REPORT

Elfin Hill Road Reserve Foreshore Stabilisation

Technical Specification

Client: Central Coast Council

Reference: M&A-PA1635-TS001-D01

Revision: 01/Final

Date: 8 March 2018

Royal HaskoningDHV

Enhancing Society Together

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Table of Contents

Abbreviations

ARI	Average Reoccurrence Interval
ASS	Acid Sulfate Soils
PASS	Potential Acid Sulfate Soils
SLR	Sea level rise
s/w	stormwater

1 DESCRIPTION OF THE WORKS

1.1 General

The Works to be carried out under the Contract include the supply of all materials, plant, equipment and labour required for the construction of the new Elfin Hill road reserve foreshore stabilisation (the 'Works').

The Drawings shall be read in conjunction with all such other drawings and specifications and with such other written instructions that may be issued during the course of the Contract. Any discrepancy shall be referred to the Superintendent before proceeding with the work.

All materials and workmanship shall be in accordance with the relevant and current Standards Australia codes and with the by-laws and ordinances of the relevant building authorities except where varied by the Drawings and Specification.

All site dimensions shall be verified by the Contractor on site before work commences. Any variance to the dimensions marked on the Drawings shall be referred to the Superintendent for resolution. Drawings shall not be scaled for dimensions.

During construction, the Works shall be maintained in a stable condition and no part shall be overstressed. The Contractor shall take particular care to ensure that its plant is not permitted so close to the crest of the existing revetment as to destabilise the structure. Temporary bracing and batters shall be provided by the Contractor to keep the Works and excavations stable at all times.

1.2 Scope of Works

The Scope of Works for this Technical Specification includes:

(i) site establishment;

(ii) environmental protection including preparation and implementation of a Works Environmental Management Plan (EMP);

(iii) protection of the Works from waves, tidal action, stormwater and the effects of any dewatering;

(iv) survey by a Registered Surveyor including a Pre-Construction Survey and a Works-as-Executed Survey;

(v) clearing vegetation and demolition of existing structures (including trees, existing s/w outlets, remains of coastal protection structures, etc.);

(vi) earthworks including excavation and filling;

(vii) stormwater extension works;

(viii) mass concrete encasement at junction of stormwater pipe extensions;

(ix) rock treatment to stabilise the foreshore;

(x) construction of salt marsh berms including soil and planting;

(xi) construction of dinghy skids;

(xii) reinstatement, site disestablishment and cleanup.

1.3 Drawings

The Scope of Works is shown on the Drawings attached in **Appendix A.** The works shown and noted on the drawings are to be read in conjunction with the requirements outlined in this Technical Specification. Any conflict in scope and specification between overlap items shall be referred to the Superintendent for clarification.

General notes to be considered whilst reading drawings include:

- all detailed dimensions are provided in millimetres (mm) unless otherwise noted; and
- where any connections to existing structures are to be implemented in the Scope of Works the Contractor shall, prior to undertaking work, confirm existing sizes and arrangements to ensure the design intent is carried through into construction.

The Contractor should seek clarifications to queries regarding the Drawings from the Superintendent.

1.3.1 Chainage System

All chainages are given in metres (m) measured along the set-out line and revetment cross-sections.

1.3.2 Level Datum and Linear Dimensions

All reference to Reduced Level (RL) in this Technical Specification and all levels shown on the Drawings are in metres above Australian Height Datum (AHD). AHD is approximately Mean Sea Level along the Australian seaboard.

2 LOCATION AND ACCESS

2.1 Location

The Works is located along the foreshore of Elfin Hill Road Reserve, from Elfin Hill Road in the south to the rock platform behind 313 Avoca Drive in the north.

2.2 Access

The Site can be accessed from Elfin Hill Road, off Avoca Drive. Avoca Drive is a four-lane bidirectional road providing access between the southern and northern suburbs of the Central Coast. Access to the foreshore would be via a gate at the southern end of the Site. There is a concrete ramp from the gate into the Site that has an approximate slope of 1V:4H. The concrete ramp is considered too steep for access by a 10T truck.

Access to the Site is considered to be one of the main challenges of the project. Tenderers are therefore required to visit the site and make their own assessment of how access to the site will be achieved prior to submitting a proposal to carry out the Works.

Access to the reserve is also possible by boat from Brisbane Water estuary. If the Contractor will be relying on access by boat, the existing water depth limitations are to be taken into consideration.

As part of the Tender submission, all Tenderers are required to provide the following:

- A method statement describing what plant will be used on site, and how it will be delivered to site;
- A method statement describing how all materials needed for the Works will be delivered to site; and
- A method statement describing how and where materials will be stored on or near the Site.

The Contractor shall manage each traffic movement to and from the Site to ensure safety and minimise disruption to pedestrian and other vehicular traffic.

Any temporary works needed to achieve access to the Site will be the responsibility of the Contractor, including post-construction remediation.

3 SITE ESTABLISHMENT

3.1 General

Site establishment shall consist of the furnishing by the Contractor at the site of all plant, equipment and personnel necessary for completion of the Works, and of other related preparatory works being completed (e.g. insurances). The site establishment shall include the installation of temporary facilities for use by the Contractor, temporary fencing and setting out of any temporary services.

Site establishment shall also include works associated with the provision of safe access and thoroughfares, protection to existing structures, a pre-construction dilapidation survey, setting out the Works, and other related activities required under the Contract.

3.2 Time for Commencement of Work

Work shall not commence on the Site before receipt and written acceptance by the Superintendent of the pre-construction dilapidation report and photographic record and/ or video record of the pre-construction condition of the Site.

3.3 Dilapidation Survey

The Contractor shall be required to undertake a dilapidation survey of all areas which may be affected by construction activity prior to the commencement of the Works. The dilapidation survey shall be replicated prior to Practical Completion. The purpose of this survey is to confirm the “Pre” and “Post” construction condition of the Site and surrounds. The extents of the area to be included in the dilapidation survey will depend on the Contractors proposed methodology and traffic management plan, and will be subject to the approval of the Superintendent.

The dilapidation survey shall be completed by the Contractor in the company of the Superintendent.

The dilapidation survey shall comprise a comprehensive photographic record and/ or video record, including comments, of the existing condition of all areas which may be affected by the construction activity. The Contractor shall compile this record into a bound report and provide two (2) copies to the Superintendent.

3.4 Site Induction Meeting

As part of site establishment, the Contractor shall convene and chair a Site Induction Meeting to be attended by:

- all personnel employed by the Contractor for carrying out the Works;
- the Superintendent; and
- representatives of any relevant authorities invited by Council.

Prior to the Site Induction Meeting, the Superintendent shall have received from the Contractor and reviewed the Site Safety Management Plan and Construction Environmental Management Plan. The following matters shall be included in the Site Induction Meeting:

- address to make operators of construction equipment aware of potential marine ecology encountered during operations and procedures to manage marine ecology; and
- check to ensure all works personnel are trained in the use of the spill control materials.

Excluding the costs to cover attendance by the Superintendent and representatives of authorities invited by Council, the full cost of the Site Induction Meeting shall be included under site establishment.

3.5 Working Hours

The work shall be conducted between the hours specified below, unless otherwise agreed in writing by the Superintendent:

- 7:00 am to 6:00 pm, Monday to Fridays
- 8:00 am to 1:00 pm, Saturday

No work shall take place on Sundays or Public Holidays unless approved.

3.6 Work Health and Safety

The Contractor shall comply with all Work Health and Safety regulations.

The Contractor shall prepare Safe Work Method Statements (SWMS) and ensure adherence to these for all construction tasks. Copies of SWMS are to be kept on site for ready reference by workers. Tool box talks/meetings and briefing sessions are to be conducted by the Contractor to ensure full compliance with the SWMS. All construction personnel shall be appropriately qualified and carry relevant documentation (such as a construction induction card or specific operating licences) with them at all times.

The Contractor shall obtain and keep on site all relevant Material Safety Data Sheets (MSDS) for any materials that are used in the Works. All transportation, storage and use of these materials shall be in accordance with the MSDS.

3.7 Sign Boards

The Contractor shall supply and erect:

- one (1) Project signboard ; and
- Safety signboard(s) as required by Work Health and Safety.

These shall be located in prominent positions to the satisfaction of the Superintendent.

The minimum size of the Project signboards shall be 800 mm x 600 mm. The required wording for the Project signboards and their location will be advised by the Superintendent. The signboards shall be erected within ten (10) working days of receipt of sign wording.

3.8 Heavy Machinery

Advice from the Superintendent shall be sought prior to using any heavy machinery or constructional plant on the Site or surrounding roads. The Contractor shall comply with instructions issued by the Superintendent. Heavy machinery shall be deemed plant which imparts a point load greater than 2 tonnes or a pressure of 15 kPa.

4 SITE INFORMATION

4.1 Site Description

Elfin Hill Road Reserve is situated on the eastern foreshore of Brisbane Water at Green Point. The Site extends around 125 m along the alignment of the foreshore from Elfin Hill Road in the south to the rock platform behind 313 Avoca Drive in the north. The reserve is between 15 to 25 m wide, grassed and relatively flat with levels ranging from 0.8 to 2.0 m AHD. It should however be noted that access to the Site is relatively steep (see Clause Location and Access, Access).

The reserve exhibits varying levels of active shoreline erosion and there are a number of ad-hoc sea walls present with varying degrees of structural integrity.

4.2 Existing Survey

The survey data shown on the Drawings is based on a survey undertaken 22nd October 2014 by Stephen Thorne and Associates. All levels are to Australian Height Datum (AHD) and horizontal positioning to the Map Grid of Australia (MGA).

The Contractor shall consider the existing survey as indicative only. The Contractor shall account for levels and slopes of the beach material being correct at the time of survey, but having potentially changed over time. The Contractor shall confirm all required levels prior to construction by undertaking a Preconstruction Survey.

4.3 Geology, Geotechnical Conditions, Acid Sulfate Soils and Contaminated Sediments

4.3.1 Geology

The *Gosford-Lake Macquarie 1:100 000 Geological Sheets 9131 & 9231* indicates the site is underlain by Terrigal Formation, part of the Narrabeen Group deposited during the Triassic Period. These deposits are described as interbedded laminate, shale and quartz to lithic quartz sandstone with minor red claystone.

The *Gosford-Lake Macquarie 1:100 000 Soil Landscape Series Sheets 9131 & 9231* indicates the terrestrial portion of the site is classified as Erina, an erosional landscape. The limitations noted on this group includes localised high soil erosion hazard, localised mass movement, foundation hazard and strongly acidic soils of low fertility. The map makes no reference to the aquatic landscape.

4.3.2 Geotechnical Conditions

A limited site investigation was undertaken on 28th October 2014 by Royal HaskoningDHV.

Four DCPs were carried out along the foreshore to depths between 0.8 m and 2.6 m below the surface and generally indicated looser or softer material for the upper 0.7 m to 0.9 m with denser or stiffer material below. Bedrock was noted as foreshore rock shelves adjacent to the north and south of the site. Inferred depth to bedrock across the site varied between 0.7 m and 2.6 m. The DCPs results and a location plan are provided in **Appendix B**.

Four sediment samples were also collected and analysed for particle size distribution (PSD). The sediment sample results indicated that the middle and southern end of the site comprises medium grained sand with silt and traces of gravel. The samples have less than 10% fines (silt and clay sized sediments) and less than 8% gravel. The northern end of the site comprises silty sand with gravel and the sample has 22% fines and 23% gravel. The PSD results are provided in **Appendix A**.

4.3.3 Acid Sulfate Soils

The Gosford Acid Sulphate Soils Risk Map (1:25,000 scale, 1995 edition) indicates the site lies within an area of high probability of occurrence of ASS materials in bottom sediments below water level. Based on the mapping, there is a severe environmental risk if the bottom sediments are disturbed by activities such as excavation or dredging.

RHDHV has undertaken soil sampling at the Site for ASS assessment. The results indicated potential oxidisable sulfur in all samples greater than the "action criteria" provided in the Acid Sulfate Soils Manual (Stone et. al, 1998).

A preferred management strategy plan has been developed for implementation as part of the Works specifically for the removal, handling and reuse of material excavated on-site. Laboratory testing of soil samples has determined that material excavated from the site will require neutralisation if it is stockpiled for an extended period, reused as fill on-site above the water table or disposed of off-site.

Refer **Appendix C** for Acid Sulfate Soils Management Plan and Clause Works EMP, Works EMP #7 Management of Acid Sulfate Soils.

4.4 Wind Climate

No measured wind data is available for the Site. The wind climate that has been adopted is therefore based on *Structural Design Actions - Wind Actions - AS 1170.2*. Wind speed is dependent on elevation, terrain, wind direction and topography amongst other factors. AS 1170.2 provides wind speeds as a peak 3 second gust for varying Average Reoccurrence Intervals (ARI). The 3 second peak gust velocity has been converted to an equivalent 1-hour duration using methods outlined in Coastal Engineering Manual (USACE, 2006). The 1 hour design wind speed for the NSW coast south of 30 degree latitude and 10 m above a water body is presented in Table 1. Whilst these estimates take topographic effects such as hill slopes into account, they do not account for topographic effects caused by valley and water way orientation, which leads to funnelling of wind.

Table 1: 1-hr Duration Design Wind Velocity (m/s) 10m above a water body

Wind Direction	5-year ARI	100-year ARI
North	17.0	21.7
North East	17.0	21.7
East	17.0	21.7
South East	20.1	25.8
South	19.1	24.4
South West	20.1	25.8

West	21.2	27.2
North West	20.1	25.8

4.5 Water Levels

The Contractor shall, in carrying out the Works, take account of variable and extreme water levels at the site including storm conditions, as outlined below.

4.5.1 Astronomical Tides

Water levels at the Site are mainly influenced by astronomical tide. Predicted tidal planes relative to Australian Height Datum (AHD) for Erina Creek are presented in Table 2. These tidal planes would be similar to the tidal planes at the Site.

Table 2: Predicted tidal Planes for Erina Creek

Tidal Plane	Water Level (m AHD)
High High Water Springs (HHWS)	0.63
Mean High Water Springs (MHWS)	0.39
Mean High Water (MHW)	0.34
Mean Tide Level (MTL)	0.08
Mean Low Water (MLW)	-0.18
Mean Low Water Springs (MLWS)	-0.23
Indian Springs Low Water (ISLW)	-0.40

The Contractor shall take account of the difference in datum used for charts (Chart Datum or CD) and that of AHD levels.

4.5.2 Extreme Water Levels

Coastal water levels are elevated above predicted tide levels during storm events. The Design Water Level (DWL) includes storm tide level, wind set up and sea setup. The DWL is based on simulations undertaken for approximate 5-year and 100-year Average Reoccurrence Intervals (ARI). Two locations near Elfin Hill Road Reserve were assessed as part of this study. The locations were approximately 150 m north of the site and 150 m south of the site. Results from the simulation are presented in Table 3.

Table 3: Predicted Design Water Level

Event	150m North of Elfin Hill Road Reserve (m AHD)	150m South of Elfin Hill Road Reserve (m AHD)
5-year ARI	1.34	1.33

100-year ARI	1.65	1.63

The wave run-up height has been estimated to be between 2.9 and 3.0 m AHD for a 100 year ARI event.

4.6 Wave Conditions

The wave climate at Green Point is limited to locally generated wind waves and boat wake. Wind waves at the site are limited by the available fetch (distance of water over which the wind blows). The longest fetch is close to 4 km to the west and north west. Wave modelling was used to predict wave heights and periods at the site for approximate 5-year and 100-year ARI events. The results of this wave modelling are summarised in the table below.

Table 4: Predicted significant wave heights for Green Point (wave modelling)

Simulted Event	150m North of Elfin Hill Road Reserve		150m South of Elfin Hill Road Reserve	
	Wave Height (m)	Wave Period (sec)	Wave Height (m)	Wave Period (sec)
5-year ARI	0.83	3.4	0.74	3.2
100-year ARI	1.02	3.8	0.92	3.6

Wind-wave hindcasting calculations based on procedures in the Coastal Engineering Manual (USACE, 2006) and using design wind velocities are summarised in Table 5. The values are similar to those predicted in the wave modelling (Table 4).

Table 5: Predicted significant wave heights at the Site (hindcast calculations)

Simulted Event	Wave Height (m)	Wave Period (sec)
5-year ARI	0.76	2.5
100-year ARI	1.03	2.8

Boat wake at the site is generated on a regular basis by the small craft that use the area. Other larger craft also generate wake on an infrequent basis. Boat wake at the site is estimated to have a maximum wave height of around 0.5 m.

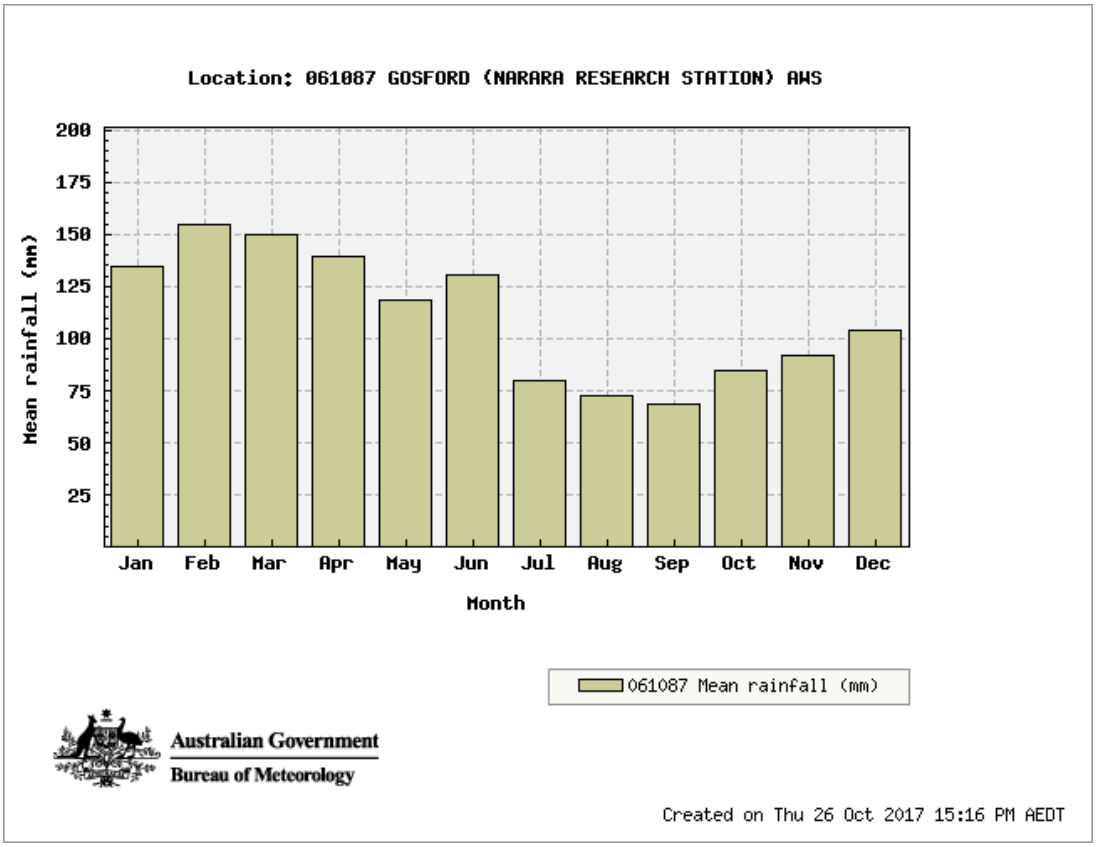
4.7 Currents

There is no measured current data at the Site, although tidal currents and localised stormwater outlet flows based on RHDHV experience are unlikely to exceed 0.2 and 3.0 m/s respectively. The Contractor is required to take the necessary precautions to deal with any currents that may be encountered at the Site.

4.8 Rainfall

The average monthly rainfall from 1916 to 30 May 2013 at the Gosford (Narara Research Station) AWS is presented in Figure 1. The rainfall pattern is typical of a subtropical climate zone with higher rainfall in the warmer months. Daily rainfall at times of severe storms could equal or even exceed average monthly rainfall.

Figure 1: Mean Rainfall Statistics at Gosford (Narara Research Station) AWS (Australian Government – Bureau of Meteorology)



Site name: GOSFORD (NARARA RESEARCH STATION) AWS
Site number: 061087
Latitude: 33.39 °S **Longitude:** 151.33 °E
Elevation: 20 m
Commenced: 1916 **Status:** Closed 30 May 2013

4.9 Services

The Drawings show the following services as having been identified on Site:

- Council sewer main;
- Council rising main; and
- Various stormwater pipes and outlets.

In addition to the above, typical services that would be expected to occur at the Site would include:

- Potable water;
- Electricity; and
- Telephone.

A Dial Before You Dig survey should be completed prior to commencing work and a services locator should be engaged to formally locate services.

5 CONTRACTOR'S WORK AREA

5.1 General

The Contractor shall be wholly responsible for the provision of offices and sheds at the Site. Offices and sheds required by the Contractor shall only be erected and equipment shall only be located in designated site compound areas (see Section 2.4.6 of the REF). The Contractor's plant, labour and materials shall be allowed on the Site only to the extent necessary for the construction of the Works.

The areas of the Site that can be made available to the Contractor for storage and construction purposes shall be agreed with the Superintendent.

As per the REF requirements (see Section 5.5.3 of the REF):

- Signs to notify the community of planned works and changes to traffic or pedestrian access shall be displayed prior to and during works; and
- Construction areas will be delineated by fencing and signage to restrict pedestrian and water access

5.2 Restrictions

The Contractor shall confine the Contractor's storage, accommodation and other facilities and manage pedestrian access within, through and around the Contractor's Work Area in accordance with Work Health and Safety (WHS) regulations.

As a minimum the Contractor shall erect and maintain man-proof temporary fencing as follows:

- Around the works compound; and,
- To isolate public areas from work areas during construction.

The man-proof temporary fencing shall suit the requirements of the Site. It shall be a minimum of 1.8 m high and meet WorkCover approval. Australian Temporary Fencing (ATF) wire mesh panels or approved equivalent shall be permitted.

At the end of each work day, the Contractor shall make the Site safe and take all necessary safety measures before leaving the Site.

5.3 Temporary Services

The Contractor shall arrange for the connection of temporary service lines for water, power, telephone and any other service that is deemed necessary by the Contractor. All such arrangements shall be in accordance with the requirements of the relevant authority.

The Contractor shall meet the cost of accessing and providing these services to the Site as appropriate, their use and their removal at Completion.

5.4 Protection of Existing Structures

The Contractor shall take every precaution to avoid damaging existing structures. The Contractor shall make the Contractor's own assessment of the location of any existing structures. Any structures damaged during the course of the Contract shall be reinstated by the Contractor at the Contractor's own expense.

5.5 Existing Services

5.5.1 General

The Contractor shall be responsible for establishing the nature and location of all services that might be encountered during the construction of the work and to consult with the relevant authorities with respect to these matters prior to commencing excavation at any location. The services enquiries made by the Contractor shall include a Dial Before You Dig search.

Failure by the Contractor to inform itself of the nature and location of all services and to take due care shall not limit its liability for the repair of all services damaged.

5.5.2 Damage to Services

In the event that the Contractor causes damage to services (such as sewer, water supply, electricity supply and telecommunications), the Contractor shall immediately notify the Superintendent and the relevant service providers.

The Contractor shall be responsible for the repair/restoration of this damage in an expeditious manner to the satisfaction of the relevant service provider and the Superintendent. The Contractor shall be accountable for the cost to complete the repair/ restoration of any such damage.

5.5.3 Relocation or Replacement of Existing Services

Relocation or replacement of existing services may be required where an existing service, which is to remain in place after construction of the Works, occupies the same space in which the construction activities are required.

The Contractor shall give notice of its requirements to the Superintendent and shall arrange for the removal or deviation of the service as soon as practicable in accordance with the requirements of the appropriate service provider.

5.6 Surface Drainage

The Contractor shall undertake all necessary works to ensure surface water is properly managed across the Site and does not interfere or damage the works in progress.

5.7 Site to be Kept Tidy

The Contractor shall ensure that all rubbish collected and all waste generated on the Site during the course of the Contract is regularly disposed offsite in an environmentally acceptable manner to the approval of the relevant authorities.

6 SETTING OUT OF THE WORKS

Subject to specified tolerances, all work is to be constructed to the lines and levels shown on the Drawings.

The Contractor shall be responsible for setting out the Works. The Contractor shall engage a Registered Surveyor to set out the Works and submit to the Superintendent a copy of the Survey Project Quality Plan (SPQP) prepared and signed by the Registered Surveyor before commencing the survey work on the Site.

The Contractor shall make good any error in setting out the Works at its own cost and to the satisfaction of the Superintendent.

All set out dimensions shown on the Drawings shall be verified by the Contractor on site before work commences.

7 PROTECTION OF WORKS FROM WAVES, TIDAL ACTION, STORMWATER, AND EFFECTS OF DEWATERING

7.1 General

The Contractor shall be responsible for protecting the Works from wave action and shoreline erosion, tidal action, stormwater, and from dewatering and/or changes in groundwater. Protection of the Works shall be provided for the duration of the Contract.

The Contractor shall construct the Works in a manner which limits the extent of works exposed to the above factors.

The Contractor shall remove and replace at the Contractor's cost all works damaged by tide, waves and weather.

7.2 Wave Action and Shoreline Erosion

The Contractor shall inform itself of the wave conditions likely to be encountered, including the effects of wave action on coastal water levels and beach levels (erosion), and adopt work methods and implement temporary works accordingly.

The method of protecting the Works from wave action and shoreline erosion shall be as stated in the Contractor's approved Method Statement.

In planning and implementing any system of temporary protection of the Works from wave action and shoreline erosion, the Contractor shall ensure that the system does not create adverse effects such as increased erosion at areas adjacent to the Works.

The Contractor shall be deemed to have made its own assessment of wave action and shoreline erosion to be encountered during construction of the Works and to have made adequate allowance for these conditions in the Tender.

7.3 High Water Levels

The Contractor shall adopt work methods and implement temporary works to manage the effects of high coastal water levels, and make allowance for these conditions in the Tender.

7.4 Stormwater

The Contractor shall be deemed to have made the Contractor's own assessment of the need for temporary diversion of stormwater and overland flows likely to be encountered during construction of the Works and made allowance for these conditions in the Tender. The Contractor shall be responsible for temporary diversion of any stormwater flows from the existing stormwater system and the management of overland flows due to any surcharging of stormwater pits or for any other reason.

7.5 Dewatering

The Contractor shall be responsible for dewatering areas of the Site as required during construction e.g. in excavations, for preparation of foundations, placement of rock and concrete, and backfilling.

The Contractor shall adequately control and remove all surface water, including tidal water, wave runup and groundwater, necessary for completion of the Works (including but not necessarily limited to demolition, excavation, preparation of foundations, and placement of rock and concrete).

The Contractor shall be deemed to have made its own assessment of dewatering requirements during construction of the Works and to have made adequate allowance for these requirements in the Tender.

8 WORKS ENVIRONMENTAL MANAGEMENT PLAN (WORKS EMP)

8.1 General

The Contractor's Works Environmental Management Plan (Works EMP) shall comply with the following sections of this Technical Specification.

During the execution of the Works, the Contractor shall ensure that Central Coast Council's ordinances relating to environmental protection, as well as any other environmental requirements of relevant authorities, are adhered to.

During the execution of the Works, the Contractor shall ensure that all rubbish or surplus material is progressively removed and disposed offsite in an environmentally acceptable manner to the approval of the relevant authorities.

8.2 Implementation of Works EMP

The Superintendent is responsible for:

- Ensuring that the Contractor's Works EMP meets the requirements of the Contract Documents.
- Auditing the Contractor's implementation of the Works EMP and for issuing corrective action requests to the Contractor as appropriate.

The Contractor is responsible for preparation of a Works EMP, which states the Contractor's policy and methods of implementation for:

- Compliance with all relevant local, State and Commonwealth environmental legislation, guidelines, permits and licences and industry codes of practice.
- Design of temporary environmental measures to mitigate any unfavourable environmental impacts.
- Construction, operation, maintenance and monitoring of all environmental measures during construction and the relevant defects liability period.
- Reporting and correcting Works EMP non-conformances during construction and the relevant defects liability period.
- Correcting Works EMP matters raised by the Superintendent on corrective action requests.

The Works EMP must be submitted and approved by the Superintendent at least seven (7) days prior to the commencement of construction works.

The Superintendent will be responsible for periodic monitoring and auditing of the Works EMP, reporting the results and issuing corrective action requests.

Corrective Action Requests (CAR) will specify the Works EMP non-conformance and require the person/organisation responsible to state the corrective action being taken and its time of completion and, in addition, will require a statement of preventive actions to ensure that similar non-conformances do not occur.

8.3 Reporting of Works EMP

An Environmental Management File (EMF) shall be maintained by the Contractor, containing all documentation pertaining to environmental management of the project. The EMF should take the form of a traditional correspondence file. The Contractor shall undertake weekly inspections of the construction area to identify any Environmental Management non-conformances with construction phase actions. A report providing details of these inspections is to be maintained on the EMF.

The Contractor shall prepare a monthly report including a description of monitoring activities, non-conformance notices and corrective action notices (both completed and pending). The monthly report shall be made available to the Superintendent for review.

During construction, the Contractor's Environmental Representative shall make daily visual inspections of the Site and any discharges from the Site.

The Contractor and any Subcontractors shall report any non-conformance with the Works EMP to the Superintendent. Reporting shall be done immediately after the non-conformance has occurred.

The Contractor is responsible for carrying out preventative action and corrective action resulting from a non-conformance.

8.4 Training, Awareness, Competence for Works EMP

All activities on the project which have a potential to cause environmental harm shall be identified by the Contractor and personnel competent to carry them out shall be selected by the Contractor or, alternatively, others shall be given specific training and assessed for competency.

All staff shall be trained and assessed in environmental responsibilities by the Contractor.

The Contractor should be aware that compliance with the Works EMP does not remove the responsibility of compliance with the law.

8.5 Sampling, Analysis and Measurements for Works EMP

The Manuals published by the Office of Environment and Heritage (OEH) shall be utilised where they apply.

Laboratories shall be selected for their certification by NATA or other accrediting body. Samples shall be collected and measurements made by persons with the necessary training and competence.

Control and calibration of measuring equipment shall be as set out in the equipment manuals, the OEH manuals or Australian Standards as appropriate. Records of calibrations shall be kept.

8.6 Standards, Legislation and Guidelines for Works EMP

Compliance with the Works EMP shall be made a condition of acceptance of the contract to work on the Site by the Contractor and any Subcontractor.

The Contractor shall plan and execute the construction to prevent or minimise environmental harm and in accordance with best practice environmental management as required by the *Protection of the Environmental Operations Act 1997.*

The following shall apply to monitoring and auditing of performance:

Item	Act, Guideline etc.
Water	Protection of the Environment Operations Act 1997 Australian Water Quality Guidelines for Fresh and Marine Waters - ANZECC.
Soils	Contaminated Land Management Acct 1997 ANZECC/NHMRC – Guidelines for the Assessment and Management of Contaminated Sites. NSW EPA (2014) Waste Classification Guidelines Part 1: Classifying Waste Acid Sulfate Soils Manual guidelines (Stone et. al, 1998) published by the NSW Acid Sulfate Soils Management Advisory Committee (ASSMAC) DEC (1995) Contaminated Sites: Sampling Design Guidelines.
Air	Protection of the Environment Operations Act 1997
Noise and Vibration	Protection of the Environment Operations Act 1997 NSW EPA Noise Manual
Flora and Fauna	Biodiversity Conservation Act 2016 Fisheries Management Act 1994
Dangerous Goods	Dangerous Goods Act 1975 Environmentally Hazardous Chemicals Act 1985 AS1940 Storage and Handling of Flammable and Combustible Liquids
Soil Erosion and Sediment Control	Soil Erosion and Sediment Control – Engineering Guidelines for Construction Sites - Institution of Engineers 1996 Soils and Construction Volume 1 (Blue Book) – Landcom 2004

8.7 Works EMP Elements

The following elements are considered the minimum requirements for the Works EMP.

8.7.1 Works EMP #1: Erosion Control, Stormwater and Coastal Water Quality Management

General

The Contractor shall determine the control measures appropriate to the Site. Prior to the commencement of the Works, the Contractor shall prepare an Erosion and Sediment Control Plan in consultation with

Central Coast Council. This shall include appropriate erosion and sediment control measures in accordance with Landcom's document "*Managing Urban Stormwater – Soils and Construction"* (the 'Blue Book').

Management measures shall incorporate the following items:

- Local stormwater runoff from undisturbed areas upstream of the Site should be diverted away from the Site and discharged to existing drains if possible. Minimise any alteration of existing drainage patterns in undisturbed areas, and stabilise to protect against erosion as required.
- Filtering devices and sediment retaining structures shall be utilised to prevent sediment, turbidity and other pollutants which result from the Works being discharged into the ocean. These devices and structures shall be used at times when the following activities are taking place:

    i. demolition;
    ii. excavation;
    iii. stockpiling
    iv. dewatering; and,
    v. filling.

- Drainage from stockpile areas shall be passed through sediment traps. Examples of sediment traps include hay bales, geo-textile fabric filter fences and silt traps. Construction of temporary sediment fences and catch drains shall be undertaken in accordance with Central Coast Council requirements.
- The extent of disturbance shall be the minimum required for construction activity or that provided in any Development Consent and/ or relevant permit(s), whichever is the lesser.
- Identify and delineate no-go or limited access areas as appropriate.
- Revegetation of stockpile areas and all other disturbed areas should be undertaken immediately after completion of construction.
- Top soil stockpiles shall be located on flat ground at least 5 metres away from areas subject to run-off and away from established flowpaths (e.g. drains, gutters, etc.). The height of the stockpiles shall not exceed 2 metres, unless stockpiles are suitably protected from wind erosion. The Contractor shall protect temporary top soil stockpiles with diversion drains, silt fences and straw bales to prevent sediment loss.
- Tracking of sediment from the construction site via construction equipment onto the road shall be minimised.
- Washout of concrete trucks and cleaning of construction equipment and/or vehicles shall not be undertaken in locations that permit flow of untreated wastewater directly to the open drainage system or the ocean.

- Stormwater from the stockpile areas shall be collected and treated via sediment control structures prior to discharge off site.
- The design of any sediment control structures by the Contractor shall minimise obstruction to freshwater runoff.
- Stores of oils, paints, fuel, etc. shall be contained in accordance with relevant regulation and ensure that no contaminants pollute land or waterways.
- At completion of construction the Site shall be cleared of potentially polluting materials.
- Inspections of the construction area and observations of work practices shall be undertaken daily to identify any existing potential problems.

Protection of the Estuary

The Contractor shall ensure that the water quality and ecology of the Elfin Hill Road Reserve and Brisbane Water is not impacted by the Contractor's work.

Except for the materials required to construct the Works, no demolition or excavation material, or any other materials supplied to the Site, shall be lost, placed or disposed in the estuary, irrespective of whether this action occurs illegally or accidentally. Upon any such incident, the following shall occur:

(i) the Contractor shall immediately provide sufficient resources to retrieve the placement or disposal;

(ii) the date, time, exact location and extent of the placement or disposal shall be recorded by the Contractor in writing and by photographs;

(iii) the incident shall be reported to the Superintendent within three (3) hours;

(iv) the placement or disposal shall be recovered from the estuary to the satisfaction of, and within a timeframe stipulated by, the Superintendent.

The cost to the Contractor of protecting the Works in accordance with this clause shall be fully borne by the Contractor, and shall be deemed to be included in the Tender price for the Works.

8.7.2 Works EMP #2: Air Quality

The Contractor is responsible for ensuring that the operation of construction plant and equipment results in minimum impact on air quality.

Best management practices shall be implemented including:

- minimising areas disturbed and exposed at any one time;
- revegetating or otherwise stabilising disturbed areas as soon as practicable;
- confining vehicle movements to designated areas;
- ensuring exhaust emissions from construction machinery and trucks remain within OEH emission standards

- watering or covering as required earthworks, spoil stockpiles and the like to minimise dust emissions;
- ensuring that all vehicles and equipment are fitted with appropriate exhaust control measures and are adequately maintained in line with manufacturer's requirements;
- covering all trucks transporting rock and fill materials where dust could be generated;
- ensuring that all trucks leaving the Site are checked daily for mud/dust and cleaned as necessary.

Burning of any waste arising from construction activities is prohibited.

8.7.3 Works EMP #3: Noise and Vibration Management

The Contractor shall ensure that noise and vibration on the Site are within acceptable limits as set out in relevant NSW legislation and guidelines.

To minimise noise impacts during construction, all construction activities on the Site including entry and departure of heavy vehicles shall be restricted to the Working Hours.

The Contractor shall utilise best practices and policies to minimise noise from construction. These shall include the following:

- All construction plant to be fitted with current best practice noise control and attenuation devices and maintained and operated to ensure that noise emissions are minimised.
- Blasting is not permitted.
- Ensure vehicles and construction equipment is maintained within service guidelines to minimise noise emissions from malfunctioning equipment.

8.7.4 Works EMP #4: Flora and Fauna Management

The Contractor shall ensure that construction activities are carried out in a manner that minimises the impact on flora and fauna.

The Contractor shall ensure that the following are included in the Works EMP in respect of flora and fauna management:

- The Works shall minimise the destruction of flora and interference with fauna.
- Implementation of the revegetation principles as described in the Specification.
- Minimise area disturbed by construction activity and use temporary fencing to delineate construction areas from protected areas. The extent of disturbance will be the minimum required for the construction activity or that prescribed in any Development Consent and/or relevant permit(s), whichever is the lesser.
- It is a requirement that the Contractor advises the Superintendent of any areas the Contractor proposes to clear for the purpose of the Works, and to mark the boundaries of clearing.

- The Contractor shall ensure that work practices prevent injury to, or death of, any native fauna on the Site. Any native fauna injured by the Works shall be transported to an animal hospital or refuge without delay.

8.7.5 Works EMP #5: Management of Dangerous Goods and Wastes

- Any site washrooms and toilets shall be provided with approved waste disposal.
- Waste oil shall be collected in drums and transported off site for recycling where possible.
- Petroleum products shall be stored, handled, separated and signed as required by the AS1940 Storage and Handling of Flammable and Combustible Liquids.
- Refuelling shall be carried out within bunded areas to prevent pollution from spillage.
- Waste oils shall be collected and transported to recycle depots or approved disposal sites. Major maintenance and repairs of construction plant and equipment shall be carried out offsite.
- Dangerous goods shall be stored and handled on bunded impervious floors and separated and signed as required by the appropriate Australian Standards.
- The Contractor shall prepare an Emergency Response Plan and train employees in the use of equipment, chemicals, and protective clothing and the application of the Emergency Response Plan.
- Any spills of dangerous goods shall be rendered harmless and collected for treatment and disposal at an approved site.

8.7.6 Works EMP #6: Road Traffic Management

The Contractor shall be responsible to undertake and invoke all necessary traffic management measures during construction as required by the relevant authorities. The cost of all such measures as required and requested by the relevant authorities is deemed to be included within the Contractor's tendered price.

Traffic management shall include safe passage and unrestricted access for pedestrians and members of the public around the perimeter of the Contractor's Work Area.

Road traffic management shall comply with the requirements of the NSW Roads and Maritime Services and Central Coast Council. The Contractor should be aware of the following minimum requirements:

- The Contractor shall coordinate transport to ensure minimum damage to public and other access roads.
- The Contractor shall utilise materials sourced locally wherever possible to limit the use of public roads for long distance hauling of bulk construction materials.
- The Contractor shall ensure that the transportation of dangerous goods is in accordance with the regulations and the relevant codes and standards published by Standards Australia.

- The Contractor shall ensure that a regular program of street cleaning is undertaken within public road entries and exits from the Contractor's Work Area.
- Washout of concrete trucks and cleaning of equipment and/or vehicles used during the road construction shall not be undertaken in locations that permit flow of untreated wastewater directly to the open drainage system or the estuary.

8.7.7 Works EMP #7: Management of Acid Sulfate Soils (ASS)

The Site is affected by ASS. An ASS Management Plan to be implemented for the Works is attached at **Appendix C**, with key extracts relating to site management activities outlined below:

A preferred management strategy has been prepared for any material disturbed during the excavations. The strategy involves acid neutralisation and utilisation of material for on-site reuse.

Neutralisation Requirements
Laboratory testing of soil samples has determined that material excavated from the Site will require neutralisation if it is stockpiled for an extended period, reused as fill on-site above the water table or disposed of off-site. Neutralisation is aimed at maintaining the pH of the sediment above 6.5 (Ahern, et. al, 2004). Neutralisation requirements for the sediment vary depending on the level of acid generating risk.

Liming rates were determined for individual samples based on the net acidity result. Rates were calculated based on the use of fine agricultural lime ($CaCO_3$) with an Effective Neutralising Value (ENV) of 98%. A safety factor of 1.5 was also applied to account for non-homogenous mixing or insolubility of lime.

An average liming rate of 14 kg/tonne has been determined for the foreshore material.

Acid Sulfate Soils Management Strategy
A preferred management strategy plan has been developed specifically for the removal, handling and reuse of material excavated on-site.

Relevant associated documents for the management of ASS impacts associated with the works include an Erosion and Sedimentation Control Plan (ESCP) and the Works Environmental Management Plan (WEMP) for the Site to which the ESCP and this ASSMP are appended. All other relevant management and mitigation measures in the WEMP and ESCP shall also be taken into account.

The implementation of this preferred management strategy would be supervised on-site by the Site Environmental Officer (SEO) who would be appropriately qualified and experienced in the removal, treatment and monitoring of ASS. The SEO would be responsible for undertaking any additional sampling, recalculating the appropriate liming rates and safety factor (if necessary), validating the treatment and identifying any revisions to treatment requirements.

This plan requires the implementation of the management strategies detailed below:

Establishment

- installation of hay bale barriers/diversion banks upslope of all excavation works, stockpiles, treatment pads and temporary sumps and the installation of sediment fencing downslope of excavation works and around the stockpiles and treatment pads. These provisions shall be installed in accordance with the Blue Book (Department of Housing and Landcom, 2004);
- preparation of a customised stockpile area(s) and treatment pad(s) to receive acid sulfate soil material including application of an underlying guard layer of lime for the protection of groundwater prior to deposition of material;
- preparation of bunded diversion drains within each stockpile and treatment pad for diversion of water to temporary sumps; bunds and sumps shall be of low permeability and shall not be made out of untreated ASS material;
- construction of temporary sumps to store water collected by diversion drains and to enable monitoring and treatment as required prior to on-site reuse;
- establishment of all treatment pads, stockpile areas and temporary sumps as close as possible to work areas but out of the direct path of existing overland flow paths and stormwater infrastructure to minimise potential impacts from flooding;
- stockpiles, treatment pads and temporary sumps shall be bunded with sandbags or the like during establishment with a minimum height of 0.5m above existing surface levels to mitigate the potential for offsite transportation of acid sulfate soils in the event of flooding;
- an initial supply of lime shall be stored on-site in weather-proof containers such as bulk bags or tanks and shall be located on an impermeable surface. Appropriate environmental controls shall be provided to ensure that stormwater runoff contaminated with lime cannot escape the work area; and,
- storage of additional materials required to manage flood risk (i.e. sandbags and geotextile layer or similar) in convenient locations on-site at all times.

Construction

- careful excavation of material utilising plant and equipment (selected by the Contractor) to avoid disturbance at depths greater than necessary;
- field screen testing of pH;
- containment of excavated material within an appropriate treatment pad. Soil shall typically be placed in 150mm to 300mm layers to facilitate ease of treatment with lime;
- minimisation of acid generation through minimisation of exposure time (particularly with sands) and immediate treatment through application of fine agricultural lime ($CaCO_3$) (Effective Neutralising Value ≥ 98%) at the recommended application rates;
- thorough mixing of lime into the soil on the treatment pad using a backhoe or excavator;
- replacement of guard layer of lime between each episode of deposition of acid sulfate soil material, over time, if necessary;
- diversion of water and leachate from stockpiles, treatment pads and ASS filled/disturbed areas, and pumping of water from excavations to temporary sumps and avoidance of groundwater and leachate runoff to existing drainage channels and waterways;
- monitoring of soil pH in treatment pads and further treatment if necessary prior to emplacement/reuse;
- monitoring of water pH in temporary sumps to ensure water is of acceptable quality prior to on-site reuse where possible (such as for dust suppression or irrigation of plantings). This shall allow filtration to the subsoils;
- daily monitoring of weather forecasts during stockpiling and treatment of material. If impending heavy rainfall (>20mm in any 24 hour period), additional protective measures to minimise runoff

from stockpiles, sediment treatment areas and temporary sumps shall be initiated. This shall include:
    - increasing the height of bunding around each stockpile, treatment area, and sump using sandbags or the like to a height of 1m above existing surface levels; and,
    - anchoring geotextile cover or similar over each stockpile and treatment pad using sandbags for the duration of each event.
- provision of sufficient plant, equipment and personnel to enable the implementation of additional protection measures in the event of impending heavy rainfall (i.e. >20mm in any 24 hour period). Where monitoring of the weather forecasts identifies the potential for impending heavy rainfall to occur out of work hours (i.e. overnight or on weekends), the additional protective measures to minimise runoff from stockpiles, treatment areas and temporary sumps shall be implemented prior to personnel leaving the site;
- minimisation of potential impacts from flooding in accordance with the mitigation and management measures detailed in the CEMP; and,
- restoration/stabilisation of the excavations and treatment areas as soon as possible upon completion.

Monitoring and Further Treatment

Soil

- following excavation of acid sulfate soils and initial treatment, validation testing shall be undertaken to ensure PASS has been effectively neutralised to a pH >6.5 (with an upper limit of 8.5). This shall involve the completion of a field assessment (i.e. visual, textural and odour), recovery of representative samples, ASS field screening and laboratory testing. Field screen results would be analysed and representative samples would be selected for testing using the Chromium Reducible Sulfur suite. Soils shall pass verification testing where the following three factors are met:
    - $pH_{KCL} \geq 6.5$;
    - TAA = 0; and,
    - Net acidity ≤ 0.
- where laboratory results indicate that samples have not passed verification, liming rates shall be recalculated, and additional lime added until it is satisfactorily confirmed that the material has been neutralised
- this Acid Sulfate Soil Management Plan should be updated where substantial additional lime application rates are determined; and
- all validation testing and further treatment shall be recorded

Water in Temporary Sumps

- regular monitoring of the pH of water collected in temporary sumps shall be undertaken;
- acid water is to be treated to achieve a pH in the range of 6.5 to 8 (targeted at pH 7) prior to on-site reuse;
- acid water shall be treated through the gradual addition of lime slurry and mixed thoroughly. The change in pH will not be instantaneous and lime shall be added gradually and monitored over time to allow any sludge to settle and to avoid overshooting the acceptable pH range. The quantity of fine agricultural lime (Effective Neutralising Value ≥ 98%) required to achieve pH 7 for 1 ML (i.e. 1,000m^3) of low salinity acid water is provided in **Table** below; and
- all monitoring and treatment (if necessary) shall be recorded.

Table A: Quantity of pure neutralising agent require to raise from existing pH to pH 7 for 1 Megalitre of low salinity acid water (Stone et al., 1998)

Current Water pH	$[H^+]$ {mol/L}	H^+ in 1 Megalitre {mol}	Lime to neutralise 1 Megalitre {kg pure $CaCO_3$}
0.5	.316	316,228	15,824
1.0	.1	100,000	5,004
1.5	.032	32,000	1,600
2.0	.01	10,000	500
2.5	.0032	3,200	160
3.0	.001	1,000	50
3.5	.00032	320	16
4.0	.0001	100	5
4.5	.000032	32	1.6
5.0	.00001	10	0.5
5.5	.0000032	3.2	0.16
6.0	.000001	1	0.05
6.5	.00000032	.32	0.016

Records

- implementation of this ASSMP shall be included in the SEO's daily site checklist; and,
- all testing, monitoring and treatment undertaken shall be recorded on appropriate report forms

9 DEMOLITION

9.1 General

This section of the Specification sets out requirements for demolition and / or removal of debris, vegetation and structures. This includes, but is not limited to, the following:

- Brick and concrete rubble of various size;
- Logs that are in the way of shoreline treatments;
- Any aluminium / steel / wooden structures that are being used as private launching ramps;
- The remains of a vertical 'piled' timber seawall (refer REF);
- Existing rock revetment;
- Boulders;
- Trees and tree stumps identified for removal; and
- Various other debris.

The Contractor is to refer to the Drawings for details of trees, stumps and / or mangroves that are to be removed.

In addition to the above, any trees, stumps, and / or mangroves that are located within the Works site and which have been uprooted are to be removed.

Also, any vegetation, trees, stumps and / or mangroves that the Contractor plans to remove or relocate in order for the Works to be completed must comply with the requirements of the REF and be pre-approved by the Superintendent.

The extent of demolition work shall be determined by comparing the Pre-Construction Survey, with the design for the Works as described in the Technical Specification and shown on the Drawings.

9.2 Standards and Codes

Demolition work shall comply with the requirements of all relevant authorities having jurisdiction over all or part of the specified works. Unless specified otherwise, work shall comply with the relevant Standards, being the latest issue of Standards, including amendments. A copy of the relevant Standards shall be kept onsite including:

- AS 2601 The Demolition of Structures
- Code of Practice: Demolition Work (Safe Work Australia, 2015).

9.3 Demolition Work

The Contractor is to be and shall remain solely responsible for the demolition methods, procedures and practices. The Contractor shall have inspected, and/or reviewed all of the information pertaining to all of the items to be removed before submitting its Tender and assessed the method of demolition for these.

No approval will be given for claims arising from the Contractor's ignorance or lack of understanding of the extent of demolition.

The Contractor shall submit a Method Statement to the Superintendent for approval which shall include details of all plant, equipment, and techniques to be used for demolition including details of any shoring and temporary works. The method of demolition used in the Works shall be as stated in the Contractor's approved Method Statement.

Approval by the Superintendent of the Contractor's Method Statement for demolition does not relieve the Contractor of its responsibility for the safe design and implementation of demolition work.

Existing structures to be demolished may be in a deteriorated condition. Demolition work shall make due allowance for the condition of the items being demolished. The Contractor shall at all times be solely liable for the care and stability of all the Works including those items being demolished.

The Contractor shall protect workers, pedestrians, vehicles, animals, the public and others from demolition activities.

The Contractor shall protect property and services which are to remain on or adjacent to the Site. During demolition or construction activities, the Contractor shall prevent damage to adjoining services and structures, including damage that may arise from vibrations. The Contractor shall undertake vibration monitoring if required to assess and control the risk of damage to existing structures.

The Contractor shall carry out the demolition in such a manner and take all precautions necessary to prevent any turbid water or materials falling into Brisbane Water. If materials do enter the water during the work they shall be recovered immediately.

9.4 Recycling and Disposal of Demolished Structures

Demolished materials shall be recycled in the Works where possible and following written approval by the Superintendent.

All demolition material not reused onsite, and all other debris, shall be completely removed from the site. Excess demolished materials and debris shall be the property of the Contractor. Excess demolished materials and debris shall be disposed of offsite at a licensed recycling or waste disposal facility. The Contractor shall keep a record of all disposal receipts on site ready to be witnessed if requested by the Superintendent. The burning off of demolished materials onsite is prohibited.

9.5 Care of Works

The Contractor shall at all times be solely liable for the care and stability of all the works including those items being demolished.

In the event that the Contractor damages any property or infrastructure, including that which belongs to the Client or a 3rd party, which was not identified as part of the Demolition Works, the Contractor will be responsible for full repair / reinstatement.

10 EARTHWORKS

10.1 Scope of Work

Earthworks, including stripping of top soil, temporary excavation of ground and bed materials to competent sub-strata, stockpiling of usable materials, importing of Engineered Fill as required to replace all unsuitable excavated materials, and placement of fill and compaction, are required to construct the Works.

The extent of earthworks work shall be determined based on the Pre-Construction Survey, and the design for the Works as described in the Technical Specification and shown on the Drawings (**Appendix A**).

10.2 Standards and Codes

The workmanship and materials provided under this Specification shall comply with the requirements of all relevant authorities having jurisdiction over all or part of the specified works. Unless specified otherwise, work shall comply with the relevant Standards, being the latest issue of Standards, including amendments. A copy of the relevant Standards shall be accessible onsite including:

- AS 1289 Methods of Testing Soil for Engineering Purposes
- AS 1726 Geotechnical Site Investigations
- AS 3798 Guidelines on Earthworks for Commercial and Residential Developments
- Code of Practice: Excavation (Safe Work Australia, July 2014)

10.3 General

10.3.1 Earthworks Generally

The Contractor shall at all times be solely liable for the care and stability of all the Works including temporary excavations and stockpiles.

Earthworks shall be undertaken in a careful manner, with a minimum of disturbance and with every possible precaution taken to prevent damage to property and injury to personnel.

Any services which require relocation as part of the work shall be relocated in accordance with the requirements of the Superintendent and any relevant authorities and codes.

Stockpiles shall be placed clear of all excavations. Slopes supported by retaining walls shall not be loaded unless an assessment of the slope and wall stability has been made which includes an allowance for additional loads due to the stockpiling.

All stripped and excavated materials which will not be reused in the Works shall be removed from the Site. Under no circumstances shall such materials be disposed in Brisbane Water.

Restrict dust caused by earthworks works to a practicable minimum.

10.3.2 Excavation Works Design

The Contractor shall be solely responsible for the excavation works design, methods, procedures and practices.

Excavation batter slopes where shown on the Drawings are indicative only. The Contractor shall be responsible for determining the appropriate batter slope. Shoring may be used if required to support a steeper batter slope.

No approval will be given for claims arising from the Contractor's ignorance or lack of understanding of the extent of excavation.

10.3.3 Existing Pipes, Sewers and Other Services

The Contractor shall be responsible for establishing the nature and location of all services that might be encountered during the execution of the Works.

10.3.4 Surface Drainage

The Contractor shall undertake all necessary works to ensure surface water is properly managed across the Site and does not interfere or damage the works in progress.

10.4 Excavation

10.4.1 Equipment and Methods

The Contractor is to be and shall remain solely responsible for the excavation methods, procedures and practices.

The Contractor shall submit a Method Statement to the Superintendent for approval which shall include details of all plant, equipment, and techniques to be used for excavation including details of any shoring, dewatering and temporary works. The method of excavation used in the Works shall be as stated in the Contractor's approved Method Statement. Approval by the Superintendent of the Contractor's Method Statement for excavation does not relieve the Contractor of its responsibility for the safe design and implementation of excavation work.

The Contractor shall be responsible for obtaining detailed information regarding the possible presence of objects on or below the existing ground and seabed level, and not necessarily shown on the Drawings.

The Contractor shall ensure that the existing structures and structure foundations are protected from undermining and damage during construction. Provide temporary supports as required.

The Contractor shall provide all temporary works necessary to retain the sides of all excavations in a manner which ensures safe working and protection of surrounding works. This may include battering back of excavation slopes, use of shields, and installation of temporary supports and provision of covers and/or fencing.

The Contractor shall be responsible for the safety and stability of all excavations, the effect of excavations on adjacent works and the design and construction of all temporary supports. The Superintendent may

direct the installation of additional support it considers necessary, but this shall not absolve the Contractor of its sole responsibility for the support of the excavation.

The Contractor shall be responsible for any damage to existing services, structures, walls, fences, batter slopes, trees and other property on the Site and adjoining properties that result from excavation and construction works.

The Contractor shall ensure excavations are adequately fenced, secure, well-lit and signed to ensure personnel safety.

10.4.2 Separating Excavated Materials for Use

Excavated materials shall be separated out and temporarily stockpiled on the Site during excavation, into the following types:

a) materials unsuitable for use anywhere in the works (e.g. clay and clayey sediments, putrescible organic and flammable materials, reinforcement bar and other metal items);

b) rocks;

c) demolished concrete and masonry;

d) top soil; and

e) estuarine and foreshore sands.

Excavated materials shall be reused onsite where considered suitable and following written approval by the Superintendent.

10.4.3 Disposal of Unsuitable and Surplus Materials

Unsuitable and surplus materials shall become the property of the Contractor, and shall be removed from the Site and disposed of by the Contractor.

Disposal off site shall comply with statutory requirements.

The Contractor shall be responsible for meeting all costs associated with disposal off site of unsuitable and surplus materials, including any tipping and haulage fees which may be levied.

10.4.4 Reuse of Rocks in the Works

Rocks shall be reusable as either armour, underlayer, or as a general fill behind the rock revetment, as shown on the Drawings and described below.

Unless otherwise agreed and accepted in writing by the Superintendent:

(i) rocks reused as armour and underlayer shall comply with the rock size requirements shown on the Drawings and the Clause Rock Work; and

(ii) rocks not meeting the requirements of (i) above may be used as general fill behind the rock revetment on the condition that these rocks are located at least 1200 mm below the

landscape levels, and no closer than 1.5 m from existing services or new services to be installed as part of the Works.

10.4.5 Recycling in the Works of Excavated and Demolished Concrete and Masonry

Excavated and demolished concrete and masonry shall be recycled in the Works where possible and following written approval by the Superintendent. Hazardous protrusions such as reinforcement shall not be accepted for recycling in the Works.

Recyclable excavated and demolished concrete and masonry may be used as general fill behind the rock revetment on the condition that these materials are located at least 1200 mm below the landscape levels, and no closer than 1.5 m from existing services or new services to be installed as part of the Works.

Concrete and masonry not accepted by the Superintendent for recycling in the Works shall be deemed unsuitable, and disposed off site at the Contractor's cost.

10.4.6 Reuse of Suitable Excavated Materials

Materials other than unsuitable and surplus excavated materials shall be reused in the Works in a cost effective manner to the Council, following written approval by the Superintendent.

Depending on the Contractor's program of construction, some materials may need to be stockpiled until the Works have progressed to the stage where the materials can be used. The location and height of stockpile(s) shall be as approved by the Superintendent.

The cost of stockpiling and handling of all excavated materials, including that reused in the Works, shall be deemed to be included in the Tender price.

10.4.7 Engineered Fill

Supply of Materials

Unless otherwise approved by the Superintendent, material used for Engineered Fill shall be clean sand or good quality crushed sandstone, free of organic matter with a maximum particle size of 40 mm and a fines content (ie content with grain size less than 75 microns) not exceeding 2% by weight. The plasticity index for the Engineered Fill shall be less than 15. The Contractor shall allow for at least two (2) Atterberg Limits tests to verify the plasticity index of the engineered fill for each separable portion of the Works.

All materials used for Engineered Fill shall be free of organic materials.

Engineered Fill materials shall be sourced locally where possible to limit haulage distance and impacts to public roads.

Placement and Compaction of Engineered Fill

Engineered Fill shall be placed in maximum 100 mm thick loose layers to achieve a minimum Density Index (I_D) of 70%.

During placement and compaction, the surface of the Engineered Fill shall be kept free draining. Static rollers only shall be used to compact filling zones. Vibratory rollers are not permitted as they will liquefy the subgrade.

10.4.8 Testing and Acceptance of Compaction

The Contractor shall test the compaction achieved during all earthworks to ensure that the compaction requirements are fulfilled. Tests shall be undertaken on replaced excavated materials in the number and locations as agreed by the Superintendent.

All compaction tests shall be undertaken by a Chartered Professional Geotechnical Engineer in accordance with the relevant Australian Standards, and NATA requirements.

Where results of the compaction testing identifies that the specified compaction requirements have not been met, the Superintendent shall require the Contractor, at the Contractor's expense, to either further compact the material to meet the required compaction, or to remove, replace and compact other approved material to the requirements of the Specification. Any additional compaction testing to meet the requirements of this clause shall be at the Contractor's expense.

10.5 Dewatering

The Contractor shall be responsible for dewatering excavated areas as required during construction. Any dewatering shall be carried out as Provisional Work to be agreed with the Superintendent prior to commencement of .dewatering.

The Contractor shall remove all surface water, including tidal water, wave runup and groundwater, necessary for completion of the Works (including but not necessarily limited to excavation, preparation of foundations, placement of rock and concrete).

The operation of the dewatering system shall ensure that no turbid water flows into the estuary. If necessary, any suspended material shall be allowed to settle out or the water discharged into a soakage system. However, saltwater shall not be discharged into areas containing vegetation or tree roots.

The Superintendent shall be advised a minimum of one (1) hour before dewatering is to commence on each and every day that dewatering takes place. The Superintendent will observe the dewatering activity from time to time and either concur with its assistance in the Works as it is being applied, or require a modified approach. The Contractor shall make all reasonable attempts to accommodate the requirements of the Superintendent in respect of dewatering.

The Contractor shall be deemed to have made its own assessment of the dewatering requirements likely to be encountered during construction of the Works and made allowance for these requirements in the Tender price.

10.5.1 Replacement of Excavated Materials as General Fill behind the Rock Revetment

Unless these comprise demolished concrete and masonry materials suitable for reuse as armour or underlayer, excavated materials suitable for reuse in the Works shall be placed in layers of maximum 150 mm loose thickness and compacted to achieve a minimum Density Index (I_D) of 65%. Due to the confined nature of the excavations and the need to prevent damage to the new and existing structures, hand-held plate compactors and/ or plate compactor attachments to the excavator will be used.

Density tests shall be carried out on the replaced material to confirm the above specifications are achieved. The frequency of density testing shall be at least one test every two layers per combined 40 linear metres. Any areas of insufficient compaction will require reworking. Level 2 testing of backfill compaction is the minimum permissible in AS3798. The Time for Practical Completion shall not be affected by such rectification activities, and the cost of all works associated with the rectification shall be borne by the Contractor.

10.6 Backfill Behind Structures and Culverts

Placement and compaction of backfill materials around structures, culverts, services and the like shall be undertaken simultaneously on both sides to avoid differential loading.

10.7 Backfill Over Pipelines

Backfilling and compaction shall commence at the pipe wall and proceed away from it.

All material shall be compacted in layers not exceeding 150 mm compacted thickness. Each layer shall be compacted to the relative compaction specified before the next layer is commenced.

At the time of compaction, the moisture content of the material shall be adjusted so as to permit the specified compaction to be attained at a moisture content which, unless otherwise approved by the Superintendent, is neither less than 60 per cent nor more than 95 per cent of the apparent optimum moisture content, as determined by AS 1289.5.7.1 (standard compaction).

Selected fill material as specified shall be placed and compacted around the pipe for the full width of the trench to a height of 300 mm above the pipe.

11 EXTENSION OF STORMWATER OUTLETS

11.1 Scope

The section of the Specification sets out requirements for stormwater outlet extensions associated with construction of the new foreshore protection works.

11.2 Materials

Unless noted otherwise on the Drawings all drainage pipes and fittings shall be polyethylene.

11.3 Standards

The workmanship and materials provided under this Specification shall comply with the requirements of all relevant authorities having jurisdiction over all or part of the specified works. Unless specified otherwise, work shall comply with the relevant Standards, being the latest issue of Standards, including amendments. A copy of the relevant Standards shall be accessible onsite including:

- AS 2033 Installation of Polyethylene Pipe Systems

11.4 Drawings and Dimensions

Drawings showing pipework layouts are diagrammatic only. Before commencing work, the Contractor shall verify with the Superintendent the exact positions of the pipework including any fixtures and the like to which the pipework is to be connected.

11.5 Existing Services

The Contractor shall accommodate all existing services as necessary to complete the work. Approval shall be obtained before interrupting any existing service, and the work shall be performed in accordance with an approved program so that the duration and number of interruptions is reduced to a minimum.

11.6 Inspections

The Contractor shall give a minimum of 24 hours notice to the Superintendent that inspection may be made at the following stages:

(a) trenches excavated and ready for pipe laying; and

(b) underground and anchored work ready to be covered up or concealed.

11.7 Temporary Works and Protection

The Contractor shall make adequate provision for runoff flows at drainage works under construction to avoid damage or nuisance due to scour, sedimentation, soil erosion, flooding, diversion of flow, damming, undermining, seepage, slumping or other adverse effects to the Works or surrounding areas and structures as a result of the Contractor's activities.

The Contractor shall not implement any proposals to dam up or divert existing watercourses (either temporarily or permanently) without the prior written approval of the Superintendent.

The Contractor's material and equipment shall be located clear of watercourses or secured so that they will not cause danger or damage in the event of large runoff flows.

11.8 Siting of Pipe Outlets

Before commencing the reconstruction of a pipe outlet, the Contractor shall set out on site the pipe position to the location and levels shown on the Drawings, and shall present this set out for inspection by the Superintendent.

11.9 Quality, Type and Minimum Size of Pipes

All pipes supplied shall be manufactured in accordance with AS 4130.

Specific works covered under this Specification include supply and installation of suitable PE100 pipe extensions as shown on the Drawings. Provisional pipe sizes for confirmation by the Contractor are given below in Table 6.

Table 6: Stormwater extension schedule

Existing SW Outlet		Extended PE100 Outlet		
No.	Shown on survey (mm)	DN	ID (mm)	Wall thickness (mm)
5	90 PVC	140	133	3.5
3	100 PVC	140	133	3.5
1	150 PVC	225	215	5.5
1	300 PVC	400	380	9.8
1	450 PVC	560	534	13.7

All reinstated PE 100 outlets are to have a maximum Standard Dimension Ratio (SDR) of 41.

Before ordering PE100 pipes, the Contractor shall confirm that the DN pipe sizes given in the table will sleeve over the existing outlets to enable construction of the pipe extension design as shown on the Drawings.

11.10 Bedding and Pipe Installation

All pipes shall be installed in accordance with AS 2033.

Bedding and pipe installation shall comply with the manufacturer’s reference manual and directions.

Underlayer rock (see Clause Rock Treatment) shall be used as bedding material as shown on the Drawings.

Where armour rock (see Clause Rock Treatment) is to be placed over the pipeline, this will be limited to 1 layer thick. See also Drawings.

Unless a higher standard of bedding is shown on the Drawings, a continuous cushion of sand 75 mm thick shall be provided as bedding.

11.11 Backfilling and Compaction for Stormwater Outlet Structures

Refer Section 10.6 and 10.7.

11.12 Joining of Pipes

Joining of the PE pipes to the existing pipes shall be carried out as shown on the Drawings.

11.13 Workmanship

11.13.1 Pipelines

Pipelines shall be laid to uniform gradients falling to outlets, straight between required changes in direction, properly supported, and with spigot ends pointed in the direction of flow. Provide the necessary fillings and accessories, including junctions, branches, inspection and cleaning openings, expansion joints and the like.

Drains shall be laid to the gradients and levels where shown on the Drawings, but not less than 1(v) : ∅ (h) where ∅ is the pipe diameter in millimetres.

11.14 Pipe Bedding

Bed the pipework on a continuous underlay of pipe bedding material, compacted to a minimum thickness of 75 mm. Grade the bedding evenly to the required gradient of the pipework.

11.15 Documentation

The Contractor shall maintain in its QA records all orders, receipts, delivery dockets for pipes and fittings. All pipes and fittings shall be marked with grade, size and class.

Records compiled shall show that all pipe and fittings are in accordance with the Drawings and this Specification. The Superintendent shall be entitled to witness the records at its request.

12 CONCRETE WORK

12.1 Scope of Work

The Contractor shall supply and deliver all plant, materials and labour for the supply, transport, placement, compaction, finishing, curing, sampling and testing of concrete work as shown on the Drawings and specified herein.

Concrete work includes (but not limited to):

(i) Stormwater mass concrete encasement

12.2 Standards

Concrete works shall comply with the current issue (including amendments) of the following Standards except where noted otherwise:

AS 1012	Methods of testing concrete (all parts)
AS 1141	Methods for sampling and testing aggregates (all parts)
AS 1170	Structural design actions (all parts)
AS 1379	Specification and supply of concrete
AS 1478	Chemical admixtures for concrete, mortar and grout (all parts)
AS 1478.1	Part 1: Admixtures for concrete
AS 2350	Methods of testing Portland and blended cements
AS 2758	Aggregates and rock for engineering purposes
AS 2758.1	Part 1: Concrete aggregates
AS 3582	Supplementary cementitious material for use with Portland cement (all parts)
AS 3600	Concrete structures
AS 3610	Formwork for concrete
AS 3972	General purpose and blended cements
AS 4997	Guidelines for the design of maritime structures
ASTM C1202	International Standard – Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration
BS 6349	British Standard – Maritime structures (all parts)

12.3 General Requirements

Concrete works shall be constructed in a safe manner and shall comply with AS 3600, AS 4997, this Specification and to the requirements shown by the Drawings. Where in conflict, the requirement which yields more durable concrete shall be adopted.

The Contractor shall submit this concrete specification and the Drawings to the concrete supply sub-contractor. These shall be used as a basis for developing a concrete mix design. Details of the mix designs for each specified class of concrete shall be provided by the Contractor for the Superintendent's review and approval not less than 2 weeks prior to commencement of concreting operations. The details submitted shall include but not necessarily be limited to:

a) Name of the concrete supplier and the proposed methods and degree of quality control;

b) Class of concrete and verification that the Specification has been received and that the proposed mix for each class of concrete meets the specified requirements;

c) A description of the means by which the requirements of this Specification and relevant standards are satisfied with respect to service design life and crack width;

d) Proportions by mass of various materials comprising the mix, including chemical admixtures;

e) Target parameters including strength, slump, shrinkage and chloride ion penetration;

f) Records of properties of wet concrete and hardened concrete of the same or similar mix designs, aggregates, cement types etc. for previous projects; and

g) Any proposed admixtures, including the Manufacturers' data sheets.

Notwithstanding apparent compliance with all other requirements of this Specification, the Contractor shall be responsible for satisfying itself that the performance characteristics of the materials used in the Works are not such as to necessitate the use of excessive cementitious contents or be likely to cause or accentuate any undesirable properties in the fresh or hardened concrete.

12.4 Concrete

12.4.1 Exposure Classification and Strength

The exposure classification for all concrete work shall be C2 (concrete in splash zone) in compliance with AS 4997.

Minimum characteristic compressive strength (f'_c) for all concrete used in the Works shall be 24 MPa unless noted otherwise on the Drawings.

12.4.2 Binder and Water Cement Ratios

Not used.

12.4.3 Aggregate

The durability class of aggregates shall be Class C in compliance with AS 2758.1.

Coarse aggregate shall be clean, hard, durable particles consisting of crushed igneous rock or river gravel with a nominal maximum size of 20 mm.

Fine aggregate shall be dense, naturally occurring sand or rock, crushed, uncrushed or a blend of both.

For maritime concrete no more than 25% of the fine aggregate shall be manufactured sand. Sand shall generally be clean silica sand proportioned with up to a maximum of one quarter by weight of manufactured sand.

Limit fines resulting from blended crushed and uncrushed material finer than 75 micrometres to 5% maximum of weight of fine aggregates, to AS 1141.12.

Fine and coarse aggregate shall comply with AS 2758 and the sampling and testing of such shall comply with AS 1141. Prior to supplying concrete, furnish test certificates based on samples from the most recent production or from stockpiles for the project, for the properties listed below:

Coarse Aggregate	Test Method	Clause No. AS 2758.1	Specification
Particle size and analysis	AS 1141.11	8.1.2	20mm
Particle Density	AS 1141.6.1	7.1	Normal weight aggregate
Water Absorption	AS 1141.6.1	7.3	2%
Particle Shape	AS 1141.14	8.3	Standard 10% of 3:1
Los Angeles Abrasion Value and/or Sodium sulphate soundness	AS 1141.23 & AS 1141.24	9.3.3	35% max and 6% loss
Alkali Aggregate Reactivity	SAA HB79	10.1 & 10.2	Non reactive
Weak/Friable Particles	AS 1141.32	11	0.5%

Fine Aggregate	Test Method	Clause No. AS 2758.1	Specification
Particle size and analysis	AS 1141.11	8.1.3	
Bulk Density	AS 1141.4	7.2	
Water Absorption	AS 1141.5	7.3	
Organic Impurities	AS 1141.34	14.1	Standard
Sodium Sulphate Soundness	AS 1141.24	9.3.3	6%
Light Particles	AS 1141.31	12	1%
Sugar	AS 1141.35	14.2	0.0%
Potential Reactivity	SAA HB79	10.1 & 10.2	Nil

12.5 Water

Mixing water shall be fresh, clear, potable water or clean recycled water clear of all deleterious impurities.

12.6 Shrinkage

Basic shrinkage strain $\varepsilon_{sc.b}$ values (as per AS 3600) at 56 days shall be a maximum of 600 microstrain achieved in the field to AS 1012.

12.7 Admixture to Improve Workability

The concrete shall be sufficiently fluid to ensure ease of placement. Use of wetting agents, water reducing agents or superplasticising admixtures to provide an initial slump (before superplasticiser) of 40 mm ± 10 mm and a final slump (with superplasticiser) of 120 ± 30 mm should be used.

Admixtures shall be added in dosages as advised by the manufacturer. The manufacturer should be consulted in relation to the effective life of admixtures used. No other admixtures shall be used in concrete unless specified or approved in writing by the Superintendent.

12.8 Chloride Ion Penetration

Not applicable.

12.9 Admixtures and Coatings to Improve Corrosion Resistance

Not applicable.

12.10 Performance Testing

In accordance with the requirements of AS 1379, a project assessment of concrete shall be made. The Contractor shall arrange for an approved registered NATA Testing Laboratory to carry out concrete testing in accordance with the requirements of AS 3600 and AS 1379. The cost of all such tests shall be borne by the Contractor. Test reports shall be supplied to the Superintendent within two (2) working days of testing.

Concrete shall be slump tested at site before and after the addition of superplasticiser. Slump testing shall be carried out in accordance with AS 1012.3. Concrete from each ready mix truck delivery of concrete to the site shall be tested. The slump shall be deemed to be acceptable if it is within the permissible tolerance in AS 1379.

Concrete shall be sampled, tested and assessed for compliance with the specified compressive strength to AS 1379. Sampling shall be carried out to AS 1012.8 and 1012.9 using rubber capping when testing 100 mm cylinders. Prepare a minimum of two cylinder specimens for each sample. Each sample shall represent the particular mix supplied since the previous sample. The following minimum sampling and testing frequency applies in addition to those in AS 1379 clauses 6.3.3 and 6.5.2:

No of batches per day	No of samples
1	1
2 to 5	2
6 to 10	3
11 to 20	4

Concrete shall be assessed for compliance with the requirements of this Specification, the Drawings, AS 4997, AS 3600 (Section 17) and AS 1379.

12.11 Mixing

Concrete mixing shall comply with AS 3600, Section 17.

The use of ready mixed concrete will be permitted from an approved plant only. Details of the plant to be used shall be submitted to the Superintendent at least two weeks prior to the date of supply. All equipment used for batching, mixing, agitating and transporting the concrete shall be in accordance with AS 1379. Copies of the manufacturer's certificate for each truck load of concrete shall be forwarded to the Superintendent immediately as the certificate(s) becomes available.

Suppliers of ready-mixed concrete shall be vetted by the Contractor and the supplier shall demonstrate that it can produce concrete conforming to this Specification. Should the use of ready-mixed concrete from a particular supplier produce concrete below the required standard the Contractor shall terminate the sub-contract and find a new supplier.

Water shall not be added to the mix until just prior to the concrete being delivered to site and under no circumstances shall any additional water be added to the mix following initial mixing.

12.12 Transportation of Concrete

The concrete shall be transported in such a manner that there shall be no segregation of its constituents. If any segregation of the concrete materials has taken place during transport, the concrete shall be again turned over and mixed just before it is finally placed in position. No water shall be added to the concrete between the time of mixing and placing.

Whilst being transported from the mixer to the site of placing, all concrete shall be properly protected from contamination by dust or sand and from excessive moisture gain or loss from rainfall or high temperature, and all equipment used shall be purpose-made for the correct transportation of concrete.

12.13 Preparation for Placing

In preparation for the placing of concrete, all construction debris and extraneous matter shall be removed from the interior of forms. Standing water on areas to receive concrete shall be removed before concrete is placed. All exposed reinforcement and other embedded items shall be thoroughly cleaned of all deleterious matter including concrete splash from previous concreting operations. Every precaution shall be taken to ensure that contamination due to windborne dust or other organic or chemical products from adjacent operations does not occur.

Placing of concrete shall not be commenced until the Contractor has inspected and passed the formwork or other areas to receive concrete and any reinforcement, cast in fixings etc., against which the concrete is to be placed.

12.14 Placing and Compaction

Concrete placing shall comply with AS 3600, Section 17.

Concrete shall be placed in the shortest possible time after mixing is completed and before it has taken an initial set. It shall be placed as close as possible to its final position to avoid segregation of materials and displacement of reinforcement.

Normally concrete may be deposited with a maximum free fall of 1.2 metres without the use of pipes, providing suitable measures are taken to prevent segregation and premature coating of upper reinforcing steel. When pipes are used they shall, as far as is practicable, be kept full of concrete during placing and their lower ends shall be kept buried in the newly placed concrete. In certain circumstances greater heights than 1.2 metres may be allowed but only following trials to establish the effect on the concrete.

Chutes may also be used and shall be of steel or steel lined. Chutes shall be constantly kept clean from coatings or hardened concrete or other obstructions. Chutes shall be set at such an angle that the concrete neither sticks to the chute nor does the concrete become segregated.

Concreting of any section or unit of the work shall be planned to be carried out in one continuous operation with no interruption of the concreting. Any delay between concrete pours which causes onset of concrete hardening between pours shall be reported immediately to the Superintendent. The Contractor shall provide rectification work at its own expense in accordance with advice provided by the Superintendent. The rectification works would involve forming a new construction joint at the hardened surface or cutting back the surface of the concrete to a suitable location for the installation of a construction joint.

No concrete shall be placed during periods of heavy rain or high winds. Wind shelters and/or awnings shall be erected around each concrete pour to protect the concrete from the drying effects of wind and sun, as required.

Concrete shall not be placed on days where the ambient temperature is likely to be below $6^{o}C$ or exceed $34^{o}C$.

The Contractor shall limit the rate of evaporation of water from freshly placed concrete to less than 1 kg/m^2/hour. Refer to RTA B80 Figure B80.1 for further guidance on how the rate of evaporation of water may be estimated on site.

Concrete shall be thoroughly compacted during and immediately after placing. This shall be achieved by mechanical immersion vibrators at the point of placing the freshly deposited concrete. External form vibration may be approved for compaction of precast concrete where the forms have been specifically designed for such purpose.

Vibrators shall only be used by competent operatives properly trained in the handling of the particular equipment in use on site. The equipment, manner and duration of use shall be selected and controlled to reduce health and safety effects on operatives, with particular reference to Hand Arm Vibration Syndrome (HAVS) and Whole Body Vibration Syndrome (WBVS).

Vibration shall not be applied directly to reinforcement which extends to partially set concrete, and shall not be used to transport or make concrete flow in the forms.

Over-vibration, causing segregation of the concrete, shall be avoided.

The finished concrete shall be a dense homogeneous mass, completely filling the formwork, thoroughly embedding the reinforcement and free of bug holes, stone pockets and honeycombing.

12.15 Setting Concrete

After initial set of the concrete the forms shall not be jarred. Adjacent works, which may cause vibrations to be transmitted to any setting concrete shall not be commenced until the concrete has fully set.

12.16 Protection against Rainfall

The Contractor shall provide adequate cover as necessary to protect concrete whilst being placed against damage from rainfall.

12.17 Finishes

Finishes to concrete surfaces shall comply with AS 3610, and to the following.

a) formed surfaces shall have a Class 2 finish;
b) unformed concrete surfaces shall have a steel float finish, except those areas which will be subject to traffic, including foot-traffic, which shall have a stiff broom finish.

12.18 Curing

Concrete curing shall comply with AS 3600, Section 17 except where varied by this clause of the Specification.

Curing of all concrete is to be achieved by keeping surfaces continuously wet for a period of 7 days and prevention of loss of moisture for a total of 14 days, followed by a gradual drying out.

Polythene sheeting or wet hessian shall be used to provide adequate protection from wind and traffic.

Sprayed on curing compounds shall not be used.

12.19 Formwork

Formwork shall comply with AS 3610 and AS 3600. Finishes shall comply with the Finish section of this Specification.

The responsibility for the sufficiency, design and construction of the whole of the formwork, including design certification, construction, inspection, safety and performance, shall rest entirely with the Contractor.

Formwork shall be rigidly constructed and shall ensure that the finished concrete is true to the required shape, position and level, and to the standard of finish specified. Formwork shall be of suitable design and substantial construction to carry the loads due to the wet concrete and any incidental loads such as during concreting operations without excessive bulging, distortion, deflection, instability or grout loss.

Where coatings are to be applied to the finished concrete (e.g. pore blockers), formwork de-bonding agents shall be compatible with the proposed coatings.

Unless otherwise approved, following concrete placement, formwork shall not be stripped until the minimum times indicated in AS 3610 have elapsed.

Special care shall be taken to ensure that all salt contamination and debris (including broken tie-wire) is completely removed from the formwork immediately before placing the concrete.

12.20 Rejection

Concrete shall be liable to rejection if it fails to comply with the provisions of this Specification and in particular with the provisions of Section 17 of AS 3600. Rejected concrete shall be removed and replaced with new concrete so that it does comply with the provisions of this Specification. Alternatively the Superintendent may, at its absolute discretion, accept the work but at a reduced valuation which shall be absolutely determined by the Superintendent and be binding on the Contractor.

In the case of concrete which has failed to satisfy the specification requirements (e.g. for strength), the Superintendent may direct that test pieces be taken from the relevant portion of the work. The Contractor shall provide all equipment, labour and supervision for obtaining test pieces of the required type, for preparation of the test pieces, for testing including trimming to an acceptable standard, and for delivery to a NATA approved laboratory to carry out the testing at no additional cost to the Superintendent.

If the portion of the work from which test pieces have been removed is subsequently approved by the Superintendent, the Contractor shall restore the damaged section to the complete satisfaction of the Superintendent.

All costs incurred by the Contractor to replace rejected concrete shall be borne by the Contractor.

13 ROCK TREATMENT

13.1 Scope

The rock work shall comprise:

- supply and install geotextile filter;
- supply and place acceptable sandstone rocks.

The extent of the rock work is shown on the Drawings.

13.2 Standards

Unless otherwise specified herein all rock work shall comply with the current editions of the Australian Standards, Codes and Specifications as appropriate.

13.3 Geotextile Underlay

13.3.1 Acceptance

Unless noted otherwise on the Drawings, all geotextile used in the Works shall be TEXCEL 600R or approved equivalent.

13.3.2 Storage and Installation

On site storage and handling of the geotextile shall comply with manufacturer/supplier's recommendations. Preparation of subgrades for covering by the geotextile, and laying of the geotextile shall satisfy the following:

(i) Ground Preparation – sharp edged rocks and the like shall be removed prior to laying of geotextile.

(ii) Joining of Fabric Elements – fabric elements shall be joined by either overlapping or sewing. Overlap widths are to be no less than 600 mm with the overlap direction taking account of the direction of rock material supply. For sewing assembly 0.1 m overlap is sufficient to ensure continuity.

(iii) Laying in Water – correctly placed immersion may require ballasting of fabric.

13.3.3 Storage and Installation

On site storage and handling of the geotextile shall comply with manufacturer/supplier's recommendations. Preparation of subgrades for covering by the geotextile, and laying of the geotextile shall satisfy the following:

(i) Ground Preparation – sharp edged rocks and the like shall be removed prior to laying of geotextile.

(ii) Joining of Fabric Elements – fabric elements shall be joined by either overlapping or sewing. Overlap widths are to be no less than 0.5 m with the overlap direction taking account of water flow

and rock material supply directions. For sewing assembly 0.1 m overlap is sufficient to ensure continuity.

(iii) Laying in Water – rapid immersion may require ballasting of fabric.

13.4 Sandstone Material Acceptance

13.4.1 Sandstone Acceptance Properties

All new sandstone supplied to the site for construction of the rock work shall be fresh or only slightly weathered, non-friable, and free from cracks, cleavage planes, seams, cross-laminations, shale lenses, sand balls, carbonate concretions and other defects which could contribute to the accelerated breakdown of the stone at a coastal site.

The sandstone used to construct the rock work shall comply with the following:

(i) minimum dry density of 2,300 kg/m^3
(ii) saturated point load strength index (*Is50*) greater than 1.5 MPa
(iii) sodium soundness weight loss less than 10 %
(iv) clay minerals less than 15%.

13.4.2 Rock Mass and Sizes

The masses and associated nominal diameters of the sandstone rocks used to construct the armour layer (referred to as armour rock) and the underlayer (referred to as underlayer rock) shall comply with the following:

	Min	Median	Max
Amour Layer			
Mass	50 kg	89 kg	125 kg
Nominal diameter	0.32 m	0.39 m	0.44 m
Underlayer			
Mass	- kg	9 kg	- kg
Nominal diameter	- m	0.13 m	- m

13.4.3 Information to be Supplied

At least seven (7) days prior to supply of any rock, the Contractor shall provide documentation to the Superintendent for approval that demonstrates that the rock to be supplied complies with the requirements of the Specification. The documentation to be provided shall include:

(i) details of the quarry from which the rock is to be supplied, including identification of the sections of the quarry where rock complies with the requirements of the Specification;

(ii) a test report from a NATA registered Independent Testing Authority on the physical and chemical properties of the rock to be supplied. The report shall include the results of laboratory testing of the rock; and

(iii) details of the Contractor's quality control procedures, to assist the Superintendent establish that the quality of rock supplied during the Contract complies with the Specification.

If the above information, supplied to the Superintendent, does not comply with the requirements of the Specification, the rock shall be rejected and the Contractor shall need to establish a new source which does comply.

13.4.4 Varying the Source of Sandstone Rock

If the Contractor seeks to vary the source of rock, the Contractor shall submit to the Superintendent for approval additional documentation as listed above that demonstrates that the rock from the new source complies with the requirements of the Specification.

13.5 Supply and Stockpiling of Rock

No rock shall be delivered to the site without written authorisation from the Superintendent following its consideration of documentation on the quarry source, rock properties and the Contractor's quality control procedures.

The Contractor shall maintain a daily log of imported rock delivered to the site. The log shall record the registration of each supply truck, its date and time of arrival on the site, the rock supply docket number issued by the quarry pertaining to the delivery, and a signature by a representative of the Contractor to verify the information.

During the course of construction of the rock work, the Contractor shall provide to the Superintendent each week a copy of the completed daily rock supply log and the original supply dockets relating to work undertaken in the previous week. The supply dockets shall include a record of loaded truck mass.

Stockpiling of rock on the site shall be limited to the minimum extent practicable for continuity of the Works.

13.6 Reuse of Rocks from the Site

Sandstone rocks sourced from excavation and demolition work on the site and which comply with the rock mass and size requirements, will be approved for reuse in the rock work. The Superintendent may stipulate where recycled rocks are to be placed in the Works.

13.7 Rock Placement

13.7.1 Method of Placement

The rock work shall be constructed to the lines and levels shown on the Drawings.

The method of placing the rock shall be such that:

(i) breakdown on handling is minimised;

(ii) segregation into size classes of rock be kept to a minimum;

(iii) rocks are wedged and locked together so that they are not free to move without disturbing adjacent rocks; and

(iv) no sand or other finer material is introduced into the rock structures during rock placement.

The Contractor shall be responsible for keeping the rocks undamaged during construction.

13.8 Construction Tolerances

Refer Clause Compliance Survey and Construction Tolerance.

13.9 Compliance Survey

The Contractor shall be responsible for the completion of a compliance survey. Compliance surveys for the rock works shall include the finished surface of the underlayer and armour. The compliance survey for the finished underlayer shall be approved prior to commencing the placement of rock armour.

In the event that the surveyed work does not meet the requirements of the Specification, the Superintendent may instruct the Contractor to reconstruct that component of the Works and resubmit the survey for approval. The Time for Practical Completion shall not be affected by such rectification activities, and the cost of all works associated with the rectification including re-survey shall be borne by the Contractor.

Refer also Clause Compliance Survey and Construction Tolerance.

14 VEGETATION

Vegetation requirements include extending the grass surface and planting saltmarsh (see Drawings).

The relevant Specification relating to vegetation requirements shall be provided by Central Coast Council.

Refer Clause Saltmarsh for planning saltmarsh.

15 SALT MARSH

15.1 GENERAL

This section of the Specification covers the supply, delivery and planting of salt marsh within the salt marsh berms.

15.2 PREPARATION OF SALT MARSH SUBSTRATUM

The berm for the salt marsh shall be created in accordance with the Drawings. The berm shall be established to the levels, widths and side slopes shown on the Drawings.

The substratum (*topsoil*) shall consist of the equivalent of a 250mm layer of 'A' horizon soil capable of supporting healthy terrestrial vegetation (*i.e. an adequate proportion of silt and clay material for water retention is essential*) placed on top of a 250 mm thick layer of 'B' horizon (*non-living*) soil. The substratum material must not be loose, and it must be of an adequate consistency. The substratum shall be free of weeds such as *Juncus acutus* (*Spiny Rush*) and any contaminants.

The substratum shall be evaluated for suitability by a qualified soil scientist and accepted by a practitioner experienced with salt marsh construction. This material may be sourced from the excess excavated fill material from the site, subject to its verification.

15.3 SUPPLY AND DELIVERY OF SALT MARSH SPECIES

The Contractor shall ensure that the seedlings for the four (4) salt marsh species are sourced from a nursery which has experience in salt marsh supply and understands the requirements of the project. Below is a list of recommended nurseries:

- Rockdale Council Nursery at Rockdale
- ABulk at Clarendon; and
- Leppington Speedy Seedlings at Leppington.

Council may also facilitate the supply of transplant saltmarsh plants from suitable donor sites around Brisbane Water.

Arrangements for the supply and delivery of saltmarsh seedlings and plants shall be agreed with the Superintendent at least two (2) working days prior to the delivery of salt marsh to the site.

15.4 PLANTING

Salt marsh species Sarcocornia quinqueflora and/ or Sporobolus virginicus shall be planted at 6 plants per square metre. Also plant the following species in a few patches of a few square metres: Triglochin striatum and Cotula coronopifolia.

The Contractor shall ensure that planting be limited to companies or individuals with experience in planting these species. It should be noted that none of the species are readily available from nurseries. These plants need to be ordered many months in advance. Rockdale Council Nursery does grow them on order, but needs substantial notice. Suitable alternative species may be selected in consultation with the Superintendent.

Planting should preferably be undertaken in the autumn and spring months. Planting can be undertaken during winter if necessary however the establishment period will be longer during this time. Planting during summer is not recommended because of the high temperatures.

15.5 STABILISATION OF SUBSTRATUM

Small boulders/shingles shall be placed around the salt marsh plants over the seaward third of the salt marsh zone so as to minimise the potential for erosion due to wave overtopping in extreme storm events. Alternatively (*or in addition*), loose-weave hessian material can be used to stabilise the soil surface over this area. If hessian is used it shall be pinned with steel 'U-shaped' pins at a density of 1.5 pins per square metre to ensure the hessian does not move and drag the salt marsh seedlings.

15.6 ESTABLISHMENT AND SHORT TERM MAINTENANCE

Following planting the salt marsh shall be watered with fresh water every 3-4 days or more frequently so as to ensure the roots are continually moist. Watering shall be undertaken for a minimum of 3 months.

16 DINGHY SKIDS

16.1 General

The dinghy skids shall comply with the design shown on the Drawings.

16.2 Sandstone Blocks at Ramp Toe

The sandstone blocks shall meet the sandstone material acceptance requirements specified for Rock Treatment. Refer Clause Rock Treatment.

The top surface of the blocks shall be horizontal with the landward upper corner of the blocks set to coincide at or just below the top edge of the bottom Replas plank.

No gap in the joints at the top surface of the blocks shall exceed 20mm.

16.3 Slope of Dinghy Skids

The slope of the dinghy skids shall be as shown on the Drawings, that is 1(v):4.5(h) for the north skid, and 1(v):5.5(h) for the south skid.

The tolerance for the skid slope shall be +/- 10% (eg a slope of 1:4.95 shall be acceptable for the 1:4.5 sloped skid, that is 4.5 + 0.45, and a slope of 1:4.95 shall be acceptable for the 1:5.5 sloped skid, that is 5.5 – 0.55).

17 COMPLIANCE SURVEY AND CONSTRUCTION TOLERANCE

17.1 Extent of Survey Work

The extent of survey work required for the Works shall comprise:

- Pre-Construction Survey;
- set out of all construction works in accordance with the Drawings;
- progress survey for the purpose of verification of earthworks;
- progress survey for the purpose of verification of the rock works; and,
- Works-as-Executed (post-construction) survey on completion of the Works to confirm compliance that works have been constructed in accordance with the Drawings.

17.2 Survey Personnel

The pre-construction survey shall be carried out by a Registered Land Surveyor with at least 3 years' experience in land surveying and set-out of civil construction projects.

All compliance and as-constructed survey work shall be carried out by, or under the supervision of an Engineering Surveyor with at least 3 years' experience in surveying and sign-off of construction projects.

All surveyors shall be employed by the Contractor and approved by the Superintendent. The surveyors shall be responsible in conjunction with the Contractor for the collection and processing of the survey data and the provision of all survey equipment required to complete this activity to the satisfaction of the Superintendent.

The Contractor shall provide all labour, materials and other assistance that the Superintendent may require at any time to check the setting out of the work or to make progress measurements.

The method of survey shall be in accordance with this section.

17.3 Horizontal Position

The horizontal positioning of the construction works shall be related to the Map Grid of Australia (MGA) Zone 56 coordinate system.

17.4 Vertical Datum

All levels shall be reduced to Australian Height Datum (AHD).

17.5 Method of Survey

As a minimum, the surveys shall show sections of the Rock Treatment, saltmarsh berms and other items of work at 10 metre intervals and at transition sections. Each section shall capture the following information:

- crest and toe of the structure;
- intermediate points along the berm side slope between the crest and toe (at not more than 1m horizontal spacing);
- intermediate points along the crest of the structure (at not more than 1m horizontal spacing; and
- sufficient points to define the toe detail.

Survey of the rock underlayer and armour shall be completed using the 'highest point' survey method whereby the surveyor shall survey the highest point of each rock or armour unit within a given profile. To ensure sufficient detail is captured for each interval, the highest point of the nearest armour units to the particular section shall be surveyed.

The survey shall provide tie lines between sections that run along the crest and toe of rock structures.

17.5.1 Survey Project Quality Plan

All survey work shall be carried out strictly in accordance with the Contractor's Survey Project Quality Plan (SPQP). The Superintendent may consider adjustments to the SPQP during the course of the Contract and may direct the use of alternative personnel or equipment. No survey work shall be undertaken prior to the acceptance by the Superintendent of the SPQP.

17.5.2 Survey Equipment

All survey equipment utilised on the Works shall be calibrated and maintained in accordance with the approved SPQP. As a minimum, calibration and maintenance shall comply with the requirements of the instruments' technical specification, survey regulations and standard survey practices.

All survey work shall be carried out in accordance with the SPQP and standard survey practice.

17.6 Processing of Survey Data

Survey information shall be presented clearly and concisely at appropriate scales on A3 sized paper. In addition, information shall be provided in digital form in DWG and DXF format on compact discs (CDs) or USB storage devices such that it can be utilised in AutoCAD.

Contours shall be shown at 0.25 m intervals reduced to Australian Height Datum and positioned to the MGA coordinate system. Spot levels shall also be provided in ASCII form.

The charts shall show details of the origin of coordinates and levels as well as a schedule of coordinates and reduced levels for any survey marks established on the Site.

All charts, calibration records, daily activity sheets, drawings and estimates of quantities prepared from the survey data shall be agreed and signed by the Superintendent and the Contractor. All raw survey data shall be provided to the Superintendent upon request. The data shall be presented in a format approved by the Superintendent.

17.7 Data Availability

At the request of the Superintendent, the Contractor shall supply, free of charge, any digital depth/ height/ coordinate and other survey information and associated documentation held by the Contractor for the purpose of verification or computation by the Superintendent. Information shall be supplied within five (5) working days of the request and shall be in a digital format as requested by the Superintendent.

17.8 Pre-Construction Survey

The Contractor shall complete a Pre-Construction Survey of the Site and immediate surrounding area. The results of the Pre-Construction Survey shall be presented on a general arrangement plan and sections through the site at not greater than 10 m centres and aligned to coincide with existing survey.

17.9 Works-As-Executed Survey

The Contractor shall complete a Works-As-Executed (Post-Construction) survey of the Works to ensure the Works have been constructed in accordance with the Drawings. The results of the survey shall be presented on a general arrangement plan and sections through the Works at not greater than 10 m centres.

Compliance surveys for the Works shall include the finished surface of all critical stages. The compliance survey for formative stages of work shall be submitted to the Superintendent for approval prior to commencing subsequent stages. No work requiring compliance survey shall be covered over with additional work before its survey is approved.

17.10 Construction Tolerance, Approval and Rectification

The Contractor shall assist the Superintendent as required to confirm that the construction tolerances are achieved in the Works. In the event that the Superintendent determines that construction tolerances do not meet the requirements of the Specification, the Superintendent may instruct the Contractor to make good that component of the Works. The Time for Practical Completion shall not be affected by such rectification activities, and the cost of all works associated with the rectification shall be borne by the Contractor.

The Contractor shall meet all construction tolerances detailed below:

Material comprising the Finished Surface of Works Item	Tolerance to Design Lines and Levels	
	Horizontal	Vertical
ROCK TREATMENT		
Excavated batter for placement of geotextile filter / underside of rock revetment	150 mm	-100 mm / +0 mm
Outer face of underlayer	100 mm	-50 mm / +200 mm
Outer face of armour layer	100 mm	-50 mm / +150 mm

The finished surface of placed rock shall be defined by the line of a straight edge placed across the width of the rock placement. The crest, slope and berm of the armour layer of the rock revetment are shown on the Drawings.

17.11 Survey by Council

For purposes of verification the Superintendent may from time to time undertake compliance check surveys at any location or any cross-section. Any non-compliance detected by such surveys shall be remedied by the Contractor at no cost to the Superintendent.

18 COMPLETION

18.1 Reinstatement

Except to the extent that the Site has been repaired and upgraded in accordance with the Works, the Contractor shall reinstate to its pre-construction condition all areas disturbed and any structures damaged during the course of the Works.

The photographic record of pre-construction condition of the Site shall be used by the Superintendent in assessing the acceptability of any reinstated areas at the completion of the Works.

All vegetated areas disturbed by the Works shall be restored with appropriate species.

18.2 Disestablishment

Upon completion of the Works, the Contractor shall clear the Site of all surplus materials, plant, fencing, Site shed, notice boards etc., to the satisfaction of the Superintendent.

18.3 Cleanup

The Contractor shall be responsible for the removal and disposal of all surplus spoil and rubbish, and for the final cleaning up of all areas covered by the Contract which shall be left clean and tidy up on completion of the Contract.

APPENDIX A

Drawings

DRAWING No.
PA1635/MA/0001

DO NOT SCALE

ELFIN HILL ROAD RESERVE FORESHORE STABILISATION
SITE - ELFIN HILL ROAD, GOSFORD

LOCALITY PLAN
1:10,000 (A1)

DRAWING SCHEDULE

DRG No.	TITLE
PA1635/MA/0001	TITLE SHEET, LOCALITY PLAN AND DRAWING LIST
PA1635/MA/1001	SITE PLAN
PA1635/MA/1011	GENERAL ARRANGEMENT PLAN - SHEET 1 OF 3
PA1635/MA/1012	GENERAL ARRANGEMENT PLAN - SHEET 2 OF 3
PA1635/MA/1013	GENERAL ARRANGEMENT PLAN - SHEET 3 OF 3
PA1635/MA/2001	ROCK TREATMENT - TYPICAL SECTIONS - SHEET 1 OF 2
PA1635/MA/2002	ROCK TREATMENT - TYPICAL SECTIONS - SHEET 2 OF 2
PA1635/MA/2011	SALTMARSH TREATMENT - TYPICAL SECTIONS
PA1635/MA/2021	STORMWATER EXTENSION - SECTIONS AND DETAILS
PA1635/MA/2101	DINGHY SKID - TYPICAL SECTIONS
PA1635/MA/2102	DINGHY SKID - DETAILS

FOR TENDER

200 0 200 400 600 800 1000m
1:20000 (A3) 1:10000 (A1)

REV	DATE	DESCRIPTION	BY	CHK	APPD
C	19.01.2018	ISSUED FOR TENDER	BAM	GPB	GPB
B	18.10.2017	ISSUED FOR REVIEW	BAM	GPB	GPB
A	14.09.2017	ISSUED FOR REVIEW	BAM	GPB	GPB

REVISIONS

CLIENT
Central Coast Council

SURVEY:
TOPOGRAPHIC: STEPHEN THORNE & ASSOCIATES (22/10/2014)
BATHYMETRIC: -
HORIZ. DATUM: MGA VERT. DATUM: AHD

PROJECT:
ELFIN HILL ROAD RESERVE
FORESHORE STABILISATION

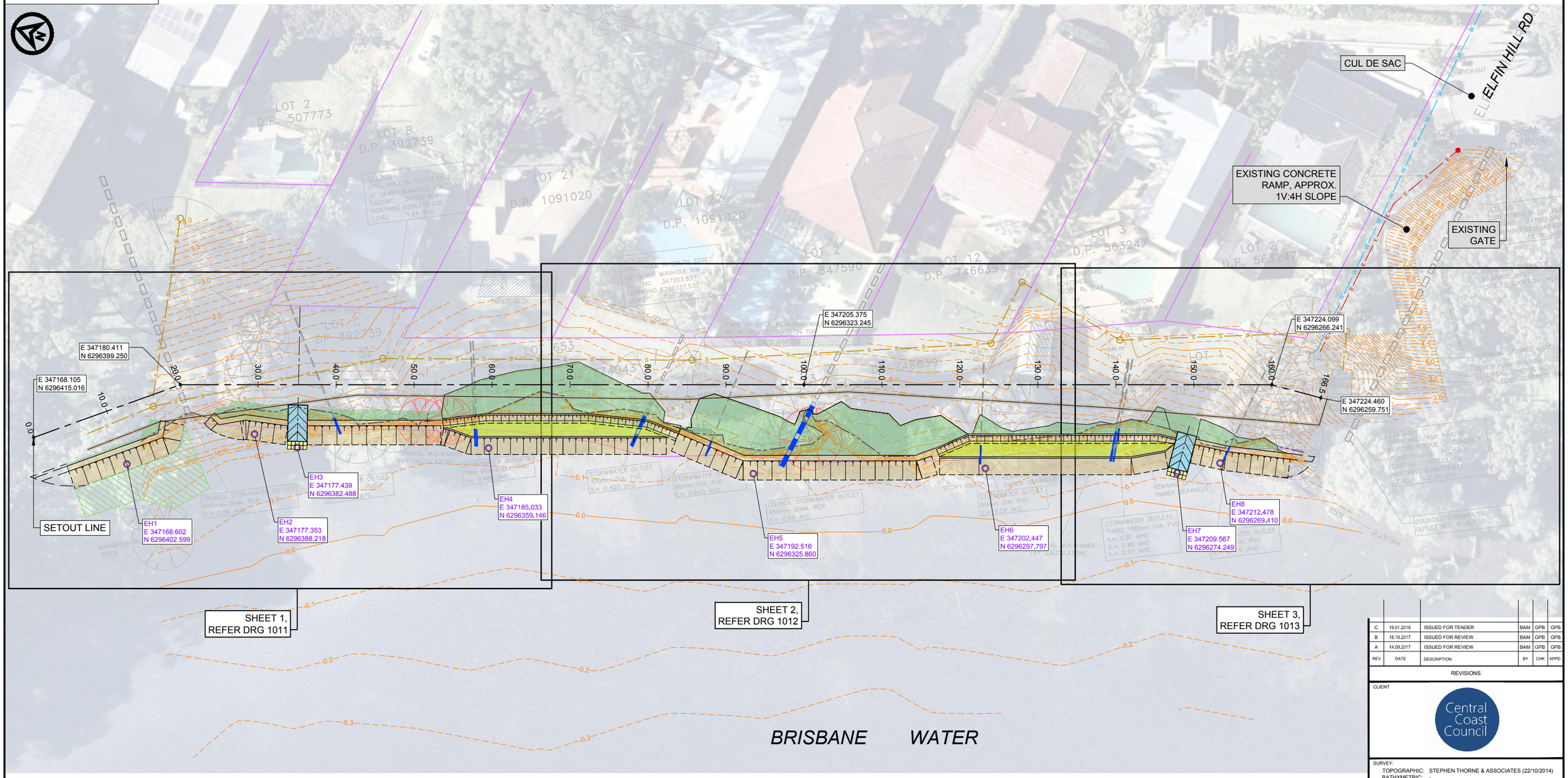
DRAWING TITLE:
TITLE SHEET, LOCALITY PLAN
AND DRAWING LIST

A COMPANY OF
Royal HaskoningDHV
Enhancing Society Together
HASKONING AUSTRALIA PTY LTD
SYDNEY
Level 14
56 Berry Street
North Sydney NSW 2060
Telephone +61 2 8854 5000
Fax +61 2 99230960
Internet www.royalhaskoning.com

DRAWN	DATE 19/01/2018	JOB No. PA1635
AUTOCAD REF.	PA1635-MA-CIVIL MODEL	
SCALE AT A1	AS SHOWN	
DRAWING No. PA1635/MA/0001		REVISION C

DRAWING No.
PA1635/MA/1001

DO NOT SCALE



NOTES

1. ALL DIMENSIONS SHOWN IN METRES. LEVELS SHOWN IN METRES ABOVE AHD.
2. SEWER RISING MAIN IS WITHIN THE VICINITY. DEPTH UNKNOWN BETWEEN CH 0 TO CH 100.
3. ALL MINOR STUMPS WITHIN 0.5m OF PROPOSED ROCK WORK TO BE REMOVED (MINOR STUMPS < Ø0.5m)
4. CLEAR BED OF DEBRIS TO 3m BEYOND LIMIT OF ROCK PLACEMENT.
   a. BRICK DEBRIS TO BE RECYCLED UNDER ROCK ARMOUR,
   b. CONCRETE SLABS TO BE BROKEN TO 600x600 OR SMALLER AND BURIED UNDER SALTMARSH BERMS,
   c. LOGS CAN REMAIN UNLESS IN WAYS OF SHORELINE TREATMENTS.
5. CONCRETE RAMP IS TOO STEEP FOR ACCESS BY 10T TRUCK. COULD USE A SMALL FRONT END LOADER TO CARRY ROCK DOWN TO RESERVE. NO STORAGE OR STOCKPILING PERMITTED IN CUL DE SAC.
6. PROPOSED REINSTATED PE OUTLET DESIGNED TO AS 4130:2009. ALL MINIMUM PRESSURE RATING SDR 41 (REFER VINIDEX PRODUCT SHEETS). REFER DRG 2020 FOR STORMWATER EXTENSION DETAILS.

LEGEND

EXISTING:

- CADASTRE
- E — ELECTRICAL
- S — SEWER
- RM — SEWER RISING MAIN
- W — WATER
- STORMWATER
- TREE
- TOP OF BANK

PROPOSED:

- ARMOUR ROCK
- SALTMARSH
- MANGROVES (ESTABLISHED NATURALLY)
- ENGINEERED FILL (GRADE FLAT OR SLOPED SEAWARD)
- DINGY SKID
- SANDSTONE BLOCK
- STORMWATER EXTENSION
- TREE TO BE REMOVED

STORMWATER EXTENSION SCHEDULE

EXISTING SW OUTLET		REINSTATED PE OUTLET (REFER NOTE 6)		
No.	SHOWN ON SURVEY (mm)	ID (mm)	WALL THICKNESS (mm)	DN
5	90 PVC	133	3.5	140
3	100 PVC	133	3.5	140
1	150 PVC	215	5.5	225
1	300 PVC	380	9.8	400
1	450 RCP	534	13.7	560

AUSTRALIAN HEIGHT DATUM

FOR TENDER

DIAL BEFORE YOU DIG www.1100.com.au

5 0 5 10 15 20 25m
1:500 (A3) 1:250 (A1)

REV	DATE	DESCRIPTION	BY	CHK	APPD
C	19.01.2018	ISSUED FOR TENDER	BAM	GPB	GPB
B	18.10.2017	ISSUED FOR REVIEW	BAM	GPB	GPB
A	14.09.2017	ISSUED FOR REVIEW	BAM	GPB	GPB

REVISIONS

CLIENT: Central Coast Council

SURVEY:
TOPOGRAPHIC: STEPHEN THORNE & ASSOCIATES (22/10/2014)
BATHYMETRIC: -
HORIZ. DATUM: MGA VERT. DATUM: AHD

PROJECT:
ELFIN HILL ROAD RESERVE FORESHORE STABILISATION

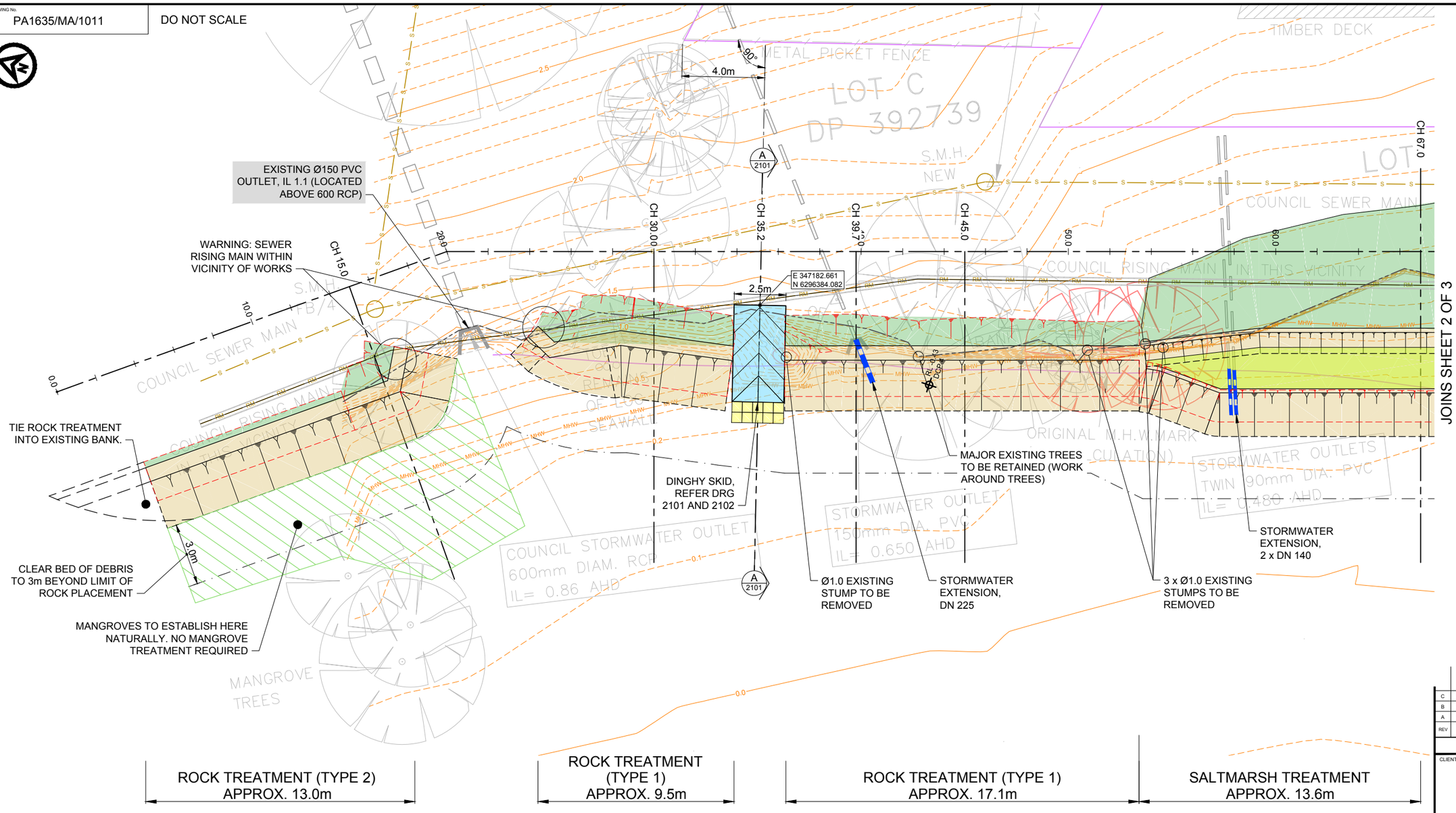
DRAWING TITLE:
SITE PLAN

A COMPANY OF Royal HaskoningDHV Enhancing Society Together
HASKONING AUSTRALIA PTY LTD
SYDNEY
Level 14
56 Berry Street
North Sydney NSW 2060
+61 2 8854 5000 Telephone
+61 2 99290960 Fax
www.royalhaskoning.com Internet

DRAWN	DATE 19/01/2018	JOB No. PA1635
AUTOCAD REF.	PA1635-MA-CIVIL MODEL	
SCALE AT A1	AS SHOWN	
DRAWING No. PA1635/MA/1001		REVISION C

DRAWING No.
PA1635/MA/1011

DO NOT SCALE



ROCK TREATMENT (TYPE 2) APPROX. 13.0m

ROCK TREATMENT (TYPE 1) APPROX. 9.5m

ROCK TREATMENT (TYPE 1) APPROX. 17.1m

SALTMARSH TREATMENT APPROX. 13.6m

NOTES

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2. SEWER RISING MAIN IS WITHIN THE VICINITY. DEPTH UNKNOWN BETWEEN CH 0 TO CH 100.
3. ALL MINOR STUMPS WITHIN 0.5m OF PROPOSED ROCK WORK TO BE REMOVED (MINOR STUMPS < Ø0.5m)
4. CLEAR BED OF DEBRIS TO 3m BEYOND LIMIT OF ROCK PLACEMENT.
   a. BRICK DEBRIS TO BE RECYCLED UNDER ROCK ARMOUR,
   b. CONCRETE SLABS TO BE BROKEN TO 600x600 OR SMALLER AND BURIED UNDER SALTMARSH BERMS,
   c. LOGS CAN REMAIN UNLESS IN WAYS OF SHORELINE TREATMENTS.
5. REFER DRG 1001 FOR STORMWATER EXTENSION SCHEDULE. TO BE REVIEWED ON SITE.

LEGEND

EXISTING:

- CADASTRE
- ELECTRICAL
- SEWER
- SEWER RISING MAIN
- WATER
- STORMWATER
- TREE
- TOP OF BANK
- DCP TEST (RHDHV, 20/10/2014)

PROPOSED:

- ARMOUR ROCK
- SALTMARSH
- MANGROVES (ESTABLISHED NATURALLY)
- ENGINEERED FILL (GRADE FLAT OR SLOPED SEAWARD)
- DINGY SKID
- SANDSTONE BLOCK
- STORMWATER EXTENSION
- TREE TO BE REMOVED
- EXCAVATION LIMITS

AUSTRALIAN HEIGHT DATUM

FOR TENDER

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2 0 2 4 6 8 10m

1:200 (A3) 1:100 (A1)

REV	DATE	DESCRIPTION	BY	CHK	APPD
C	19.01.2018	ISSUED FOR TENDER	BAM	GPB	GPB
B	18.10.2017	ISSUED FOR REVIEW	BAM	GPB	GPB
A	14.09.2017	ISSUED FOR REVIEW	BAM	GPB	GPB

REVISIONS

CLIENT: Central Coast Council

SURVEY:
TOPOGRAPHIC: STEPHEN THORNE & ASSOCIATES (22/10/2014)
BATHYMETRIC: -
HORIZ. DATUM: MGA VERT. DATUM: AHD

PROJECT:
ELFIN HILL ROAD RESERVE FORESHORE STABILISATION

DRAWING TITLE:
GENERAL ARRANGEMENT PLAN SHEET 1 OF 3

A COMPANY OF Royal HaskoningDHV Enhancing Society Together
HASKONING AUSTRALIA PTY LTD SYDNEY
Level 14
56 Berry Street
North Sydney NSW 2060
Telephone +61 2 8854 5000
Fax +61 2 99230960
Internet www.royalhaskoning.com

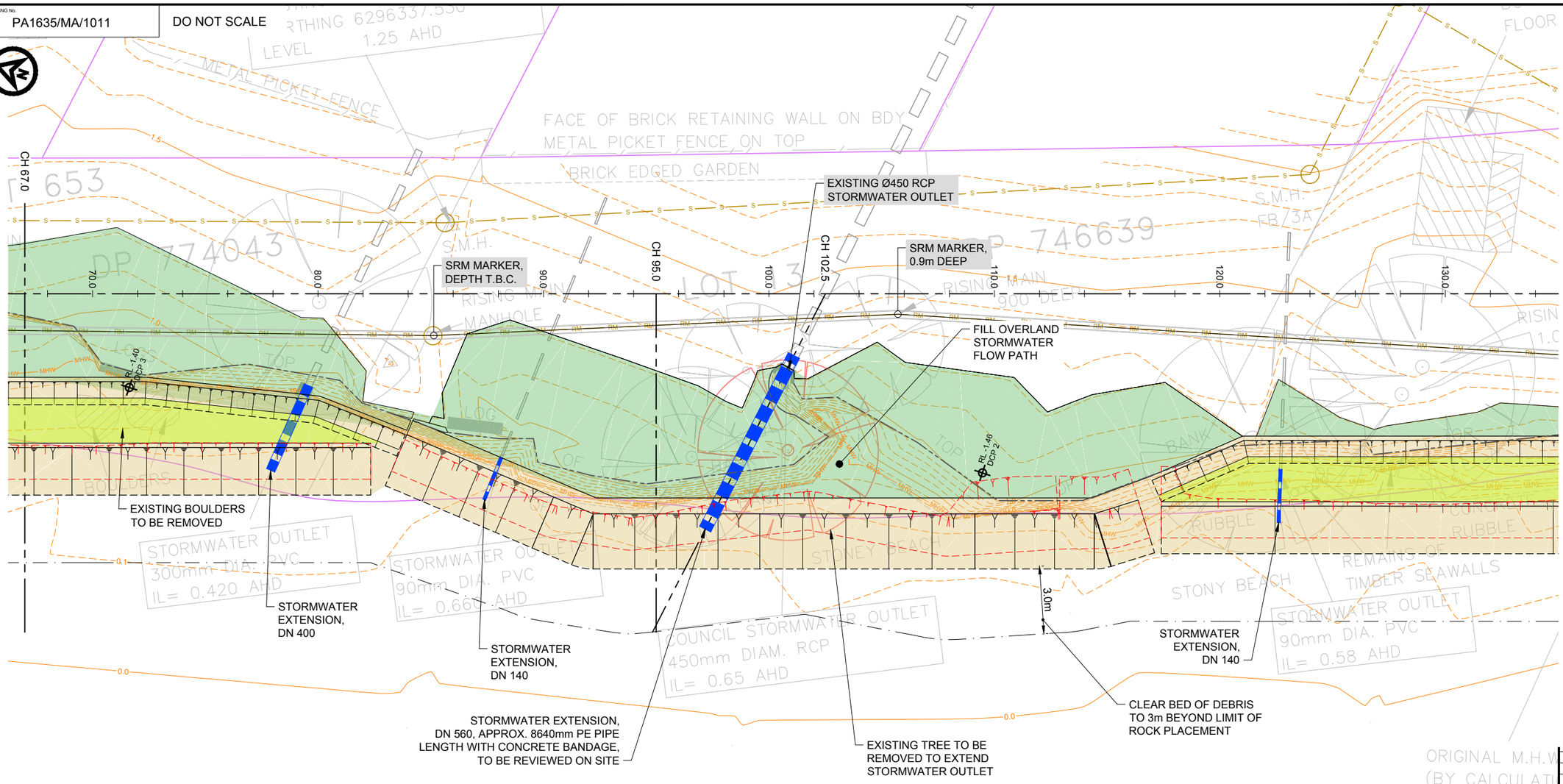
DRAWN	DATE 19/01/2018	JOB No. PA1635
AUTOCAD REF.	PA1635-MA-CIVIL MODEL	
SCALE AT A1	AS SHOWN	
DRAWING No. PA1635/MA/1011		REVISION C

DRAWING No.
PA1635/MA/1011

DO NOT SCALE

JOINS SHEET 1 OF 3

JOINS SHEET 3 OF 3



SALTMARSH TREATMENT
APPROX. 16.8m

ROCK TREATMENT (TYPE 1)
APPROX. 33.5m

SALTMARSH TREATMENT
APPROX. 17.8m

NOTES

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   c. LOGS CAN REMAIN UNLESS IN WAYS OF SHORELINE TREATMENTS.
5. REFER DRG 1001 FOR STORMWATER EXTENSION SCHEDULE. TO BE REVIEWED ON SITE.

LEGEND

EXISTING:

- CADASTRE
- ELECTRICAL
- SEWER
- SEWER RISING MAIN
- WATER
- STORMWATER
- TREE
- TOP OF BANK
- DCP TEST (RHDHV, 20/10/2014)

PROPOSED:

- ARMOUR ROCK
- SALTMARSH
- MANGROVES (ESTABLISHED NATURALLY)
- ENGINEERED FILL (GRADE FLAT OR SLOPED SEAWARD)
- DINGY SKID
- SANDSTONE BLOCK
- STORMWATER EXTENSION
- TREE TO BE REMOVED
- EXCAVATION LIMITS

AUSTRALIAN HEIGHT DATUM

FOR TENDER

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2 0 2 4 6 8 10m

1:200 (A3) 1:100 (A1)

REV	DATE	DESCRIPTION	BY	CHK	APPD
C	19.01.2018	ISSUED FOR TENDER	BAM	GPB	GPB
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REVISIONS

CLIENT: Central Coast Council

SURVEY:
TOPOGRAPHIC: STEPHEN THORNE & ASSOCIATES (22/10/2014)
BATHYMETRIC: -
HORIZ. DATUM: MGA VERT. DATUM: AHD

PROJECT:
ELFIN HILL ROAD RESERVE FORESHORE STABILISATION

DRAWING TITLE:
GENERAL ARRANGEMENT PLAN
SHEET 2 OF 3

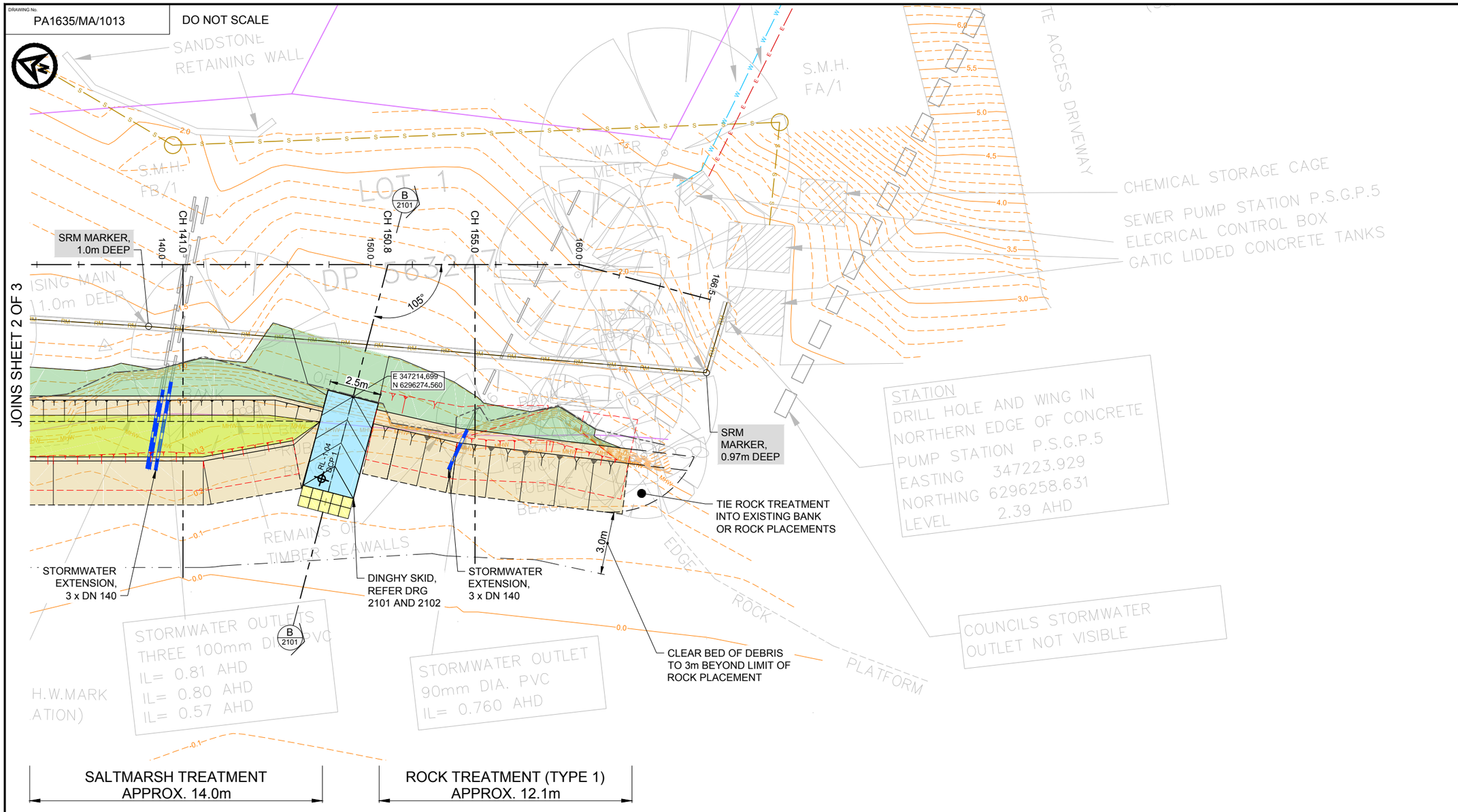
A COMPANY OF Royal HaskoningDHV Enhancing Society Together
HASKONING AUSTRALIA PTY LTD SYDNEY
Level 14
56 Berry Street
North Sydney NSW 2060
+61 2 8854 5000 Telephone
+61 2 99290960 Fax
www.royalhaskoning.com Internet

DRAWN	DATE 19/01/2018	JOB No. PA1635
AUTOCAD REF.	PA1635-MA-CIVIL MODEL	
SCALE AT A1	AS SHOWN	
DRAWING No.	PA1635/MA/1012	REVISION C

DRAWING No.
PA1635/MA/1013

DO NOT SCALE

JOINS SHEET 2 OF 3



NOTES

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   c. LOGS CAN REMAIN UNLESS IN WAYS OF SHORELINE TREATMENTS.
5. REFER DRG 1001 FOR STORMWATER EXTENSION SCHEDULE. TO BE REVIEWED ON SITE.

LEGEND

EXISTING:

- CADASTRE
- ELECTRICAL
- SEWER
- SEWER RISING MAIN
- WATER
- STORMWATER
- TREE
- TOP OF BANK
- DCP TEST (RHDHV, 20/10/2014)

PROPOSED:

- ARMOUR ROCK
- SALTMARSH
- MANGROVES (ESTABLISHED NATURALLY)
- ENGINEERED FILL (GRADE FLAT OR SLOPED SEAWARD)
- DINGY SKID
- SANDSTONE BLOCK
- STORMWATER EXTENSION
- TREE TO BE REMOVED
- EXCAVATION LIMITS

AUSTRALIAN HEIGHT DATUM

FOR TENDER

DIAL BEFORE YOU DIG www.1100.com.au

2 0 2 4 6 8 10m
1:200 (A3) 1:100 (A1)

REV	DATE	DESCRIPTION	BY	CHK	APPD
C	19.01.2018	ISSUED FOR TENDER	BAM	GPB	GPB
B	18.10.2017	ISSUED FOR REVIEW	BAM	GPB	GPB
A	14.09.2017	ISSUED FOR REVIEW	BAM	GPB	GPB

REVISIONS

CLIENT: Central Coast Council

SURVEY:
TOPOGRAPHIC: STEPHEN THORNE & ASSOCIATES (22/10/2014)
BATHYMETRIC: -
HORIZ. DATUM: MGA VERT. DATUM: AHD

PROJECT:
ELFIN HILL ROAD RESERVE FORESHORE STABILISATION

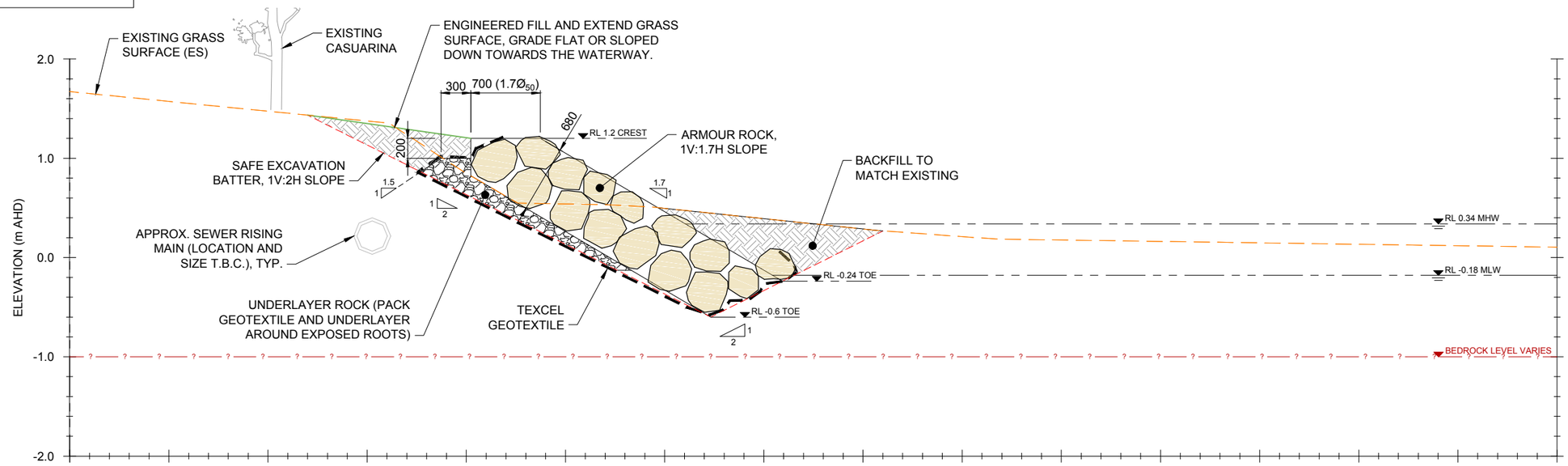
DRAWING TITLE:
GENERAL ARRANGEMENT PLAN
SHEET 3 OF 3

A COMPANY OF Royal HaskoningDHV Enhancing Society Together
HASKONING AUSTRALIA PTY LTD SYDNEY
Level 14
56 Berry Street
North Sydney NSW 2060
+61 2 8854 5000 Telephone
+61 2 99290960 Fax
www.royalhaskoning.com Internet

DRAWN	DATE 19/01/2018	JOB No. PA1635
AUTOCAD REF.	PA1635-MA-CIVIL MODEL	
SCALE AT A1	AS SHOWN	
DRAWING No.	PA1635/MA/1013	REVISION C

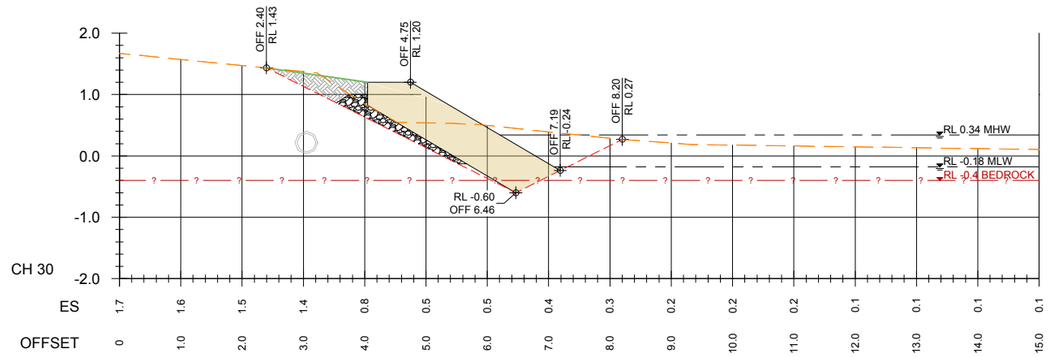
DRAWING No.
PA1635/MA/2001

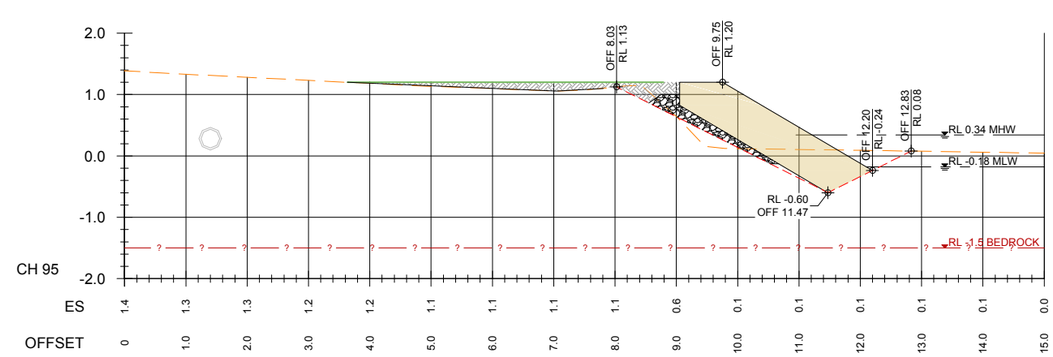
DO NOT SCALE

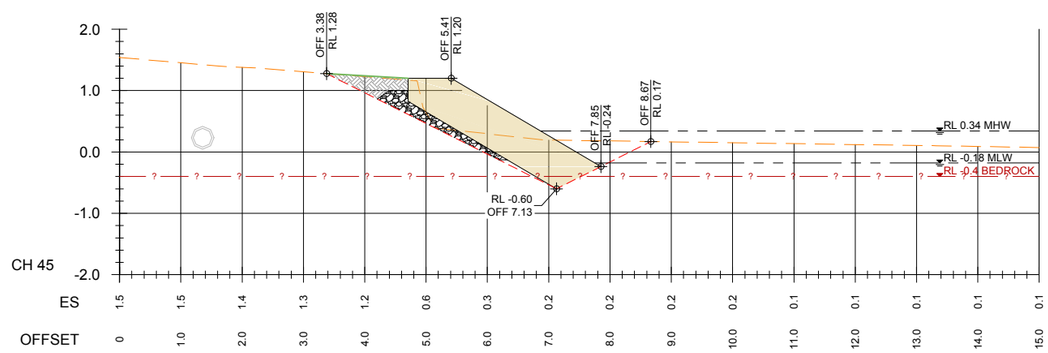


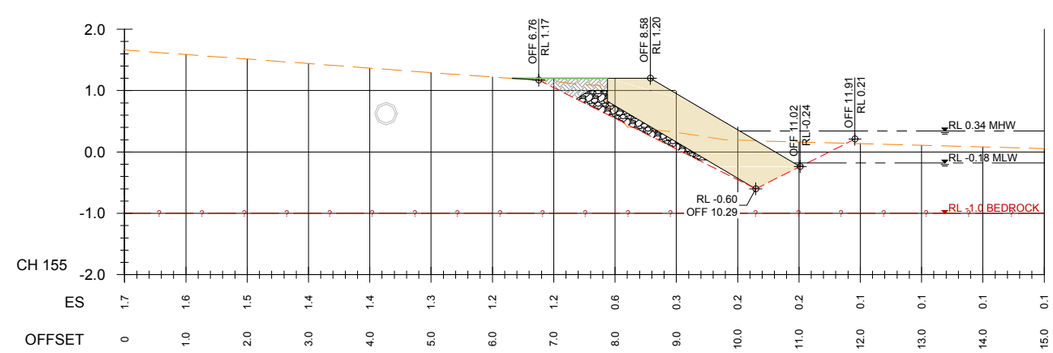
ROCK TREATMENT (TYPE 1) TYPICAL SECTION

1:50 (A3)









ROCK TREATMENT (TYPE 1) SECTIONS

1:100 (A3)

AUSTRALIAN HEIGHT DATUM

FOR TENDER

1000 0 1000 2000 3000 4000 5000mm
1:100 (A3) 1:50 (A1)

500 0 500 1000 1500 2000 2500mm
1:50 (A3) 1:25 (A1)

NOTES

1. ALL LEVELS IN METRES ABOVE AHD. ALL DIMENSIONS IN MILLIMETRES.
2. BEDROCK LEVELS ARE BASED ON DCP TESTS AND ARE APPROXIMATE ONLY.

MATERIAL SIZING

	M_{50} (kg)	M_{RANGE} (kg)	$Ø_{50}$ (m)	$Ø_{RANGE}$ (m)
ARMOUR	89	50 - 125	0.39	0.32 - 0.44
UNDERLAYER	9	-	0.13	-

REV	DATE	DESCRIPTION	BY	CHK	APPD
C	19.01.2018	ISSUED FOR TENDER	BAM	GPB	GPB
B	18.10.2017	ISSUED FOR REVIEW	BAM	GPB	GPB
A	14.09.2017	ISSUED FOR REVIEW	BAM	GPB	GPB

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SURVEY:
TOPOGRAPHIC: STEPHEN THORNE & ASSOCIATES (22/10/2014)
BATHYMETRIC: -
HORIZ. DATUM: MGA VERT. DATUM: AHD

PROJECT:

ELFIN HILL ROAD RESERVE FORESHORE STABILISATION

DRAWING TITLE:

ROCK TREATMENT TYPICAL SECTIONS SHEET 1 OF 2

A COMPANY OF
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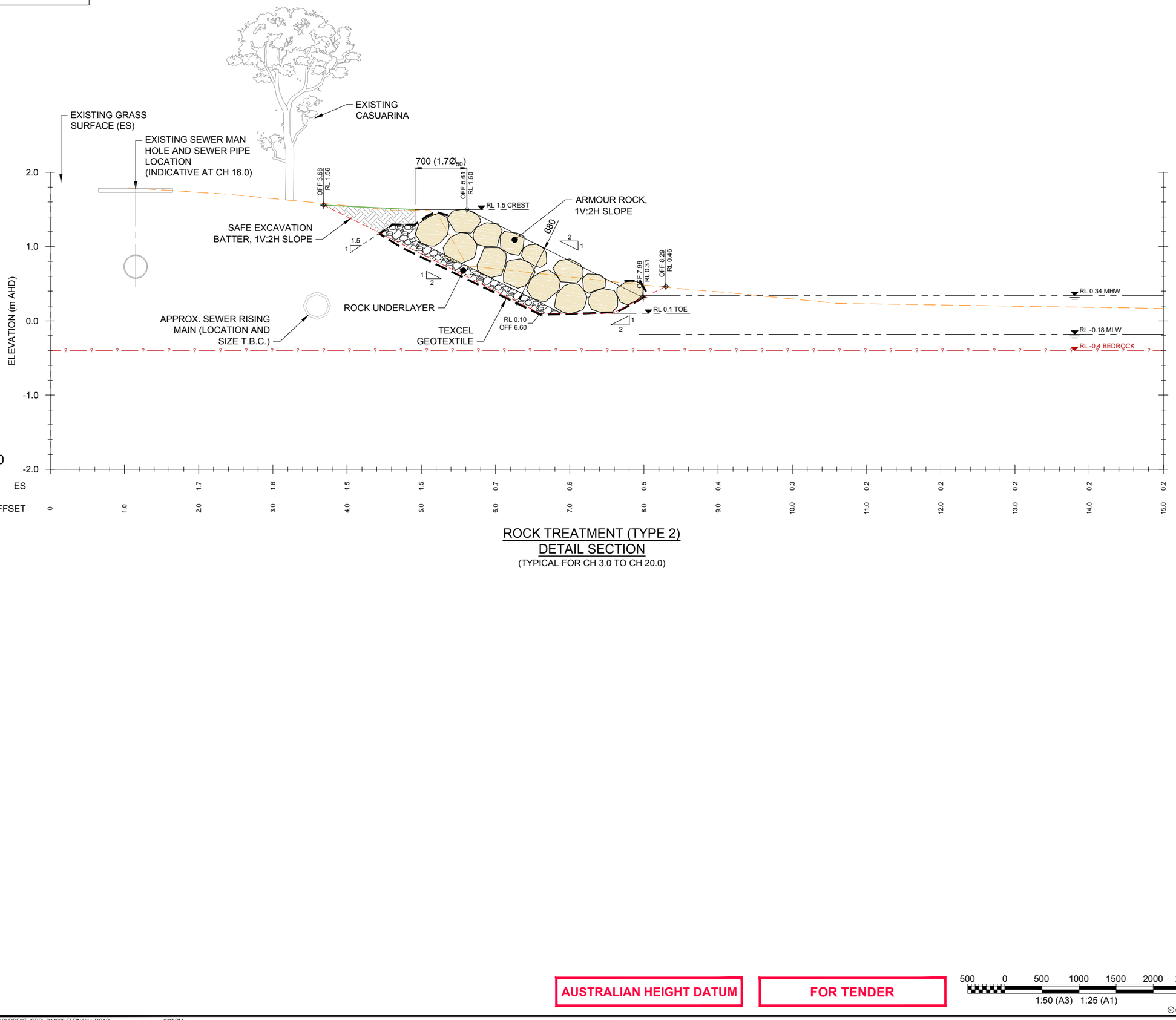
DRAWN	DATE 19/01/2018	JOB No. PA1635
AUTOCAD REF.	PA1635-MA-CIVIL MODEL	
SCALE AT A1	AS SHOWN	
DRAWING No.	PA1635/MA/2001	REVISION C

DRAWING No.
PA1635/MA/2002

DO NOT SCALE



ROCK TREATMENT (TYPE 2)
DETAIL SECTION
(TYPICAL FOR CH 3.0 TO CH 20.0)

NOTES

1. ALL LEVELS IN METRES ABOVE AHD. ALL DIMENSIONS IN MILLIMETRES.
2. BEDROCK LEVELS ARE BASED ON DCP TESTS AND ARE APPROXIMATE ONLY.

MATERIAL SIZING

	M_{50} (kg)	M_{RANGE} (kg)	$Ø_{50}$ (m)	$Ø_{RANGE}$ (m)
ARMOUR	89	50 - 125	0.39	0.32 - 0.44
UNDERLAYER	9	-	0.13	-

AUSTRALIAN HEIGHT DATUM

FOR TENDER

500 0 500 1000 1500 2000 2500mm

1:50 (A3) 1:25 (A1)

REV	DATE	DESCRIPTION	BY	CHK	APPD
C	19.01.2018	ISSUED FOR TENDER	BAM	GPB	GPB
B	18.10.2017	ISSUED FOR REVIEW	BAM	GPB	GPB
A	14.09.2017	ISSUED FOR REVIEW	BAM	GPB	GPB

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SURVEY:
TOPOGRAPHIC: STEPHEN THORNE & ASSOCIATES (22/10/2014)
BATHYMETRIC: -
HORIZ. DATUM: MGA VERT. DATUM: AHD

PROJECT:

ELFIN HILL ROAD RESERVE
FORESHORE STABILISATION

DRAWING TITLE:

ROCK TREATMENT
TYPICAL SECTIONS
SHEET 2 OF 2

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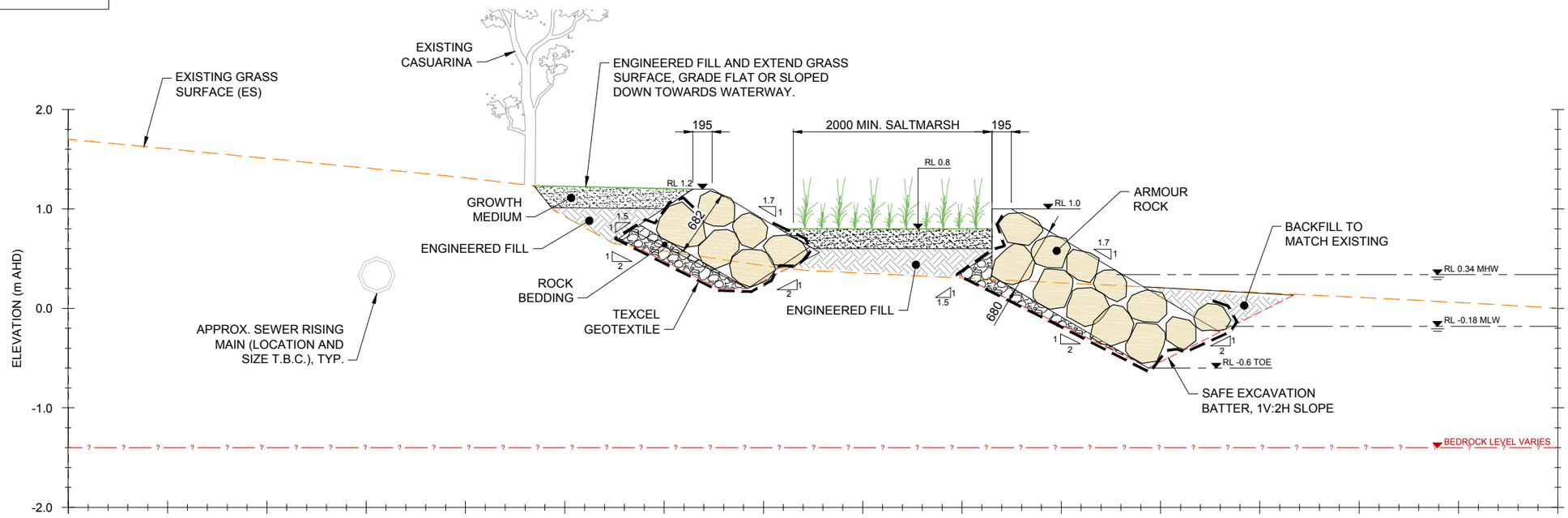
DRAWN	DATE 19/01/2018	JOB No. PA1635
AUTOCAD REF.	PA1635-MA-CIVIL MODEL	
SCALE AT A1	AS SHOWN	
DRAWING No. PA1635/MA/2002		REVISION C

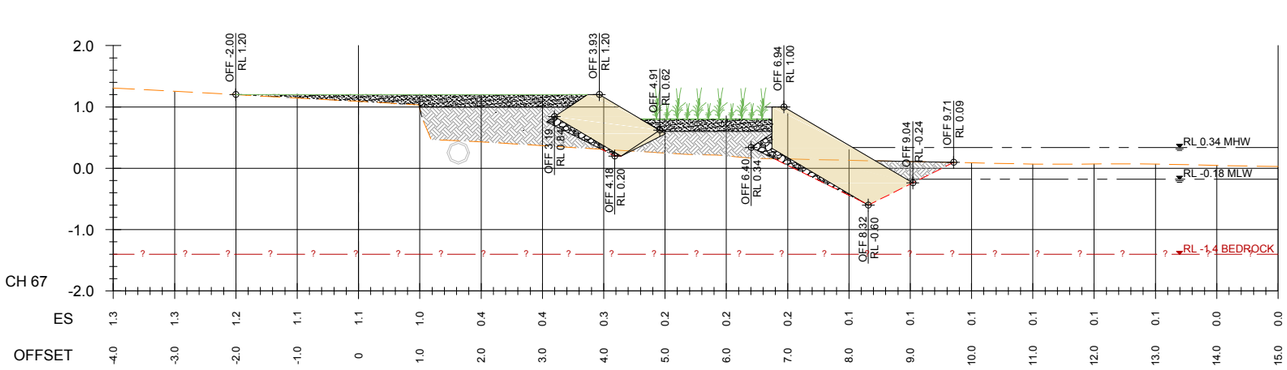
DRAWING No.
PA1635/MA/2011

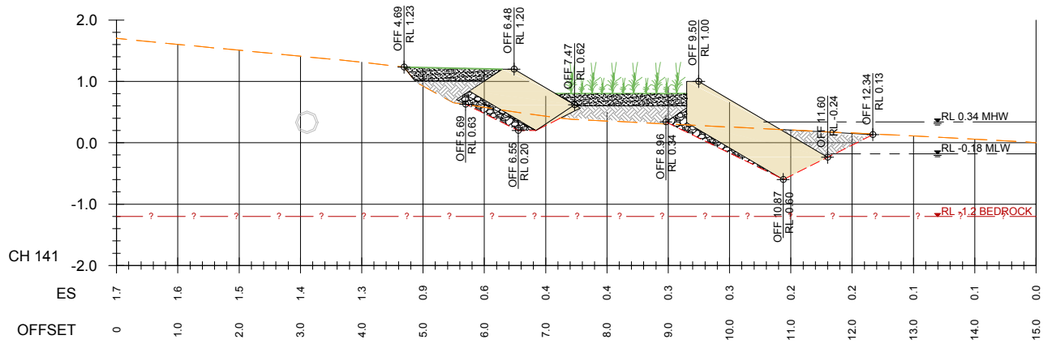
DO NOT SCALE



SALTMARSH TREATMENT TYPICAL SECTION

1:50 (A3)





SALTMARSH TREATMENT SECTIONS

1:100 (A3)

NOTES

1. ALL LEVELS IN METRES ABOVE AHD. ALL DIMENSIONS IN MILLIMETRES.
2. BEDROCK LEVELS ARE BASED ON DCP TESTS AND ARE APPROXIMATE ONLY.

MATERIAL SIZING

	M_{50} (kg)	M_{RANGE} (kg)	$Ø_{50}$ (m)	$Ø_{RANGE}$ (m)
ARMOUR	89	50 - 125	0.39	0.32 - 0.44
UNDERLAYER	9	-	0.13	-

AUSTRALIAN HEIGHT DATUM

FOR TENDER

500 0 500 1000 1500 2000 2500mm

1:50 (A3) 1:25 (A1)

REV	DATE	DESCRIPTION	BY	CHK	APPD
C	19.01.2018	ISSUED FOR TENDER	BAM	GPB	GPB
B	18.10.2017	ISSUED FOR REVIEW	BAM	GPB	GPB
A	14.09.2017	ISSUED FOR REVIEW	BAM	GPB	GPB

REVISIONS

CLIENT: Central Coast Council

SURVEY:
TOPOGRAPHIC: STEPHEN THORNE & ASSOCIATES (22/10/2014)
BATHYMETRIC: -
HORIZ. DATUM: MGA VERT. DATUM: AHD

PROJECT:
ELFIN HILL ROAD RESERVE FORESHORE STABILISATION

DRAWING TITLE:
SALTMARSH TREATMENT TYPICAL SECTIONS

HASKONING AUSTRALIA PTY LTD
SYDNEY
Level 14
56 Berry Street
North Sydney NSW 2060
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Internet www.royalhaskoning.com

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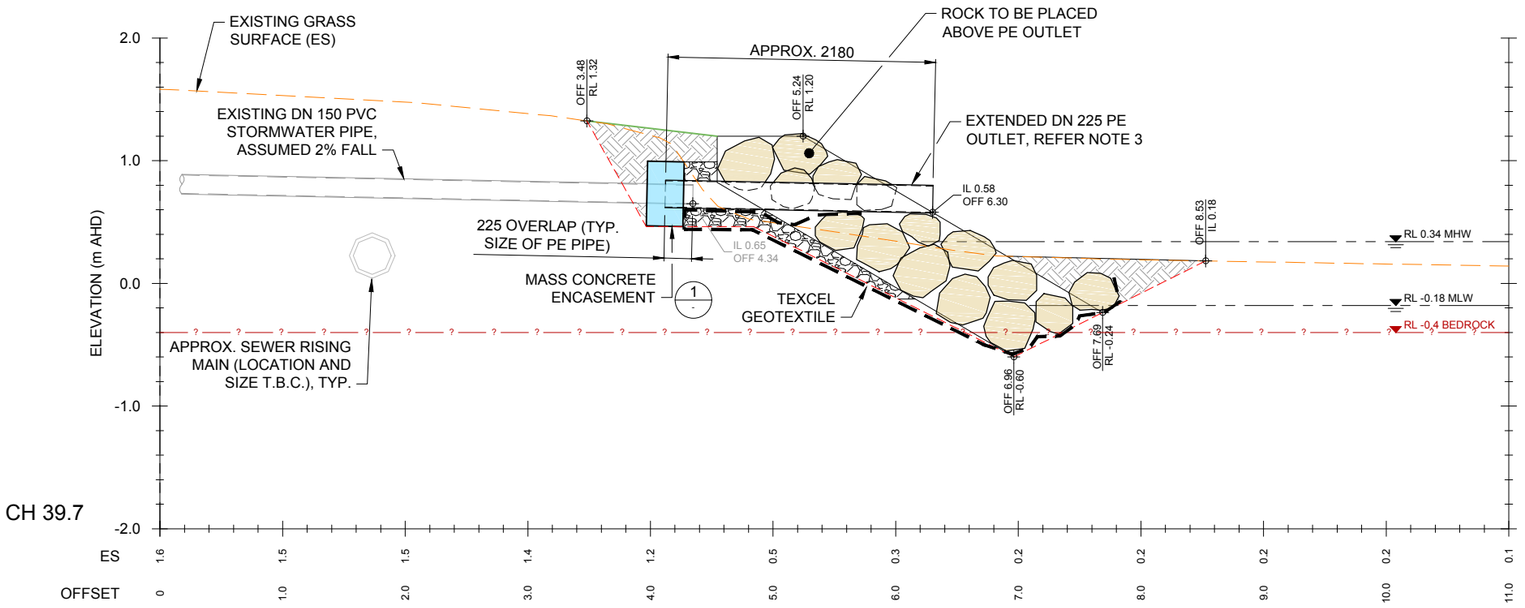
AUTOCAD REF. PA1635-MA-CIVIL MODEL
SCALE AT A1 AS SHOWN
DRAWING No. PA1635/MA/2011
REVISION C

DRAWING No.
PA1635/MA/2021

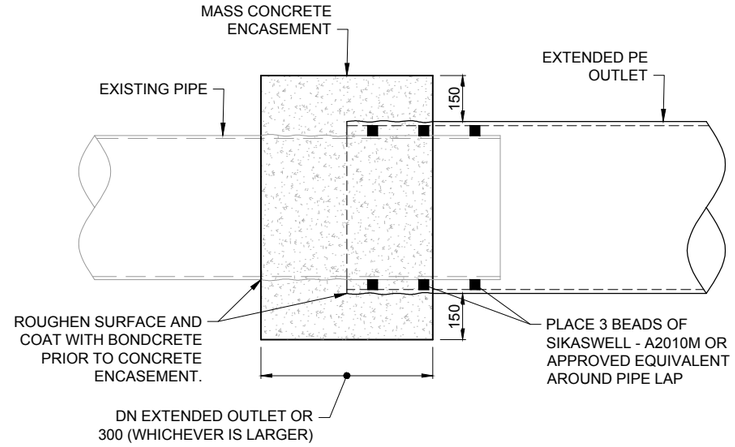
DO NOT SCALE

NOTES

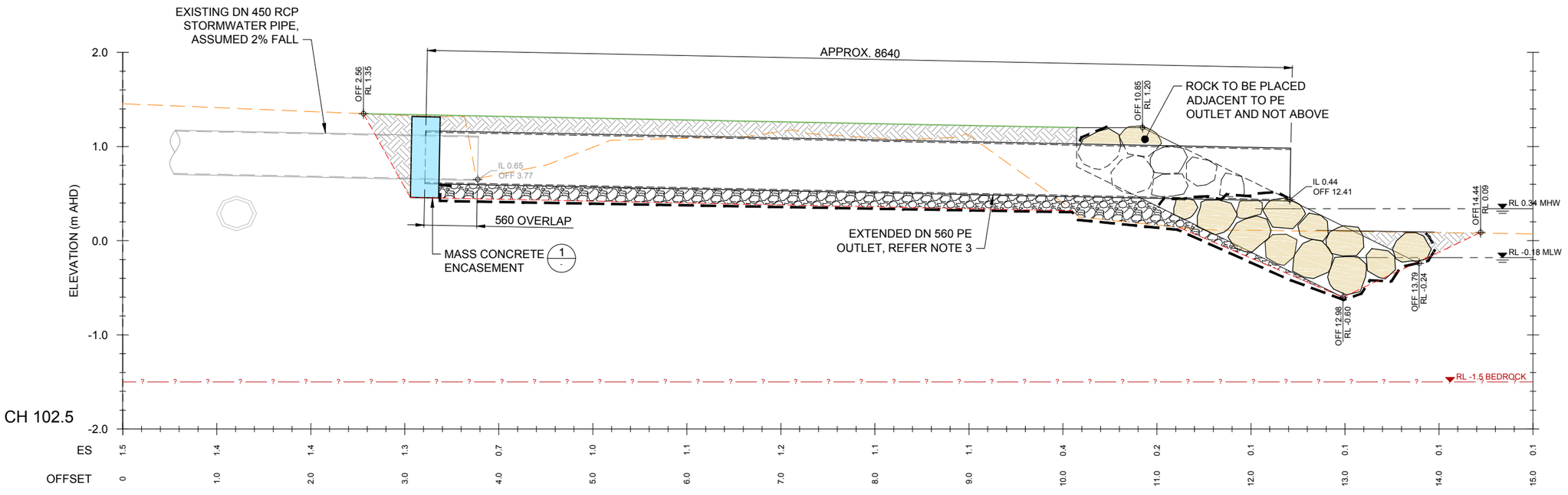
1. ALL LEVELS IN METRES ABOVE AHD. ALL DIMENSIONS IN MILLIMETRES.
2. BEDROCK LEVELS ARE BASED ON DCP TESTS AND ARE APPROXIMATE ONLY.
3. REFER DRG 1001 FOR STORMWATER EXTENSION SCHEDULE.



DN 150 PVC STORMWATER EXTENSION
DETAIL SECTION
NOTE: TYPICAL FOR ALL PVC SIZES, REFER NOTE 3
1:50 (A3)



DETAIL 1 (1:20 (A3)) — STORMWATER CONCRETE ENCASEMENT



DN 450 RCP STORMWATER EXTENSION
DETAIL SECTION
1:50 (A3)

AUSTRALIAN HEIGHT DATUM

FOR TENDER

400 0 400 800 1200 1600 2000mm
1:40 (A3) 1:20 (A1)

REV	DATE	DESCRIPTION	BY	CHK	APPD
C	19.01.2018	ISSUED FOR TENDER	BAM	GPB	GPB
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A	14.09.2017	ISSUED FOR REVIEW	BAM	GPB	GPB

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SURVEY:
TOPOGRAPHIC: STEPHEN THORNE & ASSOCIATES (22/10/2014)
BATHYMETRIC: -
HORIZ. DATUM: MGA VERT. DATUM: AHD

PROJECT:
ELFIN HILL ROAD RESERVE FORESHORE STABILISATION

DRAWING TITLE:
STORMWATER EXTENSION SECTIONS AND DETAILS

A COMPANY OF Royal HaskoningDHV Enhancing Society Together
HASKONING AUSTRALIA PTY LTD SYDNEY
Level 14
56 Berry Street
North Sydney NSW 2060
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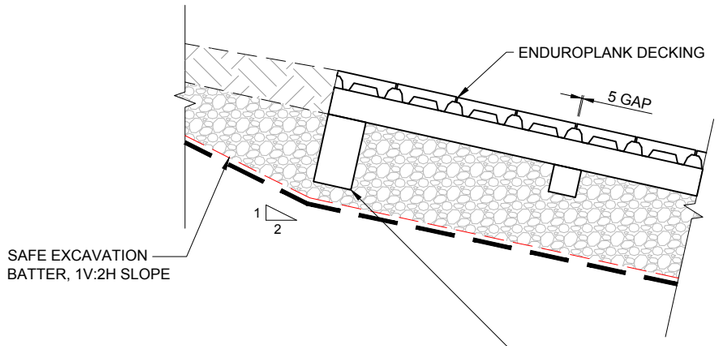
www.royalhaskoning.com Internet

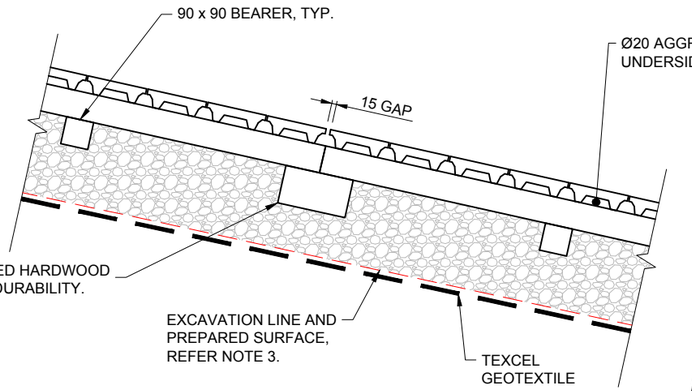
DRAWN	DATE 19/01/2018	JOB No. PA1635
AUTOCAD REF.	PA1635-MA-CIVIL MODEL	
SCALE AT A1	AS SHOWN	
DRAWING No.	PA1635/MA/2021	REVISION C

DRAWING No.
PA1635/MA/2102

DO NOT SCALE

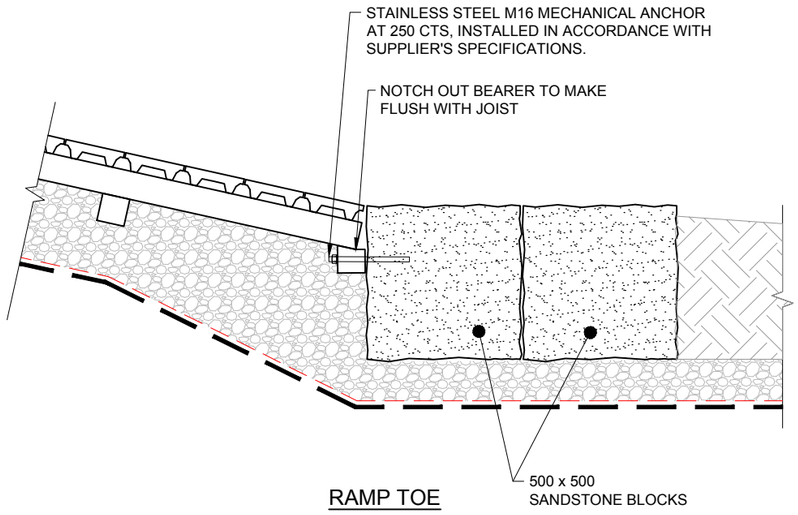


RAMP CREST



DINGHY SKID - DETAILS

1:20 (A3)



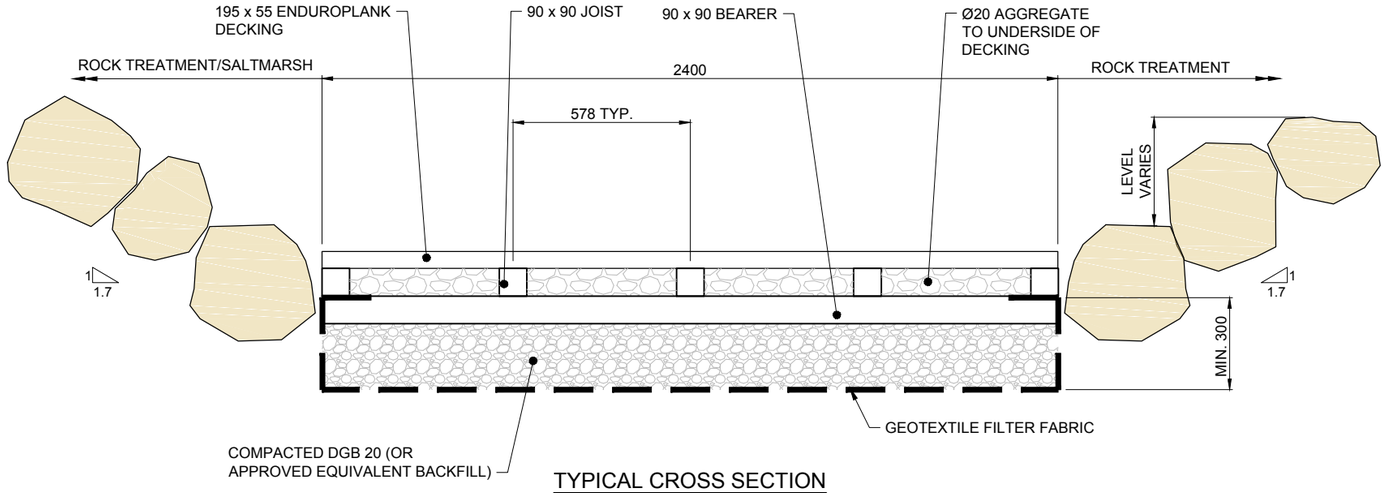
RAMP TOE

NOTES - GENERAL

1. ALL WORKS TO BE CARRIED OUT IN ACCORDANCE WITH RHDHV SPECIFICATIONS U.N.O.
2. ALL DEBRIS REMOVED FROM SITE ON COMPLETION OF WORKS AND ANY DAMAGE SHALL BE REMEDIATED.
3. ALL DIMENSIONS SHOW IN MILLIMETRES U.N.O.
4. LOCALLY TRANSITION ROCK TREATMENT TO MATCH WITH DINGHY SKID.
5. BASE MATERIAL TO BE PROOF ROLLED. MIN. BEARING CAPACITY OF PREPARED SUFACE TO BE 20kPa
6. GEOTEXTILE SHALL BE GEOFABRICS TEXCEL 900R OR APPROVED EQUIVALENT.

NOTES - RAMP

1. ALL DINGHY STRUCTURE COMPONENTS ARE REPLAS (OR APPROVED EQUIVALENT) PROFILES AND SHALL BE INSTALLED AND FIXED AS PER MANUFACTURER'S SPECIFICATIONS.
2. REPLAS PRODUCTS ARE NOT STRUCTURAL. ENSURE DGB20 OR SIMILAR IS COMPACTED FIRMLY AROUND BEARERS / SILL BEARERS TO PROVIDE ADEQUATE SUPPORT. PROVIDE A MINIMUM 90 THICK COMPACTED BASE OF DGB20 TO UNDERSIDE OF 90 x 90 BEARER. DGB20 TO BE WRAPPED IN GEOFABRIC.
3. ALL FIXINGS SHALL BE GRADE 316 STAINLESS STEEL GAUGE 14 BUGLE HEAD SCREWS 100 LONG FOR DECKING AND 150 LONG FOR JOISTS. DECKING SHALL BE FIXED WITH 2 x SCREWS ALONG THE CENTRE OF JOIST AND 1 x SCREW ON THE 4 x REMANING JOISTS. PRE-DRILL ALL HOLES FOR PLACEMENT OF SCREWS.
4. ALL COMPONENT LENGTHS ARE 2400 U.N.O.



TYPICAL CROSS SECTION

1:20 (A3)

FOR TENDER

200 0 200 400 600 800 1000mm

1:20 (A3) 1:10 (A1)

REV	DATE	DESCRIPTION	BY	CHK	APPD
C	19.01.2018	ISSUED FOR TENDER	BAM	GPB	GPB
B	18.10.2017	ISSUED FOR REVIEW	BAM	GPB	GPB
A	14.09.2017	ISSUED FOR REVIEW	BAM	GPB	GPB

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TOPOGRAPHIC: STEPHEN THORNE & ASSOCIATES (22/10/2014)
BATHYMETRIC: -
HORIZ. DATUM: MGA VERT. DATUM: AHD

PROJECT:

ELFIN HILL ROAD RESERVE FORESHORE STABILISATION

DRAWING TITLE:

DINGHY SKID DETAILS

A COMPANY OF
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+61 2 99290960 Fax
www.royalhaskoning.com Internet

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AUTOCAD REF.	PA1635-MA-DINGHY SKID DETAILS	
SCALE AT A1	AS SHOWN	
DRAWING No. PA1635/MA/2102		REVISION C

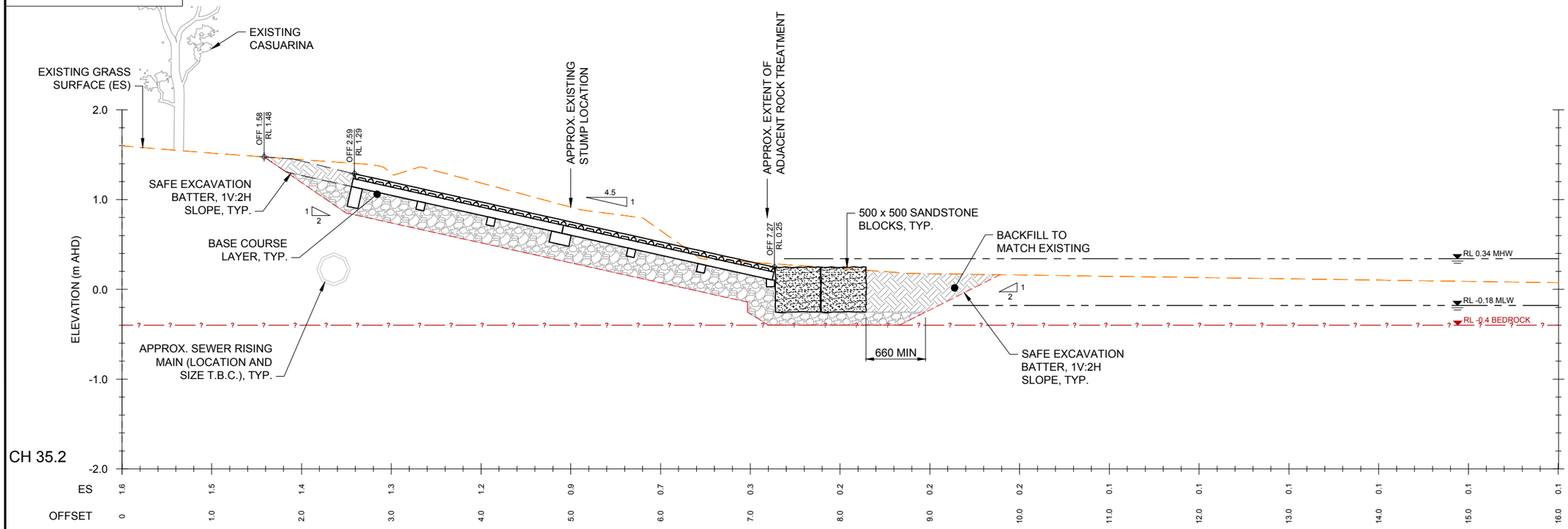
\\HKA-SERVER\PUBLIC\CURRENT JOBS\~PA1635 ELFIN HILL ROAD RESERVE\E02 WORKING DRAWINGS\PA1635-MA-DINGHY SKID DETAILS.DWG 1/19/2018 2:39 PM

DRAWING No.
PA1635/MA/2101

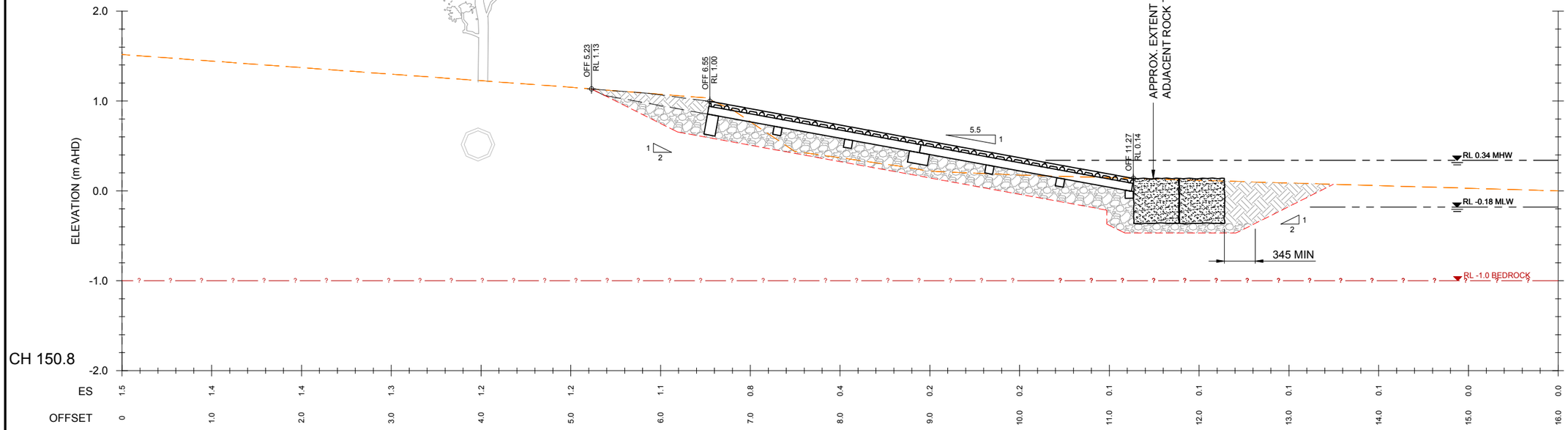
DO NOT SCALE

NOTES

1. ALL LEVELS IN METRES ABOVE AHD. ALL DIMENSIONS IN MILLIMETRES.
2. BEDROCK LEVELS ARE BASED ON DCP TESTS AND ARE APPROXIMATE ONLY.
3. REFER DRG 2102 FOR DETAILS.



SECTION A/1011 1:25 (A1) DINGHY SKID - NORTH



SECTION B/1013 1:25 (A1) DINGHY SKID - SOUTH

AUSTRALIAN HEIGHT DATUM

FOR TENDER

500 0 500 1000 1500 2000 2500mm
1:50 (A3) 1:25 (A1)

REV	DATE	DESCRIPTION	BY	CHK	APPD
C	19.01.2018	ISSUED FOR TENDER	BAM	GPB	GPB
B	18.10.2017	ISSUED FOR REVIEW	BAM	GPB	GPB
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BATHYMETRIC: -
HORIZ. DATUM: MGA VERT. DATUM: AHD

PROJECT:
ELFIN HILL ROAD RESERVE FORESHORE STABILISATION

DRAWING TITLE:
DINGHY SKID TYPICAL SECTIONS

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DRAWN	DATE 19/01/2018	JOB No. PA1635
AUTOCAD REF.	PA1635-MA-CIVIL MODEL	
SCALE AT A1	AS SHOWN	
DRAWING No. PA1635/MA/2101		REVISION C

APPENDIX B

Geotechnical Investigations

Elfin Hill Road Reserve Foreshore Stabilisation

Concept Design Report

Gosford City Council

23 February 2015
Final
8A0467

Royal HaskoningDHV
Enhancing Society Together

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Document title	Elfin Hill Road Reserve Foreshore Stabilisation Concept Design Report
Document short title	Elfin Hill Road Reserve Foreshore Stabilisation
Status	Final
Date	23 February 2015
Project name	Elfin Hill Road Reserve Foreshore Stabilisation
Project number	8A0467
Client	Gosford City Council
Reference	8A0467_Concept Design Report_rcp_20150223

Drafted by	Rick Plain
Checked by	Ben Morgan
Date/initials check	18/12/14
Approved by	Ben Morgan
Date/initials approval	23/02/15


2 SITE DESCRIPTION AND INVESTIGATIONS

The site was inspected on the 28th of October 2014 with Warren Brown (Council), Robert Baker (Council), Ben Morgan (HKA) and Rick Plain (HKA). Following the site inspection, preliminary site investigations (sediment samples, a shallow test pit and dynamic cone penetrometers (DCPs)) were carried out by and Ben and Rick.

The site inspection involved observation of matters that included effectiveness of existing foreshore stabilisation methods, influence of trees on stability/instability, riparian vegetation as an indicator of possible recent instability/slumping, proximity and influence of storm water outlets, contribution of traffic to bank conditions, wave exposure, and typical tidal level fluctuations. The implementation of various conceptual options was discussed at the site inspection.

2.1 Site Description

Elfin Hill Road Reserve is situated on the eastern foreshore of Brisbane Water at Green Point. The Study Area extends around 125 m along the alignment of the foreshore from Elfin Hill Road in the south to the rock platform behind 313 Avoca Drive in the north (refer **Figure 1**). The reserve is between 15 to 25 m wide, grassed and relatively flat with levels ranging from 0.8 to 2.0 m AHD. The reserve exhibits varying levels of active shoreline erosion and there are a number of ad-hoc sea walls present with varying degrees of structural integrity.
The Study Area has been divided into Areas A and B, which are described below.

Area A is presented in **Figure 2** and comprises of the following:

- Brick and concrete rubble of various size;
- Aluminium ramps used as a private launching ramp and 2 wooden planks thought to be used as a dinghy skid by another resident;
- Remains of a vertical 'piled' timber seawall, discontinuous, eroded behind piles and in a state of disrepair;
- Casurinas exposed at seaward base;
- Open eroded foreshore, around a 0.5 m scarp;
- Several local pvc drainage lines exposed;
- One reinforced concrete storm water outlet terminated at a headwall approximately 5m landward of MSL. Concrete channel and gabion to prevent erosion of the shoreline. Gabion is damaged with contents scattered along foreshore and signs of erosion in drainage channel;
- 150 to 250 mm angular sandstone blocks;
- Mangroves established in sediments on the rock shelf south of the site, one mangrove approximately 3 m tall was uprooted.

Inventory of shoreline blocks and rock suggests approximately 50 sandstone blocks varying in size between 150 mm and 250 mm in this area may be suitable for reuse in the foreshore stabilisation works.

Area B is presented in **Figure 3** and comprises of the following:

- A sandstone block seawall comprising of approximately 200 mm to 300 mm square sandstone blocks mortared together on places, in reasonable condition. Signs of settlement and possible washout behind the wall;
- Access steps to the water constructed using bricks and concrete;
- Casurinas exposed at seaward base and two 100mm stumps indicating removal of casurinas;
- Remains of a log seawall, in poor condition;
- Open eroded foreshore, around a 0.5m scarp;
- Scalloped area on cleared shoreline thought to extend over rising main. Rising main not visible;
- Several local drainage lines exposed, two drainage lines have headwalls;
- Approximately 4 square meters of 20 to 50 mm gravel in front of one drainage outlet;
- 2 large 1.5 m diameter boulders;
- 2 large partly burnt stumps, dilapidated dinghy near the stumps;
- 200 to 300 mm angular sandstone blocks;
- Seaweed and debris deposits at the northern end of the site up to 300 mm deep;
- One dinghy stored on the grass at the northern end of the site;
- Mangroves established on rock shelf north of the site.

Inventory of shoreline blocks and rock suggests approximately 130 square sandstone blocks varying in size between 200 mm and 300 mm, approximately 80 angular sandstone blocks varying in size between 200 mm and 300 mm and 2 large 1.5 m diameter boulders may be suitable for reuse in the foreshore stabilisation works. Other material such as logs may be suitable for developing ecosystems.

AREA A

Casurinas exposed at based behind sandstone and concrete wall

Pipe terminated behind seawall and dilapidated gabion in foreground

Aluminium ramps, vertical logs wall and brick and concrete rubble

Casurinas exposed at base. Rockshelf at southern end of site visible in the right of the photograph

Pipe terminated behind seawall and dilapidated gabion

Brick and concrete rubble along foreshore

N

NOT TO SCALE

SAVED: 8A0467_FIG2

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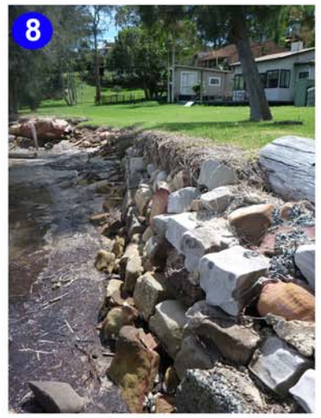
AREA B

Seaweed and debris up to 300mm thick

Stumps



Mortared sandstone blockwork wall

Local access steps at high tide

Casurinas exposed at base

Scalloped area with 0.5m scarp. Rising main thought to lie underneath scalloped area

Large boulders and log wall to the left of the photograph. Log removed from wall visible behind boulder

N

NOT TO SCALE

SAVED: 8A0467_FIG3

Royal HaskoningDHV
Enhancing Society Together

2.2 Preliminary Site Investigation

Four DCPs were carried out along the foreshore to provide input into foundation conditions for various foreshore treatments. The DCPs were carried out to depths between 0.8 m and 2.6 m below the surface and generally indicated looser or softer material for the upper 0.7 m to 0.9 m with denser or stiffer material below. Bedrock was noted as foreshore rock shelves adjacent to the north and south of the site. Inferred depth to bedrock across the site varied between 0.7 m and 2.6 m. The DCPs results and a location plan are provided in **Appendix A**.

Four sediment samples were also collected and analysed for particle size distribution (PSD). The sediment sample results indicated that the middle and southern end of the site comprises medium grained sand with silt and traces of gravel. The samples have less than 10% fines (silt and clay sized sediments) and less than 8% gravel. The northern end of the site comprises silty sand with gravel and the sample has 22% fines and 23% gravel. The PSD results are provided in **Appendix A**.

The grass reserve appears to be reclaimed land that was once likely to have been an extension of the existing intertidal foreshore. A shallow test pit was excavated in an area where subsidence and washout was thought to be occurring (around 3 metres from the foreshore). The test pit revealed good quality topsoil and grass with a thick well established root system. **Photograph 1** shows the test pit behind the existing sandstone block wall.

Photograph 1 – Shallow Test Pit behind the existing sandstone wall

It is understood investigation of acid sulphate soils (ASS) would be carried out at a later date as part of the environmental assessment.

2.3 Survey and Services

A detailed survey of the site was undertaken by Stephen Thorne and Associates on the 22nd of October 2014. The survey included site levels and the locations of visible services, trees and structures. A Dial Before You Dig request was submitted to assist in locating services. A council sewer main and a rising main were noted to run parallel to the foreshore through the reserve. Both mains lead to a pumping station at the southern end of the site with markers indicating their location.

The survey plan detailing these features is provided in **Appendix B**. Note that AHD refers to Australian Height Datum. Zero metres AHD approximates Mean Sea Level at present.

APPENDIX A
Site Investigations (DCPs and PSDs)

Geotechnical Explanatory Notes

Introduction

These notes have been produced to supplement the geotechnical aspects of the report and appendices. In particular, the notes provide specific details relating to geotechnical logging and interpretation of borehole logs, test pit logs and in situ tests presented as part of the appendices.

Geotechnical fieldwork, interpretation and reporting has been carried out by a suitably qualified engineer or scientist. The reliability of the geotechnical information provided in the logs and penetration tests will depend to some extent on the frequency and method of excavation and penetration testing. Large variation may occur in the subsurface geological conditions and records from excavations or penetration tests may vary significantly from other locations across the site.

Description and Classification Methods

The methods of description and classification of soils and rocks in this report is based on *Australian Standard AS1726: Geotechnical Site Investigation*. Field descriptions and classifications are based on visual and tactile assessment. Where appropriate, laboratory data and penetration testing have been used to verify field descriptions and classifications.

Penetration Testing

Penetration testing is used to determine soil consistency or density. Commonly implemented penetration tests include:

DCP – Dynamic Cone Penetrometer tests are carried out by driving a 16mm rod into the ground using a 9kg hammer and recording the number of blows per 100mm. Two similar tests are commonly used: the cone penetrometer utilises a 20mm diameter cone end driven into the ground with the hammer dropping from a height of 510mm (AS1289, Test F3.2), while the Perth Sand Penetrometer utilises a 16mm flat end driven into the ground with the hammer dropping from a height of 600mm (AS1289, Test F3.3).

SPT – Standard Penetration Tests are carried out by driving a 50mm diameter split sample tube 450mm into the ground using a 63kg weight falling from a height of 760mm (AS1289, Test F3.1). These tests are normally carried out in boreholes. Blows per 150mm are recorded and the 'N' value is taken as the number of blows for the last 300mm.

Sampling

Sampling is carried out during drilling or test pitting to allow for visual and tactile assessment and to allow for laboratory testing (if required). Sampling methods include:

- U_{50} - Undisturbed Sample Tube (50mm)
- B – Bulk Sample (>10kg sample size)
- D – Disturbed Sample
- W – Water Sample
- SPT – SPT Sample
- S – Surface Sample
- PID – Photoionisation detector reading in ppm

Laboratory Testing

Laboratory Testing is carried out by a NATA accredited laboratory in accordance with *Australian Standard 1289 – Methods of Testing Soil for Engineering Purposes*.

Groundwater

There are several problems associated with measuring the water level in boreholes. Perched water tables above impermeable layers may lead to an erroneous indication of the true water level in underlying strata. Also, water levels may fluctuate with changing climatic conditions, some drilling methods do not enable the presence of groundwater to be detected and in low permeability soils where groundwater flow is slow, water may not enter the hole in the time it is left open. Despite the problems, the level of groundwater is often important for design and the following symbols may be used to indicate the presence of groundwater on site.

- - Standing water level
- GNO - Groundwater Not Observed
- GNE - Groundwater Not Encountered
- - Groundwater inflow/seepage
- - Groundwater outflow/loss

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Graphic Symbols for Soil

Man Made Material


Asphalt


Concrete


Fill

Soil


Topsoil


Well Graded Gravel


Poorly Graded Gravel


Silty Gravel

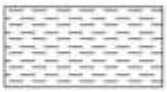

Clayey Gravel

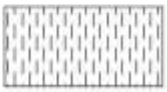

Well Graded Sand


Poorly Graded Sand

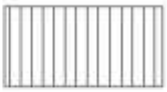

Silty Sand


Clayey Sand


Low Plasticity Silt


High Plasticity Silt


Low Plasticity Clay


High Plasticity Clay


Organic Silt


Organic Clay


Peat


Cobbles


Boulders

Soil Classification

Particle size and descriptive terms

Name	Subdivision	Size
Boulders	N/A	>200mm
Cobbles	N/A	63 mm to 200 mm
Gravel	Coarse Medium Fine	20 mm to 63 mm 6 mm to 20 mm 2.36 mm to 6 mm
Sand	Coarse Medium Fine	0.6 mm to 2.36 mm 0.2 mm to 0.6 mm 0.075 mm to 0.2 mm

Soil classification is conducted on material nominally finer than 63mm. The proportion of boulders and cobbles is recorded along with the packing characteristics as follows:

- Clast supported - clasts touching, with or without the presence of a soil matrix, and
- Matrix supported - clasts supported in a soil matrix.

Minor Component

The primary soil name is modified to include minor components as follows:

Modifier	Percentage of minor component
Omit, or use 'trace'	Fine soil in primarily coarse material: ≤5% Coarse soil in primarily fines material: ≤15%
Describe as 'with clay/silt/sand/ gravel' as applicable	Fine soil in primarily coarse material: 5-12% Coarse soil in primarily fines material: 15-30%
Prefix soil as 'silty/clayey/sandy/ gravelly'' as applicable	Fine soil in primarily coarse material: >12% Coarse soil in primarily fines material: >30%

Moisture Condition

Condition	Symbol	Guide
Dry	D	Cohesive soils are hard and friable or powdery. Granular soils are cohesionless and free running.
Moist	M	Soil feels cool and darkened in places. Cohesive soils can be remoulded. Granular soils tend to cohere.
Wet	W	Soil feels cool, darkened in colour. Free water forms on hands when handled. Cohesive soils are weakened. Granular soils tend to cohere.

Cohesive Soils

Cohesive refers to soil behaviour. Cohesive soils are classified based on strength (consistency).

Consistency

Term	Symbol	Field Guide to Consistency	Undrained Shear Strength, S_u (kPa)
Very Soft	VS	Extrudes between fingers when squeezed in hand.	<12
Soft	S	Can be remoulded by light finger pressure. Easily penetrated by thumb 30-40mm.	12-25
Firm	F	Can be remoulded by strong finger pressure. Penetrated by thumb 20-30mm with moderate effort.	25-50
Stiff	St	Cannot be remoulded by fingers. Can be indented by thumb.	50-100
Very Stiff	VSt	Can be intended by thumb nail.	100-200
Hard	H	Difficult to indent with thumb nail.	>200

Cohesionless Soil

Cohesionless refers to soil behaviour. Cohesionless soils are classified based of relative density.

Density

Term	Symbol	Field Guide to Consistency	Density Index %
Very Loose	VL	Very easily shovelled, almost no resistance.	≤15
Loose	L	Low resistance to shovelling.	15-35
Medium Dense	MD	Considerable resistance to shovelling.	35-65
Dense	D	Requires handpick for excavation.	65-85
Very Dense	VD	Requires power tool for excavation.	>85

Origin

Residual Soil	Weathered in-situ
Aeolian Soil	Deposited by wind
Alluvial Soil	Deposited by streams and rivers
Colluvial Soil	Deposited on slopes
Lacustrine Soil	Deposited by lakes
Marine Soil	Deposited in ocean basins, bays, beaches and estuaries
Fill	Man-made. May be significantly more variable between tested locations than naturally occurring soils.

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Guide to the Description Identification and Classification of Soil (AS 1726)

FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 60mm and basing fractions on estimated mass)						GROUP SYMBOLS	PRIMARY NAME
COARSE GRAINED SOILS (more than half of material less than 63mm is larger than 0.075 mm)	GRAVELS More than half of the coarse fraction is larger than 2.36mm	CLEAN GRAVELS (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength.			GW	GRAVEL
			Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength.			GP	GRAVEL
		GRAVELS WITH FINES (Appreciable amount of fines)	Excess of non-plastic fines, zero to medium dry strength.			GM	SILTY GRAVEL
			Excess of plastic fines, medium to high dry strength.			GC	CLAYEY GRAVEL
	SANDS More than half of the coarse fraction is smaller than 2.36mm	CLEAN SANDS (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength.			SW	SAND
			Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength.			SP	SAND
		SANDS WITH FINES (Appreciable amount of fines)	Excess of non-plastic fines, zero to medium dry strength.			SM	SILTY SAND
			Excess of plastic fines, medium to high dry strength.			SC	CLAYEY SAND
		DRY STRENGTH	**DILATANCY**	**TOUGHNESS**			
FINE GRAINED SOILS (more than half of material less than 63mm is smaller than 0.075 mm)	SILTS AND CLAYS Liquid limit less than 50	None to Low	Quick to slow	None		ML	SILT
		Medium to High	None	Medium		CL	CLAY
		Low to Medium	Slow to very slow	Low		OL	ORGANIC SILT
	SILTS AND CLAYS Liquid limit greater than 50	Low to Medium	Slow to very slow	Low to Medium		MH	SILT
		High	None	High		CH	CLAY
		Medium to High	None	Low to Medium		OH	ORGANIC CLAY
HIGHLY ORGANIC SOILS		Identified by colour, odour, spongy feel and generally by fibrosous texture.				Pt	Peat

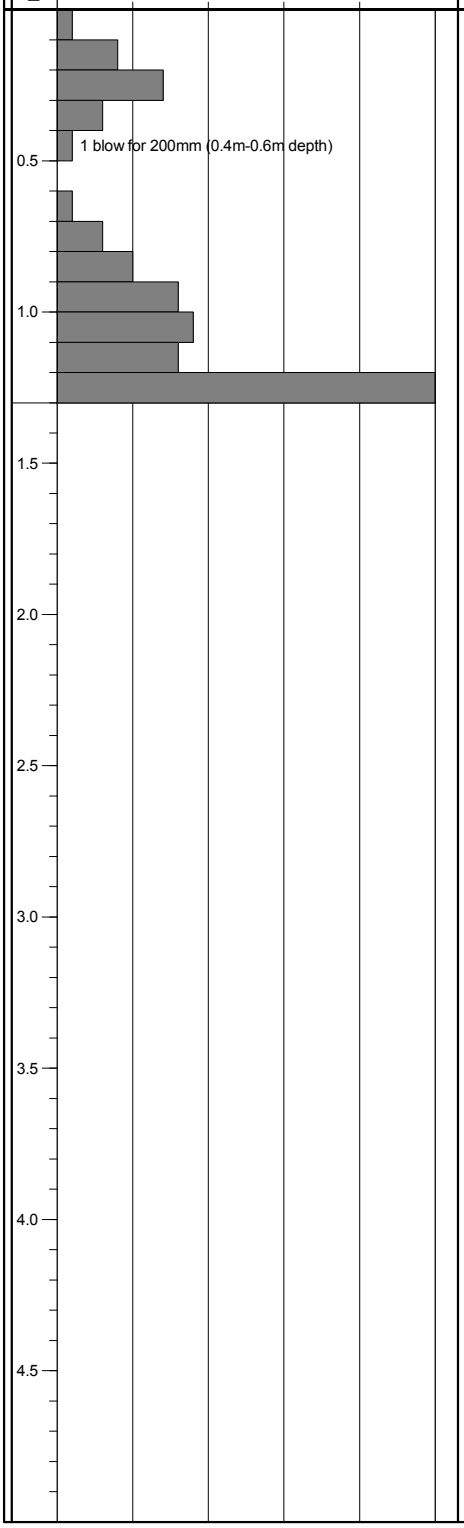
Figure 1 - DCP and Surface Sample Location Plan

DYNAMIC CONE PENETROMETER LOG

PROJECT : Elfin Hill Road Reserve
CLIENT : Gosford City Council
FILE / JOB NO : 8A0467
METHODOLOGY : AS1289.6.3.2

TEST: BH1

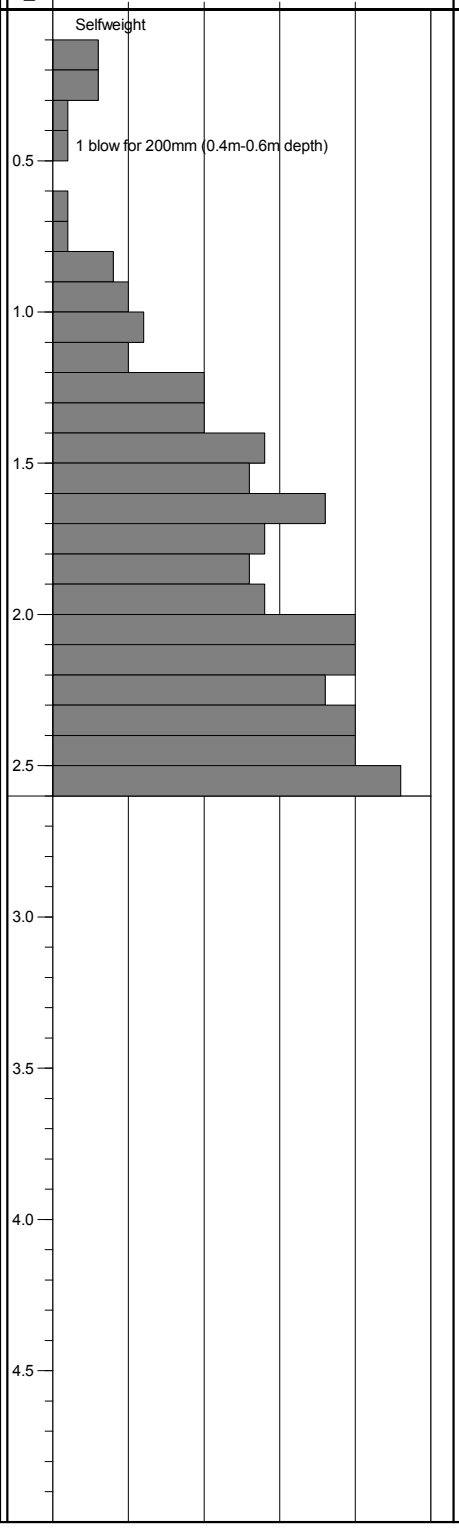
LOGGED : BM / RP 28/10/2014
CHECKED : SJB 3/11/2014
LATITUDE : Refer to plan
LONGITUDE : Refer to plan
SURFACE ELEVATION : Refer to plan



Comments
Refusal Reached (25 blows over one interval).

TEST: BH2

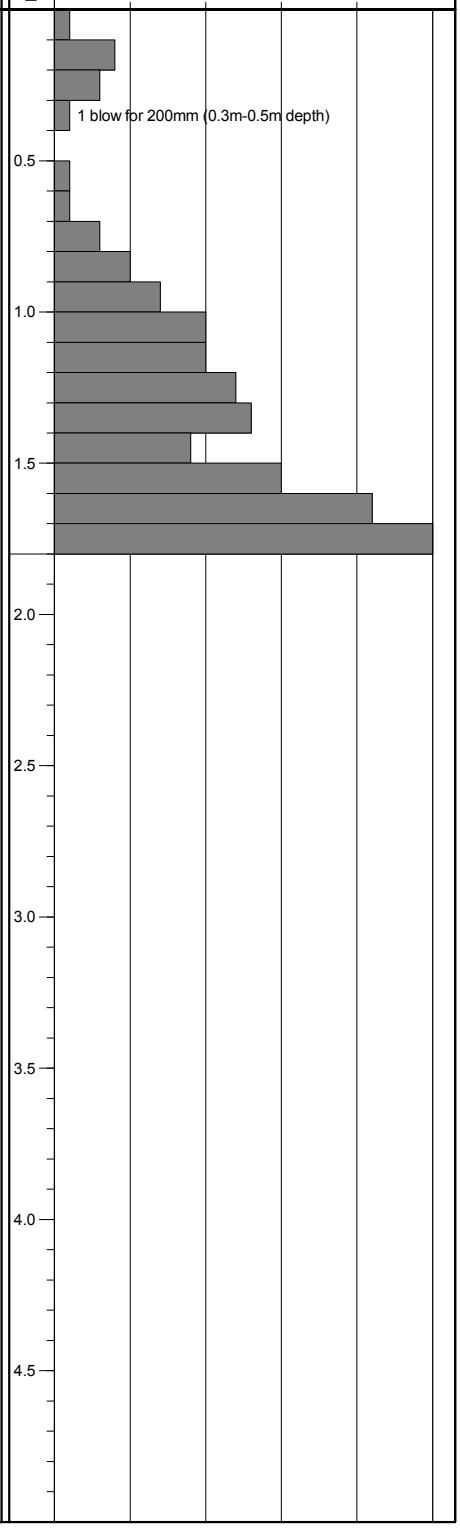
LOGGED : BM / RP 28/10/2014
CHECKED : SJB 3/11/2014
LATITUDE : Refer to plan
LONGITUDE : Refer to plan
SURFACE ELEVATION : Refer to plan



Comments
Target Depth Reached.

TEST: BH3

LOGGED : BM / RP 28/10/2014
CHECKED : SJB 3/11/2014
LATITUDE : Refer to plan
LONGITUDE : Refer to plan
SURFACE ELEVATION : Refer to plan



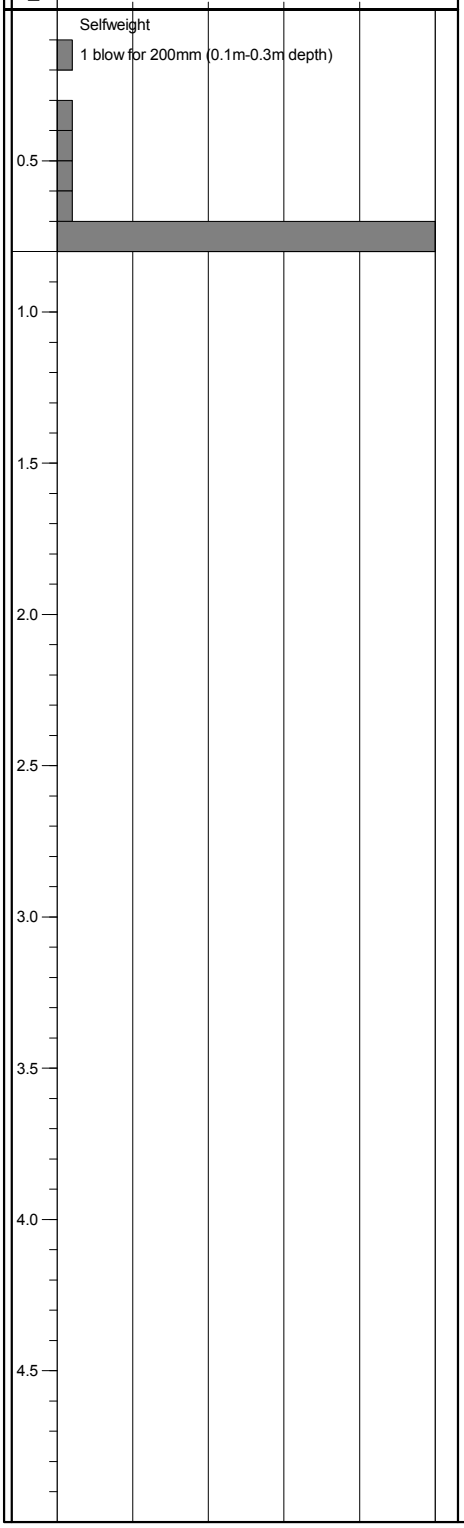
Comments
Refusal Reached (25 blows over one interval).

DYNAMIC CONE PENETROMETER LOG

PROJECT : Elfin Hill Road Reserve
CLIENT : Gosford City Council
FILE / JOB NO : 8A0467
METHODOLOGY : AS1289.6.3.2

TEST: BH4

LOGGED : BM / RP 28/10/2014
CHECKED : SJB 3/11/2014
LATITUDE : Refer to plan
LONGITUDE : Refer to plan
SURFACE ELEVATION : Refer to plan



Comments
Refusal Reached (25 blows over one interval).

Certificate of Analysis

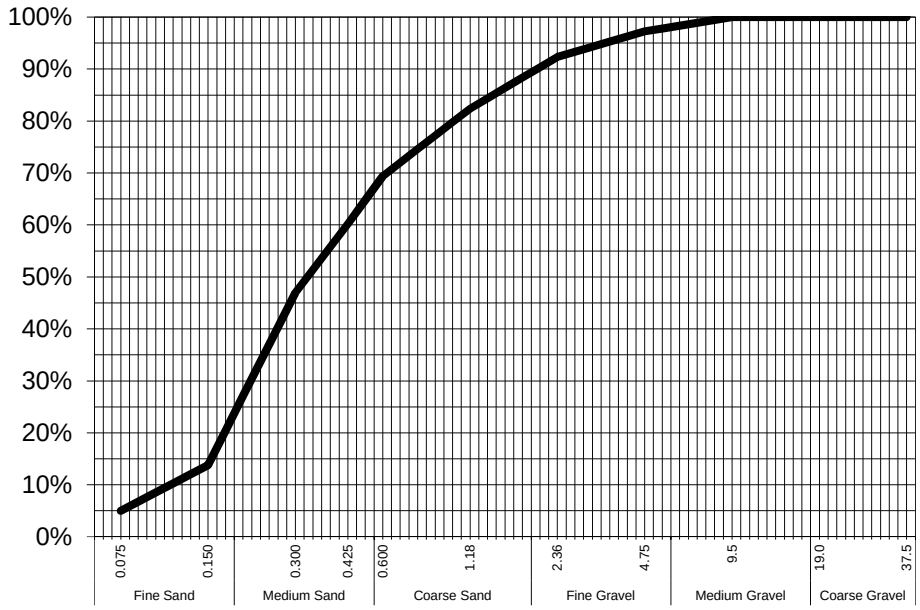
ALS Laboratory Group Pty Ltd
5/585 Maitland Road
Mayfield West, NSW 2304
pH 02 4014 2500
fax 02 4968 0349
samples.newcastle@alsenviro.com

ALS Environmental

Newcastle, NSW

CLIENT:	Ben Morgan	**DATE REPORTED:**	7-Nov-2014
COMPANY:	Haskoning Australia- Royal Haskoning	**DATE RECEIVED:**	29-Oct-2014
ADDRESS:	Suite 505 100 Walker Street North Sydney, 2060	**REPORT NO:**	ES1423739-001 / PSD
PROJECT:	Elfin Hill Road Reserve	**SAMPLE ID:**	DCP 1

Particle Size Distribution



Particle Size (mm)	Percent Passing
19.0	100%
9.5	100%
4.75	97%
2.36	92%
1.18	82%
0.600	69%
0.425	60%
0.300	47%
0.150	14%
0.075	5%

Samples analysed as received.

Median Particle Size (mm)*	0.328

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Analysed: 3-Nov-14

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description: Sand

Test Method: AS1289.3.6.1

NATA Accreditation: 825 Site: Newcastle
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Hamish Murray
Laboratory Supervisor, Newcastle
Authorised Signatory

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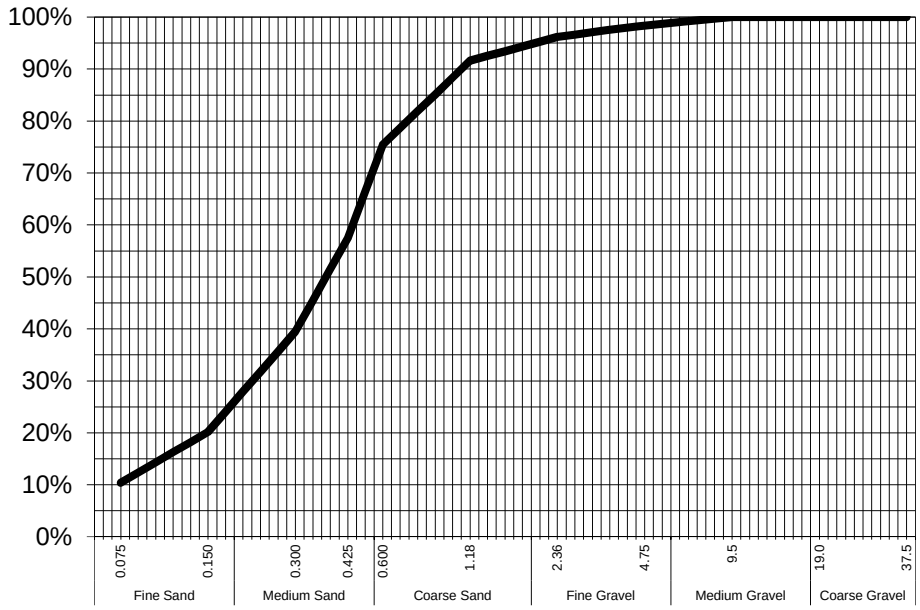
ALS Environmental

Newcastle, NSW

CLIENT:	Ben Morgan	**DATE REPORTED:**	7-Nov-2014
COMPANY:	Haskoning Australia- Royal Haskoning	**DATE RECEIVED:**	29-Oct-2014
ADDRESS:	Suite 505 100 Walker Street North Sydney, 2060	**REPORT NO:**	ES1423739-002 / PSD
PROJECT:	Elfin Hill Road Reserve	**SAMPLE ID:**	DCP 2

Particle Size Distribution



Particle Size (mm)	Percent Passing
19.0	100%
9.5	100%
4.75	98%
2.36	96%
1.18	92%
0.600	75%
0.425	58%
0.300	40%
0.150	20%
0.075	10%

Samples analysed as received.

Median Particle Size (mm)*	0.373

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Analysed: 3-Nov-14

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description: Sand and fines

Test Method: AS1289.3.6.1

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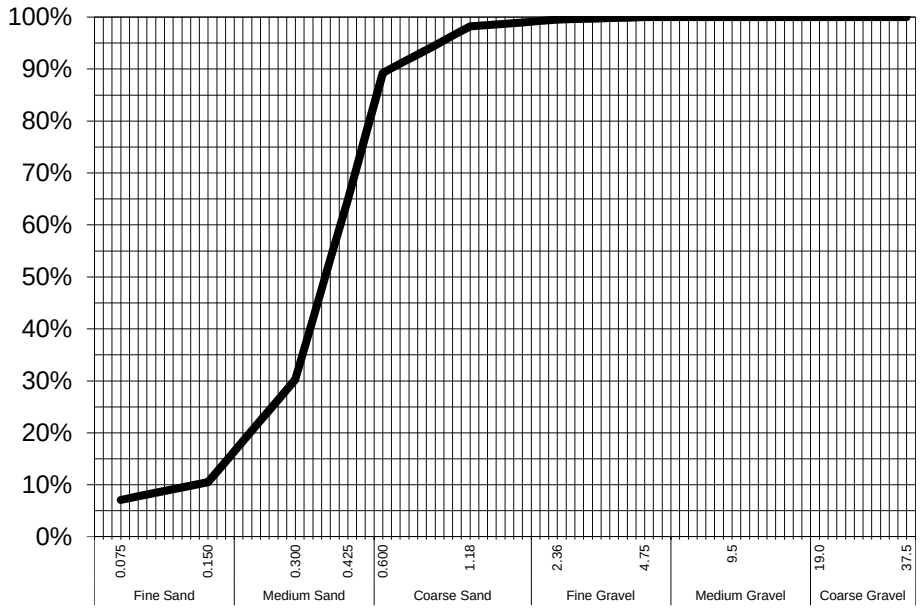
CLIENT:	Ben Morgan	**DATE REPORTED:**	7-Nov-2014
COMPANY:	Haskoning Australia- Royal Haskoning	**DATE RECEIVED:**	29-Oct-2014
ADDRESS:	Suite 505 100 Walker Street North Sydney, 2060	**REPORT NO:**	ES1423739-003 / PSD
PROJECT:	Elfin Hill Road Reserve	**SAMPLE ID:**	DCP 3

Particle Size Distribution



Particle Size (mm)	Percent Passing
19.0	100%
9.5	100%
4.75	100%
2.36	100%
1.18	98%
0.600	89%
0.425	65%
0.300	30%
0.150	11%
0.075	7%

Samples analysed as received.

Median Particle Size (mm)*	0.371

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Analysed: 3-Nov-14

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description: Sand

Test Method: AS1289.3.6.1

NATA Accreditation: 825 Site: Newcastle
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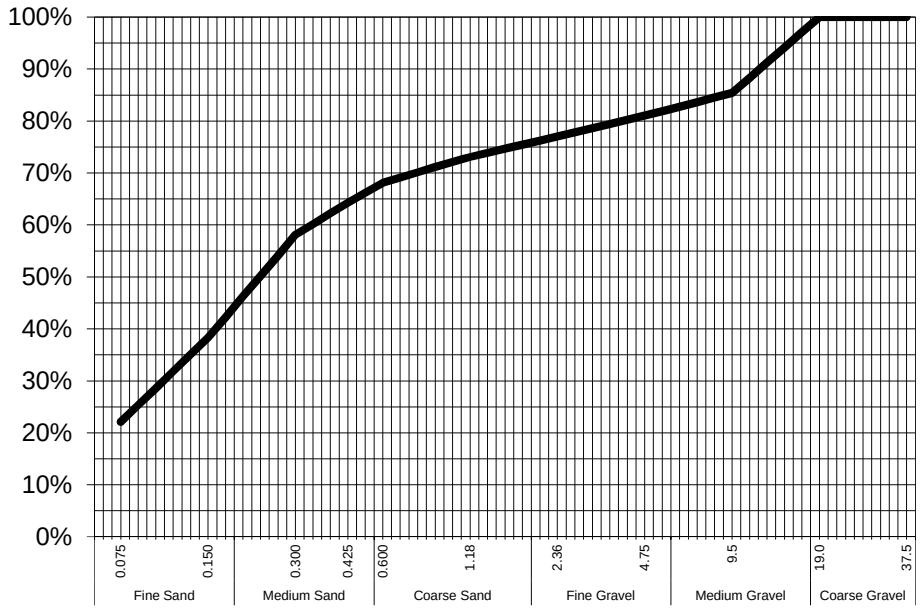
ALS Environmental

Newcastle, NSW

CLIENT:	Ben Morgan	**DATE REPORTED:**	7-Nov-2014
COMPANY:	Haskoning Australia- Royal Haskoning	**DATE RECEIVED:**	29-Oct-2014
ADDRESS:	Suite 505 100 Walker Street North Sydney, 2060	**REPORT NO:**	ES1423739-004 / PSD
PROJECT:	Elfin Hill Road Reserve	**SAMPLE ID:**	DCP 4

Particle Size Distribution



Particle Size (mm)	Percent Passing
19.0	100%
9.5	85%
4.75	81%
2.36	77%
1.18	73%
0.600	68%
0.425	64%
0.300	58%
0.150	38%
0.075	22%

Samples analysed as received.

Median Particle Size (mm)*	0.239

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Analysed: 3-Nov-14

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description: Sand, gravel, shell and fines

Test Method: AS1289.3.6.1

NATA Accreditation: 825 Site: Newcastle
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Laboratory Supervisor, Newcastle
Authorised Signatory

APPENDIX D
Cost Estimate

APPENDIX C

Acid Sulfate Soils Management Plan

REPORT

Acid Sulfate Soil Management Plan

Elfin Hill Road Reserve

Client:	Central Coast Council (Previously Gosford City Council)
Reference:	M&APA1635R001F0.1
Revision:	0.1/Final
Date:	20 February 2018

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Document title:	Acid Sulfate Soil Management Plan
Document short title:	Elfin Hill Rd ASSMP
Reference:	M&APA1635R001F0.1
Revision:	0.1/Final
Date:	20 February 2018
Project name:	Elfin Hill Road Foreshore Stabilisation
Project number:	PA1635
Author(s):	Ali Watters
Drafted by:	Caleb Dykman
Checked by:	Ali Watters
Date / initials:	20.02.18
Approved by:	Gary Blumberg
Date / initials:	20.02.18

Classification
Project related

Royal HaskoningDHV

Table of Contents

Table of Tables

Table of Figures

Appendices

1 Introduction

1.1 Overview

Central Coast Council ('Council'), previously Gosford City Council, has engaged Haskoning Australia ('HKA') to carry out concept designs for foreshore stabilisation along Elfin Hill Road Reserve (the 'Site'). Elfin Hill Road Reserve is situated on the eastern foreshore of Brisbane Water at Green Point (Refer **Figure 1**). The reserve is utilised for passive recreation and dinghy launching, primarily by local residents. The Study Area extends from Elfin Hill Road in the south to the rock platform behind 313 Avoca Drive in the north (refer **Figure 2**). The reserve exhibits varying levels of active shoreline erosion and there is a number of ad-hoc seawalls present with varying degrees of structural integrity. Council intends to carry out foreshore stabilisation works along this section of the reserve.

This project is being commissioned in line with the *Coastal Zone Management Plan for Brisbane Water* which has the following overarching aims:

- Protect, rehabilitate and improve the natural estuarine environment;
- Manage the estuarine environment in the public interest to ensure its health and vitality;
- Improve the recreational amenity of estuarine waters and foreshores;
- Recognise and accommodate natural processes and climate change; and,
- Ensure ecologically sustainable development and use of resources

This report details herein an assessment of Acid Sulfate Soils (ASS) at the Site and subsequently outlines a suitable Acid Sulfate Soils Management Plan (ASSMP) to be implemented in conjunction with the proposed foreshore stabilisation works.

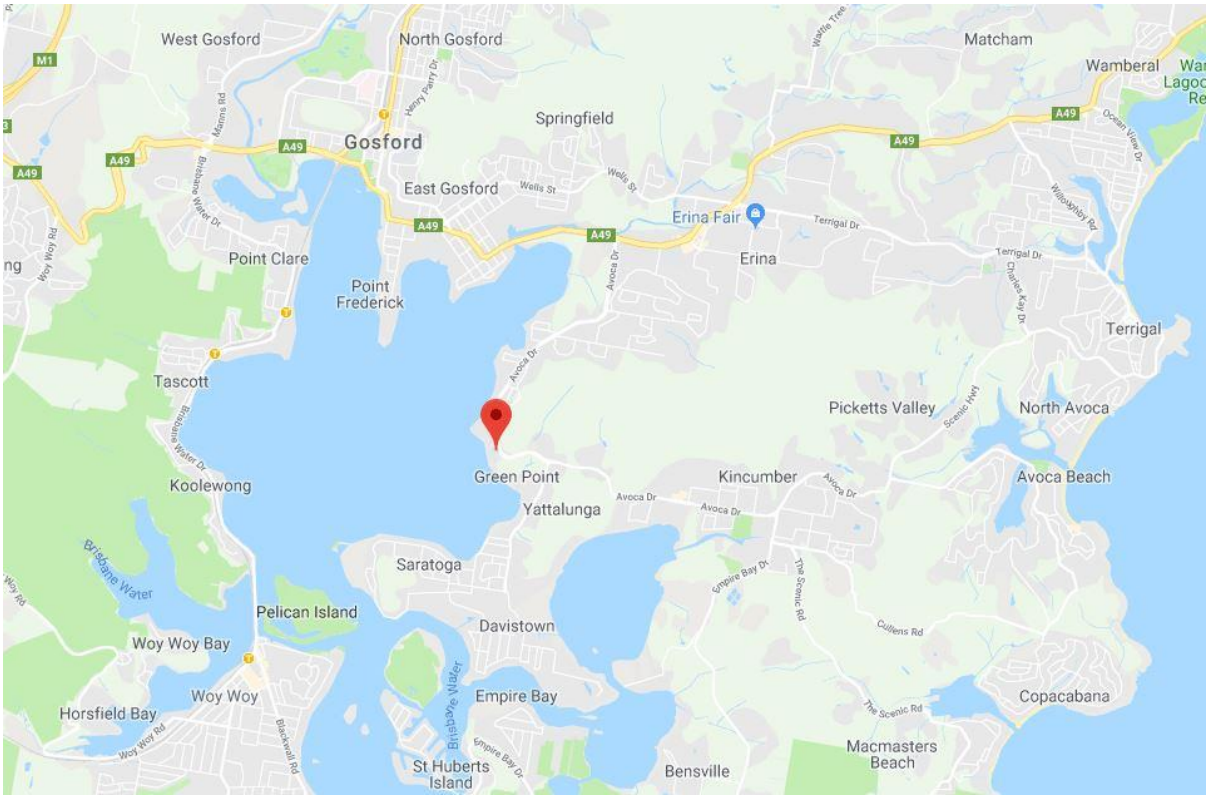

Figure 1: Elfin Hill Road Location; Site Demarked by Red Pin (Source: Google Maps 2017)

1.2 Background

The Study Area of Elfin Hill Road Reserve extends around 125m along the alignment of the foreshore from Elfin Hill Road in the south to the rock platform behind 313 Avoca Drive in the north. The reserve is between 15 to 25 m wide, grassed and relatively flat with levels ranging from 0.8m to 2.0m AHD. The Study Area has been divided into Areas A and B, which are described in further detail below.

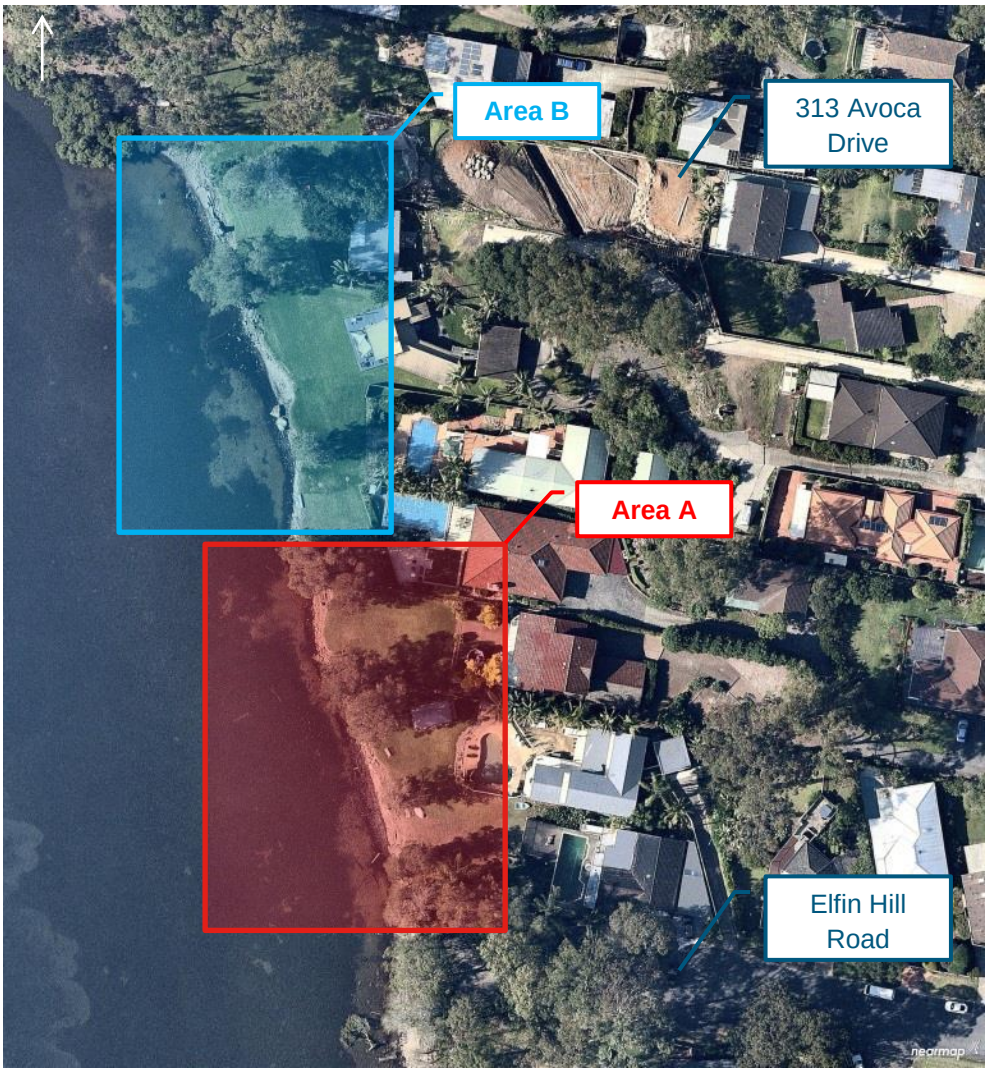

Figure 2: Site Delineation (Source: Nearmap, 2017)

Area A (Refer **Figure 2**) comprises of the following:

- Brick and concrete rubble of various size;
- Aluminium ramps used as a private launching ramp and 2 wooden planks thought to be used as a dinghy skid by another resident;
- Remains of a vertical 'piled' timber seawall, discontinuous, eroded behind piles and in a state of disrepair;
- Casurinas exposed at seaward base;
- Open eroded foreshore, around a 0.5 m scarp;
- Several local PVC drainage lines exposed;

- One reinforced concrete storm water outlet terminated at a headwall approximately 5m landward of Mean Sea Level. Concrete channel and gabion to prevent erosion of the shoreline. Gabion is damaged with contents scattered along foreshore and signs of erosion in drainage channel;
- 150 to 250 mm angular sandstone blocks;
- Mangroves established in sediments on the rock shelf south of the site, one mangrove approximately 3 m tall was uprooted.

Inventory of shoreline blocks and rock suggests approximately 50 sandstone blocks varying in size between 150mm and 250mm in this area may be suitable for reuse in the foreshore stabilisation works.

Area B (Refer **Figure 2**) comprises of the following:

- A sandstone block seawall comprising of approximately 200mm to 300mm square sandstone blocks mortared together in places, in reasonable condition. Signs of settlement and possible washout behind the wall;
- Access steps to the water constructed using bricks and concrete;
- Casuarinas exposed at seaward base and two 100mm stumps indicating removal of casuarinas;
- Remains of a log seawall, in poor condition;
- Open eroded foreshore, around a 0.5m scarp;
- Scalloped area on cleared shoreline thought to extend over rising main. Rising main not visible;
- Several local drainage lines exposed, two drainage lines have headwalls;
- Approximately 4 square meters of 20 to 50 mm gravel in front of one drainage outlet;
- large 1.5 m diameter boulders;
- large partly burnt stumps, dilapidated dinghy near the stumps;
- 200 to 300 mm angular sandstone blocks;
- Seaweed and debris deposits at the northern end of the site up to 300 mm deep;
- One dinghy stored on the grass at the northern end of the site;
- Mangroves established on rock shelf north of the site.

Inventory of shoreline blocks and rock suggests approximately 130 square sandstone blocks varying in size between 200 mm and 300 mm, approximately 80 angular sandstone blocks varying in size between 200 mm and 300 mm and 2 large 1.5 m diameter boulders may be suitable for reuse in the foreshore stabilisation works. Other material such as logs may be suitable for developing ecosystems.

The current design for foreshore stabilisation works includes several aspects, incorporating:

- Rock Treatment (two layers of sandstone rock protection);
- Saltmarsh Berm (2m wide saltmarsh berm built out from existing foreshore alignment); and
- A Dinghy Skid (concrete slab poured over rock fill with sandstone block toe and treated hard slats)

A complete overview of the design is presented in **Appendix A.**

Based on the above design the project will require cut and fill activities to achieve the design levels. Excavations are estimated to be relatively shallow at approximately 1-2m, however, given the sites location, the likelihood of disturbing ASS is relatively high.

2 Definition of Acid Sulfate Soils

Acid Sulfate Soil is the common name given to sediment and soil containing iron sulfide. The exposure of iron sulfides to air will result in oxidation and the generation of sulfuric acid. Acid leachate can strip metals such as aluminium and iron from the soil matrix and release them into water bodies. Toxic concentrations of these metals will affect water quality and adversely affect aquatic organisms (disease or death) that inhabit the water body.

Acid sulfate soils were formed during the last sea level rise and required the presence of:

- iron rich fluvial sediments;
- sulfate from seawater;
- sulfate reducing bacteria; and,
- a plentiful supply of organic matter.

These soils exist and are extensively developed around the Australian coastline (low lying parts of coastal floodplains, rivers and creeks).

When saturated mud, gravel or sand containing iron sulfides are disturbed by excavation, dredging or dewatering, and subsequently exposed to air, the generated acid leaches from the soil (Stone *et al.*, 1998). Acid leachate can cause severe environmental degradation and/or contamination. In discussing acid sulfate soils the following definitions are important (Stone *et al.*, 1998):

Acid Sulfate Soils include actual acid sulfate soils (AASS) and potential acid sulfate soils (PASS). Actual and potential acid sulfate soils are often found in the same soil profile, with actual acid sulfate soils generally overlying potential acid sulfate soil horizons.

Actual Acid Sulfate Soils (AASS) are soils containing highly acidic (pH ≤ 4) soil horizons or layers resulting from the aeration of soil materials that are rich in sulfides, primarily iron sulfide. This oxidation produces hydrogen ions in excess of the soils capacity to naturally neutralise the acid produced. These soils can usually be identified by the presence of pale yellow mottles and coatings of jarosite.

Potential Acid Sulfate Soils (PASS) are soils which contain iron sulfide material which have not yet been exposed to air and oxidised. However they pose a considerable environmental risk if disturbed, as they have the potential to become severely acidic when exposed to air and subsequently oxidised.

Exposure of acid sulfate soils to the atmosphere (lowering of the water table or disturbance through dredging/excavation) has the potential to produce acid generating conditions that may adversely affect the local environment.

3 Characteristics of the Site

3.1 Site description

3.1.1 Geology

The site is underlain by Triassic sedimentary rocks of the Narrabeen Group, Gosford Subgroup, Terrigal formation. This consists predominantly of interbedded laminite, shale and fine to coarse grained quartz to quartz-lithic sandstone with some minor red clay stone.

The site lies within the Erina Soil landscape characterised by undulating to rolling rises and low hills on the Terrigal Formation. Soils are moderately deep to deep Yellow Podzolic soils on fine grained bedrock in poorly drained areas, moderately deep to deep Yellow Podzolic soils and Yellow Earths on coarse-grained parent material, on footslopes and deep structured Loams, and Yellow Earths along drainage lines.

Limits to development of the above described landscape include: localised mass movement, high soil erosions hazard, localised foundation hazard, localised high run-on, seasonal waterlogging of footslopes and strongly acidic soils.

3.1.2 Surface Water

The site lies on the Brisbane Water foreshore where the dominant form of flooding, in terms of risk and damage, at the site is coastal flooding. The site is inundated in all flooding events from the 2 year ARI (Cardno, 2015).The flooding extents during the 100 year ARI are presented in **Figure 3**. During the 100 year ARI the foreshore area is inundated with flood depths of 0.3-0.4m at the north of the site and 0.1-0.2m at the south of the site (Cardno, 2015). Furthermore, the average flood duration for the site during the 100 year ARI event is expected to be approximately 5 hours (Cardno, 2015).

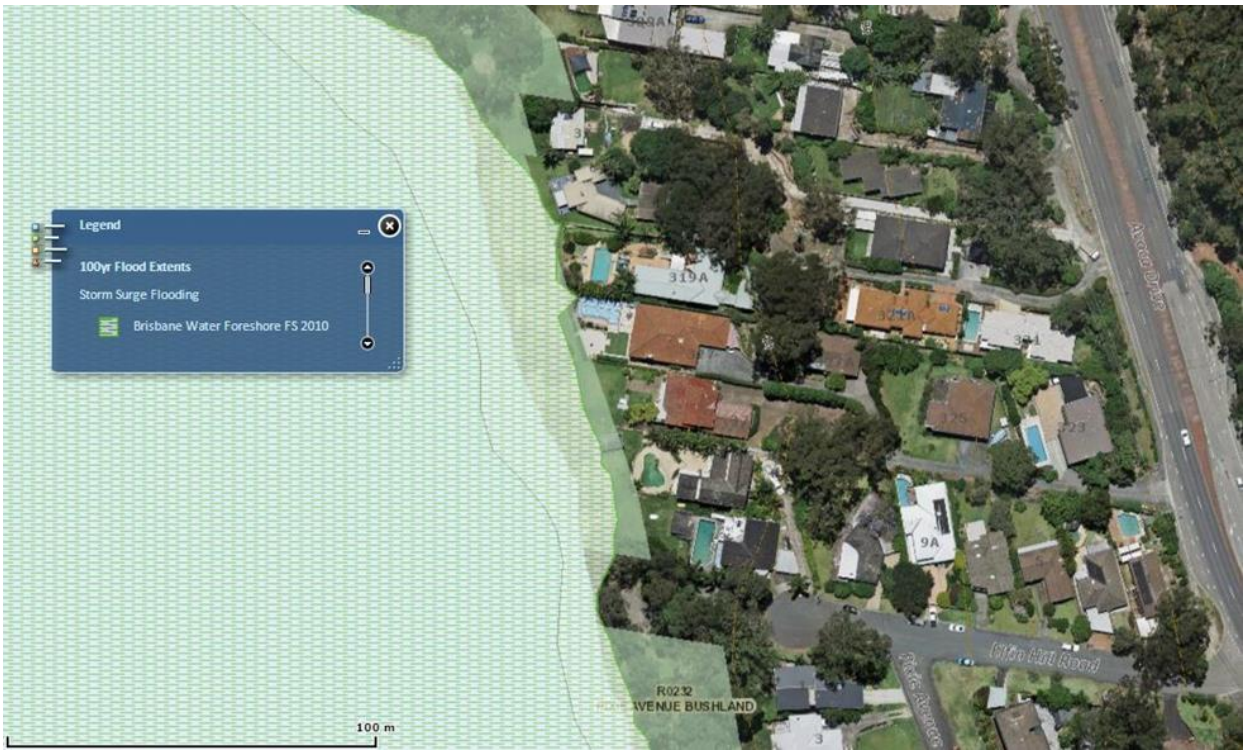

Figure 3: Flooding Extent at Elfin Hill Road Reserve During 100 Year ARI (Source: Cardno 2010)

Based on the predicted flood levels and the velocities, the site has been classed as a low hazard area, however is within close proximity to areas classed as high hazard.

A report by Cardno (2008) highlighted that poor water quality is an issue in some portions of the Brisbane Water estuary particularly with respect to nutrient and sediment inputs. This has the potential to lead to a range of environmental impacts, such as eutrophication, algal blooms and a decline in seagrasses, and may alter the community dynamics in a range of estuarine habitats. Similarly, poor water quality can impact on recreational usage in some parts the waterway. Available data suggests that water quality is currently of a standard generally suitable for recreational purposes.

3.1.3 Hydrogeology

Currently there are no monitoring bores located within the vicinity of the site. However, it can be assumed that the site overlies a coastal sands aquifer and specifically is contained within the Hawkesbury to Hunter Coastal Sands Groundwater Source (NSW DPI, 2016), bound between the Hunter River to the North and Hawkesbury River to the South. The aquifer typically consists of fine to medium grained quartz sands with interbedded clay layers (NSW DPI, 2016).

The coastal sand aquifer typically has a water table relatively close to the surface. Water quality is typically fresh due to direct rainfall infiltration through inert quartz sand (NSW DPI, 2016). However, water quality issues can arise from over extraction resulting in the ingress of salt water from adjoining estuarine bodies. Based on the current calculations of the Long Term Average Annual Extraction Limit (LTAAEL), the Hawkesbury to Hunter aquifer has been deemed High Risk. The High Risk category highlights that with the current LTAAEL there is the risk of exposing PASS, higher aquifer sea water intrusion and impacts on groundwater dependent ecosystems as a result of a lowered water table.

Groundwater works in the area are typically for domestic purposes that augment town water supplies.

3.2 Relevant Guidelines

Over the past 20 years, there has been a significant amount of research undertaken by scientists and agencies specialising in acid sulfate soils. This recent information has resulted in an improved understanding and appreciation of the issues in terms of field investigation procedures, analytical tests, management procedures, monitoring and contingency procedures.

The NSW Government established the Acid Sulfate Soils Management Advisory Committee (ASSMAC) in 1994 to coordinate a whole of government approach to managing the problems associated with acid sulfate soils. In 1998 the ASSMAC published the Acid Sulfate Soils Manual (ASSM) (Stone *et al.*, 1998). The manual was the first of its kind in Australia, providing a compendium of the latest technology and best practice including sections on assessment, management, drainage, strategic planning and laboratory analysis.

In 2004, the Acid Sulfate Soils Laboratory Methods Guidelines was published as part of a joint project between the Queensland Acid Sulfate Soils Investigation Team (QASSIT), Southern Cross University, the National Committee for Acid Sulfate Soils, Queensland Acid Sulfate Soils Management Advisory Committee (QASSMAC) and ASSMAC. These guidelines supersede the Acid Sulphate Soils Laboratory Methods Guidelines (Ahern *et al*., 1998) in the Acid Sulfate Soils Manual (Stone *et. al*., 1998).

The assessment of acid sulfate soils risk from the proposed excavation areas has been undertaken, where practicable, in accordance with the Acid Sulfate Soils Manual (Stone *et. al*., 1998) and the Acid Sulfate Soils Laboratory Methods Guidelines (Ahern *et al*., 2004).

3.3 DLWC Acid Sulfate Soil Maps

In 1995, the Department of Land and Water Conservation (DLWC) published Acid Sulfate Soils Risk Maps for NSW coastal areas. The first step in identifying the presence of ASS is to review the 1:25,000 Acid Sulfate Soils Risk Maps for NSW coastal areas published by the Department of Land and Water Conservation (DLWC) (now OEH) in 1997. The relevant map sheet for the proposed works is the Gosford map sheet 9131S2 (DLWC, 1997).

The risk maps identify three risk classes (high, low and zero) based on the probability of ASS being present along with landform information and the likely depth to acid sulfate material. It is important to note that the DLWC ASS Risk mapping does not describe the actual severity of ASS in a particular area, rather it provides a first indication that acid sulfate soils could be present (Stone et al, 1998).

A review of the ASS risk maps for Gosford (Refer **Figure 4**) prepared by DLWC (1997) indicates that the Elfin Hill Road Reserve lies in close proximity to an area of land to the south with a high probability of ASS at or near the ground surface. In addition, all the waterway adjacent to the site also has a high probability of ASS with a severe environmental risk if bottom sediments are disturbed by activities such as dredging.

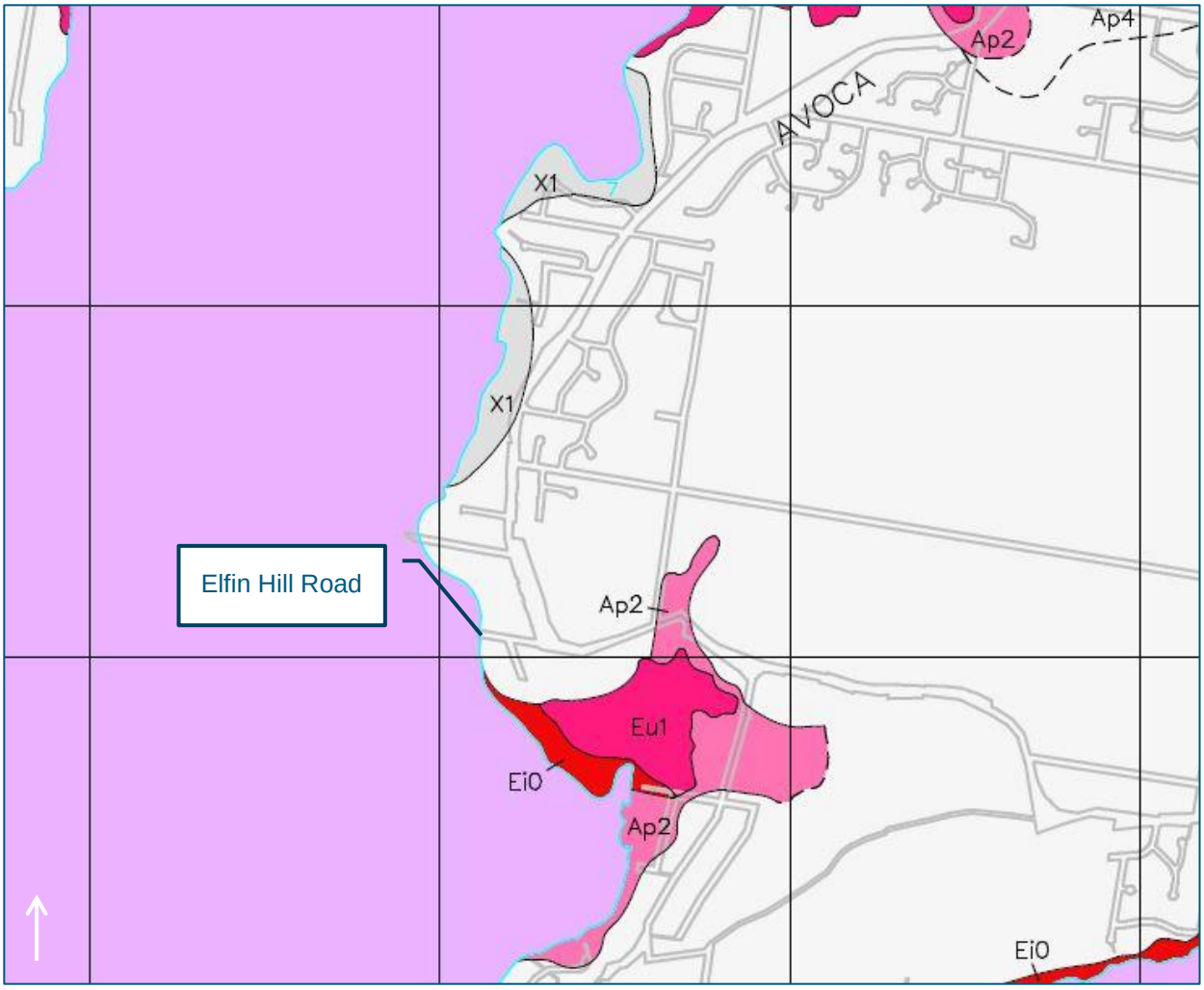

Figure 4: Excerpt from Gosford ASS Risk Map (Source: DLWC, 1997)

3.4 Investigations and Studies

3.4.1 Acid Sulfate Soils Classification System

Acid sulfate testing should be carried out in two stages in accordance with the Acid Sulfate Soils Manual (Stone, et. al, 1998), ASSMAC guidelines and the Acid Sulfate Soils Laboratory Methods Guidelines (Ahern *et al.*, 2004). The recommended procedure involves a laboratory screen test using pH measurements before and after oxidation, and detailed laboratory analysis to determine the actual acidity, potential acidity and acid neutralising capacity.

From the laboratory screening test, the presence of PASS can be indicated (though not confirmed) through one or more of the following:

- Release of hydrogen sulfide (H_2S) during oxidation;
- Effervescence and release of heat during oxidation;
- A pH following oxidation (pH_{fox}) <3.5; or
- A drop in pH following oxidation of 1 or more (ie. pHf – pH_{fox} ≥ 1).

Detailed laboratory analysis is required where the screening test indicates the presence of PASS. The Acid Sulfate Soil Manual (Stone, et. al, 1998) defines “action criteria” based on the percentage of oxidisable sulfur for broad categories of soil types (refer **Table 1**). Where the “action criteria” are exceeded, an Acid Sulfate Soil Management Plan (ASSMP) is required for construction activities that result in the removal and/or disturbance of these sediments, unless mitigating factors such as sufficient acid neutralising capacity (ANC) are established, or material is to remain under the permanent water level.

Detailed laboratory analysis is often carried out using the Chromium Reducible Sulfur suite. The suite determines the potential sulfidic acidity, which is a direct measure of reduced inorganic sulfur.

Acid neutralising capacity (ANC) of a sediment is the ability of the sediment to neutralise any acid that may be produced on oxidation and maintain the pH above 5.5. Organic matter, calcium carbonates (i.e. shell) and magnesium carbonates are common, naturally occurring neutralising agents. The effectiveness of these agents varies depending on particle size, coatings on the agent and kinetic factors which affect the rate at which they dissolve and become available. To account for these limitations, the acid neutralising capacity is divided by a minimum fineness factor of 1.5.

In accordance with the recommendations of the most recent Acid Sulfate Soils Laboratory Methods Guidelines (Ahern et al., 2004), acid base accounting is the recommended approach for the assessment of ASS as a basis for their management, especially for the purpose of predicting lime requirements. The acid base accounting equation is given as:

Net acidity = potential sulfidic acidity + existing acidity – acid neutralising capacity

Table 1: Action Criteria Based on ASS Soil Analysis for Three Texture Categories.

Type of Material		Action Criteria 1-1000 tonnes disturbed		Action Criteria if more than 1000 tonnes disturbed	
Texture range, McDonald et al (1990)	**Approx. clay content (%<0.002mm)**	**Sulfur Trail % S oxidisable (oven-dry basis) e.g. S_{TOS} or S_{POS}**	**Acid Trail mol H+/tonne (oven-dry basis) e.g., TPA or TSA**	**Sulfur Trail % S oxidisable (oven-dry basis) e.g. S_{TOS} or S_{POS}**	**Acid Trail mol H+/tonne (oven-dry basis) e.g., TPA or TSA**
Coarse Texture Sands to loamy sands	≤5	0.03	18	0.03	18
Medium Texture Sandy loams to light clays	5 – 40	0.06	36	0.03	18
Fine Texture Medium to heavy clays and silty clays	≥40	0.1	62	0.03	18

3.4.2 Investigation

RHDHV has undertaken soil sampling at the site location and collected a total of eight (8) samples along the length of subject foreshore area. The location and depths of the samples taken are summarised in **Table 2** and **Figure 5** to **Figure 7**. Sample locations can also be found on the Location Plan presented in **Appendix A**

Table 2: Soil Samples

Sample ID	Chainage	Distance from TOB (m)	Depth of Sample
EH1	10	1.5-3	0-0.5
EH2	30	3-4	0.4-0.8
EH3	35	4.5-5.5	0.1-0.5
EH4	58	4-5	0.1-0.5
EH5	94	2.5-3.5	0.1-0.5
EH6	125	4-5	0.2-0.6
EH7	150	5-6	0.2-0.6
EH8	160	3-4	0.1-0.5

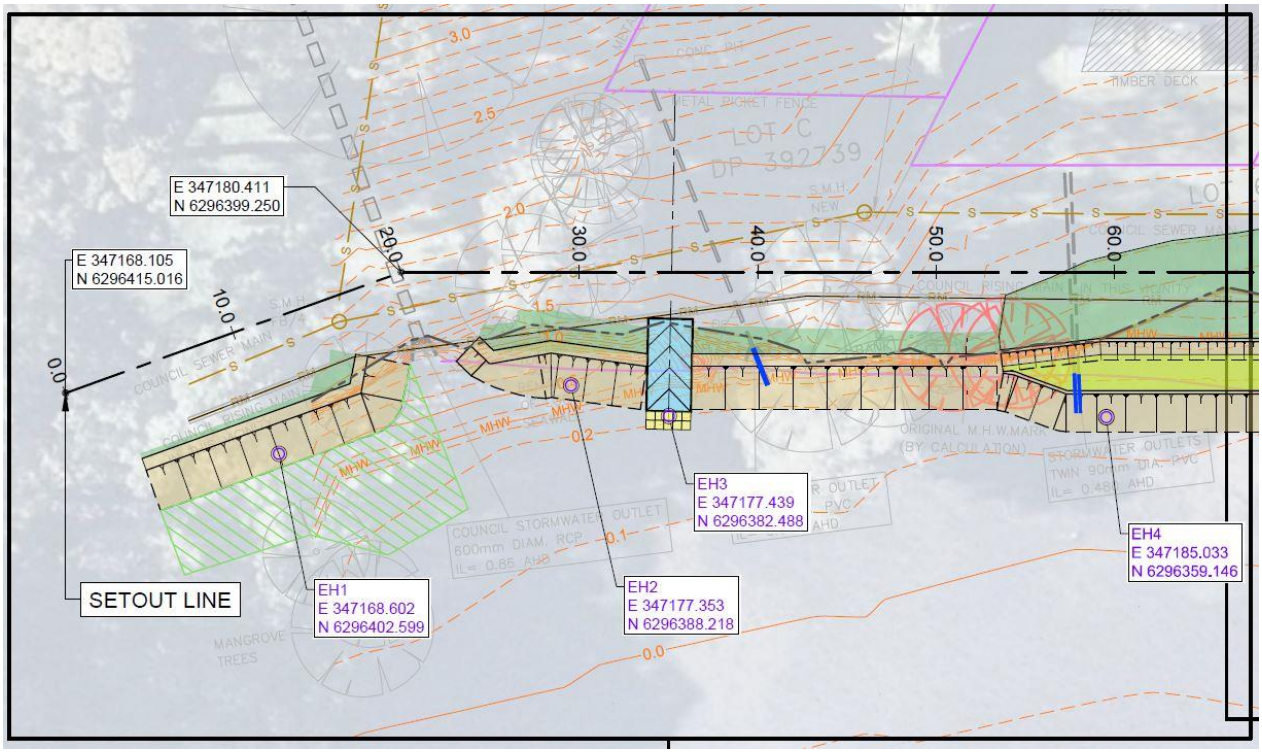

Figure 5: Sample Locations EH1-EH4

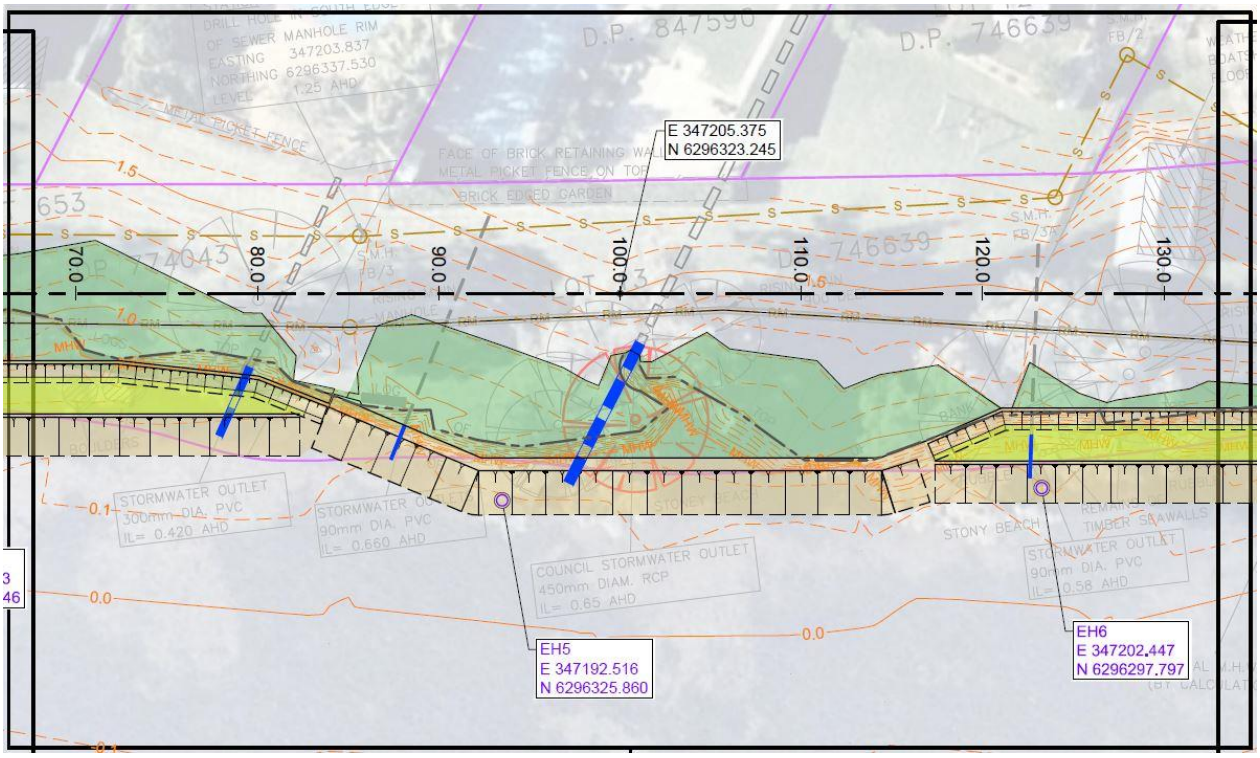

Figure 6: Sample Locations EH5-EH6

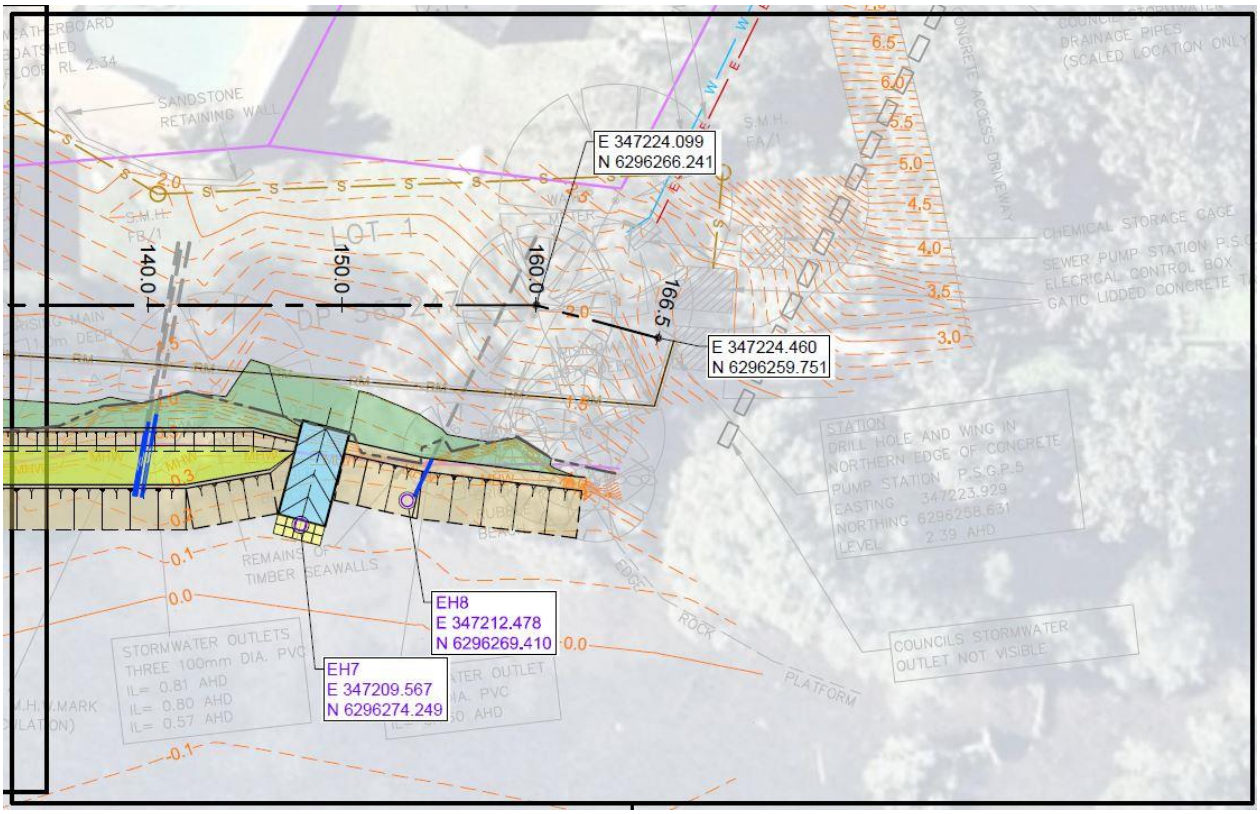

Figure 7: Sample Locations EH7-EH8

Acid sulfate testing was carried out in two stages in accordance with Acid Sulfate Soils Manual (Stone, et. al, 1998), ASSMAC guidelines and the Acid Sulfate Soils Laboratory Methods Guidelines (Ahern *et al.*, 2004). Analytical testing was undertaken by ALS Environmental. The analysis involved a laboratory screen test using pH measurements and further laboratory analysis using the Chromium Reducible Sulfur (S_{CR}) suite of testing to determine the potential risk from acid sulfate soils. The results of testing undertaken by ALS Environmental are presented in **Appendix B**.

The preliminary assessment involved laboratory screen testing of all samples to identify the presence and severity of AASS and the likely presence of PASS. Results of the screen testing are summarised in **Table 3.** The laboratory screening test indicated that pH_f prior to oxidation ranged from 6.4 to 8.3 indicating that no AASS (i.e. $pH_f \leq 4$) are likely to be present, though this should be confirmed through further testing. Samples showed very vigorous reactions during oxidation with 30% hydrogen peroxide. Following oxidation, pH_{fox} ranged from 1.9 to 2.3 with all samples showing a significant pH change (change >2 pH units). The screening test results indicated that all sample areas may contain PASS and further detailed testing was required.

Detailed laboratory analysis was subsequently carried out on four samples across the length of the foreshore (EH2, EH4, EH5 and EH7) using the more rigid Chromium Reducible Sulfur suite. Results of this testing are summarised in **Table 4**.

Potential oxidisable sulfur is reported as S_{CR}. The results indicated that the potential oxidisable sulfur in all samples tested was greater than the “action criteria” provided in the Acid Sulfate Soils Manual (Stone et. al, 1998) (Refer **Table 1**). However, the potential oxidisable sulfur results do not account for any existing acidity or any acid neutralising capacity (ANC) of the sediment which should be accounted for when classifying acid sulfate soils.

Table 3: Laboratory Screening Test Results

Sample ID	Depth	pH_f	pH_{fox}	Drop in pH	Reaction Rate
		pH Unit			
EH1	0-0.5	7.8	**2.2**	**5.6**	**4**
EH2	0.4-0.8	6.4	**2.3**	**4.1**	**4**
EH3	0.1-0.5	8.1	**2.2**	**5.9**	**4**
EH4	0.1-0.5	7.4	**2.2**	**5.2**	**4**
EH5	0.1-0.5	7.6	**1.9**	**5.7**	**4**
EH6	0.2-0.6	8.3	**2**	**6.3**	**4**
EH7	0.2-0.6	7.4	**2.1**	**5.3**	**4**
EH8	0.1-0.5	7.9	**2.2**	**5.7**	**4**

Notes:
Reaction Rate: 1 – Slight, 2 – Moderate, 3 – Vigorous, 4 – Very Vigorous
BOLD - pH_{fox} (<3.5), drop in pH (≥1) or reaction rate (≥2) indicates PASS

Existing acidity is made up of two components, the first being actual acidity which is reported as Titratable Actual Acidity (TAA). Results of the TAA testing indicated that none of the samples tested contained any actual acid sulfate soil material (AASS). The second component is retained acidity which measures the acidity bound up in less soluble compounds such as jarosite and iron sulfate minerals. Retained acidity is reported as net acid soluble sulfur (S_{NAS}). It is only necessary to measure retained acidity where pH_{KCL} <4.5, hence, no testing for retained acidity was undertaken.

As mentioned previously, the ANC is the ability of the sediment to buffer acidity produced on oxidation and resist the lowering of pH. Organic matter, calcium carbonates (i.e. shell) and magnesium carbonates are common naturally occurring neutralising agents. The effectiveness of these agents varies depending on particle size, coatings on the agent and kinetic factors which affect the rate at which they dissolve and become available. To account for these limitations, the ANC is divided by a minimum fineness factor of 1.5. It is only necessary to measure ANC where pH_{KCL} ≥ 6.5, hence, no testing for ANC was undertaken.

The acid trail results for net acidity at all locations along the foreshore were found to exceed the ASSMAC "action criteria". The results indicated a high potential for acid sulfate soil conditions to develop in the sediments if oxidized (i.e. exposed to air).

Liming rates were determined for individual samples based on the net acidity result. Rates were calculated based on the use of fine agricultural lime ($CaCO_3$) with an Effective Neutralising Value (ENV) of 98%. A safety factor of 1.5 was also applied to account for non-homogenous mixing or insolubility of lime. Liming rates for samples with a net acidity exceeding the ASSMAC "action criteria" ranged from 5 to 27 kg $CaCO_3$/t.

Table 4: Summary of ASS Testing Results

Sample ID	Actual Acidity			Potential Acidity		Acid Base Accounting						
	pH_{KCl}	TAA		S_{CR}		ANC Fineness Factor	Net Acidity		Liming Rate	Net Acidity - *Excluding ANC*		Liming Rate - *Excluding ANC*
	pH Unit	% S Pyrite	Mol. H+/t	%S	Mol. H+/t		%S	Mol. H+/t	kg $CaCO_3$/t	%S	Mol. H+/t	kg $CaCO_3$/t
EH2	4.8	<0.02	9	0.258	161	1.5	0.27	170	13	0.27	170	13
EH4	5.1	<0.02	4	0.567	353	1.5	0.57	357	27	0.57	357	27
EH5	5.9	<0.02	<2	0.115	72	1.5	0.12	72	5	0.12	72	5
EH7	5.3	<0.02	2	0.261	163	1.5	0.26	165	12	0.26	165	12

Notes:
Values in red indicate exceedance of ASSMAC action criteria thresholds.

4 Proposed Management Methods for Acid Sulfate Soils

4.1 Overview of Plan

Alternative methods considered for the management of the material comprised:

- avoidance and/or minimisation of the disturbance of potential acid sulfate soils;
- reburial and capping below water; and,
- acid neutralisation and utilisation of material for fill.

In the evaluation of these methods, consideration has been given to the environmental requirements of government agencies (such as NSW Office of Environment and Heritage (OEH) and NSW Department of Primary Industries (Fisheries)) and the potential effect on the project in terms of objectives, construction program and cost.

Due to the nature of the project it was not possible to completely avoid disturbance of material that may comprise acid sulfate soils without compromising the objectives of the project. In addition, no suitable sites could be identified nearby for the reburial and capping of any soils without treatment.

The material generally consists of silty sand and would be suitable for use as fill after treatment if necessary. If identified as acid generating, the properties of the material would need to be improved by the addition of lime.

On this basis a preferred management strategy has been prepared for any material disturbed during the excavations. The strategy involves acid neutralisation and utilisation of material for on-site reuse

4.2 Neutralisation Requirements

The potential for release of acid leachate to the surrounding environment if the sediments are excavated and stockpiled needs to be managed. Neutralisation is aimed at maintaining the pH of the sediment above 6.5 (Ahern, et. al, 2004). Neutralisation requirements for the sediment vary depending on the level of acid generating risk.

Liming rates were determined for individual samples based on the net acidity result. Rates were calculated based on the use of fine agricultural lime ($CaCO_3$) with an Effective Neutralising Value (ENV) of 98%. A safety factor of 1.5 was also applied to account for non-homogenous mixing or insolubility of lime.

An average liming rate of 14 kg/tonne has been determined for the foreshore material.

5 Acid Sulfate Soils Management Strategy

Relevant associated documents for the management of acid sulfate soil impacts associated with the works include an Erosion and Sedimentation Control Plan (ESCP) and the Construction Environmental Management Plan (CEMP) for the site of which the ESCP and this ASSMP are appended to. All other relevant management and mitigation measures in the CEMP and ESCP shall also be taken into account.

A preferred management strategy plan has been developed specifically for the removal, handling and reuse of material excavated on-site. Laboratory testing of soil samples has determined that material excavated from the site will require neutralisation if it is stockpiled for an extended period, reused as fill on-site above the water table or disposed of off-site.

The implementation of this preferred management strategy would be supervised on-site by the Site Environmental Officer (SEO) who would be appropriately qualified and experienced in the removal, treatment and monitoring of acid sulfate soils. The SEO would be responsible for undertaking any additional sampling, recalculating the appropriate liming rates and safety factor (if necessary), validating the treatment and identifying any revisions to treatment requirements.

This plan requires the implementation of the management strategies detailed below:

5.1 Establishment

- installation of hay bale barriers/diversion banks upslope of all excavation works, stockpiles, treatment pads and temporary sumps and the installation of sediment fencing downslope of excavation works and around the stockpiles and treatment pads. These provisions shall be installed in accordance with the Blue Book (Department of Housing and Landcom, 2004);
- preparation of a customised stockpile area(s) and treatment pad(s) to receive acid sulfate soil material including application of an underlying guard layer of lime for the protection of groundwater prior to deposition of material;
- preparation of bunded diversion drains within each stockpile and treatment pad for diversion of water to temporary sumps; bunds and sumps shall be of low permeability and shall not be made out of untreated ASS material;
- construction of temporary sumps to store water collected by diversion drains and to enable monitoring and treatment as required prior to on-site reuse;
- establishment of all treatment pads, stockpile areas and temporary sumps as close as possible to work areas but out of the direct path of existing overland flow paths and stormwater infrastructure to minimise potential impacts from flooding;
- stockpiles, treatment pads and temporary sumps shall be bunded with sandbags or the like during establishment with a minimum height of 0.5m above existing surface levels to mitigate the potential for offsite transportation of acid sulfate soils in the event of flooding;
- an initial supply of lime shall be stored on-site in weather-proof containers such as bulk bags or tanks and shall be located on an impermeable surface. Appropriate environmental controls shall be provided to ensure that stormwater runoff contaminated with lime cannot escape the work area; and,
- storage of additional materials required to manage flood risk (i.e. sandbags and geotextile layer or similar) in convenient locations on-site at all times.

5.2 Construction

- careful excavation of material utilising plant and equipment (selected by the Contractor) to avoid disturbance at depths greater than necessary;
- field screen testing of pH;
- containment of excavated material within an appropriate treatment pad. Soil shall typically be placed in 150mm to 300mm layers to facilitate ease of treatment with lime;
- minimisation of acid generation through minimisation of exposure time (particularly with sands) and immediate treatment through application of fine agricultural lime ($CaCO_3$) (Effective Neutralising Value ≥ 98%) at the recommended application rates;
- thorough mixing of lime into the soil on the treatment pad using a backhoe or excavator;
- replacement of guard layer of lime between each episode of deposition of acid sulfate soil material, over time, if necessary;
- diversion of water and leachate from stockpiles, treatment pads and ASS filled/disturbed areas, and pumping of water from excavations to temporary sumps and avoidance of groundwater and leachate runoff to existing drainage channels and waterways;
- monitoring of soil pH in treatment pads and further treatment if necessary prior to emplacement/reuse;
- monitoring of water pH in temporary sumps to ensure water is of acceptable quality prior to on-site reuse where possible (such as for dust suppression or irrigation of plantings). This shall allow filtration to the subsoils;
- daily monitoring of weather forecasts during stockpiling and treatment of material. If impending heavy rainfall (>20mm in any 24 hour period), additional protective measures to minimise runoff from stockpiles, sediment treatment areas and temporary sumps shall be initiated. This shall include:
    - increasing the height of bunding around each stockpile, treatment area, and sump using sandbags or the like to a height of 1m above existing surface levels; and,
    - anchoring geotextile cover or similar over each stockpile and treatment pad using sandbags for the duration of each event.
- provision of sufficient plant, equipment and personnel to enable the implementation of additional protection measures in the event of impending heavy rainfall (i.e. >20mm in any 24 hour period). Where monitoring of the weather forecasts identifies the potential for impending heavy rainfall to occur out of work hours (i.e. overnight or on weekends), the additional protective measures to minimise runoff from stockpiles, treatment areas and temporary sumps shall be implemented prior to personnel leaving the site;
- minimisation of potential impacts from flooding in accordance with the mitigation and management measures detailed in the CEMP; and,
- restoration/stabilisation of the excavations and treatment areas as soon as possible upon completion.

5.3 Monitoring and Further Treatment

5.3.1 Soil

- following excavation of acid sulfate soils and initial treatment, validation testing shall be undertaken to ensure PASS has been effectively neutralised to a pH >6.5 (with an upper limit of 8.5). This shall involve the completion of a field assessment (i.e. visual, textural and odour), recovery of representative samples, ASS field screening and laboratory testing. Field screen results would be analysed and representative samples would be selected for testing using the Chromium Reducible Sulfur suite. Soils shall pass verification testing where the following three factors are met:
    - pH_{KCL} ≥ 6.5;
    - TAA = 0; and,
    - Net acidity ≤ 0.
- where laboratory results indicate that samples have not passed verification, liming rates shall be recalculated, and additional lime added until it is satisfactorily confirmed that the material has been neutralised
- this Acid Sulfate Soil Management Plan should be updated where substantial additional lime application rates are determined; and
- all validation testing and further treatment shall be recorded

5.3.2 Water in Temporary Sumps

- regular monitoring of the pH of water collected in temporary sumps shall be undertaken;
- acid water is to be treated to achieve a pH in the range of 6.5 to 8 (targeted at pH 7) prior to on-site reuse;
- acid water shall be treated through the gradual addition of lime slurry and mixed thoroughly. The change in pH will not be instantaneous and lime shall be added gradually and monitored over time to allow any sludge to settle and to avoid overshooting the acceptable pH range. The quantity of fine agricultural lime (Effective Neutralising Value ≥ 98%) required to achieve pH 7 for 1 ML (i.e. 1,000m^3) of low salinity acid water is provided in **Table 5** below; and
- all monitoring and treatment (if necessary) shall be recorded.

Table 5: Quantity of pure neutralising agent require to raise from existing pH to pH 7 for 1 Megalitre of low salinity acid water (Stone et al., 1998)

Current Water pH	$[H^+]$ {mol/L}	H^+ in 1 Megalitre {mol}	Lime to neutralise 1 Megalitre {kg pure $CaCO_3$}
0.5	.316	316,228	15,824
1.0	.1	100,000	5,004
1.5	.032	32,000	1,600
2.0	.01	10,000	500

Current Water pH	$[H^+]$ {mol/L}	H^+ in 1 Megalitre {mol}	Lime to neutralise 1 Megalitre {kg pure $CaCO_3$}
2.5	.0032	3,200	160
3.0	.001	1,000	50
3.5	.00032	320	16
4.0	.0001	100	5
4.5	.000032	32	1.6
5.0	.00001	10	0.5
5.5	.0000032	3.2	0.16
6.0	.000001	1	0.05
6.5	.00000032	.32	0.016

5.4 Records

- implementation of this ASSMP shall be included in the SEO's daily site checklist; and,
- all testing, monitoring and treatment undertaken shall be recorded on appropriate report forms

6 References

Ahern C R, Stone, Y, and Blunden B (1998). Acid Sulfate Soils Assessment Guidelines Acid Sulfate Soil Management Advisory Committee (ASSMAC), Wollongbar, NSW, Australia.

Ahern C.R., McElnea A.E. and Sullivan L.A. (2004), Acid Sulfate Soils Laboratory Methods Guidelines. Queensland Department of Natural Resources, Mines and Energy, Indooroopilly, Queensland, Australia.

Cardno (2015a), Brisbane Water Foreshore Floodplain Risk Management Study. Prepared for Gosford City Council.

Cardno (2015b), Brisbane Water Foreshore Floodplain Risk Management Plan. Prepared for Gosford City Council.

Cardno Lawson Treloar (2010), Brisbane Water Foreshore Flood Study. Prepared for Gosford City Council and NSW Department of Environment and Climate Change.

Department of Housing and Landcom (2004), *Managing Urban Stormwater: Soils and Construction* (Blue Book).

NSW Department of Primary Industries; Water (2016). Report Card for the Hawkesbury to Hunter Coastal Sands Groundwater Source. <http://www.water.nsw.gov.au/__data/assets/pdf_file/0007/587221/wsp_north_coast_report_card_hawkesbury_hunter.pdf > Accessed 8th of January 2018.

Queensland State Government (2014), Queensland Acid Sulfate Soil Technical Manual – Soil Management Guidelines v4.0

Stone, Y., Ahern, C.R. and Blunden, B. (1998), *Acid Sulfate Soil Manual 1998*, Acid Sulfate Soils Management Advisory Committee (ASSMAC), Wollongbar. NSW, Australia.

APPENDIX A – Design Drawings

APPENDIX B – ALS Laboratory Results

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1728473**	Page	: 1 of 4
Client	: **HASKONING AUSTRALIA- ROYAL HASKONING**	Laboratory	: Environmental Division Sydney
Contact	: ALI WATTERS	Contact	: Customer Services ES
Address	: Level 3 2 Market Street Newcastle NSW 2300	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: +61 02 8854 5000	Telephone	: +61-2-8784 8555
Project	: PA1635 ELFIN HILL ROAD RESERVE	Date Samples Received	: 14-Nov-2017 09:48
Order number	: ----	Date Analysis Commenced	: 22-Nov-2017
C-O-C number	: ----	Issue Date	: 22-Nov-2017 19:12
Sampler	: PATRICK LAWLESS		
Site	: ----		
Quote number	: SYBQ/203/15		
No. of samples received	: 8		
No. of samples analysed	: 8		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris		Brisbane Acid Sulphate Soils, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ASS: EA003 (NATA Field and F(ox) screening): pH F(ox) Reaction Rate: 1 - Slight; 2 - Moderate; 3 - Strong; 4 - Extreme

Analytical Results

Sub-Matrix: **SEDIMENT** (Matrix: **SOIL**)				Client sample ID	**EH1**	**EH2**	**EH3**	**EH4**	**EH5**
				Client sampling date / time	02-Nov-2017 16:00	02-Nov-2017 16:15	02-Nov-2017 16:30	02-Nov-2017 16:45	02-Nov-2017 17:00
Compound	*CAS Number*	*LOR*	*Unit*		**ES1728473-001**	**ES1728473-002**	**ES1728473-003**	**ES1728473-004**	**ES1728473-005**
					Result	Result	Result	Result	Result
EA003 :pH (field/fox)									
pH (F)	----	0.1	pH Unit		**7.8**	**6.4**	**8.1**	**7.4**	**7.6**
pH (Fox)	----	0.1	pH Unit		**2.2**	**2.3**	**2.2**	**2.2**	**1.9**
Reaction Rate	----	1	Reaction Unit		**4**	**4**	**4**	**4**	**4**

Analytical Results

Sub-Matrix: **SEDIMENT** (Matrix: **SOIL**)			Client sample ID	**EH6**	**EH7**	**EH8**	**----**	**----**
			Client sampling date / time	02-Nov-2017 17:15	02-Nov-2017 17:30	02-Nov-2017 17:45	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**ES1728473-006**	**ES1728473-007**	**ES1728473-008**	**--------**	**--------**
				Result	Result	Result	----	----
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	**8.3**	**7.4**	**7.9**	**----**	**----**
pH (Fox)	----	0.1	pH Unit	**2.0**	**2.1**	**2.2**	**----**	**----**
Reaction Rate	----	1	Reaction Unit	**4**	**4**	**4**	**----**	**----**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1724685**	Page	: 1 of 3
Client	: **HASKONING AUSTRALIA- ROYAL HASKONING**	Laboratory	: Environmental Division Brisbane
Contact	: ALI WATTERS	Contact	: Customer Services EB
Address	: Level 3 2 Market Street Newcastle NSW 2300	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 02 8854 5000	Telephone	: +61-7-3243 7222
Project	: PA1635 ELFIN HILL ROAD RESERVE	Date Samples Received	: 14-Nov-2017 09:47
Order number	: ----	Date Analysis Commenced	: 29-Nov-2017
C-O-C number	: ----	Issue Date	: 30-Nov-2017 16:49
Sampler	: PATRICK LAWLESS		
Site	: ----		
Quote number	: SY/431/15		
No. of samples received	: 4		
No. of samples analysed	: 4		

ilac-MRA NATA
Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris		Brisbane Acid Sulphate Soils, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- **The samples in this work order have been re-batched from ES1728473.**
- ASS: EA033 (CRS Suite):Retained Acidity not required because pH KCl greater than or equal to 4.5
- ASS: EA033 (CRS Suite): ANC not required because pH KCl less than 6.5
- ASS: EA033 (CRS Suite): Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime (CaCO3) and using a safety factor of 1.5 to allow for non-homogeneous mixing and poor reactivity of lime. For conversion of Liming Rate from 'kg/t dry weight' to 'kg/m3 in-situ soil', multiply 'reported results' x 'wet bulk density of soil in t/m3'.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	EH2 ES1728473-002	EH4 ES1728473-004	EH5 ES1728473-005	EH7 ES1728473-007	----
			Client sampling date / time	21-Nov-2017 00:00	21-Nov-2017 00:00	21-Nov-2017 00:00	21-Nov-2017 00:00	----
Compound	CAS Number	LOR	Unit	EB1724685-001	EB1724685-002	EB1724685-003	EB1724685-004	--------
				Result	Result	Result	Result	----
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**4.8**	**5.1**	**5.9**	**5.3**	**----**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	**9**	**4**	<2	**2**	**----**
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	**----**
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	**0.258**	**0.567**	**0.115**	**0.261**	**----**
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	**161**	**353**	**72**	**163**	**----**
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**----**
Net Acidity (sulfur units)	----	0.02	% S	**0.27**	**0.57**	**0.12**	**0.26**	**----**
Net Acidity (acidity units)	----	10	mole H+ / t	**170**	**357**	**72**	**165**	**----**
Liming Rate	----	1	kg CaCO3/t	**13**	**27**	**5**	**12**	**----**
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	**0.27**	**0.57**	**0.12**	**0.26**	**----**
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	**170**	**357**	**72**	**165**	**----**
Liming Rate excluding ANC	----	1	kg CaCO3/t	**13**	**27**	**5**	**12**	**----**