site access is to be via Nelson Bay road and site visitors are to report to the site office located at this entrance. Trucks entering the mine site are generally going to travel to the stockpile/ sales area for product load-out and ticketing unless they have a specific product or service for the site approved and supervised by management. The site transport plan has been provided by SECA with exit onto Marsh road once trucks are loaded, ticketed and cleared to leave site.

Vibration effects from activities

Vibration from site has been modelled by VIPAC and will be minimised by operating a lean fleet of mobile equipment. Controlled haul road speed limits and driver behaviour. Better efficiency in processing of sand feed, including use of water and controlled feed rates to ensure consistent plant workload rather than unnecessary operational peaks etc.

16.3 EXTRACTION OF PLANT FEED

Mining of the Bobs Farm deposit will be dictated by the market demand for the final sand products in each market. Given the variable sand layers within the deposit the mining plan proposed for the site is flexible enough to take advantage of this variability to allow different sand markets to be exploited.

If all sand was mixed in together and processed niche markets may be lost and the overall profitability of the operation put at risk.

It is believed, by QMS, that a mining plan that incorporates dry and wet winning of feed allows the opportunity to exploit niche markets as the sand is dry mined down towards and below the water table. In this way the maximum end use can be achieved for the benefit of the deposit and the community using this valuable construction material resource.

To minimise slope stability issues in dealing with large faces of exposed and unconsolidated sand it is proposed that extraction of feed is undertaken in stages such that the working face of sand is as low as possible and controlled at all times, in accordance with Martens slope stability determinations. This significantly reduces risk with operation of mobile plant and allows selective mining as required to service different markets.

Dry mining of feed is expected to involve excavator and haul truck to processing plant while wet winning of feed is to occur with a suction/cutter dredge established on a pond at the water table surface. This dredge once established will remain within the pond for the life of the deposit and is expected to mine to the final landform below the water table.

Methodology

Extraction and Infrastructure Factors (Operations)

The extraction and operational factors will be finalised within the site operational and sustainability plan, which will be developed in subsequent stages of investigation.

Ancillary activities and Weighbridge.

Additional activities and weighbridge / loader bucket load cell details will be confirmed in the aforementioned Operational plans.

Proposed Operations

Within the eastern side of the Bobs Farm site, adjacent to Nelson Bay road will be the proposed processing stockpiling and sales areas. Within this location the processing plant will be positioned to accept the sand feed from which saleable sand products will go to ground and be stored in stockpiles or for higher end products potentially within a dedicated enclosed shed to maintain a controlled moisture content for specialist client applications.

The footprint and detail of the plant will be confirmed in the QMS stage 4 when a full plant design will be established.

Sales load out from stockpiles is to be conducted by dedicated sales loader(s). These Front End Loaders (FELs) should ideally be sized to match the intended road truck sizes used to transport the saleable sand products with the minimum of loading passes required.

The rate of sales loads out will be determined by the sales demand for the final sand products and hours of operation.

During the sales loading process, to confirm the quantity of material loaded onto individual road trucks the buckets of the FELs will have load cells attached which will be calibrated to weigh, record and ticket each truck individually. A dedicated weighbridge is not proposed for the site at this stage unless production dictates it is needed at which point this will be fully investigated and constructed in accordance with all relevant legislation and sustainable site practices.

The delivery docket/ticket for each truck delivery will be printed at a dedicated pick up point where the driver of that truck will retrieve the ticket from the printer.

All truck movements will need to comply with the SECA transport management plan and NSW legislation for truck transport weights for given axle/body configurations.

Pumps

Pumps will be used extensively across the Bobs farm site as a means of transporting and processing sand material, washing and mine development. During wet mining phase of this mine the main means of winning feed will be by pumping, from a suction cutter dredge to processing plant, so pump efficiency will be of utmost importance.

Pumping operations will be optimised to minimise power requirements for the site and associated fuel spend as part of the sustainable operation procedures. Pumps will have protective liners fitted to reduce internal wear and prolong the operating pump life, where possible practical or economically feasible.

Waste dumps

Waste generated from site is mainly expected to come as by-products from earlier processes, including washed sand tailings and rejects, unwanted vegetation, PASS which will be treated as part of the Martens designed process. Fuels, and chemicals etc. will be handled offsite in accordance with sustainable operation procedures and relevant legislation.

Bench / batter widths, face heights, orientation

Any benches, batters or exposed sand faces to be established within the Bob farm site will be done within safe mine operating practice to suit the mobile plant and equipment under use and the overall site operational plan, in accordance with Martens slope stability guidelines. Where they are to be regularly trafficked by light vehicle, truck or other vehicle, benches and batters will be appropriately designed by a suitably qualified geotechnical engineer for the expected loading they are likely to receive overtime.

Benches, batters, berms and exposed sand faces will be oriented to minimise site noise and visual impacts and minimal wind-blown sand across or off site. All batter designs are provided by Martens.

Electricity supply

Electricity will be supplied to the site from an operating main and will be utilised onsite to run lighting, pumps, processing plant, and amenities. Where electrical cables are run underground they will be clearly sign posted and noted within the site operational plan. Where electrical power is to be run above ground any overhead wires will be supported in accordance with all

legislative requirements, including height above ground in trafficable and non-trafficable areas, isolation and on-site labelling or identification etc.

Fuel, lubricants, chemical storage

There will be no fuel, lubricants or chemicals stored within the site extraction zones. All storage of such items will be offsite and in accordance with relevant requirements for the material being stored, including suitable hardstand and bunded areas as required.

Future planned development

Final landform and future planning for the site is to be completed by TL and others.

Haul truck fleet

Haul trucks within the Bobs farm site are to be matched for size and capacity with the loading equipment and the processing to allow the required quantity of feed and saleable product to meet production requirements and potential sales demand.

The number and capacity of mobile equipment will increase and decrease over the life of the deposit depending on what stage of development the site is at a given time. This is discussed in more detail later in this report.

Internal road system

Roads outside of the site mining operation are modelled and reported by SECA and the haul roads within the mine site are to consist of dedicated haul and localised access roads to assist extraction and processing. As stated earlier in this report to minimise dust and noise the major haul roads will be sealed with a bituminous seal while minor haul and access ways established with a prepared gravel base. All roadways are to be constructed within accepted mining standards to be trafficable by loaded and unloaded haul truck(s), maintenance vehicles and light vehicles as required.

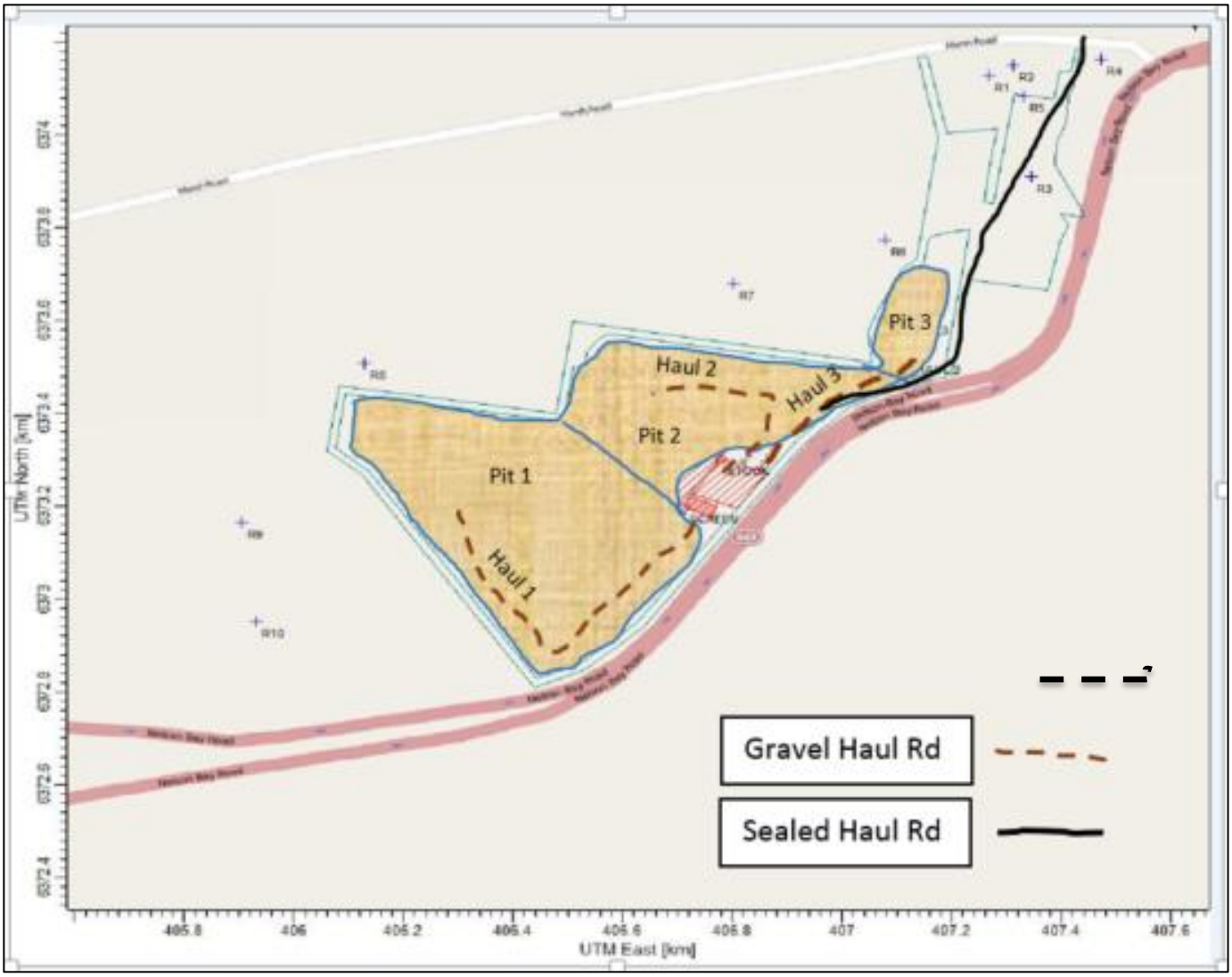


Figure 16.9 - Proposed Haul Roads Onsite
Limits of extraction; other constraints

The extraction limits for the site are based upon a 15m offset from site boundaries and easement from identified flora and fauna and provide a working envelope with batter slope as determined by Martens for slope stability before during and after mining operations. The site is broadly categorised into three sections: Pit 1, Pit 2 and Pit 3. each area will be opened as part of the site operational plan and closed as part of the site rehabilitation plan provided by others.

Figures 16.10 to 16.13 show an overview of the site including batter slopes, lot areas and site cross-sections through the mining envelope.

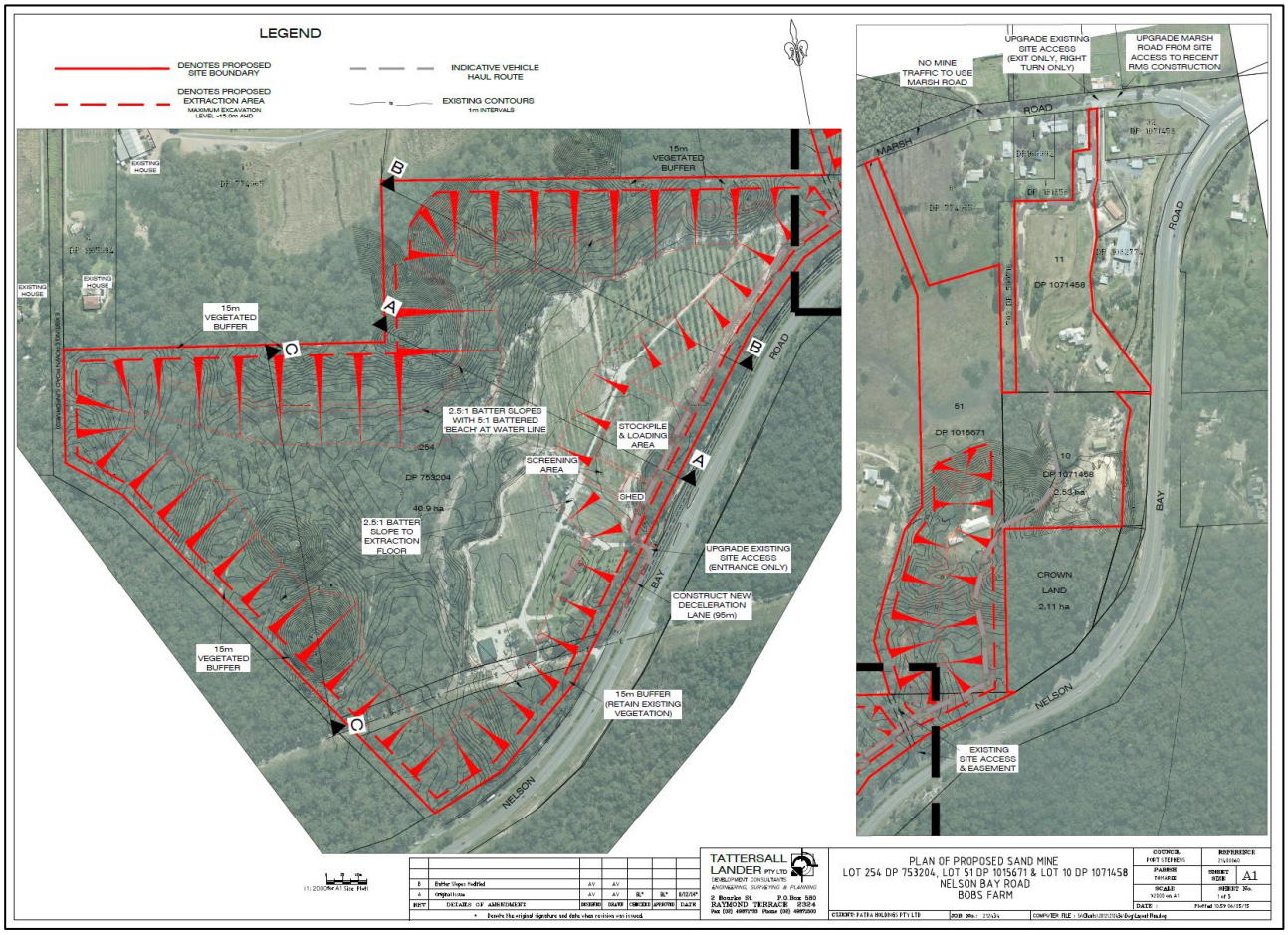


Figure 16.10 - Overview of Extraction envelope for Bobs Farm Site

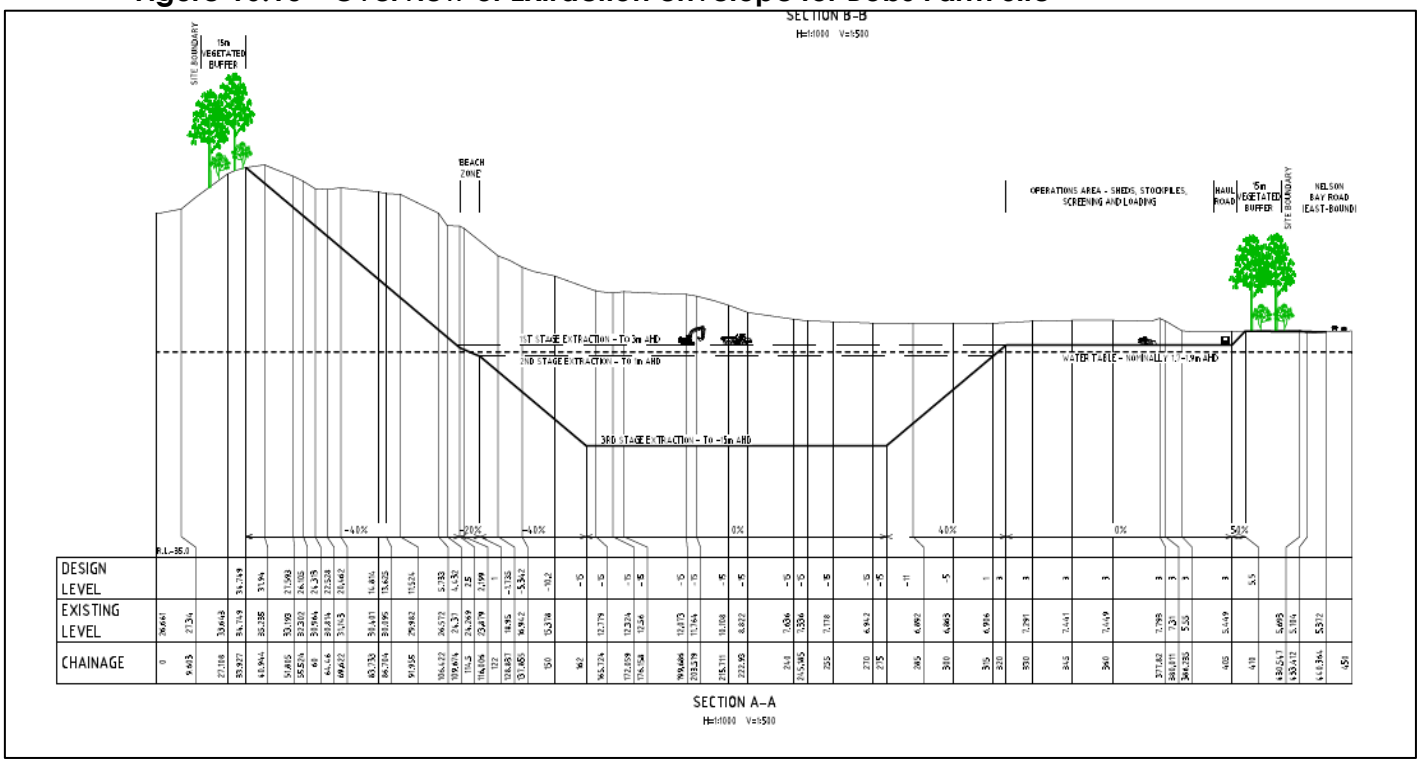


Figure 16.11 - Section A-A through the proposed mining envelope

As can be seen from the proposed cross-sections depending on the location within the site extraction zone the final landform cross-section will be different. The final batter slopes, as

discussed earlier in this report, are determined by Martens as part of an overall geotechnical investigation of the site.

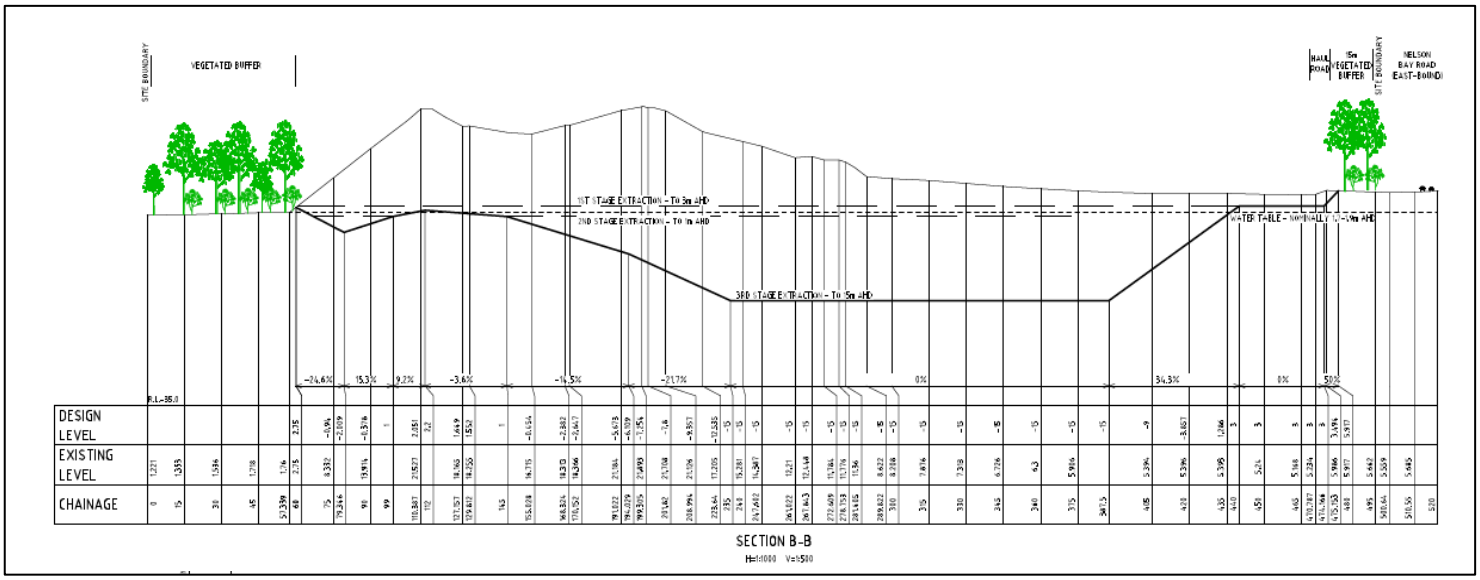


Figure 16.12 - Section B-B through the proposed mining envelope

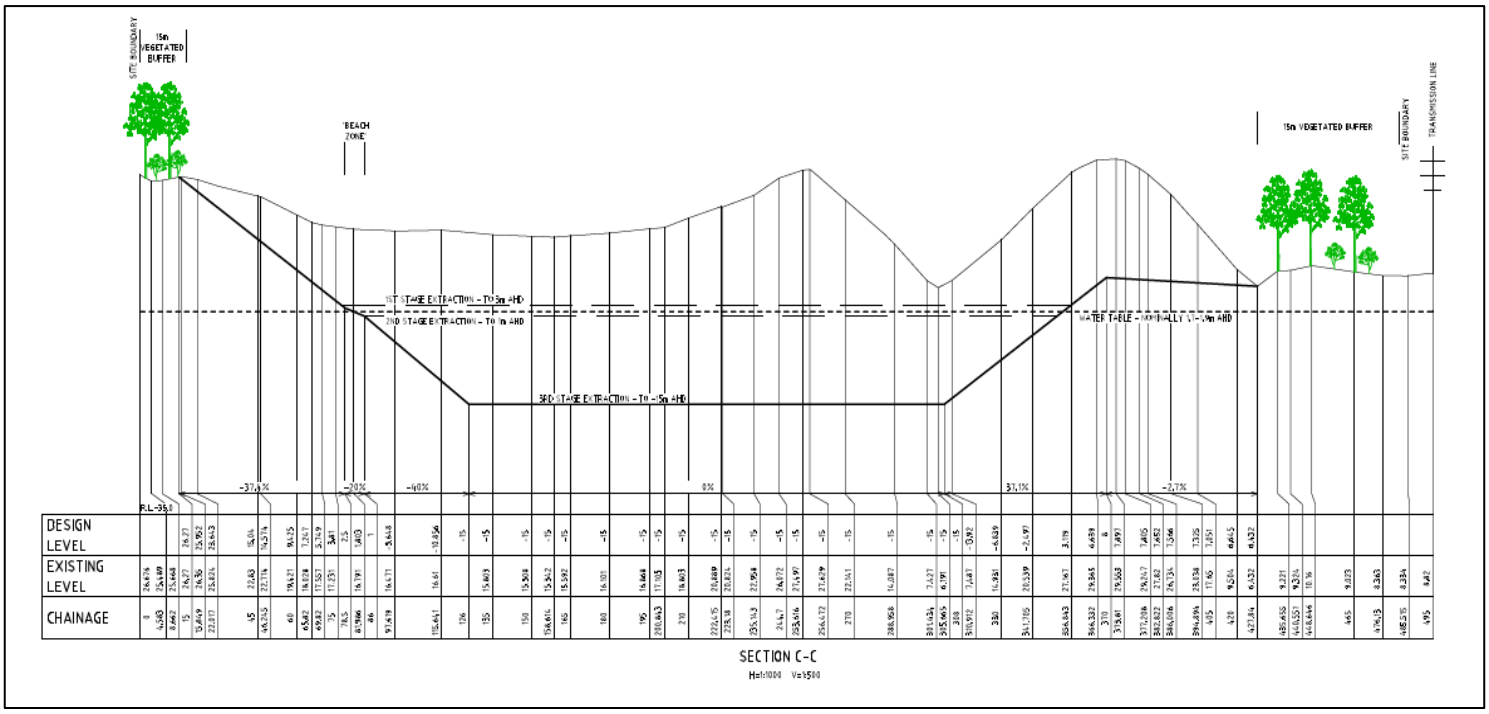


Figure 16.13 - Section C-C through the proposed mining envelope

Mining Method(s) - Active Extraction Cells

As the sand within the Bobs Farm deposit is very single sized it is important that the exposed areas of sand are minimised, at any given time, to avoid windblown sand across the site. To achieve this the concept of active extraction cells was introduced by QMS; which provides a small area of deposit which is stripped mulched and prepared for mining then after extraction is rehabilitated and closed off (inactive) before commencing the next production cell.

Over time the extraction cells will be active when ready for mining production and inactive once extraction has been exhausted and rehabilitation has been commenced. The extraction cells will follow a pre-determined route across the Bobs Farm site based upon a point of entry at the most convenient entry point and a point of exit via Marsh road at end of mine life. See Figures 16.15 and 16.16.

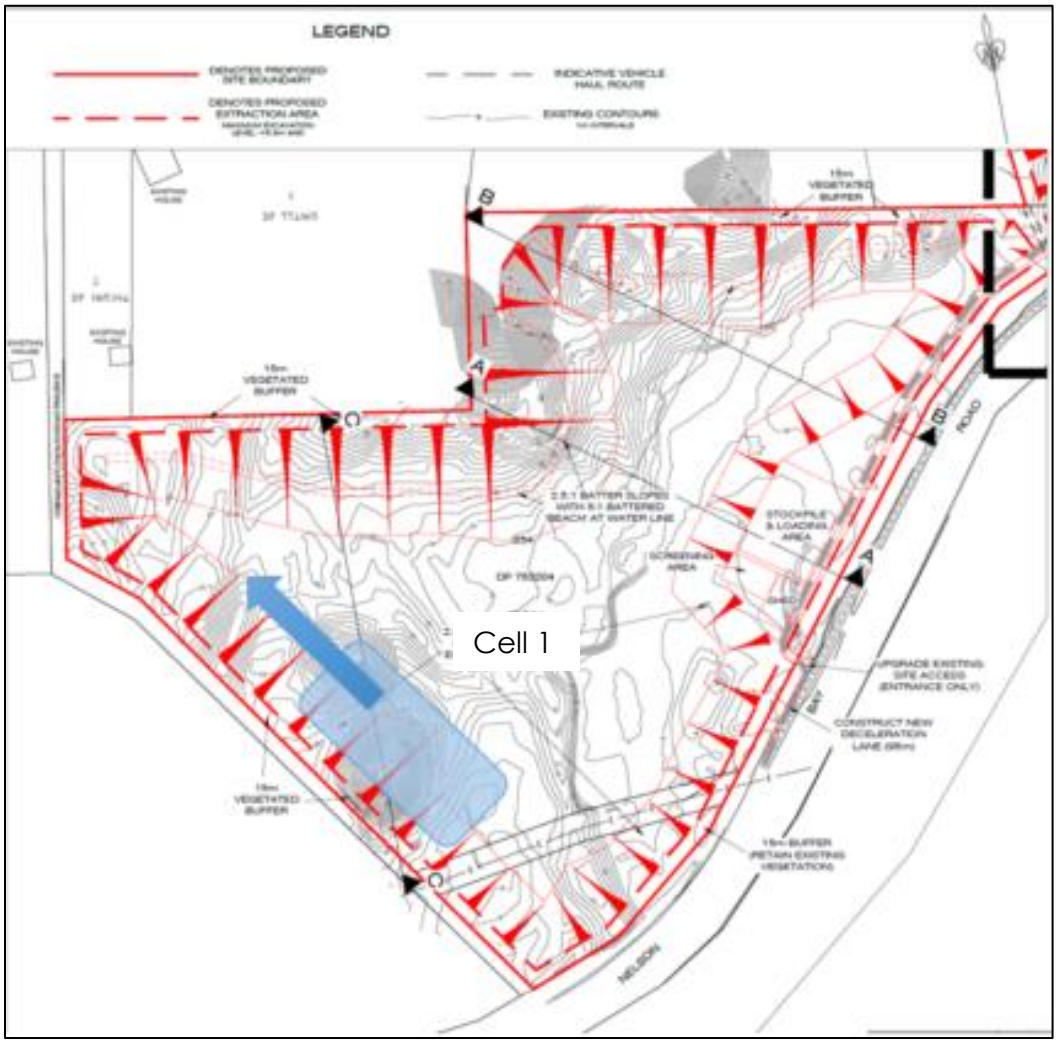


Figure 16.14 - Active Extraction cells

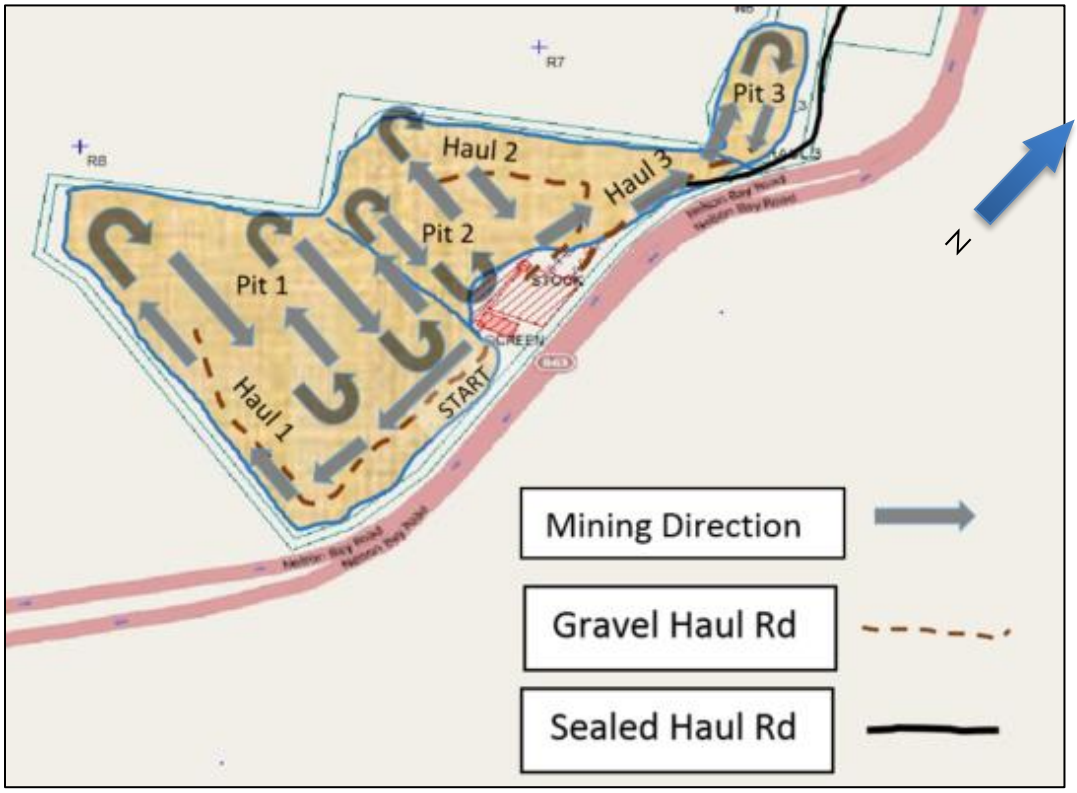


Figure 16.15 - Active Extraction cells move across the site for controlled extraction of feed

As can be seen the active cell extraction is planned to commence in the south eastern corner of the site extending west then returning east as per the illustrated extraction flow direction

Mining Method (s) – Beneath Existing Power lines

Existing power lines stretch across the south eastern corner of the site and dry mining of sand is to commence from existing ground level to 2m AHD under controlled conditions.

There will be (1) one only under-pass / cross-under area beneath the overhead lines which will accommodate traffic in two directions. This will be established and maintained to all relevant safety and operational requirements. All other existing easements and buffers to the power lines will be maintained until later stages where the existing lines will be relocated into the permanent bund near the site boundary in conjunction with Ausgrid and relevant council requirements etc.

each active cell is to be stripped of existing vegetation in turn and prepared for mining. It will then be dry mined to within 2 metres of the water table, before switching to wet mining. Main haul road 3 will be constructed and maintained with a bituminous seal to minimise dust generation; with haul roads 1 and 2 gravel during mining operation. See Figure 16.16.

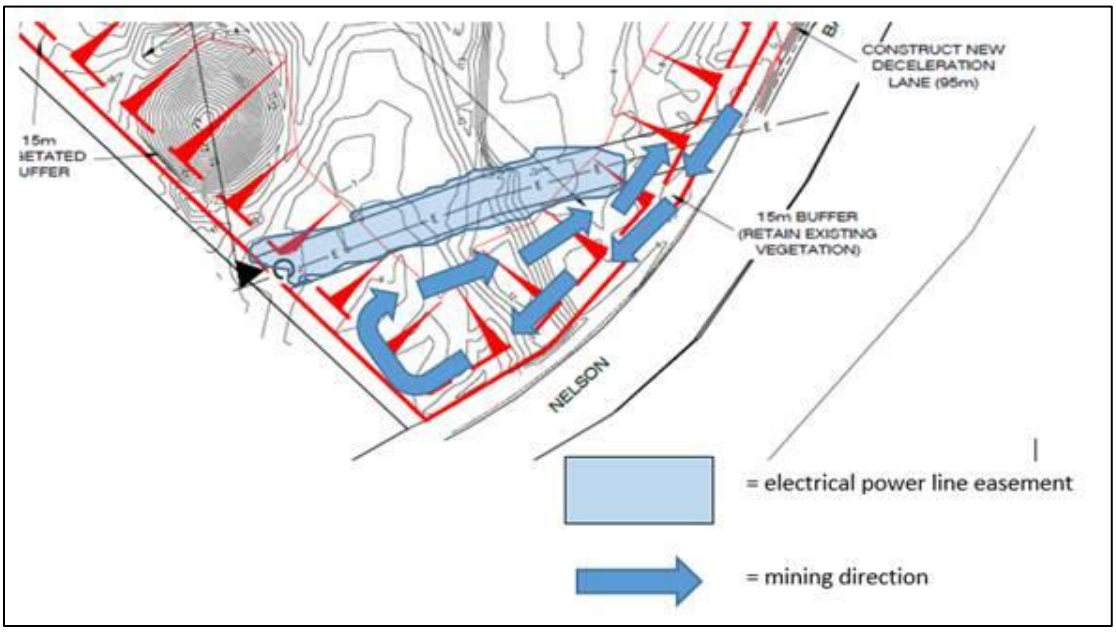


Figure 16.16 - Existing overhead power line easement to be maintained with one cross-under as shown

Dry Mining

Dry mining of the Bobs Farm deposit will commence with stripping of existing vegetation from the surface by excavator with a grab and bulldozer. The vegetation that can be saved will be stored onsite to provide the required seed stock of natives for rehabilitation while the remainder would be processed into mulch and stockpiled onsite in a location that will not cause problematic leachate discharge during rain events. This mulch material will be needed throughout the life of the deposit to vegetate the final bund profiles so should be easily accessible for this future re-use.

Temporary acoustic bunds will be required during this phase of extraction. These 6 metre high bunds will be required to attenuate noise emitted from the mining and hauling equipment at the locations shown in the Vipac Noise assessment see Annex I. The construction and design of these bunds have not been geo-technically assessed and the authors recommend this occur, prior to construction to ensure stability. It is also recommended that these bunds will be vegetated with grasses to reduce nuisance dust. The construction of these bunds where the topography allows, as illustrated below will be created using the natural landforms. Where the topography is not conducive to this the bunds will be constructed using local sand materials and will be built within the construction noise criteria, specified by Vipac, refer to Annex I. As mining progresses to the 15-metre vegetated buffer the bunds will be removed also within the construction noise criteria, specified by Vipac, refer to Annex I. These bunds will not be required during wet mining.

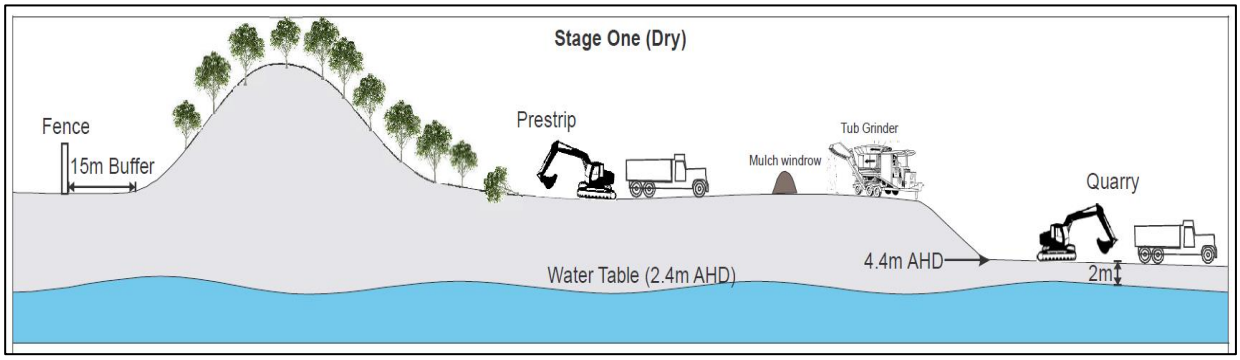


Figure 16.17 - Dry Mining Schematic

The final stages of dry mining will involve removal of the PASS black mud layer, for treatment or disposal, reducing the acid sulphate soil risk for that portion of the site. In accordance with the Martens acid sulphate management plan for the site this removal will be done by excavator which will operate at or just below the water table in removing this layer. If testing confirms pH of the sand has dropped below 5 pH points it will be treated with Lime in accordance with a PASS treatment plan to be provided by Martens.

Wet Mining

Wet mining is to commence upon establishment of the dedicated suction cutter dredge upon the water table.

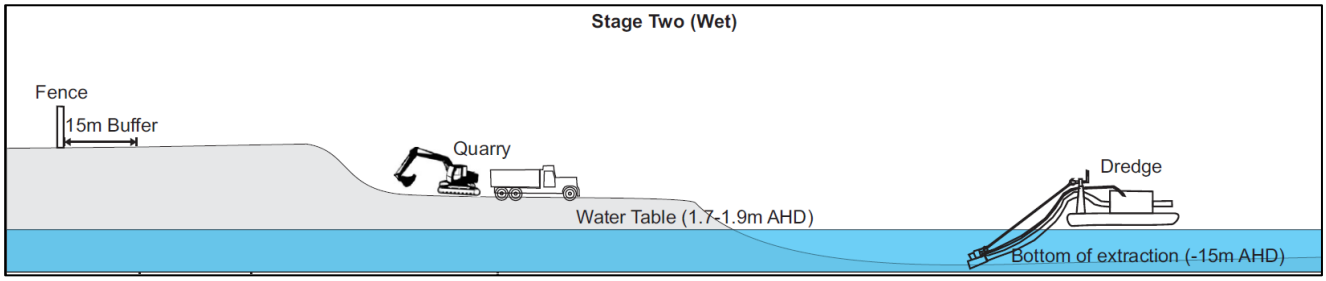


Figure 16.18 - Wet Mining Schematic

Wet mining will involve the winning of sand feed by suction cutter dredge. Sand remaining above the water table will be placed into the dredge pond by excavator with a bulldozer feeding the excavator to assist the process. The operation of the dredge will be such that it will mine the sand feed below the water table to a final profile as provided by Martens.

Final Landform

The final landform will be a bunded water pond with a geotechnically approved batter slope to eliminate slope instability issues as designed by Martens.

Note: QMS have not undertaken geotechnical analysis of the site and as such are not providing advice on suitable batter slopes but relying on the advice provided by Martens on slope stability and final landform. See Figure 16.19.

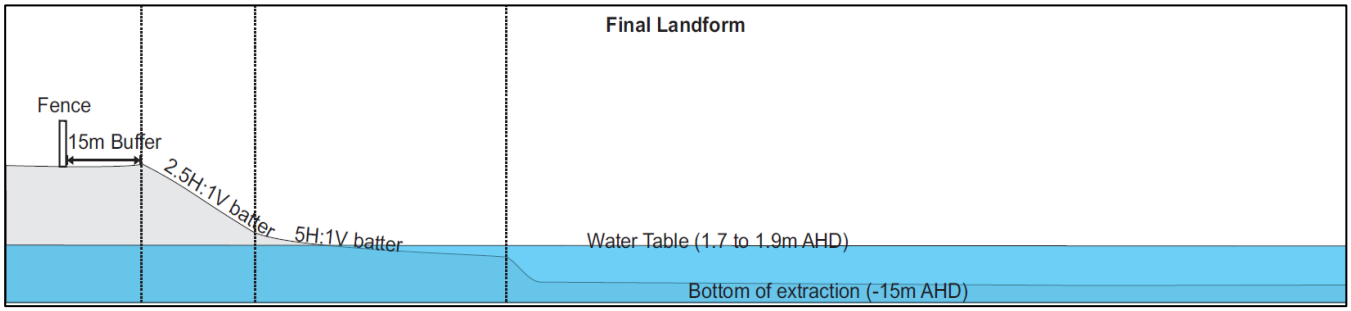


Figure 16.19 - Proposed Final Landform Schematic

Batter slopes as provided by Martens are summarised in Table 16.8 below.

Unit	Maximum Slope Batter[1]
Unit 1: Organic Sand	1:3.0
Unit 2: Aeolian Sand	1:3.0
Unit 3: Aeolian Sand	1:2.5
Unit 4: Marine Organic Sand	1:2.5
Unit 5: Marine Sand	1:2.5

Table 16.8 - Final batter slopes proposed by Martens

Stabilisation of final slopes will be as provided by Martens, or others, and are expected to include soft stabilisation (dedicated planting to retain sand locally) and hard stabilisation by rock wall, spalls, riprap, gabion basket or other means as designed and specified by Martens or others. As can be seen for the different sand layers across the site a different maximum slope is recommended by Martens.

Rates of extraction – Projected

The Director General requirements for the Bobs Farm site outlined at peak production a maximum of 750,000 TPA of sand feed may be extracted for processing. This would equate to approx. 450 Tonnes per hour based on 11 months of sand production at 19 days per month and 8 hours per day (=> 750,000 /11/19/8 = 448.56t /hr => ~ 450t/hr of extracted feed). That estimate allows enough time for plant maintenance, shutdowns and production interruptions.

The build-up of sand production volume up to the specified maximum of 750,000TPA depends on the market take up of sand products. A conservative approach for build-up of sand product volumes and sales is estimated in Tables 16.9 to 16.12, achieving maximum at year 4 onward.

Bobs Farm Mine Development- Staged Mine Construction Summary- Conservative						
Year	Sales	Mining Operation	Winning of feed	Sales Load Out	**Dry**	**Washed**
1	150,000 Tpa, ~13,636T/mth, ~717 T/day, ~90 T/hr	**Dry feed system**: - Excavator to Dump Truck -> dump truck tips feed into hopper -> hopper to a conveyor -> conveyor to wet screen -> wet screen to sump -> sump to spirals -> spirals to de-watering screens -> de-watering screens to stackers (final product). A wash / recovery plant to handle tonnage required, a 6/4 pump would handle this volumes, with limited room for increased tonnages on a 6/4, an 8/6 would handle this capacity and into the next phase. Assume 8/6 pump & plant.	**Winning plant feed**- Excavator and dumper: 2 x 22 tonne tracked excavators with an oversize mud bucket would be utilised to win sand feed with 1 x 44 tonne articulated dumper used to transport the raw feed along dedicated haul roads to the processing plant on site. (Note: The 22 tonne excavator is a miss match with the dump trucks size, however it is believed to be within existing fleet of potential quarry operator and should work in the initial phase).	**Sales loading:** 2 x 23 tonne loaders for sales load-out, (bladed bucket) (Note: If selling to ship bound consignments, each = 10,000 tonnes per consignment, => 3 x 11 hour days to load each consignment = 3,333 tonnes per day divided by 11 hours per day = 303 tonnes per hour, divided by 32 tonne per load = 9.4 loads per hour, The existing loader will not be capable of loading this volume, an additional loader of similar size would be required.	Construction sands, Native landscape soils & top dress, Golf fairway, mulch sands	Washed Golf sands, specialist construct sands, coloured glass, foundry etc.- (demand dependent)

Table 16.9 - Conservative Staged Mine Construction Summary - Year 1

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Year	Sales	Mining Operation	Winning of feed	Sales Load Out	Dry	Washed
2	250,000 Tpa, ~22,727 T/mth, ~1,196T/day, ~150 T/hr	Dry Only with process washing Production continued as per year 1 with 2 x 44 tonne articulated dumpers (1 from year 1 + 1 additional from year 2 on). Replace the 1 x 22 tonne excavator with a 1 x 35 to 40 tonne excavator to load articulated dump trucks or for a defined period utilise the second 22 tonne excavator to load the 2nd truck on each cycle as a short term compromise to engage existing equipment. An 8/6 pump should still handle this tonnage, and if required the pump may be sped up on revolutions per minute (R.P.M.) to achieve extraction targets.	Production continued as per year 1 , Dry mining only Winning plant feed- Excavator and dumper:	Dry mining is to continue until a sufficient size pond is constructed to float and engage the dredge for winning material, to feed the plant. This is more likely in year 3 of mine life. 2 x 22 tonne loader with bladed bucket for sales.	Construction sands, Native landscape soils & top dress, Golf fairway, mulch sands	Washed Golf sands, specialist construct sands, coloured glass, (demand dependent)

Table 16.10 - Conservative Staged Mine Construction Summary - Year 2

DRAFT

Year	Sales	Mining Operation	Winning of feed	Sales Load Out	Dry	Washed
3	450,000 Tpa, ~40,909 T/mth, ~2,153 T/day, ~269 T/hr	Dry and Wet Mining Production should have transitioned to dredging, direct coupled to a processing plant, using a 12 / 10 cutter suction dredge would suit, coupled to a 10" I.D. Poly / Rubber pipeline, (negating the dependence on the articulated dump trucks and excavators),	Excavator and haul trucks and suction/cutter dredge. 1 excavator should remain as a utility machine, while noise and dust emissions should be greatly reduced. The dredge should effectively be sitting at or around the water table below the surrounding natural levels also reducing noise even further.	The loaders will need to be increased in size and probably in numbers. The minimum requirement would be 2 wheel loaders with a capacity to carry and load 7 tonnes per cycle, the next most suitable size would be 12 tonne capacity per cycle.	Construction sands, Native landscape soils & top dress, Golf fairway, mulch sands	Washed Golf sands, specialist construct sands, coloured glass, (demand dependent)

Table 16.11 - Conservative Staged Mine Construction Summary - Year 3

DRAFT

Year	Sales	Mining Operation	Winning of feed	Sales Load Out	Dry	Washed
4 onwards	697,500 Tpa, ~63,409T/mth, ~3,337 T/day, ~417 T/hr	Dry and Wet Mining The dredge as described above should have the capacity to extract up to 300 tonne per hour with capacity to spare. The dredge should be capable of pumping 40% solids in this material (375 T.P.H.) (not the 30% used in this assumption). In addition tonnages could be won by increasing the R.P.M. of the pump, which should deliver approx. 400 T.P.H.	Excavator and haul trucks and suction/cutter dredge. Options at this point are to work additional hours to deliver the shortfall on 8 hours production, hot seat the dredge for morning tea, lunch etc., pump at a higher density, increase the R.P.M. on the pump or a mix of these options. Also could change out the 12/10 pump and replace it with a 14/10, in doing so the entire process on the back end of the dredge, the pipeline, the wash plant, the screens, spirals etc.. all have to be capable of handling this increase. This will be determined in QMS stage 4 when a complete plant analysis will be undertaken	The loaders will need to be increased in size and probably in numbers. The minimum requirement would be 2 wheel loaders with a capacity to carry and load 12 tonne capacity per cycle.	Construction sands, Native landscape soils & top dress, Golf fairway, mulch sands	Washed Golf sands, specialist construct sands, coloured glass, (demand dependent)

Table 16.12 - Conservative Staged Mine Construction Summary - Year 4

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Mining Plan Operational Plan- (Conservative Sales)

Bobs Farm- Est. Conservative Rate of Extraction & Sales with Time			
Year	Extraction (TPA)	Product Sales (TPA)	Assumed Product Yield from Feed
1	162,000	150,000	93
2	268,000	250,000	93
3	483,000	450,000	93
4	750,000	700,000	93
5	750,000	700,000	93

Note: This may vary depending on market demand especially if exporting sand to Asia

Table 16.13 - Conservative Sales and Production Estimates

Mining Operational Plan- (Aggressive Sales)

Bobs Farm- Est. Aggressive Extraction & Sales with Time					
Year	Extraction (TPA)	Product Sales (TPA) Road/Other	No. of 10,000T Export Shipments pa/ Tonnes	Estimated Total Sales	Assumed Product Yield from Feed
1	290,322	150,000	12 / 120,000	270,000	93
2	440,860	250,000	16/ 160,000	410,000	93
3	741,935	450,000	24/240,000	690,000	93
4 Onwards	750,000	460,000	24/240,000	697,500	93

Note: This may vary depending on market demand

Table 16.14 - Aggressive Sales and Production Estimates

The above aggressive sales strategy assumes a combination of road transported sand, and sales and export shipments via the Port of Newcastle. Dependent on demand for sand products the export shipment requirements could ramp up from one 10,000T ship per month to 1.5 to 2 per month, depending on processing production capacity, available storage and site load-out facility. The maximum extraction under the DGR's would still be 750,000 Tonnes per annum and as such an expected maximum of 700,000Tpa of saleable product is expected based upon a 97% production efficiency.

Alternative from Year 1

If proposing to sell to ships from year 1, there will need to be a rapid ramp up of production to have sufficient stock on the ground to feed the ships at 10,000T minimum per ship load.

The entire design process should then be based around peak production, under this condition, and at that time the operator could use the assumptions from year 4 and onwards, for the remainder of deposit life to accommodate the approx. 450 tonne per hour, with room for service, breakdowns etc.

Bobs Farm Mine Development- Staged Mine Construction Summary- Aggressive Sales						
Year	Sales	Mining Operation	Winning of feed	Sales Load Out	Dry	Washed
1	270,000 Tpa, ~24,545/mth, ~1,292 T/day, ~161 T/hr	**Dry feed system**: - Dry Only with process washing Production continued as per year 1 with 2 x 44 tonne articulated dumpers (1 from year 1 + 1 additional from year 2 on). Replace the 1 x 22 tonne excavator with a 1 x 35 to 40 tonne excavator to load articulated dump trucks or for a defined period utilise the second 22 tonne excavator to load the 2nd truck on each cycle as a short term compromise to engage existing equipment. An 8/6 pump should handle tonnage, if required the pump may be sped up on RPM to achieve extraction targets.	**Winning plant feed**- Excavator and dumper: Dry Mine only 2 x 22 tonne tracked excavators with an oversize mud bucket would be utilised to win sand feed with 1 x 44 tonne articulated dumper used to transport the raw feed along dedicated haul roads to the processing plant on site. (Note: The 22 tonne excavator is a miss match with the dump trucks size, however it is believed to be within existing fleet of potential quarry operator and should work in the initial phase).	**Sales loading:** 2 x 23 tonne loaders for sales load-out, (bladed bucket) (Note: If selling to ship bound consignments, each = 10,000 tonnes per consignment, => 3 x 11 hour days to load each consignment = 3,333 tonnes per day divided by 11 hours per day = 303 tonnes per hour, divided by 32 tonne per load = 9.4 loads per hour, sales loader.	Construction sands, Native landscape soils & top dress, Golf fairway, mulch sands	Washed Golf sands, specialist construction sands, coloured glass, foundry etc.- (demand dependent)

Table 16.15 - Sales Projections Aggressive -Year 1

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Year	Sales	Mining Operation	Winning of feed	Sales Load Out	Dry	Washed
2	410,000 Tpa, ~37,272T/mth, ~1,962T/day, ~245 T/hr	Dry and Wet Mining Production should have transitioned to dredging, direct coupled to a processing plant, using a 12 / 10 cutter suction dredge would suit, coupled to a 10" I.D. Poly / Rubber pipeline, (negating the dependence on the articulated dump trucks and excavators),	Excavator and haul trucks and suction/cutter dredge. 1 excavator should remain as a utility machine, while noise and dust emissions should be greatly reduced. The dredge should effectively be sitting at or around the water table below the surrounding natural levels also reducing noise even further.	The loaders will need to be increased in size and probably in numbers.	Construction sands, Native landscape soils & top dress, Golf fairway, mulch sands	Washed Golf sands, specialist construction sands, coloured glass, (demand dependent)

Table 16.16 - Sales Projections Aggressive -Year 2

Year	Sales	Mining Operation	Winning of feed	Sales Load Out	Dry	Washed
3	690,000 Tpa, ~62,727T/mth, ~3,301 T/day, ~413 T/hr	Dry and Wet Mining Production should have transitioned to dredging, direct coupled to a processing plant, using a 12 / 10 cutter suction dredge would suit, coupled to a 10" I.D. Poly / Rubber pipeline, (negating the dependence on the articulated dump trucks and excavators).	Excavator and haul trucks and suction/cutter dredge. 1 excavator should remain as a utility machine, while noise and dust emissions should be greatly reduced. The dredge should effectively be sitting at or around the water table below the surrounding natural levels also reducing noise even further.	The minimum requirement would be 2 wheel loaders with a capacity to carry and load 7 tonnes per cycle, the next most suitable size would be 12 tonne capacity per cycle.	Construction sands, Native landscape soils & top dress, Golf fairway, mulch sands	Washed Golf sands, specialist construction sands, coloured glass, (demand dependent)

Table 16.17 - Sales Projections Aggressive -Year 3

Year	Sales	Mining Operation	Winning of feed	Sales Load Out	Dry	Washed
4 onwards	697,500 Tpa, ~63,409T/mth, ~3,337 T/day, ~417 T/hr	Dry and Wet Mining The dredge as described above should have the capacity to extract up to 300 tonne per hour with capacity to spare. The dredge should be capable of pumping 40% solids in this material (375 T.P.H.) (not the 30% used in this assumption). In addition tonnages could be won by increasing the R.P.M. of the pump, which should deliver approx. 400 T.P.H.	Excavator and haul trucks and suction/cutter dredge. Options at this point are to work additional hours to deliver the shortfall on 8 hours production, hot seat the dredge for morning tea, lunch etc., pump at a higher density, increase the R.P.M. on the pump or a mix of these options. Also could change out the 12/10 pump and replace it with a 14/10, in doing so the entire process on the back end of the dredge, the pipeline, the wash plant, the screens, spirals etc.. all have to be capable of handling this increase. This will be determined in QMS stage 4 when a complete plant analysis will be undertaken	The loaders will need to be increased in size and probably in numbers. The minimum requirement would be 2 wheel loaders with a capacity to carry and load 12 tonne capacity per cycle.	Construction sands, Native landscape soils & top dress, Golf fairway, mulch sands	Washed Golf sands, specialist construction sands, coloured glass, (demand dependent)

Table 16.18 - Sales Projections Aggressive -Year 4

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Mine planning for site water management.

During the Initial stages of mine development water will be required to wash and process the sand, for dust suppression and wheel wash. Town water or rainwater tanks will supply water to amenities on site.

Preliminary site works will largely revolve around clearing, movement, storage and re-use of vegetation and overburden sand. This will also involve mulching operations which would be conducted alongside the Nelson Bay road side of the site to minimise noise, dust and vibration. The establishment of a sump will be needed, below the site water table, to access ground water for processing, dust suppression etc. This will be in a suitable location using excavators and dump trucks, (probably within the 1st cell for extraction). Stockpiling of won sand feed material should be done as close to the proposed processing plant location as practical.

Martens Surface water assessment requires a swale to be installed on the haul road between Nelson Bay road and the proposed processing plant to capture any sediment generated from site. It is noted that 184 m2 area is also required for sewer spray and filtration onsite.

Water requirements for sand transport and washing:

Depending on the rate of production and involved processes, the sand transport and washing water requirements will vary with time for the Bobs Farm operation. It is expected that the maximum water is likely to be between 1050m3/hr to 1350m3/hr based on production output when the dredge is in full operation and wash water is used in processing the sand feed. If the quarry ramps up to full production of 450t/hr of extraction in the first year the water requirements will be at the maximum in year 1 of 1350 cubic metres per hour of water.

Dredge Efficiency Estimates

The expected water usage for the wet mining process depends on the dredge efficiency and are summarised in Table 16.19.

Bobs Farm Mine Development- Staged Mine Construction Summary- Conservative				
Sand Extraction T/hr	Solids content %	Total Water + Sand Slurry = Sand Extraction/Solid% T/hr	Water = Slurry*(100% - %solids) T/Hr	Water m3/Hr
450	25%	=> 450/25%=1800	1350	1350
450	30%	=> 450/30%=1500	1050	1050
Density = Mass/Volume	Particle Density= 2.65	450T/hr => 450/2.65= 170m3/hr solids		

Table 16.19 - Dredge Solids Content and Water Demands

It is QMS understanding that both 25 and 30% solids density are achievable in pumping this type of sand/water slurry.

Water Considerations

To extract 750,000 TPA, by dredge, there will need to be up to 1800T/hr of slurry pumped and 1350m3/hr of water for the required 450t/hr sand feed. The majority of the water required on site, will be for sand dredge transport, washing and processing purposes, at the designated processing plant location.

Water Quality.

As the ground water will form the wash water required, QMS see no issues with the ground water for washing purposes. As the development progress's, the water for washing will be supplied from the 1st cell under extraction, once it is large enough, in this application the dirty water from the wash plant will be delivered back to the same cell, this will be possible as such a small percentage of reject will be returned to the ponds. QMS mining plan follows the recommendations from Martens on the treatment of the PASS material as per the agreed strategy once near the water table.

Recycling Water.

The wash water required and used within the sand washing process will be recycled on this project, with minimal losses, as it is basically a closed loop operation. The water will be pumped (with sand) via the dredge to the wash plant. The wash / processing plant will separate recoverable sand, from the reject waste. The "dirty" water will be sent back to the ponds / cells with the unwanted reject materials settling out and the water used again, and again. The only losses will be evaporation and minor spills or splashing around the plant on start-up or blockages, if and when they occur, delivering >98% return, not including evaporation on the cells / ponds.

The agreed treatment of PASS from Martens will be incorporated here in water recycling.

Water Treatment.

The only water expected to require treatment on this development is the PASS layer, which when encountered, will be processed as per agreed Martens procedures.

Water Losses.

Water will be recycled for washing, with expected minimal losses of approx. 2% in this process, other water loss will be with dust suppression of trafficable areas, and water loss due to evaporation on the cells / ponds as they are progressively developed.

Landscape Irrigation.

No specific allocation has been allowed for landscape irrigation and development. No final Landscape detail has been agreed, however the quantities of water required would still fall well within the 10% of total process water for the year 2, allowance nominated. This would constitute > 98% of total water requirements, on site for the life of the development.

As soon as the dredge is commissioned, dust emissions from on-site dump trucks and excavators will almost cease, dredging and washing alone do not generate any dust.

The main long-term area for dust suppression will be road going tip trucks entering and departing the sales loading area, as we believe the larger portion of this trafficable area is to be sealed, resulting in little or no dust being generated. An allowance of 10% of the nominated water

requirements for Year 2, listed below would be more than sufficient for all other water requirements.

Heavy Machinery and Equipment

Mining Plan:

- Stripping- Bull dozer / excavator with grab etc.
- Dry Mine- Excavator / haul trucks / sales loader(s)
- Establish dredge- excavator / haul trucks- once dredge established haul trucks limited use.
- Feed dredge with excavator (Dredge retracts excavator drops sand into pond-> dredge marches over sand and repeat)
- Push up sand with small dozer- D7 or D8 to feed excavator to feed dredge
- Move dredge once cell exhausted.

Location/description of all buildings, offices, workshops, amenities, etc. are identified on Figure 16.21 below.

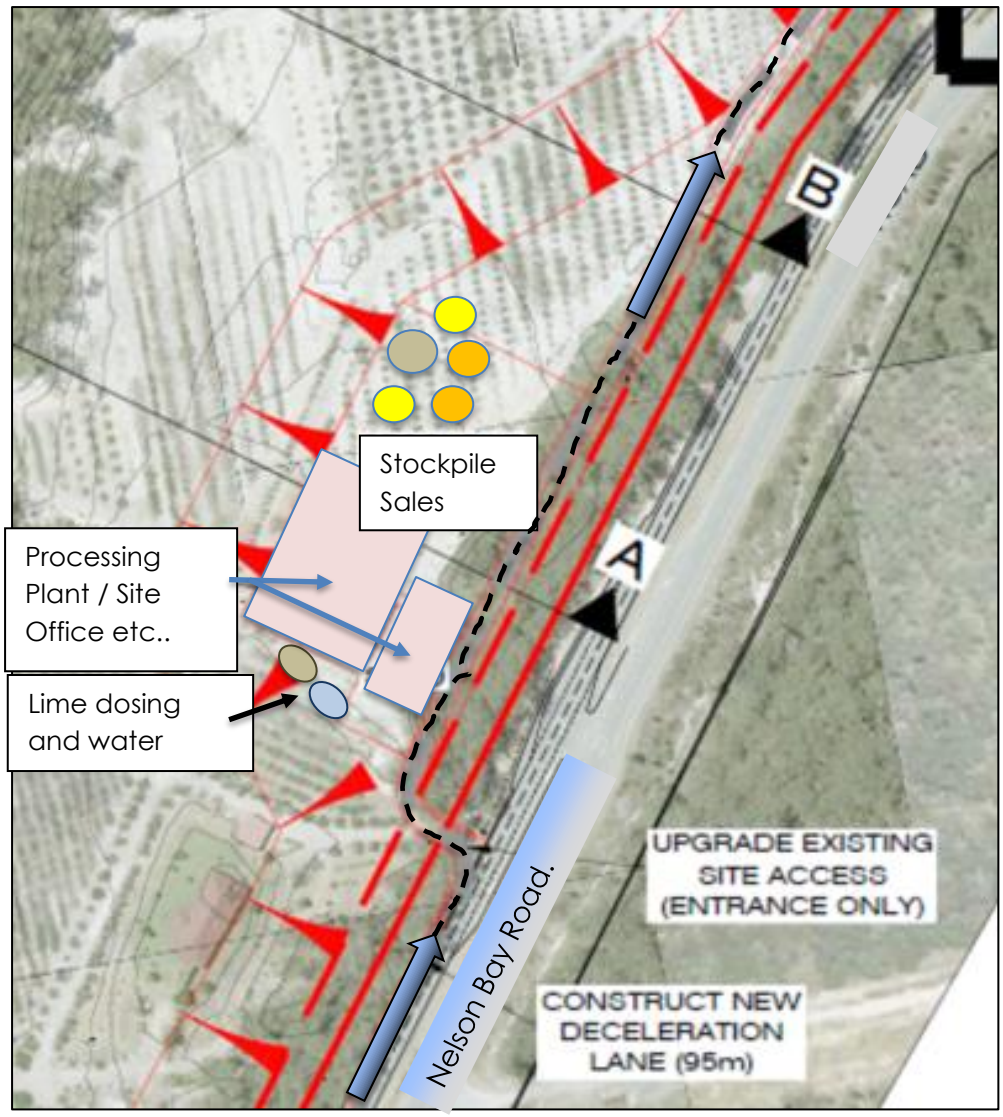


Figure 16.20 - Site building location

As can be seen from Figure 16.21 the plant processing area requires a significant footprint to allow for washing/ screening/ attrition/ spirals/ dewatering and then to final stockpile product. Provision for enclosed processing and sand storage is made where controlled moisture content is required for export sand requirements or other.

Other land uses on site

There will be no alternate land uses for agriculture, grazing or forestry applications however a caretaker residence will be maintained onsite to ensure site security is maintained at all times.

Other manufacturing plant on site – eg Concrete, asphalt

There are no plans to process the sand products from site into concrete, asphalt or any other product on site.

Parking and marshalling area

Visitor parking will be provided at the site office off Nelson Bay Road and site access will be restricted to only authorised personnel, with boom gate or similar vehicular obstacle to prevent unplanned site entry.

Employees and site staff will have designated parking area onsite outside of the extraction area.

In case of emergency or evacuation a muster point will be located at the site office and or front gate as deemed appropriate by quarry management.

To facilitate efficient and fast loading of road trucks onsite there will be a designated waiting area within the stockpile / sales area and a marshalling area where trucks can be parked up onsite overnight if required.

Safety and security measures

The safety and security of the Bobs farm site will be maintained at all times through compliance with the site operational plan, which will ensure the mine site is kept isolated from the public at all times, other than by controlled and authorised access.

Service utilities and infrastructure

The location of all related services for the site will be clearly identified and marked within the site operational plan to be developed in stages 4 and 5 of the QMS investigations. This will include any above and below ground power, telecoms, water, fibre optic, gas etc.

Processing and Stockpiling Factors (Operations)

Finished product specifications

Stockpiled products located onsite will be clearly signposted to identify what material is within a given stockpile and a current record of what product are within the stockpiled/sales area will also be available at the site office. Testing and validation of quarry product quality will be done by customised Inspection and Test Plans (ITPs) which will be developed and maintained by QMS based upon the market into which the individual product is to be sold.

Future product compliance and specification suitability will be handled by regular and periodic review of ITPs by QMS, keeping track of new opportunities to value-add sand product won from site when feed quality improves or new markets open up for individual products available from site.

Stockpile methods & requirements

Stockpiling of sand products will be utilised to make best use of available area and will include trestle conveyors capable of luffing (up/down) and slewing (side to side) to develop large stockpiles / windrows of finished saleable sand product as required for production / sales demand.

Conveyor design will be matched to the likely production capacity required, including belt speed and width.

Dewatering screens are to be incorporated in the processing operation to minimise the time required in stockpile to reach an acceptable material moisture content for transport as agreed by management or in conjunction with clients.

The stockpile areas will be prepared to be flat durable working surfaces with adequate cross fall to encourage controlled surface drainage of water. Under no circumstances will the stockpile floor be picked up during sales load-out and this will be clearly outlined in the operational plan for the Bobs farm quarry site.

16.4 ECONOMIC AND MARKET FACTORS

A local and export sand market report is presented in Annex I of this report.
While QMS have endeavoured to cover all required site aspects in this mining plan the following have not been addressed in this report:

- Business cycles for products
- Commercial and economic need - level of need
- Critical success factors for products in target market segments
- Demand and supply analysis – usage / consumption trends
- External contingency analysis (social, legal, cultural, environmental etc.)
- Industry and competitor analysis
- Market area, size – radius of economic distribution; exports
- Market segmentation by product type, application/ customer type
- Population growth
- Pricing
- Reliance on particular customers/suppliers, export markets
- Sales forecasts/ projections / sensitivities
- Social Cost Benefit Analysis
- Value-adding opportunities – ease of implementation/ impact on sales targets

Haulage and Distribution Factors (e.g. Off-site Heavy Vehicle Movements)

16.4.1.1 Costs of Transportation to Markets

The transport cost of final saleable sand products to the associated material markets will be included in delivered prices under an accepted socially responsible market pricing strategy, in compliance with the requirements of the Trades Practice act of Australia. Ex-bin sand product prices will also be available where customers wish to pick up material from the Bobs Farm site in line with the site operational plan with site safety firmly in mind. This may restrict the sale of small sand volumes by box trailer and may be restricted to tip truck load minimums as decided by mine management.

16.4.1.2 Entrance and Exit - Configuration, Surfacing

As discussed, earlier in this report, main haul roads will be surfaced with sprayed bituminous seal to minimise dust and noise including the exit road from the stockpile area; with loaded trucks to pass over a drive-over wheel wash and grate to liberate sand from tyres and wheel guards before exiting onto public roads.

16.4.1.3 Volume of Truck Movements

The daily, peak, average traffic movements within the mine site will be determined by the production and sales requirements. Traffic management entering and leaving the Bobs Farm site is modelled by SECA and outside the scope of this report.

16.4.1.4 Weighbridge

As discussed earlier in this report weighing and ticketing of loads will be via load cells within the sales loader buckets and dedicated wireless ticketing system. A weighbridge is not planned to be introduced onsite unless production demands warrant its use and this will be addressed at that stage.

16.4.1.5 Traffic Management on Site

Traffic management on site is to be controlled via the site operational plan. Quarry management will ensure haul trucks have right of way within the mining extraction zone and intersections where light vehicles or other site traffic interact with haul trucks will be minimised to encourage optimal safety outcomes. This will form part of the traffic management plan for the site.

The following Environmental, Social and Cultural Factors (Impacts) are addressed in other parts of this EIS

- Acid sulphate soils (PASS)
- Agricultural land (eg GQAL)
- Archaeological, cultural and historical heritage and values
- Buffer areas - internal, external
- Community consultation, feedback
- Contaminants – pre, during and post mining
- Climate change – sea level effects
- Discharges to water – water quality
- Drainage, bores, dams, watercourses, springs, wetlands, flood impacts and frequencies, groundwater impacts
- Dust emissions
- Existing services / utilities
- Exposed vs screened areas – landscaping/ barriers TL- Sound and visual barriers
- Fauna/ flora
- Flooding, bunding
- Fire controls
- Groundwater
- Neighbours names, addresses, details of adjoining landholders - expectations and views / submissions
- Natural features
- Noise, light and vibration emissions – operations and off-site transport
- Permit and licence conditions – history of operator, reference sites, proposed conditions Public safety and amenity – incl. school safety / amenity of students/staff
- Rehabilitation – prior, during and post extractive landform
- Sewage and effluent
- Site and surrounding land uses - current and future
- Slope stability, ground control
- Soil quality, quantity, fertility, re-use

- Surrounding land uses – impacts and their mitigation
- Sustainable development (energy efficiency, greenhouse gas emissions etc.)
- Sediment and erosion controls
- Vegetation - existing, native, ecosystems, disturbed, authorised tree cleari
- Visual amenity, views into and out of the site over time
- Wastes generated and management
- Weeds and pests

The following Governmental / Other Factors are addressed in other parts of this EIS

- State and local government policy,
- Views and attitudes of public officers

Disclaimer: The Quarry Due Diligence Index that has been used in compiling this Mining Plan was compiled by ECOROC Pty Ltd to assist in the project and risk management of quarries or quarry-related projects. The index is adapted from the 'modifying factors' in the Minerals Industry JORC Code (2014) and is intended as a guide only. The index is not exhaustive and other site-specific issues not listed in the index may be relevant for a particular resource, quarry site or project.

16.5 CONCLUSIONS

The Bobs Farm Site has minable lenses of sand that are suitable for a number of applications including; foundry sand, industrial moulding sand, fire furnace sand, coloured glass sand, construction sand(s), turf sands etc. The mine plan that is reported here will form the basis of the site processes, however a specific site operational plan will need to be developed to run the site as a dedicated quarry resource.

17 VISUAL ASSESSMENT

Chapter 17 describes the visual impacts of the proposed sand extraction extension. Potential visual impacts were determined through evaluation of the interaction between visual modification and visual sensitivity.

17.1 METHODOLOGY

The assessment of potential visual impacts involved evaluation of the interaction between visual modification and visual sensitivity. Visual modification expresses the visual interaction between the proposal and the existing visual environment. It is the visual contrast between pre and post development and is a combination of the appearance of the development (size, form, colour, texture, and so forth), the absorptive capacity of the landscape setting, and the distance from which the development is viewed. Visual modification is often expressed as high, medium or low.

The degree of visual modification is dependent on the distance the viewer is from a location. As the distance from the proposed development to the viewing location increases, the development becomes less prominent, and therefore its visual modification is less.

Visual sensitivity is a measure of how critically a change to the existing landscape will be viewed from various viewpoints. This sensitivity is dependent on a number of viewer characteristics which, for the purposes of this study, are land use, distance of the sand extraction from viewers and the visibility of acoustic barriers and mounds from critical viewing locations.

The existing landscape character of an area is a fundamental factor in determining the visual impact of any development. The background setting and surrounding natural or built environments can either expose a new development to view or help absorb the visual effects. The following elements influence the character of the landscape and visibility of a development:

- vegetation – influences lines of view as well as the visual character of an area;
- topography – can obscure or expose a development;
- distance of views – influences the area potentially affected by a development and the degree of impact; and
- built structures – form part of the visual character of an area and may also block or create lines of view.

The visual impact of the proposed sand extraction extension was assessed by examining the ability of the existing environment to absorb or accommodate physical changes and the sensitivity of the landscape. The sensitivity of the landscape is determined considering land use, landscape character, number and type of potential viewers and the distance from which the area is viewed.

In addition, the visual impact of the mitigation measures to control noise impacts, being mounds and upright barriers around the extents of the excavations and on the main haul routes within the private lands also needs assessment as does the impacts of clearing operations, sand processing operations and any overshadowing issues.

17.2 EXISTING LANDSCAPE CHARACTER

The landscape on and surrounding the sand mining area comprises generally low-lying to gently rising undulating coastal flat sand dunes that are forested with areas of cleared orchards (figs and

olives) in the central section of the site, with some steeper sand dunes to the southwestern parts of the land. The visual catchment of the site is predominantly characterised by a thin line of mature forest along the southern boundary with well forested areas to the west. The central part of the site has been disturbed by years of clearing for figs, olives and other rural activities.

To the southern boundary, Nelson Bay Road fronts the development and traffic moves along this main road at 80km/hr, north bound and 100km/hr south bound. Visability of the site is considered passive.



Plate 17-1 - North bound view of the site

In areas where the proposed acoustic mounds are intended to be located in the northwestern and northeastern sections of the site, the existing landform is a fully vegetated forest.

In some parts of the areas of the proposed acoustic barriers, there are already metal fences to 2.8m and 2.3m in height, a maintenance/machinery shed to around 5m in height with general screening fencing to the primary school (2.8m high) and the adjoining Go-kart Track and 776 Marsh Road at 2.3m in height.

17.3 VIEW POINT ANALYSIS

A view point analysis was conducted from a number of vantage points surrounding the proposed sand mine with particular emphasis on the northern residences, adjoining Go-Kart and residence to the south of the main haul route and Nelson Bay Road. The view point analysis considers how the sand mine will be viewed at all stages of development. The following comments summarise this analysis:

- from the unformed electricity easement to the south, the mine will be visible when extraction is occurring in the vicinity of the existing easement. When extracting the southern sections visibility would be low due to proposed screening vegetation This screen vegetation will also surround the sand processing areas as well as the main operation sheds and stockpile areas.
- from the nearest residence to the north at 644 Marsh Road (approximately 63m distant from the edge of the batter to the dwelling), the proposed extraction area is not visible. It is screened by significant vegetation and topography.
- An obscuring dune and screening vegetation exists between the mine and all other properties to the north.

- The school is already partially screen by existing vegetation and screens and this screen will be augmented. The proposed location of the 4m barrier to the northern side of the haul route can be located generally between existing vegetation and the road. As such, the location of this wall is generally not visually intrusive to adjoining rural properties.

- the sand mine will be partially observed from Nelson Bay Road at the entrance to the mine, including compound and the operations sheds but only as a passing glimpse from north bound traffic. No visibility will be afforded to south bound traffic.



Plate 17-2 - Typical median screen for south bound traffic



Plate 17.3 – Existing 2.8m high fence to be replaced with 4m high fence

- Only two properties to the north of the operations can view the proposed barrier and these are 712 Marsh Road, albiet from a distance of 450m, and 724 Marsh Road from a distance of 240m with this view corridor being through existing mature vegetation.

- The proposed 6m high vegetated acoustic mound around the perimeter between the operations and 724 Marsh Road will effectively screen this property from the sand extraction areas.

- The Go-Kart Track and 776 Marsh Road have already a 2.3m high metal panel fence around their facility and dwelling.

17.4 IMPACTS

The visual contrast between pre and post development impacts is a combination of the appearance of the development, the absorptive capacity of the landscape setting, and the distance from which the development is viewed.

The visual modification of the proposed development is low overall given that:

- the proposed sand mine development cannot be seen from any nearby residence.
- Local topography and screening vegetation prevents the visibility of the proposed extraction area from all surrounding residences.
- All acoustic mounds will be inserted behind a 15m existing vegetated screen that will, if necessary, be suplimented with additional plantings if required. No overshadowing occurs from the acoustic mounds.
- The northwestern acoustic mound is only a temporary structure that is required for mining operations at the western end of the project and will be removed as the operations move easterly. It is not proposed to have this mound vegetated but stabilised and mulched to limit dust movement.
- The northeastern mound will again be mulched and at specific locations that the mound becomes visible from the adjoining property at 724 Marsh Road it will be vegetated.
- The final waterbody will not be visible to any adjoining residence or passing traffic or casual observer.
- the final landform would be visually consistent with the area being one of a forested backdrop.
- the extracted areas would be progressively rehabilitated with native vegetation suited to the local area;
- A 15m metre buffer of screening vegetation would be retained around the entire perimeter of the site to reduce the visual impacts in all directions. The buffer area will be augmented with rehabilitated land as per the mining plan.
- The mining compound will be screened by the 15m buffer strip which will contain, where necessary, a mound and plantings so that only the initial construction of the development will be seen from Nelson Bay Road, Light spillage from the compound is not considered a significant issue as the property will install lighting that has directional spillage, lights that are directed away from public areas and residences and given that the operations are generally only a daytime operation, will not be needed in the am and only for around 1hr during the pm winter period.
- The location of the 4m high noise barrier along the haul route is expected to be located in the same location as the existing northern 2.8m high fence that will be screening the school. No clearing is expected to be undertaken through existing vegetation and only minor limbing of the existing significant tree cover is required. The significant existing

vegetation buffer to the south of the schools playing fields will in effect fully screen the barrier from the school.

- Parts of this northern barrier are seen from adjoining dwellings at 712 and 724 Marsh Road but the distances to these residences are significant and will be generally rehabilitated so that the barrier, in the medium term, will be fully covered by vegetation.
- The eastern end of these proposed barriers will extend from the existing maintenance shed towards Marsh Road and whilst the owner of 772 Marsh Road has previously requested that an acoustic fence not be located for the current trucking operations from Lot 10 DP 1071458, the impact on this property is considered manageable as the barrier will be located on their eastern boundary with limited overshadowing impacts. As regards the eastern barrier, it will only overshadow driveways for the majority of the length of the boundary that are used to access a residential dwelling at 776 Marsh Road and the Go-Kart access track at 778 Marsh Road. Further discussion on the impacts on these properties is below and is accompanied with specific plans to indicate the impacts.
- The 4m high acoustic barrier on the eastern side of the haul road will replace an existing 2.3m high metal fence that has been installed from the the maintenance shed on 774 Marsh Road along the northern boundary of 776 Marsh Road to the southern extents of the Go-Kart Track at 778 Marsh Road. Passing traffic will only have a momentary glimpse of the walls as it is at right angles to the direction of the vehicular traffic.
- Dirgrams of the impact relative to various locations have been prepared to discuss the impact of the mounds and barriers and are provided below.



Plate 17.4 - Partial view of the transmission line – south bound traffic

The surrounding residences are not visible from the site and it is intended that an appropriate boundary buffer to all residences is initially maintained. Under an active rehabilitation of the batters, the residential buffers will be extended to > 40m to 100m in overall width from the boundary. The buffer to Nelson Bay Road boundary will be commenced at 15m and be extended to between 23 and 40m. The overall distance from the western road edge to the future water level will be around 38m to 55m.



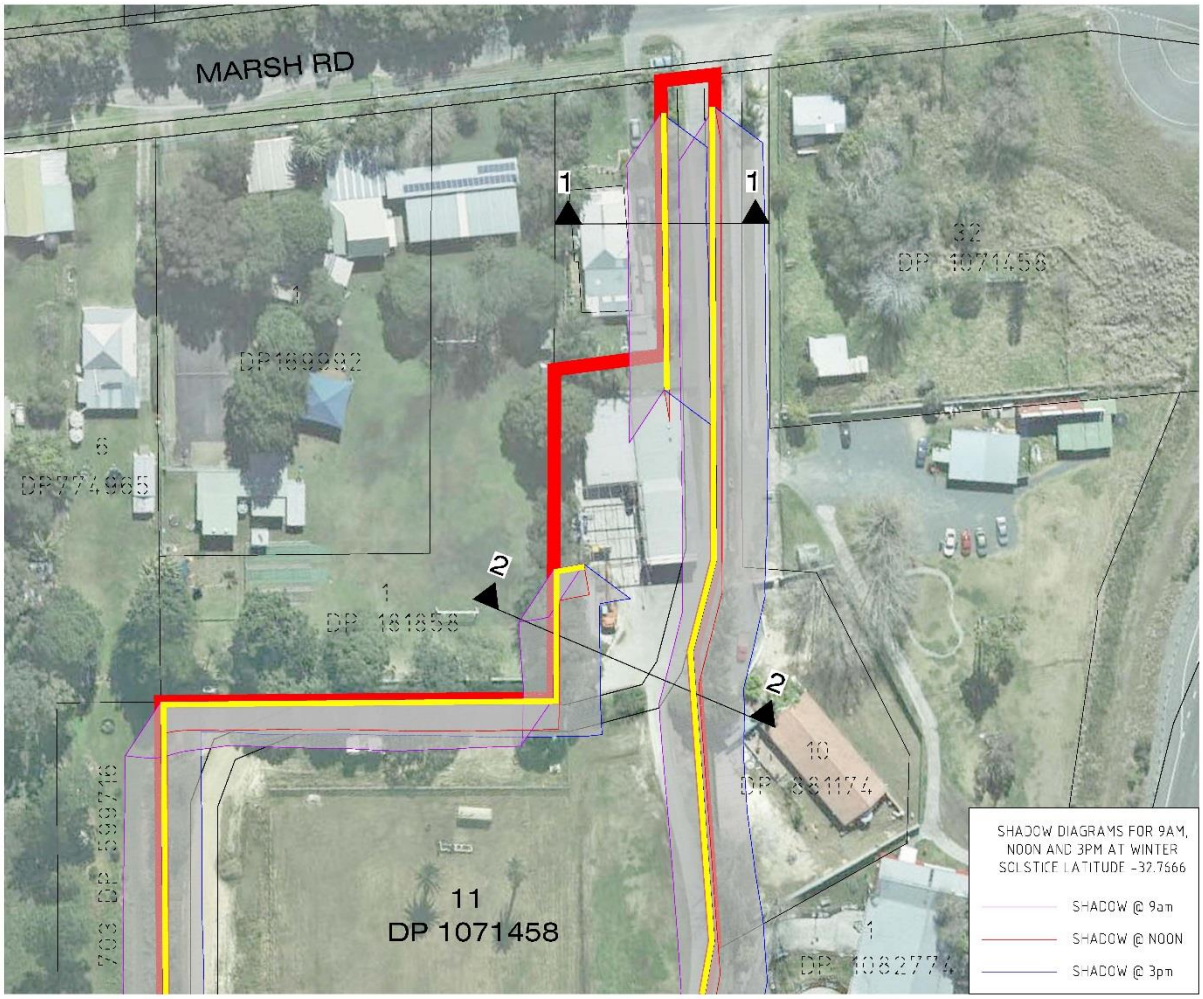
Plate 17 5 – Existing Entrance into 774 Marsh Road – Note Existing Fences and Adjoining Driveways

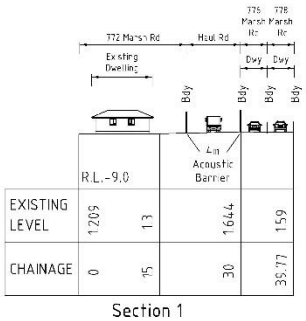
Diagram 17.1 below indicates the location of the proposed 4m high barrier at the exit point of the operations and its impact on 772 Marsh Road. Minimal impacts are expected to either 776 or 778 Marsh Road as the barrier does not closely adjoin the residence on 776 Marsh Road or is well screen by vegetation contained within the property. The Go-Kart facility at 778 Marsh Road only has a shed and the track in close proximity to the barrier. The majority of the barrier will adjoin driveways or vehicular manouvering areas. Overshadowing impacts are also included for both of these barriers for the 9:00am, 12:00 and 3:00pm hours indicating that only minimal impacts are expected.

Diagram 17.2 below is at the western end of the mining operations and is showing the relationship of the temporary mound to the 15m buffer and then adjoining properties. Clearly the mound will not be visible and given that the mound is going to be 6m high, 15m from the boundary, overshadowing impacts are nil.

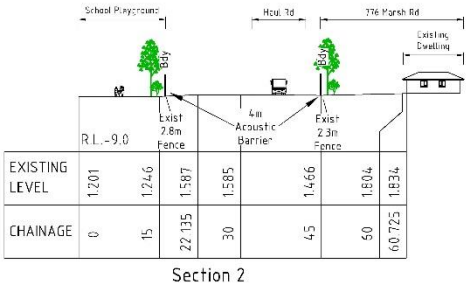
Diagram 17.3 below has been prepared to indicate the impact on the adjoining property at 724 Marsh Road. The residence at this location is well below the crest of the acoustic mound and well behind the vegetation screen. There is a 75m separation to the residence. Clearly the mound will not be visible and given that the mound is going to be 6m high, 15m from the boundary, overshadowing impacts are nil.

Diagram 17.1 – Barrier Imapcts at the main Egress Point on Marsh Road



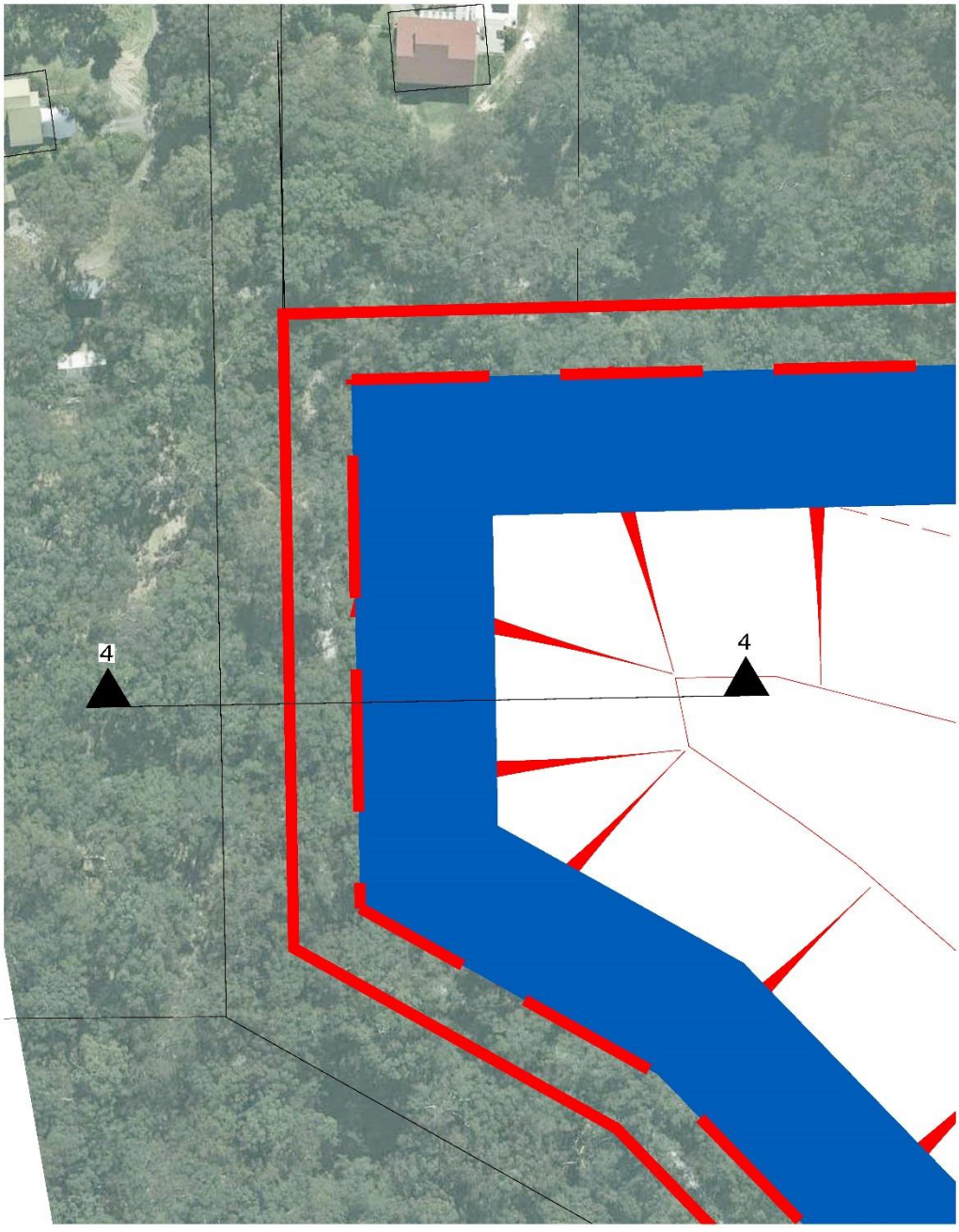


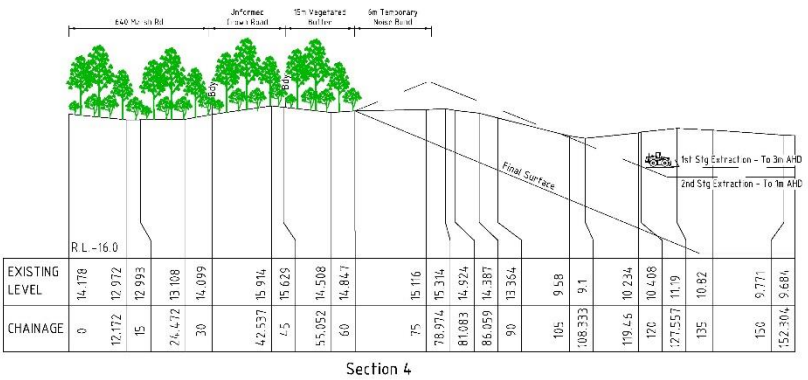
Section 1



Section 2

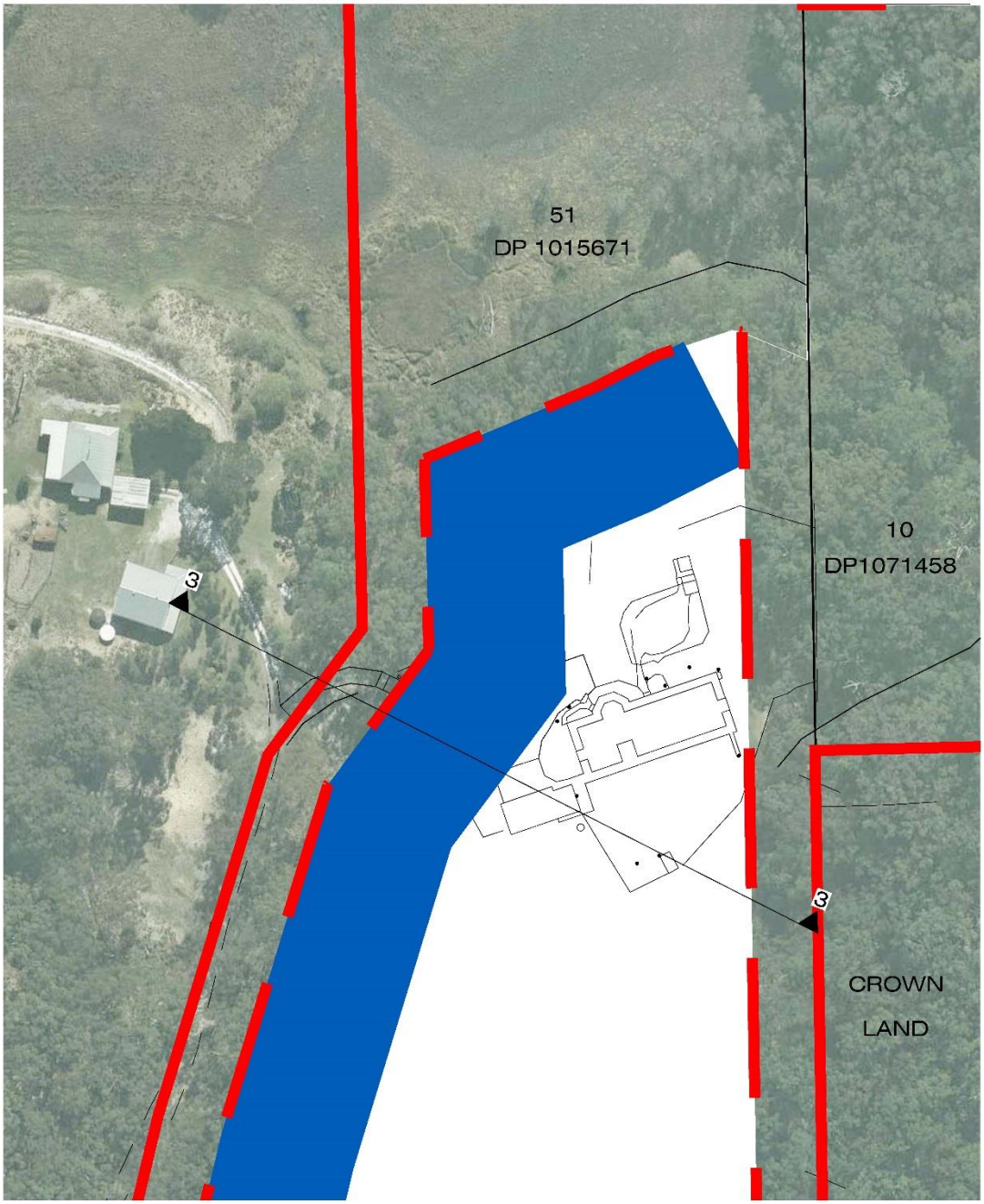
Diagram 17 2 – Mound Impacts at the Western Part of the Operations

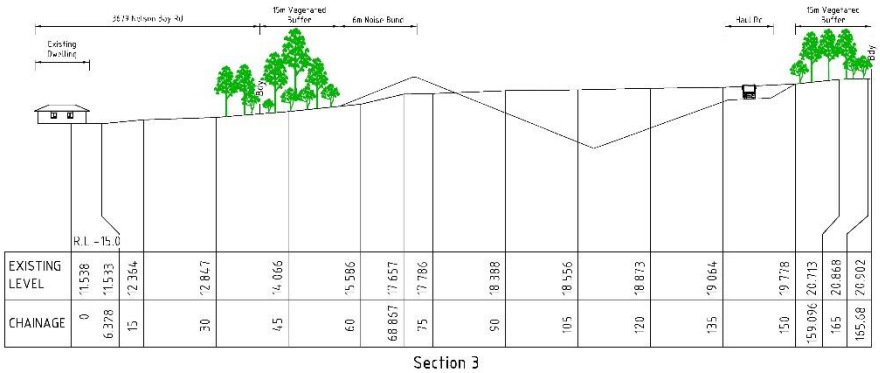




Section 4

Diagram 17 3 – Mound Impacts at the Eastern Part of the Operations





Section 3

Visual sensitivity is a measure of how critically a change to the existing landscape will be viewed from various viewpoints. The visual sensitivity of the development is low given that:

- the site is within a rural location with relatively high-speed passing traffic along Nelson Bay Road protected by roadside vegetation and a 15m buffer;
- the vegetation removal associated with the development will occur at the commencement of the life of the sand extraction with relatively small areas being cleared at any given time. These areas will be progressively rehabilitated so that for the Stage 2 & 3 (dredging) operations the site will be significantly revegetated;
- no residences in the rural areas of the Bobs Farm area have a direct line of sight to the proposed mine area. Therefore, the visual sensitivity remains low to nonexistent from adjoining residences;
- Impacts of the barrier wall on the school is considered low as the existing 2.8m fence will be replaced with a 4m fence that is already well vegetated.
- Impacts of the barrier wall on rural properties to the north are minimal and manageable.
- Impacts and overshadowing on 772 Marsh Road are medium but considered manageable and negotiations with the owner will determine if the walls will be inserted as the current trucking operations do not cause undue conflict. Impacts on their private open space is shown to be non-existent.
- Impacts and overshadowing on 776 and 778 Marsh Road will see an increase in the height of the existing wall from 2.3m to 4m. The physical impact on private open space is marginal to non-existent.
- Operational areas will be designed to limit light spillage outside the direct confines of the processing plant and operational shed.
- the proposed sand extraction is not readily visible from any public vantage points, such as parks, lookouts or recreation areas.

In the short term, sand extraction may result in minor visual impacts from vantage points along Nelson Bay Road and the electricity easement, to the south and southwest of the site respectively. However, these impacts will be relatively short lived as extracted areas would be progressively rehabilitated. The final form of the site would see a partial return to native vegetation which will enhance visual amenity. The visual impact of the proposed development will not significantly decrease the current visual amenity.

18 SOCIAL & ECONOMIC ASSESSMENT

Chapter 18 describes the social and economic impacts of the proposed sand mining operation. Further detail is contained in the Social Impact Assessment at Annex X.

18.1 SOCIO-ECONOMIC CONSIDERATIONS

A Social Impact Assessment (SIA), has been prepared to inform an Environmental Impact Statement (EIS) and accompany a development application to the Minister for Planning under Part 4 of the Environmental Planning and Assessment Act 1979.

The development application seeks approval to construct and operate a sand extraction and processing operation at Bobs Farm, NSW. The land on which the development is proposed is located on the western side of Nelson Bay Road and south of Marsh Road at Bobs Farm and it is within the Port Stephens Local Government Area.

The Department of Planning and Environment was consulted in relation to the development proposal and the Director-General's Requirements (DGRs) for SSD14/6395 were issued on 21 March, 2014.

As two years had passed from the release of the DGRs the Department was further consulted with a request for Secretary's Environmental Assessment Requirements (SEARs). SEARs were provided on 12 April, 2017.

In so far as Social Impact Assessment considerations are concerned, both the DGRs and SEARs provided identical assessment requirements.

Furthermore, correspondence dated 8 March, 2018 was received from the Department advising of the release (on 8 September, 2017) of the 'Social Impact Assessment Guideline for State Significant Mining, Petroleum Production and Extractive Industry Development (2017)'. The correspondence noted that proposals for significant mining, petroleum production or extractive industry projects for which SEARs were issued before 8 September, 2017, were given until 7 March 2018 to submit an EIS before the requirements of the said guideline came into effect. As the EIS for the project has not yet been lodged, the correspondence advised that that the following supplementary SEAR must be addressed in the EIS:

"The EIS must include a detailed assessment of the likely social impacts of the development on the local and regional community in accordance with the Social Impact Assessment Guideline for State Significant Mining, Petroleum Production and Extractive Industry Development (2017)".

This Social Impact Assessment has been prepared in accordance with the NSW Department of Planning & Environment Social Impact Assessment Guideline for State Significant Mining, Petroleum Production and Extractive Industry Development (September, 2017).

The proposed sand mine represents a scarce significant source of high-grade silica sand close to the Sydney and Newcastle glass and technology manufacturing markets. These markets are existing and there is limited local resources available for the suppling of these markets. The sand extraction can provide a cost-effective supply of high quality silica sand for local, regional, Sydney and international glass, ceramic and chemical industries.

The proposed operation will only source workers from the Port Stephens and local regional areas, so creating local sustainable jobs. The proposed sand mine provides a significant opportunity in

many aspects of sand products thus supporting local employment at the Bobs Farm facility and other local and regional businesses through the multiplier effect. The proposed sand extraction through the life of the mining operations will allow for the continued employment of local workers and future operations as a tourist facility or solar energy farm will provide a significant long-term use with major positive ecological impacts.

The approval of this mining operation will see a significant number of jobs generated for >15 years and the opportunities for alternative uses of the land post mining are creditable and achievable.

Current employment on the farm involves an onsite manager, and the owner. Under the sand mining operation, it is estimated that the mining operation will provide 7-10 full time on-site jobs and 50 to 70 fulltime transport jobs, 15 further full-time roles in downstream manufacturing and laboratory activities and 10 in the use of the product for recreational purposes. This is estimated to contribute approximately $3.5 million in employees' wages, of which approximately $2.5M is estimated to be retained within the local and regional economies. These workers will be drawn from the Port Stephens area and surrounding localities. It is estimated that a further 100 full time equivalent jobs will be supported through the multiplier effect, with a proportion of these jobs supported in the local and regional economy. Operations at the site will contribute to approximately $1 million in contracts/year with local businesses and it is likely that contributions to the local community groups will be established. The mine will contribute to the up-skilling of the local workforce in training and development of staff.

18.2 SOCIAL IMPACTS AND MITIGATION MEASURES

The Social Impact Statement prepared by Tattersall Lander Pty. Ltd. has identified a range of perceived and actual community/ other stakeholder considerations associated with the proposal. Relevant community and technical mitigation strategies have been cited for engagement purposes; specifically, relevant to address the variety of issues which have been raised.

The EIS prepared for the proposed development incorporates a significant number of specific mitigation strategies in relation to:

- Traffic Impact Assessment
- Ecological Impact Assessment
- Noise and Vibration
- Air Quality
- Groundwater
- European Heritage
- Aboriginal Cultural Heritage
- Visual Impact Considerations
- Social Impacts
- Statement of Commitments

As is the case with many resource extraction projects, the perceived and experienced social impacts/ issues are often greatest for those living in closest proximity to the proposal, or those who perceive they will be most directly impacted by the development. Consequently, should the development application be approved, an appropriate social impact monitoring program should be developed to assess the degree to which impacts are occurring and appropriate methodologies by which to mitigate any impacts.

It will be vital for the proponent to maintain an ongoing dialogue with local residents throughout the operation of the sand mine in relation to issues of relevance and importance to the community.

19 BUSHFIRE ASSESSMENT

Chapter 19 describes relevant matters related to bushfire management and assessment under NSW legislation.

19.1 INTRODUCTION

The vegetation within and around the proposed sand extraction area is identified as bush fire prone on the Port Stephens Council bush fire prone land map, refer Figure 19.1. Accordingly, under Section 79BA of the EP&A Act, the development proposal is required to address the requirements of the *Rural Fires Act 1997*, and in particular the document *Planning for Bush Fire Protection* (NSW Rural Fire Service, 2006). The proposal is not residential or for special fire protection purpose and is not integrated development. The applicant therefore does not require a bush fire safety authority from the NSW Rural Fire Service.



Figure 19.1 - PSC Bushfire Prone Land Map

19.2 OBLIGATIONS

Given that the proposed development is for sand extraction, with no residential component, compliance with *Planning for Bush Fire Protection* (PBP) is achieved by meeting the aim and objectives of PBP. The overriding aim of PBP *is to use the NSW development assessment system to provide for the protection of human life (including firefighters) and to minimise impacts on property from the threat of bush fire, while having due regard to development potential, on-site amenity and protection of the environment.* The aim is met by addressing and meeting the objectives of PBP which are:

i. *Afford occupants of any building adequate protection from exposure to a bush fire;*

   Comment – The only building proposed is a shed and this shd is to be constructed from non-combustible materials and this combined with its location within the site shall ensure that any occupants within the shed are adequately protected from exposure to any bush fire.

ii. Provide for a defendable space to be located around buildings;

Comment – An asset protection zone (APZ) is deemed to be a defendable space and there shall be an APZ of 20 metres around the shed.

iii. Provide appropriate separation between a hazard and buildings which, in combination with other measures, prevent direct flame contact and material ignition;

Comment – Given the location of the proposed sand mine in relation to the proposed shed, an APZ of 20 metres around the shed will be sufficient to prevent flame contact. The appropriate APZ combined with the fact that the shed is to be constructed of non-combustible materials (metal) shall ensure material ignition is prevented.

iv. Ensure that safe operational access and egress for emergency service personnel and residents is available;

Comment – The proposed shed is to be located along side the proposed mine entrance. Given the entrance is to be constructed to accommodate trucks, it is considered that there is safe operational access and egress for emergency service personnel and also any other persons on site.

v. Provide for ongoing management and maintenance of bush fire protection measures, including fuel loads in the asset protection zone (APZ);

Comment – Maintenance of the proposed APZ shall be undertaken on a regular basis as part of the day to day mine operations and this shall ensure that this objective is met.

vi. Ensure that utility services are adequate to meet the needs of firefighters (and others assisting in bush fire fighting).

Comment – There shall be a 100,000 litre tanks (constructed from concrete or steel) adjacent to the shed and this tank shall be made compliant with PBP, including being fitted with a 65mm storz valve with a metal ball or gate valve. This shall ensure this objective is met.

Further, the operator has an obligation under the *Rural Fires Act 1997* as an owner or occupier of land to:

"*…take the notified steps (if any) and any other practicable steps to prevent the occurrence of bush fires on, and to minimise the danger of the spread of bush fires on or from, that land*."

19.3 MITIGATION MEASURES

Bush fire protection measures incorporated into the proposed operations would apply to the the whole site. These measures aim to reduce fuel accumulation, control ignition sources and provide services on site to assist in fire fighting and minimise the spread of bush fire. Fire management on-site will include:

- provision of a separation distance (minimum of 10 m) between stockpiles of combustible material and remnant vegetation;
- managing operations and the site to minimise likelihood of ignition sources through good 'housekeeping' (for example, all waste in bins);

- emergency planning procedures in the event of a fire occurring on the site;
- fitting of all earth moving machinery with spark arresting mufflers and haul trucks have serviceable exhaust systems to prevent accidental ignition of vegetation; and
- equipping the operations to assist in the management of any fires on-site, including presence of fire extinguishers, water cart (as contracted), and the site front-end loader and bulldozer for any requisite fire fighting purposes.

These measures minimise the risk of a fire starting from operations on site, minimise the risk of fire spread, and provide services for fire fighting in the immediate area. The construction of a spinal haul road and the continued maintenance of the road will provide adequate access and egress for fire fighting purposes if and when required.

It is summarised that the proposal is not for subdivision or an SFPP development and therefore there is no requirement for referral to the NSW RFS. The proposal is compliant with the aim and objectives of PBP and therefore should be considered acceptable in this regard.

20 WASTE MANAGEMENT ASSESSMENT

Chapter 20 considers the waste management regime to be implemented in association with the proposed development.

This Waste Assessment addresses environmental considerations identified in the Secretary's Environmental Assessment Requirements (SEARs) (including authorities' attachments), dated 12 April, 2017, and relevant to waste management:

- *DoPE - A waste (overburden, rejects, tailings etc) management strategy;*
- *DoPE - Waste – including estimates of the quantity and nature of the waste streams that would be generated or received by the development and any measures that would be implemented to minimise, manage or dispose of these waste streams*
- *DoPE _ Minerials & Mining Division - Disposal of waste products and the location and size of stockpiles.*

The NSW Environmental Protection Authority (EPA) adds that:

The EIS should:

- *Identify, characterise and classify all waste that will be generated onsite through excavation, demolition or construction activities, including proposed quantities of the waste. Note: All waste must be classified in accordance with EPA's Waste Classification Guidelines.;*
- *Identify, characterise and classify all waste that is proposed to be disposed of to an offsite location, including proposed quantities of the waste and the disposal locations for the waste. This includes waste that is intended for re-use or recycling. Note: All waste must be classified in accordance with EPA's Classification Guidelines.;*
- *Include details of all procedures and protocols to be implemented to ensure that any waste leaving the site is transported and disposed of lawfully and does not pose a risk to human health or the environment.;*
- *Include a statement demonstrating that the Proponent is aware of the relevant legislative requirements for disposal of the waste, including any relevant Resource Recovery Exemptions, as gazetted by EPA from time to time.*

20.1 BACKGROUND

Project Overview

The project involves the development of a sand mine operation that is expected to utilise >99.5% of the available resource for offsite production in a wide range of commercial and industrial uses. Details of the proposed uses are contained within Chapter 16 of this EIS.

The mining operation is expected to run for 15 to 20 years, subject to market forces, with Stage 1 of the operation to be completed in 5-7 years. Stage 1 will generate nearly all of the waste products (topsoil, organics, tree mulch etc) with the majority of these non-sand wastes being used in rehabilitation works within the site or classified as resource recovery waste that will be utilised in other local operations. It is intended that commercial quality millable logs from the forested sections of the site will be transferred to local sawmills for hardwood production.

The clearing operations will be undertaken in a sequential basis as per the proposed mining plan so excessive stockpiles of topsoil and mulch is not expected.

Post Stage 1 operations, the sand mine will generally not produce any waste streams and be more akin to a domestic operation that will consequentially utilise:

- the local Port Stephens Council domestic waste collection services, and
- a domestic waste water treatment system.

Site Location

The site is located off Nelson Bay Road at Bobs Farm and is surrounded by generally rural activities, a primary school and Community Hall to the north

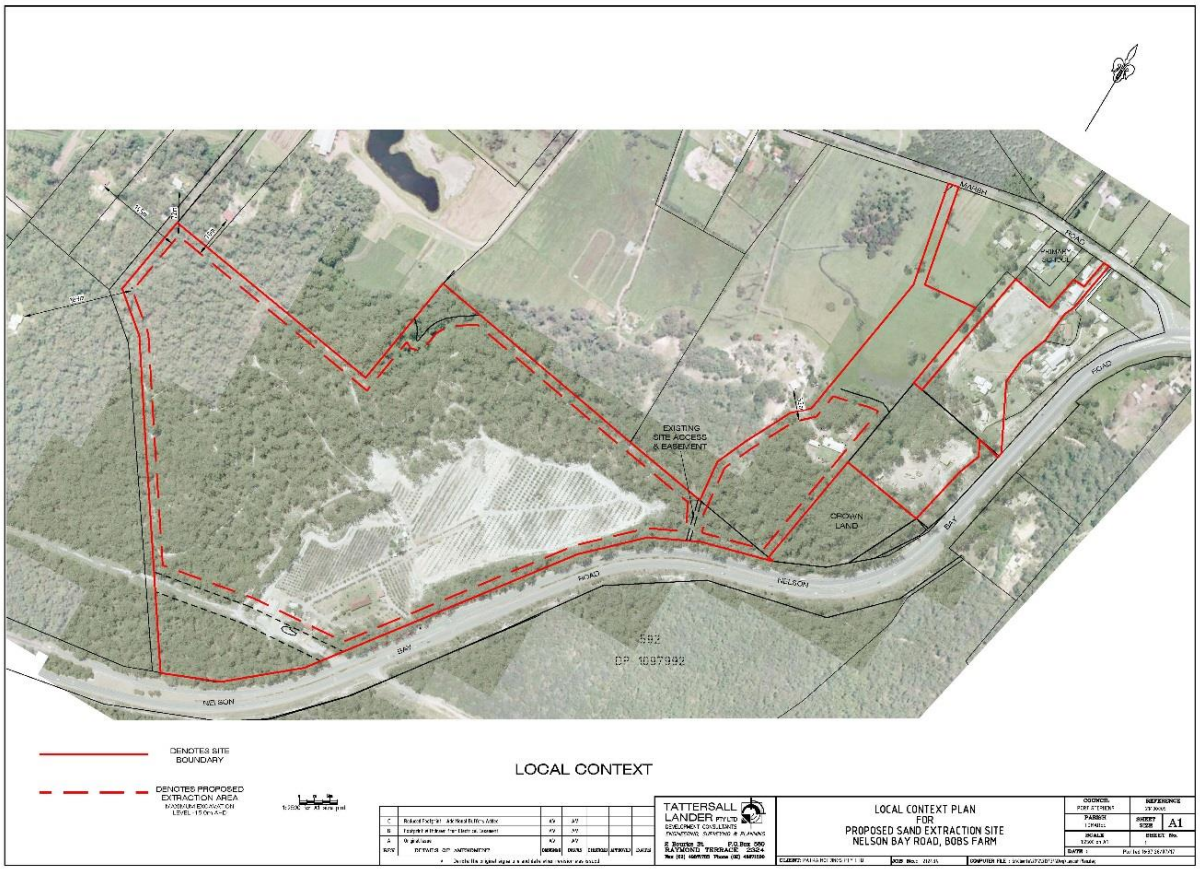


Figure 20-1 - Location Map (Local context)

Process Description

The proposal involves the development of a large-scale sand mining operation that will include a three (3) stage mining process. The proposed operations would see the staged clearing of the land and the commencement of the Stage 1 operations as per the mining plan.

The Stage 1 operations will recover sand resources 1m above the water table. Approximately half of the available resource is in this initial volume of sand. Stage 2 operations would see the mechanical removal of sand to a depth of 1m below the water table. Stage 3 is a fully operational dredging activity.

As part of the Stage 1 operations the final profile of the above ground surface will be created and rehabilitated. Overburden and organics from mulched vegetation will be utilised in the rehabilitation program and this will include the establishment of vegetated buffers. Rehabilitation will commence and be an integral component of the initial stage of the mining plan.

20.2 WASTE ASSESSMENT

Existing Environment/Background

The site of the proposal is a rural bushland environment, distant from any built-up, urban or industrial areas, except for the small Bobs Farm locality. The proposed operation has been estimated to have a minimal to no longterm solid waste management issues, other than the initial organic (likely tub ground mulch from recycling the vegetation) material and the removal of the two (2) dewllings and associated buildings. It is noted that regular litter from cars and household rubbish illegally dumped along the electricity road easement and Nelson Bay Road is a continuing issue.

To facilitate the successful operation of the proposed sand mine, waste streams generated during the construction and operational phases of the development will be effectively managed and/or disposed off-site, as described in Sections 20.3.1 to 20.3.5 below. Waste management at the Bobs Farm facility will be in accordance with the *NSW Waste Avoidance and Resource Recovery Strategy 2014-2021* (WARR Strategy).

There will be a small amount of general waste and consumables produced during continued extraction of sand at the proposed site and estimated quantities are indicated below. Toilet wastes are addressed in Chapter 6 and Annex F. Refuelling by supply tankers and only minor servicing of machinery will occur onsite, so there would be no significant waste materials generated onsite by such operations. Where possible, operational waste suitable for reuse or recycling would be treated in accordance with the *DECC Waste Classification Guidelines*

20.3 GENERAL SAFEGUARDS AND MANAGEMENT PRACTICES

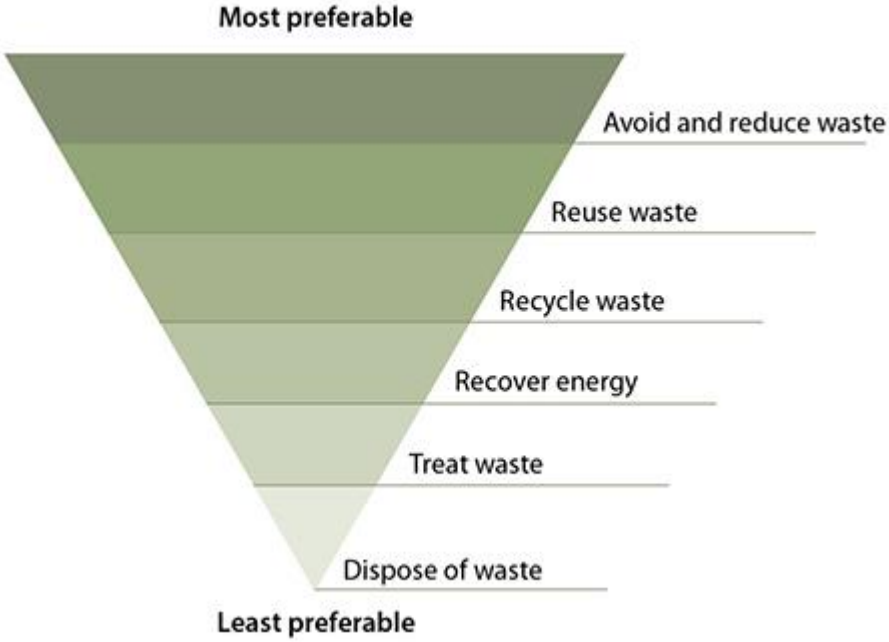
Although waste management is considered a very minor issue, the following safeguards would be implemented:

- there would be no burning of waste;
- any noxious plant species removed from the site would be disposed of at a licensed landfill;
- any waste would be collected daily and recycled or disposed of directly at a licensed landfill or relevant facility; and
- the site will be maintained and kept free of rubbish and cleaned up at the end of each working day.

Part of the operations and processing of the sand will see the recovery of a very small quantity of heavy mineral sands. Whilst this material is a by-product of the processing, it is a very valuable resource in its own right and it is classified as a Crown Mineral. A separate Mining Lease Application under the Mining Act will be undertaken concurrently with this operation so that this

by-product material can be appropriately reprocessed by regional operations that have the capacity to handle the material.

All waste management strategies for the site will be outlined within the Operations Manual for the site, which will be kept on site and easily accessible for reference at all times. Waste management strategies at the Bobs Farm mine will be developed with consideration of the NSW Waste hierarchy presented in **Figure 20-2**.



Source: *http://www.epa.nsw.gov.au/images/waste/waste-hierarchy.jpg*

Figure 20-2 - NSW Waste Hierarchy

General Non-recyclable Waste

The disposal of general non-recyclable waste is applicable to both the construction and operation phases of the proposal. As the project develops, the generation of waste is expected to be reduced to the extent that the local Council roadside collections will be utilised.

Construction wastes will be the responsibility of the building contractors and management of these wastes will be presented in the Construction Management Manual. Typically, a nominated contractor/builder will be responsible for the construction of the machinery shed /site office. The construction waste management will be managed by the nominated contractor/builder. It will be expected the contractor will consider the following measures:

- Ordering the right quantities of materials (Purchasing Policy);
- Prefabrication of materials;
- Re-using formwork;
- Modular construction and basic designs to reduce the need for off-cuts;
- Minimising site disturbance and limiting unnecessary excavation;
- Careful source-separation of off-cuts to facilitate re-use, resale or efficient recycling;
- Choice of landscaping to reduce green waste; and
- Co-ordination and sequencing of various trades.

The following assumptions have been utilised in order to estimate the potential mass of construction waste to be generated during the construction phase of the project:

- It is estimated approximately 2 – 20% of all materials ordered will end up as waste materials (2.5% will be used for this estimate given much of the construction material mass will be the concrete slab(s) and prefabricated steel sections, etc.) (WALGA, 2014);
- The floor area for the office and the machinery shed combined is estimated to be between 800m2 and 1200 m2 (A floor area of 800 m2 will be used for this estimate); and
- The mass of single storey domestic type constructions (including foundations) is approximately 1,000 kg/m2 of floor area.

The total mass of waste construction materials to be delivered to the Port Stephens Resource Recovery Centre is therefore estimated to be around 20 tonnes.

Any remaining construction waste will be expected to be disposed into a skip bin which will be collected by a contracted bin hire company.

As regards the demolition of the two (2) dwellings and their associated structures, any material that is non-recyclable will be transferred to Newline Tip as builder's waste. Estimated quantities are around 50 tonnes.

Day to day general waste will be placed into enclosed skips and removed from the facility by a licensed contractor on a regular basis. This waste will be transported to and disposed of at a local landfill site. No general, non-recyclable waste material will be stockpiled and or disposed of onsite.

Recyclable Waste

The site will incorporate standard recycling protocols for mixed recycling, with a bin always available to ensure that recyclable waste does not result in landfill. Recyclable waste will be sorted to Council requirements, collected by a licenced contractor, and then transferred to the nearby Newline Resource Recovery Facility. It is estimated that a skip bin/fortnight would be appropriate.

As regards the demolition of the two (2) dwellings and associated structures, concrete, bricks, timber and tiles will be sent to local recyclers. Estimated quantities are around 400 tonnes.

Chemical Containers

Chemicals used at the Bobs Farm facility will be primarily for weed control. Limited quantities of these chemicals would be brought to the site and only be used to ensure that the rehabilitation works were being supported. Any empty chemical containers generated by shed cleaning would be removed from the site and appropriately disposed of by the approved methods.

The proponent would be responsible for waste generated by chemicals that were stored on site. The following chemicals would be stored on site for water sanitation, as well as pest, vermin and weed control:

- Glyphosate 20L drums (herbicide);
- Rat bait stations (vermin control in sheds); and

The above chemicals will be stored in an appropriately bunded storage area for short terms and in limited volumes. All stored chemicals will be placarded if quantities exceed WorkCover placarding requirements. In the unlikely event that the quantities of chemicals stored exceed dangerous goods notification thresholds, WorkCover will be notified and standard Dangerous Goods handling processes followed.

Empty chemical containers will be disposed of either via a chemical supply company, or the Drum MUSTER program. Up to 4 drums/year would be used.

The potential risks associated with the management of chemical wastes at the Bobs Farm project are considered very low, based on the use of best management practices, the limited volumes of chemicals stored, as well as the locations and design of chemical storage areas within the sheds. Risks will be further reduced through the preparation and implementation of an environmental operations manual prior to operations commencement, which will detail requisite mitigation measures, including incident management procedures and waste disposal protocols.

Organics – General Solid Waste (Non Putricable)

Production of compost is consistent with waste reduction avenues outlined in the WARR strategy.

Onsite routine green waste composting at the proposed development will be carried out in accordance with:

- *Environmental Guidelines: Composting and Related Organics Processing Facilities* (NSW DEC 2004);
- *Australian Standard (AS) 4454 – 2012 Composts, soil conditioners and mulches;* and
- Any Council and regulatory authority requirements.

The green waste composting/storage protocol will involve the regular mulching of green plant material that cannot be used for millable logs and this material will be stockpiled for use on the rehabilitation batters and perimeter buffer strips. The stockpile of tub ground mulch will be undertaken in appropriate locations within the site depending on the intended timeframe for use, however the area immediately to the north and adjoining the main sand stockpile is there area for the main longer-term mulch stockpile. The mulch stockpile will: -

- be out of public view;
- have clean water diverted around the composting/storage site; and
- be appropriately managed to prevent pests and vermin.

Excess mulched organic material will be collected by local industries for implementation in their internal processors. Discussions have been held with the local operations at ANL @ Tea Gardens and their proposed FOGO facility is capable of utilising all excess volumes of topsoil, organics and substandard soils in their production of topsoils and fertilisers.

Conservatively the site is expected to generate 900tonnes/ha (2,000m^3) of green waste, excluding millable logs, over the forested area of 21 ha. This material will be generated over a 5-7-year horizon and be processed (tub ground) and spread over the 11.8ha of finished rehabilitation batters. Assuming that the material will be used as a one-off soil improver and then subsequent erosion and weed control layer about 60% of the mulch material will be retained on site and 40% (7,560 tonnes and this is considered as being a maximum) of the material will be

available for other users. Maximum stockpiles on site would be around 8000 tonne as an initial operation but generally the stockpile would be < 2000 tonnes operationally for only the 1st Stage.

Topsoils and Substandard Material (Screened Tailings)

Topsoils will be stripped and stockpiled onsite. All topsoil material will be utilised in the rehabilitation works and retained on site. Stockpiles will be located adjacent to the batters that would be created with the initial excavations and each stockpile would be around 5000m^3.
Given the scarcity of topsoil indicated in QMS borelogs, it is estimated that about 35,000m^3 will be generated and all of this material will be placed on the rehabilitation batters. Initially, all of the stripped material will be targeted for the establishment of the required noise and visual barriers where appropriate as indicated on the mining plan.
It should be noted that screened material will initially be inspected to ensure that if possible, it could be utilised for use in a lower order material (ie general fill) prior to having to use it on site as part of the topsoil mix.
Additionally, sand material that does contain organics has a significant use by ANL @ Tea Gardens as part of their packaged topsoil improvers and indications are that their potential annual consumption rates would far exceed the total expected topsoil generated from the whole mining operational over the life of the project. Excess material, if produced will be a commercial resource provided to a growing market.

Sewage

Sewage generated by onsite staff amenities and residences at the Bobs Farm site will be disposed via an infiltration or irrigation system.

20.3.1.1 Consultation

Summary of Primary Waste Streams and Management Commitments

Primary waste streams, along with other potential waste streams, are listed in Table 14.1 with their Classifications under the Waste Classification Guidelines Part 1: Classifying Waste (EPA 2014) and intended management.

Waste Type	NSW Classification	Management
General Waste	General solid waste (putrescible and non-putrescible)	Collected on a regular basis from the Development Site by a licensed contractor, or operators' personnel for recycling and/or disposal at the Newline Resource Recovery Facility. Green waste will be tubground on site and generally reused for internal rehabilitation works.

Waste Type	NSW Classification	Management
Chemical and fuel containers	Hazardous waste: If containers were previously used to store Dangerous Goods (Class 1, 3, 4, 5 or 8) and have not been cleaned out to remove residues. General solid waste (non-putrescible): If the containers have been washed or vacuumed.	Returned to the chemical supply company for recycling, reuse or appropriate disposal. Non-returnable chemical containers will be collected and managed by the drumMUSTER program. Note that transport of any Dangerous Goods will be conducted in accordance with Australian Codes.
Sewage (from staff amenities)	Liquid	On site disposal is used it would be by irrigation or infiltration.
Tyres	Special waste	Offsite recycling or disposal at licenced facility.
Green waste	General solid waste (non-putrescible)	Composting and/or direct reuse on site. Excess to be transferred to others.
Used motor oil, air and oil filters and rags	Special waste	Offsite recycling or disposal at licensed facility.
Batteries	Hazardous waste	Offsite recycling.
Light bulbs	Hazardous waste	Offsite recycling.

Table 20-1 - Primary waste streams, their classification and selected management commitments for the Bobs Farm Sand Mine.

21 UTILITIES AND SERVICES

Chapter 21 considers potential impacts to public utilities and essential services.

21.1 TOWN WATER

No service connections are available to the existing or proposed sand mine areas. Tank supply will provide this function.

The current bore will provide water to the water cart contractor to minimise dust erosion from the internal unsealed haul roads.

21.2 SANITARY WASTES

No service Agency connections are available to the existing or proposed sand mine areas. Chapter 6 and Annex F address the proposed waste water requirements for the mining operation.

21.3 ELECTRICITY

The existing electrical supply to the residence will be rediverted to the mining operations Office.

A major electricity transmission line is located in the easement that transects Lot 254, and forms part of the proposed sand extraction mining area. The transmission line services Nelson Bay. Discussions with Ausgrid have indicated that subject to the approval for the mining operation, Ausgrid will accept the relocation of several poles to relate the line to the south and then along the batter slope within the site. All relevant studies required by an REF for this relocation have been undertaken by this EIS.

21.4 TELECOMMUNICATIONS

The existing land line service connections available to the existing dwelling and will be redirected to the proposed sand mining operations.

Telecommunication mains and line services generally follow the Nelson Bay Road alignment. These lines will not be impacted by the proposed sand mine.

22 FUTURE USE OPTIONS

Chapter 22 considers the proposed future use options for the site.

22.1 POTENTIAL ECO-TOURIST OPTION

A viable option for the site, under the current existing RU2 zoning for an Eco-tourist development is available, subject to another Development Application that would be lodged and potentially approved by Port Stephens Council. This option provides the following opportunities: -

a. A water-based facility that could target recreational activities: -
    i. Cable skiing
    ii. Diver training including rescue training
    iii. Kayak/ training
    iv. Sailing/training
    v. Fishing
b. 40 Eco-tourist over the water bures'
c. Convention centre
d. Restaurant

Figure 22.1 provides a visual interpretation for the concept.

Expected employment for such a facility would be around 20-30 staff and would depend on the success of the cable skying, accomodation and the restaurant.

22.2 POTENTIAL SOLAR ENERGY FARM

A South Australian project has proposed the world's first floating solar farm. A similar operation is potentially available for this site but at a much higher/more intensive level.

An initial estimate of the operating efficiencies of a typical floating solar farm indicates that it will be 57% more efficient than the usual land-based operations.

This option would have the added benefit of being available as the underwater mining operation moved from one mining stage to another so that the solar farm could be commenced at a time of say at a 40% completion stage of the mining activity. Logically, if this option was to be realised, planning for this option would need to be commenced within 4 years and some potential rezoning of the land would be required. Given the positive high technical opportunities that this sort of project would generate, planning arrangements are not seen as a limiting factor.

Other benefits of this option would see the following possible outcomes: -

a. It would have the potential to access into the available and adjoining sub transmission TML for the replacement of the power requirements of Nelson Bay and surrounding villages.

b. Evaporation losses from the constructed water body would be significantly reduced so that the requirement for the acquisition of water licences would be reduced with this arrangement.

c. Employment for this sort of operation would be around 4-6 highly qualified technicians and 3-5 maintenance staff, however, the construction phase would see a significant activity that would/could provide 50+ jobs for several years.

d. Significant reductions in long-term greenhouse gases for a replacement energy

Figure 22.2 provides a visual interpretation for the concept.

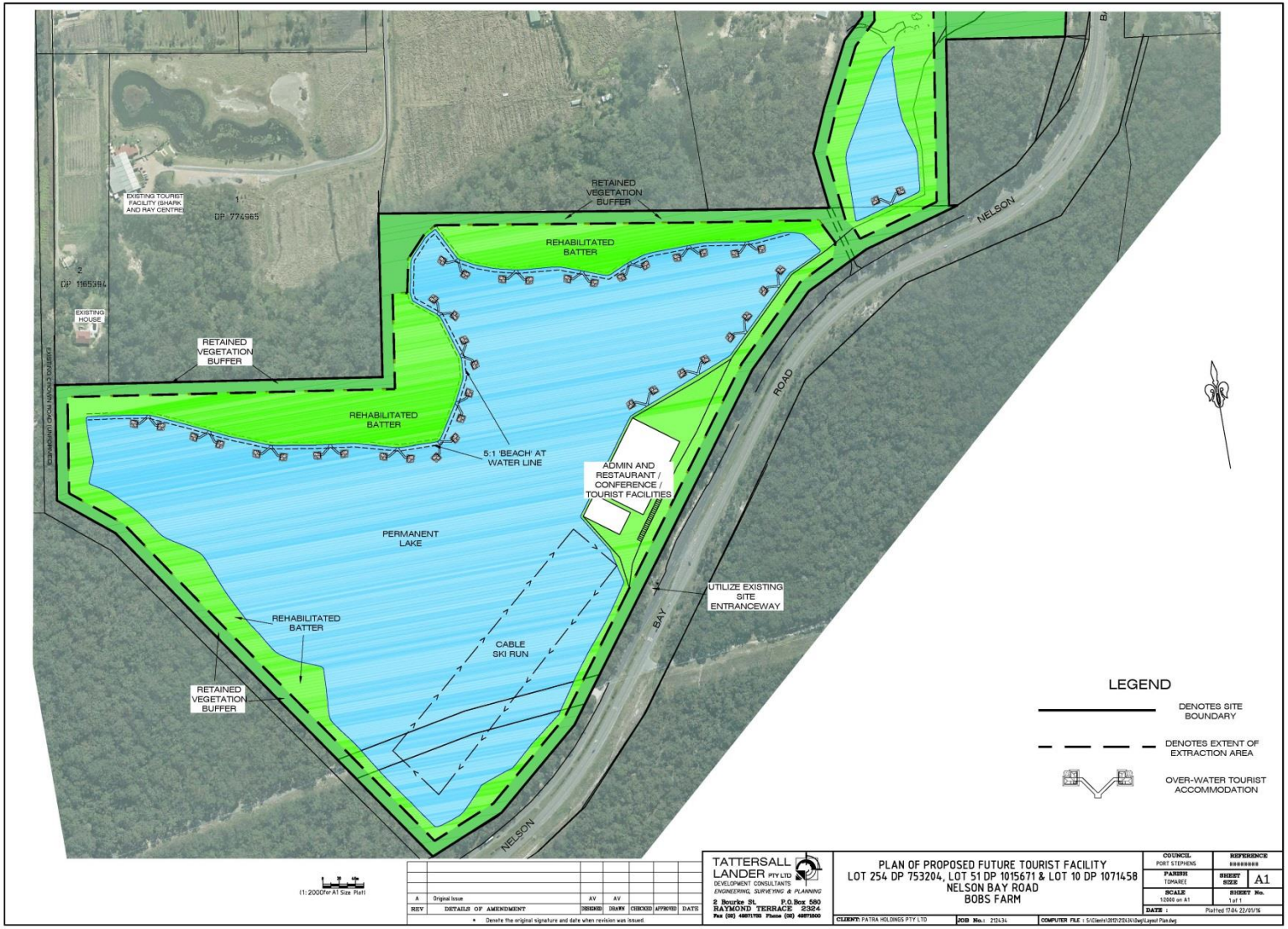


Figure 22.1 - Proposed Eco-Tourist Option

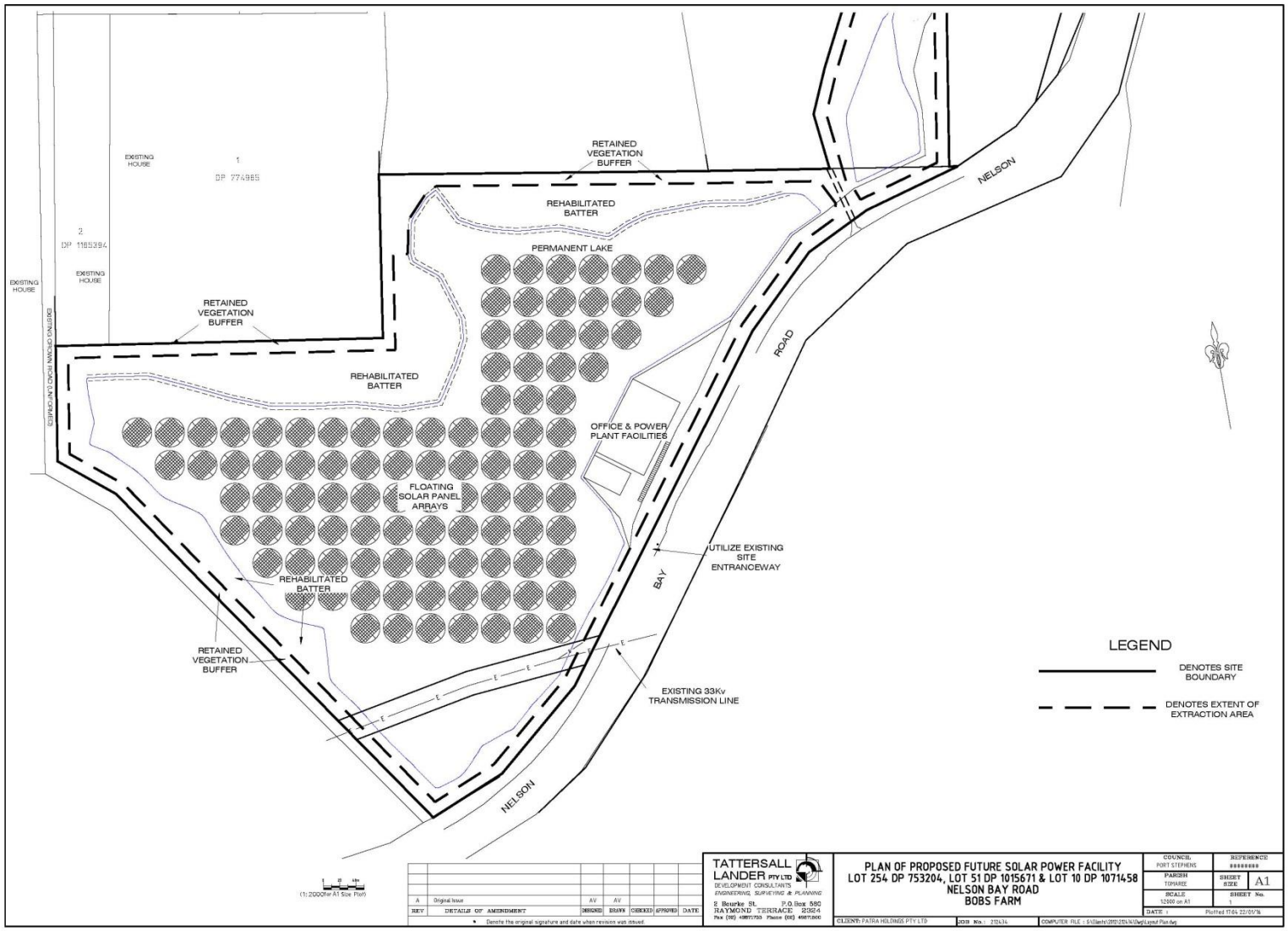


Figure 22.2 - Proposed Floating Solar Farm Option

23 REHABILITATION AND MINE CLOSURE PROTOCOL

It is the intention of this Chapter to provide advice on the intended mine closure process and the staged rehabilitation approach that will be undertaken to ensure that the post mine operations are able to be undertaken without limitations caused by the sand extractions. The mine closure plan will be developed in detail after the commencement of Stage 3 (> 5 years from actual closure) of the Mining Plan with particular emphasis on the intended post mine use of the mining operation.

23.1 OBJECTIVES AND PRINCIPLES

Identification of Stakeholders

For the mine closure plan to effectively work, it will be necessary to have a clear and open discussion with all stakeholders. These stakeholder groups will evolve as the mining operations reach specific targets and stages. Stakholders at the commencement of the mining operations may be still involved at the completion of a mine (>15-20 years time) depending on the performance of the mining operations. Additional stakeholders will be added to the group as the relationship of the operations develop and these additional groups are: -

Initial stakeholders include: -

- Adjoining land owners
- Council
- Local Businesses
- Compliance Agencies
- Aboriginal Groups

Additional stakeholders will include, in addition to the above group: -

- Mining Company employees
- Company Management
- Shareholders, if appropriate.

It will be the intention of the mine closure plan to rigorously identify the stakeholders and set up a formal process of communication with thses groups. Given the proposed mine closure process that will be undertaken with these particular sand mining operations, the final mine closure acts will only involve the decommissionoing of the dredge and the repurposing of the shed operations for either demolition or integration with the post mine activities, potentially as indicated in Chapter 23 above.

Interim rehabilitation works as described below will ensure that only minimal closure works will be required at the end of the mining operations. This incremental approach is ecologically sustainable and will ensure that full liability cost is bourne from operational cashflow.

Planning

The planning for the closure of this particular sand mining operation will see the staged rehabilitation works, refer Table 24.1, commited to and being undertaken. It is the intention of this initial planning to ensure that within 2 years of the completion of Stage 1, the Stage 1 works will be fully rehabilitated. Within 2 years of the completion of Stage 2 works, the rehabilitation of Stage 2 will be completed. Stage 3 works will only relate to the use of a mining dredge and this dredge will only excavate the final, below water profile, as per the relevant reports contained in the ea. The only above ground works that will need to be considered for rehabilitation will be the stockpile area and the operational sheds.

Consideration of the future use of the sheds will be critical in the final costing of these works, but the assumptions that demolition of the shed will be undertaken are included in this plan. The proposed Rehabilitation Plan, refer Figure 24.1 indicates the areas of activity and the proposed extent of works.

As part of the planning aspect for mine closures, the proposed end landuse options indicated in Chapter 23 above, will have some influence on the detail of the actual mine closure documentation. It is considered sufficient to indicate at this early stage that the concept mine closure plan will ensure that the operations will not produce a public health and safety issue, will not require any long-term monitoring of post activity impacts and effectively will negate the need to undertake any maintenance activities post relinquishment.

As part of the planning works for mine closure, the plan will be critically reviewed to ensure that the rehabilitation works are addressed in a timely fashion and that the targeted end of use activities are achievable and financially appropriate.

Mining Stage	Detail of Proposed Rehabilitation Works	Estimation of Required Financial Commitments	Completion of Rehabilitation Works	Comments
1	Rehabilitation of buffer mounds and batter slopes as per Rehabilitation Plans. Stage 1 works will remove all of the sand to 1m above the water table.	Rehabilitation area of 7.83Ha @ $50,000/Ha totals $391,500.	Commencement when practical and completion within 2 years of the end of Stage 1 works	Initially the buffer mounds will be installed and immediately rehabilitated. Batter slopes will then be profiled into their final length and shape and progressively, as the mining face moves, will be rehabilitated.
2	Rehabilitation of batter slopes as per Rehabilitation Plans. Stage 2 works will remove all of the sand between 1m above the water table to 1m below the water table.	Rehabilitation area of 2.08Ha @ $50,000/Ha totals $104,000.	Commencement when practical and completion within 2 years of the end of Stage 2 works	Final batter slopes will then be profiled into their final length and shape and progressively, as the mining face moves, will be rehabilitated.
3	Removal of all stockpiles on site, the decommissioning of the dredge and the potential demolition of the operations shed and facilities or the repurposing of these facilities are required.	Demolition of shed structures and facilities = $30,000. Topsoiling and grassing = $10,000. Bankers Surety to be provided.	Within 1 month of the closure of the dredging operations	Limited requirements are needed for the final stage of the mining operations. No above ground operations, other than topsoiling and seeding with native seed mix or grass will be undertaken other than the removal or repurposing of the nominated structures.

Table 23.1 - Proposed Rehabilitation Works

Financial Provisioning

It is the intention of the mining operations to only provide financial provisioning for the Stage 3 rehabilitation works. The Stage 1 and 2 works will be part on the sand mining operations and cash flow from the mining activities will be targeted to the required rehabilitation works to meet the commitment targets indicated in Table 24.1. Given that the rehabilitation works will be undertaken on a continuous basis after final profiles have been created, the need for substantial provisioning is not considered appropriate or ecologically sustainable. The need to undertake rehabilitation is not negotiable and it will be inherent in all mining plan documentation that the sequential rehabilitation of final profiles will commence immediately that the areas become available for these works. The requirement to have these rehabilitation works undertaken in a timely manner will ensure that the community is fully protected from any closure liabilities.

Implementation

It is the intention of the Mining Plan and Environmental Management Plan to actively pursue the rehabilitation of the operations. Non-compliance with any rehabilitation works would see the Mining Plan be halted and operations cease. Strict compliance with agreed timetables would therefore ensure that the rehabilition works were completed and mining operations continue without any disruptions.

Standards

The expected indicators or completion criteria that will demonstrate compliance with the relevant standards are to be included in the operational EMP and it is expected to indicate that the rehabilitation is acceptable when 90% of the disturbed areas are covered with specific native vegetation types. Given the extent of time between the completion of Stage 2 and Stage 3, all important rehabilitation works required by the Stage 2 operations will have been completed several years prior to the final closure processes that will be undertaken in Stage 3.

Relinquishment

Subject to the compliance with the nominated standards, the responsibility of the mining operations for further rehabilitation works will cease. It is expected that the Department of Industry- Environmental Sustainability Unit, Resources and Energy will be the Agency that overseas the mine closure propotcols.

23.2 RECORDS

It will be a part of the final Closure Plan that all appropriate records will be provided to the Department of Industry. These records will include: -

- Geological records and core logs;
- Plans and final profile surveys of all above and below water landforms;
- Mining production records;
- Relevant records as required by Agencies.

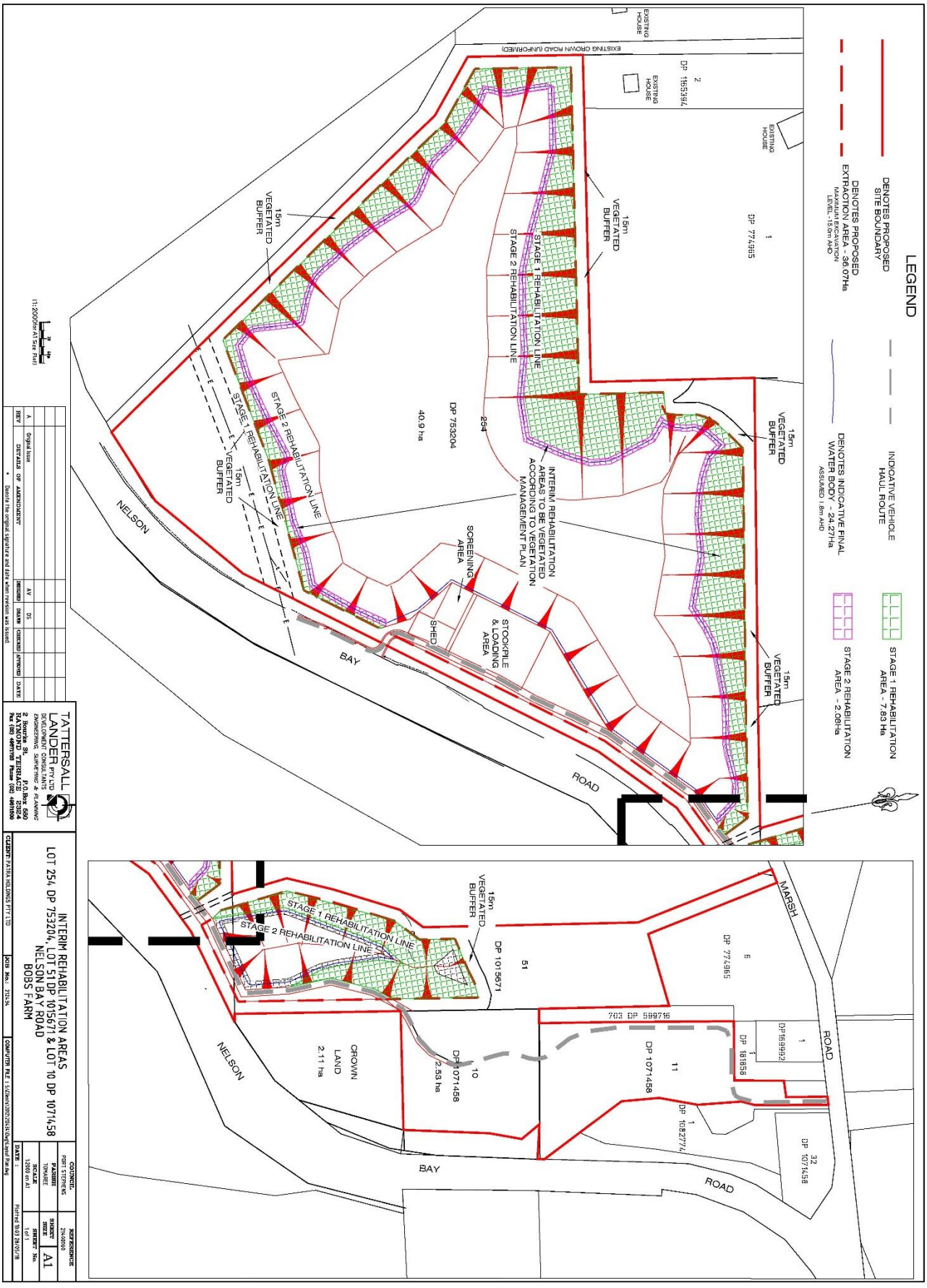


Figure 23.1 - Rehabilitation Areas

24 AGRICULTURAL IMPACT STATEMENT

Chapter 24 provides an assessment of the agricultural impacts of the proposed sand mining operations.

24.1 INTRODUCTION

The purpose of a Level 1 Agricultural Impact Statement (AIS) is to assess the impact of the mining activity on important agricultural resources. The level of detail that a Level 1 AIS should provide is directly related to the potential risk of the activity on the resource. This ea provides significant detail of the expected risks and impacts on noise, water, air quality, groundwater, EEC's and ecology and in all matters, the impact is considered low, below industry trigger values to not significant. Whilst it is proposed to replace 14ha of marginal and effectively non-sustainable agricultural land being used for figs and olives with a sand mine, the impact on agricultural resources within the region is marginal and the impact locally is non existant.

The subject site is located in the Port Stephens Local Government Area. This area is known for its tourism and waterways. There are limited agricultural activities in the LGA, however, generally the soil quality is poor.

The subject site comprises approximately 52.5 hectares located at Bobs Farm (Lots 254, 10, 11, and 51 in respective DPs 753204, 1071458, 1071458, and 1015671) in the Port Stephens Local Government Area. The site is currently used for minimal agriculture (fig and olive production), with approximately 9.6ha being used for this agricultural purpose; the remainder of the site is comprised of native forest and partially cleared pasture of around 4.0ha– the pasture is not currently used for agricultural purposes.

The following principles are involved when planning for sustainable agriculture and extractive industries:

Extractive industry developments are consistent with strategic plans and zone objectives.

a. *Extractive industry developments are designed and managed to minimise environmental impacts.*

   The proposed sand mine has been investigated with respect to its impacts on the environment, groundwater and flora and fauna. The assessment has concluded that the impact is not significant.

b. *Land use conflicts are minimised, amenity values are protected and the expectations of local communities are managed.*

   Landuse conflicts are expected to be low as the mine site cannot be viewed from any part of the adjoining properties. Amenity values have been assessed as low and the proposal will be hidden from any public viewing of the operations.

c. *Rehabilitation is undertaken progressively and any permanent changes to productive capacity are clearly justified.*

   Rehabilitation will be undertaken progressively. The productive capacity of the land will change from a fig and olive farm, through a mining phase and into an alternative operation that have been discussed in Chapter 22 above.

d. *Proposals are clearly justified in a regional context and identify the merits and community benefit of the proposal.*

The fig and olive farm is a marginal operation that has no capacity to expand. The sand mine provides an operation that generates significant employment and investment in the local communities. The sand mine will provide tangible matteral public benefit with minimal impact.

e. *Development Applications duly consider the following potential impacts and identify suitable mitigation responses for:*

- *Impacts on agricultural resources;*

  Previous advice in 2000 from the DPI raised issues on the economic viability of the fig and olive farm and the poor-quality soils that were deficient in many important agricultural elements and nutrients needed for a sustainable agricultural crop. This DPI position was provided as part of the original application to clear native vegetation for the fig and olive operation. Climate conditions were also not considered favourable. Whilst these predictions have been proven to have been generally correct, some 15 years later, the realisation that the land is not quality agricultural land has been established and it means that any impact on the agricultural resource is minimal.

- *Transport and access changes;*

This matter has been addressed in Chapter 15 above.

- *Rehabilitation plans;*

  These will be prepared as part of the site EMP.

- *Consultation with rural stakeholders;*

  Public consultation has commenced and will continue with the processing of this Application. It is envisaged that both Agency and local stakeholder consultation will be a part of the overall mining plan and EMP.

- Mitigation and monitoring

  All parts of the necessary environmental mitigation and monitoring will be undertaken, refer Chapter 25.

24.2 DETAILED ASSESSMENT OF THE AGRICULTURAL RESOURCES AND POTENTIAL OF THE AREA

Soils

The soils of the site are windblown and dunal sands with both coarse and fine grains; these sands have less than 0.5% organic content with a top soil of 100mm. These soils are of minimal use for agricultural purposes. These figures have been obtained through a QMS on site geotechnical survey.

Further soil detail is not considered necessary for the purpose of this AIS as it is clear that the soils are of poor quality from an agricultural perspective and would require substantial improvements to sustain any agricultural enterprise.

Slope and land characteristics

The site is best described as undulating (refer Figure 23.1 below for 10 metre contour maps). The site is not identified as Biophysical Strategic Agricultural Land (BSAL) – BSAL is defined as land with high quality soil and water resources capable of sustaining high levels of productivity. The NSW Department of Planning and Environment map identifies that this site is not BSAL.

It is noted that for a site to be classified as BSAL, the following is required:

a. Access to a reliable water supply (either annual rainfall of 350mm or more, or a regulated river within 150m, or a 5th order or higher unregulated river within 150m, or highly productive groundwater sources as declared by the NSW Office of Water), and

b. Land which is classed as High or Moderately High with regard to fertility under the Draft Inherent General Fertility of NSW (OEH), where it is also present with land capability classes I, II, or III under the Land and Soil Capability Mapping of NSW (OEH), or

c. Land which is classed as moderate fertility under the Draft Inherent General Fertility of NSW (OEH), where it is also present with land capability classes I or II under the Land and Soil Capability Mapping of NSW (OEH).

The Port Stephens LGA is dealt with on BSAL maps 46 and 47 (refer Figures 23.2 and 23.3 below). Figure 23.4 (below) identifies the land capability classes (Land and Soil Capability Mapping of NSW) of which the subject site is identified as Class 7. Class 7 is identified as having extremely severe limitations. Land incapable of sustaining most land uses. Limitations cannot be overcome. The Inherent Fertility of Soils in NSW (refer Figure 5 below) identifies this site as Low and Moderately Low.

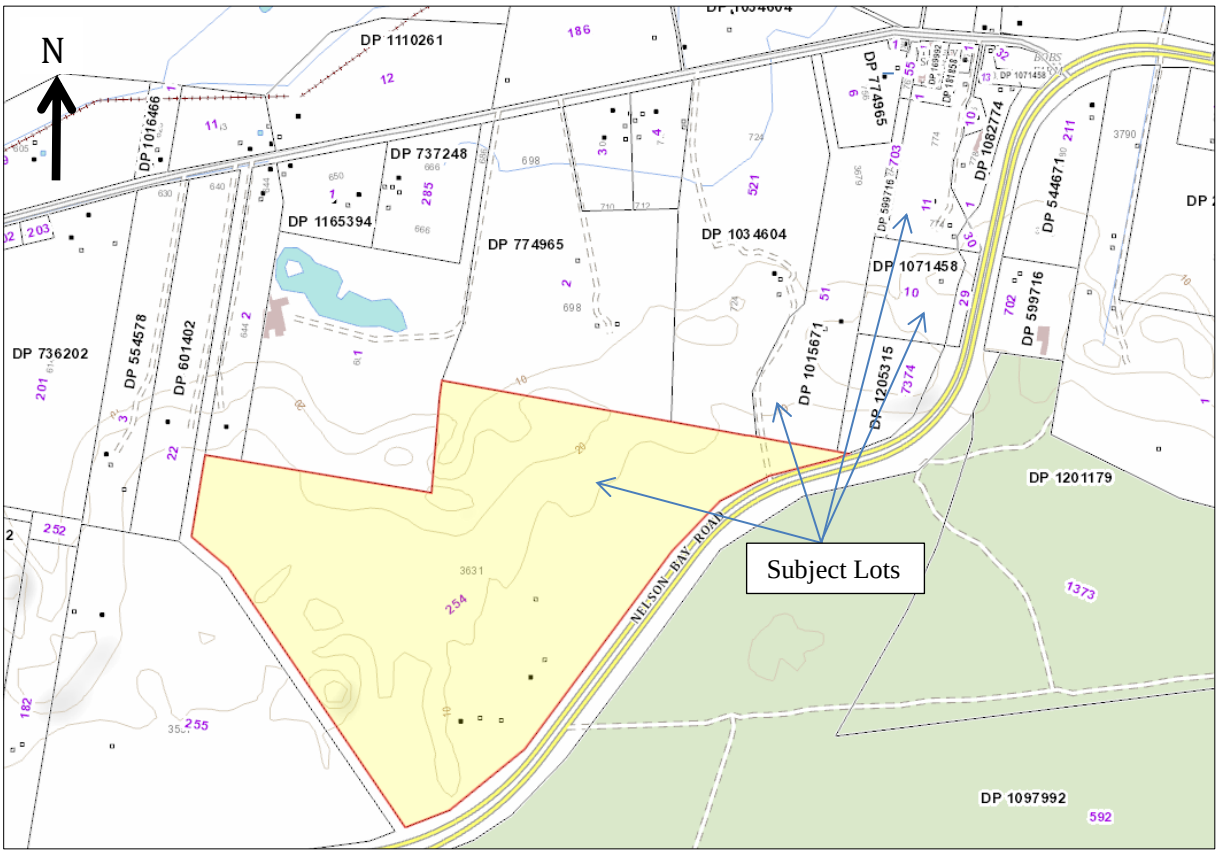


Figure 24.1 - Topographic Map

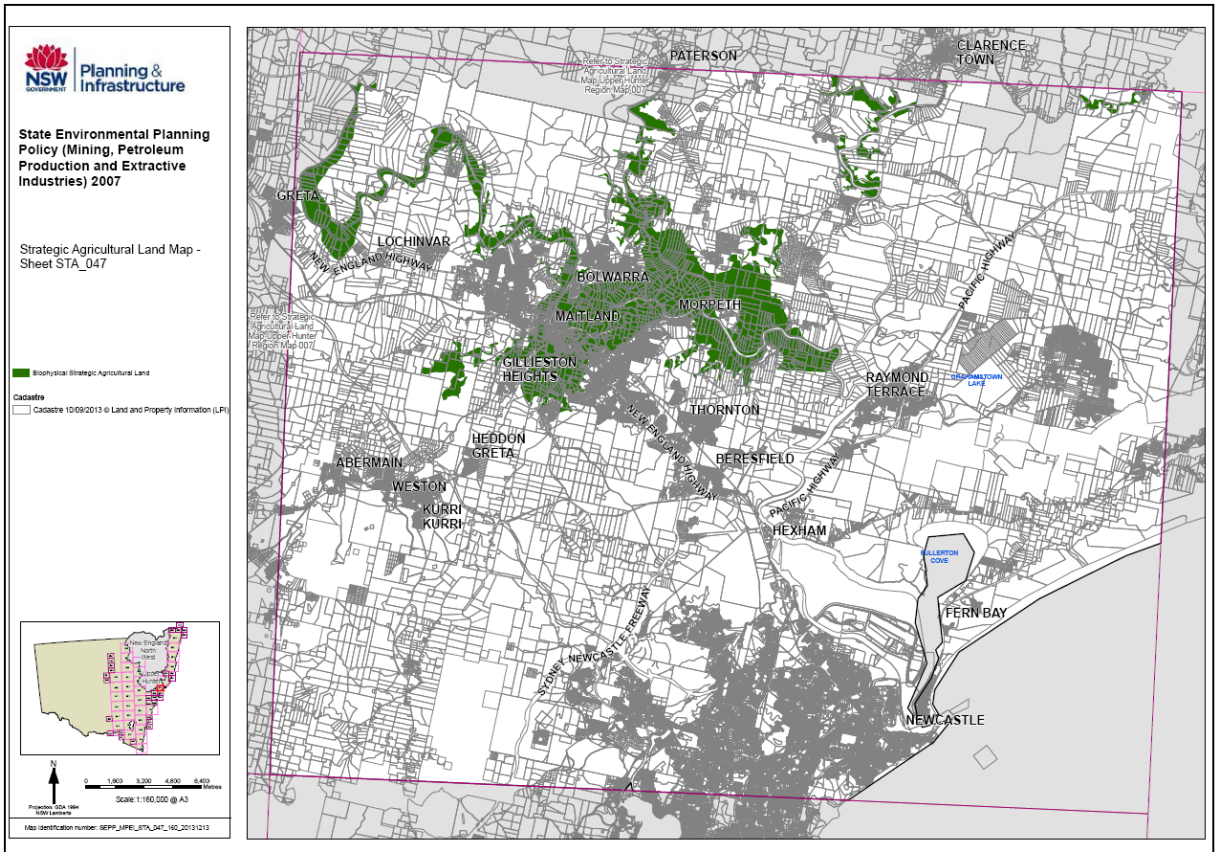


Figure 24.2 - BSAL Map 46

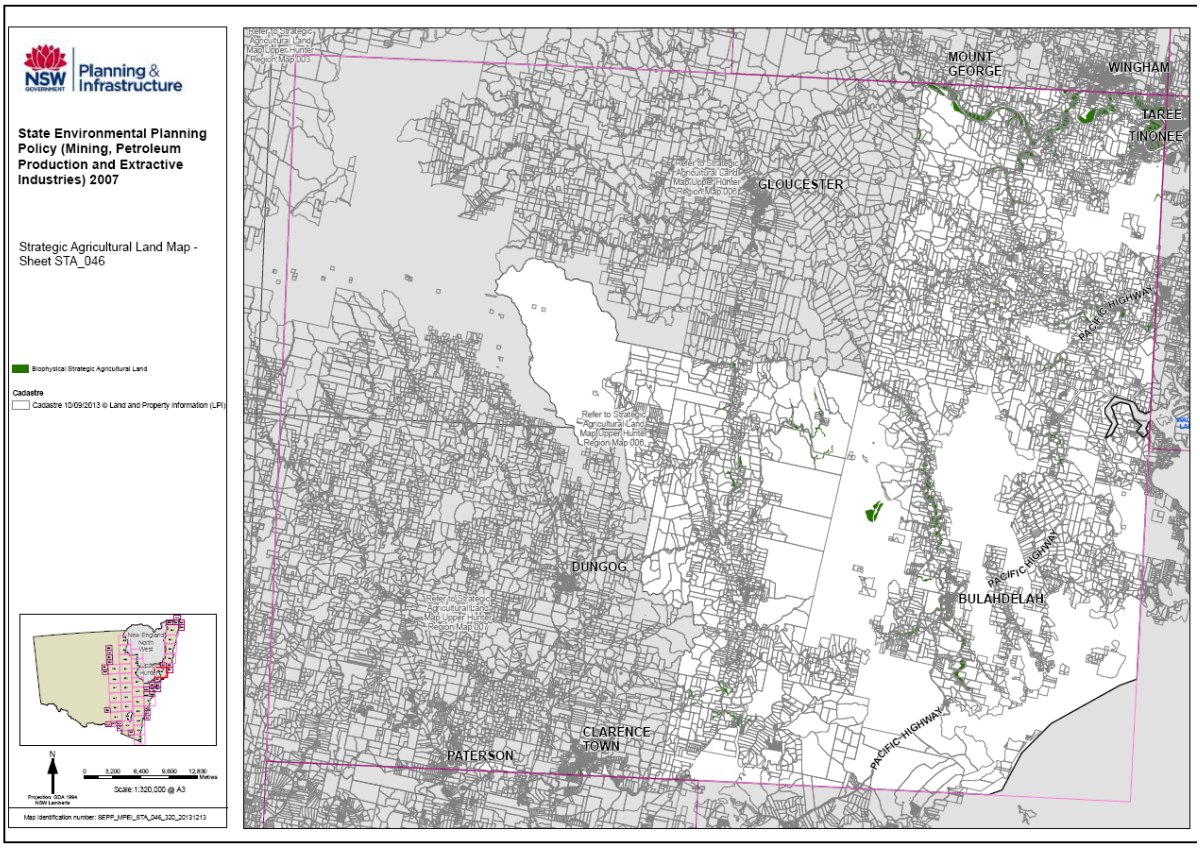


Figure 24.3 - BSAL Map 47

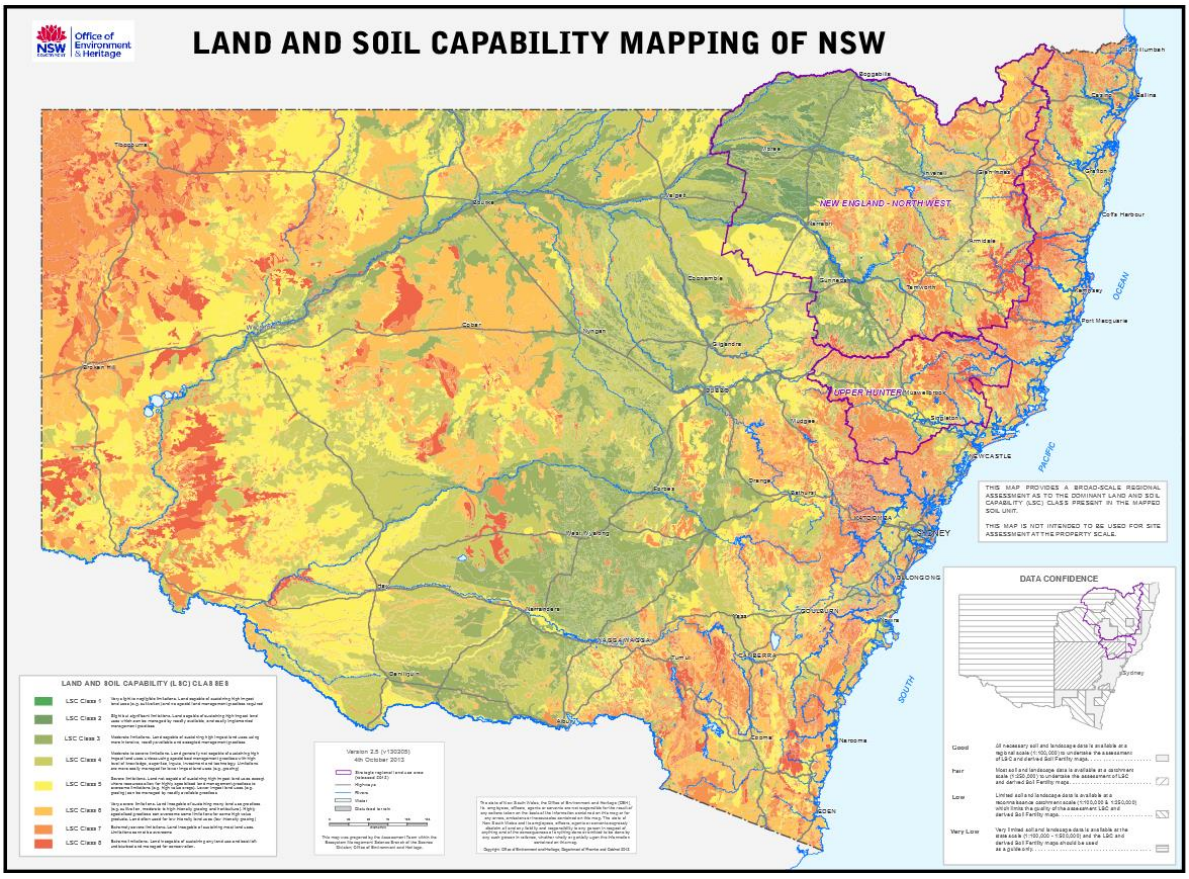


Figure 24.4 - Land Capability

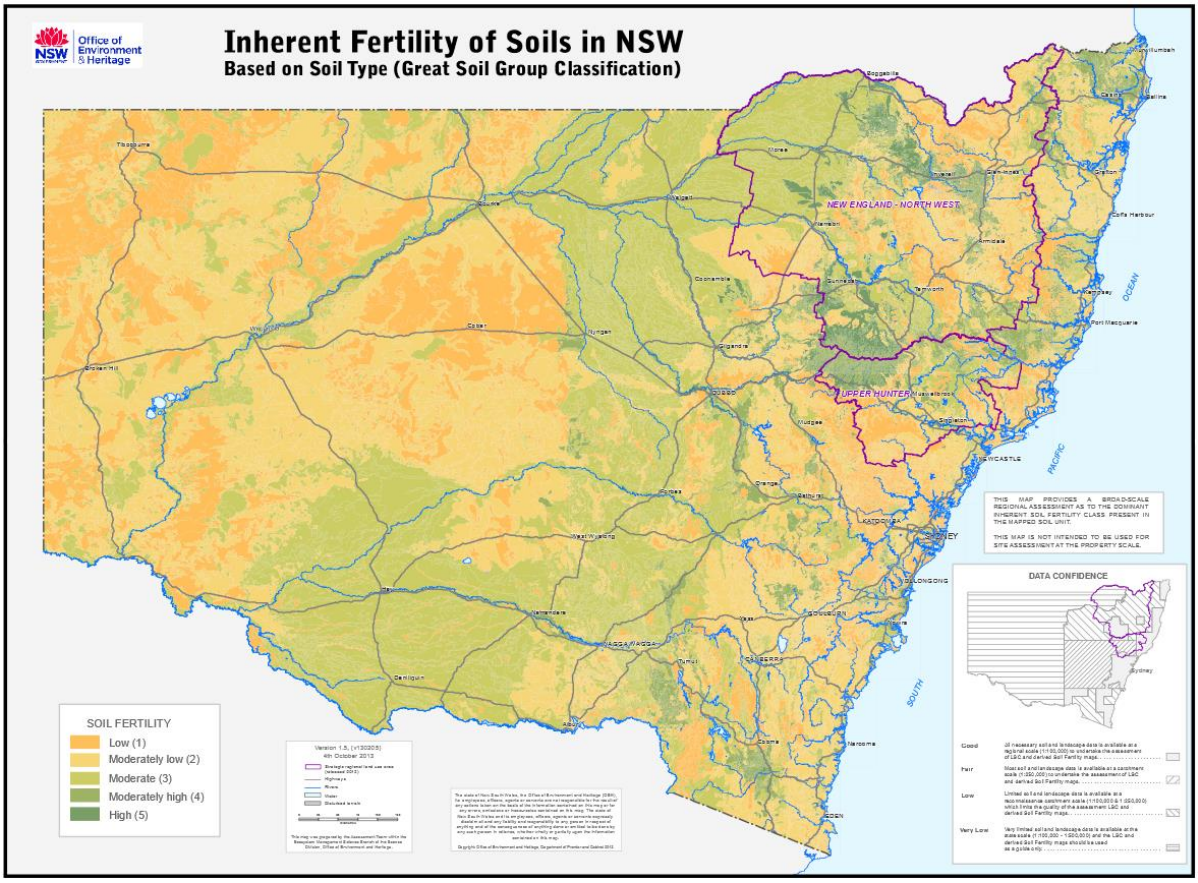


Figure 24.5 - Inherent Fertility Soils

24.3 HISTORY OF AGRICULTURAL ENTERPRISES ON THE SUBJECT SITE

The only agricultural enterprises to have been on this site are the current olive and fig growing operation and this has been in operation for approximately 14 years. The current agricultural activities on the site include the following trees:

- Olives – started with 980, now 440, due to removal as a result of die back (Abequina), failure to fruit (Kalamata), and inconsistent fruiting (Manzanillo). The average yield from the olives is 2 – 3 tonnes per year.

- Figs – 720 plants made up of 120 Black Genoa, 300 Brown Turkey, and 300 White Adriatic. The figs have proved problematic due to too much rain at times which has caused the fruit to split, as well as nematodes effecting the root systems of the trees which is resulting in frequent replacement being required.

Staff numbers for the operations are difficult to quantify as this is predominantly a family operated business with family members assisting when possible. In addition, the figs are largely picked by drive by customers. There is one part time employee.

The current agricultural operation has an annual turnover of $40,000 per annum.

24.4 AGRICULTURAL USES ON SURROUNDING LAND

There are currently no significant agricultural enterprises on immediately adjoining lands. There are some minor agricultural pursuits being undertaken on small lots in the vicinity, however, most of these are considered not to be profitable or marketable enterprises. These enterprises consist predominantly of small scale vegetable and fruit growing.

24.5 WATER RESOURCES

The site is located on the Tomago Sandbeds which is an important water resource for the Hunter region. Consultation with the NSW Office of Water will ensure that this resource is adequately protected.

24.6 VEGETATION

As mentioned above, the site has significant quantities of native vegetation; accordingly, an ecological assessment shall be prepared and lodged as part of the EIS package to address this issue.

24.7 CLIMATIC CONDITIONS

The mean climatic conditions are tabulated below. These statistics have been obtained from the Australian Government Bureau of Meteorology website and are based on statistics taken from 1942 to the current time (2014).

	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Mean Max. Temp.	28.1	27.6	26.3	23.7	20.3	17.7	17.1	18.7	21.4	23.6	25.5	27.2
Mean Min. Temp.	18	18.1	16.3	13.2	10.0	7.9	6.4	6.8	9.1	11.9	14.4	16.5
Mean Rainfall	96.6	121.4	120.2	107.5	113.0	121.3	73.3	75.2	59.3	73.4	84.1	78.7

Table 24.1 - Mean Climatic Conditions

Whilst the Technical notes call for other measurements including frost frequency, humidity, soil temperature, wind speed and direction, it is considered that these are not necessary as the limiting factor in this location for agricultural activities is the poor soils. It is not being argued that the climate is not suitable (although it is a fact that it may not be suitable for some crops due to high humidity (eg wheat) or insufficient rainfall (eg rice)).

24.8 LAND USE POST MINING

It is anticipated that at the end of the mine life the site will either be partly rehabilitated with native vegetation or some other alternative uses as a tourist development or even a solar energy farm. There is no plan to use any of the site for agricultural purposes after the proposed mining operations as the situation with regard to the poor-quality soils will remain.

24.9 ASSESSMENT OF IMPACTS

Agricultural

Given the limited agricultural activities in the immediate area it is considered that there will be negligible impacts on existing agricultural activities. The current agricultural activities on the site are considered to be unsustainable.

As a result of the poor soils in the location and surrounding area, it is considered that there are no viable future agricultural activities which the proposal may otherwise impact upon.

Social

It is considered that the proposal will have no social impact.

Economic

It is considered that the proposal is the best suited for the site in terms of economic benefit to the community as a result of employment and capital expenditure.

Amenity

The proposal will have a minor short-term impact upon the local amenity, however, so too would clearing for agricultural pursuits. Discussions with the relevant authorities will result in agreed methods to be implemented in order to reduce the impact on the local amenity which shall arise from the proposed activities.

Project Alternatives

With regard to project alternatives, the possible uses for the site and the reason they have been rejected include:

Agriculture – The soil is of extremely poor quality (as outline above) and hence significant soil improvements would be required which makes this option unfeasible.

Subdivision – anything other than minor boundary realignments are prohibited by the zoning.

It is considered that the best use for this site on an economic basis is that of the proposed sand mine.

24.10 CONCLUSION

It is noted that this AIS does not address all of the points identified in the Agricultural Impact Statement technical notes (NSW Dept. of Primary Industries, 2013) and the reason for this is that many of the points in this document refer to land with agricultural value. It is further noted that a complete copy of the EIS will be made available to the NSW Department of Primary Industries along with all the other relevant government bodies.

Whilst there will be an effective reduction in agricultural land as a result of this proposal, it is noted that in reality this "agricultural land" has next to no value for such a purpose and as such, it may be stated that realistically, there will be no loss of valuable agricultural land.

It is concluded that the scale of the impact on viable agricultural land on the site and including adjoining properties is not significant.

25 CUMULATIVE IMPACT ASSESSMENT

Chapter 25 provides an assessment of cumulative impacts of the proposal and any other existing or approved activities in the area.

Cumulative impacts are those impacts likely to arise from the interaction of the project activities and associated operations with other significant projects and activities in the area. This assessment is in accordance with the requirement to consider "any cumulative environmental effect with other existing or likely future activities" in Part 14 Division 1 Clause 228(o) of the EP&A Act.

Bobs Farm is a quiet rural locality containing a small primary school, Community Hall and approximately 30 rural type residences over an area of 1km^2 and a tourist facility (Go-Karts), a Shark Aquarium and some small businesses. There are no significant projects or activities in the area. There are no known approved or planned new intensive activity developments in the area.

The Bobs Farm locality has remained generally underdeveloped since its original occupation in the 1870/80's. The Bobs farm locality is not too dissimilar for the expectations for this mining operation to the Oyster Cove Village some 5km to the north and on the Tilligerry Peninsula. The Oyster Cove sand mining operation that has existed in harmony with the adjoining residences in that location for many years.

There are no activities operating in the locality that would cause cumulative environmental impacts in conjunction with the proposed mining operation. The potential environmental impacts have been assessed with respect to factors including noise, air quality, Aboriginal and European heritage, surface water and groundwater conditions, traffic, waste generation and visual amenity. There are no other activities that would be likely to increase the social or economic impacts of the proposal by virtue of cumulative impacts.

Ecological investigations undertaken by Wildthing (*Annex N*) found that the proposal is unlikely to reduce the long-term viability of any local populations of endangered species or endangered ecological communities considered, or to accelerate or place any species, population or ecological community at risk of extinction. The loss of native vegetation is to be offset by the protection and conservation of additional "offset" lands. There are no other activities being undertaken at or near the site that would increase the cumulative impacts of the proposal on native fauna, flora or endangered ecological communities.

Based on the assessment of individual environmental, social and economic issues throughout this EIS and the lack of other activities in the area that could cause cumulative impacts in conjunction with the proposal, it is considered that the potential impacts of the proposal have been thoroughly assessed and are acceptable.

26 MITIGATION MEASURES

Chapter 26 provides a summary of the proposed measures and actions that would see the operations of this sand mine be undertaken so that minimal impact on the environment and surrounding residences would be achieved. This summary would also form the basis of aN EMP for the sand mine.

The details of Chapter 26 are summarised in Table 26-1.

The Bobs Farm Sand Mine will be an industry best practice operation that will be committed to the highest level of environmental and operational control. The following table provides a list of the commitments and includes all of the proposed ongoing community consultation for the life of the project.

Issue	Management/Mitigation Measure
Noise & Vibration	Construction and maintenance of acoustic barriers, walls and bunds, as per the Noise Assessment.
	No haulage truck movements prior to 7am.
	Limitations of 180 truck movements per day in the worst-case weather conditions
Air Quality	General Dust Control Measures to include stockpile watering or screening, low silt gravels or sealing used on haul roads, wheel washes or shaker bars on exit roads.
	Implementation of an Air Quality Management Plan
	Installation of a TEOM machine and weather station on site
Ecological	Provision of compensatory habitat (Offsetting)
	Protection of remaining habitat/vegetation
	Protection of Fauna during vegetation removal
	Provision of mitigation measures for affected species
	Rehabilitation of extraction area
	Monitoring of groundwater levels and groundwater dependent ecosystems within proximity of the sand mine.
	Active control of extraneous noise and artificial lighting
Traffic	Upgrading of Marsh Road from the exit location to the RMS constructed turning bay.
	Truck movements will be prohibited from turning left onto Marsh Road.
	Truck movements will turn left onto Nelson Bay Road and U-turn at the roundabout at Port Stephens Drive.
Water	A Water Management Plan will be prepared to focus on inspections, monitoring of water quality treatment structures, a contingency and response plan, reporting and auditoring
	Generated sewage will be collected and reticulated by a secondary sewage treatment system.
	Implementation of a Groundwater Management Plan with monitoring data presented in an annual report to Council.
Aboriginal Heritage	A management strategy be included in an Aboriginal Cultural Heritage Management Plan in consultation with relevant stakeholders
	A comprehensive archaeological salvage program will be undertaken prior to ground clearance works within the native vegetations areas.
	Inspections of stockpiled samples of reject screen material will be available to RAPS on a monthly basis for the first 12 months of active mining.
Historic Heritage	A project Environmental Management Plan is to include contingency policies for the management of unexpected finds and skeletal remains.
Visual	Acoustic bunds are to be vegetated as they are constructed
	Rehabilitation of the progressive final landform profiles is to be in accordance with the Mine Closure Plan.

Issue	Management/Mitigation Measure
Social Impact	A social impact monitoring program will be developed and will include methodologies to mitigate any impacts.
	Ongoing dialogue with local residents will be undertaken on a regular basis via the following: • Creation of a Community Consultative Committees • Dedicated phone hot lines for regulation, compliance and emergency matters • Community events (e.g. charity fundraisers) • Community information sessions • Annual community reports • Annual dialogue with neighbours: formal and informal
Waste	General Non-recyclable waste will be transferred to a Registered Facility.
	Recyclable waste will be transferred to a Resource Recovery Facility.
	Chemical Containers will be removed in accordance with approved methods.
	Organics will generally be used on site. Excess organics will be transferred to appropriate processing facilities.
	Screened tailings will be used onsite or incorporated in products to be used by others.
Bushfire	Management of separation distances, ignition sources, development of emergency planning procedures.
	Provision of a separation distance (minimum of 10 m) between stockpiles of combustible material and remnant vegetation
	Emergency planning procedures in the event of a fire occurring on the site
	Fitting of earth moving machinery with spark arresting mufflers.
	Haul trucks to have serviceable exhaust systems to prevent accidental ignition of vegetation
	Training of onsite personnel with the use of fire extinguishers and water carts.
	Managing operations and the site to minimise likelihood of ignition sources through good 'housekeeping' (for example, all waste in bins to be emptied on a regular basis)
	Equipping the operations to assist in the management of any fires on-site, including presence of fire extinguishers, water cart (as contracted), and the site front-end loader and bulldozer for any requisite fire fighting purposes

Table 26.1 - Project Statement of Commitments: Management/Mitigation Measures

26.1 HERITAGE

Historical Heritage

The expected direct impacts on historical heritage is negligible as no sites were identified during the relevant searches. It is possible that some physical historical evidence from the Bobs Farm Cadre Camp may have not been removed when the camp was abandoned so the proposed Unexpected Finds Policy will be included: -

The following procedure guides the management of any unexpected historic heritage finds encountered the course of sand mining operations outside of the scope of works covered by the Bobs Farm Cadre Camp. Finds include artefact scatters (glass, animal bone, ceramic, brick, metal etc), building foundations and earthworks of unknown origin (i.e. not associated with mining operations):

- *All work in the area is to cease immediately;*

- *Alert the Environmental Manager to the find;*

- *If necessary, protect the area with fencing;*

- *Engage a suitably qualified archaeologist to undertake an assessment of the finds;*

- *The assessment should be undertaken using the guidelines Assessing Significance for Historical Archaeological Sites and 'Relics' (NSW Heritage Branch 2009);*

- *On the advice of the archaeologist, if necessary, prepare an Impact Assessment and Research design and methodology to submit to the Heritage Branch for a Section 140 excavation permit or exception;*

- *Undertake the archaeological mitigation in accordance with the prepared documents and the permit/exception issued by the Heritage Division; and*

- *Once the site has been mitigated to the satisfaction of the archaeologist and the Heritage Branch, works may resume in the area.*

As regards the procedures for the finding of human remains, the procedure takes into account the following documents: -

- *Burials - Exhumation of Human Remains NSW Health Policy Directive PD2008_022 (NSW Health 2008) available at :* http://www.health.nsw.gov.au/policies/pd/2008/pdf/PD2008_022.pdf

- *Manual for the Identification of Aboriginal Remains (NSW Department of Environment & Conservation 2006);*

- *Skeletal Remains – Guidelines for the management of human skeletal remains under the Heritage Act 1977 (NSW Heritage Office 1998); and*

- *The Aboriginal Cultural Heritage Standards and Guidelines Kit (NSW National Parks and Wildlife Service 1997).*

In the event that development or operations reveal possible human skeletal material (remains), the following procedure is to be followed:

- *When suspected human remains are exposed, all construction work is to cease immediately in the near vicinity of the find location and the General Manager on site is to be immediately notified. The General Manager will contact the Police at the earliest reasonable time;*

- *An area of 5 m radius is to be cordoned off by temporary fencing around the exposed human remains site - work can continue outside of this area as long as there is no risk of interference to the human remains or the assessment of human remains. Assessment of risk may utilise the risk matrix provided within the NSW Health Policy directive on the exhumation of human burials;*

- *Contact the OEH Environment line on 131 555 and the Heritage Division on 02 9873 8500; and*

- *A physical or forensic anthropologist should be commissioned by Ammos Resource Management to inspect the remains in situ (unless otherwise directed by the police), and make a determination of ancestry (Aboriginal or non-Aboriginal) and antiquity (pre-contact, historic or modern);*

    - *if the remains are identified as modern the area is deemed as crime scene; or*

- *if the remains are identified as Aboriginal, the Environmental Specialist will notify OEH and representatives of the local Aboriginal community and appropriate management measures will be determined through consultation with them. Representatives of the Aboriginal community will be present during all investigations of Aboriginal remains; or*

- *if the remains are as non-Aboriginal (historical) remains, the site is to be secured and the Heritage Division is to be contacted.*

This process functions only to appropriately identify the remains and secure the site. From this time, the management of the area and remains are to be determined through one of the following means:

- *If the remains are identified as a modern matter, liaise with the police and/or the Coroner's Office and/or NSW Health with respect to the exhumation of the remains;*

- *If the remains are identified as Aboriginal, liaise with OEH and Aboriginal stakeholders;*

- *If the remains are identified as non-Aboriginal (historical), liaise with the Heritage Division; and*

- *If the remains are identified as not being human then work can recommence without delay.*

Aboriginal Cultural Heritage

The expected direct impacts on Aboriginal Cultural Heritage have been identified with some scattered deposits being recorded. The proposed management strategy will be undertaken as per the recommendations.

26.1.1.1 Archaeological Salvage Program

A comprehensive archaeological salvage program should be undertaken within the Project area prior to the commencement of any Project-related ground clearance works. Should Ammos Resource Management wish to proceed with the salvage of any identified sites prior to Project and ACHMP approval, an Aboriginal Heritage Impact Permit (AHIP) will need to be applied for and granted by OEH.

The archaeological salvage program for the Project should incorporate the following components:

1. Surface collection of newly identified shell scatter sites BF-SC1-14, BF-SC2-14 and BF-SC3-14, all of which have been assessed as being of low scientific significance. Surface collection is considered an appropriate and effective mitigation option for these sites given their contents and significance. Surface collection should occur prior to the commencement of ground disturbance works in their vicinity.

2. Surface collections and archaeological excavations at newly identified shell scatter sites BF-SC4-14 and BF-SC5-14, which have been assessed as being of moderate scientific significance. Archaeological excavations at both sites should initially involve test excavations. Salvage (i.e., open area) excavations should only be undertaken if high density concentrations of archaeological materials (i.e., shell, flaked stone artefacts or animal bone) and/or suspected/definitive archaeological features such as hearths are identified during test excavations.

The ACHMP for the Project should include a detailed research design and methodology for the surface collection and excavation components of the salvage program.

All archaeological salvage works should be undertaken by a combined field team of archaeologists and RAP field representatives. Post-salvage work for the surface collection and excavation components of the archaeological salvage program should, at minimum, include:

- the analysis and cataloguing of all recovered Aboriginal objects by a suitably qualified specialist or specialists;

- the submission, where deemed appropriate by a qualified archaeologist and/or geomorphologist, of excavated charcoal and/or shell samples for conventional or Accelerator Mass Spectrometry (AMS) radiocarbon dating. No more than three samples will be submitted for analysis from each site;

- the submission, where deemed appropriate by a qualified archaeologist and/or geomorphologist, of excavated sediment samples for Optically Stimulated Luminescence (OSL) dating. No more than three samples will be submitted for analysis from each site;

All Aboriginal objects salvaged as part of the archaeological salvage program should be curated in an appropriate manner, as determined through consultation with RAPs, OEH and DP&E during preparation of the ACHMP. Temporary off-site storage of salvaged objects should be allowed for the purposes of analysis and recording.

Aboriginal Site Impact Recording (ASIR) forms for all salvaged sites should be submitted to OEH at the completion of the salvage program.

26.1.1.2 RAP monitoring of vegetation clearance activities

Sand mining operations within the Project area cannot be undertaken without impacting stabilised soil profiles associated with the Ridge I transgressive dune sheet. In view of the demonstrated archaeological sensitivity of these soil profiles, both on a local and regional scale, a program of archaeological monitoring by RAPs should be undertaken during vegetation clearance activities. RAPs should be provided with the opportunity to visually inspect all areas selected for vegetation clearance throughout the life of the Project. For occupational health and safety reasons, inspections in each area should be completed upon cessation of undergrowth clearance activities.

Any surface archaeological materials identified during visual inspections should be collected in accordance the research design and methodology developed for the archaeological salvage program. In addition, if high density concentrations of archaeological materials (i.e., shell, flaked stone artefacts or animal bone) and/or suspected/definitive archaeological features such as hearths are identified, test excavations should be undertaken to characterise the identified materials/feature(s) and to determine the requirement for salvage excavations. Archaeological excavations, in all instances, should be carried in accordance with the research design and methodology developed for the archaeological salvage program. Criteria for the commencement of salvage excavations at test-excavated locations should be incorporated into the ACHMP.

26.1.1.3 Inspection of Stockpiled Samples of Reject Screen Material

Ammos Resource Management should ensure that RAPs are provided with the opportunity to inspect stockpiled samples of reject screen material from sand mining operations within the Project area. Inspections of stockpiled samples should occur on a monthly basis for the first 12 months of active operations. Should RAPs identify significant quantities of Aboriginal archaeological materials (i.e., flaked stone artefacts, shell, animal bone) within inspected samples (as determined by RAPs in consultation with a qualified archaeologist), Ammos Resource Management should facilitate, as soon as practicable, a RAP inspection of the source area(s) of this material. If high density

concentrations of archaeological materials and/or suspected/definitive archaeological features (e.g., hearths) are identified in these areas, the requirement for salvage (surface and/or subsurface) of these materials/features should be discussed between Ammos Resource Management, RAPs and a qualified archaeologist. If salvage is deemed warranted, salvage activities should be completed in accordance the research design and methodology developed for the archaeological salvage program.

26.1.1.4 AHIMS site cards

AHIMS site cards should be submitted to OEH in a timely fashion for all newly recorded Aboriginal archaeological sites within the Project area. In the event that a previously unidentified Aboriginal site is discovered within the Project area at any point during the life of the Project, an AHIMS site card for that site should be submitted to OEH as promptly as possible. Timing protocols for the submission of AHIMS site cards should be included in the ACHMP for the Project.

26.1.1.5 Previously unrecorded Aboriginal archaeological sites/materials

Provisions regarding the appropriate management action(s) for any previously unrecorded Aboriginal archaeological sites/materials identified within the Project area throughout the life of the Project should be incorporated into the ACHMP. Management action(s) will vary according to the type of evidence identified, its significance (both scientific and cultural) and the nature of potential impacts.

26.1.1.6 Human Skeletal Remains

In the event that potential human skeletal remains are identified within the Project area during the development and operational phases of the Project, the following standard procedure, to be detailed in the ACHMP for the Project, should be followed.

1) All work in the vicinity of the remains should cease immediately;

2) The location should be cordoned off and the appropriate authorities notified; and

3) A physical or forensic anthropologist should be commissioned to inspect the remains in situ and make a determination of ancestry (Aboriginal or non-Aboriginal) and antiquity (pre-contact, historic or modern).

Subsequent management actions will be dependent on the findings of the inspection undertaken under Point 3.

- If the remains are identified as modern and human, the area will become a crime scene under the jurisdiction of the NSW Police;

- If the remains are identified as pre-contact or historic Aboriginal, the site will be secured and OEH and all RAPs notified in writing. Where impacts to exposed Aboriginal skeletal remains cannot be avoided, remains will be retrieved via controlled archaeological excavation and reburied outside of the Disturbance Boundary in a manner and location determined by RAPs;

- If the remains are identified as historic non-Aboriginal, the site is to be secured and the NSW Heritage Branch contacted; and

- If the remains are identified as non-human, work can recommence immediately.

26.1.1.7 Aboriginal Cultural Heritage Awareness Training

An Aboriginal cultural heritage awareness training package should be developed for use throughout the life of the Project. This package should be developed in consultation with RAPs and completed prior to the commencement any ground disturbance works within the Project area. A register of all persons having completed the training package should be maintained throughout the life of the Project.

Aboriginal cultural awareness training should be mandatory for all staff and contractors whose roles may reasonably bring them into contact with Aboriginal sites and/or involve consultation with local Aboriginal community members. Training should also be offered on a voluntary basis to all other mine staff and contractors.

Ammos Resource Management should ensure that as part of all standard site inductions, an Aboriginal cultural heritage component is included. At a minimum, this should outline current protocols and responsibilities with respect to the management of Aboriginal cultural heritage within the Project area, provide an overview of the diagnostic features of potential Aboriginal site types (e.g., scarred trees) and procedures for reporting the identification of Aboriginal archaeological sites.

26.1.1.8 Reporting under the ACHMP

All Aboriginal heritage management and mitigation works carried out under the ACHMP for the Project should be documented to a standard comparable to that required by the Code of Practice for Archaeological Investigation of Aboriginal Objects 2010 (DECCW 2010a). Printed and/or digital copies of all archaeological salvage reports (plain English and technical) should be made available to RAPs upon request.

26.1.1.9 Periodic Review of ACHMP

The ACHMP for the Project should be subject to periodic review to ensure that all management policies are being adhered to and are working effectively. Periodic reviews will also provide an opportunity to make modifications to existing policies and to add, where appropriate, new policies.

26.2 GROUNDWATER

Groundwater will be monitored over the life off the mining project, with the following arrangements: -

Groundwater Level

Groundwater level should be monitored at weekly intervals, or preferably continuously via data logger at 5 bores throughout the life of the development. Until such time as the replacement bores are constructed, the five existing bores should be monitored by data logger.

Groundwater Quality

26.2.1.1 Background Levels and Parameters

Groundwater quality should be sampled quarterly at five bores throughout the life of the development. Until such time as the replacement bores are constructed, the five existing bores should be monitored.

Samples should be analysed for the following:

- Total Nitrogen
- Nitrogen sub-species
- Total Phosphorus
- Hydrocarbons
- pH
- EC
- Manganese
- Arsenic
- Chromium
- Cobalt
- Zinc

26.2.1.2 Trigger Values

Trigger values for the analytes listed in Section 14 will be determined prior to commencement of mining based on 2 standard deviation over the observed mean value of background data at both the existing and proposed bores.

26.2.1.3 Action Requirements

Action will be required if trigger values are exceeded. Action will involve the following:

- Site owner to engage a suitably qualified professional to provide advice.
- Reviewing the data in light of environmental/climate conditions.
- Determine if further investigation is warranted.
- Spatially identify key areas requiring action.
- Determine appropriate action based on circumstances in consultation with Council and NSW DECCW.
- Undertake action.

Reporting

All monitoring data is to be presented in an annual report that will be forwarded to Council. Council and NSW DECCW are to be notified if results above trigger values are found.

26.3 SURFACE WATER

A Surface Water Monitoring Plan will be prepared and will contain the following: -

Overview

All water used during site operations shall be sourced, treated, recycled and reused on site. No discharge of waters is anticipated as a result of regular operations. In the event that the bioretention basin volume is exceeded, overflow shall be redirected to the extraction pit. Further, the nature of site soil profile (fine to medium grained sands) means that during rainfall events a high amount of infiltration and a low volume of surface runoff on the site is expected.

This plan therefore focuses on inspection and monitoring of water quality treatment structures and elements of the site water management scheme to ensure appropriate operation and functioning.

Bioretention Basin

The proposed bioretention basin and truck washdown extraction pit shall be monitored as follows:

1. Weekly visual inspection:
    - Check basin structural integrity.
    - Check outlet for signs of scour/failure.
    - Check sediment volume.
    - Check and record water level.

Records of water storage inspections are to be kept in the site register (Attachment G) along with rainfall, evaporation and general observations.

Water Use

The following water transfers / uses are to be metered and recorded daily in the site register (Attachment G) to ensure water supply and demands are appropriately managed and water loss is minimised:

- Groundwater extraction volume from the sump / basin to the processing plant.
- Return process wastewater pumped from the plant to the interim basin / sump.
- Water extracted from the basin / sump to the water cart for dust suppression.
- Water extracted from the bioretention basin to the truck washdown area.

Water Quality

The following water quality monitoring is required onsite during operation:

1. Water quality monitoring of pH, EC and TSS (or similar) from within the bioretention storage basin. Monitoring is to be completed on a weekly basis. Trigger criteria for monitoring parameters is to be determined by plant operator based on operational requirements.

2. Water quality monitoring of process wastewater transferred to the extraction basin pit / sump. Monitoring parameters and frequency to be determined by the plant operator based on operational requirements.

Contingency and Response Plan

Table 26.2 provides an outline of operational issues identified as having potential to occur on site and contingency response to be executed.

Issue	*Response*
Pump failure	*Appropriate contractor to be contacted to rectify pumps.*
Water meter failure	*Rectify and replace (where required) water meter.*
Leak is detected from bioretention basin / truck washdown basin	*Contact environmental engineer and arrange inspection. Engineer to advise on how to best repair leak.*
Water balance indicates process water return < 98 % (i.e. more than 2% loss).	*Examine the system for leaks and where required rectify.* *Check meters are functioning correctly.* *Check records are logged correctly.*
Groundwater extraction rates exceed forecasted levels.	*Check for leaks and/or adjust water consumption.*
Water quality in bioretention basin and / or extraction basin exceeds required target criteria.	*Complete an additional round of water quality sampling to confirm results.* *Inspect treatment basins for leaks / failures.* *Inspect and assess operational area for sources of increased pollutant loads.* *If repeated exceedance occurs contact environmental engineer to inspect and advise.*

Table 26.2 - Contingency response plan

Reporting and Auditing

Annual surface water management reporting is to be completed as part of the site's long term management. Reporting is to include:

- Rainfall conditions for the calendar year.
- Progress of quarrying operations.
- Any changes to the surface water management system.
- Any sediment and erosion 'events' experienced (e.g. major storm event, basin failure).
- Records of treatment basin inspection and maintenance.
- Records of water use and water quality monitoring.
- Comparison of water balance records with the previous year and any long term observations/trends.
- Identification of events/issues experienced and management/remedial process.
- An audit of the stormwater management and monitoring system and any recommendations for continued operation.

Adaptive Management

The site SWMP shall be considered a 'living' document that should be reviewed annually and updated as required. Given site surface water conditions will change as quarrying progresses, the management plan needs to be adaptive to remain relevant and effective.

26.4 COASTAL HAZARDS

Assessment of coastal lagoon regression indicates:

1. Hazard lines suggest that the subject site is unlikely to be affected by sea level rise effects within the Tilligerry Creek estuarine system. The proposed 15 m vegetated buffer zone and diversion bunds around the site perimeter will also limit some of these effects. It is recommended that diversion bund design consider potential sea level rise effects on the site.

2. Ecological zone regression into the site is not likely to be significant. Appropriate diversion bund and buffer zone designs will further limit any potential ecological regression into the site due to sea level rise.

3. Expected estuarine regression due to sea level rise should not impact site development.

26.5 GEOTECHNICAL AND ASS MANAGEMENT

The soil assessment has advised that a borehole monitoring plan will be required with the following recommendations: -

*A monitoring plan for the five wells on-site and the dredge pond is summarised in **Table 26.3**.*

Location	Frequency	Parameters	Trigger Value[1]
Dredge pond	3 months[2]	pH, EC	pH <4, EC = NA
5 on-site wells	3 months[2]	pH, EC	pH <4, EC = NA

Notes:
1. Preliminary value to be revised after 6 months monitoring.
2. 3 months monitoring over at least a 12-month period.

Table 26.3 - Dredging pond and groundwater wells monitoring plan

It is recommended that the following additional investigation works are carried out:

- Supplementary borehole drilling, sampling and testing across the site and along site boundaries to better define the extent and depth of PASS below the groundwater table.

- Further testing of soil above the groundwater level in the vicinity of BH3 to confirm assumed anomalous test results.

- Installation of 5 new wells around the dredge pond to detect possible movement of sulfidic acidic impacted groundwater.

26.6 AIR QUALITY

It is proposed that an Air Quality monitoring plan be undertaken with the following measures as well as the installation of a TEOM machine and weather station at the site as this would allow proactive dust controls measures to be enforced to reduce the likelihood of exceedences and complaints:-

Purpose & Scope

The purpose of the Plan is to:

- Provide a description of the measures to be implemented to mitigate air quality impacts;
- To detail air quality monitoring requirement;
- Provide a mechanism for assessing air quality monitoring results against the relevant air quality impact assessment criteria; and
- Provide employees with a clear and concise description of their responsibilities in relation to air quality management during the operation of the Project.

Objectives

The Air Quality Management objectives of the Plan are to ensure that appropriate procedures and programs of work are in place to:

- Maintain an air quality monitoring system which can assess the air quality impact on surrounding sensitive receivers and performance against the legislative air pollution requirements;
- Detail the controls to be implemented to minimise dust generation from the site recognising that cumulative air quality is a key issue for the local community;
- Provide a mechanism to assess monitoring results against air quality impact assessment criteria to evaluate compliance;
- Manage air quality related community complaints in a timely and effective manner; and
- Provide management commitments and strategies for dealing with air quality related issues.

Compliance Assessment Protocol

In the event of an exceedance of the relevant pollutant criteria, the operator of the Project will investigate and report the exceedance and will also implement mitigating measures for future air quality impacting activities as necessary and will monitor all activities for effectiveness and improvement opportunities. Air quality data will be collected and assessed in conjunction with meteorological data to determine the Project contribution to recorded dust events.

Community Complaints

Community complaints management includes receipt of complaints, investigation, implementation of appropriate remedial action, and feedback to the complainant as well as communication to site management or personnel and notification to external bodies, such as the OEH.

Accountabilities

Specific roles and accountabilities for employees and contractors in relation to Air Quality Management Plan are outlined below in Table 25.3.

Person Responsible	Responsibilities
Operations Manager	• *Approve appropriate resources for the implementation of this Plan.* • *Ensure the effective implementation of strategies designed to reduce air quality impacts from the operation.* • *Ensure air quality issues are reported in accordance with legal requirements.* • *Authorise internal reporting requirements of this plan*
Environment and Community Manager/Officer	• *Provide that sufficient resources are allocated for the implementation of this program.* • *Identify air quality risks and impacts to the environment and assess resources required to mitigate identified risks and impacts within the site.* • *Ensure that the air quality management controls are implemented in accordance with this Plan.* • *Ensure that the results of monitoring are evaluated and reported to senior management and to relevant personnel for consideration as part of ongoing planning.* • *Ensure any potential or actual air quality is reported in accordance with legal requirements and the corporate standard.* • *Provide visible and proactive leadership in relation to the air quality management.* • *Ensure that operational changes consider the potential air quality impacts to adjacent private landowners* • *Ensure all reporting requirements are met and complies with internal and external monitoring standards, protocols and regulations.* • *Coordinate progressive rehabilitation to minimise disturbed areas.* • *Manage and maintain the air quality monitoring programs.* • *Ensure monitoring equipment is operated in accordance with relevant industry standards and protocols.*
Managers, Supervisor, & Task Coordinators	• *Provide that sufficient resources are allocated for the implementation of this Plan, as required.* • *Ensure adequate resources are budgeted for in relation to air quality* • *Ensure that operational changes consider the potential impacts of dust emissions from the Project on the surrounding environment.* • *Monitor team members and contractors carry out work appropriate monitoring and maintenance tasks.* • *Ensure any potential or actual air quality emissions are controlled.* • *Conduct daily inspections of the work area to monitor compliance with this plan.* • *Provide input to management on the adequacy and effectiveness of this plan.* • *Ensure the effective implementation of strategies designed to reduce air quality impacts from the Project.* • *Provide visible and proactive leadership in relation to air quality management.* • *Ensure personnel working at the operation are aware of the air quality management obligations.*

Table 26.4 - Air Quality management plan

26.7 CONSTRUCTION NOISE

In order to limit the impact on the surrounding noise sensitive receivers the following recommendations to minimise noise emissions from the site during the construction phase are:

- To reduce the predicted noise impact on residential receivers in particular R1, R12, R13, R14 and R15, removal of trees by chainsaw near these receivers should only be completed following consultation with the receivers to notify them of the planned works and to advise the receivers of the proposed schedule to complete the tree removal works, with regard to the use of chainsaws for tree felling.

- Additionally, in order to minimise the potential construction phase noise impacts on the sensitive receptors located in the vicinity of the site, a site-specific noise management plan adopting feasible and reasonable noise attenuation and management measures should be implemented as detailed in **Section 11.10** of this report, as best practise to minimise the potential construction phase noise impacts.

Construction Noise Management Plan		
Component		**Details**
General/Site Management Issues		*All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include: should instruct all persons at the site with regard to all relevant project specific and standard noise and vibration mitigation measures detailed herein including permissible hours of work; any limitations on high noise generating activities; location of nearest sensitive receivers; construction employee parking areas; designated loading/unloading areas and procedures; site opening/closing times (including deliveries); and environmental incident procedures.*
		A dedicated person will form a point of contact for the dissemination of general information regarding site operations. Contact persons will also be defined to receive comment or complaints from the community.
Hours of Work/Respite Periods		*Typical Standard Hours for Construction* *07:00 – 18:00 Monday – Friday* *and 08:00 -13:00 on Saturday*
Source Controls	***General/Work Practices***	*Avoid unnecessary revving of engines and turn off plant that is not being used / required.*
		Use only non-tonal reverse alarms (broadband alternatives are needed). Where possible organise the site so that delivery trucks and haulage trucks only drive forward to avoid the use of reversing alarms.
		Organise and schedule the equipment operations to limit the noisiest machines operating simultaneously.
		Site set up / movement of plant / delivery of materials / waste removal to site should generally be restricted to the daytime period.
		Truck drivers are to be informed of site access routes, acceptable delivery hours and must minimise extended periods of engine idling.
		Ensure there is no unnecessary shouting or loud stereos/radios on-site. There must be no dropping of materials from heights, throwing of metal items, or slamming of doors.
		Equipment must be inspected on a regular basis and maintained as necessary, to ensure it is in good working order. This must include inspections of the condition and performance of mufflers.
	Substitution	*Use less noise-intensive equipment where reasonable and feasible.*
		Construction equipment with the most effective mufflers, enclosures and low-noise tool bits and blades must be procured and utilised for the project.

Construction Noise Management Plan		
Component		**Details**
		Where possible mains power should be utilised for temporary traffic signals / work area lighting. Where this is not feasible silenced generator sets are to be used instead.
	Use and Siting of Equipment/ Activities	*Where practical fixed plant should be positioned as far away as possible from sensitive receivers.*
		During paving works or any concrete cutting works consideration should be given to taking materials off site for cutting where practical.
Consultation	***Notification***	*A letter should be distributed to local residents in advance of the works to notify them of the nature and estimated timescales for completion of the proposed works.*
	Project info-line and Construction response line	*A 24-hour contact point should be provided for any complaints regarding the construction work. A Project representative must respond to all complaints as soon as possible.*
Complaints management		*Upon receiving any complaint regarding construction activities, the nominated contact must investigate the source of the complaint. The aim will be for a Project representative to initiate a complaint investigation and to respond to all complaints as soon as possible. Where practicable a visit should be made to the complainant to verify the nature of the complaint and if justified appropriate action should be taken to cease or amend the activity causing the complaint.* *A Complaint Management Plan will be developed and implemented by the contractor engaged for the Construction Works. The Complaint Management Plan will at a minimum include provisions for the recommendations outlined above.*

Table 26.5 - Construction Noise Management Plan

26.8 OPERATIONAL NOISE

The following recommendations will be implemented: -

The installation of barrier fencing or temporary earth bunds to ensure that a 4 to 6m high barrier is available to limit noise to adjoining receptors.

For mining activities to utilise trucks movements >180/day the findings in the Operational Noise Report by Vipac is to be monitored to ensure compliance and and if practically compliant the extension to 200 truck movements/day be permitted.

Limitations on night time operations will see the movement of trucks from the mine @ 6:00pm.

26.9 ECOLOGY

In addition to acquiring an offsite "offset" area to compensate for the removal of the vegetation, the following specific actions for affected species has been made: -

Diuris Arenaria (Tomaree Doubletail)

All specimens of Diuris arenaria (Tomaree Doubletail) occurring outside the disturbance area are to be located and protected from unintended removal/disturbance. This will require the erection of a barrier fence. It is recommended that individual specimens of D. arenaria occurring within the extraction area be translocated into nearby suitable habitat. The most suitable habitat would be the adjacent electricity easement which contains known habitat. Any translocation of specimens of D. arenaria will require a Translocation Plan that is approved by OEH. It will also be important to liaise with Ausgrid regarding maintenance of their easements to minimise impacts and support the protection of D. arenaria.

Hollow-Dependant Fauna

Affected hollow-dependant threatened fauna are Petaurus norfolcensis (Squirrel Glider), Scoteanax rueppellii (Greater Broad-nosed Bat) and Falsistrellus tasmaniensis (eastern Falsistrelle) (refer to Section 7.3) for the protection of fauna during vegetation removal.

Koala

Planting of specimens of Eucalyptus robusta (Swamp Mahogany) within the northern portion of Lot 51 to enhance Koala habitat within the study area and increase the connectivity for Koalas between preferred Koala Habitat within the study area to areas of Preferred Koala Habitat over Marsh Road to the north. A 50m Buffer over Supplementary and mainly cleared habitat will be required to be implemented around areas of Preferred Koala Habitat (Swamp Forest) within the study area.

Rehabilitation of Extraction Area

Rehabililitation within the extraction area will be undertaken in stages as the sand mine progresses. The rehabilitation will be required to conform to an approved vegetation management plan completed for the proposal and in accordance with the proposed Mine Closure Plan.

Monitoring of Groundwater Levels and Groundwater Dependant Ecosystems Within Proximity to the Extraction Area

Groundwater levels are to be monitored within and around the study area. Groundwater dependent communities partically the two areas of swamp forest will be monitored to access any changes in the health of these communities.

Ongoing Site Operation

26.9.1.1 Noise

A 4m high acoustic barrier has been proposed along both sides of the haul road at the Marsh Road exit, with the eastern barrier to be an absorbant barrier. Additionally, a 6m high noise bund is proposed to run the length of the western boundary of the sand mine, along the northern boundary and down to join the 4m noise barrier at Marsh Road. These noise bunds are proposed to be constructed prior to any other works being carried out within the study area. The bunds will then be regenerated with native vegetation.

26.9.1.2 Artifical Lighting

Artificial lighting used to operate at night or used for security may influence nocturnal fauna. It is recommended that lighting be minimised and confined wherever possible.

26.9.1.3 Traffic

It is recommended that low speed limits be set along the haul road to help avoid collision with any native fauna.

To help ensure these mitigation measures are carried out, a vegetation management plan is to be developed to address any likely impacts during construction and ensure the long-term viability of the nearby surrounding environment.

26.10 TRAFFIC

The following traffic management recommendations are made to reduce the potential site impacts: -

1. The proposal allows for a sand quarry with all heavy vehicle entry via a new access point off Nelson Bay Road. Light vehicle access will be via the upgraded access off Marsh Road and all vehicle exit movements will be via this access on Marsh Road.

2. The site is located within the locality of Bobs Farm with frontage to both Nelson Bay Road and Marsh Road. The major access route for outbound material will be to the west of the site along Nelson Bay Road to centres such as Newcastle, Raymond Terrace and the Lower Hunter Valley.

3. All trucks will enter the site directly off Nelson Bay Road via an upgraded access. This will require a left turn deceleration lane to be built on Nelson Bay Road and this will be designed and constructed in accordance with RMS and Council requirements. All trucks will then drive through the site and exit via the existing access point on Marsh

Road. All trucks will turn right out of the exit on Marsh Road and then proceed to the intersection of Nelson Bay Road with Marsh Road.

4. Due to potential delays for the trucks turning right out of Marsh Road and associated safety concerns, all trucks will turn left out of Marsh Road and proceed in an eastbound direction along Nelson Bay Road. The trucks will then complete a U-turn at the roundabout controlled intersection of Nelson Bay Road and Port Stephens Drive to return in a westbound direction. The trucks will then continue along Nelson Bay Road and then use Richardson Road to head towards Raymond Terrace and the Pacific Highway, or Cabbage Tree Road to head towards the New England Highway and Maitland or continue along Nelson Bay Road towards Newcastle. Both Nelson Bay Road and Cabbage Tree Road are RAV approved routes suitable for heavy haulage.

5. All light vehicles will enter and exit the site via the access point on Marsh Road. This will reduce the conflict between light and heavy vehicle and allows direct access to the site office.

6. The site access points have been reviewed on site and allow for safe vehicle movements, with adequate sight lines available based upon vehicle speeds and the posted speed limits.

7. All parking can be accommodated on site. The trucks will not be parked on site over-night and there are minimal on-site staffing levels requiring minimal on-site parking.

26.11 VISUAL IMPACTS

Boundary plantings are to be installed on the commencement of the operations, and in particular in the vicinity of the existing electrical Transmission Line, subject to Ausgrid concurrence.

Rehabilitation is to be commenced within 2 weeks of a final cell mining operations completion.

The principle for all actions to minimise visual intrusion is to ensure that at no time does the mining operations dominate the landscape.

26.12 BUSHFIRE

Bush fire protection measures incorporated into the proposed operations would apply to the the whole site. These measures aim to reduce fuel accumulation, control ignition sources and provide services on site to assist in fire fighting and minimise the spread of bush fire. Fire management on-site will include:

- provision of a separation distance (minimum of 10 m) between stockpiles of combustible material and remnant vegetation;

- managing operations and the site to minimise likelihood of ignition sources through good 'housekeeping' (for example, all waste in bins);

- emergency planning procedures in the event of a fire occurring on the site;

- fitting of all earth moving machinery with spark arresting mufflers and haul trucks have serviceable exhaust systems to prevent accidental ignition of vegetation; and

- equipping the operations to assist in the management of any fires on-site, including presence of fire extinguishers, water cart (as contracted), and the site front-end loader and bulldozer for any requisite fire fighting purposes.

These measures minimise the risk of a fire starting from operations on site, minimise the risk of fire spread, and provide services for fire fighting in the immediate area. The construction of a spinal haul road and the continued maintenance of the road will provide adequate access and egress for fire fighting purposes if and when required.

26.13 SOCIAL IMPACT ASSESSMENT

The SIA prepared by Tattersall Lander Pty. Ltd. has identified a range of perceived and actual community/ other stakeholder considerations associated with the proposal. Relevant community and technical mitigation strategies have been cited for engagement purposes; specifically, relevant to address the variety of issues which have been raised.

The EIS prepared for the proposed development incorporates a significant number of specific mitigation strategies in relation to:

- Traffic Impact Assessment
- Ecological Impact Assessment
- Noise and Vibration
- Air Quality
- Groundwater
- European Heritage
- Aboriginal Cultural Heritage
- Visual Impact Considerations
- Statement of Commitments

As is the case with many resource extraction projects, the perceived and experienced social impacts/ issues are often greatest for those living in closest proximity to the proposal, or those who perceive they will be most directly impacted by the development. Consequently, should the development application be approved, an appropriate social impact monitoring program should be developed to assess the degree to which impacts are occurring and appropriate methodologies by which to mitigate any impacts.

It will be vital for the proponent to maintain an ongoing dialogue with local residents throughout the operation of the sand mine in relation to issues of relevance and importance to the community.

27 PROJECT JUSTIFICATION

Schedule 2 of the Environmental Planning and Assessment Regulation, 2000 requires that an EIS includes:

> *The reasons justifying the carrying out of the development or activity in the manner proposed, having regard to biophysical economic and social considerations and the principles of ecologically sustainable development.*

The proposal can be justified if:

- *the socio-economic and environmental benefits outweigh the disadvantages; and*
- *the overall impacts are acceptable to the community in terms of the principles of ecologically sustainable development.*

This section justifies the proposal in these terms.

27.1 SOCIO-ECONOMIC CONSIDERATIONS

The existing fig and olive farm has been operating for more than 13 years on land that has little to no agricultural potential. The current size of the farm is marginal and there is little opportunity for a significant expansion of the existing farming operations. The farm occupies a valuable and scarce sand resource that has been evaluated as providing material for many important and cost-effective uses. The approval of this mining operation would see a significant number of jobs generated for >15 years and the opportunities for alternative uses of the land post mining are creditable and achievable.

Adverse social impacts will be largely confined to an increase in truck movements on Nelson Bay Road and some short-term visual impacts from Nelson Bay. Issues relating to groundwater and surface water are logically manageable. Ecological impacts will be offset under the relevant Bio-banking provisions and in agreement with OEH.

Increases in overall noise, air quality/dust and vibration have been assessed and where small exceedances have been identified, mitigation measures have been recommended and acknowledged.

Current employment on the farm involves an onsite manager, and the owner. Under the sand mining operation, it is estimated that the mining operation will provide 7-10 full time on-site jobs and 50 to 70 fulltime transport workers, 15 involved in downstream manufacturing and laboratory activities and 10 in the use of the product for recreational purposes. This would contribute approximately $3.5 million in employees' wages, of which approximately $2.5M is estimated to be retained within the local and regional economies. These workers would be drawn from the Port Stephens area. It is estimated a further 100 FTE jobs are supported through the multiplier effect, with a proportion of these jobs supported in the local and regional economy. Operations at the site will contribute to approximately $1 million in contracts/year with local businesses and and it is likely that contributions to the local community groups will be established. The mine will contribute to the up-skilling of the local workforce in training and development of staff.

27.2 ENVIRONMENTAL CONSIDERATIONS

The environmental impacts of the proposal have been carefully considered during the preparation of this EIS. The works would pose minimal risk to surface and groundwater resources. The development site is in a sensitive landscape with respect to Aboriginal heritage and the likelihood of the operations impacting items of Aboriginal heritage is manageable and well controlled. Mitigation measures are proposed to manage associated risks. Minor noise and air quality impacts would occur; however, mitigation measures have been proposed to ensure that emissions are predicted to be within relevant acceptable and industry limits, and are unlikely to increase above industry permitted levels. The proposal will increase traffic numbers marginally to local road users of Nelson Bay Road.

The site is within a locality that has been partially disturbed in the past by vegetation clearing and general farming operations. Clearing of native vegetation has been assessed as having an impact but can be undertaken if a suitable Bio-bank offset strategy is arranged.

Mitigation measures have been developed to manage potential impacts where these might otherwise exceed acceptable standards.

27.3 ECOLOGICALLY SUSTAINABLE DEVELOPMENT

Ecologically Sustainable Development (ESD) can be defined as 'using, conserving and enhancing the community's resources so that the ecological processes, on which life depends, are maintained and the total quality of life, now and in the future, can be increased' (Department of the Environment).

The four principles of ESD are listed in Schedule 2 of the Environmental Planning and Assessment Regulation 2000 as follows:

(a) the **precautionary principle**, namely, that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, public and private decisions should be guided by:

  (i) careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment, and

  (ii) an assessment of the risk-weighted consequences of various options,

(b) **inter-generational equity**, namely, that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations,

(c) **conservation of biological diversity and ecological integrity**, namely, that conservation of biological diversity and ecological integrity should be a fundamental consideration,

(d) **improved valuation, pricing and incentive mechanisms**, namely, that environmental factors should be included in the valuation of assets and services, such as:

  (i) polluter pays, that is, those who generate pollution and waste should bear the cost of containment, avoidance or abatement,

(ii) the users of goods and services should pay prices based on the full life cycle of costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste,

(iii) environmental goals, having been established, should be pursued in the most cost-effective way, by establishing incentive structures, including market mechanisms, that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems.

The Precautionary Principle

According to the POEO Act, the precautionary principle means that 'if there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation'.

In the application of the principle, decisions should be guided by careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment and an assessment of the consequences of various options.

This principle was developed in response to the great difficulty of interpreting scientific data. The scientific method produces results based on confidence limits determined by the scope of data acquisition, interpretation methods and general understanding within a particular scientific discipline.

This proposal has been planned and assessed through a conservative and precautionary approach. The proposal has been assessed as having a manageable environmental impact. The long-term impacts would be minimised by a commitment to rehabilitation and revegetation. The proposal is economically sound as it will utilise existing road infrastructure and it will continue to provide a valuable manufacturing resource close to the market ensuring continuation of the current supply to the community.

In addition, potential threats to the quality of the environment have been determined with a reasonable degree of certainty through the use of scientific investigation and analysis of the individual and cumulative environmental impacts of the proposal. It should be noted that no major threats of 'irreversible or long-term environmental damage' were identified during the ea process and where other more minor issues have been identified, the application has been modified with appropriate controls proposed and will be put in place should the proposal proceed.

Social & Intergenerational Equity

Social equity involves value concepts of justice and fairness so that the basic needs of all sectors of society are met and there is a fair distribution of costs and benefits to improve the wellbeing and welfare of the community, population or society. Social equity does not imply equality, rather that there should be equal access to opportunities for improved welfare with a bias towards advantaging the least well-off sectors of society.

Social equity includes intergenerational equity, which requires that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations. The proposal provides employment

opportunities for a significant number of local people. The social well-being of residents of Bobs Farm would not be compromised by commencing a development that would see it operating for many years in a similar form to other operations on the Tilligerry Peninsula.

Potential impacts on Aboriginal heritage were assessed as manageable. Whilst the proposal will result in a greater use of the land for increased sand product production, the rights of future generations would not be compromised in the process.

Conservation of Biological Diversity & Ecological Integrity

Biological diversity refers to the diversity of genes, species, populations, communities and ecosystems and the linkages between them. Biological resources are responsible for vital ecological services such as maintaining soil fertility and the supply of fresh water. Maintaining biological diversity safeguards life support functions and can be considered a minimal requirement for ecological integrity.

A comprehensive assessment of the likely impacts of the proposal on flora and fauna is detailed in Chapter 14 and Annex N. The proposal will result in the disturbance of 988 habitat trees with other native trees to be impacted in a landscape classed as forest and orchards. The investigations of these habitats have assessed the presence of an Endangered Ecological Community and existence of a number of threatened species and the study area would be considered to have conservation significance. The proposed sand mine will result in a loss of habitat for a number of the addressed threatened species occurring within the local area. Taking into account the relatively large amount of similar habitat along Stockton Bight and given the recommendations which include a suitable Biobanking Offset, it is believed that the proposal is unlikely to disrupt the life cycle of any addressed threatened species, endangered population or endangered ecological community such that local extinction would occur

Improved Valuation & Pricing of Environmental Resources

This principle establishes the need to determine economic values for services provided by the natural environment, such as the atmosphere's ability to receive gaseous emissions, cultural values and visual amenity. Applying standard methods of valuation and pricing to environmental resources is a difficult process, largely due to the intangible nature of much of the natural environment.

The environment has conventionally been considered a free resource and environmental factors have been excluded from determining the real cost of an activity. The indicative costs to the environment are shown by the cost of the mitigation measures and safeguards and are included in the real costs of any development.

The proposal will minimise the adverse effects on flora and fauna brought about by clearing, through rehabilitation of the site and the provision aof a suitable Bio-banking offset area to restore a productive ecological habitat while giving protection to endangered flora. The proposal also assists ESD outcomes by providing access to a resource, significant number of jobs, downstream processors and the local consumers close to its point of production, thus reducing environmental impacts relating to the transport of bulk materials.

28 CONCLUSION

The environmental impacts of the proposal have been carefully considered during the preparation of this EIS and it is considered that the works would pose an acceptable and very low risk to the environment. The production of sand products within the region has been ongoing for many years with minimal negative impacts to the local community and adjoining owners. Commencing a sand mine in this location is logical and would provide a continued cost-effective supply of an important resource to local and regional centres.

The project can be implemented with minimal adverse socio-economic and environmental impacts as demonstrated throughout this EIS. While some environmental impacts are expected, these are manageable and mitigation measures are developed to minimise the impacts and ensure the operations can proceed in an environmentally sustainable manner.

The project is justified on the basis of the efficient utilisation of existing infrastructures, resources and overall economic benefits to local, regional and State economies. It satisfies the objectives of ecologically sustainable development.