Our Ref: STH13/00004/02
Contact: Hala Sattouf 4221 2769
Your Ref: 18/2015

Transport
Roads & Maritime
Services

6 February 2015

Victoria Nicholson
Shellharbour City Council
PO Box 155
Shellharbour City NSW 2529

DEVELOPMENT APPLICATION 18/2015 – LOT 21 DP 653009, 44 BUCKLEYS ROAD, DUNMORE – SAND EXTRACTION QUARRY DUNMORE

Dear Madam

Roads and Maritime Services (RMS) refers to your letter dated 23rd January 2015 regarding the subject development application.

RMS does not object to the development application in principle given:

- The proposal does not gain direct access from the classified road network. Access is gained via local roads.
- No increase in traffic generation is anticipated during the operational phase of the quarry as the proposed extraction area will replace existing extraction activities
- A temporary (3-7 months) and minor increase in traffic generation (10-24 additional movements) are anticipated during the construction and rehabilitation stages of the project.
- Therefore, RMS considers the proposed development is unlikely to have a significant impact on the classified road network.

If you have any questions please contact Hala Sattouf on 4221 2769.

Yours faithfully

Chris Millet
Manager Land Use
Southern Region

Roads & Maritime Services

Level 4, Southern Regional Office, 90 Crown Street, Wollongong NSW 2500 | PO Box 477 Wollongong East NSW 2520
T 02 4221 2460 | F 02 4221 2777 | **www.rmservices.nsw.gov.au** |

NSW GOVERNMENT | Department of Primary Industries

Our Ref: OUT15/11
Your Ref: DA No 18/2015

19 February 2015

Victoria Nicholson
Senior Development Assessment Officer
Shellharbour City Council
Locked Bag 155
SHELLHARBOUR CITY CENTRE NSW 2529

Dear Ms Nicholson

Re: Designated IDA 18/2015 Extension of Dunmore Sand Extraction, Potential Acid Sulphate Soil Disposal and Rehabilitation Works Lot 21 DP635009 – 44 Buckleys Road Dunmore

I refer to your letter dated 23 January 2015 (INW15/4588) and accompanying information seeking comments from Fisheries NSW, a division of NSW Department of Primary Industries, on the above proposal.

Fisheries NSW is responsible for ensuring that fish stocks are conserved and that there is "no net loss" of key fish habitats upon which they depend. To achieve this, the Department ensures that developments and land use planning complies with the requirements of the *Fisheries Management Act 1994* (namely the aquatic habitat protection and threatened species conservation provisions in Parts 7 and 7A of the Act respectively) and the associated *Policy and Guidelines for Aquatic Habitat Management and Fish Conservation (1999)*. In addition the Department is responsible for ensuring the sustainable management of commercial and recreational fishing and aquaculture within NSW.

Fisheries NSW has reviewed the proposal prepared for Shellharbour City Council (SCC) by Hyder Consulting dated December 2014 and supporting documentation. We understand that there will be no direct impact upon important fish habitats including seagrass, mangrove and saltmarsh communities.

The subject site is situated adjacent to Rocklow Creek and SEPP 14 Wetland No. 374a, draining to the Minnamurra Estuary. The potential impacts on these waterways resulting from the discharge of sediment laden waters, particularly during high rainfall events, as well as groundwater drawdown and creek realignment is of interest to this Department.

The REF has identified that the site area is 'subject to frequent flooding' and that the proposal represents a 'high risk of impact to the quality and quantity of surface and ground water'. The proposal includes provisions for surface water quality monitoring (Volume 2, Appendix C, Part 6, p7) to be conducted on a quarterly basis. It is Fisheries NSW policy that all developments should aim to achieve no net impacts on receiving waterways. The proposed water quality monitoring and management measures regime will not provide adequate information to verify that there is no

significant impact upon adjacent waterways because high rainfall events are not likely to coincide with the sampling dates.

The EIS suggests that groundwater will be drawn down by 3m in the vicinity of the dredging works. The Department is concerned that this may pose a risk to nearby wetland habitats.

Based on the information provided, Fisheries NSW does not object to the extension of the Sand Extraction works, subject to the following conditions being included in any approval of the planning proposal:

1. All works conform to and are consistent with the Environmental Impact Statement (EIS) by Hyder Consulting dated December 2014;
2. A surface water quality management and monitoring plan is to be developed and submitted to Fisheries NSW for approval prior to any works taking place. The plan must include sampling and testing regimes for the construction and operational phases and include provisions for sampling of water quality during discharge events;
3. A copy of the draft Ground Water Monitoring and Management Plan is to be submitted to Fisheries NSW for comment prior to any works taking place;
4. The draft design plans for the realignment of the western diversion channel including stormwater dissipation devices and water quality improvement devices are to be submitted to Fisheries NSW for approval prior to any works taking place.
5. Environmental safeguards (e.g. silt curtains, sediment fences, booms etc.) are to be installed and maintained throughout the proposal in accordance with "*Managing Urban Stormwater: Soils and Construction*" (4th Edition Landcom, 2004, aka the Blue Book) to ensure that there is no escape of turbid plumes into the adjacent aquatic environment;
6. Spill kits suitable for the containment of fuel and oil spills must be kept on site;
7. Fisheries NSW (1800 043 536) is to be immediately notified of any fish kills in the vicinity of the works. In such cases, all works other than emergency response procedures are to cease until the issue is rectified and written approval to proceed is provided by Fisheries NSW.
8. Independent audits of the operation of the dredging operation are to be conducted after 12 months and thereafter at 3 yearly intervals. Audits are to be conducted by suitably qualified practitioners. A copy of each audit report is to be provided to Fisheries NSW within 3 months.

If you require any further information, please do not hesitate to contact me on (02) 4428 3406.

Yours sincerely

Reynolds.

Jillian Reynolds
Regional Assessment Officer – South Coast
Aquatic Ecosystems

NSW GOVERNMENT | Office of Environment & Heritage

Date: 10 April 2015
Your reference: DA18/2015
Our reference: DOC15/101955-6
Contact: Calvin Houlison
4224 4179

Tim Collins
Assessment Officer
Shellharbour City Council
Locked Bag 155
SHELLHARBOUR NSW 2529
E-mail: tim.collins@shellharbour.nsw.gov.au

Dear Mr Collins

RE: Dunmore Sand Quarry Extraction (DA18/2015)

Thank you for providing us the opportunity to provide comments on the Dunmore Sand Quarry Extraction EIS (Hyder, 2015). We have conducted a review of the proposal and provide the following comments:

Biodiversity & Offsetting

The proposal will result in the removal of endangered ecological community (EEC) and threatened species habitat, namely portions of Swamp Oak Floodplain Forest (SOFF) which is listed as an EEC under the NSW Threatened Species Conservation Act (TSC) Act 1995. This is found in both a regrowth and revegetated (planted) form on the site, with the southern portion of SOFF contiguous with a large patch which extends offsite to the south. Marginal habitat for the Green & Golden Bell Frog (GGBF) has also been identified on the site.

In summary, an offsets strategy should be developed to compensate for this loss utilising BioBanking Assessment Methodology (BBAM) (2014) and the associated OEH Biobanking Calculator to determine suitable offsets for the proposal. This should be provided prior to issuing of consent to ensure a suitable offset is available and will be provided to compensate for the removal of vegetation from the site as proposed. Should this not be provided before the project is approved, a condition of consent requiring an offsets strategy to be prepared should be imposed by the consent authority.

The following detailed comments are provided for your consideration:

- The proposal involves clearing of endangered vegetation and sand extraction within RU1 and E3 zoned land. The E3 zone objectives are aimed at protecting areas of ecological value, including EEC's and threatened species habitat. The proposal to sand mine in an E3 zone is therefore inconsistent with the zone objectives and ideally should be removed from the E3 zoned portion of the site which covers only a small component of the proposed extraction area.
- The proposal involves the removal of an area of SOFF EEC. The DGR's require *'a detailed description of the measures to maintain or improve the biodiversity values within the development area'* and OEH's supporting comments state that any unavoidable residual impacts should be offset utilising the BBAM calculator. The Ecological Assessment (Hyder, 2014) makes reference to this requirement however no offset calculation has been provided. This offset assessment should be undertaken up front and detailed in an Offset Strategy so that the requirement to provide the offset can be conditioned on any consent, should one be forthcoming.

- However, should the consent authority impose a condition requiring a biodiversity offset strategy to be prepared post consent, we suggest that the strategy be prepared by an accredited BioBanking assessor. The offset strategy should be prepared in accordance with the BBAM and associated Biobanking Calculator in consultation with OEH.
- The proposal also involves the relocation of a drainage line which runs along the eastern boundary of the proposed extraction area. The documentation indicates that this will be extended into the area of SOFF and into an existing drainage line. The plans indicate that the proposed line will extend beyond the existing drainage line, requiring the removal of SOFF to facilitate its construction (see Figure 18 of the Ecological Assessment). This appears to be unnecessary and if possible, should be re-designed to the minimal extent required, in turn reducing the extent of SOFF clearing required.
- The requirement for a detailed rehabilitation plan to be prepared should form part of any consent for sand extraction, to ensure that the site is suitably rehabilitated post extraction.

Water Quality & Flooding

We suggest that Council be satisfied that the following matters have been adequately addressed with relation to floodplain management:

- the impact of flooding on the potential development (including overland flow)
- the impact of the potential development on flood behaviour (particularly topography changes) including any management measures to mitigate adverse flood impacts
- the impact of flooding on the safety of people/users of the development including flood hazard on access routes and access requirements in times of flood
- the full range of flood events, up to and including the PMF
- the impact of climate change (including sea level rise and rainfall intensity increases)

Based upon the information available, consideration should be given to these issues in their entirety, particularly with regard to overland flow and climate change impacts.

In relation to estuary health and water quality impacts, we suggest Council ensure the proposed development is consistent with the Fisheries Management Act (Particularly Part 7), State Environmental Planning Policy No 14 (SEPP 14) – Coastal Wetlands, the NSW Coastal Policy, the NSW Aquatic Habitat Management and Fish Conservation Policy and guidelines, the NSW State Rivers and Estuary Policy, Shellharbour LEP 2013 (particularly Clauses 6.1-6.4) and the Minnamurra River Estuary Management Plan and its objectives.

It is unclear whether adequate consideration has been given to contingencies related to the dredging, stockpiling, treatment, and disposal of PASS & ASS and erosion impacts particularly if failure of the leachate collection system occurs and/or if the design capacity is exceeded. We recommend further refinement to the risk management methodology be considered to account for acidification, in line with current engineering best practice to minimise impacts upon downstream SEPP 14 wetlands and the Rocklow Creek / Minnamurra River estuary.

Please contact me on 4224 4179 or via e-mail calvin.houlison@environment.nsw.gov.au should you have any further queries.

Yours sincerely

CALVIN HOULISON
Conservation Planning Officer

Shellharbour CITY COUNCIL

All Communication address to the General Manager
Shellharbour City Council,
Locked Bag 155
Shellharbour City Centre, NSW 2529
p. 02 4221 6111 **f.** 02 4221 6016
e. records@shellharbour.nsw.gov.au
www.shellharbour.nsw.gov.au

DX 26402 Shellharbour City Centre

13 May 2015

Shellharbour City Council
DX26402
SHELLHABROUR CITY CENTRE

Attention: Ms Courtney Williams

BY EMAIL
courtney.williams@shellharbour.nsw.gov.au

Integrated Designated Development Application No. 18/2015
Dunmore Sand Extraction
Lot 21 DP 653009, 44 Buckleys Road, Dunmore

Dear Ms Williams

Acid Sulfate Soils

Further assessment of the proposal has been completed with specific regards to the reinstatement/rehabilitation phase of the project involving the use of imported acid sulfate soil material.

The risk assessment detailed within the hydrogeology assessment accompanying the submission highlights that there is a critical risk to adjoining sensitive ecosystems (i.e. Rocklow Creek and Minnamurra River) associated with the reinstatement proposal. However through the implementation of suitable acid sulfate soils management provisions the report indicates that this risk could be reduced from a "high" to "moderate" risk. Through an assessment of the acid sulfate soils management details outlined for the proposal it remains unclear if the proposed management practices and safeguards would reduce the level of risk to the environment to an acceptable level.

Further information is required to substantiate that the environmental risks identified in the hydrogeology assessment are able to be reduced to an acceptable level. To achieve this a comprehensive acid sulfate soils management plan is required to be prepared in accordance with the Acid Sulfate Soils Assessment Guidelines (NSW Acid Sulfate Soils Management Advisory Committee, 1998) by a suitably qualified environmental scientist.

Biodiversity

In consultation with Office of Environment and Heritage a biodiversity offset strategy should be prepared through utilising the Bio Banking Assessment Methodology and Bio Banking Calculator to compensate for the loss of endangered vegetation.

Drainage

The relocation of a drainage line includes its extension into the area of SOFF and into an existing drainage line. The plans indicate that the proposed line will extend beyond the existing drainage line, requiring the removal of SOFF to facilitate its construction. If possible, the drainage line should be re-designed to the minimal extent required, in turn reducing the extent of SOFF clearing required.

Please also provide a plan, or advise where it is located in the EIS, that shows the full footprint of vegetation removal/modification (Figure 19 does not appear to include the above works), the existing drainage line and proposed drainage line.

Information

Can you please provide a hard copy of Appendix E - Biodiversity Impact Assessment Report

The following information was requested 11 March 2015; apologies in advance if you have already provided this information however I cannot locate it:

a. What is the depth of the quarry likely to be. The EIS says '... excavation to a depth below standing water table'

b. If the levee is to be constructed to RL 1.8m, how high is this relative to surrounding landform levels – I cannot find a survey within the EIS (again I may have missed it) – Intramaps show a contour of about 4m AHD and the plans in Appendix D show 2m contour line.

c. The EIS refers to an extraction of 100,000 tonnes. Page ii refers to 142,000m3 of sand. Are these equivalent?

   The 142,000m3 is a specific volume – out of interest, how was this determined?

d. Page ii also states that 'once 143,000m3 has been transferred ..... the site will be rehabilitated. Does this mean that there will be more sand extracted as rehabilitation is occurring, or is this figure the total amount of sand that is to be extracted? Please also confirm the volume of sand noting there are 2 different figures provided in the EIS.

It would be appreciated if information addressing the above matters can be submitted to Council by 1 June 2015.

Please do not hesitate in contacting me should you wish to discuss the above.

Yours sincerely

Victoria Nicholson
Senior Development Assessment Officer
City Development

MEMORANDUM

Date	27 May 2015
To	Victoria Nicholson Senior Development Assessment Officer
From	Bradley Searle
Copies	Courtney Williams
Subject	Integrated Designated Development Application No. 18/2015 Dunmore Sand Extraction - Drainage

Dear Victoria,

Hyder Consulting (Hyder) has prepared this memorandum in response to your queries regarding the relocation of the drainage line at the Dunmore Resource Recovery Facility to accommodate the proposed sand mine. In your letter, dated 13 May 2015, posed the following query:

"The relocation of a drainage line includes its extension into the area of SOFF and into an existing drainage line. The plans indicate that the proposed line will extend beyond the existing drainage line, requiring the removal of [Swamp Oak Floodplain Forest] SOFF to facilitate its construction. If possible, the drainage line should be re-designed to the minimal extent required, in turn reducing the extent of SOFF clearing required.

Please also provide a plan, or advise where it is located in the EIS, that shows the full footprint of vegetation removal/modification (Figure 19 does not appear to include the above works), the existing drainage line and proposed drainage line."

It is understood that clarification is sought on two points with regard to the drainage channel:

1. Demonstrate that the drainage channel has been designed to minimise the impact on SOFF; and
2. Confirm the extent of clearing associated with the realignment of the drainage channel.

These issues are discussed below.

Design of drainage channel

Hyder undertook a hydrological and hydraulic assessment of the existing drainage line to determine the existing performance of the channel and develop a design to match or improve flow conditions (thereby reducing potential flood impacts). The assessment identified that the existing drainage channel provides for less than the 1 exeedence per year (1 year ARI capacity).

Several physical constraints are present within the vicinity of the proposed drainage line, which restrict the location of the channel, being:

1. The access track around the existing sand extraction area to the west of the existing drainage line.
2. An existing sediment pond to the west of the existing drainage line.
3. The levee bank for the existing sand extraction area.
4. The SEPP 14 wetland to the south of the proposal site.
5. The minimal gradient of the existing site.

6. The location of the sand resource.

The highly constrained nature of the site meant that there were limited options for realignment of the channel. The proposed channel was sized to match the flows in the existing channel. This, when coupled with the installation of the proposed levee bank, would accommodate flows up to the 2 year ARI, representing an improvement on the current hydrology at the site. The length of the channel was designed to meet up with the existing drainage line, whilst diverting the flows around the sand resource. The incursion into the regrowth SOFF community, mapped to the south of the extraction pit, is necessary to allow the realigned channel to meet up with the existing channel.

It is noted that, during the survey undertaken to inform the hydraulic and hydrologic investigation and the flora and fauna survey for the Biodiversity Assessment, the location of the channel was found to be further west than the 'watercourse' mapped in Shellharbour City Council's geographical information systems (GIS) (and as shown in some maps within the EIS). A figure is attached to this memorandum that shows the location of the channel as mapped in the Council GIS and the true location of the channel (mapped as 'aquatic habitat'), as ground-truthed during the biodiversity investigation. The GPS points taken during the biodiversity assessment are also show. Within the EIS, Figure 8-20 'Watercourse locations' shows the watercourse locations, as ground-truthed on the site, and better shows how the proposed realignment will meet with the true location of existing channel. The correct alignment of the channel is also reflected in Figure 19 of the Biodiversity Assessment, which shows 'Aquatic habitat' in the true location of the channel. The size and extent of the realigned channel shown in the figures in the EIS represents the extent of the channel realignment required to meet with the location of the existing channel as surveyed.

A memorandum, dated 15 July 2014, that was prepared to inform Shellharbour City Council of the sizing and design of the realignment to the channel is attached to this memorandum. It is noted that the memorandum of July 2014 proposed a concrete lined channel; however, to reduce the potential environmental impacts of the channel realignment a greased swale is proposed in the EIS, as a result of the biodiversity impact assessment. As noted in the compilation of mitigation measures and the biodiversity assessment report, the realigned drainage line would be revegetated with native species and the riparian corridor would be revegetated with locally occurring species of the SOFF community.

Clearing associated with realignment of the drainage line

The Biodiversity Assessment for the proposal included an assessment of the impacts of the realigned drainage channel on SOFF. Figure 18 of the Biodiversity Assessment and Figure 8-26 of the EIS show the extent of the vegetation communities mapped within the biodiversity study area (shown as purple in the figures) and the proposal footprint (shown as red in the figures, and includes the realigned drainage channel, being the section of the proposal footprint that extends southwards). A buffer of ten metres was applied to the centreline of the proposed channel to account for the construction footprint of the channel. The impacts on SOFF as a result of the proposal, equating to 0.76 ha, included this area. Figure 18 of the Biodiversity Assessment shows the approximate location of the existing channel, shown in light blue as 'watercourse' and the location of the proposed channel realignment, shown in dark blue as 'Drainage channel'. For further clarification Figure 2-4 of the EIS shows the proposed channel realignment (shown in dark blue) and the approximate location of the existing channel (shown in light blue). Figure 18 of the Biodiversity Assessment is attached to this memorandum.

It is noted that the 'Proposal site', as shown in the majority of figures of the EIS and the Biodiversity Assessment, includes the construction footprint of the realigned channel and impacts associated with the channel have been addressed for each environmental aspect.

We trust this information meets your requirements with regards to drainage within the Proposal site.

Bradley Searle
Business Leader – Environment
(0) 2 8907 9059

Included:

1. Memorandum to Shellharbour City Council – Hydraulic and Hydrologic Assessment
2. Figure showing channel as mapped in council GIS and ground-truthed location
3. Figure 8-20 from EIS – Watercourse locations in relation to the Proposal site
4. Figure 18 from Biodiversity Assessment – Vegetation communities to be cleared in the study area

MEMORANDUM

Date	15 July 2014
To	Courtney Williams
From	Patrick Sloan
Subject	Dunmore Sand Mine & PASS Disposal Site – Hydraulic and Hydrologic Assessment

This memorandum documents the hydraulic and hydrologic assessment of the existing waterway channel and its realignment to suit the proposed works of the Sand Mine & PASS Disposal area. This area and surrounds including the channel form "the site". The site is located within the boundaries of the Dunmore Recycling and Waste Disposal Depot.

The assessment was undertaken for Shellharbour City Council ("the Council") and was carried out entirely as a desktop study. The objective of this assessment was to determine the hydraulic performances of the existing and proposed channels and determine if the proposed channel improved flow conditions.

Hydraulic models of the existing and proposed channel were prepared and simulated. The simulation results were used to draw comparisons between the existing and proposed conditions.

1. Key Findings

The key findings of this assessment are provided below:

- No flood studies, flood models or historic flood data of Rocklow Creek were available at the time of this assessment. During the 1% Annual Exceedance Probability (AEP) flood event, it is expected that the flood level of Rocklow Creek will be 3.55m A.H.D., which will flood the site. It is assumed that during all flood events less frequently occurring than the 1 Exceedance per year flood event, floodwaters will encroach and inundate the site.
- Based on the expected frequency the site is inundated by Rocklow Creek, the realigned channel has not been hydraulically design to suit a specific design storm event. The channel has instead been designed to maintain or otherwise improve the hydraulic performance of the proposed channel when compared to the existing channel. The design also considers the expected change to flow conditions resulting from the construction of a vegetated bund structure around the sand mine & PASS disposal area.
- The channel has been designed to suit identified physical constraints and to maintain the existing drainage pattern.
- Based on the hydraulic results, it is expected that prior to inundation from Rocklow Creek:
  - The existing channel provides less than the 1 Exceedance per year (1 year ARI) event capacity.
  - The proposed channel without the bund will also provide less than the 1 Exceedance per year.
  - The proposed channel and bund will achieve 0.5 Exceedance per year (2 year ARI) event capacity. Flows generated by less frequent event are expected to overtop the bund and spill into the site.

2. Available Data

The assessment was carried out using the following data:

- Ground survey of the existing channel and surrounding area, provided by LandTeam surveyors on 8 July 2014 in digital format.
- Topographic survey map of the Dunmore Recycling and Waste Disposal Depot, dated 17 December 2013 and provided by the Council in digital format.
- Site plan of the sand mine and PASS disposal area, dated 15 January 2014, prepared by Coffeys and provided to Hyder in digital format.
- Photos taken during a site visit on the 8 August 2013.
- Aerial imagery of the site, sourced from Google Earth.
- Site-based orthographic aerial imagery, dated 13 May 2013 and provided by the Council in digital format.
- Concept alignment of the proposed channel, dated 4 June 2014 and prepared by Hyder in digital format.
- Bureau of Meteorology Intensity-Frequency-Duration (IFD) data sourced for the site by Hyder in July 2014.
- Shellharbour Local Environment Plan 2013 zoning information, provided by the Council in digital format.
- Site Management Plan of the Dunmore Recycling and Waste Disposal Depot, dated September 2012 and prepared by Golder Associates.

3. Site Description

The site is located within western part of the Dunmore Recycling and Waste Disposal Depot. The site is generally surrounded on all sides, with embankments to the west and east, a creek to the south as well as a hill to the northwest. There is also an existing sedimentation pond to the northeast.

The entire site is covered by natural grasses and mostly dense vegetation. There are no buildings or other structures in this area.

Within the site there exists a densely vegetated, waterway channel. The channel is approximately 970m long, and follows a general north-to-south alignment. It forms a drainage pattern that conveys upstream runoff and then discharges it into the nearby creek, Rocklow Creek. Rocklow Creek is a tributary of Minnamurra River. These two waterways have been identified from the Council Local Environment Plan (LEP) as SEPP14 wetlands. The nearby sedimentation pond does not form part of this drainage pattern.

The existing channel passes through the proposed boundaries of the sand mine & PASS disposal area. This area will be enclosed by a proposed vegetated bund structure. The top of the proposed bund is RL 1.8m A.H.D. The bund has been designed to protect the site from flooding, but has not been designed to provide flood immunity up to and including a specific flood event.

In order to maintain the existing drainage pattern, it has been proposed that a 290m long section of existing channel be realigned to completely circumvent the site.

The proposed realignment has been designed to suit identified physical constraints. These constraints are: the sedimentation pond, the sand mine & PASS disposal area, the proposed bund as well as the SEPP14 wetland. The realigned channel will be concrete lined and will be graded to achieve positive drainage.

A sketch of the site layout, 'SK002-AA005925-P1', has been included at the end of the document.

4. Methodology

The following activities outline the methodology used for the assessment:

- Determined and acknowledged the extents of the study.
- Prepared assumptions based on engineering judgement and observations of the available data.
- A digital terrain model (DTM) of the project site was assembled using all available digital information including ground survey and the topographic survey map. The DTM was prepared using the software-based topographic and civil engineering program, 12d Model.
- Identified the alignment of the existing channel using the DTM.
- Developed the design of proposed channel using the DTM. The basis for this design was so that hydraulic modelling would confirm the proposed channel provided expected equal or greater hydraulic performance when compared to the existing channel.
- Catchments were delineated using the DTM and the site plan.
- Peak flows coinciding with the 1, 0.5 and 0.2 Exceedance per year storm events were calculated by Probabilistic Rational Method (PRM) using the delineated catchments design rainfall data and other site parameters.
- Hydraulic models were:
  - Assembled using the design storm event peak flows and the 12d Model outputs to simulate the following conditions:
    1. Existing channel.
    2. Proposed channel without the bund surrounding the sand mine & PASS disposal area.
    3. Proposed channel with the bund surrounding the sand mine & PASS disposal area.
  - Assembled in and simulated using software-based hydraulic program, HEC-RAS version 4.1.0.
  - Simulated in HEC-RAS using steady flow analysis.
- Observations of the hydraulic results of the existing and proposed models were then made.

5. Exclusions

Based on Hyder's understanding of the scope of this assessment, the following activities were excluded:

- Undertake impact assessment for upstream and downstream waterways.
- Undertake hydraulic assessment using elevated tailwater levels to simulate flooding in Rocklow Creek.
- Design flood mitigation measures based on observed results.
- Estimation of subsurface water flows

6. Assumptions

This assessment was based on the following assumptions:

- The following table lists the Manning's roughness values used in the models, which were assumed as appropriate:

Surface	Manning's n
Channels with mostly natural surfaces, composed of grasses and rock	0.035
Floodplains	0.1

- It has been noted from the site management plan that during the 1% AEP flood event, it is expected that the flood level of Rocklow Creek will be 3.55m A.H.D. No other information described more frequent flood events was included in this document or other available documents. The 1% AEP event will wholly inundate the sand mine & PASS disposal site. Hydraulic simulation considers only the flow in the channel prior to flooding by Rocklow Creek. Downstream and upstream boundaries were modelled using a normal slope of 0.001 to suit this setup and to simulate the site's flat topography.
- The sand mine & PASS disposal proposed works include construction of a new bund enclosing the site and topsoil removal to expose sand for extraction. It has been assumed that all runoff generated within the sand mine area will be contained by the bund and will infiltrate the sand during all design storm events up to and including the 1% AEP storm event.
- During storm events where the capacity of the existing sedimentation pond is exceeded, all overflows will not spill the site and be captured the existing and proposed channel.
- It is assumed that the operational phase of the proposed site will last for approximately 5 years. It is expected that the coincidence of a low frequency flood event occurring during this 5 year period is very low. Based on this assumption, only storm events up to and including the 0.2 Exceedance per year event have been determined and used in the hydraulic models.

7. Hydrology

Peak flows were calculated using the Probabilistic Rational Method for small to medium-sized rural catchments in Eastern New South Wales, as described in Australian Rainfall & Runoff (ARR) Book IV. The peak flows were calculated using site-specific data: IFD intensities, catchments areas, the 10 year ARI runoff coefficient and frequency factors.

The proposed bund enclosing sand mine & PASS disposal area is expected to reduce the total catchment area of the existing and proposed channel

The table below identifies the design storm event peak flows prior to and following construction of the proposed bund.

Design Storm Event		Peak Flow (cu.m/s)	
(Exceedances per year / AEP)	*(ARI)*	"Existing Channel" "Proposed Channel without Bund"	"Proposed Channel with Bund"
1 Exceedance per year	1 year	1.6	1.4
0.5 Exceedance per year	2 year	2.6	2.2
0.2 Exceedance per year	5 year	3.8	3.3

8. Hydraulics

It has been noted elsewhere that the site is expected to be frequently inundated by floodwaters originating from Rocklow Creek, based on the expected 1% AEP flood level noted in the site management plan. As no further flooding information has been made available at the time of this assessment, the expected drainage pattern during most storm events is as follows:

- The response time channel's catchment is expected to be faster than the combined catchment of the Rocklow Creek and Minnamurra River, due its perceived smaller size and shorter flow path. It is expected there will be short initial phase during the storms when the existing and proposed channel will convey flow downstream unimpeded by flooding in Rocklow Creek.
- The floodwaters will rise later in the storm, inundating the site and the channel. The channel itself will stop flowing freely. During this time, the runoff will likely be stored on site.
- As floodwaters recede, the channel will likely return to free flowing conditions, first draining the stored runoff and then upstream runoff.

Due to unknown but likely frequent flooding of the site, the simulated models of the existing and proposed channels have not been simulated using elevated tailwater conditions. The models have been simulated to provide hydraulic results during the short initial phase of the storm when the channels are flowing free.

Three models were prepared to suit the construction of the channel realignment and the proposed bund. It is expected that the channel realignment will be constructed before the proposed bund.

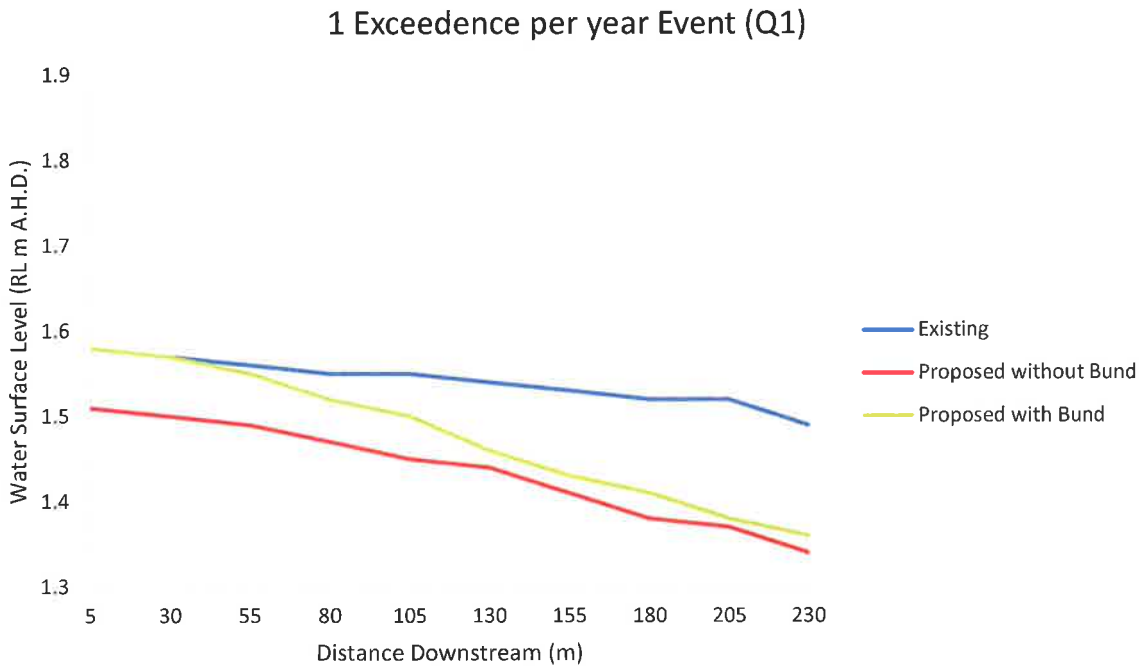
The software-based hydraulic program, HEC-RAS, was used to generate results of the existing and proposed channels.

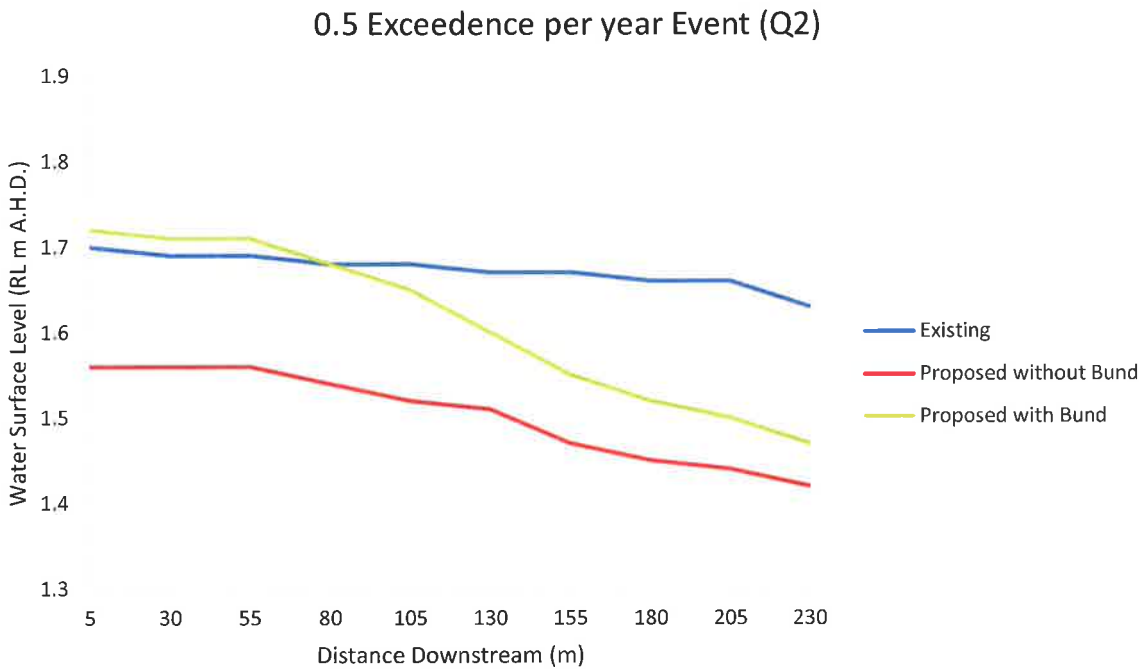
A table of the three models' hydraulic performances has been prepared below. Please note that in this table:

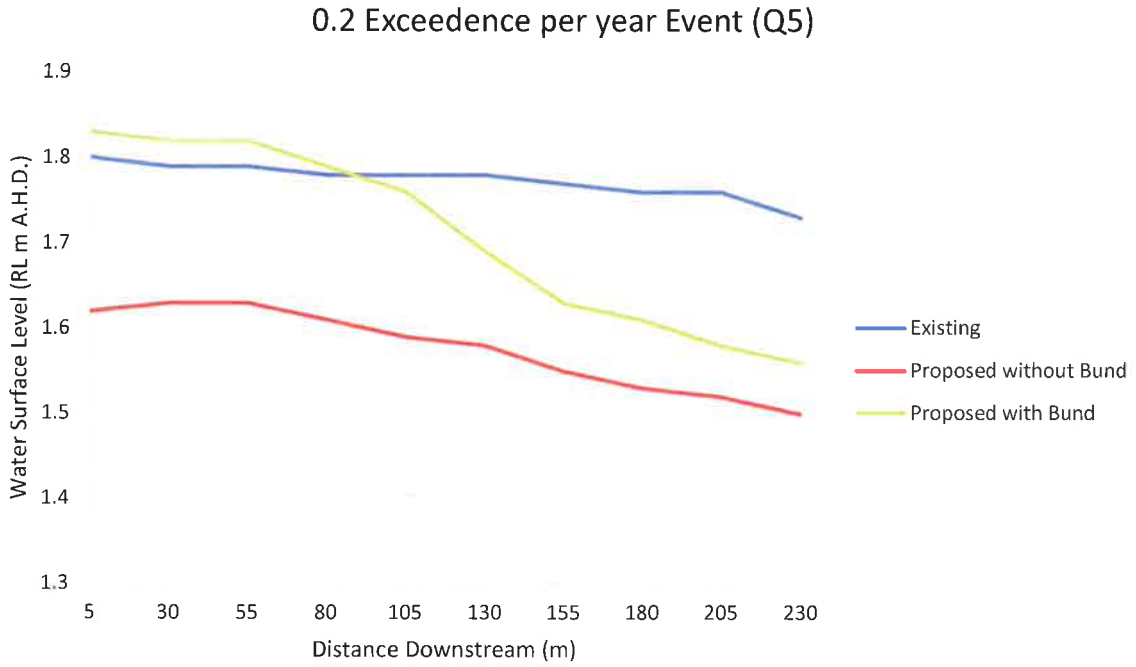
- The 'Distance D/S' to the distance equal to the value in the cell below, measured downstream from the upstream starting point of the channel realignment. Refer to the site layout for these channel distances.
- The 'Q1', 'Q2' and 'Q5' water surface level results refer to the 1, 0.5 and 0.2 Exceedance per year storm events respectively.
- The hydraulic performance that has been observed is the water surface level.

Distance D/S (m)	Water Surface Level (RL m A.H.D.)								
	Existing			Proposed without Bund			Proposed with Bund		
	Q1	Q2	Q5	Q1	Q2	Q5	Q1	Q2	Q5
5	1.58	1.70	1.80	1.51	1.56	1.62	1.58	1.72	1.83
30	1.57	1.69	1.79	1.5	1.56	1.63	1.57	1.71	1.82
55	1.56	1.69	1.79	1.49	1.56	1.63	1.55	1.71	1.82
80	1.55	1.68	1.78	1.47	1.54	1.61	1.52	1.68	1.79
105	1.55	1.68	1.78	1.45	1.52	1.59	1.5	1.65	1.76
130	1.54	1.67	1.78	1.44	1.51	1.58	1.46	1.60	1.69
155	1.53	1.67	1.77	1.41	1.47	1.55	1.43	1.55	1.63
180	1.52	1.66	1.76	1.38	1.45	1.53	1.41	1.52	1.61
205	1.52	1.66	1.76	1.37	1.44	1.52	1.38	1.50	1.58
230	1.49	1.63	1.73	1.34	1.42	1.50	1.36	1.47	1.56

The results in the table have been displayed presented in graphs below, comparing the water surface level of the three models during each of the selected storm events.

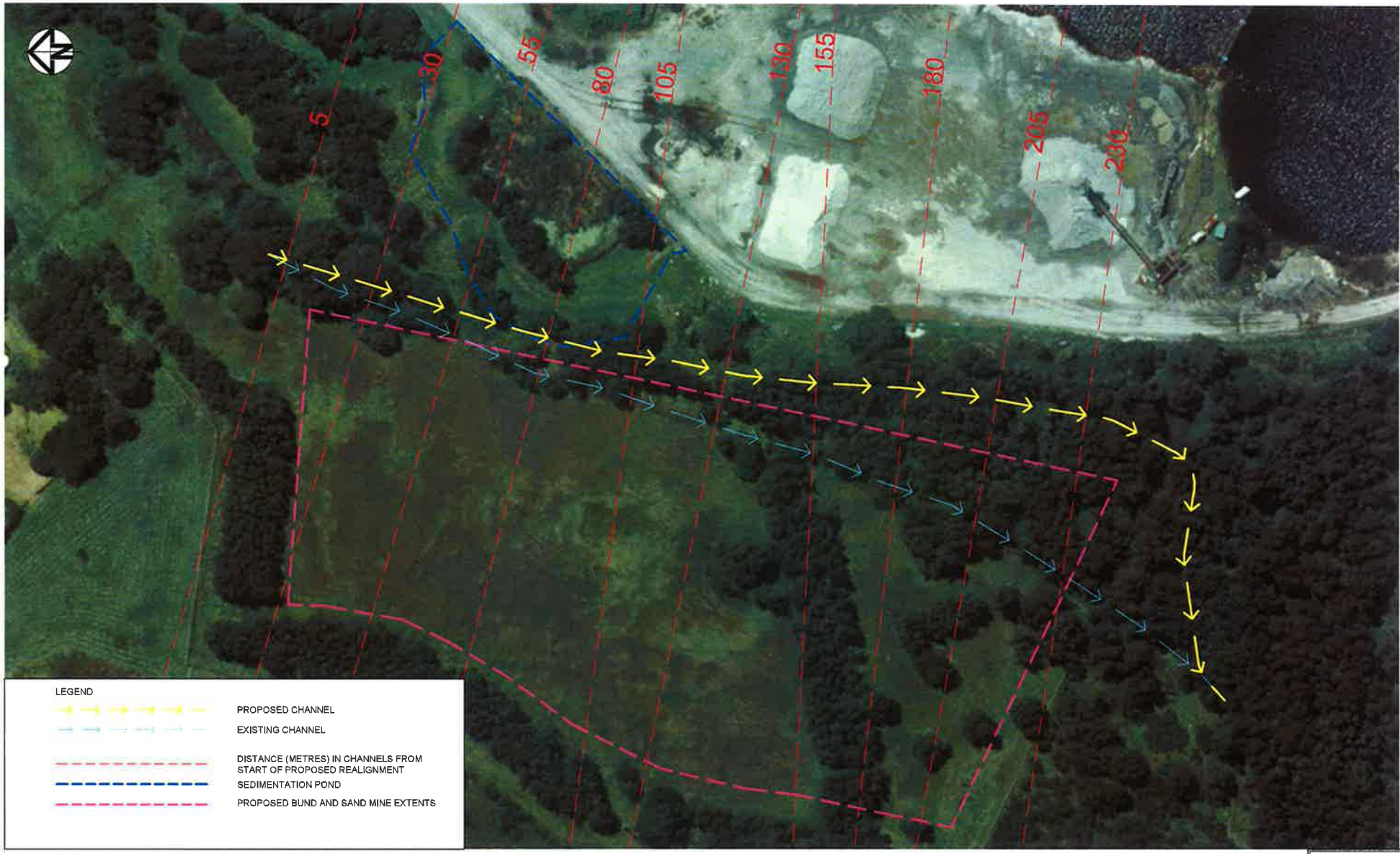






7. Observations and Conclusions

- It has been observed from the hydraulic assessment results that:
  - The existing channel provides less than the 1 Exceedance per year (1 year ARI) event capacity. Overflows encroach into the land occupied by the site.
  - The proposed channel without the bund will also provide less than the 1 Exceedance per year event capacity, although overflows will encroach less into the future site when compared to the existing channel.
  - The proposed channel and bund will achieve 0.5 Exceedance per year (2 year ARI) event capacity to flows originating from upstream of the channel only. Flows generated by less frequent event are expected to overtop the bund and spill into the site.
  - The proposed channel, with or without the bund, will generally improve the flow conditions when compared to the existing channel, although water surface levels near the upstream start of the proposed channel have been worsened.
- The capacity of the proposed channel could be increased by increasing the height of the bund or the size of the channel itself. Please note that any change to the bund or the channel is expected to:
  - Reduce the available area of the sand extraction & PASS disposal site.
  - Further increase the upstream water surface levels when increasing the bund height only.
  - Not change expected flooding conditions experienced by the site from Rocklow Creek.



SKETCH

Issue	Description	Date
P1	FOR INFORMATION	JUL '14

50mm on Original

0 20 40m
1 1000

Client: SHELLHARBOUR CITY COUNCIL

Status: PRELIMINARY ONLY
NOT TO BE USED FOR CONSTRUCTION

		Current Issue Signatures
Scales	1:1000	Drawn PS
Original Size	A3	Designed PS
Height Datum	AHD	Checked PS
Grid	MGA	Approved PS
Filename	SK0002-aa005925-vsk-00.dwg	

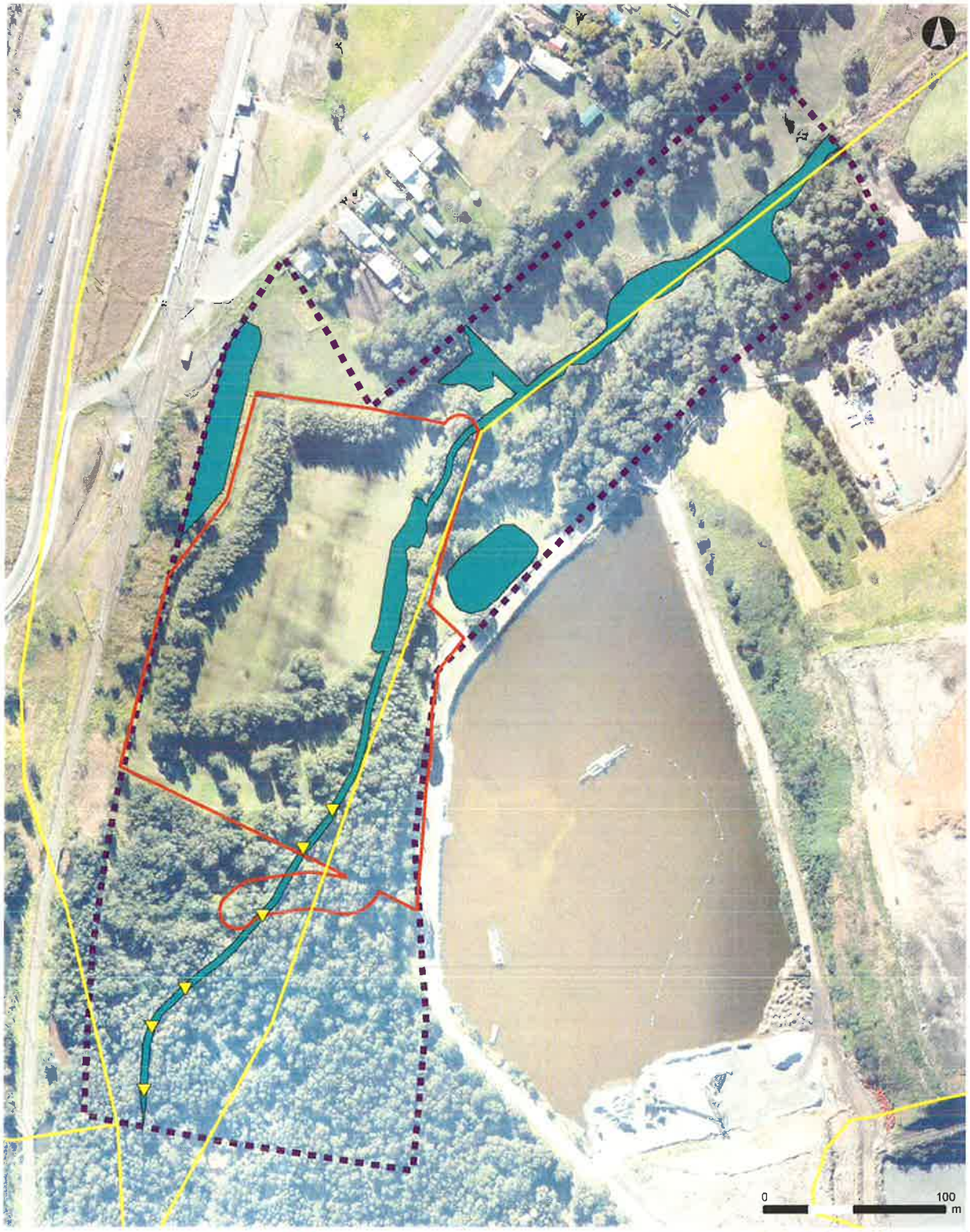
Project: DUNMORE RESOURCE RECOVERY CENTRE
SAND MINE & PASS DISPOSAL SITE
SHELLHARBOUR CITY COUNCIL

Title: PROPOSED CHANNEL REALIGNMENT SITE LAYOUT

HYDER CONSULTING PTY LTD
ABN 76 104 485 289
Level 5, 141 Walker St
North Sydney NSW 2060
Australia
Tel +61 (0)2 8907 8000
Fax +61 (0)2 8907 9001
www.hyderconsulting.com

Drawing No.	Project No.	Issue
SK0002	AA005925	P1

Date Plotted: 21 JUL 2014 - 01:08PM File Name: P:\AA005925\SK-CAD\C-Civil\Sketch\sk0002-aa005925-vsk-00.dwg



Site
Study area
Channel (as mapped in Council GIS)
Aquatic habitat
Ground-truthed channel

HYDER CONSULTING PTY LTD
ABN 76 104 485 289
Level 5, 141 Walker St
North Sydney NSW 2060
Australia
P: +61 (0) 2 8907 9000
F: +61 (0) 2 8907 9001

SCALE: 3,127 @ A4

IMAGERY:
NearMap 2011-11-27

Hyder

Channel as mapped in council GIS and ground-truthed location

DRAFT

LEGEND

- Proposal site
- Existing sand washery and stockpiles
- Watercourse
- Water body
- Rocklow Creek catchment boundary
- Lot boundary

Map scale: 1:10,000 @ A4

DATA SOURCES
Shellharbour City Council, LPI, NearMap 2013-07-05

HYDER CONSULTING PTY LTD
ABN 76 104 485 289
Level 5, 141 Walker St
North Sydney NSW 2060
Australia
P: +61 (0) 2 8907 8000
F: +61 (0) 2 8907 8001

Water course locations in realtion to the Proposal site

Figure 18: Vegetation communities to be cleared in the study area

Attachment 4 - Response to request for Information March 2015

SCC Query	Hyder Response
The EIS refers to an extraction of 100,000 tonnes. Page ii refers to 142,000m3 of sand. Are these equivalent?	The actual volume of sand to be extracted is 142,000m^3, as referenced in the introduction of the EIS. The reference to 'approximately 100,000 tonnes' of sand resource in the statement of validity was an approximation of the equivalent tonnage to the proposed extraction volume.
The 142,000m3 is a specific volume – out of interest , how was this determined?	The available sand resource was calculated based on a comprehensive geotechnical assessment undertaken by Coffey Environment for the Proposal site. Section 2.1.1 of the EIS notes that Coffey assessed the volume of the sand resource and the batter slope stability to identify an appropriate profile for the sand mine. It was determined that a batter slope of 2.5:1 would allow 142,000m^3 of fine to medium sand to be extracted. A standalone technical report which supports the derivation of available sand resource can be provided to Council as and when required.
Page ii also states that 'once 143,000m3 has been transferred ..... the site will be rehabilitated. The language is a bit vague. Does this mean that there will be more sand extracted as rehabilitation is occurring, or is this figure the total amount of sand that is to be extracted?	Rehabilitation would commence following complete extraction of the 142,000 m^3 of sand resource. No sand will be extracted beyond the quantity of 142,000 m^3. As outlined in Section 3.3 of the EIS there are two options for rehabilitation, including partial filling of the excavation area to form a wetland and re-vegetation of the Site with native water plant species (Option 1); and filling of the excavation area to form a stockpile site to support operations of the DRWDD site (option 2). Option 2 has been assessed in the environmental impact assessment section of the EIS as this option is considered to pose greatest environmental risk.
What is the depth of the quarry likely to be – I just don't seem to be able to find it. The EIS says '... excavation to a depth below standing water table'	Section 1.1 of the EIS notes that the maximum depth for sand mining within the extraction area is -14m AHD.
Also, if the levee is to be constructed to RL 1.8m, how high is this relative to surrounding landform levels – I cannot find a survey within the EIS (again I may have missed it) – Intramaps show a contour of about 4m AHD.	Section 8.2.1 of the EIS states that the existing surface level of the extraction area is 1.3 mAHD, hence the levy would be 0.5 m higher than the existing surface level. The height of the proposed levy would be of a similar profile and character to the current authorised sand extraction activities and would blend with the surrounding landscape. The levy would be vegetated with low shrubs and grasses to blend it with the surrounding landscape. As such there would be negligible impacts for nearby receivers.

Our reference: DOC15/27405-06

The General Manager
Shellharbour City Council
Locked Bag 155
SHELLHARBOUR CITY COUNCIL NSW 2529

Attention: Victoria Nicholson

EMAIL AND STANDARD POST
9 June 2015

Dear Mr Willis

Integrated Designated Development Application No. 18/2015
Shellharbour City Council Dunmore Sand Extraction Proposal
Lot 21, DP 653009, 44 Buckleys Road, Dunmore

I am writing to you about development application 18/2015 for the Dunmore Sand Extraction Proposal that was received by the EPA on 27 January 2015. The EPA notes that Shellharbour City Council holds an environment protection licence that permits the extraction of up to 100,000m^3 of material at the site per year. I apologise for the delay in responding.

The EPA has reviewed the '*Dunmore Stand Extraction Proposal - Environmental Impact Statement*', Hyder Consulting, January 2015 (EIS). As the sand extraction is already permitted by the licence, and the application was not referred to the EPA under the Integrated Development Assessment provisions of the *Environmental Planning & Assessment Act 1979*, the EPA is not issuing General Terms of Approval for this project.

Notwithstanding this, the EPA has completed a review of the EIS and provides comments and recommendations for Council's consideration as an attachment to this letter. Some of these are proposed to be progressed through a licence variation, should the development be approved by Council.

If you have any questions about this matter, please contact Megan Whelan on (02) 4224 4109.

Yours sincerely

CATE WOODS
Unit Head – Waste Compliance
Environment Protection Authority

Attached: EPA comments on Environmental Impact Statement

PO Box 513 Wollongong NSW 2520
Block D, Level 3, 84 Crown Street
Wollongong NSW 2500
Tel: (02) 4224 4100 Fax: (02) 4224 4110
ABN 43 692 285 758
www.epa.nsw.gov.au

Attachment 1

Dunmore Waste Facility – 44 Buckleys Road, Dunmore
Dunmore Sand Extraction Proposal – EPA Comments on Environmental Impact Statement

The EPA does not oppose the sand extraction proposal, but makes the following comments and recommendations in relation to the potential environmental impacts that may arise as a result of the proposal:

Noise Impacts

The EPA recommends that the applicant clarify what noise mitigation measures they plan to implement at the site. There is no commitment in the documentation to a noise barrier mound, nor to any of the other potential noise mitigation measures that are mentioned.

Without the implementation of a noise barrier mound, or other noise mitigation measures mentioned in the EIS, noise levels are predicted to be up to 5dB over the Project Specific Noise Level (PSNL) at R1 and also exceed the PSNLs at a number of other residences. Even with the implementation of a noise barrier mound, the predicted noise levels exceed the PSNL at R1.

The EPA proposes the PSNL noise limits outlined below, and notes that the applicant will need to implement additional noise mitigation measures to achieve these limits.

PrNOISE LIMITS IN dB(A)

		NOISE LIMITS dB(A)
Locality	Location	Day
		$L_{Aeq\ (15\ minute)}$
R1, R2, R3, R7 & R8	*1, 21 & 51 Dunmore Road, Dunmore and isolated residences on Swamp and James Roads*	45 dB(A)
R4	*21 Buckleys Road, Shell Cove*	42 dB(A)
R5	*North East receivers along Augusta Parkway, Shell Cove*	41 dB(A)
R6	*Killalea State Camp Site*	50 dB(A) $L_{Aeq,1hr}$ When in use

Traffic Noise Management

The EPA recommends that a Traffic Noise Management Strategy (TNMS) be developed by the applicant, for the purposes of construction and operational noise impacts prior to commencement of construction and to improve operation transport, to ensure that feasible and reasonable noise management strategies for vehicle movements associated with the facility are identified and applied, that include but are not necessarily limited to the following:

- driver training to ensure that noisy practices such as the use of compression engine brakes are not unnecessarily used near sensitive receivers;
- best noise practice in the selection and maintenance of vehicle fleets;
- movement scheduling where practicable to reduce impacts during sensitive times of the day (trucking shall be contained to day operations only);
- communication and management strategies for non-licensee/proponent owned and operated vehicles to ensure the provision of the TNMS are implemented;
- a system of audited management practices that identifies non conformances, initiates and monitors corrective and preventative action (including disciplinary action for breaches of noise minimization procedures) and assesses the implementation and improvement of the TNMS;
- specific procedures to minimize impacts at identified sensitive areas; and
- clauses in conditions of employment, or in contracts, of drivers that require adherence to the noise minimization procedures and facilitate effective implementation of the disciplinary actions for breaches of the procedures.

Air Quality Impacts

The EPA recommends that the applicant conducts further assessment in relation to the potential odour impacts from the proposal. There is the potential for oxidisation of PASS to occur during the dredging of the extraction pit, and during the placement of PASS received from offsite into the extraction pit if it is not managed appropriately. The oxidisation of PASS has the potential to cause offsite odour impacts and the gases released during oxidisation can result in serious air quality impacts.

Water Quality Impacts

It appears that this project may have water quality, flood and estuary related impacts. As such, it is recommended that the proposal be referred to the Office of Environment and Heritage and the NSW Office of Water for comment if it has not already.

Hyder Consulting Pty Ltd
Level 5, 141 Walker Street
Locked Bag 6503
North Sydney NSW 2060
Australia
Tel: +61 2 8907 9000
Fax: +61 2 8907 9001
www.hyderconsulting.com

2 July 2015

Ms Victoria Nicholson
Senior Development Assessment Officer - City Development
Shellharbour City Council
Locked Bag 155
NSW 2529

Your Ref: Integrated Designated Development Application No. 18/2015

Email: Victoria.Nicholson@shellharbour.nsw.gov.au

Integrated Designated Development Application No. 18/2015: Dunmore Sand Extraction Lot 21 DP 653009, 44 Buckleys Road, Dunmore - Response to Enquiries

Dear Ms Nicholson,

In response to your letter dated 13 May 2015, Hyder Consulting (Hyder) is pleased to provide the following information.

Acid Sulfate Soils – As requested a comprehensive acid sulfate soils management plan (ASSMP) has been prepared in accordance with the Acid Sulfate Soils Assessment Guidelines (NSW Acid Sulfate Soils Management Advisory Committee, 1998) by a suitably qualified environmental scientist of Environmental Earth Sciences (EES). The Acid Sulfate Soil Management Plan is included as **Attachment 1**.

Biodiversity - A biodiversity offset Bio Banking Assessment Methodology (BBAM) and Bio Banking Calculator to compensate for the loss of Swamp Oak Floodplain Forest (SOFF) associated with the Proposal. In accordance with the methodology established under the BBAM the Green and Golden Bell Frog (GGBF) was excluded from occurring on the site. Consultation was undertaken with the Office of Environment and Heritage (OEH) to confirm survey requirements for development of the strategy. The Biodiversity Offset Strategy is included as **Attachment 2**.

Drainage – A memorandum has been prepared to provide an explanation for the position of the relocated drainage line and includes figures showing the full footprint of vegetation clearing from Environmental Impact Statement (EIS) and the Biodiversity Impact Assessment Report. It is noted that the existing drainage line, as shown on some figures within the EIS, is not shown in the correct location based on site surveys. Hence, the footprint for the proposed drainage line relocation, which is based on ground survey of the existing drainage line, may appear not to join to the drainage line as shown. The memorandum explains the design development process undertaken for the drainage line relocation and explains that the clearing footprint assessed for the Proposal includes the construction footprint for relocation of the drainage line. It is noted that these calculations inform the Biodiversity Offset Strategy. This is included as **Attachment 3**.

Information – the information provided in response to several queries raised by Shellharbour City Council in March 2015 is attached to this response. This is included as **Attachment 4**.

If you have any further enquiries or would like further clarification on the information provided, please don't hesitate to contact me on Phone: 02 8907 9085 or email: Shannon.blackmore@hyderconsulting.com. Alternatively, please contact Courtney Williams of

Shellharbour City Council on Phone: 02 4221 6117 or email: courtney.williams@shellharbour.nsw.gov.au.

Yours sincerely

Shannon Blackmore
Senior Environmental Consultant
Ph: 02 8907 9085

Enc
1. Acid Sulfate Soil Management Plan
2. Biodiversity Offset Strategy
3. Memorandum on drainage line design development
4. Responses to queries of 11 March 2015

Attachment 1 - Acid Sulfate Soil Management Plan (EES, 2015)

ENVIRONMENTAL
EARTH SCIENCES
THE KNOW AND THE HOW

REPORT NO. **115047**

ACID SULFATE SOIL MANAGEMENT PLAN, LOT 21 DP653009, BUCKLEYS ROAD, DUNMORE NSW

ENVIRONMENTAL EARTH SCIENCES NSW
REPORT TO SHELLHARBOUR CITY COUNCIL
DATE 26 JUNE 2015
VERSION 1

Glaeba (02) Pty Ltd trading as Environmental Earth Sciences NSW
7 - 9 George Place, Artarmon, NSW, 2064 PO Box 380, North Sydney, NSW 2059
P 61 2 9922 1777 F 61 2 9922 1010 E eesnsw@environmentalearthsciences.com
www environmentalearthsciences com

EXECUTIVE SUMMARY

Introduction

Environmental Earth Sciences was requested by Shellharbour City Council (Council) to respond to an information request (dated 13 May 2015) in relation to the management of Acid Sulfate Soils (ASS) as part of Development Application No. 18/2015.

Background

In 2013 an Environmental Impact Statement (EIS) was prepared to address the Director General's Requirements (DGRs) with regard to potential environmental impacts during the establishment, operation and decommissioning of the proposed sand extraction and disposal of potential acid sulfate soil (PASS) at Lot 21 DP 653009 (the Project Site). The information request dated 13 May 2015 relates to the information provided in the EIS. Environmental Earth Sciences has been requested, in particular, to respond to questions regarding the environmental risks associated with ASS as identified within the EIS hydrogeological assessment report (Environmental Earth Sciences, 2013b).

As indicated in the information request, "*a comprehensive acid sulfate soils management plan is required to be prepared in accordance with the Acid Sulfate Soils Assessment Guidelines (NSW Acid Sulfate Soils Management Advisory Committee, 1998) by a suitably qualified environmental scientist... to substantiate that the environmental risks identified in the hydrogeology assessment are able to be reduced to an acceptable level*".

The EIS agricultural impact and acid sulfate soil assessment (Environmental Earth Sciences, 2013a) determined that the ASS risks associated with excavation of the site as a sand resource are low. This is due primarily to the absence of dewatering, and the requirement for particle size separation to provide the sand resource. The resultant fines (containing PASS as reduced inorganic sulfides [RIS]) will be returned to the dredge pond in a saturated state.

The greatest risks associated with ASS at the site have been identified with the proposal to import up to 100,000 cubic metres (m^3) of PASS during site rehabilitation works, however it has also been identified that the risk can be mitigated with appropriate management and monitoring (Environmental Earth Sciences, 2013b).

Objectives

The purpose of this Acid Sulfate Soils Management Plan (ASSMP) is to summarise the potential impact of ASS at the site and the surrounding area. Further, this ASSMP aims to provide appropriate mechanisms to mitigate the risks associated with the disturbance of PASS. The greatest risks are associated with oxidation of imported PASS and subsequent acidification and off-site migration of groundwater.

Management Strategies

Avoidance or minimal disturbance

The nature of the proposed development (sand extraction) means excavation of PASS is unavoidable, however the proposed methodology of particle size separation and sale/ re-use of the sand component will result in return of the fine fractions (containing PASS) to the base of the dredge pond. Thus a strategy of minimising disturbance and reburial (see below) will be adopted for the *in-situ* PASS excavation component of the Project.

Attachment 2 - Biodiversity Offset Strategy

On-going monitoring of PASS remaining *in-situ* will be required as part of this strategy, until it can be demonstrated that the water table is in equilibrium with the surrounding environment and is not facilitating oxidation of *in-situ* PASS.

Prevent oxidation

When disturbance is unavoidable, the prevention of oxidation of excavated or remaining *in-situ* PASS sediments without need for neutralisation is the most favourable option. The local environmental setting within which this site is situated lends itself to a reburial strategy, so long as it is efficiently managed. This strategy is detailed in this ASSMP and essentially involves the sieving of fines (particle separation for commercial sale or reuse of the sand component) and reburial of fines within the dredge pond excavation, along with the placement of PASS material within the same excavation.

Neutralisation treatment

Where reburial and placement within the mine excavation is not possible, and/or oxidation of excavated PASS occurs, treatment strategies and liming rates have been detailed.

Environmental monitoring and controls

Of major consideration to the proposed works is on-going environmental monitoring pre-, during- and post-development. During development, factors such as stockpile monitoring, validation of neutralisation (i.e. treatment), and soil/ sediment migration/ relocation issues are of primary importance.

Of secondary but considerable importance is on-going monitoring of *in-situ* PASS during- and post-development, pertaining primarily to ensuring that these sediments remain saturated. This will be required until it can be demonstrated that the water-table is in equilibrium with the surrounding environment and is not facilitating oxidation of *in-situ* PASS. Timing of the recommended environmental monitoring works is detailed in this plan.

It is expected that management of discharging groundwater will be able to occur within the confines of the excavations, with any water accumulating in excavations to be managed at these points. It is expected that the only active management of water may be periodic lime-dosing to decrease natural levels of acidity.

Preferred management strategy

The preferred strategy for management of PASS and/or actual acid sulfate soils (AASS) as part of the sand mining activities is as follows:

1. Commence excavation works by mining the shallow sand material (above the water table) and work to depth;
    a. This strategy will ensure excavation works commence away from areas of PASS and groundwater ingress, hence there will be no restrictions on the excavation process other than standard environmental management practices such as erosion and sediment controls;
2. Once the excavation extends in depth greater than 1-2m below the ground surface some groundwater ingress may commence;
    a. Instigate a system of controlling groundwater discharges within the excavation area (e.g. creation of a bunded ponding area within the excavation);

3. Manage the excavation of sand materials (containing PASS) by sieving the fines out of the excavated material and returning fines to the excavation (under the watertable) immediately;
    a. If this material does not remain saturated, or is to be stockpiled dry for more than 48 hours, it is recommended that lime be added at a rate of 30 kg $CaCO_3$/T and validation occur at a rate of one sample analysed for the Chromium Reducible Sulfur (CRS) suite per 100 T of treated soil; and
4. Manage the final excavated landform in preparation for placement of PASS to ensure that the excavation is deep enough to manage approximately 100,000 m^3 of PASS material being imported from offsite;
    a. If this material does not remain saturated, or is to be stockpiled dry for more than 48 hours, it is recommended that lime be added at a rate to be determined based on ASS assessment results prior to transportation and validation occur at a rate of one sample analysed for the CRS suite per 100 T of treated soil.

Prior to, during and following the sand mining excavation works, bores BH21 and BH22 should be retained and monitored for changes in static water level (SWL) and chemistry (field and laboratory analysis). Any surface water ponding in the excavations as a result of discharging groundwater should also be monitored for chemistry (weekly using field instruments and monthly by submitting samples to a laboratory), whilst the water chemistry of the excavation once rehabilitated should also be monitored at the same frequency for a period of 12 months.

Updating management plans

ASSMPs should not be static documents, they require periodic review and update, especially as unexpected issues arise, or the success or failure of management methods may become apparent well before the project is complete. It is imperative that the management plan be reviewed and periodically updated to reflect knowledge gained during the course of operations and to reflect new scientific advances and changed community standards. Changes to the management plan should be developed and implemented in consultation with relevant authorities.

This executive summary is not a stand-alone document and must be read in conjunction with the attached ASSMP.

On behalf of
Environmental Earth Sciences NSW

Project Manager
Nicole Cheung
Senior Environmental Scientist

Project Director / Technical Reviewer
Mark Stuckey
Principal Soil Scientist & Hydrogeologist (CPSS-3)
115047 ASSMP_V2

TABLE OF CONTENTS

FIGURES

1 INTRODUCTION AND OBJECTIVE

Environmental Earth Sciences was requested by Shellharbour City Council (Council) to respond to an information request (dated 13 May 2015) in relation to the management of Acid Sulfate Soils (ASS) as part of Development Application No. 18/2015.

The ultimate objective for Council is the approval of a development application for sand extraction activities. The objective of this work would be to support the approval process by addressing potential ASS issues at the site. Further to this, risks associated with possible importation of ASS to the site also need to be managed.

In 2013 an Environmental Impact Statement (EIS) was prepared to address the Director General's Requirements (DGRs) with regard to potential environmental impacts during the establishment, operation and decommissioning of the proposed sand extraction and disposal of potential acid sulfate soil (PASS) at Lot 21 DP 653009 (the Project Site). The information request dated 13 May 2015 relates to the information provided in the EIS. Environmental Earth Sciences has been requested, in particular, to respond to questions regarding the environmental risks associated with ASS as identified within the EIS hydrogeological assessment report (Environmental Earth Sciences, 2013b).

As indicated in the information request, "*a comprehensive acid sulfate soils management plan is required to be prepared in accordance with the Acid Sulfate Soils Assessment Guidelines (NSW Acid Sulfate Soils Management Advisory Committee, 1998) by a suitably qualified environmental scientist... in order to substantiate that the environmental risks identified in the hydrogeology assessment are able to be reduced to an acceptable level*".

The purpose of this Acid Sulfate Soils Management Plan (ASSMP) is to summarise the potential impact of ASS at the site and the surrounding area. Further, this ASSMP aims to provide appropriate mechanisms to mitigate the risks associated with the disturbance of PASS.

2 SITE IDENTIFICATION

A summary of the site details is presented in **Table 1**. The site is currently used as the Dunmore Recycling and Waste Disposal Depot (DRWDD), with the site location shown on the attached **Figure 1**. The proposed sand mining area is located at the north-west corner of the DRWDD, which is part of the landfill area regulated under EPL 5984. See **Figure 2** for the outline of the proposed sand extraction area.

TABLE 1 PROPERTY IDENTIFIERS

Item	Details
Site Owner	Shellharbour City Council
Address	Buckleys Road, Dunmore
Lot and DP numbers	Lot 21 DP 653009
Area (of proposed project site)	3.5 hectares
Zoning	RU1 – Primary Production E3 – Environmental Management
Local Government Authority	Shellharbour City Council
Site Location and Layout	Figure 1 and Figure 2

Based upon the information provided, the overall area of the landfill is 60 hectares. The area proposed for mining (herein referred to as the Project Area or the Proposal) has an area of approximately 3.5 hectares, with 2.05 hectares to be disturbed.

3 OVERVIEW OF ENVIRONMENTAL ATTRIBUTES OF THE SITE AND SURROUNDS

3.1 Regional meteorology

Regional meteorological data has been source from the Bureau of Meteorology (2013) (*www.bom.gov.au*, verified 12 August 2013) Kiama Bowling Club weather station, approximately 7 km from site, and is summarised in **Table 2**. As no daily total evaporation data was available from the Kiama weather station, data from the Nowra RAN Air Station No. 068076 has been provided for comparison.

TABLE 2 AVERAGE MONTHLY CLIMATE DATA

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Maximum Temperature (°C)	25.2	25.2	24.3	22.3	20.1	17.7	16.9	18.2	20	21.8	22.4	24.3
Minimum Temperature (°C)	17.5	17.8	16.5	13.8	11.9	9.4	8.5	8.9	10.7	12.4	14	16.3
Rainfall (mm)	107	119	143	131	119	124	88	81	73	87	90	93
Evaporation (mm)	208	160	143	117	93	84	96	127	144	174	180	211

Dunmore's climate can be described as temperate with mild winters and summers. The temperature ranges from winter with an average daily maximum temperature of 16.9°C in the coldest month of July, to warm summers with mean daily maximum temperatures of 25.2°C in January. Minimum winter daily temperatures range from 8.5 - 8.9°C and the area is rarely subjected to frosts and temperatures below zero degrees Celsius.

Average annual rainfall recorded at Dunmore is about 1112.1 mm and the rainfall pattern has a late spring to summer dominant trend. Monthly total evaporation rates are larger than the average monthly rainfall (**Table 2**) except for April, May and June. It is during these times that the potential for recharge or deep drainage is the greatest. Soil moisture is generally not limiting to plant growth during the hottest summer months although pasture growth of summer active grasses is slowed during the colder months.

3.2 Landform and topography

The Project Area is part of a small catchment (Rocklow Creek) comprising of ~2,200 hectares where the upper catchment is characterised by long to gently moderately inclined side slopes and undulating to rolling hills with slopes <15 per cent. Drainage lines are between 300 and 3,000 m long and elevation ranges from one metre Australian Height Datum (mAHD) to approximately 160 mAHD. The lower catchment comprising the Project Area is situated on level to gently inclined (0 - 5 per cent) wide alluvial plains, which contain scattered swamps on Quaternary sediments (Hazelton, 1992).

Elevation across the Project Area is between approximately 3 - 5 mAHD (**Figure 2**), with the area of greatest elevation in the catchment being the artificial rise of the landfill to the east. The upper limit of the catchment alluvial soils is positioned at close to 10 mAHD. The catchment drains to Rocklow Creek, which flows south east into the estuary of Minamurra River, approximately 1,100 m south-east of the site. The lower catchment is subject to floods and has water-logging issues due to the permanently high water tables (Hazelton, 1992).

3.3 Geology and soil

The local geology has been described in the Kiama 1:50,000 Geological series sheet 9028-1 (Bowman, 1974) as Quaternary (up to three million years old) alluvium, comprising of gravel, beach and dune sand. Alluvium is underlain by early to late Permian aged (225-275 million years old) latite, which can be found outcropping to the north of the site. Swamp deposits consisting of sands, silts and clays are located in and around the area of Shellharbour. Local area geology (after Bowman 1974) has been provided on **Figure 3**.

Environmental Earth Sciences (2013a) reported that the soil type at the site is a Oxyaquic Hydrosol (**Figure 4**), while review of the Soil Landscapes of the Kiama 1:100,000 Sheet (Hazelton, 1992) indicates that the site falls within the Killalea (swamp) soil landscape (**Figure 5**). The soils are common on coastal alluvial plains and swamps. Soil was described as organic, black, massive sandy loam topsoil overlying loose bleached light grey sand with iron staining in the subsoil. The structure is generally apedal massive, with abundant roots and limited coarse material. The soils may also be sodic and strongly acid.

The Department of Land and Water Conservation (1997) Albion Park ASS risk map (reproduced as **Figure 6**) indicates the site lies within the "Ap2" category, indicating a high probability of ASS occurring within the soil profile. The potential ASS material is within one metre of the ground surface, and severe environmental risk is considered likely if ASS materials are disturbed by activities such as shallow drainage, excavation or clearing.

3.4 Groundwater use

In summary, the site is underlain by a shallow, unconfined aquifer that is likely connected to Rocklow and Dunmore Creek's, the confluence of which lies approximately 200 - 300 m south of the Project Area. Rocklow Creek flows south into the estuary of Minnamurra River.

Environmental Earth Sciences monitoring and modelling of the site (Environmental Earth Sciences 2004, 2012 and 2013b) indicates that the landfill has not caused any measurable impact on the groundwater levels (or quality) surrounding the site beyond slight mounding within the immediate vicinity (100 m) of the site. A general south easterly groundwater flow for the unconfined shallow groundwater has been established across the lower catchment including the landfill and sand quarry.

A search of registered groundwater licenses surrounding the Project Area indicates that only three boreholes within a three km radius of the site are registered for any purpose other than monitoring. Boreholes GW044447 and GW100090 are registered for stock use and are located approximately 1.2 km north and 2.2 km north, north-west of the Project Area respectively. Borehole GW060313 is licensed for recreational use and is located approximately three kilometres north, north-east of the Project Area.

Given the site's position in the catchment the Project Area is likely to be down gradient of these extraction sites and as such, it is unlikely that site activities will impact on these extractive sites. In addition, only bore GW044447 is located within the same aquifer as the Project Area.

3.5 Land-use

Land use over the 2,200 hectares Rocklow Catchment is varied and ranges from grazing cattle and horses on small lot holdings, mining (quarries), industrial (landfilling), commercial, residential and recreational (golf course). Large areas of native remnant vegetation are found around Rocklow Creek and Minnamurra River and on the upper slopes of the catchment (Environmental Earth Sciences, 2013a). The Project Area is currently a vacant lot with remnant vegetation, planted tree stands and grassland **(Figure 7**).

3.6 Vegetation

The existing vegetation communities within the Project Area are shown on **Figure 7**, and include the following:

- Exotic grass cover (pasture species) (approximately 1.43 hectares);
- Planted buffer zone: native Casuarina sp. trees with pasture grass understorey (approximately 0.44 hectares); and
- Native Swamp Oak Floodplain Forest (NSW Endangered Ecological Community) (approximately 0.18 hectares).

3.7 Primary industry resources

The Project Area is located in an area with a history of mining and agricultural production. The Project Area is adjacent to the Princes Highway, which ensures a buffer distance of >200 m to any agricultural enterprise. The current dominant land uses adjacent to the Project Area are sand mining activities, hard rock mining, residential/recreational areas and grazing activities (Environmental Earth Sciences, 2013a).

The Killalea soil landscape is generally used for grazing of cattle and horses on improved and native pasture when not inundated. The Killalea soil landscape limitations are generally high for cultivation and grazing, owing to flood hazard, water-logging, poor water holding capacity and permanently high water-tables. As such, there is no current evidence of crop production (irrigated or unirrigated) or intensive horticulture within the immediate surrounds (one kilometre radius) of the Project Area. The Links Shell Cove Golf Course is approximately 500 m to the north east of the Project Area.

The Project Area is adjacent to the Mangrove Creek soil landscape (see **Figure 5**), which is largely unused for agricultural production, given the flood hazard, high water tables, and potential salinity issues. Mining activities lie immediately east and west of the site. These are highly disturbed environments.

4 OVERVIEW OF THE PROPOSED WORKS

Shellharbour City Council (SCC) is proposing to undertake works for the purpose of sand extraction and placement of potential acid sulfate soil (PASS) materials within the Dunmore Recycling and Waste Disposal Depot (DRWDD), at Dunmore (the Proposal). The Proposal would involve the extraction of sand from a portion of Lot 21 DP 653009 (the Project Site), for sale. It is possible that the excavation formed would be used to dispose of approximately 100,000 cubic metres (m^3) of material identified as PASS from offsite sources.

SCC owns and operates the DRWDD which services the Shellharbour Local Government Area (LGA). A component of the operations at this site includes the extraction of sand from below the water-table for sale to local businesses and residents. Sand reserves in the existing sand extraction area are nearing depletion. Therefore, SCC is seeking consent for the extraction of sand in a new location within Lot 21 DP 653009.

SCC sees an opportunity to assist with the management of PASS material at sites outside of the project site, within the LGA as part of this project. SCC proposes to take approximately 100,000 m^3 of PASS, with the intention to place it beneath the water-table in the excavation formed by sand extraction at the DRWDD. This would remove the need to source a large quantity of new, clean fill material for rehabilitation purposes by providing an appropriate reuse site for PASS material.

The disposal of PASS within the excavation would be undertaken in accordance with the best practice management recommendations set out in Part 4 of NSW EPA (2014) and in accordance with conditions of Environment Protection Licence (EPL) 5984. The site EPL requires PASS to be *"disposed of at least 1 metre below the permanent water table at the premises"*.

In summary, the Proposal includes the following works:

- Extraction of sand from a location in Lot 21 DP 653009 at the DRWDD, for sale or reuse; and
- Disposal of approximately 100,000 m^3 of PASS in the excavation at the DRWDD.

As identified within the scope of proposed works, the project would involve establishment of the sand extraction site, extraction of sand, deposition of PASS within the excavated area

and rehabilitation of the area, over a period of approximately two years. The proposed sand extraction site consists of an area to be disturbed of approximately 2.05 hectares.

Figure 8 presents an approximate schematic drawing of the Project Site following the completion of excavation works, prior to reinstallation works. **Figure 9** provides a cross-section of the Project Site following reinstatement with PASS and subsequent capping with either a wetland or clay capping material, and **Figure 10** shows a plan view of the Project Site over the course of the proposed site works (from existing environment to final rehabilitated landform).

5 PERFORMANCE CRITERIA AND EXISTING DATA

5.1 Soil screening criteria

The term acid sulfate soils (ASS) includes both actual and potential acid sulfate soils (AASS and PASS). Actual ASS are defined as soil "containing highly acidic soil horizons" producing "hydrogen ions in excess of the sediments capacity to neutralise the acidity, resulting in soil of pH of '4' or less when measured in dry season conditions". PASS are defined as soil "that contains sulfidic material that has not been oxidised and poses a considerable environmental risk, as they will become extremely acid when exposed to air and oxidised."

Any soil either excavated or dewatered at the site, or imported to the site, that exceeds the screening criteria presented in **Table 3** will be considered ASS (PASS if it exceeds the Sulfur Trail values, AASS if it exceeds the Acid Trail values, and ASS if it exceeds the NA/ NAGP values).

TABLE 3 SOIL SCREENING CRITERIA

Type of Material		**≤1000 T (≤600 m^3) disturbed**			**>1000 T (>600 m^3) disturbed**		
Texture	Clay	Sulfur Trail	Acid Trail	NA/ NAGP	Sulfur Trail	Acid Trail	NA/ NAGP
Units	%	%S	mol H^+/T	kgH_2SO_4/T	%S	mol H^+/T	kgH_2SO_4/T
Coarse	≤5	0.03	18	1.0	0.03	18	1.0
Medium	5-40	0.06	36	2.0	0.03	18	1.0
Fine	≥40	0.1	62	3.0	0.03	18	1.0

Notes:
1. 'disturbed' refers to excavation, dewatering, dredging, etc;
2. Coarse = sands; Medium = sandy loams/silts to light clays/silts; Fine = medium to heavy clays, silty clays; and
3. NA net acidity/ NAGP net acid generation potential – requires %S and acid neutralising capacity (ANC) to determine.

5.2 Hazard assessment

Hazard classes are a means to define material based on impact to the environment, and are based on soil sulfide (S) and net acidity (NA) values. Net acidity refers to acid-base accounting (ABA), as it includes assessment of the natural buffering capacity of soil, usually present as carbonates measures as acid neutralising capacity (ANC) in the laboratory. Risk classes normally used to determine the degree of management and remediation required (if

any) are no risk - no sulfur, no risk - non-reactive, moderate risk and high risk. An explanation of these classes is presented below and summarised in **Table 4**.

5.2.1 No risk-no sulfur (Not Acid Sulfate Soil [NASS]) and no risk-non reactive

The no risk – no sulfur classification is based solely on the presence of sulfides measured by the CRS, S_{POS} or TOS methods (Ahern, *et al*. 2004). Soils classified as 'no sulfur' are not acid sulfate soils (NASS), while 'non-reactive' soils are completely self buffering and do not require management through neutralization if oxidized (although they do require monitoring).

No risk - non-reactive is based on NA and is defined as having S values greater than the no risk – no sulfur threshold but NA values below three times that of the no risk – no sulfur values. Thus: for sand, NA <3 kg H_2SO_4/tonne of soil; for sandy silts and silts, NA <6 kg H_2SO_4/tonne of soil; and for sandy clays, silty clays and clays, NA <9 kg H_2SO_4/tonne of soil (**Table 4**).

Note that these levels are based on consideration of buffering agents in the soil, as per the ABA equation:

- NA (kg H_2SO_4/tonne) = sulfur (S) + acidity (TAA) + retained acidity (S_{RAS} at pH_{KCl}<4.5) – buffering (ANC/Ca+Mg)

These levels are also based on Environmental Earth Sciences experience with ASS and require consideration and trialling on a site specific basis to define the exact value, as soil texture variation can cause deviation by up to 30 per cent from the anticipated value.

5.2.2 Moderate risk and high risk ASS

Moderate risk and high-risk sediment and soil could potentially cause a significant adverse risk to the environment. Essentially, moderate risk will generate a small amount of acid slowly while high risk will either generate acid quickly, in large volumes or both. Values for moderate or high risk sediments have to be derived by either field trials or accelerated weathering experiments, but broad class groups are presented in **Table 4**. These are the only two classes that are considered ASS from a management point of view.

Table 4 presents soil sulfide hazard classes which rank the net acidity of a soil against its texture. This reflects the buffering capacity of the soil, which is generally lower in coarser (sandier) soils (i.e. sands have limited ability to offset acid generation).

TABLE 4 SOIL SULFIDE HAZARD CLASSES

Risk Class	No risk				Risk			
Hazard Class	'No-sulfur'		'Non-reactive'		'Moderate Risk'		'High Risk'	
Texture Group	Sulfur	NA	Sulfur	NA	Sulfur	NA	Sulfur	NA
1	1	N/A	>1 (<10)[4]	<3	>1	>3	>10	>5
2	2	N/A	>2 (<20)[4]	<6	>2	>6	>20	>10
3	3	N/A	>3 (<30)[4]	<9	>3	>9	>30	>15

Note(s): 1. all units in kg H_2SO_4 generated per tonne of soil
2. NA net acidity (sulfur + acid – buffering capacity)
3. Texture groups are: 1. Coarse: sands; 2. Medium: loams/silts-light clays; 3. Fine: medium to heavy clays, silty clays
4. [4] sulfur levels exceeding the values in brackets require confirmation through incubation tests or weathering trials
5. shaded values indicate relevant texture group and associated criteria for the Project Area

5.3 Acid sulfate soil assessment works to date

5.3.1 On-site *in-situ* soil assessment

An acid sulfate soil (ASS) assessment (across the areas of disturbance at the Project Site) was undertaken to inform the Agricultural Impacts section of the EIS for this Project (Environmental Earth Sciences, 2013a).

The following field and laboratory data assessment was undertaken to determine potential impacts of ASS at the extraction site, and to determine any future mitigation and management requirements (as per the requirements of Ahern *et al.* 2004):

- Field determination of:
  - Soil texture (proportion of sand, silt and clay);
  - pH_F and temperature (1:5 soil/water);
  - pH_{FOX} and temperature (30 per cent H_2O_2); and
  - Level of effervescence following H_2O_2 addition.
- Laboratory determination of:
  - Total actual acidity (TAA) (including pH_{KCl});
  - Potential acidity (S_{CR}) using the Chromium Reducible Sulfur (CRS) method;
  - Retained acidity as Net Acid Soluble Sulfur (S_{NAS}) when $pH_{KCl} \leq 4.5$;
  - Acid Neutralising Capacity (ANC) –when $pH_{KCl} \geq 6.5$; and
  - Acid Base Accounting (ABA) based on the above results.

The laboratory results obtained for the Project Site confirm that potential acid sulfate soils (PASS) are present on site (as predicted by **Figure 6**). Net acidity values are presented in **Table 5** below (after Environmental Earth Sciences, 2013a) and show that, in general, PASS is present below 1 m depth, but up to 0.6 m depth as shown by the results for borehole BH22.

Soils collected from different depths (between 0 and 2.7 m below ground level) show variable net acidity (NA) with no correlation between depth and acidity. There is a limited correlation between the depth of water table and NA, with NA highest in borehole BH22 (0.6-2.7m depth range). It is considered likely that fine material (<0.02 mm) is responsible for the elevated net acidity. The volume of fines material between layers is likely to vary, thereby contributing to various levels of acidity.

Given the sandy nature of the soils and the absence of organic matter and shell grit in the subsoil, it is considered that the soils have very low buffering capacity, which is supported by the ANC results in **Table 5**. The topsoils, on the other hand, have high organic matter content, which may contribute to the slightly acidic (pH of between 5 and 6) nature of the topsoil. These slightly acidic conditions in the topsoil are therefore not related to sulfide oxidation, rather the natural formation of organic acids.

TABLE 5 LABORATORY ACIDITY RESULTS – ON-SITE SOIL ASSESSMENT

Sample (depth)	Texture	pH_L (1:5)	pH_{KCl} (1:5)	pH_F (1:5)	pH_{FOX} (H_2O_2)	Potential Acidity (CRS)	Actual Acidity (TAA)	Buffering Capacity (ANC)	Net acidity (NA)	Risk Level
Units	-	-	-	-	-	kg H_2SO_4/T				-
BH21 (0.5-0.6)	Sand	-	5.6	6.0	5.5	<0.15	0.29	-	0.29	NASS
BH21 (2.2-2.4)	Sand	-	5.8	6.8	6.3	**6.94**	0.15	-	**7.09**	**High**
BH22 (0-0.1)	SCL	6.3	5.0	6.1	5.4	0.40	2.74	-	3.14	NASS
BH22 (0.6-1.2)	LS	6.27	6.7	6.6	**2.9**	**18.84**	<0.1	5.0	**13.85**	**High**
BH22 (1.2-1.9)	LS	-	6.1	6.9	**3.1**	**17.19**	0.15	-	**17.34**	**High**
BH22 (1.9-2.7)	Sand	-	8.8	7.3	6.1	**14.56**	<0.1	6.1	**8.49**	**High**
HA1 (0.1-0.2)	FSCL	6.51	5.2	-	-	0.34	2.45	-	2.79	NASS
HA1 (0.8-0.9)	Sand	6.0	6.1	6.9	6.7	<0.15	0.1	-	0.10	NASS
HA2 (0.1-0.2)	SCL	6.57	5.4	6.3	6.8	0.43	1.67	-	2.09	NASS
HA2 (0.8-0.9)	Sand	-	6.0	6.8	6.8	<0.15	0.1	-	0.10	NASS
HA3 (0.4-0.5)	Sand	6.49	4.7	-	-	0.31	2.74	-	3.05	NASS
HA3 (0.8-0.9)	Sand	-	5.4	5.9	5.7	<0.15	0.20	-	0.20	NASS
Criteria	-	**≥4.5**	**≥4.5**	**≥4.5**	**<4.5**	**1**	**1**	-	**3**	

Notes:
1. Shaded cells indicate exceeds criteria; **shaded and bold cells** indicates is High Risk and requires management if disturbed; – indicates no data available.

5.3.2 Off-site soil assessment of PASS materials

Prior to the importation of PASS materials to backfill the mined-out void on the Project Site, an ASS assessment of the material should be undertaken and the results of that assessment reviewed in relation to the receiving site by a suitably qualified soil scientist. The results of that assessment will inform the levels of soil sulphides (after Ahern *et al.*, 2004) within the material and allow for the calculation of NA.

The management of off-site PASS is further detailed within Section 6.2.

5.4 Summary of performance criteria, hazard and existing data assessment

Despite the necessity of a ASSMP, the likelihood of impacts from PASS or AASS handling on site is considered low. This is because:

- All imported PASS will be placed one metre below the current level of the groundwater, inhibiting the development of acid leachate;
- Excavation activities on site, while encountering the water bearing zone, are considered unlikely to change the groundwater level;
- Current site dredging activities include the sieving of material, so that fines (materials finer than sand) are separated on site and immediately returned below the water table. This technique has been used across the landfill and adjacent sand quarries with no adverse affects;
- Registered boreholes within a 1 km radius of site are used for monitoring purposes only, thereby minimising the likelihood of dewatering from an extraction well; and
- Current site monitoring by Environmental Earth Sciences has not recorded indicators that acid generation is occurring on the landfill site with current dredging activities. This is significant given that the Project Site is within a similar lithology and soil landscape as existing dredging areas.

6 EVALUATION OF ACID SULFATE SOIL MITIGATION STRATEGIES

A suitable management strategy is to be implemented to ensure that any excavated soil/ sediment is effectively managed without causing any environmental damage, onsite or offsite. More importantly, stringent controls in terms of monitoring, contingencies and placement will be put on any imported PASS. In addition, in compliance with NSW EPA (2014, Part 4), no AASS will be able to be accepted at the Project Site unless it has been appropriately treated to neutralise acidity and validated at the source site. Further, AASS will also have to be classified as a waste in accordance with Step 5 of NSW EPA (2014, Part 1), and would only be able to be accepted at the Project Site if licence conditions permit.

In formulating a management methodology, industry best practise procedures were considered, as detailed in ASSMAC (1998). The Plan has been prepared in accordance with ASSMAC (1998), and also addresses all monitoring and mitigation measures associated with the importation of PASS from off-site.

This included considering the hierarchy for preferable environmental management strategies as follows (in order of priority):

- avoid disturbance of PASS/AASS – remove risk by avoiding disturbance;
- minimise disturbance;
- prevent oxidation – reduce risk by strategic reburial below water table onsite or offsite;
- treat to reduce or neutralise acidity – reduce risk by buffering for potential acid production onsite; and
- offsite re-use or disposal – reduce risk by disposing of ASS offsite for treatment.

Unacceptable ASS management practices include:

- the use of receiving waters (marine, estuarine, brackish or fresh) as the primary means of diluting or neutralising ASS or associated treatment of acidic leachates; and
- long term stockpiling of ASS above the permanent water table without appropriate treatment, and validation that sufficient neutralising agent has been added to the ASS material.

The occurrence of ASS, both on- and off-site, has been described in Section 5 of this report. We have therefore allocated appropriate risk categories to the relevant soil/ sediment identified.

6.1 On-site PASS mitigation

6.1.1 Avoid or minimise disturbance

Due to the elevated levels NA detected in Quaternary aged sediments at this site (7 and 17 kg H_2SO_4/ tonne at boreholes BH21 and BH22respectively), avoidance where possible is the most sound management strategy.

The nature of the proposed development means excavation of PASS is unavoidable, however the proposed methodology of particle size separation and sale/ re-use of the sand component will result in return of the fine fractions (containing PASS) to the base of the dredge pond. Thus a strategy of minimising disturbance and reburial (see below) will be adopted for the *in-situ* PASS excavation component of the Project..

Based on our assessment works to date, we can estimate there will be approximately 180,000 m^3 (290,000 T) of sand material containing PASS (from between approximately 0.6 and 10m depth based on PASS occurrence in and around boreholes BH21 and BH22, as well as proposed depth of future excavation). These values are estimates only.

On-going monitoring of PASS remaining *in-situ* will be required as part of this strategy, until it can be demonstrated that the water-table is in equilibrium with the surrounding environment and is not facilitating oxidation of *in-situ* PASS.

6.1.2 Prevent oxidation

When disturbance is unavoidable, the prevention of oxidation of excavated or remaining *in-situ* PASS sediments without need for neutralisation is the most favourable option.

The local environmental setting within which this site is situated lends itself to a reburial strategy, so long as it is efficiently managed. Groundwater is encountered across the site

less than 2m below the site surface, except beneath relict dunes (Environmental Earth Sciences, 2013b). Based on the site data, PASS is present between 0.6 and 2.7 m depth around boreholes BH21 and BH22. However PASS could exist throughout the sand profile to a depth of approximately 10-15 m.

In consideration of the above, the sieving and reburial of fines below the water table during the sand extraction project (particle separation for commercial sale or reuse of the sand component) is likely to prove to be the most cost-effective and environmentally sound management option. This option would also be in line with the placement of PASS material from offsite within the final excavation as proposed as part of this Project.

Of consideration for this management strategy is:

- establishment of an on-going monitoring system; and
- determination of a method for capping of buried PASS.

Based on the data obtained to date, the volume of sand (containing PASS) to be excavated as part of sand mining activities has been estimated to be approximately 180,000 m^3 *in-situ* and approximately 100,000 m^3 of PASS material is to be imported to be placed back in the excavation following the completion of the sand mining activities.

6.2 Off-site PASS mitigation

The greatest risk of oxidation of RIS as part of the Proposal is expected to be associated with the imported PASS material, as this material will need to be:

- excavated from its *in-situ* location;
- loaded and transported to the Project Site;
- unloaded, stockpiled, tested and placed in the dredge pond; and this needs to occur
- within a finite timeframe to ensure oxidation of RIS/ PASS does not commence.

The following sections have been provided as recommendations for mitigation of the processes to be undertaken as part of the Proposal.

6.2.1 Assessment prior to transportation

The only sulfidic (RIS/ PASS) material to be accepted without treatment at the DRWDD Project Site will be that with a pH above 5.5 and total actual acidity (TAA) below 1 kg H_2SO_4/tonne of soil (0.03 %S equivalent) for sand or 3 kg H_2SO_4/tonne of soil for clay (0.1 %S equivalent).

Should soil have oxidised to form actual acid sulfate soil (AASS), such that pH <5.5 and TAA >1 kg H_2SO_4/tonne of soil for sand or >3 kg H_2SO_4/tonne of soil for clay, treatment will be required to neutralise all potential and actual acidity, prior to placement. This can occur either at the originating site prior to transport, or should limitations not allow this to occur, at the DRWDD Project Site prior to placement.

Neutralisation of the material by agricultural lime, prior to transportation, will be acceptable to raise the pH providing it can be demonstrated that neutralisation of TAA has been effective.

A 'transportation documentation' form will need to be formulated to cover additional information required for PASS and AASS. It will include a pH measurement prior to transport and at the receiving end.

6.2.2 Loading and transport

The pH of representative soil samples will be measured using a spear-point meter for wet soils or on a 1:5 soil:water basis using a glass electrode and meter for dry soils. The pH of likely PASS or ASS must be above 5.5 before being allowed to be transported, unless the generator has agreed with DRWDD operators (i.e. Shellharbour City Council) and the regulator (i.e. NSW EPA) that neutralisation will occur at the Project Site prior to placement below the water table. This pH measurement can be done for each truck or by an investigation immediately prior to excavation supported by spot checks during loading. Note that daily two-point pH calibration certificates will be required.

The soil if loaded moist must be kept moist and if loaded dry has to be kept dry. All loads will be covered and wet or moist loads will be handled in a manner to ensure loss of liquid does not occur during transport. Each load will have a chain of custody form signed by the responsible person or their representative at the point of origin. Without the signed form the truck will not be allowed to tip its load at the Project Site.

6.2.3 PASS material handling on the Project Site

When the trucks come onto the Project Site, the documents are to be checked and a sample collected and pH measured (as per the methods described in Section 6.2.2 above). If the pH and the documents are in order the material will be accepted and unloaded onto the day stockpile. This stockpile is to be placed below the water table by an excavator or dozer within 24 hours of receipt onto the Project Site.

Should the pH of any load received be <5.5, or have changed by over 1 unit during transport, the soil will be taken to a designated soil treatment area for complete neutralisation (which is to be confirmed by laboratory testing, with a report submitted to the regulator) prior to placement. It is recommended that laboratory testing for the CRS suite, including acid neutralising capacity (ANC) determination, be undertaken. No neutralised soil will be placed below the water table unless it meets the criteria for pH, NA and TAA.

6.3 Summary

Under these mitigation strategies, all PASS and/or AASS encountered during this project, both during sand mining activities as well as during the placement of PASS into the excavation, can be managed. Therefore environmental management strategies further down the hierarchy would not need to be assessed or adopted, other than retaining an appropriate volume of Ag Lime on-site for contingency measures.

7 ASS MANAGEMENT PLAN

7.1 Preferred strategy

7.1.1 Management

The preferred strategy for management of PASS and/or AASS as part of the sand mining activities is as follows:

1. Commence excavation works by mining the shallow sand material (above the water table) and work to depth;

   a. This strategy will ensure excavation works commence away from areas of PASS and groundwater ingress, hence there will be no restrictions on the excavation process other than standard environmental management practices such as erosion and sediment controls;

2. Once the excavation extends in depth greater than 1-2m below the ground surface some groundwater ingress may commence;
   a. Instigate a system of controlling groundwater discharges within the excavation area (e.g. creation of a bunded ponding area within the excavation);
3. Manage the excavation of sand materials (containing PASS) by sieving the fines out of the excavated material and returning fines to the excavation (under the watertable) immediately;
   a. If this material does not remain saturated, or is to be stockpiled dry for more than 48 hours, it is recommended that lime be added at a rate of 30 kg $CaCO_3$/T and validation occur at a rate of one sample analysed for the Chromium Reducible Sulfur (CRS) suite per 100 T of treated soil; and
4. Manage the final excavated landform in preparation for placement of PASS to ensure that the excavation is deep enough to manage approximately 100,000 m^3 of PASS material being imported from offsite;
   a. If this material does not remain saturated, or is to be stockpiled dry for more than 48 hours, it is recommended that lime be added at a rate to be determined based on ASS assessment results prior to transportation and validation occur at a rate of one sample analysed for the CRS suite per 100 T of treated soil.

The most important features of management of PASS in the proposed sand extraction area is as follows:

- ensuring that acid leachate is not produced; and
- ensuring the saturated nature of sediments beneath the site surface is maintained.

Hence long-term dewatering of these sediments should be avoided or minimised if possible, and a groundwater level monitoring program implemented as part of the management strategy.

7.1.2 Monitoring

Prior to, during and following the sand mining excavation works, bores BH21 and BH22 should be retained and monitored for changes in static water level (SWL) and chemistry (field and laboratory analysis). Any surface water ponding in the excavations as a result of discharging groundwater should also be monitored for chemistry (weekly using field instruments and monthly by submitting samples to a laboratory), whilst the water chemistry of the excavation once rehabilitated should also be monitored at the same frequency for a period of 12 months.

7.2 Contingency measure: treatment to neutralise potential acid generation

In the event that PASS material is excavated and cannot be reburied below the permanent water-table or permanent water level in the basin within the timeframes detailed in **Table 6** (below), treatment to prevent acid production due to oxidation will be required. The most favourable method of neutralising acidic or potentially acidic sediments is the mixing of agricultural lime ($CaCO_3$) with the targeted material.

The neutralising requirements of these sediments are based on the 'actual' acid already produced by oxidation (titratable actual acidity or TAA), potential for further production of acid (S_{CR}), and the effective neutralising value (ENV) of the neutralising agent to be used.

Liming rates are calculated according to the safety factor of 1.5 (kg of lime per tonne of soil), which allows for the possibility of inefficient mixing and the slow reaction rate of agricultural lime. The safety factor of 1.5 is determined through calculating the neutralising value (NV) and ENV of the liming material used.

7.2.1 Recommended liming rates

Recommended liming rates (LRs) are based on the maximum NA determined for each soil population being considered. For the on-site *in situ* PASS material to be excavated and separated from the sand resource before being placed back in the dredge pond in a saturated state, the LR is 76 kg $CaCO_3$/T (17.34 kg H_2SO_4/T x 1.02. x 1.5). The value of 1.5 is a 'safety factor' to account for inefficient mixing (ASSMAC 1998, Dear *et al.* 2014) while the value of 1.02 is to convert units from kg H_2SO_4/T to kg $CaCO_3$/T. Note that it is considered very unlikely that liming of this material will be required under the management strategy proposed.

The recommended LR for the material to be sourced from offsite will need to be calculated based on the results of an ASS assessment to be undertaken on the material prior to transportation.

7.2.2 Treatment

Agricultural lime ($CaCO_3$), which has a NV of 0.95 and an ENV of 1.02, is recommended for use in any treatment process performed. Application of a safety factor of 1.5 in the calculation of liming rates is considered to be adequate in this instance.

Other treatment options, in order of preference, include hydrated lime ($Ca(OH)_2$), quicklime (CaO), sodium bicarbonate ($NaHCO_3$), ground limestone, gypsum ($CaSO_4$), dolomite ($Ca.Mg(CO_3)_2$) and magnesite ($MgCO_3$). Calcium carbonate ($CaCO_3$), $Ca(OH)_2$, CaO and $NaHCO_3$ are all quite soluble, while the remainder have a low solubility and will act as slow-release neutralising agents (i.e. they have lower neutralising values).

All neutralising agents have benefits and liabilities. For example $CaSO_4$ can form insoluble coatings on carbonaceous material, while soluble compounds can get washed out or leached from the soil profile quite readily. They are also more caustic, making them a potential occupational hazard when handling. Ag Lime ($CaCO_3$) is preferred over $Ca(OH)_2$ and CaO, as over-liming can only raise the soil pH to 8.3, preventing potential toxic metal dissolution at very high pH (which can be an effect of over application of hydrated lime or quick lime).

7.2.3 Application of neutralising agents

It is recommended that the agricultural lime or other neutralising agents required for the buffering of potential acid generation, should PASS be allowed to oxidise, be applied by a rotary hoe, road stabiliser, dredge or excavator bucket mechanism. This will depend on the method/s of excavation used to create the sand mine excavation and timing of excavation and transport of materials from offsite. Each layer of PASS excavated and placed on the ground surface needs to be treated, then tested after mixing to confirm sufficient lime was applied and mixing was successful.

After calculating the volume (and tonnage) of soil requiring treatment in accordance with the level of treatment recommended, the volume of neutralising agent required can be easily calculated.

For operational purposes, it is estimated that each bucket load operating on a 21 tonne excavator holds approximately 1.2 m^3 of soil, while a 12 tonne excavator bucket nominally contains approximately 0.8 m^3 of soil. The actual equipment used on-site should be assessed for bucket volumes prior to work commencing.

Neutralisation should be conducted on a constructed treatment or liming pad. This will involve spreading a guard layer of neutralising agent onto the surface of a treatment pad and compacting beneath a clay layer. This will reduce the risk of infiltration of acidic leachate that may be generated during the treatment process.

Drainage from a treatment area should be directed, via a graded surface, to a sump that has been constructed with low permeability sides and base. Lime may be incorporated into the sides and base to aid in treatment of drainage. Please note that this method of water treatment may not be effective over a lengthy period, and metallic sludges can often be produced which require ongoing removal and disposal.

See Dear *et al.* (2014) and WA DEC (2011) for further information on undertaking PASS treatment by neutralisation.

7.2.4 Work health and safety recommendations

The application of neutralising agents such as agricultural lime should be conducted in line with work health & safety (WHS) guidelines relevant to the use of such materials. Although quicklime (CaO) reacts slightly faster than agricultural lime in neutralising acidic sediments, agricultural lime is considered to be a "safer option".

The WHS recommendations for the application of lime at the site are as follows:

- machinery operators are to have all windows closed during operation;
- persons present in the treatment area are to be attired with suitable gloves, safety glasses and long sleeved and trousered clothing;
- persons present in the immediate vicinity of the lime stockpile and/or application area are to be wearing appropriate dust masks and have immediate access to breathing respirators and a first aid kit;
- first aid kits onsite should also comprise a container of milk to be used in emergencies where lime has entered a person's eye; and
- a temporary enclosure constructed of shade-cloth, or other materials suitable for dust suppressing, should be erected around the lime stockpile/application area to prevent unnecessary migration of lime either across the site or offsite.

7.2.5 Validation sampling of neutralised materials

Validation sampling is required to ensure that adequate amounts of neutralising agent have been added during homogenisation. It should be undertaken at a rate of at least one sample (discrete or composited in sub-sets of up to 4 samples) per 250 m^3 of treated soil or layer being treated, whichever is the lesser.

It is recommended that all collected primary validation samples be analysed for the Chromium Reducible Sulfur (CRS) suite as part of the validation procedure. The CRS suite includes S_{CR}, TAA, pH_{KCl}, acid neutralising capacity (ANC) and net acid soluble sulfur (S_{NAS}).

Blind duplicate samples should be collected and analysed for the CRS suite at a rate of one blind duplicate per 20 primary samples. In addition, 10% of samples (1 in 10 primary samples) should also be analysed for the sPOCAS suite (peroxide-oxidisable sulfur [S_{POS}], TAA, pH_{KCl}, total potential acidity [TPA], pH_{OX}, S_{NAS} and ANC/ alkali (Ca+Mg) cations).

We further recommend that validation sampling should occur two days after the agricultural lime (or other neutralising agent) has been mixed with any re-worked soil. The results of the laboratory analysis are anticipated to be available approximately seven to ten days after the samples arrive at the laboratory.

7.2.6 Stockpile management and monitoring

Please refer to **Table 6**, which details how long stockpiles can be left on-site prior to treatment.

TABLE 6 STOCKPILE MANAGEMENT

Type of material (NCST 2009)	Approx. clay content %	Duration of stockpile
Monosulfidic Black Ooze (MBO)	≤ 5	Overnight (12 hours)
Coarse (sands to loamy sands)	≤ 5	Overnight (18 hours)
Medium (sandy loams to light clays)	5 – 40	2 days (48 hours)
Fine (medium to heavy clays and silty clays)	≥ 40	3 days (72 hours)

Once PASS stockpiles are neutralised and tested, management of stockpiles is limited to visual monitoring to ensure acid leachate is not being generated. This will need to be accompanied with periodic (weekly) field pH measurements to ensure soil pH does not fall below 5.5. Any low pH values or acid leachate areas can be easily treated with stockpiled lime (or other neutralising agent) once identified. All stockpiles should be completely bunded to ensure run-off of acid leachate or dissolved neutralising agents does not occur. Any collected leachate should also be monitored for pH and not be allowed to fall below 5.5.

7.3 On-going environmental monitoring

Of major consideration to the proposed works is on-going environmental monitoring during- and post-development. During development, factors addressed above such as stockpile monitoring, validation of neutralisation, and soil/sediment issues are of primary importance. Of secondary but considerable importance is on-going monitoring of *in-situ* PASS during- and post-development, pertaining primarily to ensuring that these sediments remain saturated.

If short term, any water-table dewatering required as part of site works should be kept localised and monitored to determine the exact changes in water levels and groundwater/soil chemistry. Any long-term water-table changes should be avoided. As such, should any dewatering occur, a monitoring program to map piezometric surface levels will be required at the commencement of the construction works and will continue into the post-development phase. This monitoring program can cease once it has been demonstrated that the water-table is in equilibrium, with all *in-situ* PASS present in a permanently saturated state.

Prior to, during and following the excavation works, bores BH21 and BH22 (**Figure 4**) should be retained and monitored for changes in SWL and chemistry (field and laboratory analysis).

Further detail on monitoring requirements at the site during (and potentially after) development are provided in Section 7.5 below.

7.4 Schedule of operations

Sand mining activities are proposed to be conducted over a 2 year period, prior to the placement of PASS material from offsite within the excavation left after mining has ceased. This is based on the information that has been supplied by the client to date.

Note that for the preferred option of reinstatement and reburial, no lime treatment is necessary so long as the PASS excavated is not allowed to oxidise.

7.5 Monitoring program

The monitoring program is designed to provide feedback to the project manager on the effectiveness of the management strategy and to provide an early warning of the development of any environmental degradation or impact to surface water, groundwater and soils, both during the Project and for a period of time after completion.

Upon remediation of the area, the site would be precluded from agricultural use and any remedial measures would be specifically target the offset of acid generation and future use as passive recreation.

7.5.1 Water monitoring

As all imported PASS will be placed 1m below the existing groundwater level a leachate management system will not be necessary. However regular monitoring will be undertaken using the existing bores BH21 and BH22 (**Figure 4**). This will allow a proactive monitoring regime to be employed so that early indications of acid generation can trigger appropriate management. These bores would be initially monitored on a monthly basis, with the monitoring regime to be scaled back in the instance of consistent results through consecutive monitoring rounds. The monitoring should proceed immediately prior, during and at the conclusion of dredging and filling activities.

Tables 7 and **8** have been presented below to assist in the interpretation of water analysis results.

TABLE 7 INTERPRETATION OF WATER ANALYSIS RESULTS

Parameter	Result Range	Interpretation	Action Required
pH	>6.0	Natural buffered water, no acid	None
	<6.0	Potential acid influence	Do not allow offsite discharge
EC (µS/cm)	>15,000	Saline, good acid buffering	None
	1,500-15,000	Brackish, moderate buffering	None
	<1,500	Fresh, poor acid buffering	Ensure pH is appropriate
TDS (mg/L)	>10,000	Saline, good acid buffering	None
	1,000-10,000	Brackish, moderate buffering	None
	<1000	Fresh, poor acid buffering	Ensure pH is appropriate
ORP (mV)	>100	Oxygenated water	Ensure pH is appropriate
	<100	Anaerobic water, O_2 depleted	None
Cl/SO_4 ratio	See Table 8	-	-
Cl/HCO_3 ratio	See Table 8	-	-
Al (mg/L)	>0.5	Potentially toxic	Do not allow off-site discharge
	0.1-0.5	Acid conditions exist	Ensure pH is appropriate
	<0.1	Water pH >5.0	None
Fe (mg/L)	>50	Water pH <6.0	Do not allow off-site discharge[3]
	10-50	Water is reducing, saline, or acid	Ensure pH is appropriate
	<10	Not acid or sulfide affected	None
SWL_{GL} (m)	<1.5	PASS layers saturated	Continue monitoring regularly
	>1.5	Potential for PASS oxidation	Ensure pH is appropriate

Notes:

1. SWL_{GL} depth to static water level below natural ground level;
2. Al and Fe are dissolved species; and
3. [3] note that the presence of dissolved Fe species may facilitate further acidification through ferrolysis.

TABLE 8 WATER CHEMISTRY INDICATORS FOR ASSESSING THE PRESENCE OF SOIL SULFIDES

Class	pH	Cl/SO_4	Cl/HCO_3	ORP (mV)	Sulfide Behaviour	Action Required
1	6-8	5-9	130-150	-ve	Absent or never oxidised	None
2	7-9	>9	<130	-ve	SO_4 converted to S (incl $H_2S_{(g)}$)*	Preliminary study
3	<5	>4	>150^	-ve	Acidity due to other causes	Explain other source
4	5-8	<4	<130	+ve	S oxidised but buffered by carbonate	Preliminary study
5	4-8	<2	<100	+ve	Abundant S oxidized, but neutralised	Detailed assessment
6	2-4	<2	>150^	+ve	Some S, low buffering capacity	Detailed assessment
7	<2	<2	>150^	+ve	Abundant S with no buffering capacity	Highly detailed study

Notes:
1. the Cl/SO_4 ratio is only relevant when TDS >1,000 mg/L;
2. this table is produced after Mulvey 1993;
3. * noted as 'rotten egg gas'; and
4. ^ HCO_3 converted to $CO_{2(g)}$ and lost to atmosphere.

7.5.2 Soil monitoring

Soil that is stockpiled onsite should be monitored on a regular basis, particularly for soil pH ($pH_{1:5}$ and pH_{FOX}). Should evidence of potential oxidation of PASS be observed through pH changes in particular, laboratory testing should be carried out. We recommend that an appropriate volume of neutralising agent be maintained on-site for the duration of the development to allow its use if localised acidification of stockpiled or dewatered soil is detected.

8 RECOMMENDATIONS

The following recommendations have been made with respect to management of potential acid sulfate soils at the proposed Sand Mine Development, Lot 21 DP653009, Buckley's Road, Dunmore, New South Wales:

- PASS should be managed and treated in accordance with this ASSMP and all relevant guidelines stipulated within;
- the requirements of any ASSMP should be referenced as part of an Environmental or Construction Management Plan prepared for the proposed development;
- the preferred management strategy includes:
    - strategic reburial of PASS that is excavated from the sand mine excavation (via particle separation and return of the fine fractions containing PASS to the base of the dredge pond); as well as

- placement of PASS material from offsite within the confines of the sand mine excavation at least 1m below the permanent water-table; and
- lime treatment of any PASS that is allowed to oxidise.

- the preferred monitoring strategy includes:
  - regular groundwater monitoring of bores BH21 and BH22 (**Figure 4**);
  - monitoring of surface water quality in the dredge pond excavation; and
  - regular monitoring of soil quality of any excavated stockpiled soil, or soil imported to the site prior to unloading and placement in the dredge pond.

9 LIMITATIONS

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

1. The specific instructions received from Shellharbour City Council;
2. The specific scope of works set out in PO115088 issued by Environmental Earth Sciences for and on behalf of Shellharbour City Council;
3. May not be relied upon by any third party not named in this report for any purpose except with the prior written consent of Environmental Earth Sciences NSW (which consent may or may not be given at the discretion of Environmental Earth Sciences NSW);
4. This report comprises the formal report, documentation sections, tables, figures and appendices as referred to in the index to this report and must not be released to any third party or copied in part without all the material included in this report for any reason;
5. The report only relates to the site referred to in the scope of works being located at Lot 21 DP653009, Buckleys Road, Dunmore, New South Wales ("the site");
6. The report relates to the site as at the date of the report as conditions may change thereafter due to natural processes and/or site activities;
7. No warranty or guarantee is made in regard to any other use than as specified in the scope of works and only applies to the depth tested and reported in this report;
8. Fill, soil, groundwater and rock to the depth tested on the site may be fit for the use specified in this report. Unless it is expressly stated in this report, the fill, soil and/or rock may not be suitable for classification as clean fill if deposited off site; and
9. Our General Limitations set out at the back of the body of this report.

10 REFERENCES

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11 GLOSSARY OF TERMS

The following descriptions are of terms used in the text of this report.

Acid neutralising capacity (ANC). The soils natural resistance to acid generation. It is the number of moles of protons per unit mass of soil required to raise the pH of the soil by one pH unit. ANC is measured as percentage $CaCO_3$.

Acid Sulfate Soil (ASS). A soil containing iron sulfides deposited during either the Pleistocene or Holocene geological epochs (Quaternary aged) as sea levels rose and fell.

Actual Acid Sulfate Soil (AASS). A soil in which soil sulfides are undergoing oxidation and producing more acid than the soils ANC, leading to a net acid generation.

Anaerobic. Reducing or without oxygen.

Aquifer. A rock or sediment in a formation, group of formations, or part of a formation which is saturated and sufficiently permeable to transmit economic quantities of water to wells and springs.

Background. The natural level of a property.

Bore. A hydraulic structure that facilitates the monitoring of groundwater level, collection of groundwater samples, or the extraction (or injection) of groundwater. Also known as a well, monitoring well or piezometer, although piezometers are typically of small diameter and only used for measuring the groundwater elevation or potentiometric surface.

Clay. A soil material composed of particles finer than 0.002 mm. When used as a soil texture group such soils contain at least 35% clay.

Discrete sample. Samples collected from different locations and depths that will not be composited but analysed individually.

Gleyed soils, waterlogged soils. Develop where drainage is poor or the watertable is high. A reducing environment exists in the saturated layers, which become mottled greyish-blue or brown because of the content of ferrous iron and organic matter.

Gradient. The rate of inclination of a slope. The degree of deviation from the horizontal; also refers to pressure.

Groundwater. The water held in the pores in the ground below the water table.

Horizon. An individual soil layer, based on texture and colour, which differs from those above and below.

Oxidation. Was originally referred only to the addition of oxygen to elements. However oxidation now encompasses the broader concept of the loss of electrons by electron transfer to other ions.

Parameters. A population value of a particular characteristic, which is descriptive of the distribution of a random variable.

Peat. Organic matter partly decomposed by water, heat and microbes, and partly carbonised and mineralised.

pH. A logarithmic index for the concentration of hydrogen ions in an aqueous solution, which is used as a measure of acidity.

Potential Acid Sulfate Soil (PASS). A soil that has the potential to become acidic if it is exposed to the atmosphere.

Profile. The solum. This includes the soil A and B horizons and is basically the depth of soil to weathered rock.
suitable for other, beneficial uses.

Representative Sample. Assumed not to be significantly different than the population of samples available. In many investigations samples are often collected to represent the worst case situation.

Saturated Zone. A zone in which the rock or soil pores are filled (saturated) with water.

Stratigraphy. A vertical sequence of geological units.

Subsoil. Subsurface material comprising the B and C horizons of soils with distinct profiles. They often have brighter colours and higher clay content than topsoils.

Texture. The size of particles in the soil. Texture is divided into six groups, depending on the amount of coarse sand, fine sand, silt and clay in the soil.

Titratable Actual Acidity (TAA). The moles of titratable protons per unit mass of soil displaced by an un-buffered KCl solution, otherwise known as the salt-replaceable acidity.

Water Table. The interface between the saturated zone and unsaturated zones. The surface in an aquifer at which pore water pressure is equal to atmospheric pressure.

ENVIRONMENTAL EARTH SCIENCES GENERAL LIMITATIONS

Scope of services

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

Data should not be separated from the report

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

Subsurface conditions change

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

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

Problems with interpretation by others

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

Obtain regulatory approval

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

Limit of liability

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

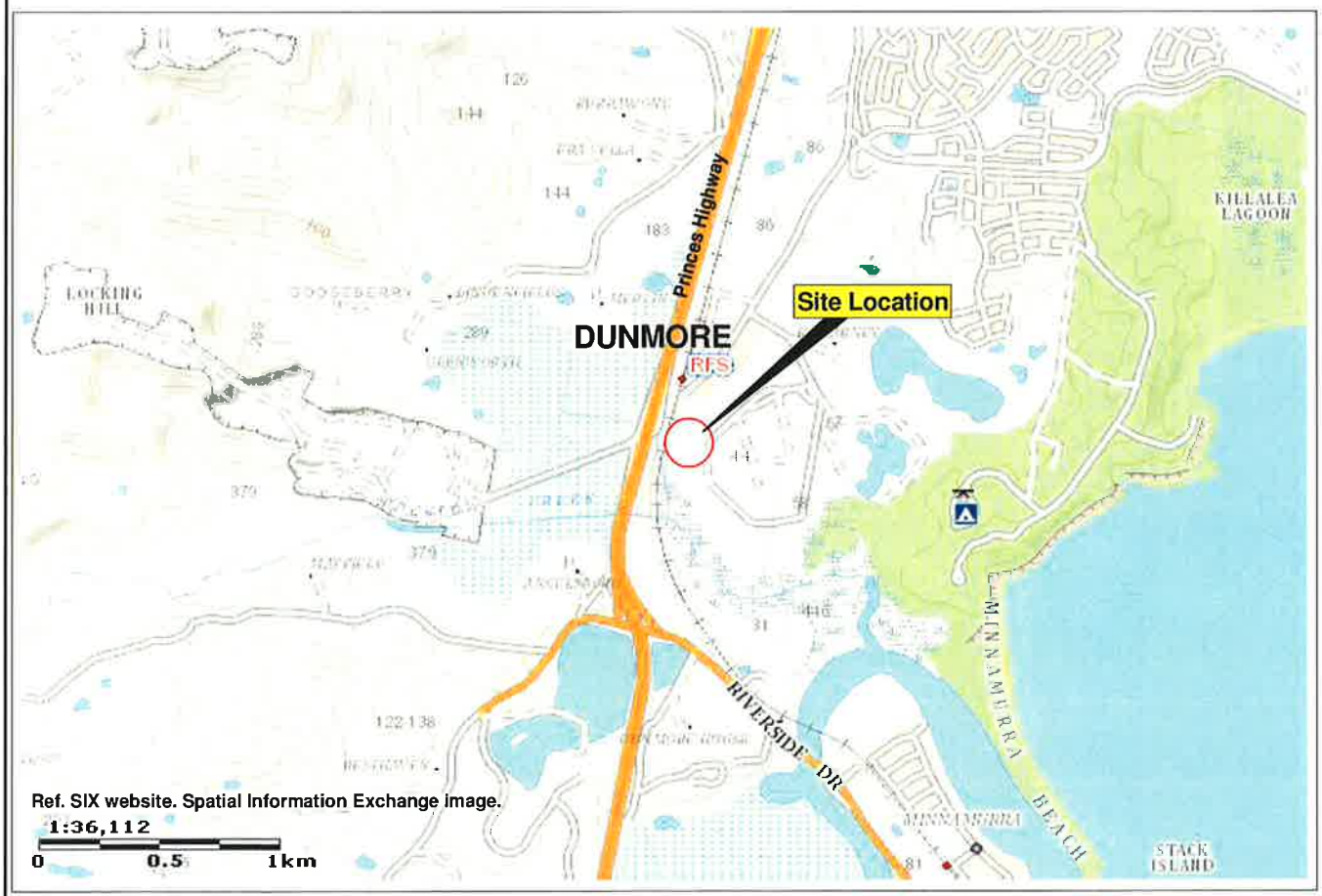
To the maximum extent permitted by law, we exclude all liability of whatever nature, whether in contract, tort or otherwise, for the acts, omissions or default, whether negligent or otherwise for any loss or damage whatsoever that may arise in any way in connection with the supply of services. Under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

FIGURES

NORTH

Regional Locality Map Dunmore, Shellharbour

Ref. Bonzle.com Map Digital Image.



Ref. SIX website. Spatial Information Exchange Image.

Site Locality Map - Dunmore, Shellharbour

ENVIRONMENTAL EARTH SCIENCES THE KNOW AND THE NOW	Title: Site Location Map	
	Location: Dunmore Recycling & Waste Disposal Depot, Shellharbour	
Client: Shellharbour City Council		Job number: 115047
Drawn by: TRJ	Scale: As shown	Source: See Ref.
Proj Man: NC	Date: June 2015	Figure 1

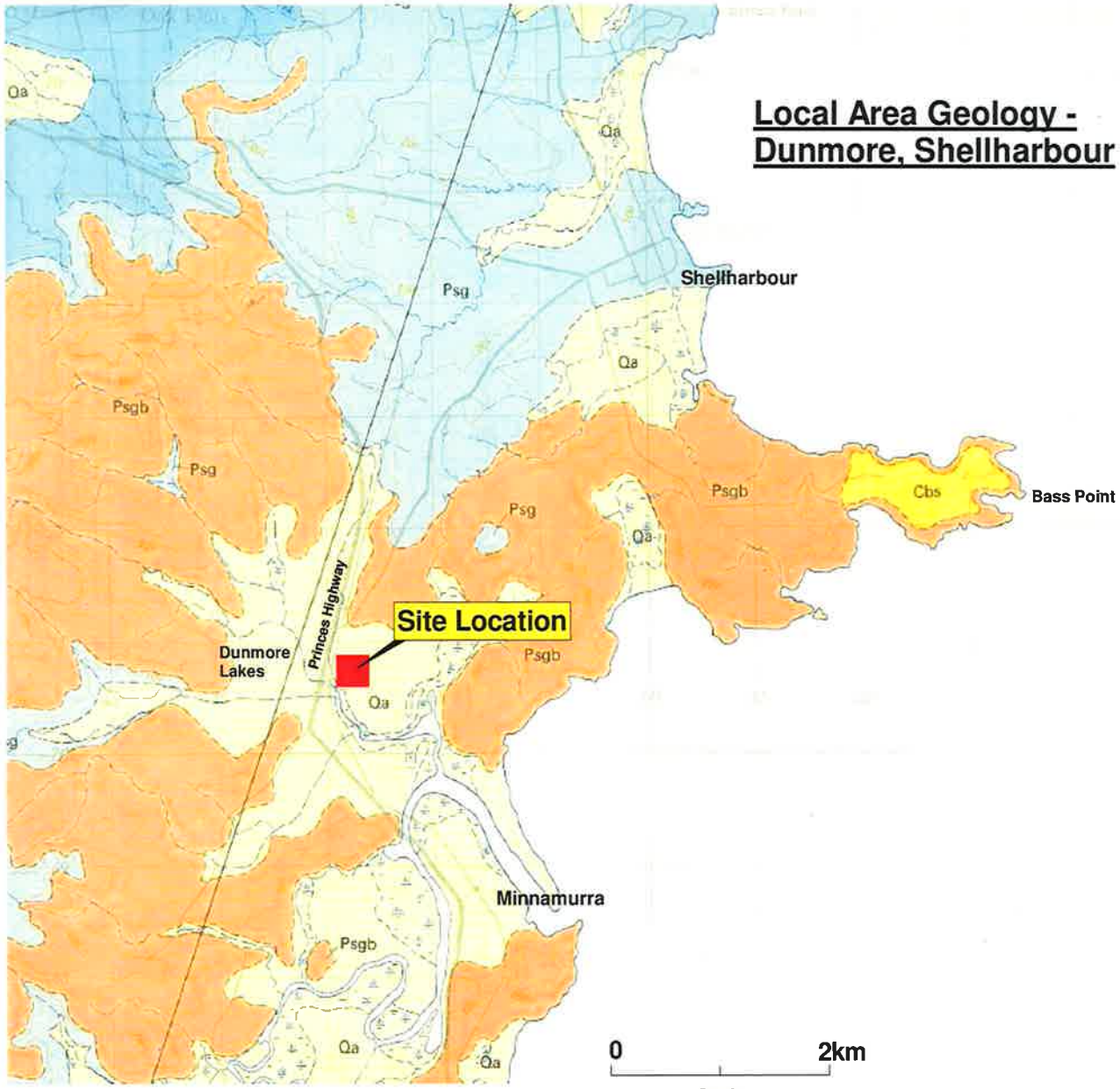
Ref. Google Earth Image 2013.

0 100 200 300 400 500 600metres

Scale Approximate

ENVIRONMENTAL EARTH SCIENCES		Title: Approximate Surface Contours	
		Location: Lot 21, DP.653009 Shellharbour, NSW	
Client: Shellharbour City Council			Job number: 115047
Drawn by: TRJ	Scale: As shown		Source: See Ref.
Proj Man: NC	Date: June 2015		Figure 2

Local Area Geology - Dunmore, Shellharbour



North

Key:

Qa	-	Alluvium, gravel, beach and dune sand (Quaternary <1.8Ma)
Psgb	-	Bumbo Latite Member (Late Permian 270-251 Ma) aphantic to porphyritic latite
Psg	-	Gerringong Volcanic Facies (Late Permian 270-251 Ma) red-brown and grey volcanic sandstones
Cbs	-	Bass Point Sandstone (Quaternary <1.8 Ma) indurated beach and near-shore marine sand

Reference: Bowman, H.N. (1974) Kiama 1:50,000 Geological Sheet, Geology. Survey. NSW. Sydney.

ENVIRONMENTAL EARTH SCIENCES
THE KNOW AND THE HOW

Title: Local Area Geology		
Location: Dunmore, Shellharbour, NSW		
Client: Shellharbour City Council		Job number: 115047
Drawn by: TRJ	Scale: As shown	Source: See Ref.
Proj Man: NC	Date: June 2015	Figure 3

North

Soil Distribution Shellharbour

0 100metres

Scale Approximate

Legend:

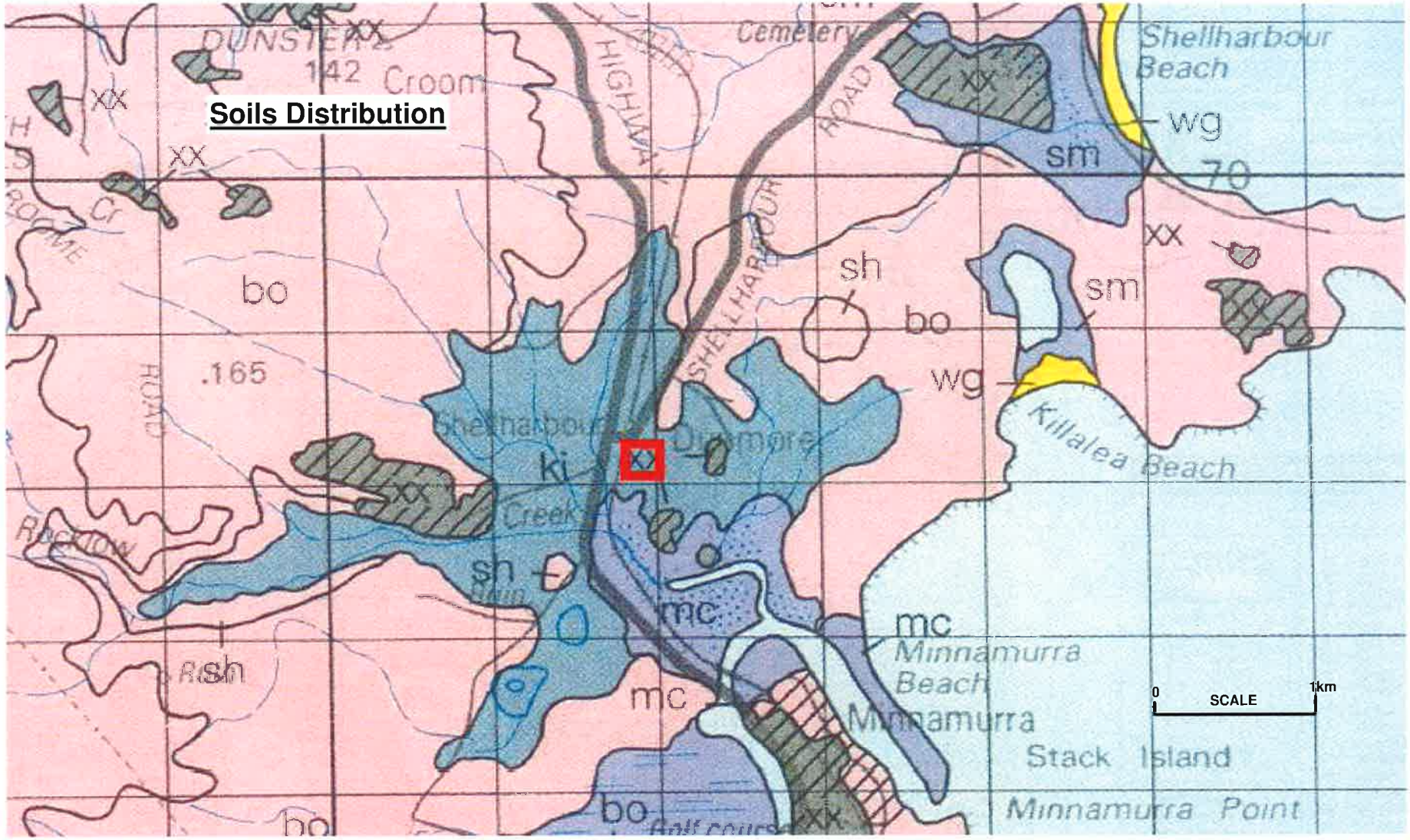
EPL 5984 Boundary

Oxyaquic Hydrosols

HA1 – Hand Auger hole location

BH22 – Borehole location

ENVIRONMENTAL EARTH SCIENCES	Title: Soil Distribution Shellharbour	
	Location: Lot 21, DP.653009 Shellharbour, NSW	
Client: Shellharbour City Council		Job number: 115047
Drawn by: TRJ	Scale: As shown	Source: See Ref.
Proj Man: NC	Date: June 2015	Figure 4



Legend:

bo - Bombo: Rolling low hills. Shallow structure loams occur on crests, podzolic soils occur on mid & lower slopes.

ki - Killalea: Level to gently inclined wide alluvial plain. Moderate to deep alluvial soils.

mc - Mangrove Creek: Vegetated tidal flats. Deep solonchaks on mangrove flats.

sh - Shellharbour: Rolling low hills. Podzols on lower slopes & drainage plains.

wg - Wollongong: Beaches & coastal foredunes. Deep siliceous sands.

xx - Disturbed terrain: Original soil removed, gretaly disturbed or buried. Original vegetation completely cleared.

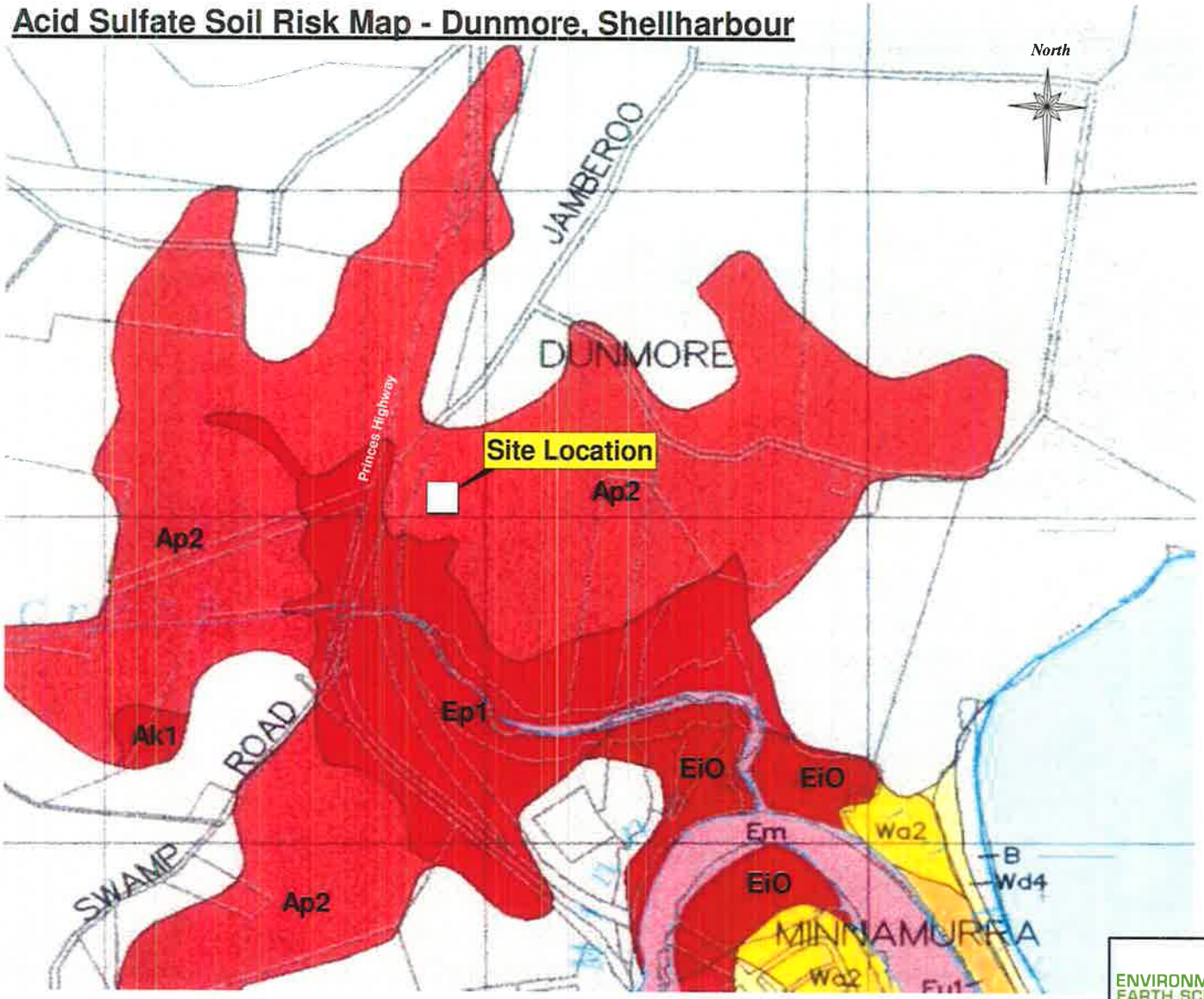
- Site Location

Source: Soil Landscapes of Kiama 1:100,000 Sheet.

ENVIRONMENTAL EARTH SCIENCES
THE KNOW AND THE HOW

Title: Soils Distribution		
Location: Dunmore, Shellharbour, NSW		
Client: Shellharbour City Council		Job number: 115047
Drawn by: TRJ	Scale: As shown	Source: See Ref.
Proj Man: NC	Date: June 2015	Figure 5

Acid Sulfate Soil Risk Map - Dunmore, Shellharbour



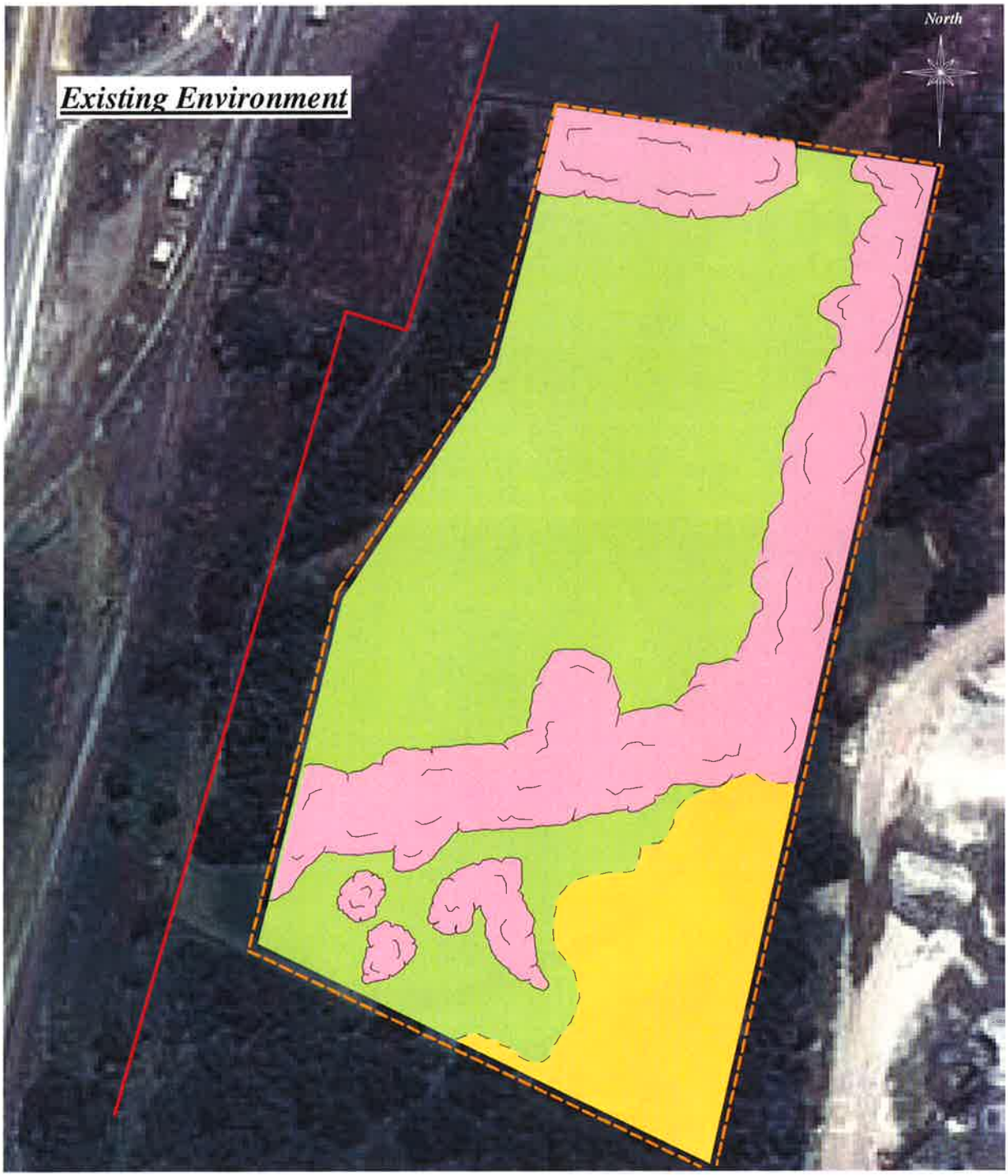
Key:

Landform Process Class	Landform Element
W.....Aeolian A.....Alluvial B.....Beach E.....Estuarine L.....Locustrine S.....Swamp	b.....Backplain k.....Backswamp m.....Bottom Sediments n.....Channel d.....Dune r.....Interbarrier Swamp i.....Intertidal Flat g.....Lagoon l.....Levee t.....Levee Toe o.....Ox-bow p.....Plain a.....Sandplain s.....Swamp y.....Splay u.....Supratidal Flat w.....Swale c.....Tidal Creek
Elevation	
0.....0-1m 1.....1-2m 2.....2-4m 4.....>4m	
Additional Descriptive Codes	
(p).....Pleistocene (s).....Acidic Scald	

Reference: Department of Land and Water Conservation (1974) Albion Park Acid Sulfate Soils Risk Map 1:25,000 (edition 2).

ENVIRONMENTAL EARTH SCIENCES
THE KNOW AND THE HOW

Title: Acid Sulfate Soil Risk Map		
Location: Dunmore, Shellharbour, NSW		
Client: Shellharbour City Council		Job number: 115047
Drawn by: TRJ	Scale: As shown	Source: See Ref.
Proj Man: NC	Date: June 2015	Figure 6



EPL 5984 Boundary

Proposed sand extraction area

Swamp Oak Floodplain Forest - (EEC) ~ 0.18 hectare.

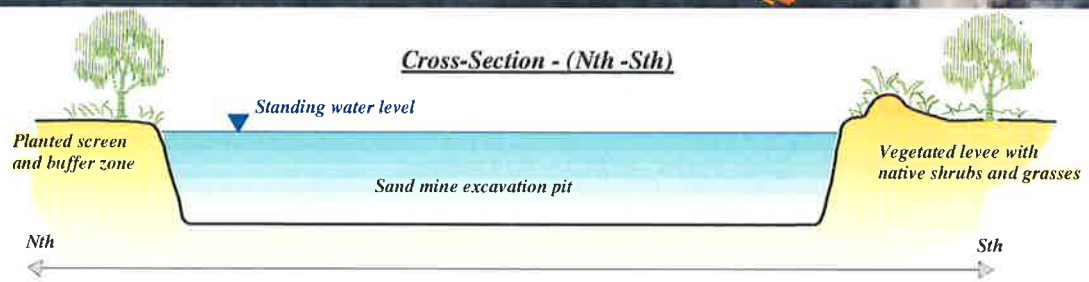
Planted buffer zone - (Native Casuarina sp. with grass understorey) ~ 0.44 hectare.

Exotic grass cover - (Pasture species) ~ 1.43 hectare.

0 *20* *40* *60* *80* *100m*

Approximate Scale

ENVIRONMENTAL EARTH SCIENCES THE KNOW AND THE FLOW	Title: Existing Environment	
	Location: Shellharbour, NSW	
Client: Shellharbour City Council		Job number: 115047
Drawn by: TRJ	Scale: As shown	Source: See Ref.
Proj Man: NC	Date: June 2015	Figure 7



EPL 5984 Boundary

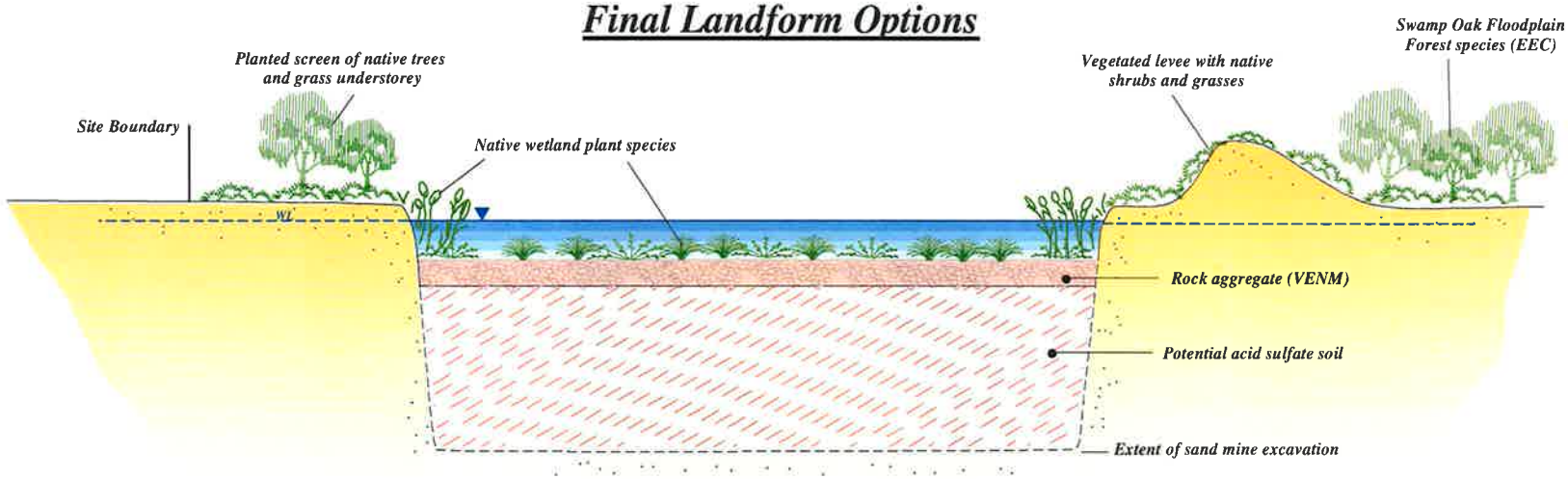
Proposed sand extraction area

Completed excavation pit

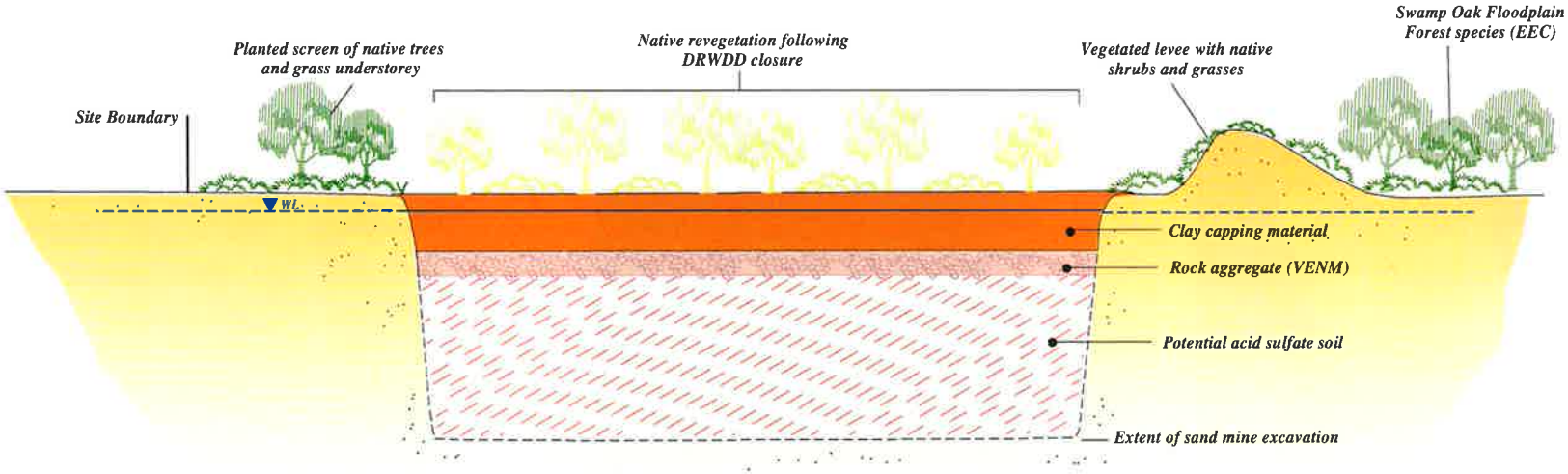
Levee

ENVIRONMENTAL EARTH SCIENCES	Title: Proposed Extent of Excavation Area	
	Location: Shellharbour, NSW	
Client: Shellharbour City Council		Job number: 115047
Drawn by: TRJ	Scale: As shown	Source: See Ref.
Proj Man: NC	Date: June 2015	Figure 8

Final Landform Options



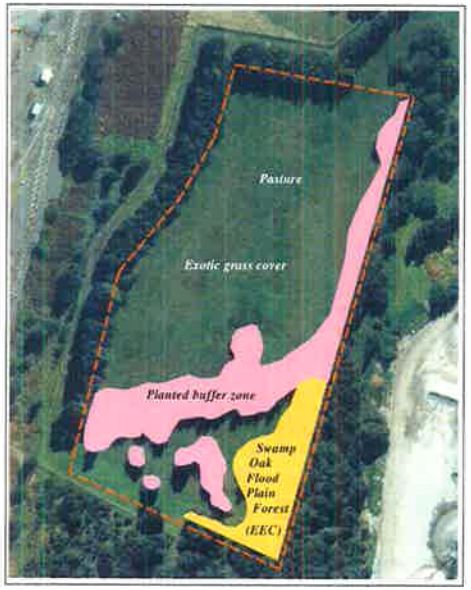
REHABILITATION OPTION ONE : WETLAND (OPEN PIT)



REHABILITATION OPTION TWO : STOCKPILING AREA (BACKFILL PIT)

ENVIRONMENTAL EARTH SCIENCES	Title: Final Landform Options	
	Location: Shellharbour, NSW	
Client: Shellharbour City Council		Job number: 115047
Drawn by: TRJ	Scale: Schematic Only	Source: See Ref.
Proj Man: NC	Date: June 2015	Figure 9

1. Existing Environment



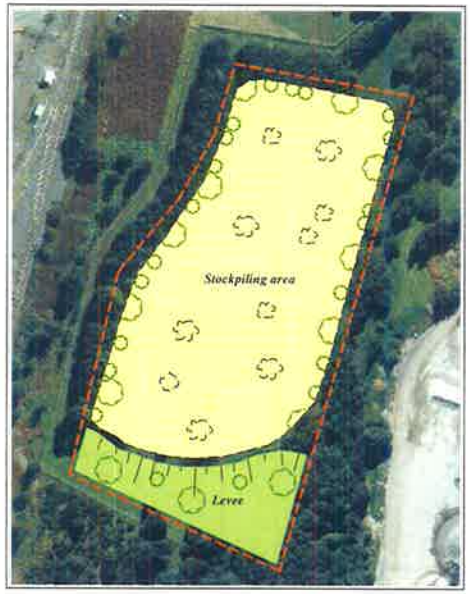
2. During site establishment

3. Conclusion of site operations

North

4.1. Final rehabilitated landform - wetland

4.2. Final rehabilitated landform - stockpiling area.



Rehabilitation Works

Scale (Approx.)

0 *60* *120metres*

Ref. Aerial baseplan from http://maps.six.nsw.gov.au/ spatial information xchange website.

Proposed sand extraction area

ENVIRONMENTAL EARTH SCIENCES	Title: Rehabilitation Works	
	Location: Shellharbour, NSW	
Client: Shellharbour City Council		Job number: 115047
Drawn by: TRJ	Scale: Schematic Only	Source: See Ref.
Proj Man: NC	Date: June 2015	Figure 10

Attachment 2 - Biodiversity Offset Strategy (Hyder, 2015)

DUNMORE SAND EXTRACTION AND REHABILITATION

Biodiversity Offset Strategy

Hyder Consulting Pty Ltd
ABN 76 104 485 289
Level 5, 141 Walker Street
Locked Bag 6503
North Sydney NSW 2060
Australia
Tel: +61 2 8907 9000
Fax: +61 2 8907 9001
www.hyderconsulting.com

SHELLHARBOUR CITY COUNCIL

DUNMORE SAND EXTRACTION AND REHABILITATION

Biodiversity Offset Strategy

Author	Jane Rodd	
Checker	Kate Carroll	
Approver	Shannon Blackmore	
Report No	AA005925	
Date	3 July 2015	

CONTENTS

APPENDICES

1 INTRODUCTION

Shellharbour City Council proposes to undertake sand extraction and site rehabilitation activities at the Dunmore Recycling and Waste Disposal Depot (DRWDD) in Dunmore NSW. The Proposal includes the extraction of approximately 142,000m^3 of sand that would be processed at the existing washer facility at the DRWDD. Once the sand extraction is complete, the Site would be rehabilitated with either of the following three options:

- Stabilisation of the excavation embankments and conversion of the excavation area to a water body.
- Partial filling of the excavation area to form a wetland and re-vegetation of the site with native water plant species.
- Filling of the excavation area to form a stockpile site to support the operations of the DRWDD.

The two rehabilitation options that involve filling of the extraction area would use either potential acid sulphate soil (PASS) material or virgin excavated natural material (VENM).

1.1 Purpose of this report

This Biodiversity Offset Strategy has been prepared to support the Environmental Impact Statement (EIS) for the Proposal and to address the relevant Director General's Requirements (DGRs) for the Proposal, as issued by the NSW Department of Planning and Infrastructure (DP&I) on 25 January 2013. The DGRs state that the EIS must include consideration of a biodiversity offset strategy.

The NSW Office of Environment and Heritage (OEH) provided input to the DGRs in a letter dated 21 January 2013.The OEH biodiversity requirements for the EIS include:

> *Where direct or indirect impacts on endangered vegetation, threatened flora and fauna or their habitat cannot be avoided, they should be offset. The OEH Biobanking Credit Calculator should be used to determine the scale of the offset required.*

The purpose of this Biodiversity Offset Strategy is to establish a commitment to offsetting the impacts of the Proposal on threatened species, populations and communities. The Strategy has been prepared to mitigate (as far as possible) the impacts of the Proposal.

This Strategy should be read with reference to the associated Biodiversity Assessment for the Proposal (Hyder Consulting 2014).

1.2 Objectives of the Biodiversity Offset Strategy

The overarching objective for the Biodiversity Offset Strategy is to achieve an overall long-term conservation gain for the biodiversity values impacted by the Proposal. The measures used to gauge success of this objective will be:

- An outcome that maintains or improves biodiversity values.
- Successfully securing the long-term (in perpetuity) protection and management of lands containing the impacted threatened biota or their habitat.
- The total area of lands used to offset the biodiversity impacts shall exceed the scale of impacts of the proposal.

- The process for setting the scope and quantum of the biodiversity offsets is transparent and justifiable on environmental, social and economic grounds.

The Biodiversity Offset Strategy summarises the impacts of the Proposal on biodiversity, details the mitigation measures proposed to minimise biodiversity impacts, and sets out options for offsetting impacts on threatened species, populations and communities, and a framework for delivery of these options.

2 IMPACTS OF THE PROPOSAL

2.1 Biodiversity Impact Assessment

A biodiversity assessment of the Proposal was prepared by Hyder Consulting (2014). The study area for the biodiversity assessment includes the Proposal site and adjacent areas of vegetation to the north and south (Figure 1). Flora and fauna surveys were conducted across the study area in August, September and December 2013 and January 2014.

The biodiversity assessment determined the impacts of the Proposal on biodiversity values, as summarised below.

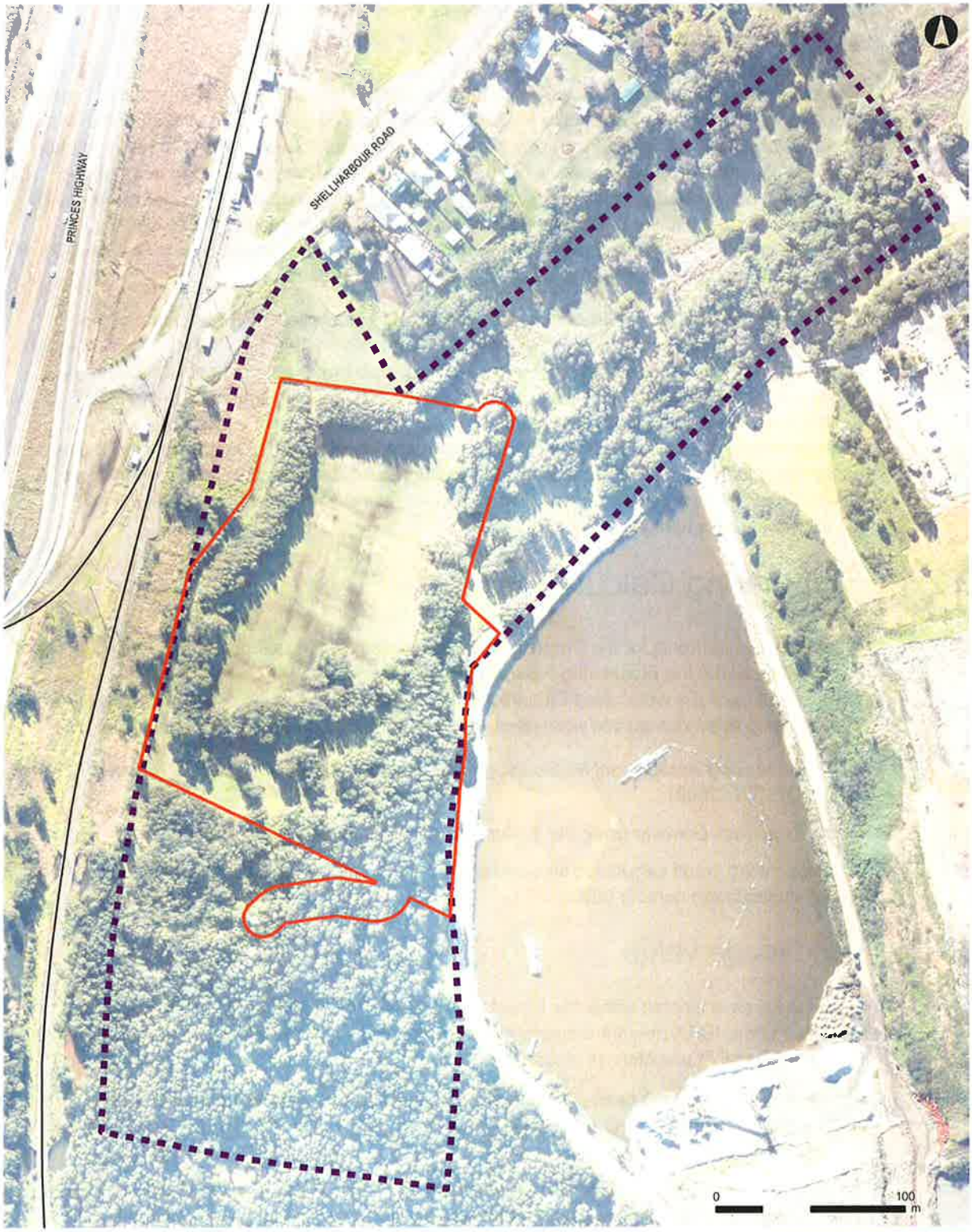
2.1.1 Flora

The Proposal will require clearing of approximately 2.65 hectares of vegetation, including 0.76 hectares of Regrowth Swamp Oak Floodplain Forest, an endangered ecological community under the TSC Act (Swamp Oak Floodplain Forest in the NSW North Coast, Sydney Basin and South East Corner Bioregions) and 0.56 hectares of planted Swamp Oaks. The remaining 1.33 hectares of land that will be impacted is already cleared and disturbed, and is generally dominated by exotic grasses and herbs. The areas of vegetation to be cleared are largely within existing edge habitats. The proposal could result in further encroachment of edge effects into surrounding habitats which could result in impacts to seed germination, flora and fauna species composition and weed establishment.

2.1.2 Fauna and fauna habitats

The clearing of woodland and grassland habitats would result in the loss of mature trees that provide shelter, nesting and roosting habitat for fauna, foraging resources (grasses, flowering and fruiting trees and shrubs) and groundlayer fauna habitats such as fallen timber and deep leaf litter. The drainage channel that passes through the eastern part of the site would be relocated, removing fish and frog habitat including snags and instream vegetation that provide potential shelter, foraging and breeding habitat. The Proposal is unlikely to require blockage of fish passage during realignment works as they can be staged to ensure the channel is complete prior to redirecting flow. Approximately 1.21 hectares of disturbed woodland would be removed and 0.18 hectares of aquatic habitat would be impacted from the relocation of the eastern drainage channel. An additional 1.26 hectares of disturbed grassland would be removed. The removal of vegetation would have minimal impacts to habitat connectivity for fauna given it is located on the edge of previously cleared habitats currently subject to edge effects. A dispersal corridor for the Green and Golden Bell Frog (*Litoria aurea*) has been identified at the Site, however it is unlikely that the species still persists in the area and as such, is unlikely to be impacted by removal of potential habitat.

Fauna injury or mortality could occur during vegetation clearing activities and creek realignment works or from collisions with vehicles or plant, or accidental entrapment in plant, machinery or within the sand extraction pit. The likelihood of this occurring is low given the low value of the habitat proposed for removal and current level of disturbance at the Site. The site establishment phase of the proposal may impact upon the roosting, breeding and foraging activities of locally occurring fauna, as a result of increased exposure to light, noise, dust, vehicles and people. Impacts are likely to be minor given the site is already subject to a level of disturbance from current activities in the DRWDD.



Site
Study area
Lot boundary
Railway

Map scale: 1:3,000 @ A4

DATA SOURCES
Shellharbour City Council, LPI, NearMap 2013-07-05

HYDER CONSULTING PTY LTD
ABN 76 104 485 289
Level 5, 141 Walker St
North Sydney NSW 2060
Australia
P: +61 (0) 2 8907 9000
F: +61 (0) 2 8907 9001

Figure 1: Study area

2.1.3 Groundwater dependent ecosystems and water quality impacts

The sand extraction and site rehabilitation phases of the Proposal have the potential to impact groundwater dependent ecosystems (GDEs) and water quality. The likely consequences of minor lowering of the water table during sand extraction would have localised or minor impacts to GDEs. Chemicals and sediment-laden runoff reaching waterways could degrade aquatic habitats including swamp, saltmarsh and mangrove habitats. A reduction in water quality could impact on foraging habitat quality for wading birds and affect the health and life cycles of amphibians and fish inhabiting these areas. Downstream impacts could occur in Rocklow Creek if spills/sediment reach intertidal areas.

Accidental release of acidic water from the area used to stockpile PASS material has the potential to result in aquatic biodiversity impacts such as increased fish mortality, loss of aquatic vegetation and habitat degradation. Acidification of groundwater as a result of encountering PASS during extraction or placement of PASS during site rehabilitation could impact GDE health. Potential impacts would be reduced through the installation of a levee bank and implementation of an Acid Sulphate Soil Management Plan (ASSMP). Furthermore, if acidic water reached these waterways in a flood event/high rainfall, floodwaters and stream flows would further dilute the acidity of the released water, thereby minimising the potential and severity of impacts to biodiversity.

2.2 Biobanking Calculation

The offset requirements for the Proposal were calculated using the Biobanking Credit Calculator in accordance with the Biobanking Assessment Methodology 2014 (OEH 2014). This assessment uses the web-based Biobanking Credit Calculator version 4.1 (Credit Calculator). The following reference guides were used when carrying out the assessment:

- *Biobanking Assessment Methodology and Credit Calculator Operational Manual* (DECCW 2008)
- *Assessors Guide to using the Biobanking Credit Calculator v2.0* (OEH 2012).

The biobanking credit calculation was undertaken by an accredited Biobanking assessor (Jane Rodd, accreditation number 0023).

2.2.1 Landscape value

The study area is located within the Illawarra Subregion of the Sydney Basin Bioregion, as classified under IBRA (Interim Biogeographic Regionalisation for Australia), and within the Lake Illawarra Alluvial Plains Mitchell landscape.

The landscape value has been calculated from the site-based methodology outlined in Appendix 4 of the *Biobanking Assessment Methodology* (OEH 2014) (BBAM) by determining the following:

1. Percent native vegetation cover in the landscape – percentage of all land within the inner and outer assessment circles that contains native vegetation is to be calculated for the current extent of cover and future extent of cover once clearing for the development has occurred.
2. Connectivity value – the value determined by identifying connecting links and state or regional biodiversity links. Where the development will impact on more than one connecting link, a connectivity value must be determined for each link based on the linkage widths and

conditions. State significant biodiversity links have a connectivity value of 12 and regionally significant biodiversity links have a connectivity value score of 9.

3. Patch size score – determined from the percentage of native vegetation that has been cleared within the Mitchell landscape in which most of the development occurs and the patch size class. The patch size class considers the largest patch of native vegetation occurring within or connecting to the study area and attributing a size class between nil or small to extra large, dependent on the size of the patch in hectares and the percentage of native vegetation cleared.

A discussion of each of these determining factors in relation to the study area is provided below.

Native vegetation cover in landscape

Two assessment circles were mapped to determine the percent current extent of native vegetation cover within and adjacent to the development site. In accordance with the allowable combinations of inner and outer assessment circles in Table 13 of the BBAM, an inner circle of 100 hectares and an outer circle of 1000 hectares were used. Both circles were centred on the study area (Figure 2).

The native vegetation cover in the landscape was determined with reference to the regional vegetation mapping by Tozer *et al.* (2006). All native vegetation types mapped by Tozer *et al.* (2006) within the inner and outer assessment circles were considered to represent the current native vegetation cover. The future native vegetation cover was determined by subtracting the area of native vegetation to be cleared for the Proposal from the current summed native vegetation cover in each circle. The current and future percentage of native vegetation cover in the inner and outer assessment circles has been provided in Table 1. Scores for each percent cover were then determined using the score criteria in Table 14, Appendix 4 of the BBAM.

Table 1 Scores for the assessment of landscape value

Criteria	Assessment circle	% cover	Score
Current native vegetation cover	Inner assessment circle	21-25	3.75
	Outer assessment circle	21-25	6.25
Future native vegetation cover	Inner assessment circle	21-25	3.75
	Outer assessment circle	21-25	6.25

Connectivity value

Three connecting links have been identified in the study area: one wide link (<100-500m) to larger areas of native vegetation to the south of the study area, and two smaller more fragmented links along drainage lines to regrowth and planted vegetation in the north of the study area. The vegetation in both locations represents native vegetation in moderate to good condition (although the vegetation in the north of the study area is degraded), have a patch size greater than 1 hectare and minimal cleared or hostile land features between patches of vegetation.

The study area is located immediately to the north of land identified as Coastal Wetland in accordance with SEPP 14. This land is considered to be an "important wetland" according to the definition in BBAM (2014); however as no impact is occurring within 50 metres of the SEPP 14 wetland boundary (at its closest point, the proposal footprint is approximately 110 metres from the SEPP 14 boundary), this connectivity value class has not been used in calculations.

- Proposal Site
- Study area
- Assessment circles
- Watercourse

Vegetation mapping (Tozer et al. 2006)

- Basalt Hilltop Scrub
- Coastal Freshwater Lagoon
- Coastal Sand Forest
- Coastal Scrub & Beach Strand
- Coastal Warm Temperate Rainforest
- Estuarine Creekflat Scrub
- Estuarine Fringe Forest
- Estuarine Mangrove Forest
- Estuarine Saltmarsh
- Floodplain Swamp Forest
- Illawarra Gully Wet Forest
- Illawarra Lowland Swamp Woodland
- Littoral Thicket
- River Mangrove
- Seagrass Meadow (Zostera)
- South Coast Grassy Woodland
- Subtropical Dry Rainforest
- Temperate Littoral Rainforest
- Warm Temperate Layered Forest

HYDER CONSULTING PTY LTD
ABN 76 104 485 289
Level 5, 141 Walker St
North Sydney NSW 2060
Australia
P: +61 (0) 2 8907 9000
F: +61 (0) 2 8907 9001

SCALE: 23,088 @ A4

Hyder

Figure 2. Assessment circles and regional vegetation mapping (Tozer et al. 2006)

The two links extending north across the study area are in the narrow (>5-30 m) linkage width class. One of these links will be removed as a result of the Proposal, while the other link will be maintained. The wider link to the south will not be impacted.

Patch size

Using the Tozer *et al.* (2006) mapping of south-eastern NSW to determine the approximate current extent of native vegetation, the percent native vegetation cleared in the Lake Illawarra Alluvial Plain Mitchell landscape is calculated to be 87%. The size of the patch of native vegetation occurring in and adjacent to the study area is approximately 180 hectares. In accordance with the criteria in Table 20 of Appendix 4 of the BBAM, the patch size class is considered to be *extra large* with a corresponding patch size score of 12.

2.2.2 Native vegetation

One native vegetation community was identified in the study area: Regrowth Swamp Oak Floodplain Forest, which occurs in the south of the study area. This area was historically cleared; on the 1948 aerial photograph, tree-dominated vegetation is only visible in the south of the study area. It is not known whether this forest is regrowth or whether it was planted, but as this area is shown in the Landscape Management Plan for the DRWDD (SCC 1997) as remnant vegetation, it is assumed for the purposes of this assessment that it is regrowth.

The regrowth Swamp Oak Forest comprised open forest dominated by *Casuarina glauca* to about 14 metres in height. The diameter at breast height (dbh) of most of the trees was approximately 0.2 to 0.3 metres, with few older or larger trees observed. Recruitment of *Casuarina glauca* was noted to be very low, with few seedlings or juvenile plants recorded. The midlayer was largely absent, with a few scattered trees of *Lagunaria patersonia* (Norfolk Island Hibiscus) in some areas and some *Exocarpos cupressiformis* (Cherry Ballart) in the north of the Swamp Forest adjoining the constructed drainage channel. The shrub layer was dominated by exotic species, with large stands of *Lantana camara* present, particularly in the area within the proposal area to the north of the pig fence, and *Senna pendula* var. *glabrata* (Easter Cassia) common.

Swamp Oak Forest with disturbed understorey in south of study area

The ground layer varies from sparse cover of native and exotic grasses and herbs in areas where there is a dense canopy or midlayer, to dense grass and herb cover. Frequently occurring species include *Carex appressa* (Tall Sedge), *Oplismenus aemulus* (Broad-leaved Basket Grass), *Viola hederacea* (Native Violet) and *Ehrharta erecta*. The native climber *Parsonsia straminea* (Common Silkpod) is often present on the trunks of *Casuarina glauca.*

The equivalent Plant Community Type (PCT) for the Regrowth Swamp Oak Forest in the study area is SR650: Swamp Oak swamp forest fringing estuaries, Sydney Basin and South East Corner, according to the NSW PCT classification as provided in the Vegetation Information

System (VIS) database. The estimated percent cleared value of this PCT in the Southern Rivers CMA is 95%, as sourced from the VIS database (29 June 2015).

SR650 Swamp Oak swamp forest fringing estuaries, Sydney Basin and South East Corner falls within the definition of the endangered ecological community Swamp Oak Floodplain Forest in the NSW North Coast, Sydney Basin and South East Corner Bioregions as listed under the TSC Act.

There is one vegetation zone in the study area for SR650 Swamp Oak swamp forest fringing estuaries, Sydney Basin and South East Corner in Moderate/Good_Poor condition. This vegetation zone is of 3.56 hectares in area and was sampled using two quadrats (Q2 and Q3). The site value score for the vegetation zone was determined through assessment of site attribute data collected in vegetation quadrats. The site attribute data was entered into the credit calculator to generate site value scores. The site attribute data entered into the credit calculator is presented in Table 2.

Table 2: Quadrat data compared with benchmark values for Swamp Oak swamp forest fringing estuaries, Sydney Basin and South East Corner

Benchmark Attribute	Benchmark Values	Recorded values for benchmark attributes	
		Q2	Q3
Native plant species richness	7	11	14
Native overstorey cover	0-60%	37	27
Native midstorey cover	5-10%	7	7
Native ground cover (grasses)	5-20%	22	20
Native ground cover (shrubs)	0-5%	0	0
Native ground cover (other)	10-75%	42	26
Exotic species cover	N/A	52	32
Number of trees with hollows	2	0	0
Total length of fallen logs (m)	35	5	14

The calculated site value score for the 3.56 hectares of Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion within the study area is 64.06.

Based on the assumption that a 0.76 hectare management zone within the Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion would be cleared for the Proposal, the score for development for each site attribute, and the total future site value score within this management zone, is reduced to zero. The future site values score for the remaining 2.8 hectares of Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion within the study area remains the same as this area will be retained.

2.2.3 Threatened Species

Predicted Ecosystem credit species

Ten threatened fauna species were derived from the vegetation zone in the study area as predicted ecosystem credit species.

Each species has been assessed for potential habitat presence in the study area using information obtained from the Threatened Species Profiles Database (TSPD)(Table 3). It was found that five species have potential habitat in the vegetation zone in the study area and as such would be considered ecosystem credit species. None of the species were recorded in the study area during site surveys. The threatened species with the lowest Tg value will determine the final ecosystem credit value; following review, the threatened species with the lowest Tg value are Eastern Freetail-bat, Greater Broad-nosed Bat and Yellow-bellied Sheathtail-bat (Tg value of 0.45).

Table 3 Predicted ecosystem credit species presence assessment

Predicted ecosystem credit species	Patch size	TG Value	Habitat requirements (from TSPD)	Ecosystem credit species habitat presence in SR650
Eastern Freetail-bat *Mormopterus norfolkensis* V-TSC Act	5-25 ha	0.45	Associated vegetation types provide foraging habitat for the species. Species roosts in tree hollows, loose bark or man-made structures. Breed in hollows in dead or alive trees.	**Yes**. Potential foraging habitat is present in this vegetation zone.
Greater Broad-nosed Bat *Scoteanax rueppellii* V-TSC Act	<5ha	0.45	Utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest. Although this species usually roosts in tree hollows, it has also been found in buildings.	**No.** Species prefers tall forest with trees over 20m.
Little Eagle *Hieraaetus morphnoides* V-TSC Act	<5ha	0.725	Occupies open eucalypt forest, woodland or open woodland. Sheoak or Acacia woodlands and riparian woodlands of interior NSW are also used. Nests in tall living trees within a remnant patch, where pairs build a large stick nest in winter.	**Yes**. Potential habitat is present in this vegetation zone.
Long-nosed Potoroo *Potorous tridactylus* V-TSC Act V-EPBC Act	5-25 ha	0.75	Forages in coastal heaths or dry or wet forests with a dense understorey of grass-trees, sedges, ferns or heath, or low tea-trees or melaleucas, with occasional open areas usually over sandy loam soil. Breeds in rainforest or vegetation with dense understorey.	**No.** Vegetation features and structure associated with the species are not present.
New Holland Mouse *Pseudomys novaehollandiae* V-EPBC Act	<5ha	0.375	Known to inhabit open heathlands, woodlands and forests with a heathland understorey and vegetated sand dunes.	**No.** Heath not present.
Orange-bellied Parrot *Neophema chrysogaster* CE-TSC Act CE-EPBC Act	<5ha	0.75	Occurs in low samphire herblands, open grassy or heathland areas within 3 km of coast. Breeds in Tasmania.	**Yes.** Site contains open grassy areas.

Predicted ecosystem credit species	Patch size	TG Value	Habitat requirements (from TSPD)	Ecosystem credit species habitat presence in SR650
Square-tailed Kite *Lophoictinia isura* V-TSC Act	<5ha	0.725	Species is found in a variety of timbered habitats including dry woodlands and open forests. Shows a particular preference for timbered watercourses.	**Yes.** Site contains timbered habitat and a watercourse.
Varied Sittella *Daphoenositta chrysoptera* V-TSC Act	5-25ha	0.75	Inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland.	**No.** Vegetation not considered eucalypt forest or woodland, mallee or Acacia woodland.
White-fronted Chat *Epthianura albifrons* V-TSC Act	5-25ha	0.75	Species is usually found foraging on bare or grassy ground in wetland areas, singly or in pairs. They have been observed breeding from late July through to early March, with 'open-cup' nests built in low vegetation.	**No.** Site not considered wetland.
Yellow-bellied Sheathtail-bat *Saccolaimus flaviventris* V-TSC Act	<5ha	0.45	Roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows. Forages in most habitats across its very wide range, with and without trees; appears to defend an aerial territory.	**Yes.** Potential foraging habitat is present in this vegetation zone.

Predicted Species credit species

One threatened flora species and five threatened fauna species listed under the TSC Act were identified in the credit calculator as predicted species credit species.

Table 4 assesses the potential for these species credit species to be present on the development site using information obtained from the TSPD and results of targeted surveys. It also identifies species that cannot withstand further loss and whether a species polygon is required to be prepared or other further action is required. None of the predicted species credit species are considered likely to occur in the study area, and no further action is required for assessment of these species.

Table 4 Species credit species and their presence status

Species	Habitat requirements	Habitat present in development site?	Targeted survey effort/ methods	Targeted survey timing and weather	Presence status	Can species withstand further loss?	Further action?
Wilsonia backhousei Narrow-leafed Wilsonia	Occurs on the margins of salt marshes and lakes. Flowers spring and summer.	Marginal habitat present in southern parts of study area near saltmarsh areas.	Diurnal search of habitats on site.	Aug, Sept, Dec 2013 & Jan 2014. Weather ranged from wet and windy to warm and clear	Unlikely. Preferred habitat for species not present in impact areas.	No	No
Australasian Bittern *Botaurus poiciloptilus* E-TSC Act	Favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes (*Typha* spp.) and spikerushes (*Eleocharis* spp.).	No. Site not considered freshwater wetland.	Diurnal search of habitats on site.	Aug, Sept, Dec 2013 & Jan 2014. Weather ranged from wet and windy to warm and clear.	Unlikely. Preferred habitat for species not present.	No	No
Black Bittern *Ixobrychus flavicollis* V-TSC Act	Inhabits both terrestrial and estuarine wetlands, generally in areas of permanent water and dense vegetation. Where permanent water is present, the species may occur in flooded grassland, forest, woodland, rainforest and mangroves.	Marginal habitat present in drainage channel.	Diurnal search of habitats on site.	Aug, Sept, Dec 2013 & Jan 2014. Weather ranged from wet and windy to warm and clear.	Unlikely. Species has not been recorded in the area for more than 20 years. Marginal habitat present in drainage channel.	Yes	No

Species	Habitat requirements	Habitat present in development site?	Targeted survey effort/ methods	Targeted survey timing and weather	Presence status	Can species withstand further loss?	Further action?
Eastern Osprey *Pandion cristatus* V-TSC Act	Land within 40 m of fresh/brackish/saline waters of larger rivers or creeks; estuaries, coastal lagoons, lakes and/or inshore marine waters. Breed from July to September in NSW. Nests are made high up in dead trees or in dead crowns of live trees, usually within one kilometre of the sea.	Marginal habitat present.	Diurnal search of habitats on site.	Aug, Sept, Dec 2013 & Jan 2014. Weather ranged from wet and windy to warm and clear.	Unlikely. Species has not been recorded in the area for 20 years. Marginal habitat present.	Yes	No
Green and Golden Bell Frog *Litoria aurea* E-TSC Act V-EPBC Act	Breeding habitat comprises natural and constructed waterbodies including wetlands, stormwater detention basins, marshes, dams and streams-side, preferably those that are unshaded but with fringing vegetation. Forage for invertebrates within grassy habitats near breeding habitat. May shelter under vegetation, rocks and building materials such as fibro, sheet iron or bricks.	Yes. Habitat is present in drainage channel. Ephemeral habitat present in soaks within grassy areas.	Call playback, diurnal hand searches, tadpole dip netting.	Sept 2013 & Jan 2014. Weather ranged from wet and windy to warm and clear. Both surveys were undertaken after periods of rainfall.	Unlikely. Potential habitat is present in the development site however species was not recorded during targeted surveys and nearby records are from the 1970's and 1980's.	Yes	No
Southern Brown Bandicoot *Isoodon obesulus obesulus* E-TSC Act E-EPBC Act	Southern Brown Bandicoots are largely crepuscular (active mainly after dusk and/or before dawn). They are generally only found in heath or open forest with a heathy understorey on sandy or friable soils.	No. Heath/heathy understorey not present in the site.	N/A	N/A	Unlikely. Preferred habitat not present.	No	No

Green and Golden Bell Frog

The Green and Golden Bell Frog has historically been recorded in the Dunmore area, including within 600 - 800 metres of the site. The Dunmore/Bass Point area was identified in the Draft Recovery Plan for the Green and Golden Bell Frog (DEC 2005) as likely to contain one of the key populations of Green and Golden Bell Frogs in the Shellharbour area. The site contains potential foraging, dispersal, refuge and breeding habitat for the species in the drainage line and potential dispersal and foraging habitat in grassy areas. As such, the species was considered a candidate species credit species in accordance with the BBAM and targeted surveys for this species were undertaken by Hyder as part of the EIS.

Although Green and Golden Bell Frog habitat was identified on the site, no evidence of the species occurrence was found during targeted surveys undertaken for the EIS. Furthermore, the species has not been found on the site or nearby during other targeted surveys: White and Pyke, 2008, Kevin Mills and Associates, 1995, Gaia Research 2011. Pyke and White (2008) suggest that the local population is probably now extinct. Accordingly, the Green and Golden Bell Frog is considered unlikely to occur on the site and would not require further assessment under Section 6.5.1.13 of the BBAM or offsetting.

2.2.4 Biodiversity Credit Requirement

The Biobanking credit report (Appendix 1) identifies the credit requirements for impacts on ecosystems and threatened species that would arise from the proposal. These include ecosystem credits only; no species credits are required - following review of the predicted species credit species using information in the TSPD and Bionet Wildlife Atlas, none of the predicted species credit species are considered likely to occur in the study area, and no further action is required for assessment of these species.

Loss of landscape and site value for the vegetation in the study area and associated ecosystem species, as determined using the credit calculator, is presented in Table 5.

Table 5 Impact summary for PCTs and associated ecosystem credit species requiring offsets and their required credits

PCT/Vegetation zone	Associated EECs and/or Threatened Species	Loss in landscape value	Loss in site value score	Number of Ecosystems credits required
SR650 Swamp Oak swamp forest fringing estuaries, Sydney Basin and South East Corner Moderate/Good_Poor	▪ Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions ▪ Eastern Freetail-bat ▪ Little Eagle ▪ Orange-bellied Parrot ▪ Square-tailed Kite ▪ Yellow-bellied Sheathtail-bat	18	64.06	53

The clearing of 0.76 hectares of Swamp Oak swamp forest fringing estuaries, Sydney Basin and South East Corner requires an application for a red flag determination under the BBAM (OEH 2014), as this vegetation is >70% cleared and/or contains an endangered ecological community. Where a development will have an adverse impact on a red flag area, the

development is not to be regarded as improving or maintaining biodiversity values unless the Chief Executive of OEH makes all of the relevant determinations under sections 9.2.4 to 9.2.7 of BBAM 2014. Additional assessment criteria for impacts on PCTs and ecological communities include assessment of the viability of biodiversity values in the red flag area and the contribution of the red flag area to regional biodiversity values.

3 AVOIDANCE AND MITIGATION OF BIODIVERSITY IMPACTS

Measures to manage the impact of the Proposal on biodiversity values have been developed as part of the environmental assessment for the project. Management measures for biodiversity impacts were developed following three general principles, in order of preference:

- Avoid areas of high biodiversity value wherever possible.
- Mitigate actions and safeguard values identified for retention by prescribing appropriate controls.
- Compensate for or offset the removal of biodiversity values.

3.1 Avoid Impacts

Impacts to ecological values should be avoided where feasible and reasonable. Potential measures to avoid ecological impacts include:

- Avoid native tree removal where feasible and reasonable.
- Avoiding removal of important fauna habitat features such as dead wood.
- Avoiding construction and operational activities with a high pollution risk in proximity to the drainage channel, realigned or otherwise.

3.2 Mitigate Impacts

Where impacts on biodiversity cannot be avoided, safeguards provided in Table 6 should be implemented to mitigate these impacts during construction and operation of the Proposal.

Table 6: Mitigation measures for biodiversity impacts of the Proposal

Activity	Impact	Mitigation Measure
Management framework	Flora and fauna impacts	All relevant flora and fauna mitigation measures will be incorporated into the Construction Environmental Management Plan (CEMP) and Operational Environmental Management Plan (OEMP).
Earthworks, sand extraction and other activities involving soil disturbance	Sedimentation and erosion leading to a reduction in water quality and degradation of adjacent aquatic habitats	A Soil and Water Management Plan would be prepared to manage soil and water impacts on the Site and prevent impacts to water quality in local aquatic habitats. Clearing of vegetation and excavation activities would not be undertaken during overland flow events. Stabilisation of disturbed areas adjacent to retained native vegetation, including revegetation where appropriate, would be undertaken as soon as feasible and reasonable after disturbance. The levee bank would be constructed and vegetated as soon as practical.

Activity	Impact	Mitigation Measure
	Potential impacts to Green and Golden Bell Frogs	Pre-clearing surveys for the Green and Golden Bell Frog would be undertaken on the Site. In the event that they are found, a management plan would be developed and strategies for translocation and exclusion of frogs would be prepared in consultation with OEH, who would also approve any translocation plan. Staff working on site would be made aware of the potential presence of Green and Golden Bell Frogs through site inductions. This would include identification guidelines, notification processes and the risks associated with chytrid.
	Weed establishment and invasion	Soil stripped and stockpiled from areas containing known noxious and high priority weed infestations are to be stored separately and are not to be moved to buffer areas. Actions for weed management would be developed as part of the CEMP documentation. These actions would include, but not be limited to, the following: • Type and location of weeds of concern (including noxious weeds and high priority weeds as identified in the Illawarra Biodiversity Strategy) within the proposal area. • Identify sensitive receivers (such as native vegetation and waterways) within or adjacent to the proposal area. • Management and disposal of weeds (including Declared noxious weeds) which would be in accordance to requirements under the Noxious *Weeds Act 1993* • Communication strategies to improve contractor awareness of weeds and weed management. Any application of herbicide for weed management would be undertaken in accordance with the requirements of the *Pesticides Act 1999* and an herbicide that is appropriate to the sensitivity of the area would be used.
Vegetation clearance	Loss of fauna habitat	Fauna microhabitat such as logs would be removed from areas to be cleared and relocated to suitable nearby habitat in consultation with an ecologist or relevant agency (e.g. OEH). Extent of clearing would be fenced with highly visible temporary fencing to ensure that clearing does not extend beyond the area necessary.
	Fauna injury/mortality	Site inductions would include a briefing regarding the local fauna of the site and identification of protocols to be undertaken if fauna are encountered. Contact details would be kept on site for the local WIRES group and veterinarian if any fauna are injured on site or require capture and/or relocation.
	Loss and degradation of native vegetation	Clearance of native vegetation, particularly trees, would be minimised as far as is feasible and reasonable. The extent of vegetation clearing would be clearly identified on construction plans.

Activity	Impact	Mitigation Measure
		Any additional construction areas, such as site offices, construction stockpile locations and machinery/equipment laydown areas would be located within existing cleared or disturbed areas. Extent of clearing would be fenced with highly visible temporary fencing to ensure that clearing does not extend beyond the area necessary. The levee would be revegetated with local native species of the Swamp Oak Floodplain Forest community. Site rehabilitation would commence as soon as feasible and reasonable.
Sand extraction encountering groundwater	Reduction in water table impacting GDEs Reduction in groundwater quality impacting GDEs	A Groundwater Monitoring and Management Plan (GMMP) would be prepared prior to commencement of site preparation. The GMMP would include the following measures: Static groundwater levels (SWL) and pond water level AHD heights would be measured weekly during excavation works. Actions would be included in the GMMP to respond appropriately to lowered SWL. Groundwater bores and water within the extraction pit would be tested for pH on a weekly basis.
Site establishment activities in proximity to waterways	Reduction in water quality as a result of chemical spills and sediment-laden runoff	Emergency response protocols and procedures for implementation in the event of a contaminant spill or leak would be clearly articulated in the Environmental Management Plans. Spill kits would be readily available during construction activities to allow for timely response to uncontained spills. Site inductions would include a briefing on the use of spill kits and spill response. Refuelling would be undertaken at least 40 metres away from any waterbody. Chemicals and fuels would be stored in bunded containers in site buildings. The new channel and crossing would be completed and stabilised prior to diversion of water from the existing channel.
	Realignment of drainage channel resulting in removal of aquatic habitat features	The bed of the realigned channel should be grassed with native species and the channel banks revegetated with native flora species. Revegetate the riparian corridor of the realigned channel with native, locally occurring species (of the Swamp Oak Forest community).

Activity	Impact	Mitigation Measure
Sand extraction activities in proximity to waterways	Sediment-laden water and chemicals reaching waterways	The following infrastructure would be constructed to divert clean water flows at the Site and minimise impacts to aquatic habitats: • A vegetated levee around the southern perimeter of the extraction pit. • Realignment of the eastern diversion channel. • A causeway and culverts over the realigned channel between the new extraction pit and the existing extraction area. • Two new drainage channels to the north and west of the extraction pit to convey clean surface water around the extraction pit. To minimise impacts associated with overtopping of the bund during a major flood event the sand extraction operator would monitor the Bureau of Meteorology's Flood Warning Service and cease operations when a medium or major flood event is notified for the region, allowing sediment to settle out of suspension prior to inundation of the extraction pit.
	Acidic water reaching waterways	An Acid Sulfate Soil Management Plan (ASSMP) would be prepared prior to commencement of sand extraction activities in accordance with the Acid Sulfate Soils Assessment Guidelines (ASSMAC 1998 (ASSMAC Guidelines)). The pH of water within the extraction pit and the existing sand extraction area would be sampled daily to monitor any reduction in pH. Should the pH water in either extraction area fall below a pH of 6.5 a neutralising agent, such as lime, would be applied to the water body/s, in quantities prescribed in the ASSMP.

Activity	Impact	Mitigation Measure
Site rehabilitation	Acidic water reaching waterways	The ASSMP would include the following measures: • The only sulfidic material that would be accepted for placement within the extraction pit would be that with a pH above 5.5. • Should PASS material have oxidised to form actual acid sulfate soil (AASS), such that the pH of the soil is less than 5.5, treatment would be required to neutralise all potential and actual acidity, prior to acceptance at the DRWDD site. Neutralisation of the material by crushed limestone or agricultural lime, prior to transportation, would be acceptable to raise the pH providing it can be demonstrated that neutralisation of acid in the material has been effective. • The pH of PASS material for transport to the Proposal site must be above 5.5 before being allowed to be transported or received on site. • If PASS material from the site of origin are loaded moist they would be kept moist, to minimise the risk of oxidation. All loads would be covered and wet or moist loads would be handled in a manner to ensure loss of liquid does not occur during transport. • The pH of the water of the extraction pit would be monitored hourly. Should the pH of the water fall below 6.5, no more PASS would be received at the Site until approval to continue has been received in writing from the EPA. Crushed limestone and/or agricultural lime would be held on site to neutralise water.
	Acidic water reaching groundwater	The GMMP would include the following measures: • Groundwater bores and water within the extraction pit would be tested for pH daily during PASS placement and revert back to weekly during other rehabilitation works. • The pH of groundwater would be monitored both up and down gradient of the Site at least once every three months for a minimum of one year after the last load of PASS or VENM material is placed within the extraction pit. If the pH of the water falls below 6.5 the proponent would notify the EPA in writing as soon as practicable and within 24 hours. • Static groundwater levels (SWL) and pond water level AHD heights would be measured daily during reinstatement works involving the placement of PASS material, and weekly during all other rehabilitation works (bores only). Following rehabilitation, all of the five bores would be incorporated into the quarterly groundwater monitoring program for the DRWDD.
	Sediment-laden water reaching waterways	Only aggregate greater than 20 mm would be permitted to be stockpiled on the site.
Alteration to air quality	Disruption of fauna	Directional lighting would be used where lighting is required in construction areas.

Activity	Impact	Mitigation Measure
and noise environments during construction and operation	foraging, nesting or roosting behaviours	Frequent maintenance of construction machinery and plant would be undertaken to minimise unnecessary noise. Dust suppression activities would be undertaken where appropriate.
General sand extraction and site rehabilitation activities	Fauna injury/ mortality	Site inductions would include a briefing regarding the local fauna of the Site and identification of protocols to be undertaken if fauna are encountered. Contact details would be kept on site for the local WIRES group and veterinarian if any fauna are injured on site or require capture and/or relocation.
	Introduction of weed/pest species	OEMP documentation will include details relating to the monitoring, management and where necessary eradication of weeds, disposal of green waste, and vehicle/plant weed wash down protocols if required. Noxious and high priority weeds (as identified in the Illawarra Biodiversity Strategy) are to be targeted in weed control programs.

4 OFFSETTING BIODIVERSITY IMPACTS

4.1 Policy framework

4.1.1 *Environmental Protection and Biodiversity Conservation Act 1999* Environmental Offsets Policy

Under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) Offsets Policy, environmental offsets are measures that compensate for the residual adverse impacts of an action. Offsets should counterbalance the impacts that remain after avoidance and mitigation measures have been implemented. For assessments under the EPBC Act, offsets are only required if residual impacts are significant.

There are no Matters of National Environmental Significance considered to be subject to residual significant impacts as a result of the Proposal.

4.1.2 OEH principles for the use of biodiversity offsets in NSW

Offsets are to be determined with reference to the OEH principles for the use of biodiversity offsets in NSW (Table 8).

Table 7: OEH principles for the use of biodiversity offsets in NSW

Biodiversity Offset Principles
1. Impacts must be avoided first by using prevention and mitigation measures - offsets are then used to address remaining impacts.
2. All regulatory requirements must be met - offsets cannot be used to satisfy approvals or assessments under other legislation.
3. Offsets must never reward ongoing poor performance - offset schemes should not encourage landholders to deliberately degrade or mismanage offset areas in order to increase the value from the offset.
4. Offsets will complement other government programs - a range of tools is required to achieve the NSW Government's conservation objectives, including the establishment and management of new national parks, nature reserves, state conservation areas and regional parks and incentives for private landholders.
5. Offsets must be underpinned by sound ecological principles – including consideration of structure, function and compositional elements of biodiversity, including threatened species and ecological communities, enhancement of biodiversity at a range of scales, and ensuring the long-term viability and functionality of biodiversity.
6. Offsets should aim to result in a net improvement in biodiversity over time - Enhancement of biodiversity in offset areas should be equal to or greater than the loss in biodiversity from the impact site.
7. Offsets must be enduring - they must offset the impact of the development for the period that the impact occurs - as impacts on biodiversity are likely to be permanent, the offset should also be permanent and secured by a conservation agreement or reservation and management for biodiversity.
8. Offsets should be agreed prior to the impact occurring - offsets should minimise ecological risks from time-lags.

Biodiversity Offset Principles

9. Offsets must be quantifiable - the impacts and benefits must be reliably estimated - offsets should be based on quantitative assessment of the loss in biodiversity from the clearing or other development and the gain in biodiversity from the offset. The methodology must be based on the best available science, be reliable and used for calculating both the loss from the development and the gain from the offset.

10. Offsets must be targeted - they must offset impacts on the basis of like-for-like or better conservation outcome.

11. Offsets must be located appropriately - wherever possible, offsets should be located in areas that have the same or similar ecological characteristics as the area affected by the development.

12. Offsets must be supplementary - they must be beyond existing requirements and not already funded under another scheme. Areas that have received incentive funds cannot be used for offsets.

13. Offsets and their actions must be enforceable through development consent conditions, licence conditions, conservation agreements or a contract - offsets must be audited to ensure that the actions have been carried out, and monitored to determine that the actions are leading to positive biodiversity outcomes.

4.2 Biodiversity Offset Strategy

4.2.1 Proposed Offset Measures

This Biodiversity Offset Strategy proposes three potential measures for consideration. These are listed in Table 8.

Table 8 .Proposed Offset Measures

Offset Measures	Actions
Offset Measure 1	Secure additional native vegetation on lands adjacent to the impact area, to be protected through establishment of an offset site under a Biobanking Agreement. This offset measure may alternatively be partially or fully delivered through the retirement of an appropriate number and class of biodiversity credits under the NSW Biobanking scheme.
Offset Measure 2	Establishment of an offset site under another suitable mechanism that ensures the land is managed for conservation in perpetuity.
Offset Measure 3	Use of supplementary measures in lieu of offsets

Offset Measure 1 is Council's first priority to achieve the objectives of the Biodiversity Offset Strategy, and is the focus of the current report. Offset Measures 2 and 3 would only be considered after further consultation with OEH and DP&E.

4.3 Proposed offset site

The proposed biodiversity offset is comprised of an approximately seven hectare area of land in the south-west of the DRWDD site. The proposed offset site is currently part of the portion of land known as Lot 21 DP 653009, and is located immediately adjacent to the areas to be impacted by the Proposal (Figure 3). The area of the proposed offset site is preliminary and Council may choose to conserve another portion of the DRWDD site under a biobanking agreement.

The proposed offset area is currently zoned E2 Environmental Conservation and E3 Environmental Management under the Shellharbour Local Environmental Plan 2011. The E2 Environmental Conservation zoning follows the boundary of the mapped SEPP 14 wetland along Rocklow Creek (Figure 3).

Three vegetation communities were identified in the proposed offset site in the Mills (2001) mapping of the natural vegetation of the Shellharbour LGA. Table 9 lists the vegetation communities and the equivalent PCT in the VIS database for each community.

Table 9: Vegetation communities mapped by Mills (2001) and equivalent Plant Community Types

Vegetation community (Mills 2001)	Plant Community Type
Bangalay - Banksia Forest	SR512 Bangalay - Old-man Banksia open forest on coastal sands, Sydney Basin and South East Corner
Mangrove Forest	SR575 Mangrove forest in estuaries of the Sydney Basin and South East Corner
Swamp Oak Forest	SR650 Swamp Oak swamp forest fringing estuaries, Sydney Basin and South East Corner

IMAGERY: SIX Maps

HYDER CONSULTING PTY LTD
ABN 76 104 485 289
Level 5, 141 Walker St
North Sydney NSW 2060
Australia
P +61 (0) 2 8907 9000
F +61 (0) 2 8907 9001

SCALE 4,000 @ A4

- Site
- Biodiversity offset site
- DRWDD Site Boundary
- Watercourse
- SEPP 14 wetland

Zoning

- E2
- E3
- RU1
- RU2
- SP2

Figure 3. Proposed biodiversity offset site

The proposed offset site overlaps the study area assessed for the Proposal. The vegetation of the northern portion of the proposed offset area was inspected and mapped as part of the ecological assessment (Hyder Consulting 2014). The vegetation of the proposed offset site has been mapped using the ground-truthed vegetation data combined with Mills (2001) vegetation mapping in the south of the study area (Figure 4). Two of the vegetation communities in the study area are equivalent to endangered ecological communities listed under the TSC Act. The area of each mapped community within the proposed offset site and equivalent EEC is provided in Table 10.

Table 10: Area of each vegetation community in the proposed offset site

Vegetation community	Equivalent EEC	Area
Bangalay - Banksia Forest	Bangalay sand forest, Sydney Basin and South East Corner bioregions	0.59 hectares
Mangrove Forest	N/A	0.38 hectares
Swamp Oak Forest	Swamp Oak Floodplain Forest of the North Coast, Sydney Basin and South East Corner Bioregions	5.97 hectares

Figure 4. Vegetation of the proposed biodiversity offset site

4.4 Improvement in biodiversity values at an offset site

The proposed offset site overlaps the study area and the vegetation of this area is in similar condition to that in the study area. The native vegetation of the proposed offset site would require active management, including weed removal and supplementary planting with native species, in order to improve the condition of the vegetation and habitats contained therein.

A preliminary biobanking calculation for the proposed offset area has been undertaken using data collected from the study area as a guide; the calculation indicates that the proposed offset site would generate at least the 53 ecosystem credits for SR650 that the development site requires.

The proposed offset site would be assessed using the Biobanking assessment methodology (BBAM) (OEH 2014) as part of the Biodiversity Offset Package, which would provide a more precise calculation of the biodiversity credits generated.

4.4.1 Management actions proposed to improve biodiversity values

The proposed offset site is currently managed by Council. There are no known existing obligations or binding agreements applicable to the proposed offset site.

It is proposed to establish a biobank site on the proposed offset site, to be managed in perpetuity under a Biobanking Agreement. A Biodiversity Offset Management Plan would be prepared for the proposed offset site. The Biodiversity Offset Management Plan is required to address, as a minimum, the standard and additional management actions specified in the Biobanking Assessment Methodology (OEH 2014) for Plant Community Types. The standard management actions are:

- Management of grazing for conservation (not applicable to the Proposal site)
- Weed control
- Management of fire for conservation
- Management of human disturbance
- Retention of regrowth and remnant vegetation
- Replanting or supplementary planting where natural regeneration will not be sufficient
- Retention of dead timber
- Erosion control
- Retention of rocks.

The plan must:

- describe the implementation of any additional management actions required by the Threatened Species Profile Database;
- set out the area to which each management action applies and the time frame for implementation of each management action; and
- identify which management actions apply and the timeframe for implementation of each management action on any area of the biobank site that is subject to a legal impediment, such as a covenant or an easement on the land title, that restricts full implementation of the management actions.

Annual reporting on management actions is required to demonstrate how the conditions set out in the biobanking agreement have been met.

A preliminary Biobanking credit calculation for the proposed offset site specifies the following additional management actions for SR650 Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion:

- Control of feral pigs
- Exclude miscellaneous feral species
- Feral and/or over-abundant native herbivore control
- Fox control

Green and Golden Bell Frog habitat

Though biodiversity offsets are not required for the Green and Golden Bell Frog, the species habitat would be impacted. Given the fluctuating nature of Green and Golden Bell Frog populations and the species' ability to recolonise previously inhabited areas, the Green and Golden Bell Frog could utilise habitats in the study area in future, including those proposed to be impacted. As such, it is advisable that impacts to the species habitat are managed through ecological restoration of potential habitat on the DRWDD. Such management and restoration measures could include:

- Planting in the stream bed and banks of the realigned drainage channel. Plantings would preferably contain a diversity of aquatic plants that the species is known to inhabit.
- Bank stabilisation and planting of suitable aquatic flora species in the drainage channel upstream of the site.
- Weed management.
- Remediation of poor water quality and ongoing water quality monitoring in the drainage channel.

5 CONCLUSION

Shellharbour City Council proposes to undertake sand extraction and site rehabilitation activities at the Dunmore Recycling and Waste Disposal Depot (DRWDD) in Dunmore NSW. This Biodiversity Offset Strategy summarises the impacts of the Proposal on biodiversity values, details the mitigation measures proposed to minimise biodiversity impacts, and sets out options for offsetting impacts on a threatened community and a framework for delivery of these options

The Biodiversity Assessment for the Proposal found that it would result in the removal of 0.76 hectares of Swamp Oak Floodplain Forest in the NSW North Coast, Sydney Basin and South East Corner Bioregions, an Endangered Ecological Community (EEC) listed under the TSC Act.

Further assessment of the Proposal using the Biobanking credit calculator has resulted in an offset requirement of 53 ecosystem credits of the vegetation type SR650 Swamp Oak swamp forest fringing estuaries, Sydney Basin and South East Corner. The impacts to Swamp Oak swamp forest fringing estuaries, Sydney Basin and South East Corner additionally requires an application for a red flag determination under the BBAM (OEH 2014), as this vegetation is >70% cleared and/or contains an endangered ecological community.

This Biodiversity Offset Strategy proposes three potential measures for consideration:

- Offset Measure 1 - Secure additional native vegetation on lands adjacent to the impact area, to be protected through establishment of an offset site under a Biobanking Agreement.
- Offset Measure 2 - Establishment of an offset site under another suitable mechanism that ensures the land is managed for conservation in perpetuity.
- Offset Measure 3 - Use of supplementary measures in lieu of offsets

Offset Measure 1 is Council's first priority to achieve the objectives of the Biodiversity Offset Strategy, and is the focus of the current report. Offset Measures 2 and 3 would only be considered after further consultation with OEH and DP&E.

The proposed biodiversity offset is comprised of an approximately seven hectare area of land in the south-west of the DRWDD site, located immediately adjacent to the areas to be impacted by the Proposal. It is proposed to establish a biobank site on the proposed offset site, to be managed in perpetuity under a Biobanking Agreement. A Biodiversity Offset Management Plan would be prepared for the proposed offset site.

The area of the proposed offset site is preliminary and Council may choose to conserve another portion of the DRWDD site under a biobanking agreement. A preliminary biobanking calculation for the proposed offset area indicates that it would generate at least the 53 ecosystem credits for SR650 that the development site requires.

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APPENDIX 1

BIOBANKING CREDIT REPORT

BioBanking credit report

This report identifies the number and type of credits required at a DEVELOPMENT SITE.

Date of report: 3/07/2015 Time: 7:58:30AM Calculator version: v4.0

Development details

Proposal ID:	0023/2015/1900D
Proposal name:	Dunmore Sand Extraction
Proposal address:	Buckleys Road Dunmore NSW
Proponent name:	Shellharbour City Council
Proponent address:	Locked Bag 155 Shellharbour City Ce NSW 2529
Proponent phone:	0242216111
Assessor name:	Jane Rodd
Assessor address:	Level 5, 141 Walker Street NORTH SYDNEY NSW 2060
Assessor phone:	8907 8266
Assessor accreditation:	0023

Improving or maintaining biodiversity

An application for a red flag determination is required for the following red flag areas

Red flag	Reason
Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion	Vegetation type being > 70% cleared; or it contains an endangered ecological community;

The application for a red flag determination should address the criteria set out in the BioBanking Assessment Methodology. Please note that a biobanking statement cannot be issued unless the determination is approved.

Additional information required for approval:

- ☐ Change to percent cleared for a vegetation type/s
- ☐ Use of local benchmark
- ☐ Change negligible loss
- ☐ Expert report...
- ☐ Request for additional gain in site value
- ☐ Predicted threatened species not on site
  - Greater Broad-nosed Bat — Scoteanax rueppellii
  - Long-nosed Potoroo — Potorous tridactylus
  - New Holland Mouse — Pseudomys novaehollandiae
  - Varied Sittella — Daphoenositta chrysoptera
  - White-fronted Chat — Epthianura albifrons
- ☐ Change threatened species response to gain (Tg value)

Ecosystem credits summary

Plant Community type	Area (ha)	Credits required	Red flag
Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion	3.56	52.93	Yes
Total	3.56	53	

Credit profiles

1. Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion, (SR650)

Number of ecosystem credits created 53

IBRA sub-region Illawarra

Offset options - vegetation types	Offset options - CMA sub-regions
Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion, (SR650) Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion, (SR649)	Illawarra and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

Attachment 3 - Memorandum in response to query on drainage

NSW GOVERNMENT | Office of Environment & Heritage

Date: 31 July 2015
Your reference: DA 18/2015
Our reference: DOC15/271085-2
Contact: Calvin Houlison
4224 4179

Victoria Nicholson
Senior Development Assessment Officer
Shellharbour City Council
Locked Bag 155
SHELLHARBOUR NSW 2529
E-mail: victoria.nicholson@shellharbour.nsw.gov.au

Dear Ms Nicholson

RE: Dunmore Sand Extraction – Biodiversity Offset Strategy (DA18/2015)

Thank you for the opportunity to provide comment on the Biodiversity Offset Strategy (Hyder, July 2015), submitted in support of DA18/2015 as recommended in our comments dated 10 April 2015. We have reviewed the strategy and generally support the findings. Based on our preliminary review, it appears likely that the calculations will require fine tuning prior to an application for a Biobanking Agreement being submitted. We recommend discussion with our office as early as possible to ensure a smooth process moving forward with the biobanking options.

Our preferred option for offset arrangements for the proposed development is Option 1, comprising an offset site adjacent to the impact area as per the recommendations of the strategy, or alternatively in another site containing the same vegetation community being removed as part of the current proposal. However, it is important to note that Clause 11(1)(d)-(e) of the Threatened Species Conservation (Biodiversity Banking) Regulations 2008 relates to offset measures being secured by any formal mechanism prior to the issue of a Biobanking Agreement. This clause states as follows:

(1) 'Land is not to be designated as a biobank site by a biobanking agreement if:

...

(d) the Minister is of the opinion that the land is already the subject of a requirement to carry out biodiversity conservation measures of an ongoing nature on the land under a condition of an approval or consent granted under Part 3A, 4 or 5 of the Environmental Planning and Assessment Act 1979 (this extends to any land that is the subject of a conservation agreement entered into under the National Parks and Wildlife Act 1974 for the purpose of compliance with such a condition), or

(e) the Minister is of the opinion that biodiversity conservation measures are already being carried out, or are required to be carried out, on the land under an offset arrangement made for the purpose of complying with requirements imposed by or under any Act (including the requirements of any authority granted by a public authority under any Act)'.

Therefore should Council be minded to recommend approval of the application, we recommend that the following condition be applied:

'Impacts associated with the clearing of native vegetation shall be addressed in accordance with one of the recommendations contained within Table 8 of the Biodiversity Offset Strategy Report No. AA005925 (Hyder, 3 July 2015), as prepared by an accredited BioBanking assessor in accordance with the OEH BioBanking Assessment Methodology'.

Please contact me on 4224 4179 or via e-mail calvin.houlison@environment.nsw.gov.au should you wish to discuss further.

Yours sincerely

CALVIN HOULISON
Conservation Planning Officer