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# ACID SULFATE SOIL MANAGEMENT PLAN AND RADIOACTIVE SANDS ASSESSMENT

Staged Seniors Living Development

**87-89 Tweed Coast Road, Hastings Point**

ENV240556 (previously 20124)

For:

TriCare (Hastings) Limited

By:

ENV Services

Date:

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# SCOPE OF ENGAGEMENT AND LIMITATIONS

This report has been prepared by ENV Services at the request of TriCare (Hastings) Limited for the purpose of a Staged Seniors Living Development. This report is to support a State Development Application. No other parties may rely on the contents of this report for any purposes except those stated.

This report has been prepared based on the information provided to us and from other information obtained as a result of enquiries made by us. ENV accepts no responsibility for any loss or damage suffered howsoever arising to any person or corporation who may use or rely on this document for a purpose other than that described above.



ENV declares that it does not have, nor expects to have, a beneficial interest in the subject project.

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# LIST OF ACRONYMS

Below is a list of commonly used acronyms in this report:

AASS – Actual Acid Sulfate Soil

ASS – Acid Sulfate Soil

ASSMAC – Acid Sulfate Soils Management Advisory Committee

COC – Chain of Custody

ENV – ENV Services Pty Ltd

HMSR – Heavy Mineral Sands Residue

NASSIMM – National Acid Sulfate Soil Sampling and Identification Methods Manual

NATA – National Association of Testing Authorities

NEPC – National Environment Protection Council

NEPM – National Environment Protection (Assessment of Site Contamination) Measure 1999 (as amended 2013)

NSW EPA – New South Wales Environment Protection Authority

PASS – Potential Acid Sulfate Soil

$ppm_v$ – Parts Per Million (by volume)

QA/QC – Quality Assurance and Quality Control

# EXECUTIVE SUMMARY

ENV Services Pty Ltd (ENV) has been commissioned by Tricare (Hastings) Limited to prepare an Acid Sulfate Soil Management Plan (ASSMP) with additional Radioactive Soils Assessment (RSA) for the construction of a staged seniors living development at 87-89 Tweed Coast Road, Hastings Point, NSW 2489 (Lot 1 DP 786570) (the site) (Figure 1a, **Appendix A**). Proposed plans have been provided to ENV detailing four (4), three (3) storey buildings (Buildings D-G) with a single level basement carpark, a bowls pavilion and pool pavilion. The proposed development has an approximate building footprint of 5,099m$^2$, excluding roads, gardens, bowling green and ground level carparks. Drawing DA-2-11, **Appendix E** illustrates the overall site and drawing DA-2-31, **Appendix E** illustrates the section plans of proposed multi storey buildings.

The site is mapped as Class 3 with respect to Acid Sulfate Soils (ASS) by the Tweed Shire Council (refer to Figure 2, **Appendix A**). This means that works more than 1 metre below the natural ground surface, or works by which the water table is likely to be lowered more than 1 metre below the natural ground surface require ASS investigations and preparation of a Management Plan (if required).

The *Geotechnical Assessment* prepared by Martens and Associates Pty Ltd (Martens, 2025) indicated excavations up to a minimum of 4.5m below ground level (BGL) will be required (excluding additional excavations for lift wills). The *Civil Engineering Report* prepared by Cozens Regan Group (Cozens Regan Group, 2025), indicate 12,000m$^3$ of material will be excavated during the basement construction. Approximately 4,000m$^3$ of treated material will be used onsite and 8,000m$^3$ of soil will require off-site management.

Reference to information provided in a document outlining minutes of the Development Assessment (DA) meeting for the site, which was attended by representatives involved in the development, indicated the need for a radioactive soils assessment of *in situ* material requiring excavation. Cause for this was raised during the DA meeting held in 2019 due to historical heavy mineral sand extractions and potential for disposal of residues at the site. As such, ENV undertook field investigations to note radioactive properties in material removed during ASS drilling.

Based on this information, ENV has conducted an ASS investigation and radioactive sands assessment in accordance with the requirements of the Acid Sulfate Soil Management Advisory Committee (ASSMAC) Guidelines (1998); the Australian Government, *National Acid Sulfate Soils Sampling and Identification Methods Manual* (NASSIMM) (June 2018); the Australian Government – Australian Radiation Protection and Nuclear Safety Agency, *Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing* (2005); and the Australian Government – Australian Radiation Protection and Nuclear Safety Agency, *Management of Naturally Occurring Radioactive Material (NORM)* (2008).

The investigation included the drilling of eight boreholes to a depth of 5 m (0.5 m below the proposed depth of disturbance), with the collection of soil samples at approximate 0.5 m intervals, including one just below the root zone at approximately 0.2 mBGL.

**Radioactive properties within material assessed during drilling works were not noted to be present, based on Geiger counter results. As such, laboratory radionuclide testing was not undertaken.**

**The results of the ASS investigation indicated that soil profiles from 2.5 to m 5.0 are classifiable as ASS. Therefore, soils in these locations will require liming treatment.**

The following liming rates have been calculated for soils which are excavated and/or disturbed at the site, relative to excavation depth collected in March 2020.

**Table 1: Calculated Acid Sulfate Soils Liming Rates**

| Depth Interval to which Liming Rate Applies (mBGL) | Sample Depth used for Calculation (mBGL) | Liming Rate (kg $CaCo_3$ per tonne of soil) |
|---|---|---|
| 0.0 – 0.5 | 0.5 | No liming required |
| 0.5 – 1.0 | 1.0 | No liming required |
| 1.0 – 1.5 | 1.5 | No liming required |
| 1.5 – 2.0 | 2.0 | No liming required |
| 2.0 - 2.5 | 2.5 | No liming required |
| 2.5 – 3.0 | 3.0 | 3 |
| 3.0 – 3.5 | 3.0 | 3 |
| 3.5 – 4.0 | 4.0 | 5 |
| 4.0 – 4.5 | 4.5 | 4 |
| 4.5 – 5.0 | 4.5 | 4 |

It is recommended that reuse of treated acid sulfate soils occurs on the source site wherever possible. Soils that are surplus to the development must be disposed of as waste to a nominated landfill, or can be beneficially re-used as fill material off-site, under a specific exemption granted by the NSW Environment Protection Authority (EPA) in accordance with the NSW Resource Recovery framework. ENV can prepare an application for this exemption if required. If the application is approved by EPA, the treated excavated material can be transported to the approved receiving site and used as engineered fill. Movement of the treated excavated material to another site is not permissible until the specific exemption for beneficial reuse is granted by the EPA.

If the application to EPA is not approved, or it is considered more cost-effective to dispose of the material to landfill, it can be disposed to a suitably licensed landfill facility. Alternatively, off-site transport to a suitably licensed interstate facility in Queensland may be possible without prior treatment. These management options should be reviewed to ascertain the most cost-effective treatment and/or disposal method for the soil.

**Data Gaps and Reccomendations**

The original soil sampling program in March 2020 included soil sampling to 5.0m BGL, based on the proposed excavation depth of 3.5m BGL. However, updated plans and *Civil Engineering Report* (Cozens Regan Group, 2025) indicate revised excavation depths of 4.5m BGL, excluding lift wells. The *HIA (Issue 3)* (Martens, 2025) indicates groundwater depths ranging from 1.0m - 4.0m BGL.

Excavations for the proposed basement car park, lift wells and footings will intercept the groundwater table and dewatering will be required. A suitably qualified Environmental Engineer/Scientist should therefore be engaged to prepare a Dewatering Management Plan (DMP) which addresses potential environmental risks posed by the dewatering activities and provides environmental management measures to mitigate these risks.

The NASSIMM stipulates where the alteration of groundwater is expected, soil sampling is to extend at least one metre below the depth of the lowest estimated drawdown. Additional testing of ASS is therefore required to assess the soil to a depth of 1m below the expected dewatering depth. The depth of dewatering is anticipated to be approximately 6.0m BGL, therefore additional ASS

investigations are required to a depth of at least 7.0m BGL. The depth of ASS soil sampling should be confirmed with the civil engineer to determine final depths inclusive of lift wells, footings and services.

This ASSMP should be revised to include the results of the additional ASS soil sampling program.

# 1 INTRODUCTION

## 1.1 Overview

This Acid Sulfate Soils Assessment and Management Plan (ASSMP) and Radioactive Soils Assessment (RSA) has been prepared by ENV Services Pty Ltd (ENV) to support a Staged Seniors Living Development at 87-89 Tweed Coast Road, Hastings Point, NSW 2489 (Lot 1 DP 786570). The development will require the excavation and exposure of *in situ* soils on site that have been flagged as potentially containing acid sulfate soil (ASS) and radioactive residues. The relative location of the site is presented in Figure 1a, **Appendix A**.

Proposed plans have been provided to ENV detailing four (4), three (3) storey buildings (Buildings D-G) with a single level basement carpark, a bowls pavilion and pool pavilion. The proposed development has an approximate building footprint of 5,099m$^2$, excluding roads, gardens, bowling green and ground level carparks. Drawing DA-2-11, **Appendix E** illustrates the overall site and drawing DA-2-31, **Appendix E** illustrates the section plans of proposed multi storey buildings.

The *Geotechnical Assessment* (Martens, 2025) indicated excavations up to a minimum of 4.5m below ground level (BGL) will be required (excluding additional excavations for lift wills). The C*ivil Engineering Report* (Cozens Regan Group, 2025), indicate 12,000m$^3$ of material will be excavated during the basement construction. Approximately 4,000m$^3$ of treated material will be used onsite and 8,000m$^3$ of soil will require off-site management.

Information provided in a document outlining minutes of the Development Assessment (DA) meeting for the site, attended by representatives involved in the development, indicated the need for a radioactive soils assessment of *in situ* material located in portions of the site to be excavated during the earthworks program. Cause for this was raised during the DA meeting held in 2019, due to historical heavy mineral sand extraction and potential disposal of residue at the site. As such, ENV undertook field investigations to assess potential radioactive properties in material removed during ASS investigations.

The site is mapped as Class 3 with respect to Acid Sulfate Soils (ASS) by the Tweed Shire Council (refer to Figure 2, **Appendix A**); meaning any works more than 1 m below the natural ground surface and/or works by which the water table is likely to be lowered more than 1 metre below the natural ground surface trigger the need for an Acid Sulfate Soils (ASS) investigation and preparation of an ASSMP (if required).

This ASSMP sets out the methodology and results of an ASS investigation conducted by ENV at the site to evaluate ASS conditions as well as the potential for radioactive sands, together with treatment works and management procedures to be adopted during the proposed earthworks.

## 1.2 Acid Sulfate Soils (ASS)

Acid Sulfate Soil (ASS) is the common name given to soils containing iron sulfides. When exposed to oxygen through lowering of surrounding groundwater or excavation, air drawn into the soils can cause oxidation of the iron sulfides, producing sulfuric acid.

ASS typically occurs in low-lying coastal areas with historically high organic matter. Runoff from exposed ASS areas may find its way to stormwater, groundwater and eventually into natural aquatic environments. The acidic runoff may lower the pH of receiving waters, increase the concentration of metals and reduce the natural buffering capacity of the receiving waters.

There are two basic types of ASS: Actual Acid Sulfate Soils (AASS) and Potential Acid Sulfate Soils (PASS). AASS are soils in which some sulfides have already been oxidised. Hence AASS environments

may be acidic but have low potential for further acid generation. PASS are soils in which the sulfides have not yet been oxidized (i.e. they contain oxidisable sulfur). AASS and PASS can coexist.

In anaerobic conditions (such as below the water table), PASS do not pose an environmental threat, however if conditions change (such as during dewatering, excavation or drought), the sulfides can oxidise and form sulfuric acid. Developments involving excavation or dewatering must establish the presence and extent of ASS down the soil profile, as works may intercept ASS horizons and pose risks to both human and ecological health.

## 1.3 Radioactive Sands

Radioactive isotopes, or radioisotopes, occur naturally in the earth's crust. They are chemical elements that give off radiation. Mineral sands contain small amounts of naturally occurring radioactive material (NORM), which is mainly uranium and thorium and their natural decay products. The radioisotope impurities in what are collectively known as heavy minerals are bound within the crystal structure of the grains of the mineral sands monazite (a mix of various rare-earth phosphate minerals), zircon (zirconium silicate), xenotime (yttrium phosphate) and leucoxene (altered iron–titanium dioxide).

When mineral sands are mined and processed, they result in residues of reject or unmarketable heavy minerals that contain radioactivity. These residues are normally highly insoluble and are generally associated with either the mineral monazite, which is a thorium and rare-earth phosphate, or the dense mineral zircon and other dense minerals such as rutile (titanium dioxide).

Mining and mineral processing of radioactive ores generally leads to the generation of large volumes of radioactive waste. The most important are uranium mill tailings and monazite wastes from mineral sand mining. These have the potential to generate radiation doses significantly in excess of the acceptable dose limit for members of the public if they are not managed appropriately.

# 2 EXISTING SITE CONDITIONS AND SURROUNDING ENVIRONMENT

## 2.1 Site Conditions

The site is approximately 1.5 hectares (ha) in area, is irregularly shaped and is relatively flat. At the time of the investigation, the site consisted of a cleared portion of land behind the currently operational TriCare Hastings Point Retirement Community. The site was predominantly covered in grass, was fenced on all boundaries and had a service road leading from the site's entry point along the northern boundary to the southern boundary. ENV understands that historically, the site was used as a caravan park. Characteristics of this were noted to be present during fieldworks undertaken on 17 March 2020 and included lot identifiers, cleared areas making up the lots and associated underground services such as sewer, hydrant lines and power. Photographs recorded during site works are provided in the Photolog in **Appendix B**.

## 2.2 Surrounding Environment

The site is bordered by the TriCare Hastings Point Retirement Community to the east followed by Tweed Coast Road. Bushland is located to the approximate north and south of the site, while Cudgera Creek is located directly to the site's west. The township of Hastings Point is located 850m to the approximate north-east of the site.

A Shell Service Station is also located to the direct south of the TriCare Hastings Point Retirement Community, with access from Tweed Coast Road.

# 3 FIELD INVESTIGATION

## 3.1 Methodology

Site based work was conducted by ENV on 17 March 2020, comprising the drilling of six (6) boreholes to a depth of 5.0 mBGL. Reference to each borehole location can be found in Figure 1b, **Appendix A**. Drilling of the 6 boreholes was undertaken via the use of a trailer-mounted drill rig and solid flight augers. The 6 boreholes undertaken as part of the investigation meets the minimum density required by the ASSMAC (1998) and NASSIMM (2018) guidelines for a site of approximately 1.5 hectares (ha) in size.

Samples were collected directly from the auger, approximately every 0.5 m, to the maximum investigation depth of 5.0 mBGL (based on a proposed excavation depth of 4.0 mBGL) and included a surface sample at each location at approximately 0-0.2 mBGL (below the surface vegetation). The geological profile was logged in general accordance with the Unified Soil Classification System (USCS). Selected photographs taken of the spoil and investigation areas are presented in **Appendix B**. Sampling was conducted in accordance with the Acid Sulfate Soils Manual, as required in Section 7.1 of the Tweed Local Environmental Plan 2014. Whilst the sampling depth intervals of the Acid Sulfate Soil Manual do not meet current national guidance (NASSIMM 2018) sampling requirements, the data presented in this ASSMP is considered sufficent to detect the presence of ASS (and the treatment requirements).

All samples were transported to the analytical laboratory (Environmental Analysis Laboratory (EAL), Lismore) with accompanying chain of custody (COC) documentation. Each of the 64 samples collected were subjected to field peroxide screening, with 17 of these samples (more than 25%) analysed for ASS using the chromium suite method.

In addition to the ASS investigation, assessment of radioactive properties in soils extracted during the drilling program was undertaken at each location, with radiation levels recorded (measured in microSieverts per hour) at 0.5m increments using a Geiger counter. A total of 64 sampling points were measured. Laboratory analysis was not conducted on the samples, in consideration of the field results.

## 3.2 Results

### 3.2.1 Radioactive Sands

All Geiger counter results were recorded below the safe level of human exposure of 0.7 uSv/h, with each reading being around 0.1 uSv/h. Borelogs with individual Geiger readings are provided in Appendix G. Detailed field sheets from boreholes 5-6 have been lost since the original site investigation in March 2020 and detailed borelogs are unavailable. Notwithstanding, there were no field observations made during the drilling program which would indicate the likely presence of heavy mineral sand residue (HMSR). This is supported by the generally low Geiger Counter readings recorded in each of the other boreholes.

Table 2 summarises the available Geiger counter readings from the sampling program.

**Table 2: Summary of Geiger Counter Readings**

| Borehole | Lower Reading (uSv/h) | Upper Reading (uSv/h) | Criteria (uSv/h) |
|---|---|---|---|
| BH-01 | 0.00 | 0.12 | 0.7 |
| BH-02 | 0.16 | 0.16 | 0.7 |
| BH-03 | 0.07 | 0.12 | 0.7 |
| BH-04 | 0.08 | 0.16 | 0.7 |
| BH-05 | * | * | * |
| BH-06 | * | * | * |

* Detailed reading unknown due to loss of field sheets.

A SOEKS-01M Geiger Counter was used for the collection of radiation readings. The Certificate of Conformity for the device is provided in Appendix H. No elevated radiation readings were recorded during the site inspection.

### 3.2.2 Acid Sulfate Soils

Soils encountered during the site investigation generally consisted of a shallow reworked clayey material noted to be dry, fine, loose and soft with a low to medium plasticity index in each borehole extending from directly below the root zone (at approximately 0.2 mBGL) to 0.3 mBGL. Following this at each location, natural sands noted to be white/pale grey, moist, coarse, loose and soft with a low plasticity index were observed to extend to approximately 3.5 mBGL. At BH01, groundwater was intercepted at approximately 2.5 mBGL and auger refusal encountered on inferred rock at 3.5 mBGL and as such, was completed to this depth. For locations BH02, BH03 and BH04, groundwater was encountered at approximately 2.5 mBGL, while BH05 and BH06 encountered groundwater at approximately 1.5 mBGL. It is noted that BH05 and BH06 have a lower topographical elevation than the other boreholes, with a closer proximity to Cudgera Creek.

Below the natural sand layer, alluvial (natural) sand was encountered in BH02 to BH06 and was noted to be dark brown/grey, wet, coarse, loose and soft with a low plasticity index. Within this layer, between 2.5 to 4.0 mBGL, a sulfuric odour was noted.

The texture of each sample across site was reported by the laboratory to be coarse (sand). As such, all sample locations will have net acidity trigger values for the chromium suite analysis for coarse texture (e.g. sand) of ≥ 0.03% S for oxidisable sulfur and 18 mol H+/t for net acidity. These same trigger values would have been applied even if other textured material was reported by the lab due to excavation works at site exceeding 1,000 tonnes of material to removed. Understanding the net acidity trigger values for the Chromium Reducible Sulfur (CRS) analysis is important in evaluating the ASS results for each sample. The laboratory results for the ASS investigation are presented in **Appendix C** and Table 1, while laboratory certificates are presented in **Appendix D**.

The analytical field results indicate that of the soils sampled and analysed, samples BH03_ 3.0 and BH06_ 4 are reported as having a soil pHfox >4 pH units when field pH is >4 but <5. Based on the field pH tests, results indicate that material within the soil profile for BH03 at 3.0 mBGL and BH06 at 4.0 mBGL is classified as being Actual Acid Sulfate Soils (AASS).

Potential Acid Sulfate Soils (PASS) were also noted from the field results in BH03_ 0.2, BH03_ 3.0, BH03_ 3.5, BH03_ 4, BH03_ 4.5, BH03_ 5.0, BH04_ 3.0, BH04_ 3.5, BH04_ 4, BH04_ 4.5, BH04_ 5.0, BH05_ 3.0, BH05_ 3.5, BH05_ 4, BH05_ 4.5, BH05_ 5.0, BH06_ 4 and BH06_ 4.5; with each recording a pHFox of <3 pH units. In addition, various sample locations across each borehole were recorded as having a pH change <1 pH unit following exposure of material to hydrogen peroxide – also a potential indicator of PASS.

With reference to the Chromium Reducible Sulfur (CRS) results, in samples BH04_4.5 (0.083% S) and BH05_4.0 (0.073% S), the oxidisable sulfur recorded in each sample was greater than the trigger value of 0.03% S. This indicates that soil profiles within and potentially surrounding BH04 at 4.5 mBGL and BH05 at 4.0 mBGL may contain ASS. In addition, samples BH03_3.0, BH04_4.5, BH05_4.0 and BH06_4.0 were reported to have a net acidity concentration greater than the trigger value of 18 mol H+/t. An exceedance of the net acidity trigger value is another indication of ASS. As such, soil profiles within and potentially surrounding BH03_3.0, BH04_4.5, BH05_4.0 and BH06_4.0 contain ASS. Tabulated CRS results are presented in Table 2.

The laboratory analysis has determined a liming application rate (with a safety factor of 1.5) based on the results of the chromium reducible sulfur (CRS) analysis. Tabulated liming rates for each 0.5 m layer are provided in Table 3, with a summary of adopted liming rates presented in Table 4. The calculated liming rates were derived directly from laboratory reports.

**Table 3: Summary of Chromium Reducible Sulfur Results**

| Sample Location | Depth (m) | Texture | $pH_{KCl}$ | Titratable Actual Acidity (TAA) (mole $H^+$/tonne) | Reduced Inorganic Sulfur (%$S_{cr}$) | CRS Action Criteria[1] (%$S_{cr}$) | Net Acidity (mole $H^+$/tonne; based on %$S_{cr}$) | CRS Action Criteria[1] (Net Acidity mole $H^+$/tonne) | Liming Rate (kg $CaCO_3$/tonne DW[2]) |
|---|---|---|---|---|---|---|---|---|---|
| BH01 | 1.0 | Coarse | 6.43 | 2 | <0.005 | 0.03 | 2 | 18 | 0 |
| BH01 | 3.5 | Coarse | 6.24 | 3 | <0.005 | 0.03 | 3 | 18 | 0 |
| BH02 | 0.5 | Coarse | 6.08 | 2 | <0.005 | 0.03 | 2 | 18 | 0 |
| BH02 | 2.5 | Coarse | 6.36 | 2 | <0.005 | 0.03 | 2 | 18 | 0 |
| BH02 | 3.5 | Coarse | 6.58 | 0 | <0.005 | 0.03 | 0 | 18 | 0 |
| BH03 | 1.0 | Coarse | 6.27 | 2 | <0.005 | 0.03 | 2 | 18 | 0 |
| BH03 | 3.0 | Coarse | 4.73 | 23 | 0.021 | 0.03 | 36 | 18 | 3 |
| BH03 | 5.0 | Coarse | 5.79 | 4 | 0.011 | 0.03 | 11 | 18 | 1 |
| BH04 | 1.0 | Coarse | 6.13 | 3 | <0.005 | 0.03 | 3 | 18 | 0 |
| BH04 | 2.5 | Coarse | 6.28 | 4 | <0.005 | 0.03 | 4 | 18 | 0 |
| BH04 | 4.5 | Coarse | 5.61 | 6 | 0.083 | 0.03 | 58 | 18 | 4 |
| BH05 | 0.5 | Coarse | 6.31 | 1 | <0.005 | 0.03 | 1 | 18 | 0 |
| BH05 | 2.0 | Coarse | 6.39 | 2 | <0.005 | 0.03 | 2 | 18 | 0 |
| BH05 | 4.0 | Coarse | 5.24 | 15 | 0.073 | 0.03 | 60 | 18 | 5 |
| BH06 | 1.5 | Coarse | 6.31 | 1 | <0.005 | 0.03 | 1 | 18 | 0 |
| BH06 | 3.5 | Coarse | 5.61 | 9 | <0.005 | 0.03 | 9 | 18 | 1 |
| BH06 | 4.0 | Coarse | 4.94 | 17 | 0.028 | 0.03 | 35 | 18 | 3 |

Grey shaded cell indicates a net acidity or sulfur content greater than the ASSMAC (1998) and NASSIMM (2018) criteria.

**Table 4: Summary of Adopted Liming Rates**

| Depth Interval to which Liming Rate Applies (mBGL) | Sample Depth used for Calculation (mBGL) | Liming Rate (kg $CaCo_3$ per tonne of soil) |
|---|---|---|
| 0.0 – 0.5 | 0.5 | No liming required |
| 0.5 – 1.0 | 1.0 | No liming required |
| 1.0 – 1.5 | 1.5 | No liming required |
| 1.5 – 2.0 | 2.0 | No liming required |
| 2.0 - 2.5 | 2.5 | No liming required |
| 2.5 – 3.0 | 3.0 | 3 |
| 3.0 – 3.5 | 3.0 | 3 |
| 3.5 – 4.0 | 4.0 | 5 |
| 4.0 – 4.5 | 4.5 | 4 |
| 4.5 – 5.0 | 4.5 | 4 |

### 3.2.3 Data Gaps

The original soil sampling program in March 2020 investigated soils to a depth of 5.0m BGL, based on the proposed excavation depth of 3.5m BGL. However, updated plans and the *Civil Engineering Report* (Cozens Regan Group, 2025) indicate revised excavation depths of 4.5m BGL, excluding lift wells. The NASSIMM stipulates where the alteration of groundwater is expected, soil sampling is to extend at least one metre below the depth of the lowest estimated drawdown. Additional testing of ASS is required to assess the soil to a depth of 1m below the dewatering depth.

# 4 ENVIRONMENTAL ROLES AND RESPONSIBILITIES

## 4.1 Overview

TriCare is responsible for ensuring that the principal contractor for the development implements the management requirements of this ASSMP. This contractor will have responsibility for ensuring that all employees, subcontractors and persons involved with the proposed works are familiar with the requirements of the ASSMP.

Determining and implementing management for other environmental aspects associated with the works at the proposed development site; including but not limited to erosion and sediment control, and stormwater management; is the responsibility of TriCare and is to be addressed in the Environmental Management Plan prepared by the principal contractor. This ASSMP does not address environmental impact and mitigation measures associated with other environmental aspects of the project.

A copy of this ASSMP and the Environmental Management Plan must be kept by TriCare and a copy must always also be kept by the principal contractor onsite and accessible to all site personnel.

Successful implementation of this ASSMP relies upon support from and compliance by all involved parties. Such responsibilities are detailed below.

## 4.2 Appointed Project Manager

- Review and monitor environmental performance at regular worksite meetings.
- Required to be notified of any major environmental incidents and review the management procedures in place to deal with such occurrences.
- Monitor non-compliance and review management procedures if problem persists.
- Ensure that appropriate and adequate resources are allocated to allow for effective implementation and maintenance of the ASSMP.

## 4.3 Principal Contractor's Site Supervisor/Foreman

- Facilitate the reporting of incidents that may impact on the surrounding environment.
- Manage remediation actions to correct incidents of environmental non-compliance.
- Ensure that all staff are aware of and understand their responsibilities under the ASSMP.
- Identify any environmental training requirements.

## 4.4 Principal Contractor's Environment Officer

- Provide guidance and advice to staff regarding ASS management requirements.
- Monitor statutory requirements and ensure compliance.
- Where necessary, coordinate and/or assist in the response to environmental incidents.
- Maintain records of treatment, including verification testing of treated soils.
- Report all incidents with the potential to cause serious environmental harm to the Project Manager and where necessary, to the NSW EPA.

# 5 MANAGEMENT OF ASS

## 5.1 Summary of Works

The extent and particulars of the development at the site are set out in design plans provided in **Appendix E**. ENV has been advised that excavations at the site will be limited to a depth of approximately 4.50 mBGL (excluding lift wells). As such, the primary work activities identified that could potentially lead to disturbance or exposure of natural soils at the site may relate to:

- Excavation during construction works associated with basement carparks; and,
- Excavation during construction works associated with structural footings.

The *Civil Engineering Report* (Cozens Regan Group, 2025), indicate 12,000m$^3$ of material will be excavated during the basement construction. Approximately 4,000m$^3$ of material will be used onsite and 8,000m$^3$ of soil will require off-site management.

In an effort to reduce the risk of exposure and subsequent oxidation of (possibly exposed) material, this ASSMP provides management guidelines and mitigation practices that are to be incorporated as a part of the proposed works should material be exposed during excavations and should this material be exported off-site.

## 5.2 Potential Environmental Impacts

Oxidisation and incorrect management of acid sulfate soils can lead to the following environmental impacts.

- Leaching of sulfuric acidic into the soil, groundwater and surface water.
- Deoxygenation of groundwater and surface water.
- Corrosion of building footings and building services.
- Increase of dissolved metals in soil, groundwater and surface water. .
- Fish kills and poisoning of plants.

This ASSMP outlines the management requirements to mitigate the environmental impacts of acid sulfate soils.

## 5.3 Relevant Objectives

The objectives that are relevant to ASS management include:

- To minimise the potential for inappropriate material handling through accurate identification of ASS;
- To manage ASS material so that the potential for environmental harm is minimised;
- To minimise lowering of the groundwater, due to dewatering, in areas containing PASS;
- To minimise the potential for adverse environmental impact due to handling, storage and application of hazardous materials related to the treatment of ASS (note: this is unknown to be required for the proposed development); and,
- To ensure awareness of all personnel involved in the works at the proposed development of the requirements of this ASSMP and its objectives and management, particularly those aspects relevant to the individual.

## 5.4 Targets & Performance Indicators

The targets that are relevant to management of ASS include:

- ASS material has been identified;
- Excavation and/or filling to occur only in those areas where disturbance is necessary;
- No residual sulfidic acidity is present following full oxidation of disturbed ASS i.e. appropriate treatment of excavated ASS confirmed by collection and analysis of verification samples;
- Confirmation that any containment measures (i.e. bunds) are intact and impermeable and that records be kept of effectiveness and augmentation of these facilities (note: this is an unknown control measure for the proposed development);
- Groundwater level is maintained above ASS during and after works, where possible;
- Confirmation that any collected groundwater or surface water meets relevant criteria and/or existing characteristics prior to discharge to a receiving environment (note: this is an unknown control measure for the proposed development);
- Confirmation that handling and storage of hazardous materials is undertaken in accordance with relevant legislation and that records are kept of said handling and storage (note: this is an unknown control measure for the proposed development); and,
- All personnel involved in the works have undertaken appropriate training for their role in the project with regards to management of ASS.

# 6 DEWATERING

## 6.1 Dewatering

Dewatering should be avoided where possible to ensure that AASS and PASS within the site and on adjacent properties are not exposed to oxygen during the construction phase of this project. Exposure to oxygen, even for a short period of time, can result in the continued oxidisation of pyrite ($FeS_2$) through the exchange of electrons between $Fe^{2+}$ and $Fe^{3+}$. This reaction, which can produce sulfuric acid ($H_2SO_4$), can continue in the absence of oxygen (re-saturated sediments) resulting in the same environmental impact as could be expected should the materials be exposed to the atmosphere. The ASS field program indicated a depth to groundwater ranging between 1.5 mBGL (BH05 & BH06) and 2.5 mBGL (BH01, BH02, BH03 and BH04). It is therefore expected that excavations will extend into the groundwater table at each location.

A *Hydrological Impact Assessment (HIA) (Issue 3)* has been prepared by Martens & Associates Pty Ltd (Martens, 2025). The HIA recommends the following;

*A dewatering management plan should be prepared as part of the detailed design process and construction certificate documentation to guide dewatering during the basement construction phase. We recommend that this includes:*

> *1. Monitoring of groundwater levels outside the basement excavation areas using existing monitoring wells.*
>
> *2. The establishment of trigger values for groundwater level and water quality based on monitoring of existing groundwater conditions.*
>
> *3. Routine monitoring of groundwater quality during the groundwater extraction process to inform any treatment requirements.*
>
> *4. Monitoring of groundwater extraction (pumping) rates.*
>
> *5. A description of treatment and disposal methods.*
>
> *6. A trigger, action and response plan (TARP) to manage situations where trigger values are exceeded.*

The HIA (Martens, 2025) calculated the temporary dewatering volumes for a 3–6-month construction period. The temporary dewatering volumes range between 2.74-4.54 million litres (ML). Furthermore, as the predicted water take is greater than 3ML, a water supply works approval, and a Water Access License (WAL) are required prior to the commencement of the basement excavations.

A suitably qualified Environmental Engineer/Scientist should be engaged to prepare a Dewatering Management Plan (DMP) which addresses potential environmental risks posed by the dewatering activities and provides environmental management measures to mitigate these risks.

# 7 NEUTRALISATION TREATMENT OF EXCAVATED SOIL

## 7.1 Excavation

Information provided to ENV by the client indicates the final depth of excavations to be approximately 4.5 mBGL. This section of the ASSMP discusses the options for neutralisation of ASS material excavated from the aforementioned depths.

## 7.2 Treatment Area

Establishment of a treatment area in accordance with the information presented in this section will be required before commencing earthworks. Material should be moved to the treatment area within 24 hours of exposure. As part of earthworks, soil requiring neutralisation will be placed in maximum 250 $m^3$ (bulked volume) stockpiles on the treatment pad (refer below). Multiple treatment areas may be required for different portions of the excavation to allow for effective onsite treatment and validation before removal.

Figure 3, **Appendix A** illustrates the approximate locations of the treatment area between Building E and F, on the proposed bowling green and footprints of building D & E. However, the treatment area may require re-location depending on earthworks staging, underground services and area availability. The locations of the treatment pads are to be nominated during the detail design and construction phase with input from a civil contractor and project engineer. This ensures the pads are located in a practical location for the excavation, treatment and transport of treated material and to ensure the pad is not located within the proposed construction footprint of underground services and roads. The treatment pad should not be located within 50m of Cudgera Creek.

### 7.2.1 Leachate Capture

The entire liming pad (treatment area) is to be constructed with a perimeter bund wall, no less than 400 mm high and no less than 500 mm wide. The bund wall should be constructed using fine-grained and non-dispersive material (clay) and should be compacted to be as impermeable as possible. The leachate collection point should be constructed as a sump that is of sufficient size to store a $Q_{10}$ storm event (1:10 year ARI). Additional construction details are provided in Section 7.2.3.

It may be more efficient and effective to have a sump of limited size that is fitted with a pump with a float trigger. Water would then be pumped from the smaller (concrete pit style) sump to a portable plastic water tank. This tank could then be emptied by a wastewater contractor or the water treated and released in accordance with the site Environmental Management Plan.

### 7.2.2 Leachate Treatment

Water and leachate collected in the sump should be monitored using a calibrated pH meter prior to the commencement of work, and following the completion of work, each day for 14-21 days after the completion of works. All pH measurements should be recorded.

Should water in the sump have a pH falling outside the ANZG Water Quality Guidelines (2018) trigger value appropriate for the receiving watercourse, the water should be buffered using an accepted chemical neutralisation agent (commonly superfine agricultural lime). Additional treatment may be required where other parameters such as turbidity (high iron “floc”) exceed the trigger values.

Standard application rates for the treatment of water and leachate are presented in Table 5. The table indicates the amount of neutralising agent required to raise the pH of the water to neutral (7.0 pH

units). For example, if the leachate has low salinity and a pH of 3.5, 16 kg of Aglime would be required to neutralise 1ML of water.

**Table 5: Neutralisation Rates for Leachate**

| Water pH | H+ (mol/L) | H+ (mol/ML) | Aglime to Neutralise 1 ML | Hydrated Lime to Neutralise 1 ML | Sodium Bicarbonate to Neutralise 1 ML |
|---|---|---|---|---|---|
| | | | Kilograms Required | | |
| 0.5 | 0.316 | 316228 | 15824 | 11716 | 26574 |
| 1.0 | 0.1 | 100000 | 5004 | 3705 | 8403 |
| 1.5 | 0.032 | 31623 | 1582 | 1172 | 2657 |
| 2.0 | 0.01 | 10000 | 500 | 371 | 840 |
| 2.5 | 0.0032 | 3162 | 158 | 117 | 266 |
| 3.0 | 0.001 | 1000 | 50 | 37 | 84 |
| 3.5 | 0.00032 | 316 | 16 | 12 | 27 |
| 4.0 | 0.0001 | 100 | 5 | 4 | 8.4 |
| 4.5 | 0.000032 | 32 | 1.6 | 1.17 | 2.66 |
| 5.0 | 0.00001 | 10 | 0.5 | 0.37 | 0.84 |
| 5.5 | 0.0000032 | 3.2 | 0.16 | 0.12 | 0.27 |
| 6.0 | 0.000001 | 1.0 | 0.05 | 0.037 | 0.08 |
| 6.5 | 0.00000032 | 0.3 | 0.016 | 0.012 | 0.027 |

*Source: State Planning Policy 2/02 Guideline: Acid Sulfate Soils, Department of Natural Resources and Mines, Brisbane, 2004.*

Table 5 has been provided as a guide only. Depending on the chemistry of the water, additional neutralising agent may be required to obtain a pH of 7.0. Regular pH testing of the water should also be undertaken to monitor changes in pH during any dosing operations.

### 7.2.3 Liming Pad Design

Prior to the commencement of excavation, the liming pad (treatment area) should be constructed in an area that is not to be disturbed during the excavation and filling processes. If this is not possible, the treatment area may need to be relocated as excavation works progress. A graphical representation of a treatment pad is provided as Figure 1.

**Basic Design**

The liming pad should be constructed so the base of the pad is composed of compacted fine-grained material, to produce as impermeable foundation as possible. Ideally a clay liner, no less than 300 mm thick, should be placed on the base of the pad. The base of the pad should slope gently (2 – 5%) so as

to allow water/leachate to drain to a designated collection point. A leachate collection system, as described above, should be constructed.

**Guard Layer**

The base of the liming pad should be dusted with AgLime at a rate determined using the following equation:

Guard layer ($kg/m^2$) = 0.2 x thickness of layer to be treated (m) x average liming rate (kg/tonne).

For excavations surrounding depths and known locations of ASS at the proposed development, the guard-layer liming rate was calculated to be 0.2 $kg/m^2$ for a 0.5 m thick layer.

The AgLime for the guard layer should be spread using a lime/fertilizer spreader (tractor-towed) to ensure the base of the pad is evenly covered, prior to the placement of the material requiring treatment.

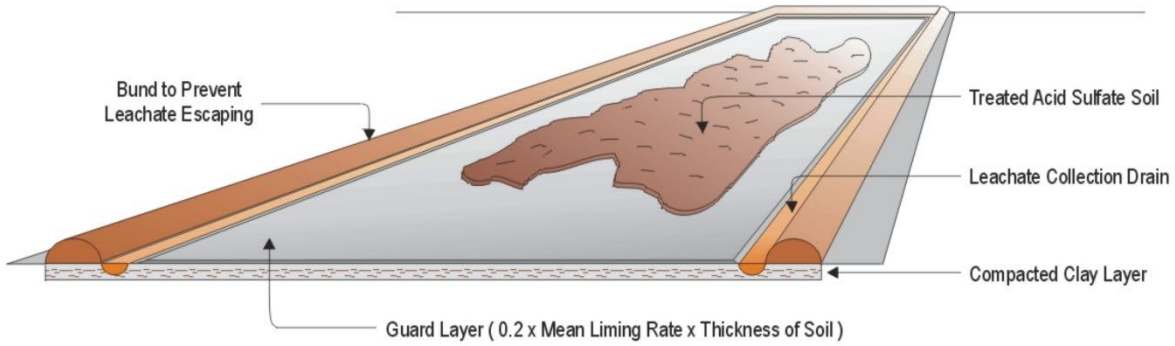


**Figure 1: Treatment Pad Design**

## 7.3 Application Rates for Neutralising Agent

The generalised liming rates for excavated material are:

- 0.0 – 2.5 m: No liming treatment.
- 2.5-3.5m: 3 kg of $CaCO_3$/tonne.
- 3.5 – 4.0m: 5 kg of $CaCO_3$/tonne.
- 4.0 – 4.5 m: 4 kg of $CaCO_3$/tonne.
- 4.5 – 5.0 m: 4 kg of $CaCO_3$/tonne.

All material excavated from these depths, identified as containing ASS, should be treated using the specified liming rate. If a variation from the liming rate is proposed, further field investigations will be required. If sub-surface conditions vary significantly from those observed during the ASS investigation (ENV, 2020), including any indications of contamination, excavation should cease and qualified personnel engaged to assess the site conditions, including laboratory testing to confirm the concentrations of any contaminants observed.

### 7.4 Mixing of Neutralising Agent

The material excavated from 2.5 mBGL and deeper should be placed on the liming pad in a layer no greater than 300 mm in thickness. Ideally, the soils/sediments should be allowed to partially dry prior to attempting to mix the neutralising agent. If the soils are too moist, the neutralising agent will not be evenly distributed throughout the soils and pockets of AgLime and untreated sediment will form within the stockpile. If this occurs, the soils will not self-neutralise when acidic leachate develops.

There are several ways to mix the neutralising agent into the materials to be treated, all of which have positive and negative aspects. Common mixing methods are described in Table 6.

**Table 6: Common Mixing Methods (Liming Agent)**

| Method | Positive Factors | Negative Factors |
|---|---|---|
| Tractor-towed disc plough | • Allows thorough mixing of AgLime and constant turning of soil to ensure AgLime distribution is even.<br>• Works well on dry soils. | • Requires a tractor, which may have no other use on site.<br>• Can require relatively large areas to enable treatment, as tractor will require turning space. |
| Rubber tyred vehicles | • Able to utilise any idle machinery to drive over the AgLime/soil mixture to mix materials together. | • Often results in pockets of lime forming in the soils. |
| Excavator | • Can utilise idle excavators to mix AgLime with soils.<br>• Works well on moist/wet soils. | • Requires specialised (longer) teeth to allow soils to be ripped deeply, allowing lime to be mixed more thoroughly.<br>• Can result in the formation of lime pockets in the soils. |
| Grader | • Can utilise idle machinery on site.<br>• Allows some churning of soil/AgLime mix by inclining blade and using tines. | • Can result in pockets of lime developing.<br>• Can result in damage to low permeability liner beneath the liming pad. |
| Pug Mill | • Allows high lime dosage rates.<br>• Guaranteed thorough mixing of neutralising material and soil. | • Additional plant required at high mobilisation cost. |

The most efficient and effective method of mixing neutralising agents, from those listed above, is the tractor-towed disc-plough. Provided the soils are dry to moist, the disc plough is ideal, however should water be present, and the soils comprise of cohesive material (clays), the excavator is likely to be more efficient (however not as effective) in mixing the neutralising agent through the soils. It may also be the only machinery practical to use for the proposed development.

No less than three (3) passes will be required to mix the neutralising agent through the soil. The effectiveness of the mixing process is contingent on the methodology of mixing.

## 7.5 Short Term Exposure

**Table 7: Indicative Maximum Periods for Short-Term Stockpiling of Untreated ASS**

| Type of Material | | Duration of stockpiling | | |
|---|---|---|---|---|
| **Texture range** | **Approx clay content (%)** | **Days** | | **Hours** |
| Coarse texture:<br>Sands to loamy sands | ≤ 5 | Overnight | or | 18 hours |
| Medium texture:<br>Sandy loams to light clays | 5-40 | 2½ days | or | 70 hours |
| Fine texture:<br>Medium to heavy clays and silty clays | ≥ 40 | 2½ days | or | 70 hours |

Source: Queensland Acid Sulfate Soil Technical Manual: Soil Management Guidelines, Department of Natural Resources and Mines, Brisbane, 2014.

Table 7 presents information regarding the short-term stockpiling of soils within the treatment area without liming for neutralisation.

The *in-situ* walls of the excavations should also be dusted with lime to ensure any acid generated during the period of exposure can be neutralised (refer below).

## 7.6 Lime Dusting of Exposed Excavation Surfaces

If left untreated after excavation, the exposed ASS in excavation faces may oxidise over time, causing an acidic environment. In addition, any acid produced during exposure may corrode concrete and other structures constructed within the excavations. It is therefore critically important to neutralise the exposed surfaces (base and walls) of excavations into ASS, to minimise drying out and reduce the potential for ASS and/or PASS to produce acid leachate. Dusting of exposed surfaces should be carried out at a rate of not less than 1kg of fine Aglime per $m^2$ of exposed soil surface.

## 7.7 Waste Tracking

Waste tracking must be undertaken by the contractor and provided in a final report to the Project Manager, as per the requirements outlined in Section 8. Refer to Section 10 for Management of Treated Excavated Material.

# 8 VALIDATION OF TREATED SOILS

## 8.1 Environmental Testing of Treated Soils

The principal contractor will be responsible for ensuring that any validation sampling and analysis of lime treated soil undertaken is conducted by a suitably qualified person, and in a manner that will demonstrate, with acceptable confidence, that sufficient AgLime has been mixed into the ASS, to provide an adequate buffer, such that the material meets the criteria set out in Table 8.

Validation sampling locations will be selected, as approved by the Site Supervisor/Foreman, such that a representative distribution for sample locations is achieved for the treated soil.

Validation sampling and analysis will be undertaken at a frequency that will demonstrate that satisfactory neutralisation has taken place. The frequency of soil validation sampling and analysis in accordance with the NASSIMM will be:

- 2 samples per 250 $m^3$ of remediated soil.

### 8.1.1 Sampling Technique

A suitably qualified Engineer/Scientist shall collect ten representative sub-samples to produce two (2) representative (composite) samples from each 250 $m^3$ of treated soil, in accordance with the following requirements:

- Approximately 250 g of soil must be collected from 10 representative locations, evenly distributed through the 250 $m^3$ of treated spoil; and
- Where the soil is cohesive, the sample must be homogenised in a large stainless bowl or similar, and a representative sample taken from the homogenised material.

### 8.1.2 Laboratory Analysis

Chromium Reducible Sulfur (CRS) testing must be undertaken by a third-party laboratory accredited by the National Association of Testing Authorities (NATA) for the required testing on all material that has been treated. Southern Cross University's Environmental Analysis Laboratory (EAL) can perform the required testing.

## 8.2 Validation Reporting

The principal contractor is responsible for ensuring that a suitably qualified Engineer/Scientist prepares two (2) copies of an ASS Neutralisation Certification Report ("ASSNCR") suitable for submission to Tweed Shire Council and the NSW EPA. The report will demonstrate that the excavated and treated soil has been sufficiently neutralised and meets the criteria presented in Table 8.

The ASSNCR will include, but not be limited to, the following information:

- Summary table of analytical results for each soil stockpile and the results of validation analysis;
- Plan of earthworks stockpile locations, showing:
    - Sample identification numbers
    - Location of validation sampling.

By submitting the ASSNCR to the Superintendent for review, the contractor is deemed to be stating to the Superintendent that all information presented in the ASSNCR is true and accurate and that the

remediation and validation of the ASS soils is of sufficient quality that the contractor is certifying that remediation, as defined under the contract, has been satisfactorily completed.

If the Superintendent considers that the ASSNCR does not provide sufficient evidence to demonstrate that satisfactory remediation has been achieved, or is of unsatisfactory quality, the Superintendent shall notify the contractor in writing, outlining the deficiencies in the ASSNCR and any corrective actions to be undertaken before approval by the Superintendent will be further considered. The contractor must immediately undertake such corrective action to the ASSNCR. The cost of such corrective action will be borne by the contractor.

## 8.3 Neutralisation Criteria

The criteria presented in Table 8 will be used to ensure that the excavated material has been sufficiently neutralised. The criteria have been drawn from the ASSMAC (1998) and NASSIMM (2018) Guidelines.

**Table 8: Action Limits for Treatment**

| ASS Soil Texture | Clay Content % | < 1000 Tonnes Disturbed | | > 1000 Tonnes Disturbed | |
|---|---|---|---|---|---|
| | | Sulfur Content % w/w | Acid Trail mol $H^+$ /tonne | Sulfur Content % w/w | Acid Trail mol $H^+$ /tonne |
| **Coarse** (sand & gravel) | < 5 | 0.03 | 18 | 0.03 | 18 |
| **Medium** (sandy loam - light clay) | 5 - 40 | 0.06 | 36 | | |
| **Fine** (medium to heavy clays, silty clays) | > 40 | 0.10 | 62 | | |

Where the laboratory results meet the action criteria presented in Table 8, the material will be considered to have been sufficiently neutralised.

Where the laboratory results do not meet the action, criteria presented in Table 8, additional neutralisation and validation testing of the soil will be required.

# 9 WASTE TRACEABILITY

All work under the Contract will be subdivided into distinct work lots or work items. Work lots or work items shall be chosen by the Contractor, consistent with any specified requirements, but will be subject to approval by the Superintendent.

Each work lot or work item will be assigned a unique identification number, and the Contractor will maintain a register of all allocated work lot or work item numbers. This register will contain as a minimum, the following information:

- Brief description of the work lot or work item;
- Location reference (3 dimensional, where applicable); and
- Lot or item status (ASS conforming or non-conforming).

The Contractor will ensure that traceability is maintained throughout all documented records under this Contract. All test results, where applicable under this Contract, will be positively identified with their respective work lot or work item number. The Contractor will notify the Superintendent in writing 24 hours prior to commencing a new work lot or work item.

The Contractor will be responsible for implementing a traceability programme for neutralisation and off-site transport of the material. The documentation will contain, but not be limited to, the following information:

- Truck registration;
- Truck driver;
- Date and time of departure from site;
- Date and time of arrival at the disposal or beneficial re-use site;
- Source of material (stockpile identification); and,
- Estimated volume of material transported.

Clear records of movements of excavated material to the treatment pads (source and destination), *in-situ* treatment details (AgLime volumes and application times) and disposal/reuse destinations are to be kept. Table 8 provides an example of how the records could be tabulated.

If dewatering is required, details of dewatering volumes, water quality, and disposal/reinjection destinations and volumes are also to be kept.

**Table 9: Example of a Record of Movement**

| Label | Date | Volume ($m^3$) | Location | Disposal Location A | Treatment Date | Volume of Aglime required | pH field testing | Testing Date | Result[1] | Disposal Location B | Disposal Location B |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vol A | 5-6-06 | 150 | Channel Ch 0-40 | Treatment Pad | 7-6-06 | 160 kg/tonne = 45,600 kg | $pH_f$ = 6.5 $pH_{fox}$ = 6.0 | 7-6-06 | 12-6-06 Acceptable (refer lab results) | 12-6-04 | Existing Drain Ch 0 to Ch 50, 3 m below surface level. |
| Vol B | 6-6-06 | 330 | Channel Ch 40-80 | Treatment Pad | 8-6-06 | 220 kg/tonne = 139,940 kg | $pH_f$ = 5.5 $pH_{fox}$ = 5.0 | 8-6-05 | 13-6-06 Failed | - | - |
| | | | | | 14-6-06 | 120 kg/tonne = 45,240 kg | $pH_f$ = 6.5 $pH_{fox}$ = 6.0 | 14-6-06 | 19-6-06 Acceptable (refer lab results) | 19-6-06 | Existing Drain Ch 50 to Ch 120, 3 m below surface level. |
| Vol C | 7-6-05 | 120 | Table Drain | Lemura Quarry | NA | NA | NA | 25-5-06 | 27-5-06 Sent to Lemura | NA | NA |
| Vol D | 9-6-05 | NA | Existing Drain Ch 20 - Ch 60 | *In-situ* guard layer | 9-6-06 | 80 kg/$m^3$ = 4,800 kg | NA | NA | NA | NA | NA |

# 10 MANAGEMENT OF TREATED EXCAVATED MATERIALS

All management of treated ASS materials must be undertaken in accordance with the NSW EPA Waste Classification Guidelines, Part 4: Acid Sulfate Soils (refer **Appendix F**), and other applicable EPA guidance documents.

Once the excavated material is treated, and the validation testing results are shown to meet the neutralisation criteria (Section 8.3), the treated material can be re-used on site. The *Civil Engineering Report* (Cozens Regan Group, 2025), indicate 12,000m$^3$ of material will be excavated during the basement construction. Approximately 4,000m$^3$ of material will be used onsite and 8,000m$^3$ of soil will require off-site management.

With respect to off-site management of ASS, it is not possible to beneficially re-use AASS or PASS as virgin excavated natural material (VENM) or excavated natural material (ENM). This means that any treated excavated material that is surplus to the construction works will need to be disposed of as waste to a nominated landfill, or beneficially re-used as fill material off-site under a specific exemption granted by EPA in accordance with the NSW Resource Recovery framework. ENV can prepare an application for this exemption if required. If the application is approved by EPA, the treated excavated material can be transported to the approved receiving site and used as engineered fill. Movement of the treated excavated material to another site is not permissible until the specific exemption for beneficial reuse is granted by the EPA.

If the application to EPA is not approved, or it is considered more cost-effective to dispose of the material to landfill, it can be disposed to a suitably licensed landfill facility. Alternatively, off-site transport to a suitably licensed interstate facility in Queensland may be possible without prior treatment. However, additional waste classification sampling may be required to support disposal to Queensland.

These management options should be reviewed to ascertain the most cost-effective treatment and/or disposal method for the soils.

# 11 DATA GAPS AND RECOMMENDATIONS

The original soil sampling program in March 2020 included soil sampling to 5.0m BGL, based on the proposed excavation depth of 3.5m BGL. However, updated plans and *Civil Engineering Report* (Cozens Regan Group, 2025) indicate revised excavation depths of 4.5m BGL, excluding lift wells. The *HIA (Issue 3)* (Martens, 2025) indicates groundwater depths ranging from 1.0m - 4.0m BGL.

Excavations for the proposed basement car park, lift wells and footings will intercept the groundwater table and dewatering will be required. A suitably qualified Environmental Engineer/Scientist should therefore be engaged to prepare a Dewatering Management Plan (DMP) which addresses potential environmental risks posed by the dewatering activities and provides environmental management measures to mitigate these risks.

The NASSIMM stipulates where the alteration of groundwater is expected, soil sampling is to extend at least one metre below the depth of the lowest estimated drawdown. Additional testing of ASS is therefore required to assess the soil to a depth of 1m below the expected dewatering depth. The depth of dewatering is anticipated to be approximately 6.0m BGL, therefore additional ASS investigations are required to a depth of at least 7.0m BGL. The depth of ASS soil sampling should be confirmed with the civil engineer to determine final depths inclusive of lift wells, footings and services.

This ASSMP should be revised to include the results of the additional ASS soil sampling program.

# 12 REFERENCES


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# APPENDIX A

Figures


**Legend**

Site Location (Approximate)

0 0.2 0.4km

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**Figure 1a – Site Location**
Staged Senior Living Development
Hastings Point, NSW 2480

**Project:** Acid Sulfate Soils Management Plant and Radionuclide Assessment
**Client:** TriCare
**Assessment Date:** May 2025

Image source: Six Maps (2009)


**Legend**

Borehole Location (Approximate)

Site Boundary (Approximate)

0 30 60 m

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**Figure 1b – Sample Locations**
Staged Senior Living Development
Hastings Point, NSW 2480

**Project:** Acid Sulfate Soils Management Plant and Radionuclide Assessment
**Client:** TriCare
**Assessment Date:** May 2025

Image source: google Earth (2020)

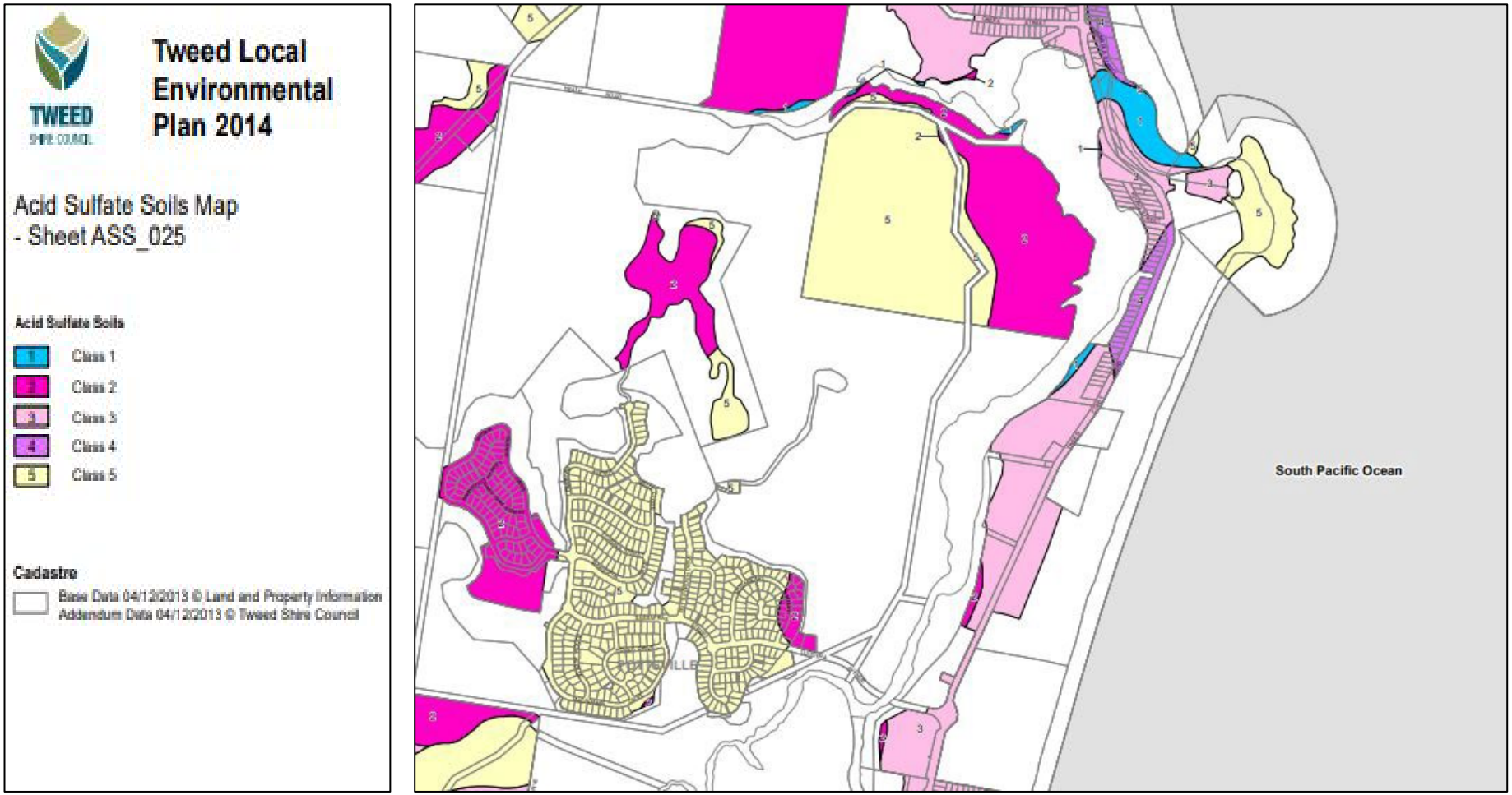


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**Figure 2 – Acid Sulfate Soils Risk Map (Tweed Shite Council LEP)**
Staged Senior Living Development
Hastings Point, NSW 2480

**Project:** Acid Sulfate Soils Management Plant and Radionuclide Assessment
**Client:** TriCare
**Assessment Date:** May 2025

Image source: Tweed Shire Council (2020)


**Legend**

Proposed Treatment Pads (Approximate)

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**Figure 3 – Site Plan and Proposed Treatment Areas**
Staged Senior Living Development
Hastings Point, NSW 2480

**Project:** Acid Sulfate Soils Management Plant and Radionuclide Assessment
**Client:** TriCare
**Assessment Date:** May 2025

Image source: Tweed Shire Council (2020)

# APPENDIX B

Photographs

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ENVIRONMENTAL | ASBESTOS | REMEDIATION | RESOURCE RECOVERY

# PHOTOGRAPHIC LOG

| Client Name | Site Location | Project |
|---|---|---|
| TriCare | 85-87 Tweed Coast Way, Hastings Point | ASSMP and RSA |

| Photo No. | Date |
|---|---|
| 1 | 17/03/2020 |

**Description**

Drilling location BH01. Material present on auger representing approximate 0.2 – 1.5 m profile.

No acid sulfate soils encountered at location BH01.

| Photo No. | Date |
|---|---|
| 2 | 17/03/2020 |

**Description**

Image showing soils encountered at BH02_2.5 and BH02_5.0.

Soils noted at 2.5 mBGL to be of natural, fine, soft sands.

Soils at 5.0m profile depth noted to be of natural saturated sands. Groundwater encountered at approximately 2.5 mBGL at this location.

No acid sulfate soils encountered at location BH02.


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# PHOTOGRAPHIC LOG

| Client Name | Site Location | Project |
|---|---|---|
| TriCare | 85-87 Tweed Coast Way, Hastings Point | ASSMP and RSA |

| Photo No. | Date |
|---|---|
| 3 | 17/03/2020 |

**Description**

Drilling location BH03. Natural sands encountered from 0.2 mBGL onwards. Groundwater noted at 2.5 mBGL.

Acid sulfate soils reported at 3.0 mBGL for this location.

| Photo No. | Date |
|---|---|
| 4 | 17/03/2020 |

**Description**

Drilling location BH04. Sulfuric odour noted from approximately 2.5 mBGL onwards.

Acid sulfate soils reported at 4.5 mBGL for this location.

ENV Solutions
ENVIRONMENTAL | ASBESTOS | REMEDIATION | RESOURCE RECOVERY

# PHOTOGRAPHIC LOG

| Client Name | Site Location | Project |
|---|---|---|
| TriCare | 85-87 Tweed Coast Way, Hastings Point | ASSMP and RSA |

| Photo No. | Date |
|---|---|
| 5 | 17/03/2020 |

**Description**

Drilling location BH05. Material present on auger representing approximate 0.2 – 1.5 m profile.

Acid sulfate soils reported at 4.0 mBGL for this location.

| Photo No. | Date |
|---|---|
| 6 | 17/03/2020 |

**Description**

Drilling location BH06. Groundwater encountered at approximately 1.5 mBGL.

No acid sulfate soils encountered at location BH06.

# APPENDIX C

Results Table

# RESULTS OF ACID SULFATE SOIL ANALYSIS

63 samples supplied by Env Solutions Pty Ltd on 18th March, 2020. Lab Job No.J1864
Analysis requested by Jacques Choimey. Your Job: 20124

PO Box 248 BALLINA NSW 2478

| | | | | | | | | | | | | | | | Non-treated soil | | Non-treated soil | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample Identification** | **EAL Lab Code** | **Texture** | **Moisture Content** | | **$pH_F$ and $pH_{FOX}$** | | | | **Potential Sulfidic Acidity** (Chromium Reducible Sulfur - CRS) | | | **Actual Acidity** (Titratable Actual Acidity - TAA) | **Retained Acidity** | | **Acid Neutralising Capacity** ($ANC_{BT}$) | | **Net Acidity** | **Lime Calculation** |
| | | | (% moisture of total wet weight) | (g moisture / g of oven dry soil) | $pH_F$ | $pH_{FOX}$ | pH change | Reaction | (% $S_{cr}$) | (mol $H^+$/t) | $pH_{KCl}$ | (mol $H^+$/t) | (%$S_{NAS}$) | (mol $H^+$/t) | (% $CaCO_3$) | (mol $H^+$/t) | (mol $H^+$/t) | (kg $CaCO_3$/t DW) |
| *Method Info.* | | ** | ** | | *(In-house method S21)* | | | | *(In-house method S20)* | | *(In-house method 16b)* | | ** | | *(In-house method S14)* | | ** | ** |
| **BH01_ 0.2** | *J1864/1* | Coarse | 10.5 | 0.12 | 5.94 | 4.57 | -1.37 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH01_ 0.5** | *J1864/2* | Coarse | 5.4 | 0.06 | 6.19 | 5.96 | -0.23 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH01_ 1.0** | *J1864/3* | Coarse | 17.8 | 0.22 | 6.37 | 5.90 | -0.47 | Low | <0.005 | 0 | 6.43 | 2 | .. | .. | .. | .. | 2 | 0 |
| **BH01_ 1.5** | *J1864/4* | Coarse | 4.7 | 0.05 | 6.47 | 5.83 | -0.64 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH01_ 2.0** | *J1864/5* | Coarse | 7.7 | 0.08 | 6.54 | 5.87 | -0.67 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH01_ 2.5** | *J1864/6* | Coarse | 12.9 | 0.15 | 6.59 | 5.92 | -0.67 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH01_ 3.0** | *J1864/7* | Coarse | 17.3 | 0.21 | 6.54 | 5.84 | -0.70 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH01_ 3.5** | *J1864/8* | Coarse | 14.4 | 0.17 | 6.49 | 5.40 | -1.09 | Low | <0.005 | 0 | 6.24 | 3 | .. | .. | .. | .. | 3 | 0 |
| **BH02_ 0.2** | *J1864/9* | Coarse | 19.2 | 0.24 | 5.06 | 4.15 | -0.91 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH02_ 0.5** | *J1864/10* | Coarse | 14.6 | 0.17 | 5.91 | 5.83 | -0.08 | Low | <0.005 | 0 | 6.08 | 2 | .. | .. | .. | .. | 2 | 0 |
| **BH02_ 1.0** | *J1864/11* | Coarse | 6.2 | 0.07 | 5.94 | 5.75 | -0.19 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH02_ 1.5** | *J1864/12* | Coarse | 20.6 | 0.26 | 5.96 | 5.77 | -0.19 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH02_ 2.0** | *J1864/13* | Coarse | 7.5 | 0.08 | 5.88 | 5.82 | -0.06 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH02_ 2.5** | *J1864/14* | Coarse | 10.5 | 0.12 | 6.00 | 5.81 | -0.19 | Low | <0.005 | 0 | 6.36 | 2 | .. | .. | .. | .. | 2 | 0 |
| **BH02_ 3.0** | *J1864/15* | Coarse | 17.6 | 0.21 | 5.98 | 5.78 | -0.20 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH02_ 3.5** | *J1864/16* | Coarse | 18.8 | 0.23 | 6.31 | 5.85 | -0.46 | Low | <0.005 | 0 | 6.58 | 0 | .. | .. | 0.07 | 13 | 0 | 0 |
| **BH02_ 4** | *J1864/17* | Coarse | 19.3 | 0.24 | 6.50 | 5.75 | -0.75 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH02_ 4.5** | *J1864/18* | Coarse | 21.6 | 0.28 | 6.32 | 4.72 | -1.60 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH02_ 5.0** | *J1864/19* | Coarse | 20.8 | 0.26 | 6.02 | 4.47 | -1.55 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH03_ 0.2** | *J1864/20* | Coarse | 17.3 | 0.21 | 6.01 | 2.71 | -3.30 | Medium | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH03_ 0.5** | *J1864/21* | Coarse | 17.4 | 0.21 | 6.24 | 5.21 | -1.03 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH03_ 1.0** | *J1864/22* | Coarse | 18.5 | 0.23 | 6.20 | 5.51 | -0.69 | Low | <0.005 | 0 | 6.27 | 2 | .. | .. | .. | .. | 2 | 0 |
| **BH03_ 1.5** | *J1864/23* | Coarse | 19.6 | 0.24 | 6.18 | 5.49 | -0.69 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH03_ 2.0** | *J1864/24* | Coarse | 18.8 | 0.23 | 6.20 | 5.71 | -0.49 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH03_ 2.5** | *J1864/25* | Coarse | 19.9 | 0.25 | 6.40 | 5.67 | -0.73 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH03_ 3.0** | *J1864/26* | Coarse | 17.7 | 0.22 | 4.97 | 2.22 | -2.75 | Medium | 0.021 | 13 | 4.73 | 23 | .. | .. | .. | .. | 36 | 3 |
| **BH03_ 3.5** | *J1864/27* | Coarse | 19.7 | 0.25 | 5.41 | 2.18 | -3.23 | Medium | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH03_ 4** | *J1864/28* | Coarse | 19.8 | 0.25 | 5.06 | 1.50 | -3.56 | Medium | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH03_ 4.5** | *J1864/29* | Coarse | 19.1 | 0.24 | 5.67 | 2.05 | -3.62 | Medium | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH03_ 5.0** | *J1864/30* | Coarse | 21.1 | 0.27 | 5.79 | 2.59 | -3.20 | Medium | 0.011 | 7 | 5.79 | 4 | .. | .. | .. | .. | 11 | 1 |
| **BH04_ 0.2** | *J1864/31* | Coarse | 17.8 | 0.22 | 5.36 | 3.67 | -1.69 | Medium | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH04_ 0.5** | *J1864/32* | Coarse | 15.8 | 0.19 | 5.88 | 5.08 | -0.80 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH04_ 1.0** | *J1864/33* | Coarse | 17.2 | 0.21 | 6.10 | 5.36 | -0.74 | Low | <0.005 | 0 | 6.13 | 3 | .. | .. | .. | .. | 3 | 0 |
| **BH04_ 1.5** | *J1864/34* | Coarse | 16.8 | 0.20 | 6.26 | 5.19 | -1.07 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH04_ 2.0** | *J1864/35* | Coarse | 18.3 | 0.22 | 6.34 | 5.49 | -0.85 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH04_ 2.5** | *J1864/36* | Coarse | 18.1 | 0.22 | 6.25 | 3.91 | -2.34 | Medium | <0.005 | 0 | 6.28 | 4 | .. | .. | .. | .. | 4 | 0 |
| **BH04_ 3.0** | *J1864/37* | Coarse | 19.4 | 0.24 | 5.35 | 1.91 | -3.44 | Medium | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH04_ 3.5** | *J1864/38* | Coarse | 18.6 | 0.23 | 5.81 | 2.53 | -3.28 | Medium | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH04_ 4** | *J1864/39* | Coarse | 19.5 | 0.24 | 5.80 | 1.40 | -4.40 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH04_ 4.5** | *J1864/40* | Coarse | 20.4 | 0.26 | 5.75 | 1.36 | -4.39 | Low | 0.083 | 52 | 5.61 | 6 | .. | .. | .. | .. | 58 | 4 |
| **BH04_ 5.0** | *J1864/41* | Coarse | 18.5 | 0.23 | 5.87 | 3.50 | -2.37 | Medium | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH05_ 0.2** | *J1864/42* | Coarse | 18.4 | 0.22 | 5.88 | 3.18 | -2.70 | Medium | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH05_ 0.5** | *J1864/43* | Coarse | 18.4 | 0.23 | 6.20 | 5.51 | -0.69 | Low | <0.005 | 0 | 6.31 | 1 | .. | .. | .. | .. | 1 | 0 |
| **BH05_ 1.0** | *J1864/44* | Coarse | 18.7 | 0.23 | 6.10 | 5.64 | -0.46 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH05_ 1.5** | *J1864/45* | Coarse | 19.1 | 0.24 | 6.14 | 5.38 | -0.76 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH05_ 2.0** | *J1864/46* | Coarse | 17.7 | 0.22 | 6.32 | 5.56 | -0.76 | Low | <0.005 | 0 | 6.39 | 2 | .. | .. | .. | .. | 2 | 0 |
| **BH05_ 2.5** | *J1864/47* | Coarse | 19.0 | 0.24 | 6.12 | 5.53 | -0.59 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH05_ 3.0** | *J1864/48* | Coarse | 19.0 | 0.24 | 5.62 | 1.14 | -4.48 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH05_ 3.5** | *J1864/49* | Coarse | 18.7 | 0.23 | 5.35 | 1.71 | -3.64 | Medium | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH05_ 4** | *J1864/50* | Coarse | 19.5 | 0.24 | 5.24 | 1.29 | -3.95 | Low | 0.073 | 46 | 5.24 | 15 | .. | .. | .. | .. | 60 | 5 |
| **BH05_ 4.5** | *J1864/51* | Coarse | 18.9 | 0.23 | 5.83 | 1.78 | -4.05 | Medium | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH05_ 5.0** | *J1864/52* | Coarse | 19.9 | 0.25 | 5.86 | 2.45 | -3.41 | Medium | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH06_ 0.2** | *J1864/53* | Coarse | 12.8 | 0.15 | 6.37 | 5.12 | -1.25 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH06_ 0.5** | *J1864/54* | Coarse | 17.1 | 0.21 | 6.50 | 5.23 | -1.28 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH06_ 1.0** | *J1864/55* | Coarse | 18.6 | 0.23 | 6.30 | 5.57 | -0.73 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH06_ 1.5** | *J1864/56* | Coarse | 17.0 | 0.20 | 6.62 | 5.40 | -1.22 | Low | <0.005 | 0 | 6.31 | 1 | .. | .. | .. | .. | 1 | 0 |
| **BH06_ 2.0** | *J1864/57* | Coarse | 17.2 | 0.21 | 6.27 | 5.39 | -0.88 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH06_ 2.5** | *J1864/58* | Coarse | 18.6 | 0.23 | 6.35 | 5.14 | -1.21 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH06_ 3.0** | *J1864/59* | Coarse | 18.2 | 0.22 | 6.29 | 4.44 | -1.85 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH06_ 3.5** | *J1864/60* | Coarse | 16.9 | 0.20 | 5.62 | 3.59 | -2.03 | Low | <0.005 | 0 | 5.61 | 9 | .. | .. | .. | .. | 9 | 1 |
| **BH06_ 4** | *J1864/61* | Coarse | 19.2 | 0.24 | 4.81 | 1.53 | -3.28 | Medium | 0.028 | 18 | 4.94 | 17 | .. | .. | .. | .. | 35 | 3 |
| **BH06_ 4.5** | *J1864/62* | Coarse | 19.6 | 0.24 | 5.44 | 2.33 | -3.11 | Medium | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH06_ 5.0** | *J1864/63* | Coarse | 18.2 | 0.22 | 5.83 | 3.07 | -2.76 | Medium | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |

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checked: .....
Graham Lancaster
Laboratory Manager

# APPENDIX D

Laboratory Documentation

# RESULTS OF ACID SULFATE SOIL ANALYSIS

63 samples supplied by Env Solutions Pty Ltd on 18th March, 2020. Lab Job No.J1864
Analysis requested by Jacques Choimey. Your Job: 20124

PO Box 248 BALLINA NSW 2478

| Sample Identification | EAL Lab Code | Texture | Moisture Content | | pH$_F$ and pH$_{FOX}$ | | | | Potential Sulfidic Acidity (Chromium Reducible Sulfur - CRS) | | | Actual Acidity (Titratable Actual Acidity - TAA) | Retained Acidity | | Non-treated soil: Acid Neutralising Capacity (ANC$_{BT}$) | | Non-treated soil: Net Acidity | Lime Calculation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | (% moisture of total wet weight) | (g moisture / g of oven dry soil) | pH$_F$ | pH$_{FOX}$ | pH change | Reaction | (% $S_{CR}$) | (mol $H^+$/t) | pH$_{KCl}$ | (mol $H^+$/t) | (% $S_{NAS}$) | (mol $H^+$/t) | (% $CaCO_3$) | (mol $H^+$/t) | (mol $H^+$/t) | (kg $CaCO_3$/t DW) |
| *Method Info.* | | ** | ** | | *(In-house method S21)* | | | | *(In-house method S20)* | | | *(In-house method 16b)* | ** | | *(In-house method S14)* | | ** | ** |
| **BH01_ 0.2** | *J1864/1* | Coarse | 10.5 | 0.12 | 5.94 | 4.57 | -1.37 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH01_ 0.5** | *J1864/2* | Coarse | 5.4 | 0.06 | 6.19 | 5.96 | -0.23 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH01_ 1.0** | *J1864/3* | Coarse | 17.8 | 0.22 | 6.37 | 5.90 | -0.47 | Low | <0.005 | 0 | 6.43 | 2 | .. | .. | .. | .. | 2 | 0 |
| **BH01_ 1.5** | *J1864/4* | Coarse | 4.7 | 0.05 | 6.47 | 5.83 | -0.64 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH01_ 2.0** | *J1864/5* | Coarse | 7.7 | 0.08 | 6.54 | 5.87 | -0.67 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH01_ 2.5** | *J1864/6* | Coarse | 12.9 | 0.15 | 6.59 | 5.92 | -0.67 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH01_ 3.0** | *J1864/7* | Coarse | 17.3 | 0.21 | 6.54 | 5.84 | -0.70 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH01_ 3.5** | *J1864/8* | Coarse | 14.4 | 0.17 | 6.49 | 5.40 | -1.09 | Low | <0.005 | 0 | 6.24 | 3 | .. | .. | .. | .. | 3 | 0 |
| **BH02_ 0.2** | *J1864/9* | Coarse | 19.2 | 0.24 | 5.06 | 4.15 | -0.91 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH02_ 0.5** | *J1864/10* | Coarse | 14.6 | 0.17 | 5.91 | 5.83 | -0.08 | Low | <0.005 | 0 | 6.08 | 2 | .. | .. | .. | .. | 2 | 0 |
| **BH02_ 1.0** | *J1864/11* | Coarse | 6.2 | 0.07 | 5.94 | 5.75 | -0.19 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH02_ 1.5** | *J1864/12* | Coarse | 20.6 | 0.26 | 5.96 | 5.77 | -0.19 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH02_ 2.0** | *J1864/13* | Coarse | 7.5 | 0.08 | 5.88 | 5.82 | -0.06 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH02_ 2.5** | *J1864/14* | Coarse | 10.5 | 0.12 | 6.00 | 5.81 | -0.19 | Low | <0.005 | 0 | 6.36 | 2 | .. | .. | .. | .. | 2 | 0 |
| **BH02_ 3.0** | *J1864/15* | Coarse | 17.6 | 0.21 | 5.98 | 5.78 | -0.20 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH02_ 3.5** | *J1864/16* | Coarse | 18.8 | 0.23 | 6.31 | 5.85 | -0.46 | Low | <0.005 | 0 | 6.58 | 0 | .. | .. | 0.07 | 13 | 0 | 0 |
| **BH02_ 4** | *J1864/17* | Coarse | 19.3 | 0.24 | 6.50 | 5.75 | -0.75 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH02_ 4.5** | *J1864/18* | Coarse | 21.6 | 0.28 | 6.32 | 4.72 | -1.60 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH02_ 5.0** | *J1864/19* | Coarse | 20.8 | 0.26 | 6.02 | 4.47 | -1.55 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH03_ 0.2** | *J1864/20* | Coarse | 17.3 | 0.21 | 6.01 | 2.71 | -3.30 | Medium | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH03_ 0.5** | *J1864/21* | Coarse | 17.4 | 0.21 | 6.24 | 5.21 | -1.03 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH03_ 1.0** | *J1864/22* | Coarse | 18.5 | 0.23 | 6.20 | 5.51 | -0.69 | Low | <0.005 | 0 | 6.27 | 2 | .. | .. | .. | .. | 2 | 0 |
| **BH03_ 1.5** | *J1864/23* | Coarse | 19.6 | 0.24 | 6.18 | 5.49 | -0.69 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH03_ 2.0** | *J1864/24* | Coarse | 18.8 | 0.23 | 6.20 | 5.71 | -0.49 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH03_ 2.5** | *J1864/25* | Coarse | 19.9 | 0.25 | 6.40 | 5.67 | -0.73 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH03_ 3.0** | *J1864/26* | Coarse | 17.7 | 0.22 | 4.97 | 2.22 | -2.75 | Medium | 0.021 | 13 | 4.73 | 23 | .. | .. | .. | .. | 36 | 3 |
| **BH03_ 3.5** | *J1864/27* | Coarse | 19.7 | 0.25 | 5.41 | 2.18 | -3.23 | Medium | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH03_ 4** | *J1864/28* | Coarse | 19.8 | 0.25 | 5.06 | 1.50 | -3.56 | Medium | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH03_ 4.5** | *J1864/29* | Coarse | 19.1 | 0.24 | 5.67 | 2.05 | -3.62 | Medium | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH03_ 5.0** | *J1864/30* | Coarse | 21.1 | 0.27 | 5.79 | 2.59 | -3.20 | Medium | 0.011 | 7 | 5.79 | 4 | .. | .. | .. | .. | 11 | 1 |
| **BH04_ 0.2** | *J1864/31* | Coarse | 17.8 | 0.22 | 5.36 | 3.67 | -1.69 | Medium | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH04_ 0.5** | *J1864/32* | Coarse | 15.8 | 0.19 | 5.88 | 5.08 | -0.80 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH04_ 1.0** | *J1864/33* | Coarse | 17.2 | 0.21 | 6.10 | 5.36 | -0.74 | Low | <0.005 | 0 | 6.13 | 3 | .. | .. | .. | .. | 3 | 0 |
| **BH04_ 1.5** | *J1864/34* | Coarse | 16.8 | 0.20 | 6.26 | 5.19 | -1.07 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH04_ 2.0** | *J1864/35* | Coarse | 18.3 | 0.22 | 6.34 | 5.49 | -0.85 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH04_ 2.5** | *J1864/36* | Coarse | 18.1 | 0.22 | 6.25 | 3.91 | -2.34 | Medium | <0.005 | 0 | 6.28 | 4 | .. | .. | .. | .. | 4 | 0 |
| **BH04_ 3.0** | *J1864/37* | Coarse | 19.4 | 0.24 | 5.35 | 1.91 | -3.44 | Medium | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH04_ 3.5** | *J1864/38* | Coarse | 18.6 | 0.23 | 5.81 | 2.53 | -3.28 | Medium | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH04_ 4** | *J1864/39* | Coarse | 19.5 | 0.24 | 5.80 | 1.40 | -4.40 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH04_ 4.5** | *J1864/40* | Coarse | 20.4 | 0.26 | 5.75 | 1.36 | -4.39 | Low | 0.083 | 52 | 5.61 | 6 | .. | .. | .. | .. | 58 | 4 |
| **BH04_ 5.0** | *J1864/41* | Coarse | 18.5 | 0.23 | 5.87 | 3.50 | -2.37 | Medium | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH05_ 0.2** | *J1864/42* | Coarse | 18.4 | 0.22 | 5.88 | 3.18 | -2.70 | Medium | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH05_ 0.5** | *J1864/43* | Coarse | 18.4 | 0.23 | 6.20 | 5.51 | -0.69 | Low | <0.005 | 0 | 6.31 | 1 | .. | .. | .. | .. | 1 | 0 |
| **BH05_ 1.0** | *J1864/44* | Coarse | 18.7 | 0.23 | 6.10 | 5.64 | -0.46 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH05_ 1.5** | *J1864/45* | Coarse | 19.1 | 0.24 | 6.14 | 5.38 | -0.76 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH05_ 2.0** | *J1864/46* | Coarse | 17.7 | 0.22 | 6.32 | 5.56 | -0.76 | Low | <0.005 | 0 | 6.39 | 2 | .. | .. | .. | .. | 2 | 0 |
| **BH05_ 2.5** | *J1864/47* | Coarse | 19.0 | 0.24 | 6.12 | 5.53 | -0.59 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH05_ 3.0** | *J1864/48* | Coarse | 19.0 | 0.24 | 5.62 | 1.14 | -4.48 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH05_ 3.5** | *J1864/49* | Coarse | 18.7 | 0.23 | 5.35 | 1.71 | -3.64 | Medium | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH05_ 4** | *J1864/50* | Coarse | 19.5 | 0.24 | 5.24 | 1.29 | -3.95 | Low | 0.073 | 46 | 5.24 | 15 | .. | .. | .. | .. | 60 | 5 |
| **BH05_ 4.5** | *J1864/51* | Coarse | 18.9 | 0.23 | 5.83 | 1.78 | -4.05 | Medium | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH05_ 5.0** | *J1864/52* | Coarse | 19.9 | 0.25 | 5.86 | 2.45 | -3.41 | Medium | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH06_ 0.2** | *J1864/53* | Coarse | 12.8 | 0.15 | 6.37 | 5.12 | -1.25 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH06_ 0.5** | *J1864/54* | Coarse | 17.1 | 0.21 | 6.50 | 5.23 | -1.28 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH06_ 1.0** | *J1864/55* | Coarse | 18.6 | 0.23 | 6.30 | 5.57 | -0.73 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH06_ 1.5** | *J1864/56* | Coarse | 17.0 | 0.20 | 6.62 | 5.40 | -1.22 | Low | <0.005 | 0 | 6.31 | 1 | .. | .. | .. | .. | 1 | 0 |
| **BH06_ 2.0** | *J1864/57* | Coarse | 17.2 | 0.21 | 6.27 | 5.39 | -0.88 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH06_ 2.5** | *J1864/58* | Coarse | 18.6 | 0.23 | 6.35 | 5.14 | -1.21 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH06_ 3.0** | *J1864/59* | Coarse | 18.2 | 0.22 | 6.29 | 4.44 | -1.85 | Low | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH06_ 3.5** | *J1864/60* | Coarse | 16.9 | 0.20 | 5.62 | 3.59 | -2.03 | Low | <0.005 | 0 | 5.61 | 9 | .. | .. | .. | .. | 9 | 1 |
| **BH06_ 4** | *J1864/61* | Coarse | 19.2 | 0.24 | 4.81 | 1.53 | -3.28 | Medium | 0.028 | 18 | 4.94 | 17 | .. | .. | .. | .. | 35 | 3 |
| **BH06_ 4.5** | *J1864/62* | Coarse | 19.6 | 0.24 | 5.44 | 2.33 | -3.11 | Medium | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| **BH06_ 5.0** | *J1864/63* | Coarse | 18.2 | 0.22 | 5.83 | 3.07 | -2.76 | Medium | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |

**NOTES:**

1. All analysis is reported on a dry weight (DW) basis, unless wet weight (WW) is specified.
2. Samples are dried and ground immediately upon arrival (unless supplied dried and ground).
3. Analytical procedures are sourced from Sullivan L, Ward N, Toppler N and Lancaster G. 2018. National acid sulfate soils guidance: national acid sulfate soils identification and laboratory methods manual, Department of Agriculture and Water Resources, Canberra, ACT. CC BY 4.0.
4. The Acid Base Accounting Equation, where Acid Neutralising Capacity has not been corroborated by other data, is **Net Acidity = Potential Acidity + Actual Acidity + Retained Acidity** (Eq. 3.2; Sullivan et al. 2018 - full reference above).
5. The Acid Base Accounting Equation for post-limed soil materials is **Net Acidity = Potential Acidity + Actual Acidity + Retained Acidity - (post treatment Acid Neutralising Capacity - initial Acid Neutralising Capacity)** (Eq. 3.3; Sullivan et al. 2018 - full reference above).
   While the Acid Neutralising Capacity of a soil material may not be included in the Net Acidity calculation (Note 4), it must be measured to give an Initial Acid Neutralising Capacity if verification testing is planned post-liming.
   **The Inital Acid Neutralising Capacity must be provided by the client to enable EAL to produce Verification Net Acidity and Liming calculations for post-limed soil materials.**
6. The Acid Base Accounting Equation, where Acid Neutralising Capacity has been corroborated by other data, is Net Acidity = Potential Acidity + Actual Acidity + Retained Acidity - Acid Neutralising Capacity (Eq. 3.1; Sullivan et al. 2018 - full reference above).
7. The lime calculation includes a Safety Factor of 1.5 as a safety margin for acid neutralisation (Sullivan et al. 2018). This is only applied to positive values. An increased Safety Factor may be required in some cases.
8. Retained Acidity is required when the pH$_{KCl}$ < 4.5 or where jarosite has been visually observed.
9. A negative Net Acidity result indicates an excess acid neutralising capacity.
10. If insufficient mixing occurs during intial sampling, or during post-liming, or both: the Potential Sulfidic Acidity may be greater in the post-limed sample than in the intial sample; the post-liming Acid Neutralising Capacity may be lower in the post-limed sample than in the intial sample.
11. **An acid sulfate soil management plan is triggered by Net Acidity results greater than the texture dependent criterion: coarse texture ≥ 0.03% S or 18 mol $H^+$/t; medium texture ≥ 0.06% S or 36 mol $H^+$/t; fine texture ≥ 0.1% S or 62 mol $H^+$/t)** (Table 1.1; Sullivan et al. 2018 - full reference above)
12. For projects that disturb > 1000 t of soil material, the coarse trigger of ≥ 0.03% S or ≥ 18 mol $H^+$/t must be applied in accordance with Sullivan et al. (2018) (full reference above).
13. Acid sulfate soil texture triggers can be related to NCST (2009) textures: coarse and peats = sands to loamy sands; medium = clayey sand to light clays; fine = light medium to heavy clays (Sullivan et al. 2018 - full reference above).
14. Bulk density is required to convert liming rates to soil volume based results. Field bulk density rings can be submitted to EAL for bulk density determination.
15. A negative Net Acidity result indicates an excess acid neutralising capacity.
16. '..' is reported where a test is either not requested or not required. Where pH$_{KCl}$ is < 4.5 or > 6.5, zero is reported for $S_{NAS}$ and ANC in Net Acidity calculations, respectively.
17. Results refer to samples as received at the laboratory. This report is not to be reproduced except in full.
18. ** NATA accreditation does not cover the performance of this service.
19. Analysis conducted between sample arrival date and reporting date.
20. All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions (refer scu.edu.au/eal or on request).
21. Results relate to the samples tested.
22. This report was issued on 20/03/2020.

NATA
WORLD RECOGNISED ACCREDITATION
Accreditation No. 14960
Accredited for compliance with ISO/IEC 17025 - Testing

Environmental Analysis Laboratory, Southern Cross University,
Tel. 02 6620 3678, website: scu.edu.au/eal

checked: .....
Graham Lancaster
Laboratory Manager

Environmental Analysis Laboratory

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ABN: 41 995 651 524

# Sample Receipt Notification (SRN)

Project: **EAL/J1864**
Customer: Env Solutions Pty Ltd
Contact: Jacques Choimey
Client Job ID: 20124
No. of Samples 63 x soil
Date Received: 18 MAR 2020
Comments: cc(attached)

Biller: **Env Solutions Pty Ltd** - Accounts Payable



**Test Request**

| Sample Text ID | Client Sample ID | AS-PACK-007 Acid Sulfate Soil pH-F and pH-FOX Testing | AS-PACK-008 Acid Sulfate Soil Net Acidity - S-CR |
|---|---|---|---|
| J1864/001 | BH01_ 0.2 | 1 | 0 |
| J1864/002 | BH01_ 0.5 | 1 | 0 |
| J1864/003 | BH01_ 1.0 | 1 | 1 |

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# Sample Receipt Notification (SRN) for EAL/J1864



| | | Acid Sulfate Soil pH-F and pH-FOX Testing | Acid Sulfate Soil Net Acidity - S-CR |
|---|---|---|---|
| | | AS-PACK-007 | AS-PACK-008 |
| J1864/004 | BH01_ 1.5 | 1 | 0 |
| J1864/005 | BH01_ 2.0 | 1 | 0 |
| J1864/006 | BH01_ 2.5 | 1 | 0 |
| J1864/007 | BH01_ 3.0 | 1 | 0 |
| J1864/008 | BH01_ 3.5 | 1 | 1 |
| J1864/009 | BH02_ 0.2 | 1 | 0 |
| J1864/010 | BH02_ 0.5 | 1 | 1 |
| J1864/011 | BH02_ 1.0 | 1 | 0 |
| J1864/012 | BH02_ 1.5 | 1 | 0 |
| J1864/013 | BH02_ 2.0 | 1 | 0 |

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# Sample Receipt Notification (SRN) for EAL/J1864



| | | Acid Sulfate Soil pH-F and pH-FOX Testing | Acid Sulfate Soil Net Acidity - S-CR |
|---|---|---|---|
| | | AS-PACK-007 | AS-PACK-008 |
| J1864/014 | BH02_ 2.5 | 1 | 1 |
| J1864/015 | BH02_ 3.0 | 1 | 0 |
| J1864/016 | BH02_ 3.5 | 1 | 1 |
| J1864/017 | BH02_ 4 | 1 | 0 |
| J1864/018 | BH02_ 4.5 | 1 | 0 |
| J1864/019 | BH02_ 5.0 | 1 | 0 |
| J1864/020 | BH03_ 0.5 | 1 | 0 |
| J1864/021 | BH03_ 1.0 | 1 | 0 |
| J1864/022 | BH03_ 1.5 | 1 | 1 |
| J1864/023 | BH03_ 2.0 | 1 | 0 |

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# Sample Receipt Notification (SRN) for EAL/J1864



| | | Acid Sulfate Soil pH-F and pH-FOX Testing | Acid Sulfate Soil Net Acidity - S-CR |
|---|---|---|---|
| | | AS-PACK-007 | AS-PACK-008 |
| J1864/024 | BH03_ 2.5 | 1 | 0 |
| J1864/025 | BH03_ 3.0 | 1 | 0 |
| J1864/026 | BH03_ 3.5 | 1 | 1 |
| J1864/027 | BH03_ 4 | 1 | 0 |
| J1864/028 | BH03_ 4.5 | 1 | 0 |
| J1864/029 | BH03_ 5.0 | 1 | 0 |
| J1864/030 | BH04_ 0.5 | 1 | 1 |
| J1864/031 | BH04_ 1.0 | 1 | 0 |
| J1864/032 | BH04_ 1.5 | 1 | 0 |
| J1864/033 | BH04_ 2.0 | 1 | 1 |

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# Sample Receipt Notification (SRN) for EAL/J1864



| | | Acid Sulfate Soil pH-F and pH-FOX Testing | Acid Sulfate Soil Net Acidity - S-CR |
|---|---|---|---|
| | | AS-PACK-007 | AS-PACK-008 |
| J1864/034 | BH04_ 2.5 | 1 | 0 |
| J1864/035 | BH04_ 3.0 | 1 | 0 |
| J1864/036 | BH04_ 3.5 | 1 | 1 |
| J1864/037 | BH04_ 4 | 1 | 0 |
| J1864/038 | BH04_ 4.5 | 1 | 0 |
| J1864/039 | BH04_ 5.0 | 1 | 0 |
| J1864/040 | BH05_ 0.5 | 1 | 1 |
| J1864/041 | BH05_ 1.0 | 1 | 0 |
| J1864/042 | BH05_ 1.5 | 1 | 0 |
| J1864/043 | BH05_ 2.0 | 1 | 1 |

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# Sample Receipt Notification (SRN) for EAL/J1864



| | | Acid Sulfate Soil pH-F and pH-FOX Testing | Acid Sulfate Soil Net Acidity - S-CR |
|---|---|---|---|
| | | AS-PACK-007 | AS-PACK-008 |
| J1864/044 | BH05_ 2.5 | 1 | 0 |
| J1864/045 | BH05_ 3.0 | 1 | 0 |
| J1864/046 | BH05_ 3.5 | 1 | 1 |
| J1864/047 | BH05_ 4 | 1 | 0 |
| J1864/048 | BH05_ 4.5 | 1 | 0 |
| J1864/049 | BH05_ 5.0 | 1 | 0 |
| J1864/050 | BH06_ 0.5 | 1 | 1 |
| J1864/051 | BH06_ 1.0 | 1 | 0 |
| J1864/052 | BH06_ 1.5 | 1 | 0 |
| J1864/053 | BH06_ 2.0 | 1 | 0 |

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# Sample Receipt Notification (SRN) for EAL/J1864



| | | Acid Sulfate Soil pH-F and pH-FOX Testing | Acid Sulfate Soil Net Acidity - S-CR |
|---|---|---|---|
| | | AS-PACK-007 | AS-PACK-008 |
| J1864/054 | BH06_ 2.5 | 1 | 0 |
| J1864/055 | BH06_ 3.0 | 1 | 0 |
| J1864/056 | BH06_ 3.5 | 1 | 1 |
| J1864/057 | BH06_ 4 | 1 | 0 |
| J1864/058 | BH06_ 4.5 | 1 | 0 |
| J1864/059 | BH06_ 5.0 | 1 | 0 |
| J1864/060 | x | 1 | 1 |
| J1864/061 | x | 1 | 1 |
| J1864/062 | x | 1 | 0 |
| J1864/063 | x | 1 | 0 |

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# Sample Receipt Notification (SRN) for EAL/J1864



| | Acid Sulfate Soil pH-F and pH-FOX Testing | Acid Sulfate Soil Net Acidity - S-CR |
|---|---|---|
| | AS-PACK-007 | AS-PACK-008 |
| **Total** | 63 | 17 |

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# Sample Receipt Notification (SRN) for EAL/J1864



## Test Descriptions

| Test List Item | Item Description |
|---|---|
| AS-PACK-007 | **Acid Sulfate Soil pH-F and pH-FOX Testing**<br>Moisture, Drying, Grinding<br>Peroxide pH Screening<br>Routine TAT of 2 days |
| AS-PACK-008 | **Acid Sulfate Soil Net Acidity - S-CR**<br>Net Acidity Complete as per new National Guidelines<br>Moisture, Drying, Grinding<br>TAA, CRS<br>(ANC INCLUDED when pH > 6.5 and SNAS INCLUDED when pH < 4.5) |

EAL Environmental Analysis Laboratory

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**Submitting Client Details**

Quote Id: EALQ5465
Job Ref: 20124
Company: ENV Solutions
Contact: Jacques Chiomey
Phone: 0430407023
Mobile:
Email: jacques@envsolutions.com.au; ben@envsolutions.com.au
Postal address:

**Billing Client Details**

□ Tick if same as submitting details
ABN:
Company:
Contact:
Phone:
Mobile:
Email:
Postal address:

**Payment Method:**

□ Purchase Order
□ Cheque
□ Credit/Debit Card (EAL staff will phone for details)
□ Invoice (prior approval)

Relinquished: JC Date: 17/03/2020
Received: Date: 18.3.20

Preservation: none - freezer bricks - ice - acidified - filtered - other
Condition on receipt: ambient - cool - frozen - other

In submitting samples, the Client agrees to the EAL Laboratory Services Terms and Conditions. These Terms and Conditions are available on the EAL website: scu.edu.au/eal, or on request.

**Comments:**

**Likelihood and nature of Hazardous material:**

| Lab ID | Sample ID | Sample Depth | Sampling Date | Sampler | Your Client | Crop ID | Sample Type (e.g. water, leaf, soil) | Total number of samples: AS-PACK-007 | AS-PACK-008 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Sample Analysis Request: Price list code (e.g. SW-PACK-06) | | | | | |
| 1 | BH01_0.2 | 0.2 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| | BH01_0.5 | 0.5 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| | BH01_1.0 | 1 | 17/03/2020 | JC | Tricare | | Soil | X | X | | | | |
| | BH01_1.5 | 1.5 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| | BH01_2.0 | 2 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| | BH01_2.5 | 2.5 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| | BH01_3.0 | 3 | 17/03/2020 | JC | Tricare | | Soil | X | X | | | | |
| 8 | BH01_3.5 | 3.5 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
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| | | | | | | | | Sample Analysis Request | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Price list code (e.g. SW-PACK-06) | | | | | |
| Lab ID | Sample ID | Sample Depth | Sampling Date | Sampler | Your Client | Crop ID | Sample Type (e.g. water, leaf, soil) | AS-PACK-007 | AS-PACK-008 | | | | |
| 9 | BH02_0.2 | 0.2 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| | BH02_0.5 | 0.5 | 17/03/2020 | JC | Tricare | | Soil | X | X | | | | |
| | BH02_1.0 | 1 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| | BH02_1.5 | 1.5 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| | BH02_2.0 | 2 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| | BH02_2.5 | 2.5 | 17/03/2020 | JC | Tricare | | Soil | X | X | | | | |
| | BH02_3.0 | 3 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| | BH02_3.5 | 3.5 | 17/03/2020 | JC | Tricare | | Soil | X | X | | | | |
| | BH02_4.0 | 4 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| | BH02_4.5 | 4.5 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| 19 | BH02_5.0 | 5 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
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| | | | | | | | | Sample Analysis Request | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Price list code (e.g. SW-PACK-06) | | | | | |
| Lab ID | Sample ID | Sample Depth | Sampling Date | Sampler | Your Client | Crop ID | Sample Type (e.g. water, leaf, soil) | AS-PACK-007 | AS-PACK-008 | | | | |
| 20 | BH03_0.2 | 0.2 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| | BH03_0.5 | 0.5 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| | BH03_1.0 | 1 | 17/03/2020 | JC | Tricare | | Soil | X | X | | | | |
| | BH03_1.5 | 1.5 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| | BH03_2.0 | 2 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| | BH03_2.5 | 2.5 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| | BH03_3.0 | 3 | 17/03/2020 | JC | Tricare | | Soil | X | X | | | | |
| | BH03_3.5 | 3.5 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| | BH03_4.0 | 4 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| | BH03_4.5 | 4.5 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| 30 | BH03_5.0 | 5 | 17/03/2020 | JC | Tricare | | Soil | X | X | | | | |
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| | | | | | | | | Sample Analysis Request | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Price list code (e.g. SW-PACK-06) | | | | | |
| Lab ID | Sample ID | Sample Depth | Sampling Date | Sampler | Your Client | Crop ID | Sample Type (e.g. water, leaf, soil) | AS-PACK-007 | AS-PACK-008 | | | | |
| 31 | BH04_0.2 | 0.2 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| | BH04_0.5 | 0.5 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| | BH04_1.0 | 1 | 17/03/2020 | JC | Tricare | | Soil | X | X | | | | |
| | BH04_1.5 | 1.5 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| | BH04_2.0 | 2 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| | BH04_2.5 | 2.5 | 17/03/2020 | JC | Tricare | | Soil | X | X | | | | |
| | BH04_3.0 | 3 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| | BH04_3.5 | 3.5 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| | BH04_4.0 | 4 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| | BH04_4.5 | 4.5 | 17/03/2020 | JC | Tricare | | Soil | X | X | | | | |
| 41 | BH04_5.0 | 5 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
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| | | | | | | | | Sample Analysis Request | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Price list code (e.g. SW-PACK-06) | | | | | |
| Lab ID | Sample ID | Sample Depth | Sampling Date | Sampler | Your Client | Crop ID | Sample Type (e.g. water, leaf, soil) | AS-PACK-007 | AS-PACK-008 | | | | |
| 42 | BH05_0.2 | 0.2 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| | BH05_0.5 | 0.5 | 17/03/2020 | JC | Tricare | | Soil | X | X | | | | |
| | BH05_1.0 | 1 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| | BH05_1.5 | 1.5 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| | BH05_2.0 | 2 | 17/03/2020 | JC | Tricare | | Soil | X | X | | | | |
| | BH05_2.5 | 2.5 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| | BH05_3.0 | 3 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| | BH05_3.5 | 3.5 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| | BH05_4.0 | 4 | 17/03/2020 | JC | Tricare | | Soil | X | X | | | | |
| | BH05_4.5 | 4.5 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| 52 | BH05_5.0 | 5 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
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| | | | | | | | | Sample Analysis Request | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Price list code (e.g. SW-PACK-06) | | | | | |
| Lab ID | Sample ID | Sample Depth | Sampling Date | Sampler | Your Client | Crop ID | Sample Type (e.g. water, leaf, soil) | AS-PACK-007 | AS-PACK-008 | | | | |
| 53 | BH06_0.2 | 0.2 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| | BH06_0.5 | 0.5 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| | BH06_1.0 | 1 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| | BH06_1.5 | 1.5 | 17/03/2020 | JC | Tricare | | Soil | X | X | | | | |
| | BH06_2.0 | 2 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| | BH06_2.5 | 2.5 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| | BH06_3.0 | 3 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| | BH06_3.5 | 3.5 | 17/03/2020 | JC | Tricare | | Soil | X | X | | | | |
| | BH06_4.0 | 4 | 17/03/2020 | JC | Tricare | | Soil | X | X | | | | |
| | BH06_4.5 | 4.5 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
| 63 | BH06_5.0 | 5 | 17/03/2020 | JC | Tricare | | Soil | X | | | | | |
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# APPENDIX E

Design Plans

## AREA SCHEDULE (SITE COVERAGE)

**PROPOSED BUILDINGS**

| | |
|---|---|
| BOWLS PAVILION | 111.3m² |
| POOL PAVILION | 485.06m² |
| BUILDING D | 1315.63m² |
| BUILDING E | 1523.88m² |
| BUILDING F | 1082.70m² |
| BUILDING G | 580.32m² |
| TOTAL BUILDING COVER | 5098.88m² |

**EXISTING DEVELOPMENT** (AS PER R.H. FRANKLAND & ASSOCIATES PROJECT NO. 05170 DRAWING: TP00 REV E AND TP01 REV P)

| | |
|---|---|
| COVERED | 5740m² |

**PROPOSED DEVELOPMENT**

| | |
|---|---|
| COVERED | 5098.88m² |

**TOTAL**

| | |
|---|---|
| COVERED | 10838.88m² (approx.) |
| UNCOVERED | 27131.12m² (approx.) |
| SITE COVERAGE (TOTAL AREA = 37970m² approx.) | 28.55% (approx.) |


1 OVERALL AREA PLAN - SITE COVERAGE
1 : 500

Arqus DESIGN

## Integrated perspective


Arqus Design Pty Ltd
ABN 68 135 616 303

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Phone 07 3358 0888
Fax 07 3358 0899


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NOTES

Contractors are to verify all dimensions on site before commencing any work or producing shop drawings.



Detail applicable to the scale of the drawing published.

| DATE | REVISION | ISSUE |
|---|---|---|
| 24.01.22 | DRAFT DA PACKAGE | A |
| 24.08.16 | DRAFT DA PACKAGE | B |
| 24.10.09 | DA PACKAGE | C |

CLIENT

TriCare
Retirement Living. Home Care. Aged Care.

PROJECT

**TRICARE HASTINGS POINT**

**87 TWEED COAST RD, HASTINGS POINT 2489, NSW**

**COUNTRY: BUNDJALUNG**

DRAWING

**OVERALL AREA PLAN - SITE COVERAGE**

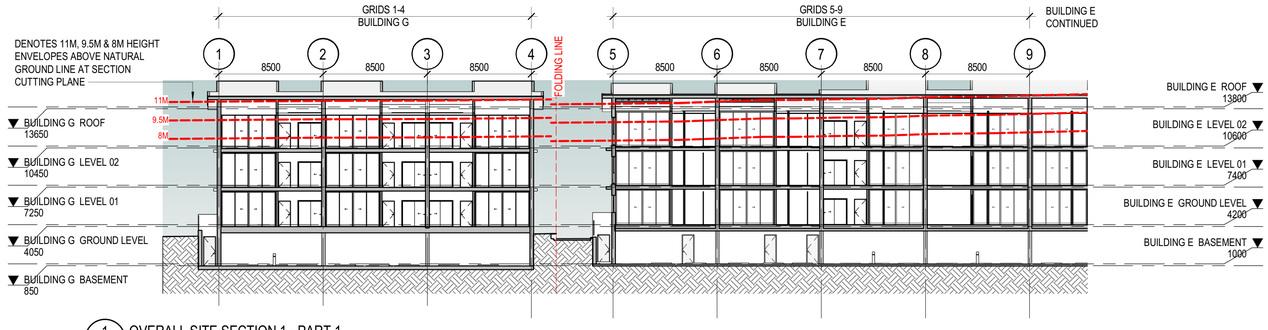
| JOB NUMBER | DESIGN | DRAWN | CHECKED |
|---|---|---|---|
| 23-0025 | SP | KF | SP |

| SCALE | DATE CREATED | NORTH |
|---|---|---|
| 1 : 500 @A1<br>1 : 1000 @A3 | 01/12/23 | |

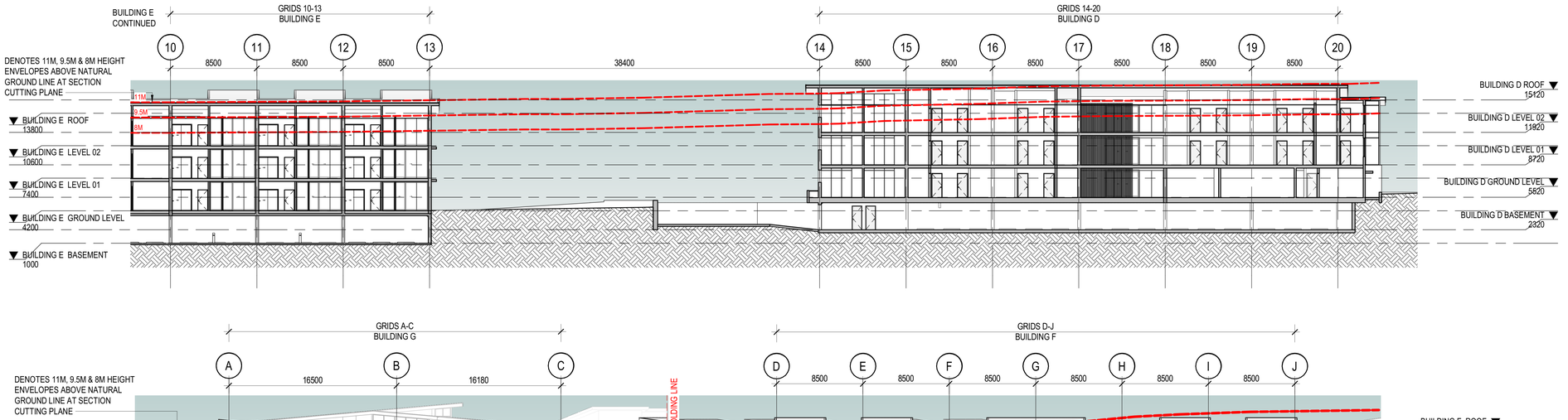
| DRAWING NUMBER | ISSUE |
|---|---|
| **DA-2-11** | **C** |

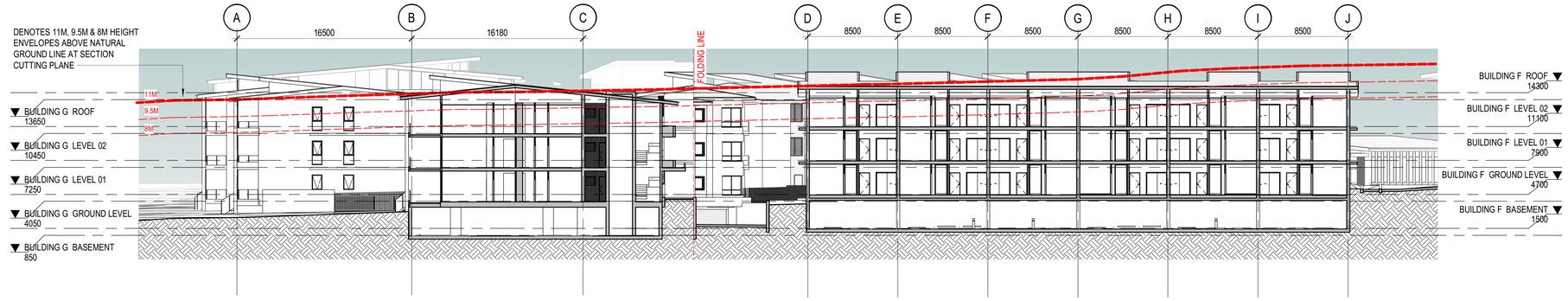
ISSUED FOR 9/10/2024 10:19:41 AM

**DEVELOPMENT APPLICATION**

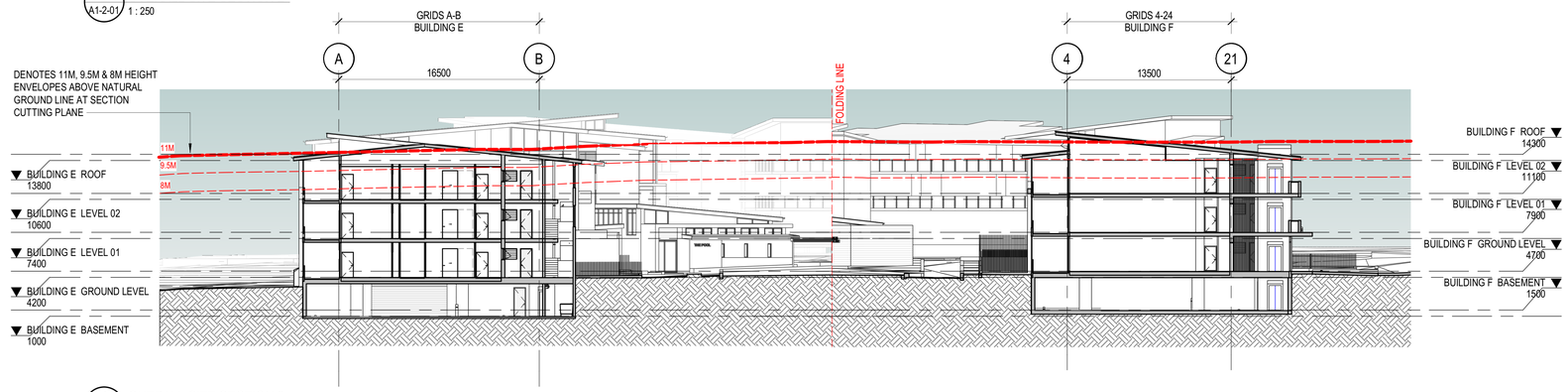



1 A1-2-01 OVERALL SITE SECTION 1 - PART 1
1 : 250




2 A1-2-01 OVERALL SITE SECTION 2
1 : 250




4 A1-2-01 OVERALL SITE SECTION 3
1 : 250

Arqus DESIGN

## Integrated perspective


Arqus Design Pty Ltd
ABN 68 135 616 303

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PO Box 2455
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Nominated Architect: Scott Peabody
QLD: 2644
NSW: 9038
VIC: 800111 (Arqus Design 600035)

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Phone 07 3358 0888
Fax 07 3358 0899


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NOTES

Contractors are to verify all dimensions on site before commencing any work or producing shop drawings.



Detail applicable to the scale of the drawing published.

| DATE | REVISION | ISSUE |
|---|---|---|
| 24.01.22 | DRAFT DA PACKAGE | A |
| 24.04.15 | FOR INFORMATION | B |
| 24.08.16 | DRAFT DA PACKAGE | C |
| 24.10.09 | DA PACKAGE | D |

CLIENT

TriCare
Retirement Living. Home Care. Aged Care.

PROJECT

**TRICARE HASTINGS POINT**

**87 TWEED COAST RD, HASTINGS POINT 2489, NSW**

**COUNTRY: BUNDJALUNG**

DRAWING

**OVERALL SITE SECTIONS**

| JOB NUMBER | DESIGN | DRAWN | CHECKED |
|---|---|---|---|
| 23-0025 | SP | KF | SP |

| SCALE | DATE CREATED | NORTH |
|---|---|---|
| 1 : 250 @A1<br>@A3 | 18/09/2023 | |

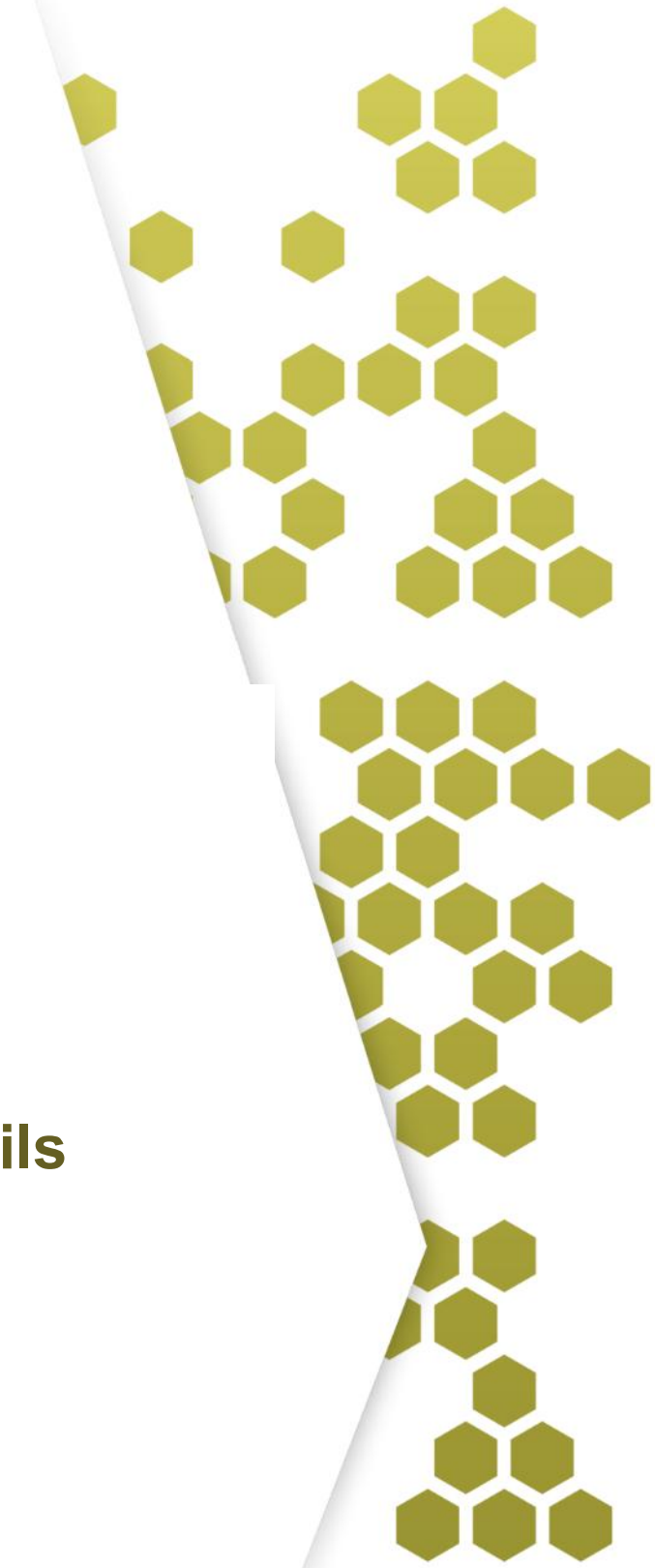
DRAWING NUMBER **DA-2-31** ISSUE **D**

ISSUED FOR 9/10/2024 10:25:49 AM

**DEVELOPMENT APPLICATION**

# APPENDIX F

NSW Waste Classification Guidelines Part 4: Acid Sulfate Soils (ASS)



# Waste classification guidelines

## Part 4: Acid sulfate soils

www.epa.nsw.gov.au

**Published by:**

NSW Environment Protection Authority (EPA)
59–61 Goulburn Street, Sydney
PO Box A290
Sydney South NSW 1232

**Report pollution and environmental incidents**
Environment Line: 131 555 (NSW only) or info@environment.nsw.gov.au
See also www.epa.nsw.gov.au/pollution

Phone: +61 2 9995 5000 (switchboard)
Phone: 131 555 (NSW only – environment information and publication requests)
Fax: +61 2 9995 5999
TTY users: phone 133 677, then ask for 131 555
Speak and listen users: phone 1300 555 727, then ask for 131 555

Email: info@environment.nsw.gov.au
Website: www.epa.nsw.gov.au

ISBN 978 1 74359 808 5
EPA 2014/0798

November 2014

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**Potential acid sulfate soils** ..... **1**
Handling potential acid sulfate soils prior to disposal ..... 1
Disposal of potential acid sulfate soils *below* the water table ..... 2
Disposal of potential acid sulfate soils *above* the water table ..... 2
**Actual acid sulfate soils** ..... **2**
Treatment of actual acid sulfate soils prior to disposal ..... 2
Disposal of actual acid sulfate soils ..... 3

Classifying wastes into groups that pose similar risks to the environment and human health facilitates their management and appropriate disposal. It is the responsibility of those who generate waste to classify that waste. To assist waste generators classify the wastes they produce, the EPA has developed the *Waste Classification Guidelines* ('the Guidelines') which are a step-by-step process for classifying waste.

Generators and waste facilities must carefully follow the procedures in these Guidelines to ensure they comply with applicable laws in classifying their waste and safeguard protection of the environment and human health.

The Guidelines are comprised of the following sections, of which this document is Part 4:

Overview of the Guidelines

Part 1: Classifying waste

Part 2: Immobilisation of waste

Part 3: Waste containing radioactive material

Part 4: Acid sulfate soils

All sections of the Guidelines are available for download from the EPA website at www.epa.nsw.gov.au/waste/classification.htm.

# Introduction

Acid sulfate soils (ASS) are those naturally occurring sediments and soils which contain sulfides, mainly iron sulfide and iron disulfide or their precursors. Exposure of these sulfides in the soil to oxygen – often as a result of drainage or excavation – can produce sulfuric acid, which may have a significant impact on the environment. Leaching of sulfuric acid into waterways can cause serious water quality problems, resulting in fish kills and damage to infrastructure, such as floodgates and bridges.

ASS are most commonly found in NSW along the coast and they need to be managed appropriately to avoid major environmental damage.

The NSW *Acid Sulfate Soils Manual*[1] (the ASS Manual) provides 'best practice' guidance for planning, assessing and managing activities in areas prone to developing ASS. The manual is available from the NSW Department of Planning: phone 1300 305 695.

## Using this part of the Guidelines

This part of the EPA Waste Classification Guidelines (the Guidelines) applies to acid sulfate soils which are unable to be managed on-site. In these cases, off-site disposal to landfill is often the most appropriate management option.

Waste generators need to assess the status of ASS at their point of generation, using the techniques outlined in the ASS Manual. The ASS Manual also provides guidance for on-site management, while this part of the Waste Classification Guidelines details disposal requirements for ASS that need to be transported and managed off-site.

This document has advice on dealing with both 'potential' ASS and 'actual' ASS. The two types are often found together in the same soil profile, with actual ASS generally overlying potential ASS horizons.

# Potential acid sulfate soils

Potential ASS are soils that contain iron sulfides or sulfidic materials that have not been exposed to air and thus are not oxidised. The pH of these soils in their undisturbed state is 5.5 or more, making them neutral or slightly alkaline. If not managed appropriately, potential ASS pose a considerable environmental risk: disturbance and exposure to air may render them severely acidic.

## Handling potential acid sulfate soils prior to disposal

Potential ASS must be kept wet at all times during excavation and subsequent handling, transport and storage, until they can be disposed of safely. They must be received at the proposed disposal point within 16 hours of being dug up.

[1] Stone Y, Ahem, CR and Blunden, B 1998. *Acid Sulphate Soils Manual 1998*. Acid Sulphate Soils Management Advisory Committee (ASSMAC), Wollongbar, NSW.

## Disposal of potential acid sulfate soils *below* the water table

Potential ASS may be disposed of in water below the permanent water table, provided:

- this occurs before they have had a chance to oxidise, i.e. within 24 hours of excavation

and

- they meet the definition of 'virgin excavated natural material' (VENM) under the *Protection of the Environment Operations Act 1997*, even though they contain sulfidic ores or soils.

Landfills must be licensed by the EPA to dispose of potential ASS below the water table. EPA's Environment Line has details on facilities able to accept this waste: phone 131 555.

Potential ASS must be disposed of within 8 hours of their receipt at a landfill and kept wet at all times until their burial at least two metres below the lowest historical level of the water table at the disposal site.

Documentation must be provided to the occupier of the landfill for each truckload of potential ASS received, indicating that the soil's excavation, transport and handling have been in accordance with the ASS Manual, thus preventing the generation of acid.

The occupier of the disposal site must also test the pH of each load of soil received immediately prior to its placement under water using the test method(s) 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 occupier of the landfill site.

The disposal site's licence will outline what documentation needs to be kept and for how long.

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 and disposed of at a landfill that can lawfully accept it (see **Disposal of actual acid sulfate soils** below).

The pH of the water at the landfill into which the potential ASS is placed must not be less than 6.0 at any time. Landfill licence conditions require the occupiers of potential ASS disposal sites to regularly monitor the pH of ground and surface waters at their premises.

## Disposal of potential acid sulfate soils *above* the water table

Where potential ASS cannot be classified as VENM or a suitable underwater disposal site at a landfill is not available, the soil must be treated in accordance with the neutralising techniques in the ASS Manual. After treatment the soil should be chemically assessed in accordance with Step 5 in Part 1 of the Waste Classification Guidelines, available at www.epa.nsw.gov.au/waste/classification.htm. This will determine whether any other contaminants are present in the material. When the classification has been established, the soil should be disposed of to a landfill that can lawfully accept that class of waste.

# Actual acid sulfate soils

Actual ASS contain highly acidic soil horizons or layers resulting from the aeration of soil materials that are rich in sulfides, primarily iron sulfide. This oxidation produces more hydrogen ions than the sediment is able to neutralise, resulting in soils with a pH of 5.5 or less when measured in dry season conditions. These soils can usually be identified by the presence of pale yellow mottles and coatings of jarosite.

## Treatment of actual acid sulfate soils prior to disposal

Actual ASS must be treated by the generator of the waste before they can be considered for disposal. Treatment should be in accordance with the neutralising techniques outlined in the ASS Manual.

## Disposal of actual acid sulfate soils

Following neutralisation, the generator of the waste must chemically assess the soil in accordance with Step 5 of Part 1 of the Waste Classification Guidelines. This will determine whether there are any other contaminants that may affect how the waste is classified for disposal.

Once classified, the waste must be taken to a landfill licensed to accept that class of waste.

Prior arrangements should be made with the occupier of the landfill to ensure that it is licensed to accept the waste. The landfill should be informed that the actual ASS has been treated in accordance with the neutralising techniques outlined in the ASS Manual and that the waste has also been classified in accordance with Part 1 of the Waste Classification Guidelines.

# APPENDIX G

Borelogs

# ENVIRONMENTAL BOREHOLE BH-01

| | | |
|---|---|---|
| **PROJECT NUMBER** ENV240556 | **DRILLING COMPANY** ENV Solutions | **COORDINATES** N/A |
| **PROJECT NAME** TriCare Retirement | **DRILLER** JC & CH | **COORD SYS** N/A |
| | **DRILL RIG** Solid Flight Auger | **SURFACE ELEVATION** N/A |
| **ADDRESS** 87-89 Tweed Coast Road | **DRILLING METHOD** | **WELL TOC** N/A |
| **DRILLING DATE** 17/03/2020 | **TOTAL DEPTH** 3.5 | **LOGGED BY** TB |
| | **DIAMETER** 100mm | **CHECKED BY** TB |
| **COMPLETION** 18/06/2024 | **CASING** N/A | **SCREEN** N/A |

**COMMENTS** Surface: Grass

| Depth (m) | Material Type | Water | Graphic Log | Material Description | Samples | Geiger uSv/h | Additional Observations |
|---|---|---|---|---|---|---|---|
| 0.1 | Fill | | | Gravelly clay, brown/orange, dry, loose, fine, soft with low to medium plasticity and occasional gravels up to 10mm. | | | No odour, staining or asbestos. |
| 0.2 | Natural | | | Sand, white/light grey, moist, loose, course, soft, low plasticity. Saturated at 3.0m. | BH01_0.2 | 0 | |
| 0.5 | | | | | BH01_0.5 | 0.12 | |
| 1 | | | | | BH01_1.0 | 0.12 | |
| 1.5 | | | | | BH01_1.5 | | |
| 2 | | | | | BH01_2.0 | 0.12 | |
| 2.5 | | ▽ | | | BH01_2.5 | 0.12 | |
| 3 | | | | | BH01_3.0 | 0.12 | |
| 3.5 | | | | | BH01_3.5 | 0.12 | |
| 3.6 | | | | Termination Depth at 3.5 mbgs per program depth. | | | |

**Disclaimer** This bore log is intended for environmental not geotechnical purposes.



produced by ESlog.ESdat.net on 29 Aug 2024

ENVIRONMENTAL | ASBESTOS | REMEDIATION | RESOURCE RECOVERY

# ENVIRONMENTAL BOREHOLE BH-02

**PROJECT NUMBER** ENV240556
**PROJECT NAME** TriCare Retirement
**ADDRESS** 87-89 Tweed Coast Road
**DRILLING DATE** 17/03/2020

**DRILLING COMPANY** ENV Solutions
**DRILLER** JC & CH
**DRILL RIG** Solid Flight Auger
**DRILLING METHOD**
**TOTAL DEPTH** 5.0
**DIAMETER** 100mm

**COORDINATES** N/A
**COORD SYS** N/A
**SURFACE ELEVATION** N/A
**WELL TOC** N/A
**LOGGED BY** TB
**CHECKED BY** TB

**COMPLETION** 18/06/2024
**CASING** N/A
**SCREEN** N/A

**COMMENTS** Surface: Grass

| Depth (m) | Material Type | Water | Graphic Log | Material Description | Samples | Geiger uSv/h | Additional Observations |
|---|---|---|---|---|---|---|---|
| 0.1 | Fill | | | Gravelly clay, brown/orange, dry, loose, fine, soft with low to medium plasticity and occasional gravels up to 10mm. | BH02_0.2 | 0.16 | No odour, staining or asbestos. |
| 0.2 | Natural | | | Sand, white/light grey, moist, loose, course, soft, low plasticity. Saturated at 3.0m. | | | |
| 0.3 | | | | | | | |
| 0.4 | | | | | BH02_0.5 | 0.16 | |
| 0.5 | | | | | | | |
| 0.6 | | | | | | | |
| 0.7 | | | | | | | |
| 0.8 | | | | | | | |
| 0.9 | | | | | BH02_1.0 | 0.16 | |
| 1 | | | | | | | |
| 1.1 | | | | | | | |
| 1.2 | | | | | | | |
| 1.3 | | | | | | | |
| 1.4 | | | | | BH02_1.5 | 0.16 | |
| 1.5 | | | | | | | |
| 1.6 | | | | | | | |
| 1.7 | | | | | | | |
| 1.8 | | | | | | | |
| 1.9 | | | | | BH02_2.0 | 0.16 | |
| 2 | | | | | | | |
| 2.1 | | | | | | | |
| 2.2 | | | | | | | |
| 2.3 | | | | | | | |
| 2.4 | | | | | BH02_2.5 | 0.16 | |
| 2.5 | | | | | | | |
| 2.6 | | | | | | | |
| 2.7 | | | | | | | |
| 2.8 | | | | | | | |
| 2.9 | | | | | BH02_3.0 | 0.16 | |
| 3 | | ▽ | | Sand, black/grey, wet, loose, course, soft, low plasticity. | | | |
| 3.1 | | | | | | | |
| 3.2 | | | | | | | |
| 3.3 | | | | | | | |
| 3.4 | | | | | BH02_3.5 | 0.16 | |
| 3.5 | | | | | | | |
| 3.6 | | | | | | | |
| 3.7 | | | | | | | |
| 3.8 | | | | | | | |
| 3.9 | | | | | BH02_4.0 | 0.16 | |
| 4 | | | | | | | Sulfur odour. |
| 4.1 | | | | | | | |
| 4.2 | | | | | | | |
| 4.3 | | | | | | | |
| 4.4 | | | | | BH02_4.5 | 0.16 | |
| 4.5 | | | | | | | |
| 4.6 | | | | | | | |
| 4.7 | | | | | | | |
| 4.8 | | | | | | | |
| 4.9 | | | | | BH02_5.0 | 0.16 | |
| 5 | | | | Termination Depth at 5.0 mbgs per program depth. | | | |
| 5.1 | | | | | | | |
| 5.2 | | | | | | | |
| 5.3 | | | | | | | |
| 5.4 | | | | | | | |





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# ENVIRONMENTAL BOREHOLE BH-03

| | | |
|---|---|---|
| **PROJECT NUMBER** ENV240556 | **DRILLING COMPANY** ENV Solutions | **COORDINATES** N/A |
| **PROJECT NAME** TriCare Retirement | **DRILLER** JC & CH | **COORD SYS** N/A |
| | **DRILL RIG** Solid Flight Auger | **SURFACE ELEVATION** N/A |
| **ADDRESS** 87-89 Tweed Coast Road | **DRILLING METHOD** | **WELL TOC** N/A |
| **DRILLING DATE** 17/03/2020 | **TOTAL DEPTH** 5.0 | **LOGGED BY** TB |
| | **DIAMETER** 100mm | **CHECKED BY** TB |
| **COMPLETION** 18/06/2024 | **CASING** N/A | **SCREEN** N/A |

**COMMENTS** Surface: Grass

| Depth (m) | Material Type | Water | Graphic Log | Material Description | Samples | Geiger uSv/h | Additional Observations |
|---|---|---|---|---|---|---|---|
| 0.1 | Fill | | | Reworked sand, grey/dark brown, moist, loose, course, soft, low plasticity. | | | No odour, staining or asbestos. |
| 0.2 | Natural | | | | BH03_0.2 | 0.07 | |
| 0.3 | | | | Sand, light grey/white, moist, loose, course, soft, low plasticity. Becoming lighter in colour from 1.2-2.0m. | | | |
| 0.4 | | | | | BH03_0.5 | 0.08 | |
| 0.5 | | | | | | | |
| 0.6 | | | | | | | |
| 0.7 | | | | | | | |
| 0.8 | | | | | | | |
| 0.9 | | | | | BH03_1.0 | 0.07 | |
| 1 | | | | | | | |
| 1.1 | | | | | | | |
| 1.2 | | ▽ | | | | | |
| 1.3 | | | | | | | |
| 1.4 | | | | | BH03_1.5 | 0.08 | |
| 1.5 | | | | | | | |
| 1.6 | | | | | | | |
| 1.7 | | | | | | | |
| 1.8 | | | | | | | |
| 1.9 | | | | | BH03_2.0 | 0.10 | |
| 2 | | | | Sand, dark brown/grey, moist, soft, loose, course, low plasticity | | | |
| 2.1 | | | | | | | |
| 2.2 | | | | | | | |
| 2.3 | | | | | | | |
| 2.4 | | | | | | | |
| 2.5 | | | | | BH03_2.5 | 0.11 | |
| 2.6 | | | | | | | Sulfur odour. |
| 2.7 | | | | | | | |
| 2.8 | | | | | | | |
| 2.9 | | | | | BH03_3.0 | 0.11 | |
| 3 | | | | | | | |
| 3.1 | | | | | | | |
| 3.2 | | | | | | | |
| 3.3 | | | | | | | |
| 3.4 | | | | | BH03_3.5 | 0.12 | |
| 3.5 | | | | | | | |
| 3.6 | | | | | | | |
| 3.7 | | | | | | | |
| 3.8 | | | | | | | |
| 3.9 | | | | | BH03_4.0 | 0.12 | |
| 4 | | | | | | | |
| 4.1 | | | | | | | |
| 4.2 | | | | | | | |
| 4.3 | | | | | | | |
| 4.4 | | | | | BH03_4.5 | 0.10 | |
| 4.5 | | | | | | | |
| 4.6 | | | | | | | |
| 4.7 | | | | | | | |
| 4.8 | | | | | | | |
| 4.9 | | | | | | | |
| 5 | | | | | BH03_5.0 | 0.11 | |
| 5.1 | | | | Termination Depth at 5.0 mbgs per program depth. | | | |
| 5.2 | | | | | | | |
| 5.3 | | | | | | | |
| 5.4 | | | | | | | |





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# ENVIRONMENTAL BOREHOLE BH-04

| | | |
|---|---|---|
| **PROJECT NUMBER** ENV240556 | **DRILLING COMPANY** ENV Solutions | **COORDINATES** N/A |
| **PROJECT NAME** TriCare Retirement | **DRILLER** JC & CH | **COORD SYS** N/A |
| | **DRILL RIG** Solid Flight Auger | **SURFACE ELEVATION** N/A |
| **ADDRESS** 87-89 Tweed Coast Road | **DRILLING METHOD** | **WELL TOC** N/A |
| **DRILLING DATE** 17/03/2020 | **TOTAL DEPTH** 5.0 | **LOGGED BY** TB |
| | **DIAMETER** 100mm | **CHECKED BY** TB |

**COMPLETION** 18/06/2024 | **CASING** N/A | **SCREEN** N/A

**COMMENTS** Surface: Grass

| Depth (m) | Material Type | Water | Graphic Log | Material Description | Samples | Geiger uSv/h | Additional Observations |
|---|---|---|---|---|---|---|---|
| 0.1 | Fill | | | Reworked sand, grey/dark brown, moist, loose, course, soft, low plasticity. | BH04_0.2 | 0.08 | No odour, staining or asbestos. |
| 0.2 | Natural | | | Sand, light grey/white, moist, loose, course, soft, low plasticity. Becoming lighter in colour from 1.2-2.0m. | | | |
| 0.3 | | | | | | | |
| 0.4 | | | | | BH04_0.5 | 0.08 | |
| 0.5 | | | | | | | |
| 0.6 | | | | | | | |
| 0.7 | | | | | | | |
| 0.8 | | | | | | | |
| 0.9 | | | | | BH04_1.0 | 0.08 | |
| 1 | | | | | | | Sulfur odour. |
| 1.1 | | | | | | | |
| 1.2 | | ▽ | | | | | |
| 1.3 | | | | | | | |
| 1.4 | | | | | BH04_1.5 | 0.08 | |
| 1.5 | | | | | | | |
| 1.6 | | | | | | | |
| 1.7 | | | | | | | |
| 1.8 | | | | | | | |
| 1.9 | | | | | BH04_2.0 | 0.08 | |
| 2 | | | | Sand, dark brown/grey, moist, soft, loose, course, low plasticity | | | |
| 2.1 | | | | | | | |
| 2.2 | | | | | | | |
| 2.3 | | | | | | | |
| 2.4 | | | | | BH04_2.5 | 0.1 | |
| 2.5 | | | | | | | |
| 2.6 | | | | | | | |
| 2.7 | | | | | | | |
| 2.8 | | | | | | | |
| 2.9 | | | | | BH04_3.0 | 0.11 | |
| 3 | | | | | | | |
| 3.1 | | | | | | | |
| 3.2 | | | | | | | |
| 3.3 | | | | | | | |
| 3.4 | | | | | BH04_3.5 | | |
| 3.5 | | | | | | | |
| 3.6 | | | | | | | |
| 3.7 | | | | | | | |
| 3.8 | | | | | | | |
| 3.9 | | | | | BH04_4.0 | 0.10 | |
| 4 | | | | | | | |
| 4.1 | | | | | | | |
| 4.2 | | | | | | | |
| 4.3 | | | | | | | |
| 4.4 | | | | | BH04_4.5 | 0.12 | |
| 4.5 | | | | | | | |
| 4.6 | | | | | | | |
| 4.7 | | | | | | | |
| 4.8 | | | | | | | |
| 4.9 | | | | | | | |
| 5 | | | | | BH04_5.0 | 0.08 | |
| 5.1 | | | | Termination Depth at 5.0 mbgs per program depth. | | | |
| 5.2 | | | | | | | |
| 5.3 | | | | | | | |
| 5.4 | | | | | | | |





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# APPENDIX H

Certificate of Conformity

**ISO 9001 Certificate**

Voluntary Certification System
«Unitary Standard»

Registered in the federal agency for technical regulation and metrology
Registration number in the unified register of registered
voluntary certification systems
РОСС RU.0001.04УК00

Governing body of the System
Evaluation of Quality Management Systems, LLC
Bldg.7/9, Bolshaya st., Moscow

Certification authority
Quality Management in Accordance with International Standards, LLC
Bldg.7/9, Bolshaya st., Moscow, 125284, tel.: +7 (495) 646-11-13

№ РОСС RU.3609.04УК00 / EC.C.O.02.01.000777-12

# CERTIFICATE OF CONFORMITY

issued to SOEKS, Limited Liability Company
Altuflevskoye shosse, h.48, bld. 1, pr.1, room 39, Moscow, 127566, Russia
TIN 7842376568

This is to certify that

Quality management system in respect to designing, manufacturing, sale,

warranty and maintenance service of electric and electrical devices

Conforms to the requirements of

GOST R ISO 9001-2008 (ISO 9001:2008)

This Certificate obliges the organization to maintain the quality of the works performed by it according to the requirements of the above regulatory document, and this will be monitored by the Certification Authority of the Voluntary Certification System "Unitary Standard" and confirmed at annual inspections.

This Certificate is issued by the decision of the expert committee
№ EC.C.O.02.01.000777-12 dated 07.03.2012

Registration date: 07.03.2012 Valid before: 07.03.2015

Head of the Certification Authority _____ Firsova N.A.

Chairman of the Committee _____ Artemov D. A.

005444

# APPENDIX I

Professional Qualifications

# Tim Bischof

**Environmental Scientist**

## Qualifications, Accreditations and Memberships

Master of Environmental Management and Sustainability, University of Newcastle

Bachelor of Property, Central Queensland University

General Construction Induction (White Card)

Member, Environment Institute of Australia and New Zealand (EIANZ)

## Professional Overview

Tim is a dedicated Environmental Scientist at ENV, with a solid foundation in managing contaminated land, conducting site investigations, and performing environmental monitoring. In his few years in the field, Tim has developed a strong capability in handling the complexities of environmental projects, ensuring that they meet both environmental and regulatory requirements. Tim's growing expertise and practical approach allow him to contribute effectively to the ENV team. He is committed to delivering reliable and responsible environmental solutions, providing our clients with the confidence that their projects are well supported.

## Key Areas of Expertise

- Contaminated Land Management
- Environmental Management
- Detailed Site Investigations
- Remediation
- Environmental Monitoring

## Project Experience

**Royal Flying Doctors Apron Extension (RFDS) – Townsville Airport (July 2024 – August 2024)**

Tim conducted a Soil Sampling and Material Reuse Risk Assessment in alignment with the PFAS National Environmental Management Plan (NEMP) for the RFDS Apron Extension project. The assessment required meticulous sampling of airside land, adhering to Townsville Airport's stringent environmental, safety, and security protocols. The analysis focused on both soil and leachate from the excavated material and the receiving environment. The Risk Assessment concluded that the material was suitable for reuse without posing an increased risk to environmental or human health.

**Kingscliff Public and High School Redevelopment – Richard Crookes Construction (RCC) (October 2022 - July 2024)**

As Project Manager, Tim liaised with RCC site managers to ensure compliance with RCC's environmental responsibilities. The site works encompassed noise and vibration monitoring during construction, demolition, and rock-breaking activities. Additionally, Tim oversaw asbestos-in-soil testing, acid sulfate soil testing, Excavated Natural Material (ENM) testing, and the development of comprehensive Environmental Management Plans.

**Gold Coast Airport – Avis Budget Group - Underground Petroleum Storage System (UPSS) Removal (January 2023 - April 2024)**

Tim assumed the role of Project Manager for the removal of a decommissioned UPSS system. His responsibilities included conducting a comprehensive site contamination assessment, developing a Sampling and Analysis Quality Plan (SAQP) and a Demolition Environmental Management Plan (DEMP), and securing all necessary airport-specific safety approvals. Tim managed all onsite demolition and remediation activities, supervised subcontractors, and ensured validation reporting was completed in full compliance with Gold Coast Airport's Health, Safety, and Environmental requirements.

## Professional History

- **ENV Solutions**
  **Environmental Scientist**
  May, 2022 - Present

## Contact

E: tim.bischof@envsolutions.com.au

M: 0490 468 037

www.envsolutions.com.au



ENV Solutions
ENVIRONMENTAL | ASBESTOS | REMEDIATION | RESOURCE RECOVERY

# Craig Helbig

**Principal Environmental Scientist**

## Qualifications, Accreditations and Memberships

Graduate Diploma, Environmental Management, University of South Australia

Bachelor of Applied Science, Environmental Biology/Toxicology, University of South Australia

Member, Australasian Land and Groundwater Association (ALGA)

Member, Environment Institute of Australia and New Zealand (EIANZ)

Certified Environmental Practitioner (CEnvP) (EIANZ)

## Professional Overview

Craig Helbig is a highly respected Principal Environmental Scientist with over 20 years' of experience in the environmental sector. At ENV, Craig plays a pivotal role as a senior technical expert and co-team leader, where he oversees a wide range of environmental fieldwork activities. His expertise includes subcontractor procurement and management, as well as conducting comprehensive sampling of soil, sediment, surface water, groundwater, soil vapour, and air. Craig is also highly skilled in soil and groundwater remediation and validation, and he regularly leads environmental monitoring and inspections to ensure compliance with regulatory standards.

In addition to his fieldwork expertise, Craig excels in the preparation, implementation, and administration of various management plans, including waste management, environmental management, and remediation management plans. His work in environmental remediation is extensive, covering the installation of remediation infrastructure, validation sampling, and ongoing monitoring requirements.

Craig is also involved in environmental risk assessment, specialising in source-pathway-receptor analysis, fate and transport modelling, and both qualitative and quantitative human health and ecological risk assessments. Beyond his technical skills, Craig is dedicated to mentoring junior and mid-level staff and contributes to ENV's ongoing success by delivering internal training and fostering a culture of continuous improvement.

## Key Areas of Expertise

**Environmental fieldwork:**

- Subcontractor procurement and management
- Soil, sediment, surface water, groundwater, soil vapour and air sampling
- Soil and groundwater remediation and validation
- Environmental monitoring, inspections and audits

**Preparation, implementation and administration of management plans:**

- Waste management plans
- Environmental management plans
- Remediation management plans
- Remediation action plans
- Bioremediation management plans
- Acid sulfate soil management plans
- Validation plans

**Environmental remediation:**

- Soil and groundwater remediation
- Installation of remediation infrastructure
- Validation sampling and reporting
- Ongoing monitoring requirements

**Environmental risk assessment:**

- Source-pathway-receptor analysis
- Fate and transport modelling
- Qualitative and quantitative human health and ecological risk assessment

## Project Experience

**Waste Management (with focus on SWMMP)**
(various sites in Byron Shire, Ballina Shire and Lismore Shire)

- Jonson Lane (Byron Shire): Preparation of SWMMP for mixed use development, including ground floor commercial and multi-storey residential.
- 156 Jonson Street (Byron Shire): Preparation of SWMMP for commercial development.
- 119-123 Jonson Street (Byron Shire): Preparation and review of SWMMP for mixed use development, including ground floor commercial and multi-storey residential.
- Ballina Central (Shopping Centre, Ballina Shire): Preparation and review of SWMMP for commercial development.
- Crowley Aged Care (Ballina Shire): Preparation and review of 2 x SWMMPs for aged care facility function centre and residential facilities (different sites).
- Lismore Shire: Preparation and review of SWMMP for multi-storey student residential accommodation.

**Contaminated land remediation**
(various sites in South Australia, New South Wales and Queensland)

- Ongoing works associated with multi-staged investigation and remediation of former industrial land within a waterfront precinct on the mid-coast of NSW, for future residential development. The land is the subject of a current statutory Audit. Services provided to date include project management, completion of a Preliminary Site Investigation (PSI), preparation of several Sampling and Analysis Quality Plans (SAQPs), multi-staged investigations (Detailed Site Investigations, DSI) in on-site and off-site areas and preparation of remediation planning documentation for portions of the site. The site will require progressive remediation and Auditor sign-off in stages across several years. Contaminants include petroleum hydrocarbons, PFAS asbestos and VOCs/SVOCs. Total project value to date (ENV fees and disbursements) of $0.5 m.
- Investigation and remediation of a service station site in SE QLD, operating in accordance with a Transitional Environmental Program (TEP) since 2020. Works conducted to date have included project management, multi-staged investigations, preparation of remediation planning documentation, installation of groundwater remediation infrastructure, removal and validation of fuel-related infrastructure, classification and disposal of excavated spoil and review of third party consultant reports. Expected fulfilment of the TEP obligations is in April 2023.
- Investigation and remediation of two former fuel depots in central northern NSW. The works conducted included project management, review of historical investigation reports, completion of PSIs and multi-staged DSIs, preparation of remediation planning documentation, conducting multi-staged remediation programs to remove and bioremediate more than 10,000 $m^3$ of hydrocarbon & PFAS affected soils, groundwater treatment during excavation works and validation sampling and reporting. Remediation was completed at the first site in 2020 and at the second site in early 2022. Both sites are now the subject of a DA for residential land use.
- Removal of a site formerly used as a service station from the Environmental Management Register (EMR) in SE QLD (Brisbane). All works were completed to the approval of a Site Contamination Auditor. Works included conducting a PSI, DSI, validation services associated with removal of all former fuel related infrastructure from both on-site and off-site areas and validation reporting. The site was successfully removed from the EMR and later on-sold as suitable for future residential development.
- Removal of a site used to store wheat grain from the EMR in SE QLD. All works were completed to the approval of a Site Contamination Auditor. Works included conducting a PSI, DSI, validation services associated with removal of all former fuel related infrastructure and validation reporting. The site was successfully removed from the EMR and later on-sold for continued commercial land use.
- Preparation of remedial planning documentation for removal of waste oil USTs at a truck maintenance depot in central northern NSW. Services completed included project management, validation sampling and reporting and liaison with EPA (site notified to them under the CLM Act). Liaison is ongoing, pending final approval and close out of potential off-site risks.
- Completion of multi-staged DSIs at a former service station in central northern NSW, which required removal of all fuel related infrastructure and closure to facilitate construction of a roundabout in a portion of the site area. Works included project management, soil and groundwater sampling (DSIs), supervision of validation services associated with removal of five USTs and associated pipework and dispensing infrastructure, reporting. Construction for the roundabout is underway. ENV will assist the owner of the remaining site portion to construct a new service station on the balance of the former site.
- Investigation and remediation services for a service station in northern NSW to allow its redevelopment. Services provided to date have included preparation of remediation planning documents, removal and validation of the former UPSS with associated dewatering (also provided by ENV), stockpiling of excavated soils for land farming and treatment of hydrocarbon impacts, segregation of asbestos containing materials (ACM) with subsequent asbestos removal, successful remediation of all soils allowing their retention on site; groundwater, soil vapour, sub-slab and indoor air assessment; reporting. The site is pending further off-site investigations to assess the potential for an adjacent surface water body to be acting as a receptor for contaminated groundwater, in consultation with EPA.
- Investigation and remediation of LNAPL impacts to groundwater at a corner store which sells petroleum in northern NSW. The site was the subject of a Voluntary Management Proposal (VMP), endorsed by EPA, which has successfully been completed. Several rounds of soil sampling, groundwater well installation and sampling, soil vapour and indoor air sampling were completed at the site between 2017 and 2021. LNAPL remediation has occurred largely via regular manual removal, in consideration of the clay geology and substantial costs associated with installation of remedial infrastructure for these soils. The remaining LNAPL body has been shown to be stable under varying climatic conditions, and all potential on-site and off-site vapour risks have been addressed to the satisfaction of EPA.
- Investigation and remediation services for a general store which formerly dispensed petroleum in central northern NSW. The site was the subject of scrutiny by EPA, following the discovery of hydrocarbons in bore water (the only water supply) in the township. Environmental services included preparation of

remediation documentation, undertaking validation sampling and reporting associated with removal of the fuel related infrastructure, installation of groundwater monitoring and extraction wells to a depth of up to 50 m in fractured bedrock, active groundwater extraction and treatment, soil vapour sampling, indoor air sampling, town bore sampling and reporting. EPA has completed its own investigations and is currently in the process of evaluating alternate water supplies for the town residents.

- Investigation and preparation of remediation planning documentation for an embankment which experienced a landslip after heavy rainfall in northern NSW. The landslip exposed a high density of ACM fill within the embankment. The embankment was excavated and reformed, which creating more than 20,000 $m^3$ of asbestos containing soils requiring transport and disposal in SE QLD. ENV supervised the entire remediation process, undertook site audits during remediation, completed control air monitoring (for airborne asbestos fibres), arranged waste disposal permitting from DES and prepared all validation reports. The site has been successfully remediated and the embankment reformed with new drainage to prevent a recurrence.
- Project managed and completed site history assessments and environmental site assessments, and successfully designed a remediation strategy for contaminated soils at a former gasworks storage facility in metropolitan Adelaide, to the approval of a Site Contamination Auditor. Remediation services included preparation and superintendence of the Remediation Contract on behalf of the Principal (SA Government), preparation of management plans for the works (EMP, RAP, Validation Plan, Liner Management Plan), visual and chemical assessment and characterisation of site soils, auditing of Remediation Contractor documentation and site activities, and liaison with project stakeholders (including the SA EPA, Council and residents in the vicinity of the site). The site has since been redeveloped with affordable housing.

**Contaminated land assessment**

(various sites in all eight jurisdictions in Australia)

- Byron Hospital
- Yamba Marina
- Lismore Gasworks (roadways)
- Jonson St (Harris Farm) ESA, including radiological
- Jonson St (Secret Garden) ESA, including radiological
- Caltex Glen Innes
- Caltex Tamworth
- Project managed and carried out services associated with assessment and remediation planning for an 8 ha former landfill site containing mixed wastes placed into historically quarried gullies up to 12 m deep, in metropolitan Adelaide. Environmental assessment services included multiple soil quality assessments, installation and monitoring of both shallow and deep groundwater wells, and landfill gas assessment including surface Flame Ionisation Detector (FID) surveys, flux hood testing and installation and monitoring of landfill gas wells and vapour probes. All services were conducted in accordance with work plans endorsed by a Site Contamination Auditor. Site remediation works will comprise innovative solutions for management of the landfill gas, including technologies such as vapour cut-off walls and sub-slab vapour membranes to mitigate the potential for adverse impacts from the landfill gas.

**Infrastructure development:** Environmental Impact Assessments (EIAs); soil, groundwater and surface water investigations; Waste Derived Fill (WDF) classification; ASS investigations; geotechnical investigations.

- Provision of pre-construction design advice and construction phase sampling and monitoring for the extension of a light rail corridor in Adelaide's southern suburbs. With a total project value of more than $150 m and a duration of more than 2 years, the project involved assistance with preparation of the contractor's EMP (for approval by the Principal of the contract), extensive liaison with contractor and subcontractor staff, drilling activities, sampling and chemical classification of excavated soils for re-use classification and disposal purposes, Acid Sulfate Soil (ASS) investigations.

Member of the project team (technical specialist) tasked with completing an EIA for a proposed port facility on the Eyre Peninsula, South Australia.

Member of the project team (technical specialist) responsible for completing an EIA for a proposed transport (rail, road) corridor on the Eyre Peninsula, South Australia.

Project managed environmental services associated with the construction phase of the new Rail Car Depot, a project with a value of $157 m. Included a quantitative human health (asbestos) risk assessment. The risk assessment was completed to the satisfaction of an independent Site Contamination Auditor, and resulted in a significant financial saving (estimated >$1 m) for the client associated with re-use of asbestos-contaminated soils.

Project managed and conducted field services associated with assessing and limiting effluent discharge from a major steel works facility on the Eyre Peninsula, South Australia. The project necessitated regular liaison with the EPA and coordination of marine survey contractors.

Project managed environmental services for the design phase of an 18 km high voltage electricity cable route. The

$200 m project involved approximately six weeks of environmental and geotechnical field investigations.

Project managed and provided technical oversight for numerous WDF investigations, to assess the potential re-use options for waste soil excavated during site redevelopment activities.

Project managed services associated with the sampling of sediments along the proposed alignment of a weir across the lower Murray River at Wellington, South Australia. Works were conducted in strict accordance with health and safety protocols governing sediment sample collection.

Project managed and conducted environmental fieldwork for the assessment of several petroleum storage facilities in regional New South Wales.

**Landfills:** landfill gas assessment; soil, groundwater and surface water investigations; geotechnical investigations; preparation and implementation of management plans for remediation.

Project director for an assessment of chlorinated solvent contamination in groundwater emanating from a large municipal landfill in Adelaide, South Australia.

Project managed landfill gas and groundwater investigations for various regional landfill sites within South Australia, on behalf of local Councils.

**Manufacturing facilities and industrial land:** multi-stage soil and groundwater investigations; soil vapour assessment; preparation and implementation of management plans for remediation.

Member of a project team involved in the long-term assessment (> 5 years) of land formerly occupied by, and used for, oil refining and petroleum storage in metropolitan Adelaide. Investigations included multiple phases of soil assessment, groundwater well installation, passive remediation of hydrocarbons in groundwater and hydrogeological modelling.

Conducted multiple phases of soil and groundwater investigations with reporting over a period of approximately three years, to assess the environmental condition of a 15 ha former textile manufacturing site in metropolitan Adelaide and facilitate its redevelopment for low density residential purposes.

**Mining:** multi-stage soil and groundwater investigations; hydrogeological assessment, hydraulic fracturing risk assessment.

Project managed and provided technical oversight for the investigation of shallow soil and perched water quality in the vicinity of a former tailings storage facility at a mine in SW New South Wales. The investigation included assessment of geochemistry, installation and sampling from multiple groundwater wells and conducting hydraulic conductivity testing of the shallow perched water system.

Conducted a human health and ecological risk assessment for proposed hydraulic fracturing operations in northern New South Wales and south-east Queensland.

Conducted fieldwork programs for the planning stages of a large sand quarry in regional New South Wales. The investigations included ASS assessments, hydrogeological assessments, surface water/groundwater interaction assessments and investigation into the potential for adverse effects on local groundwater dependent ecosystems (GDEs).

**Quantitative Risk Assessment** (various sites in Australia and Internationally)

Member of a team responsible for completing risk assessments to estimate and prioritise risks associated with hydraulic fracturing ('fraccing') operations for unconventional gas extraction in south-west Queensland.

Conducted quantitative health risk assessments for construction of the new Royal Adelaide Hospital, a project with a total value exceeding $3 bn. Works included review of all existing documentation relating to site contamination, examination of plausible exposure pathways and receptors, construction of a conceptual site model, and quantitative assessment of potential health risks posed to future users of the hospital.

Conducted a quantitative vapour intrusion health risk assessment for soils and shallow groundwater impacted by former underground petroleum and coal tar storages within the Port Waterfront Redevelopment area, Adelaide. The assessment was part of a broader project which won the Case Earth Award in 2006; presented by the Civil Contractors Federation in South Australia for excellence in contaminant remediation.

Conducted a quantitative human health risk assessment to establish site-specific clean up criteria for remediation and redevelopment of a former service station site in New South Wales. The assessment included vapour intrusion modelling (RISC V5.0) and calculation of potential risks posed to the identified future residential receptors via direct contact exposure pathways (dermal and ingestion).

Completed a quantitative human health risk assessment of contamination and emissions from a smelter complex in

Tsumeb, Namibia. The assessment included examination of potential health risks posed by fugitive dust and stack emissions to smelter workers and nearby residents, as well as to biota identified in the surrounding area. The chemicals of interest included arsenic, cadmium, lead and sulfur dioxide.

**Contaminated Land Remediation** (various sites in Australia)

On the basis of investigations completed during the assessment phase, Golder successfully designed remediation strategies for three parcels of land which were part of the Port Waterfront Redevelopment; an area of approximately 50 ha of former industrial land earmarked for redevelopment, with an estimated project value of $1.5 bn. The strategies were approved by an independent Site Contamination Auditor.

## Professional History

- **ENV Solutions**
  **Principal Environmental Scientist**
  July, 2023 – Present

  **Senior Environmental Scientist**
  Sept, 2016 – June, 2023

- **Golder Associates**
  **Senior Environmental Scientist**
  2006 – 2014

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