CONSULTING EARTH SCIENTISTS

BACKFILL MANAGEMENT PLAN
251 ADELAIDE STREET, RAYMOND TERRACE, NEW SOUTH WALES

PREPARED FOR RAYMOND TERRACE PARKLANDS

CES DOCUMENT REFERENCE: CES200502-PHB-AL

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Document Control

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LIST OF FIGURES

LIST OF APPENDICES

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1. INTRODUCTION

Consulting Earth Scientists Pty Ltd (CES) has been commissioned by Raymond Terrace Parklands (the Client) to provide a Backfill Management Plan for the proposed rehabilitation of the former quarry at 251 Adelaide Street, Raymond Terrace in New South Wales. The quarry void and area to the west that was the former location of ancillary services and for the quarrying operations shall herein be referred to as the Site (refer to Figure 1).

The proposed works at the Site involve backfilling the quarry with approximately 3.5 million tonnes of fill. The disused quarry has been proposed to be rehabilitated for future recreational use.

This backfill management plan is a living document intended to be updated at regular intervals during the quarry rehabilitation works.

2. OBJECTIVE AND SCOPE OF WORK

The objective of this Backfill Management Plan (BMP) is to propose an efficient backfilling strategy and suitable environmental controls for the filling and rehabilitation of the quarry void. In preparing this plan, CES undertook the following:

- A review of the engineering characteristics of the proposed material to be imported and used for backfilling.
- Calculation of backfill volumes and mass estimates based on the latest bathymetric survey of the quarry and the backfill material characteristics such as soil type, bulk density, bulking and shrinkage factors etc.
- An assessment of backfilling rates including the maximum daily limit and associated timeframe for the backfilling works.
- Provide a backfilling methodology including backfill staging, location of stockpile areas and erosion and sediment control measures.
- Preparation of a Potential Acid Sulfate Soils (PASS) Contingency Management plan in the event that PASS is not delivered to site or backfilled in an appropriate manner.

3. BACKGROUND INFORMATION

3.1 SITE DESCRIPTION

The Site is located at 251 Adelaide Street, Raymond Terrace, NSW and is formally defined as Lot 232 in Deposited Plan (DP) 593512 (Figure 1). The Site located within the local government area (LGA) of Port Stephens Council. The approximate coordinates of the centre of the site are (382310.47 E, 6372882.941 N) within the MGA 1994 Zone 56. The surrounding land use comprises the following:

- **North** – Bushland and residential properties located approximately 200m along Meredith Crescent;
- **East** – Bushland and Raymond Terrace Wastewater Treatment Works with the Pacific Highway located approximately 800m to the east;
- **South** – Bushland and Windeyers Creek with the Pacific Highway and the Masonite Road commercial industrial properties located approximately 250m to the south; and
- **West** – Adelaide Street and agricultural land to the Hunter River located at approximately 1.4 km to the west of the Site.

3.2 SITE HISTORY

The Site is a former sand quarry, formerly owned by Monier Drilling Pty Ltd and then Rocla Drilling Pty Ltd. It is understood that extractive sand operations started in the 1950s. The quarry reached the end of its economic life and the quarrying activities at the Site ceased in 2010. The quarry void has since become inundated with water.

3.3 PREVIOUS INVESTIGATIONS

Between August and October 2020, CES completed environmental and hydrogeological investigations at the Site. The investigations comprised the drilling of seventeen (17) shallow boreholes ranging from 0.2m to 3.6m located in the western part of the Site (the former operations area for the quarry) and installation of five (5) groundwater monitoring wells (MW1 to MW5) around the perimeter of the quarry void to depths ranging between 13.5m and 20m. The location of the monitoring wells is shown in Figure 2.

The site investigations revealed the following general findings:

- In the western area of the Site (i.e. former quarrying operations area), fill comprising clayey and silty Sand to a depth of up to 2.4m, which overlies natural alluvium consisting of silty and clayey Sand and sandy Clay to maximum borehole depth 3.6m.
- In the groundwater monitoring wells installed around the quarry perimeter, fill consisting of Sandy Clay and Silty Sand was encountered to depths ranging between 0.2m and 3.8m.

This fill is generally underlain by natural alluvium consisting of Clayey Sand and Sandy Clay to borehole termination depths ranging from 13.5m to 20m. At groundwater monitoring well MW4 which is located north-east of the quarry, bedrock was inferred to be encountered at approximately 13.5m deep.

- The groundwater flow direction based on the monitoring of the groundwater wells is from east to west toward Windeyers Creek which is situated in the southwest of the quarry. The groundwater then flows toward the Hunter River located approximately 1.6km west of the Site.

3.4 QUARRY VOID

Information on the inundated quarry geometry and depth has been obtained by review of the bathymetric survey undertaken in 2010 by Tattersall Lander Pty Ltd. A copy of the survey plan is enclosed in Appendix A.

The survey indicates a total quarry surface area of approximately 219,579m^2. The typical depth to the base of the inundated quarry is assessed to be about 8m, with the deepest part of the quarry located in the central southern part of the void. The void in the deepest part is shown to be at an elevation of approximately RL -10.8m AHD which corresponds to an approximate depth to the base of the quarry void of 11.8m.

3.5 EARTHWORKS FLOOD IMPACT ASSESSMENT

An Earthworks Flood Impact Assessment was undertaken for the Site by BMT in 2019. As part of this assessment, a Concept Fill Plan was prepared to allow filling of the disused quarry with minimal impact on flood conditions. The concept fill plan proposes an area of elevated ground (exceeding 2.1m AHD) in the north-west part of the void, a transition zone with a slope of between 1.1 to 2.1m AHD and a lower lying area in the south and south-east of the quarry with a proposed elevation of 1.1m AHD for the conveyance of flood waters. A copy of the proposed earthworks concept fill plan is provided in Appendix B.

4. PROPOSED BACKFILL MATERIAL

4.1 GENERAL

The quarry void at the Site is proposed to be filled with imported materials to the indicative final landform presented in Figure 7. Following the completion of rehabilitation, the proposed land use is as an area for recreational purposes.

The materials to be imported and used for backfilling the Site are to be sourced from various locations in the Sydney, Newcastle, the Hunter region and other sites in New South Wales. The backfill material shall comprise Virgin Excavated Natural Material (VENM), Excavated Natural

(ENM), Potential Acid Sulfate Soil (PASS) and other material that is suitable to be used for backfill that is subject to a General or Specific Resource Recovery Exemption approved by the NSW Environment Protection Authority (NSW EPA). Further details of the proposed backfill materials are as follows:

4.1.1 VIRGIN EXCAVATED NATURAL MATERIAL

The Protection of the Environment Operations Act 1997 (POEO Act) defines Virgin Excavated Natural Material (VENM) as:

Natural material (such as clay, gravel, sand, soil or rock fines):

a) that has been excavated or quarried from areas that are not contaminated with manufactured chemicals, or with process residues, as a result of industrial, commercial, mining or agricultural activities; and

b) that does not contain any sulfidic ores or soils or any other waste and includes excavated natural material that meets such criteria for virgin excavated natural material as may be approved for the time being pursuant to an EPA Gazettal notice.

4.1.2 EXCAVATED NATURAL MATERIAL

Excavated Natural Material (ENM) is excavated natural material that is, or is intended to be, applied to land as engineering fill or for use in earthworks, that is subject to *"The Excavated Natural Material Exemption 2014"* issued by the NSW EPA under the Protection of the Environment Operations (Waste) Regulation 2014. Under this exemption, ENM is defined as naturally occurring rock and soil (including but not limited to materials such as sandstone, shale, clay and soil) that has:

a) been excavated from the ground, and

b) contains at least 98% (by weight) natural material, and

c) does not meet the definition of Virgin Excavated Natural Material in the Act. Excavated natural material does not include material located in a hotspot; that has been processed; or that contains asbestos, Acid Sulfate Soils (ASS), Potential Acid Sulfate soils (PASS) or sulfidic ores.

4.1.3 FILL SUBJECT TO OTHER GENERAL & SPECIFIC RESOURCE RECOVERY EXEMPTIONS

Where permitted under an existing General Resource Recovery Exemption (other than the ENM Exemption), geotechnically suitable fill may be used as backfill in accordance with the conditions of the relevant exemption.

Applications for a Specific Resource Recovery Exemption(s) may also be made to the NSW EPA for fill used in the quarry rehabilitation works for which there is no current general exemption and where the proposed fill is a bona fide beneficial, fit-for-purpose re-use that will not cause harm to human health or the environment.

For the purpose of brevity, fill other than ENM, that is subject to a General or Specific Resource Recovery Exemption and suitable for purpose will be referred to in this document as 'Resource Recovered Exempt Material or RRE.

4.1.4 POTENTIAL ACID SULFATE SOILS

Acid sulfate soils are naturally occurring soils and sediments containing iron sulfide minerals and compounds. When acid sulfate soils are exposed to air, the iron sulfides in the soil react with oxygen and water to produce a variety of iron compounds and sulfuric acid. Acid sulfate soils which have not been oxidised by exposure to air are known as Potential Acid Sulfate Soils (PASS) which when maintained in an anaerobic condition such as below water or in a saturated waterlogged condition, the iron sulfides in the soil are stable.

PASS accepted at the Site shall be classified as VENM in accordance with the NSW EPA Waste Classification Guidelines even though it contains sulfidic ores or soils.

PASS will only be backfilled at the Site below water, at elevations at least 2m below the lowest historical level of the water table, in accordance with the requirements stated in NSW EPA *Waste Classification Guidelines, Part 4: Acid Sulfate Soils* (EPA 2014). Based on the groundwater monitoring results for the Site (CES Document Reference: CES200502-PHB-AF), the lowest groundwater level is assessed to be RL 0m. Hence PASS will only be permanently backfilled at the Site below an elevation of RL -2m.

4.1.5 TOPSOIL & LANDSCAPING

Following completion of filling, topsoil should be placed over the backfilled areas and the landform suitably vegetated in accordance with a Landscaping and Vegetation Planting Plan prepared by a suitably experienced and qualified landscaper/horticulturalist. For clarification, the term Topsoil may include the following:

- General purpose soil: Material consisting of natural soil, amended natural soil, a blend of sand and organic materials or a blend of sand, natural soil materials and organic material, which is suitable for growth of plants.
- Topsoil: A natural soil which is the original surface layer of soil from grassland, bushland or cultivated land.
- Natural soil: A soil that has been dug from the landscape and is presented for use with no more than minor amendment. This soil can be topsoil, subsoil or a mixture of topsoil and subsoil, typically with a bulk density* of greater than 0.7 kg/L.

- Organic Soil: A general purpose soil (normally an amended natural soil or soil blend) that has a bulk density* of greater than 0.6 kg/L and an organic matter content in the range of 15% to 25% by mass.
- Soil Blend: A general purpose soil derived from the blending of two or more of: sand, natural soil material or organic material; and having a bulk density of greater than 0.7 kg/L and an organic matter content in the range of 3% to 15% by mass.
- Growth mediums being commercial composts to Australian Standards.
- Commercially available soil products and growth media.
- On site blended soil that meets the requirement of, and is tested in accordance with AS4419 *"Soils for Landscaping and Garden Use"*.

4.2 BACKFILL ACCEPTANCE & VERIFICATION

4.2.1 PRIOR TO RECEIPT AT THE SITE

Imported fill for backfilling shall be certified as Virgin Excavated Natural Material (VENM), Potential Acid Sulfate Soils (PASS), Excavated Natural Material (ENM) or other suitable material that is permitted to be used as fill that is subject to a General or Specific Resource Recovery Exemption (RRE) approved by the NSW EPA.

Prior to receipt at the Site, VENM and PASS should be appropriately waste classified and certified by a suitably qualified and experienced Environmental Consultant in accordance with applicable NSW EPA waste classification guidelines.

ENM or any material the subject of a Resource Recovery Exemption (RRE) to be received at the Site must be accompanied by documentation confirming the material's compliance with the exemption conditions.

4.2.2 AT THE TIME OF RECEIPT AT THE SITE

Verification at time of acceptance should be carried out by a suitably trained and experienced Environmental Practitioner or consultant employed or engaged by the Site Operator. The verification procedures should include as a minimum:

a) Visual confirmation that the characteristics of the fill to be accepted is consistent with the material from the source site and is the subject of the corresponding waste classification/compliance certificate.

b) The date and time of entry of the transporting vehicle.

c) A description of the types of imported fill in the load.

d) The identification details of the source of the fill and site of origin.

e) The details of the transporting vehicle including registration number.

4.2.3 SPECIFIC REQUIREMENTS APPLICABLE TO POTENTIAL ACID SULFATE SOILS

PASS should only be accepted at the Site if it meets the following criteria which are consistent with the requirements of the NSW EPA publication *Waste Classification Guidelines Part 4: Acid Sulfate Soils* (NSW EPA 2014):

- PASS must be able to be classified as VENM in accordance with the NSW EPA Waste Classification Guidelines even though it contain sulfidic ores or soils.
- The PASS must be kept wet at all times during excavation and subsequent handling, transport and storage until it can be appropriately backfilled. The PASS must be received at the proposed filling point within 16 hours of being excavated;
- The PASS shall only be backfilled in water below the permanent water table before it has had a chance to oxidise i.e. within 24 hours of excavation.
- The PASS must be disposed of within 8 hours of receipt at a Site and kept wet at all times until placed at least two metres (2m) below the lowest historical groundwater level at the Site, which based on the monitoring results is assessed to be RL 0m, hence PASS is only to be permanently backfilled below an elevation of RL -2m
- The PASS must have a pH greater than 5.5, both immediately following excavation and immediately prior to filling beneath the permanent water table.
- Documentation must be provided by the Supplier of the PASS for each truckload received at the Site. The documentation must confirm that excavation, transport and handling of the PASS has been in accordance with the Acid Sulfate Soil Manual (ASS Manual), published by the Acid Sulfate Soils Management Advisory Committee (ASSMAC 1998), thereby preventing the generation of acid. Information to be included in the confirmatory documentation should include:
    - The pH of each load of PASS recorded at the source site and at the site of filling;
    - Details of the source site;
    - Details of the transporter;
    - Date and time of the extraction of the PASS;
    - pH of the PASS at time of extraction;
    - pH of PASS immediately prior to placement under the water at the backfill location;
    - The name and details of the person classifying the material as PASS;

- A satisfactory review and confirmation by a representative of the Site Operator of geotechnical and contamination reports pertaining to the source site;
- An inspection of the source site by a representative of the Site Operator.

- The Site Operator should also test the pH of each load of soil received immediately prior to its placement under water using test methods specified in the ASS Manual (Methods 21A and/or 21Af). These details, together with the pH of the soil recorded at the time of its extraction, must be retained by the Site Operator.
- Maintenance of documentation shall be in accordance with the Environment Protection Licence (EPL) for the Site.
- The pH of the water at the landfill into which the PASS is placed must not be less than 6 at any time. Monitoring of groundwater and surface waters should be in accordance with the Environmental Monitoring Plan and EPL for the Site.
- Soil that has dried out, undergone any oxidation of its sulfidic minerals, or which has a pH of less than 5.5 must be treated by neutralisation with lime or other suitable substance in accordance with the techniques prescribed in the ASS Manual. After treatment the soil should be chemically assessed in accordance with NSW EPA Waste Classification Guidelines and disposed of at a Waste Facility that can lawfully accept the determined class of waste.
- Where PASS cannot be classified as VENM or a suitable underwater disposal site is not available at the Site, the PASS must be neutralised with lime or other suitable substance in accordance with the techniques prescribed in the ASS Manual. After treatment the soil should be chemically assessed in accordance with the NSW EPA Waste Classification Guidelines and disposed of at a Waste Facility that can lawfully accept the determined class of waste.

4.3 ASSUMED MATERIAL PROPERTIES

As described in Section 4.1, the Backfill Materials are to be sourced from various locations and hence the material properties of the backfill are anticipated to be variable. For the purpose of estimating backfill volumes, masses and the duration of quarry rehabilitation, it is assumed that the VENM, ENM, PASS and RRE would typically comprise clayey Sand material. The following material characteristics have been assumed in the assessment:

- Bank insitu density of fill material (sourced from various locations in NSW) ~ 2.1 tonnes/m^3.
- Bulking factor (expansion on excavation) = $^{\text{Volume after Excavation}}/_{\text{Volume before Excavation}}$ ~ 1.25.
- Shrinkage Factor (shrinkage on backfilling) = $^{\text{Volume after Backfilling}}/_{\text{Volume after Excavation}}$ ~ 0.95.

- Insitu bulk density when placed in the quarry and consolidated under the weight of the overlying materials ~ 1.8 tonnes/m^3.

The above are assumed parameters which should be confirmed and amended as appropriate at regular intervals during the progress of the rehabilitation works. Construction programmes and filling requirements should be updated accordingly in consideration of any amended parameter.

4.4 BACKFILL VOLUME & MASS ESTIMATES

An assessment of the required volume of fill to rehabilitate the quarry void has been undertaken using the specialist spatial analytical software programme ArcGIS and considering the survey data provided in the Tattersall Lander survey. Based on this analysis, the following volume estimates are provided:

- The total void space to be backfilled from the surveyed quarry base to an elevation of RL 1m is estimated to be approximately 1,443,000 m^3.
- The volume of material required to be placed above the elevation of RL 1m to construct the proposed final landform (Figure 7) is estimated to be approximately 99,000 m^3.
- The total volume of material estimated to be required to rehabilitate the quarry void is therefore approximately 1,540,000 m^3 (Figure 3).

Using the assumed bulking and shrinkage factors presented in Section 4.3, the estimate required mass of backfill material is:

- Backfill material to RL -2m (assumed to be PASS) ~ 784,263m^3, calculated to be approximately 1,411,673 tonnes of PASS;
- Backfill material from RL 1m to Final landform levels (assumed to be VENM/ENM/RRE) ~ 757,737m^3 , calculated to be approximately 1,363,927 tonnes.
- Total estimated weight of placed insitu backfill material is approximately 2,775,600 tonnes.
- Total estimated weight of backfill to be brought to site to rehabilitate the quarry, assuming a backfill shrinkage factor of 0.95 is approximately 2,921,700 tonnes.

5. ESTIMATED BACKFILL PROGRAMME

The proposed timeframe from start to completion of backfilling and construction of the final landform is a maximum period of 10 years. CES has been informed that a maximum 50 truck movements per day has been considered in the proposed traffic management plan.

Assuming the backfill delivery trucks to be a Truck and Dog combination with a carrying capacity of 32 tonnes and assuming 50 truck movements per day, this corresponds to a maximum backfill import rate of 1,600 tonnes per day.

If it is assumed that the available delivery time for backfill material is 235 days per annum (assuming a 5.5 day working week (to allow for late deliveries to be backfilled), including an assumed allowance of 15% due to lost production due to adverse weather and allowing for public holidays), it is estimated that it will take approximately 7 years and 9 months to backfill the Site.

In consideration of the above, an indicative backfill programme for 8-year period (including preliminaries and project set up) has been developed with respect to the proposed backfill staging areas. The indicative backfill programme is provided in Figure 4.

6. PROPOSED BACKFILL METHODOLOGY

6.1 GENERAL

As described in Section 4, it is proposed to backfill the site with Virgin Excavated Natural Material (VENM), Excavated Natural (ENM), Potential Acid Sulfate Soil (PASS) and other material that is suitable to be used to backfill the site that is subject to a General or Specific Resource Recovery Exemption (RRE) approved by the NSW EPA.

Any PASS deposited at the Site will be placed below an elevation of RL -2m and will be capped by layers of overlying VENM, ENM and RRE material to construct the final landform.

6.2 METHODOLOGY

The proposed backfill methodology is as follows:

- The quarry void is to be backfilled progressively in continuous Stages A to G as shown in Figure 5. Filling should commence in the north western part of the quarry near to the location of the former quarry ancillary works area and work in a clockwise direction from west to east.
- The proposed backfilling method is a combination of placement methods 1) dump short and push, 2) conveyor delivery system and/or 3) using conventional long reach excavator(s) (LRE) to be implemented as follows:
    - Establish haul roads, stockpile areas and identify suitable plant set up areas on existing land.
    - Each Stage to be filled in a series of cells that are to be suitably sized to manage control of filling in consideration of the rate and type of backfill accepted and with a nominal size of 100m x 100m. The extent of the cell to be filled should defined

using silt curtains which should be designed to provide sediment control to mitigate the generation of excessive suspended solids during filling.

- Establish the first lift of fill by placing VENM, ENM and/or RRE (Not PASS) and push the fill forward into the quarry void using a track-dozer to create a working platform and propagating beach front.
- Once a suitable working platform has been established, use a Long Reach Excavator and/or conveyor dump system to place VENM/ENM/RRE or PASS directly into the quarry void below water in the near shore and central part of the cell.

  The drop height for fill materials should be kept to a minimum and the fill placed directly below the water surface where practicable to reduce the amount of sediment liberated during backfilling.

  PASS should only be filled 2m below the standing water level in the quarry void and at permanent elevations below RL -2 m. Above this elevation or where the water in the quarry void is not deeper than 2m, VENM/ENM/RRE only to be placed.
- Once the subaqueous fill has been placed to the required elevation, VENM/ENM/RRE backfill may be dumped and pushed into the water using a track-dozer to create a propagating beach front and extend the working platform over the underlying deposited fill and construct the VENM/ENM/RRE capping layers. Tracked equipment such as dozers and excavators should be used to apply compactive effort to increase the density of the fill.

  The above process of depositing fill in deeper water using LRE or conveyors and then covering and capping by dumping and pushing off using tracked equipment should be repeated in a continuous cycle to progress the filling works and construct the final landform.
- Subaqueous fill batters should be placed at slope ratios no steeper than 1Vertical (V):1.5 Horizontal (H) with a maximum batter height of 8m. Where batter heights are in excess of 8m, the subaqueous fill should be benched with a minimum 5m horizontal bench for every 5m vertical height.
- Regular survey monitoring of the placed fill should be undertaken to confirm that PASS has been placed at appropriate elevations and to monitor the filling progress and geometry of the constructed subaqueous and subaerial landform. The monitoring could be undertaken using conventional survey methods, plumb lines or suitable sonar techniques as appropriate.

- Following completion of filling to final landform level, the ground surface should be stabilised to reduce erosion and dust emission in accordance with a suitable soil and water and landscaping management plan applicable to the final landform and land use.

A proposed works area layout for Stage A is shown in Figure 6.

7. EROSION AND SEDIMENT CONTROL

An Erosion and Sediment Control Plan (ESCP) should be established to provide a strategy for the temporary soil and water management at the site to be implemented during the backfilling works and should be based upon the requirements of Landcom (2004) publication Managing Urban Stormwater: Soils and Construction.

For the purpose of this backfill management plan, localised erosion and sediment control measures should be implemented to manage surface water during the backfilling works as required. Such management measures include:

- Setting up of silt curtains for the designated cells to contain and control sediment migration to other cells. The silt curtains should be designed for low risk applications:
  - 150mm float size up to 8m depth;
  - A skirt made of non-woven geotextile; and
  - Galvanised chain ballast thickness of 8-10mm.
- Construction of temporary diversion bunds around the stockpile areas and quarry perimeter to direct water to the water-filled inactive cells.
- Covering with suitable geotextiles such as tarpaulin or jute mesh to provide local soil erosion protection.
- Use of sandbags, straw bales, coir logs (or similar) at the edge facing inactive cells to reduce the velocity and control the flow of surface water and provide localised erosion protection.
- Install silt curtains and sediment fences on the downstream boundary in close proximity of the discharge point in the south west.
- Provide a wheel wash system at the site access / egress location, which will further control the tracking of sediment by vehicles onto adjoining roadways.
- Installation of dust control measures, including water sprinklers and a mobile dust suppression system, comprising a fine mist generator (‘fogger’).
- Revegetation of the filled cells for medium to long term quarry rehabilitation.

The indicative locations of sediment and erosion control measures are shown in Figure 6.

8. PASS CONTINGENCY MANAGEMENT PLAN

In the event that PASS is not delivered to site or backfilled in an appropriate manner, the contingency plan below should be followed:

- For PASS not delivered to Site in an appropriate manner, the PASS must be detected at the gate and not be accepted at the Site as per the Backfill Acceptance and Verification procedure described in Section 4.2. The PASS should be transported back to their source locations or disposed of at a Waste Facility that can lawfully accept the determined class of waste.
- For PASS that have been already accepted at the Site but cannot be backfilled in a appropriate manner, the PASS must be neutralised with lime or other suitable substance in accordance with the techniques prescribed in the ASS Manual as described in Section 4.2.3. After treatment the soil should be chemically assessed in accordance with the NSW EPA Waste Classification Guidelines and disposed of at a Waste Facility that can lawfully accept that determined class of waste.

9. GROUND SETTLEMENT MONITORING

Ground settlement monitoring could be undertaken at regular intervals less than every six months using a suitable survey technique to the approval of the Geotechnical Practitioner.

10. GROUND TREATMENT

Should excessive ground movements (settlement or heave) be observed or monitored at the Site, ground treatment should be considered. The requirement for any ground treatment should be assessed and confirmed by the Geotechnical Practitioner and could include *inter alia*:

- Preloading of select areas by applying surcharge of additional fill to increase consolidation of the underlying material.
- Dynamic Compaction. This technique increases the density of soil by transmitting high energy impacts to the ground.
- Vibroflotation. This technique uses a vibrating probe (poker) to penetrate the fill and increase density of the ground by applying vibrational energy.
- Any other method considered appropriate by a suitably qualified and experienced Geotechnical Practitioner.

11. ENVIRONMENTAL MONITORING

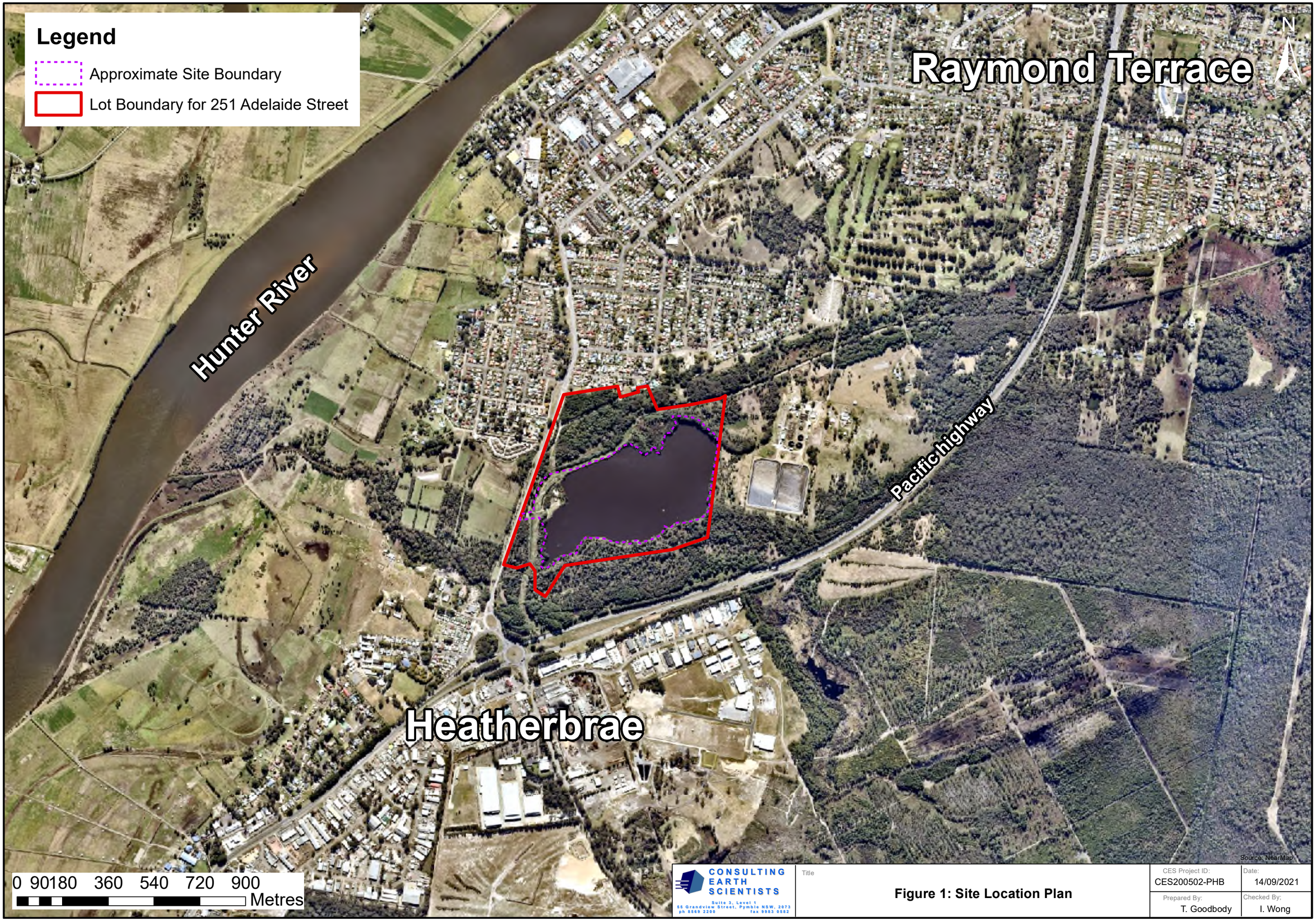
An Environmental Monitoring Plan should be prepared for the Site that should describe as a minimum, the proposed locations and monitoring frequencies of the following components:

- Groundwater,
- Surface water,
- Air quality;
- Noise and vibration (if applicable for ground treatment works); and
- Discharge.

12. REFERENCES

- BMT Eastern Australia Pty Ltd, 2019, *251 Adelaide Street, Raymond Terrace - Earthworks Flood Impact Assessment Letter Report, Report Ref: DXW: L.N21195.003.docx*, 5 May 2019;
- Charles J. A. and Watts K. S, 2001. *Building on fill: geotechnical aspects, Second Edition BRE Bookshop.*
- Consulting Earth Scientists Pty Ltd (CES), 2020, *Detailed Contaminated Land Assessment Report, 251 Adelaide Street, Raymond Terrace, NSW 2324, CES Document Reference (CES200502-PHB-AE)*, 18 December 2020.
- NSW EPA, 2014, *New South Wales Environment Protection Authority (EPA) Waste Classification Guidelines Part 4: Acid Sulfate Soils.*
- NSW Government Planning, Industry, & Environment (DPIE), (2020,), *Waste Management Facilities or Works for 251 Adelaide Street, Raymond Terrace (Lot 232 DP 593512) Planning Secretary's Environmental Assessment Requirements (SEARs) 1409*, 28 January 2020.
- NSW Resources Regulator, 2018, *Health and Safety At Quarries Guide November 2018.*

FIGURES



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Title

Figure 1: Site Location Plan

CES Project ID:	Date:
CES200502-PHB	14/09/2021
Prepared By: T. Goodbody	Checked By: I. Wong

Legend

- Groundwater Monitoring Wells
- Inferred Discharge Channel
- Grahamstown Drain
- Windeyers Creek
- Approximate Site Boundary
- Lot Boundary for 251 Adelaide Street

MW4
1.28 m AHD

Grahamstown Drain

MW3
0.86 m AHD

MW1
0.87 m AHD

MW5
0.69 m AHD

Windeyers Creek

MW2
0.49 m AHD

N

0 20 40 80 120 160 200
Metres

Water Levels Recorded
16 September 2020

Source: NearMap

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Figure 2: Site Layout and Groundwater Monitoring Plan

CES Project ID:	Date:
CES200502-PHB	14/09/2021
Prepared By: T. Goodbody	Checked By: I. Wong

Legend

Lot Boundary for 251 Adelaide Street

Base of Void Elevation

- -1.2 - 0
- -2.4 - -1.2
- -3.6 - -2.4
- -4.8 - -3.6
- -6 - -4.8
- -7.2 - -6
- -8.4 - -7.2
- -9.6 - -8.4
- -10.8 - -9.6

Total Void Volume to Final Landform 1,542,000 m3

N

0 25 50 100 150 200 250 Metres

Source: NearMap

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Figure 3: Total Quarry Void Estimate

CES Project ID:	Date:
CES200502-PHB	14/09/2021
Prepared By: T. Goodbody	Checked By; I. Wong

Figure 4: Indicative Backfill Programme
251 Adelaide Street Raymond Terrace
CES2005002-PHP
Total Project Duration
347 Weeks

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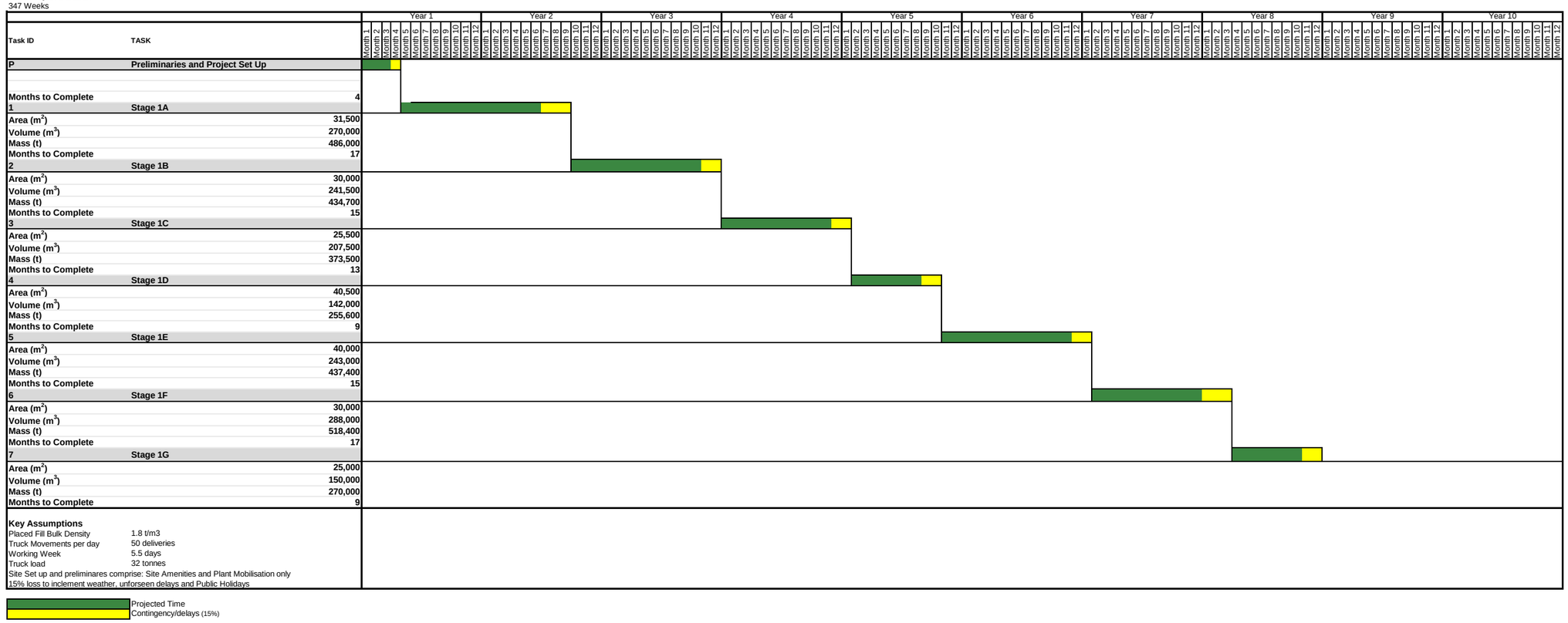
Task ID	TASK	
P	**Preliminaries and Project Set Up**	
Months to Complete		4
1	**Stage 1A**	
Area (m^2)		31,500
Volume (m^3)		270,000
Mass (t)		486,000
Months to Complete		17
2	**Stage 1B**	
Area (m^2)		30,000
Volume (m^3)		241,500
Mass (t)		434,700
Months to Complete		15
3	**Stage 1C**	
Area (m^2)		25,500
Volume (m^3)		207,500
Mass (t)		373,500
Months to Complete		13
4	**Stage 1D**	
Area (m^2)		40,500
Volume (m^3)		142,000
Mass (t)		255,600
Months to Complete		9
5	**Stage 1E**	
Area (m^2)		40,000
Volume (m^3)		243,000
Mass (t)		437,400
Months to Complete		15
6	**Stage 1F**	
Area (m^2)		30,000
Volume (m^3)		288,000
Mass (t)		518,400
Months to Complete		17
7	**Stage 1G**	
Area (m^2)		25,000
Volume (m^3)		150,000
Mass (t)		270,000
Months to Complete		9



Key Assumptions

Placed Fill Bulk Density	1.8 t/m3
Truck Movements per day	50 deliveries
Working Week	5.5 days
Truck load	32 tonnes

Site Set up and preliminares comprise: Site Amenities and Plant Mobilisation only
15% loss to inclement weather, unforseen delays and Public Holidays

Projected Time
Contingency/delays (15%)

Legend

- Stages
- Approximate Site Boundary
- Void Boundary

N

Stage A
31500 m2

Stage B
30000 m2

Stage C
25500 m2

Stage D
40500 m2

Stage E
40000 m2

Stage F
30000 m2

Stage G
25000 m2

0 1530 60 90 120 150
Metres

Source: Nearmap

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Title

Figure 5: Proposed Staged Filling Plan

CES Project ID:	Date:
CES200502-PHB	14/09/2021
Prepared By: T. Goodbody	Checked By: I. Wong

Diversion bund to be installed around stockpile area to prevent run on and minimise runoff.

All weather access road to be established progressively to provide access for trucks and plant.

Final landform to be contoured to design specification and landscaping plan. Fillied Area graded to fall towards inactive stages. Suitable controls (sandbags and sediment fencing) to be installed to prevent erosion of placed soils.

VENM, ENM or RRE filling above water to be completed dumping short and push methods. Dumping to be completed at least one truck length from the quarry crest.

VENM, ENM or RRE filling above -2 m AHD and below water to be completed using coveyor and/or long reach excavator or by dumping short and pushing. When dumping short, dumping should be completed a minmum of on truck length from the quarry crest.

PASS (and VENM, ENM or RRE) filling below -2 m AHD to be completed using coveyor and/or long reach excavator.

Silt Curtain to be installed at extents of subsurface filling to minimise migration of suspended solids

Diversion bund to be installed around the quarry void to minmise surface water inflows.

N

Legend

- Lot Boundary for 251 Adelaide Street
- Approximate Site Boundary
- Inferred Discharge Channel
- Grahamstown Drain
- Windeyers Creek
- Active Stage
- Inactive Stages
- Final Landform
- PASS, VENM, ENM, RRE to -2 m AHD
- VENM, ENM, RRE > -2 m AHD
- VENM, ENM, RRE Above Water Table
- Silt Curtain
- Sediment Controls at Discharge Point
- Stockpile Area
- Allweather Access Road
- Diversion Bund

0 10 20 40 60 80 100 Metres

Source: NearMap

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Title

Figure 6: Proposed Works Area Layout

CES Project ID:	Date:
CES200502-PHB	14/09/2021
Prepared By: T. Goodbody	Checked By: I. Wong

Legend

Area

- High Ground
- Low-lying for Flood Conveyance
- Transition Slope
- Approximate Site Boundary
- Lot Boundary for 251 Adelaide Street

N

High Ground
71000 m2 >2.1 m AHD

Low-lying for Flood Conveyance
13600 m2 1.0 m AHD

Transition Slope
34000 m2 1.1 to 2.1 m AHD

0 2550 100 150 200 250
Metres

Source: NearMap

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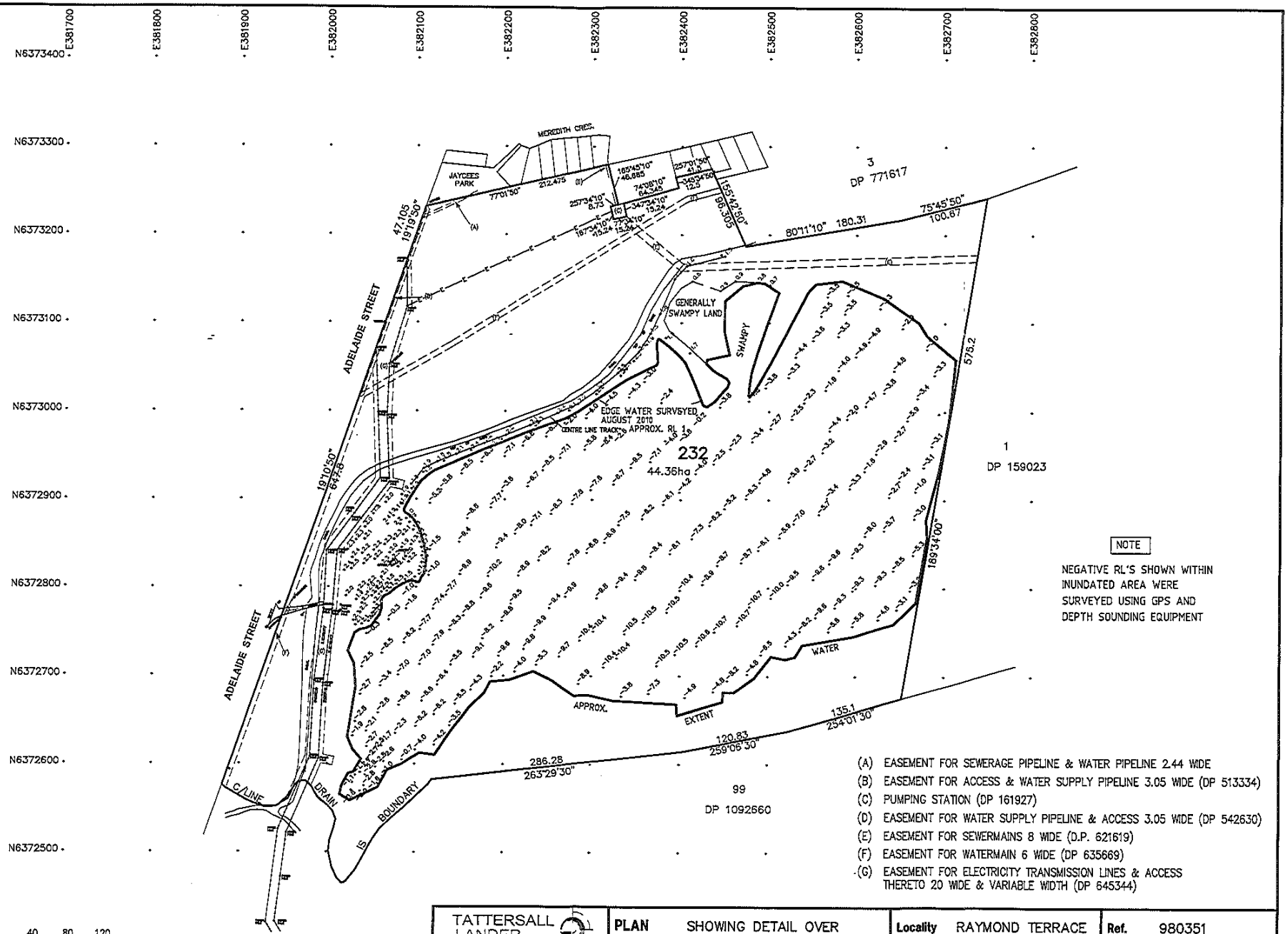
Title

Figure 7: Indicative Final Landform (Post-Filling)

CES Project ID:	Date:
CES200502-PHB	14/09/2021
Prepared By: T. Goodbody	Checked By; I. Wong

APPENDIX A: 2010 SURVEY PLAN
(TATTERSALL LANDER PTY LTD, 2010)



NOTE

NEGATIVE RL'S SHOWN WITHIN INUNDATED AREA WERE SURVEYED USING GPS AND DEPTH SOUNDING EQUIPMENT

(A) EASEMENT FOR SEWERAGE PIPELINE & WATER PIPELINE 2.44 WIDE
(B) EASEMENT FOR ACCESS & WATER SUPPLY PIPELINE 3.05 WIDE (DP 513334)
(C) PUMPING STATION (DP 161927)
(D) EASEMENT FOR WATER SUPPLY PIPELINE & ACCESS 3.05 WIDE (DP 542630)
(E) EASEMENT FOR SEWERMAINS 8 WIDE (D.P. 621619)
(F) EASEMENT FOR WATERMAIN 6 WIDE (DP 635669)
(G) EASEMENT FOR ELECTRICITY TRANSMISSION LINES & ACCESS THERETO 20 WIDE & VARIABLE WIDTH (DP 645344)

100 80 60 40 20 0 40 80 120 METRES
SCALE

DATUM OF LEVELS : AUSTRALIAN HEIGHT DATUM (AHD)
R.L. ADOPTED : SSM 91322 3.826m AHD

FILE: S:\Clients\1998\980351\Dwg\980351_site22102010.dwg

TATTERSALL LANDER PTY LTD
DEVELOPMENT CONSULTANTS
2 Bourke St. P.O.Box 580
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PLAN SHOWING DETAIL OVER LOT 232 IN DP 593512

Client ROCLA QUARRY PRODUCTS

Locality RAYMOND TERRACE
Council PORT STEPHENS
Purchase No. Q218763

Ref. 980351
Date of Survey SEPT 2010
Scale 1:4000 **Sheet Size** A3

APPENDIX B: PROPOSED CONCEPT FILL PLAN (BMT, 2019)

Title:
Concept Fill Plan

Figure:	Rev:
4	A

BMT endeavours to ensure that the information provided in this map is correct at the time of publication. BMT does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

N

0 100 200m

Approx. Scale

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