Acid Sulfate Soils Assessment

Proposed Residential Subdivision

Lot 9 DP1219664, 157 Arakoon Road, South West Rocks

Report Ref: G0840-GI-001-Rev1

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Project Details

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We confirm that the following report has been produced for Sam & Margaret Walls, based on the described methods and conditions within.

For and on behalf of Hunter Geotechnical Services,

Daniel Soffer
Senior Geotechnical Engineer
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Executive Summary

The following report details the geotechnical investigation undertaken by Hunter Geotechnical Services (HGS) under the request of Sam and Margaret Walls. The investigation was undertaken at Lot 9 DP1219664157, Arakoon Road, South West Rocks, on 5 December 2024, and consisted of a desktop study, a visual site assessment, and intrusive excavations and testing.

The site is characterised by gently undulating floodplain terrain, intersected by a central swale swamp trending north to south. Vegetation includes swamp mahogany, paperbark trees, and smooth-barked apple, indicative of varying drainage and hydrological conditions.

The desktop study indicated that the lower elevations of the site are mapped as low probability of acid sulfate soils occurring at depths greater than 3m below the ground surface; typically coinciding with the central swamp swale and western development extent, characterised by Paperbark (*Melaleuca*) vegetation, are underlain by Pleistocene-aged Back Barrier Flat deposits.

Investigations within the central swamp swale and western development extent were underlain by high plasticity, grey – blue Estuarine Clays (Unit 7). The results of the laboratory testing indicated that the concentration sulfides within the Unit 7 represents Pleistocene-aged estuarine exceeded the ASS Assessment Guidelines Action Criteria of for a large scale project (>1,000 tonne) in all samples and only TP18 for a small scale project (<1,000 tonne). The extent of potential disturbance is not yet known.

An Acid Sulfate Soils Management Plan is only required for Unit 7 soils, as identified in Figure 27 of this report.

The approximate area of Potential ASS should be delineated and marked with pegs in accordance with Figure 27, and identification through observations of paperbark vegetation and low-lying areas around the drainage swale.

The geotechnical assessment supports the proposed rezoning from R5 Large Lot Residential to R1 General Residential, provided the recommendations in this report are followed. The presence of acid sulfate soils within the site is manageable with appropriate treatment and mitigation measures.

Table of Contents

Annex List:

Annex A Test Pit Location Plan
Annex B Borehole & DCP Log Report
Annex C Hunter Geotechnical Services & External Laboratory Test Reports
Annex D General Acid Sulfate Soil Management Strategies

1 Introduction

At the request of Sam & Margaret Walls, Hunter Geotechnical Services (HGS) have undertaken an Acid Sulfate Soils assessment for the proposed residential subdivision to be constructed at Lot 9 DP1219664, 157 Arakoon Road, South West Rocks.

It is understood that the assessment assessment is required to support the planning proposal to change the landzoning of the site from R5 Large Lot Residential to R1 Genereal Residential, and to assess the suitability of the land for future urban purposes and intensification of development on the site for a residential subdivision.

The site is situated in an area of low probability of acid sulfate soils occurring at depths greater than 3m below the ground surface, centralised around the centre third coinciding with elevation.

The purpose of the investigation was to provide geotechnical comment and recommendations on the following:

- A geotechnical model of the subdivision that includes the following (if encountered);
  - Identification of poor or potentially problematic ground conditions.
  - Ground water levels
  - Depth of soil profiles
  - Depth to rock
  - Prescence of fill
- Preliminary Site Investigation
- Acid Sulfate Soil Assessment and Management Plan (if required) to ASSMAC guideline

This report provides details of the investigation, laboratory testing and provides recommendations for the proposed development.

2 Site Description

The site was located at Lot 9 DP1219664, 157 Arakoon Road, South West Rocks and was bordered by rural residential development and Arakoon Road to the south, Athena Parde to the north, Seascape Residential Subdivision to the west, and an area of moderately dense bushland to east.

The site is approximately 23.5 hectares and is located in an area characterised by gently undulating flood plain terrain with surface elevations less than 10mAHD with a northeasterly plunging ridge spur approximately 10 – 20mAHD intersection the western third of the site with a central swale swamp trending north to south. Surface slopes typically fall towards a central broad sublinear drainage line draining from the south to the north of site towards broad depression vegetated with swamp grasses and surface water in the central northern boundary of the site associated with the swale swamp.

The central swale swamp traverses the site from the south to the north, delineated by the yellow polygon; exposures of peat accumulation were observed in the vicinity of the swamp swale. This area is characterised by moisture-retaining soils that support vegetation adapted to wet conditions. Dominant flora include complexes of sedgeland, wet heath and paperbark trees (Melaleuca), which thrive in the wetter microenvironment created by the natural drainage patterns.

The elevated terrace, located to the west central drainage line and represented in dark green, features well-drained soils that sustain a vegetation profile of mature swamp mahogany, whereas smooth bark apple was dominated in the light green area in the northeastern extent. The residual northerly plunging spur was vegetated with open scribbly gum forest as identified in the light blue region.

The site is located at Lot 9 DP1219664, 157 Arakoon Road, South West Rocks, and spans approximately 23.5 hectares. It is bordered by rural residential development and Arakoon Road to the south, Athena Parade to the north, the Seascape Residential Subdivision to the west, and an area of moderately dense bushland to the east. The site lies within a region characterized by gently undulating floodplain terrain with surface elevations generally below 10 m AHD, intersected by a northeasterly plunging ridge spur (elevations approximately 10–20 m AHD) in the western third of the site. A central swale swamp trends north to south through the site, forming a key geomorphic feature.

Surface slopes across the site typically fall towards a broad, sublinear drainage line that extends from the southern boundary to a central depression in the northern boundary. This drainage feature, associated with the swale swamp, channels surface water and supports a wetter microenvironment. The depression in the central-northern boundary is vegetated with swamp grasses, indicative of prolonged surface water retention. Peat accumulations were observed in areas along the drainage swale, particularly within the yellow polygon area shown in Figure 1.

The central swale swamp supports moisture-retaining soils that sustain sedgeland, wet heath, and paperbark trees (*Melaleuca spp.*). This vegetation complex thrives under the hydrological conditions created by the natural drainage patterns, further contributing to the site's ecological diversity.

- Western Elevated Terrace (Dark Green Area): This terrace features well-drained soils and is dominated by mature stands of swamp mahogany (Eucalyptus robusta).

- Northeastern Extent (Light Green Area): The northeastern extent is characterized by smooth-barked apple (Angophora costata) dominating the vegetation profile.
- Residual Ridge Spur (Light Blue Area): The ridge spur, which plunges gently to the north, supports an open forest of scribbly gum (Eucalyptus haemastoma), indicative of drier and more elevated conditions.

Figure 1: Photo obtained from ‘Nearmap’ depicting site setting and location

Figure 2: Looking north, Stringybark trees (Eucalyptus spp.) lining the entrance road to the

site, located within an area dominated by Pleistocene-aged aeolian sands.

Figure 3: Looking north across the gently undulating flood plain terrain. High Voltage power lines traverses the site

Figure 4: Looking north towards the smooth barked vegetated area in an area characterised by Alluvial flood plain

Figure 5: Vegetation contrast observed between Pleistocene-aged alluvial floodplains (QPa) and adjacent Pleistocene-aged back barrier flats. The floodplain, dominated by smooth-barked apple trees (*Angophora costata*), reflects better-drained conditions, while the back barrier flats, characterized by paperbark (*Melaleuca*) vegetation, indicate waterlogged, organic-rich soils typical of swampy environments.

Figure 6: View looking west toward the elevated region dominated by swamp mahogany (Eucalyptus robusta), corresponding to the dark green region in Figure 1.

Figure 7: looking south across the central drainage swale area, delineated as the yellow region in Figure 1. This low-lying area is characterised by swampy conditions with

vegetation dominated by moisture-loving species, including paperbarks (Melaleuca)

Figure 8: Looking north along the swale swamp within Pleistocene-aged back barrier flat deposits, characterised by poorly drained soils and dominated by paperbark (Melaleuca) vegetation.

Figure 9: Looking south across a low-lying depression at the headwaters of the swamp swale, located in the central southern boundary within the yellow region identified in Figure 1. The area features swamp grass and standing water, indicative of its role in the site's natural drainage system

Figure 10: Standing water and peat accumulations observed adjacent to the swamp swale in the northern region of the yellow area identified in Figure 1. These features are indicative of prolonged water saturation and the accumulation of organic material in the depositional environment.

Figure 11: Standing water and peat accumulations observed adjacent to the swamp swale in the northern region of the yellow area identified in Figure 1. These features are indicative of prolonged water saturation and the accumulation of organic material in the depositional environment.

Figure 12: Stringybark trees in the residual terrain to the west of the site, corresponding to the blue-shaded area in Figure 1. Elevated terrain underlain by residual soil, supporting mature vegetation

Figure 13: Miscellaneous materials and debris located near the existing dwelling on the site. These items, including pipes, concrete blocks, and construction materials

3 Desktop Review

3.1 Geological & Soil Landscape Setting

Reference to the 1:100,000 Kempsey Coastal Quaternary Mapping 1:250,000 Dorrigo – Coffs Harbour Geological Mapping Sheet and the indicates that the site is located at the transition zone between multiple formations. To the south, the Smoky Cape Adamellite dominates, consisting of biotite-hornblende adamellite.

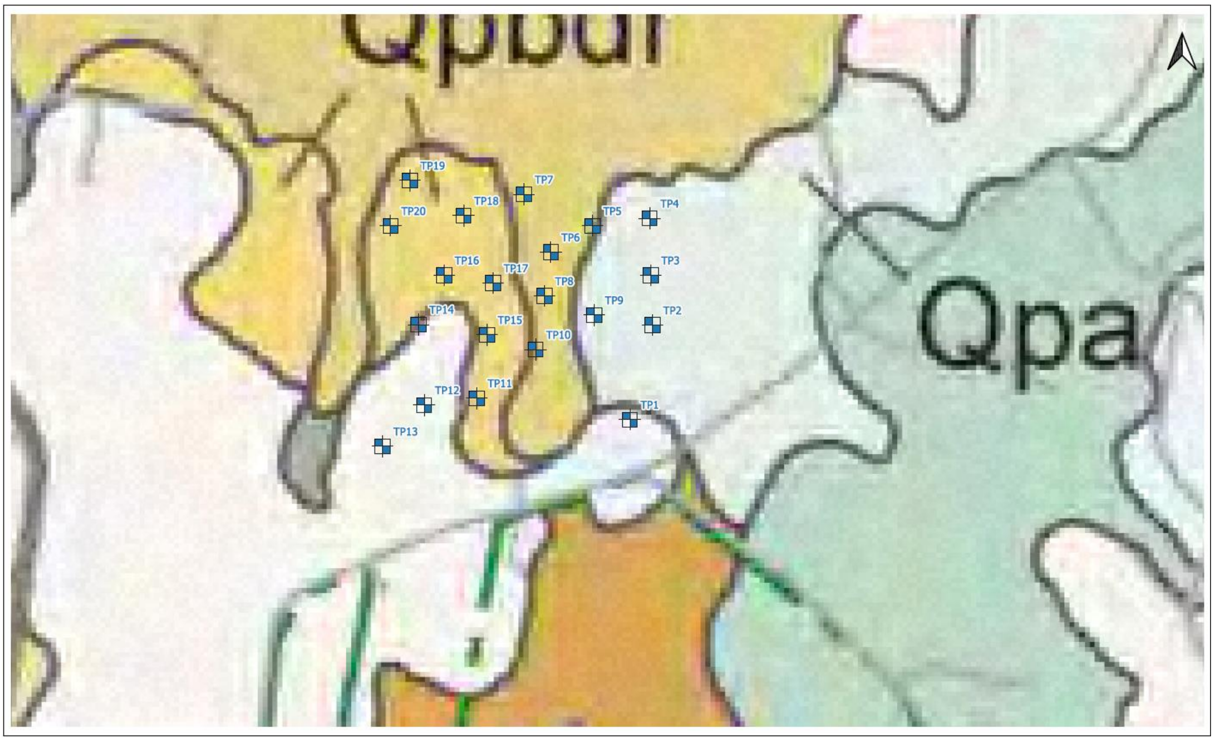

Figure 14: Extract of Quaternary Geological Mapping

The site reflects a barrier estuary setting typical of medium to broad coastal embayments. Depositional processes are driven by gradients of fluvial, tidal, and marine influence, with a three-part zonation of deposition evident from sediment supply and energy gradients (as depicted in Figure 1 and idealised in Figure 15). These depositional systems have resulted in a diverse assemblage of geological and geomorphic features across the site.

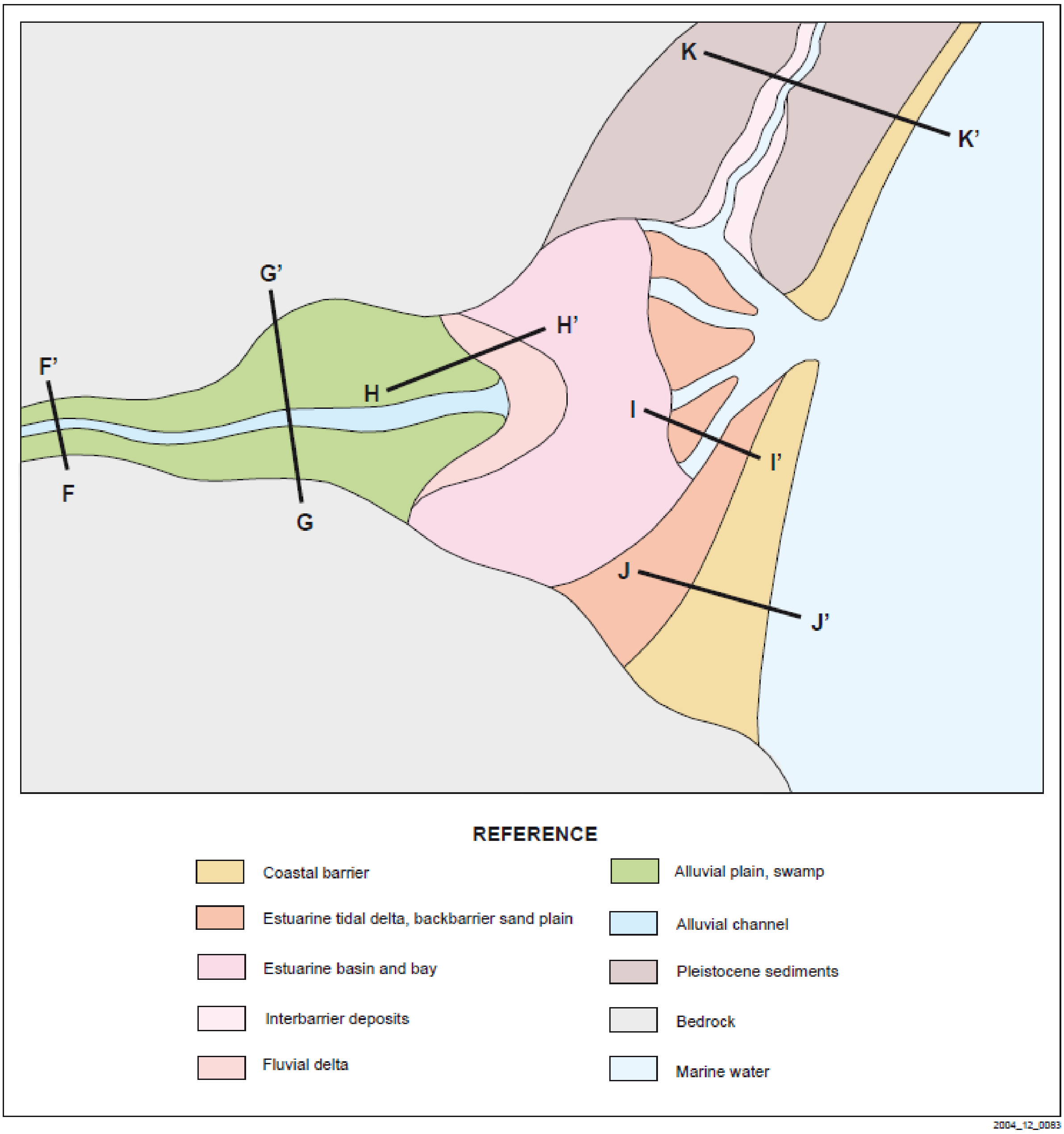

Figure 19. Plan view of an idealised coastal valley depositional system showing locations of cross-sections depicted in figures 21 to 26

Figure 15: Idealised coastal valley deposition system

3.2 Residual Terrain: Light Blue Area

To the west of the site, the elevated residual terrain is underlain by the Smoky Cape Adamellite, consisting of biotite-hornblende adamellite. This area supports Stringybark (*Eucalyptus*) vegetation, indicative of well-drained soils and stable geomorphic conditions. The light blue-shaded area represents the residual terrain's influence on the site's hydrology, as it directs water flow toward lower-lying areas. The adamellite bedrock also serves as a significant marker for the site's geological history.

3.3 Backbarrier Flats: Yellow Area

The central swamp swale and eastern development extent, characterised by Paperbark (*Melaleuca*) vegetation, are underlain by Pleistocene-aged Back Barrier Flat deposits. These deposits consist of marine sand, indurated sand, silt, gravel, organic mud, and peat. Back barrier flats are believed to have formed from storm washover deposition during early barrier evolution. Over time, these processes became inactive, leaving relict features commonly mantled by organic-rich freshwater swamp sediments. These deposits may also exhibit tidal modification in proximity to estuarine systems.

Swales within the northern yellow region exhibit standing water, peat accumulations, and swamp grass vegetation. These features represent remnants of former drainage systems or headwater environments, often associated with reduced groundwater flow and localied sedimentation. The presence of Paperbarks highlights waterlogged conditions, with the potential for acid sulfate soils.

3.4 Alluvial Floodplain: Green Area

The eastern portion of the site, dominated by Smooth Bark trees, overlies Pleistocene-aged alluvial floodplain deposits. These deposits consist of fluvial sands, silts, clays, and gravels deposited by ancestral river systems. The vegetation and slight elevation changes emphasize the boundary between floodplain deposits and adjacent depositional environments.

3.5 Holocene Aeolian Sand Dunes: Southern Margins

The southern boundary of the site transitions into Holocene-aged aeolian dune sands. These deposits are predominantly composed of well-sorted fine to medium-grained quartz sand, reflecting wind-driven deposition along the coastal fringe. The dunes often interfinger with estuarine sediments, complicating the site's subsurface stratigraphy.

4 Fieldwork Methodology

Fieldwork was undertaken on 5 December 2024 and comprised a general site walk over and observation of the site and surrounding features. Twenty test pits were excavated with a 2 tonne excavator with tiger tooth bucket attachment to a depth of up to 3.0m. The test pits were logged and sampled by a Senior Geotechnical Engineer from HGS in accordance with AS1726-2017.

5 Subsurface Conditions

The subsurface soil conditions encountered during the investigation at test locations have been categorised into distinct geomorphological units based on diagnostic criteria derived from depositional systems and inferred relative ages as publicised by Troedson & Hashimoto, 2008. These criteria, adopted from established methodologies for differentiating Holocene and Pleistocene deposits, consider landscape position, degree of post-depositional weathering, sediment consistency, colour, and composition. This approach ensures that the characterization of subsurface materials aligns with their depositional history and environmental context.

5.1 Methodology and Diagnostic Criteria

5.1.1 Position in the Landscape

The spatial location and elevation of soil units relative to active depositional systems and landforms were analysed. For example, Holocene deposits are typically associated with active depositional environments, such as floodplains and estuarine systems, while Pleistocene deposits are often located at higher elevations or beneath Holocene deposits.

5.1.2 Degree of Weathering and Erosion

The extent of weathering, soil formation, and erosion were used as indicators of relative age. Holocene deposits exhibit minimal weathering due to their recent formation, while Pleistocene materials often show evidence of significant soil development and oxidation processes.

5.1.3 Sediment Consistency

The physical characteristics of sediments, including their stiffness, friability, and cohesiveness, were considered. Holocene sediments are typically looser and less consolidated, whereas Pleistocene materials are stiffer and more indurated.

5.1.4 Sediment Colour and Composition

Variations in sediment colour, such as grey hues in water-saturated Holocene deposits and reddish tones in oxidized Pleistocene materials, were diagnostic. The presence or absence of specific minerals, such as Fe-oxide coatings, jarosite, and organic matter, further informed depositional environments and age.

5.2 Summary of Subsurface Units

Based on the above criteria, the subsurface soil conditions encountered at test locations are presented in detail in the test pit logs and have been summarised into the following units:

Table 5-1: Summary of units

Unit	Unit Description
UNIT 1 Topsoil	Silty to Sandy CLAY, low plasticity, grey / brown, fine to medium grained, with rootlets
UNIT 2 Aeolian	Sand, fine to medium grained, grey, mainly quartz grained
UNIT 3 Holocene Barrier	Sand, fine to medium grained, siliceous, rare shell fragments, iron oxide staining on grains
UNIT 4 Pleistocene Barrier	Sand, fine to medium grained, dark grey, non-cemented, inferred Pleistocene Barrier, landward of Holocene Barrier
UNIT 5 Alluvium Holocene	Sandy CLAY, medium plasticity, Dark grey / grey and pale grey, fine to medium grained
UNIT 6 Alluvium Pleistocene	Silty to Sandy CLAY, medium to high plasticity, pale grey to pale brown / brown
UNIT 7 Estuarine Pleistocene	Silty CLAY, high plasticity, pale grey to blue mottled orange, sulfuric odour, very stiff exhibit well-developed soil structure, and display reddish to mottled hues, indicative of extensive post-depositional weathering and oxidation, elevation at around 5mAHD, **POTENTIAL ACID SULFATE SOIL**
UNIT 8 Residual	Sandy CLAY, medium to high plasticity, pale brown to brown / grey mottled red,
UNIT 9 Extremely weathered material	Sandy CLAY, medium plasticity, pale grey mottled dark grey and grey

Figure 16: Unit 2 Aeolian Sand overlying Unit 3 Holocene Barrier Sands and Unit 4 indurated sand at depth.

Figure 17: Typical Unit 6, Pleistocene alluvial, formed through alluvial floodplain environments at recovered from TP2.

Figure 18: Typical Unit 6, Pleistocene alluvial, formed through alluvial floodplain environments at recovered from TP3.

Figure 19: Typical Unit 6, Pleistocene alluvial, formed through alluvial floodplain environments at recovered from TP4.

Figure 20: Typical Unit 7, Pleistocene Estuarine, recovered from TP5. Sediment colour blue – grey with Fe-oxide mottling at near surface.

Figure 21: Typical Unit 7, Pleistocene Estuarine, recovered from TP6. Sediment colour blue – grey with Fe-oxide mottling at near surface, grading to Clayey Sand with depth

Figure 22: Typical Unit 7, Pleistocene Estuarine, recovered from TP9

Figure 23: Typical Unit 7, Pleistocene Estuarine, recovered from TP10. Groundwater inflow encountered

Figure 24: Typical Unit 2 Aeolian sand as encountered in TP11.

Figure 25: Typical residual profile as encountered in TP12.

Table 5-2: Summary of the soil unit depths encountered

Test Pit	**Unit Depth** (m)									
	UNIT 1 Topsoil	**UNIT 2** Aeolian	**UNIT 3** Holocene Barrier	**UNIT 4** Pleistocene Barrier	**UNIT 5** Alluvium Holocene	**UNIT 6** Alluvium Pleistocene	**UNIT 7** Estuarine Pleistocene	**UNIT 8** Residual	**UNIT 9** Extremely weathered material	***Groundwater Inflow***
TP1	0.0 – 0.1	0.1 – 0.5	0.5 – 1.6	1.6 ≥ 1.9	--	--	--	--	--	*1.7*
TP2	0.0 – 0.1	--	--	--	0.1 – 0.7	0.7 ≥ 2.5	--	--	--	*1.8*
TP3	0.0 – 0.15	--	--	--	0.15 – 0.9	0.9 ≥ 2.4	--	--	--	--
TP4	0.0 – 0.1	--	--	--	0.1 – 1.2	1.2 ≥ 2.4	--	--	--	--
TP5	0.0 – 0.2	--	--	--	0.2 – 1.2	--	1.2 ≥ 2.8	--	--	--
TP6	0.0 – 0.2	--	--	--	0.2 – 0.55	--	0.55 ≥ 2.8	--	--	*1.6*
TP7	0.0 – 0.25	--	--	--	0.25 – 0.55	--	0.55 ≥ 2.6	--	--	--
TP8	0.0 – 0.29	--	--	--	0.29 – 0.9	--	0.9 ≥ 2.5	--	--	--
TP9	0.0 – 0.25	--	--	--	0.25 – 0.9	--	0.9 ≥ 2.1	--	--	--
TP10	0.0 – 0.35	--	--	--	0.35 – 0.8	--	0.8 ≥ 1.8	--	--	*1.6*
TP11	0.0 – 0.15	≥0.15 – 2.5	--	--	--	--	--	--	--	--
TP12	0.0 – 0.1	--	--	--	--	--	--	0.1 – 0.9	0.9 ≥ 1.8	--
TP13	0.0 – 0.1	--	--	--	--	--	--	0.1 ≥ 1.8	--	--
TP14	0.0 – 0.1	--	--	--	--	--	--	0.1 ≥ 2.0	--	--

TP15	0.0 – 0.3	--	--	--	--	--	--	0.3 – 0.9	≥0.9 – 1.8	--
TP16	0.0 – 0.1	--	--	--	--	--	--	0.1 – 1.45	≥1.45 – 2.0	--
TP17	0.0 – 0.1	--	--	--	--	--	--	0.1 – 0.9	≥0.9 – 2.0	--
TP18	0.0 – 0.1	--	--	--	--	--	0.8 ≥ 2.0	--	--	--
TP19	0.0 – 0.1	--	--	--	0.1 – 1.4	--	1.4 ≥ 2.0	--	--	--
TP20	0.0 – 0.1	--	--	--	0.1 – 1.5	--	1.5 ≥ 2.0	--	--	--

Note: ≥ Indicates that base of material layer was not encountered

Groundwater inflows were encountered at the site in TP1, TP2, TP6 and TP10 at depths shown above. It is further noted that groundwater conditions are dependent on factors such as soil permeability and recent weather conditions and will vary with time.

Refer to **Annex A** for the borehole location plan and **Annex B** for detailed borehole logs.

6 Acid Sulfate Soils

6.1 Acid Sulfate Soils Explained

These soils are widespread in low-lying coastal areas of New South Wales, particularly within estuarine and deltaic systems. The 1:100,000 Kempsey Coastal Quaternary mapping highlights zones of potential ASS risk in backswamps and near estuarine fringes.

Acid sulfate soils is the common name given to naturally occurring sediments and soils containing iron sulfides, iron disulfide or their precursors which, when exposed to oxygen, generate sulfuric acid. These soils form when iron-rich sediments are deposited in saltwater or brackish water environments. They typically occur in natural, low-lying coastal depositional environments below approximately 5m AHD.

Common settings include coastal estuarine plains, backbarrier flats, and tidal wetlands, which were often exposed or inundated during the Holocene highstand. In these environments, bacterial activity reduces sulfate to sulfide, which then reacts with iron to precipitate pyrite in the sediment. The site, encompassing Pleistocene backbarrier flats and adjacent alluvial floodplain areas

Refence to the Kempsey-Korogoro Acid Sulfate Soil (ASS) Risk Map indicates that a low probability of ASS occurrence at depths greater than 3m below ground level.

Figure 26: (eSPADE) Known occurrences of Acid Sulfate Soils

Under natural conditions, ASS remains stable and does not pose environmental risks. However, when these soils are disturbed—through activities such as excavation, drainage, or agricultural development—they are exposed to oxygen, initiating the oxidation of pyrite to sulfuric acid. This process releases significant amounts of acidity into the surrounding environment, often leading to:

1. Acidification of soil and water resources.
2. Mobilisation of toxic metals such as aluminum and iron.
3. Detrimental effects on vegetation, aquatic ecosystems, and infrastructure.

The term “acid sulfate soils” can refer to either “actual acid sulfate soils” or “potential acid sulfate soils”. “Actual acid sulfate soils” is the term given to highly acidic sediments and soil horizons that have resulted from the aeration of soil material with a concentrated sulfide content. “Potential Acid Sulfate Soils” is the term given to sediment and soil horizons that have not undergone exposure to oxygen, however, have the potential to becoming highly acidic when exposed to air and oxidise.

Reference to the National Acid Sulfate Soils Guidance (*Water Quality Australia 2018*) provides a summary of general site conditions (Table 2.1) that can be indicative of Potential and Actual ASS. A summary of relevant site conditions is presented below:

- Sites with an elevation of less than 5 m Australian Height Datum (AHD) are often associated with ASS. This is consistent with the site's low-lying areas, particularly within the backbarrier flats and swamp swale environments.
- Landforms associated with tidal reaches, estuaries, or saline environments are at high risk for ASS. The site’s proximity to estuarine depositional systems suggests conditions conducive to ASS formation
- Wetland vegetation, such as paperbarks (Melaleuca), swamp grasses, and other moisture-loving species, indicates potential ASS conditions. The site’s low-lying areas dominated by such vegetation reflect these characteristics.
- A water table less than 3 m from the surface can indicate the presence of ASS. Observations at the site, including standing water and swamp vegetation, align with this criterion
- Soils containing fine-grained sediments, such as silts and clays, are often associated with ASS. This is characteristic of estuarine and floodplain deposits found at the site.
- The presence of organic matter, such as peat or muck soils, is a key indicator of ASS. Peat accumulations were observed in the swampy regions of the site, particularly in the yellow-shaded areas of Figure 1.
- Mottled or pale grey subsoils, transitioning to dark grey or black sediments in anaerobic conditions, are typical of ASS. These colours result from sulfide-rich, reduced environments, common in the site’s backbarrier flats and estuarine deposits.

In estuarine–deltaic plains, pyritic sediments of estuarine, deltaic and alluvial in-channel bar/channel origins are typically capped by non-pyritic subaerial alluvial plain deposits. Pyritic sediments are virtually unknown in coastal barrier (except in some backbarrier deposits) and non-deltaic alluvial deposits.

Moreover, Pleistocene estuarine and deltaic sediments are usually non-pyritic at near-surface levels, due to post-depositional subaerial exposure during periods of lower sea levels prior to the Holocene.

It is recognised that it is generally considered that pyritic soils which formed prior to the Holocene period (ie >10,000 years ago) would already have oxidised and leached during periods of low sea level which occurred during ice ages, exposing pyritic coastal sediments to oxygen.

6.2 Laboratory Test Results

The field pH screening test method is a qualitative method used to assist in the identification of iron sulphides in acid sulfate soils. The field pH (pH_F) is used to indicate the likelihood and severity of "actual acid sulfate soils". Peroxide is used to rapidly oxidise iron sulfides and can assist in the identification of "potential acid sulfate soils". The pH reading after oxidation is known as pH_{FOX}.

Actual acid sulfate soils tend to have a field pH reading of less than or equal to 4 while "potential" acid sulfate soils tend to have a non-acidic or neutral pH reading. pH_{FOX} values of less than 3 indicate a high level of certainty for potential acid sulfate soils whilst pH_{FOX} readings greater than 3 are less positive and require further laboratory analysis to confirm the presence of iron sulfides.

This test method is used to assist in identifying soil acidity only. This method is used to assist in selecting a soil sample for further detailed testing of acid sulfate soils and does not quantify the amount of acidity in the soil. Therefore, this method should not be used as a substitute for detailed testing and further analytical methods must be used to quantify the amount of acidity within the soil. Chromium Reducible Sulfur (CRS) test method is used for further detailed analysis of acid sulfate soils. Refer to **Section 6.2.2** for a discussion of the CRS testing and results.

6.2.1 Laboratory Field pH Screening Test Results

Each borehole selected representative soil sample from the fieldwork investigation for the purpose of an acid sulfate soils assessment. The samples were immediately placed in sample bags then placed on ice and transported on ice to HCL's NATA accredited soil testing laboratory or external NATA accredited laboratory for analysis.

The laboratory test results are summarised below in **Table 6.1** below.

Table 6.1: Summary of acid sulphate soils pH screening results

Test pit	Depth (m)	Soil Description	pH (field)	pH (field oxidised)	Delta pH (field – field oxidised)
TP1	0.4 – 0.5	**UNIT 2** Aeolian	5.0	2.3	2.7
TP1	0.9 – 1.0	**UNIT 3** Holocene Barrier	5.4	5.9	-0.5
TP1	1.2 – 1.5	**UNIT 4** Pleistocene Barrier	5.3	5.1	0.2

TP1	1.6 – 1.8	**UNIT 4** Pleistocene Barrier	5.4	4.3	1.1
TP2	0.5 – 0.6	**UNIT 5** Alluvium Holocene	6.4	4.8	1.6
TP2	0.7 – 0.8	**UNIT 6** Alluvium Pleistocene	6.1	2.7	3.4
TP2	1.2 – 1.4	**UNIT 6** Alluvium Pleistocene	6.3	5.1	1.2
TP2	1.8 – 1.9	**UNIT 6** Alluvium Pleistocene	6.3	5.3	1.0
TP3	0.6 – 0.7	**UNIT 6** Alluvium Pleistocene	6.1	4.7	1.4
TP3	1.0 – 1.1	**UNIT 6** Alluvium Pleistocene	6.8	5.3	1.5
TP3	1.7 – 1.8	**UNIT 6** Alluvium Pleistocene	6.3	5.0	1.3
TP4	0.6 – 0.4	**UNIT 5** Alluvium Holocene	5.7	4.4	1.3
TP4	1.2 – 4.3	**UNIT 7** Estuarine Pleistocene	5.3	4.0	1.3
TP4	1.9 – 2.0	**UNIT 7** Estuarine Pleistocene	5.1	4.0	1.1
TP5	0.3 – 0.4	**UNIT 5** Alluvium Holocene	5.3	3.4	1.6
TP5	0.9 – 1.0	**UNIT 5** Alluvium Holocene	5.2	3.2	2.0
TP5	1.4 – 1.5	**UNIT 7** Estuarine Pleistocene	5.3	3.7	1.5
TP5	1.6 – 1.8	**UNIT 7** Estuarine Pleistocene	5.3	3.3	2.0
TP5	2.4 – 2.5	**UNIT 7** Estuarine Pleistocene	5.2	4.3	0.9
TP6	0.4 – 0.5	**UNIT 5** Alluvium Holocene	5.3	3.3	1.9
TP6	0.8 – 0.9	**UNIT 7**	5.5	3.6	1.8

		Estuarine Pleistocene			
TP6	0.9 – 1.0	**UNIT 7** Estuarine Pleistocene	5.4	3.8	1.6
TP6	1.2 – 1.3	**UNIT 7** Estuarine Pleistocene	5.4	4.0	1.4
TP6	1.6 – 1.7	**UNIT 7** Estuarine Pleistocene	5.3	4.1	1.2
TP6	2.0 – 2.2	**UNIT 7** Estuarine Pleistocene	5.3	4.2	1.1
TP7	0.6 – 0.7	**UNIT 7** Estuarine Pleistocene	4.8	3.6	2.0
TP7	0.9 – 1.0	**UNIT 7** Estuarine Pleistocene	4.7	3.3	1.4
TP7	1.2 – 1.3	**UNIT 7** Estuarine Pleistocene	5.6	4.6	0.9
TP7	1.6 – 1.7	**UNIT 7** Estuarine Pleistocene	5.2	4.4	0.8
TP7	1.9 – 2.0	**UNIT 7** Estuarine Pleistocene	5.2	4.5	0.7
TP7	2.4 – 2.5	**UNIT 7** Estuarine Pleistocene	5.0	4.0	1.0
TP8	0.5 – 0.6	**UNIT 5** Alluvium Holocene	4.9	4.3	0.6
TP8	1.4 – 1.5	**UNIT 7** Estuarine Pleistocene	5.3	3.6	1.7
TP8	1.8 – 1.9	**UNIT 7** Estuarine Pleistocene	5.3	3.7	1.7
TP8	2.4 – 2.5	**UNIT 7** Estuarine Pleistocene	4.9	3.8	1.1
TP9	1.4 – 1.5	**UNIT 7** Estuarine Pleistocene	4.8	3.8	1.0
TP9	1.9 – 2.0	**UNIT 7** Estuarine Pleistocene	4.8	4.0	0.8

TP10	0.5 – 0.6	**UNIT 5** Alluvium Holocene	5.5	4.4	1.1
TP10	0.9 – 1.0	**UNIT 7** Estuarine Pleistocene	5.1	4.3	0.8
TP10	1.2 – 1.4	**UNIT 7** Estuarine Pleistocene	4.8	5.5	-0.7
TP10	1.6 – 1.7	**UNIT 7** Estuarine Pleistocene	5.2	6.1	-0.8
TP11	0.5 – 0.6	**UNIT 2** Aeolian	4.8	4.3	1.5
TP11	0.9 – 1.0	**UNIT 2** Aeolian	5.5	5.8	-1.3
TP11	1.4 – 1.4	**UNIT 2** Aeolian	4.9	4.4	0.5
TP11	1.9 – 2.0	**UNIT 2** Aeolian	5.1	4.1	1.0
TP13	0.5 – 0.6	**UNIT 8** Residual	5.5	3.6	1.9
TP13	1.4 – 1.5	**UNIT 9** EW	5.2	4.0	1.2
TP14	1.0 – 1.1	**UNIT 8** Residual	5.3	3.9	1.4
TP15	0.5 – 0.6	**UNIT 8** Residual	5.1	3.7	1.3
TP15	1.4 – 1.5	**UNIT 9** EW	5.3	4.0	1.3
TP16	0.5 – 0.6	**UNIT 8** Residual	5.4	3.5	1.9
TP16	1.0 – 1.1	**UNIT 8** Residual	4.4	3.6	0.8
TP16	1.5 – 1.6	**UNIT 9** EW	4.2	3.4	0.8
TP16	1.9 – 2.0	**UNIT 9** EW	4.1	3.3	0.8
TP17	0.4 – 0.5	**UNIT 8** Residual	5.0	3.9	1.1
TP17	0.9 – 1.0	**UNIT 9** EW	5.0	4.1	0.8
TP17	1.4 – 1.5	**UNIT 9** EW	5.0	4.2	0.7
TP17	1.8 – 1.9	**UNIT 9** EW	4.9	4.0	0.9
TP18	0.4 – 0.5	**UNIT 8** Residual	5.1	3.7	1.3
TP18	0.9 – 1.0	**UNIT 9** EW	5.1	3.8	1.3
TP18	1.8 – 1.9	**UNIT 9** EW	5.0	4.2	0.8
TP19	0.4 – 0.5	**UNIT 5** Alluvium Holocene	4.9	3.8	1.1
TP19	0.9 – 1.0	**UNIT 5** Alluvium Holocene	5.3	4.0	1.2
TP19	1.4 – 1.5	**UNIT 8** Residual	5.5	4.3	1.2

TP19	1.8 – 1.9	**UNIT 9** EW	5.6	4.8	0.8

6.2.2 Discussion of Field pH Screening Results

A pH_F <5.5 is an indication that actual acid sulfate soils may exist at the site. Field pH_F test results ranged from:

- Unit 2: Aeolian Sand – 5.1 to 5.5
- Unit 3: Holocene Barrier – 5.4 to 6.4
- Unit 4: Pleistocene Barrier – 5.3 to 6.3
- Unit 5: Alluvial Holocene – 4.9 to 6.4
- Unit 6: Alluvial Pleistocene – 4.7 to 6.3
- Unit 7: Esturaine Pleistocene – 4.8 to 5.6
- Unit 8: Residual – 5.0 to 5.5
- Unit 9: EW – 4.9 to 5.6

A pH_{FOX} <3.5 is an indication that potential acid sulfate soils may exist at the site. A change in pH greater than or equal to 1 is also an indication that potential acid sulfate soils may exist at the site. The oxidised pH_{FOX} test results were between:

- Unit 2: Aeolian Sand – 3.5 to 5.8
- Unit 3: Holocene Barrier – 5.1 to 5.9
- Unit 4: Pleistocene Barrier – 4.3 to 5.3
- Unit 5: Alluvial Holocene – 3.2 to 4.8
- Unit 6: Alluvial Pleistocene – 2.7 to 5.3
- Unit 7: Estuarine Pleistocene – 3.3 to 4.6
- Unit 8: Residual – 3.3 to 4.4
- Unit 9: EW – 3.3 to 4.2

The field pH Screening results indicate that acid sulfate soils are likely to exist at the site. Further detailed reducible sulphur (CrS) analysis was undertaken to determine the presence and extent of iron sulphides to better classify existing site conditions.

6.2.3 Analytical Testing

The Chromium Reducible Sulfur (CRS) method is an effective analytical procedure for determining the sulfur content in acid sulfate soils. It provides a precise measure of the reduced inorganic sulfur compounds (e.g., pyrite) in soil samples, which are the primary contributors to potential acid generation when oxidized. The CRS test is integral to assessing acid sulfate soil risk and developing management strategies tailored to the site conditions.

An Acid Sulfate Soil Management Plan is assessed based on the percentage of oxidisable sulfur or the acid trail results achieved from the SPOCAS test method. The action criteria for a management plan is summarised below in Table 6.2. Soils are split up into three broad texture categories known as coarse texture (Sands to Loamy Sands), medium texture (Sandy Loams to light clays) and fine texture (medium to heavy clays and silty clays).

Table 6.2: Action criteria for analysis of acid sulphate soils based on soil texture

Type of Material		Action criteria < 1000 tonnes disturbed		Action criteria > 1000 tonnes disturbed	
Texture	**Clay (%)**	**Sulfur Trail (% S)**	**Acid Trail (Mol H*/tonne) TPA or TSA**	**Sulfur Trail (% S)**	**Acid Trail (Mol H*/tonne) TPA or TSA**
Coarse	≤ 5	0.03	18	0.03	18
Medium	5 - 40	0.06	36	0.03	18
Fine	≥ 40	0.1	62	0.03	18

If the sulfur trail (%S) and the acid trail (TPA or TSA) results are above the action criteria specified above in Table 6.2, an acid sulfate soils management plan will be required for the disturbance of soil site.

6.2.4 Analytical Test CRS Results (AN217)

The results for the CRS test method for the site are shown below in Table 6.3.

Table 6.3: Summary of Detailed ASS Analysis Results

ID	Depth	Unit	pH KCL	Titratable Actual Acidity, TAA (mol H^+/t)	Chromium Reducible Sulfur, S_{cr} (%)	Chromium Reducible Sulfur, S_{cr} (mol H^+/t)	a-Net Acidity (mol H^+/t)	s-Net Acidity (%w/wS)	Lime kg $CaCO_3$/ tonne
TP1	0.4 – 0.5	**UNIT 2** Aeolian	5.3	6	<0.005	<5	6	0.010	--
TP2	0.7 – 0.8	**UNIT 6** Alluvium Pleistocene	5.4	10	<0.005	<5	10	0.016	--
TP3	0.6 – 0.7	**UNIT 5** Alluvium Holocene	5.2	14	<0.005	<5	14	0.022	--
TP5	0.3 – 0.4	**UNIT 5** Alluvium Holocene	4.8	20	0.007	<5	24	0.039	1.8
TP5	1.6 – 1.8	**UNIT 7** Estuarine Pleistocene	4.8	15	0.005	<5	18	0.029	1.4
TP6	2.0 – 2.2	**UNIT 7** Estuarine Pleistocene	6.0	<5	<0.005	<5	<5	0.006	--
TP7	2.4 – 2.5	**UNIT 7** Estuarine Pleistocene	4.8	33	0.007	<5	27	0.043	2.0
TP11	0.5 – 0.6	**UNIT 2** Aeolian	5.4	10	<0.005	<5	10	0.016	--

TP13	0.5 – 0.6	**UNIT 8** Residual	5.2	15	<0.005	<5	15	0.024	--
TP18	0.9 – 1.0	**UNIT 7** Estuarine Pleistocene	5.6	60	<0.005	<5	62	0.10	4.7
TP19	1.4 – 1.5	**UNIT 7** Estuarine Pleistocene	4.7	52	<0.005	<5	55	0.088	4.1
TP20	1.8 – 1.9	**UNIT 7** Estuarine Pleistocene	4.6	60	<0.005	<5	60	0.096	4.5

6.2.5 Laboratory Analysis & Recommendations

Review of the detailed acid sulfate soils testing results indicates the following:

- **The TAA (pHKCL)** value ranged from 4.8 to 5.6. Values of less than 4 in this test are considered indicative of Actual ASS. Values >4 or <5.5 are acidic which may be due to limited oxidation of PASS or other sources of acidity such as organic acids. The results indicate that the sediments exchangeable acidity to low and therefore has low acid reserves, and therefore unlikely to generate further acid
- **Titratable Actual Acidity (TAA)** measures the existing acidity of the soil, reflecting current acidic conditions. Concentrations were notably variable:
  - **Unit 2 Aeolian Sand** typically indicating that the amount of actual acidity is low. Noting that the pHFOX indicates that the soil has potential to generate acid, detailed testing indicates current level of acidity is low. Values for
  - **Unit 3: Holocene Barrer** were less than 5 less than 5 mole H+/tonne, indicating that the current level of acidity in this unit is low. Despite the low TAA values, the pHFOX results suggest that these soils may have some potential to generate acidity under oxidizing conditions. However, the results confirm that actual acidity levels are currently negligible
  - **Unit 4: Pleistocene Barrier (Indurated Sand)** represents older, compacted sandy deposits. Induration often results in reduced permeability and limited sulfide accumulation, contributing to lower acid sulfate soil (ASS) risk. TAA values for Unit 4 were consistently less than 5 mole H+/tonne, confirming low current acidity levels in this unit.
  - **Unit 5: Holocene Alluvium** ranged from 5–10 mole H+/tonne
  - **Unit 6: Pleistocene Alluvium** ranged from 10–20 mole H+/tonne, with localised areas exceeding 20 mole H+/tonne indicating higher current acid levels than the overlying Holocene material.
  - **Unit 7 represents Pleistocene-aged estuarine** deposits characterised by silty clays with high plasticity, organic matter, and sulfide-rich sediments. These low-lying, poorly drained deposits are typical environments for acid sulfate soil (ASS) formation. TAA values for Unit 7 were consistently greater than 20 mole H+/tonne, with localized areas exceeding 50 mole H+/tonne, indicating very high levels of actual acidity. High TAA values confirm the presence of actual acid sulfate soils (AASS), where sulfides have already oxidized, leading to significant acidity in the soil profile.
  - **Unit 8 and 9** represents residual soils derived from in situ weathering of the host rock, primarily adamellite. These soils are typically sandy clays with moderate to high plasticity and show evidence of red and brown mottling due to oxidation of iron-bearing minerals. The observed acidity is likely caused by the dissolution of **iron oxides** and other mineral phases during chemical weathering of adamellite. They are not considered ASS due to their geological origin. These units are derived from the in-situ weathering of the

    adamellite host rock, which consists of biotite-hornblende adamellite. The acidity observed in these units is attributed to natural geochemical processes, including the oxidation and hydrolysis of iron-bearing minerals present in the adamellite, rather than sulfide oxidation typical of ASS.

- The **Chromium Reducible Sulfur (Scr)** value in the results indicates the amount of potentially oxidizable sulfur, which is a critical measure of acid-producing potential in the soil.
    - **Unit 8 and 9** represents residual soils derived from in situ weathering of the host rock, primarily adamellite. Values were consistently <0.01%, confirming negligible sulfide content. The low CRS values align with the geological origin of these residual soils, which are derived from the weathering of adamellite. The acidity observed in these units is attributed to the dissolution of iron-bearing minerals, not sulfide oxidation. Units 8 and 9 are not PASS and do not require ASS-specific management
    - **Unit 2 Aeolian Sand** typically indicated less than 5 mole H+/tonne. The low CRS values confirm that Unit 2 does not pose a significant risk for potential acid sulfate soils (PASS). While pHFOX results suggest limited potential for acid generation, detailed CRS testing confirms that sulfide content is minimal.
    - **Unit 3: Holocene Barrer** typically indicated less than 5 mole H+/tonne. The low CRS values confirm that Unit 2 does not pose a significant risk for potential acid sulfate soils (PASS). While pHFOX results suggest limited potential for acid generation, detailed CRS testing confirms that sulfide content is minimal.
    - **Unit 4: Pleistocene Barrier (Indurated Sand)**. typically indicated less than 5 mole H+/tonne. The low CRS values confirm that Unit 2 does not pose a significant risk for potential acid sulfate soils (PASS). While pHFOX results suggest limited potential for acid generation, detailed CRS testing confirms that sulfide content is minimal.
    - **Unit 5:** Holocene Alluvium Chromium Reducible Sulfur (Scr) was <0.007%, below the critical threshold of 0.03%, indicating negligible sulfur content and minimal PASS risk.
    - **Unit 6:** Pleistocene Alluvium Chromium Reducible Sulfur (Scr) was <0.007%, below the critical threshold of 0.03%, indicating negligible sulfur content and minimal PASS risk.
    - **Unit 7 represents Pleistocene-aged estuarine** were consistently **less than 0.01%**, well below the critical threshold of **0.03%**, indicating negligible levels of oxidisable sulfur. The low CRS values are consistent with the weathering and leaching processes typical of Pleistocene estuarine deposits, where sulfides may have been removed over time through oxidation and drainage. The moderate pHFOX and Delta pH values observed in some areas are more likely associated with organic acid contributions or other geochemical factors, rather than sulfide oxidation.
    - Based on CRS alone, Unit 7 would not typically be classified as PASS.
        - The s-Net Acidity values at TP18, TP19, and TP20 indicate PASS potential, with values reaching 0.10% w/w S, exceeding the critical threshold of 0.03% w/w S. These high values reflect the presence of sulfides, likely preserved in less oxidised, poorly drained zones of the estuarine sediments.

- The high s-Net Acidity values across multiple locations and depths confirm that sulfides are present and capable of generating sulfuric acid upon oxidation.

The s-Net Acidity concentration of Unit 7 represents Pleistocene-aged estuarine exceeded the ASS Assessment Guidelines Action Criteria of for a large scale project (>1,000 tonne) in all samples and only TP18 for a small scale project (<1,000 tonne).

The extent of potential disturbance is not yet known. An Acid Sulfate Soils Management Plan is required for disturbance of Unit 7 represents Pleistocene-aged estuarine, if volumes exceed 1,000 tonne.

The acidity within the soil profile at the investigation site is primarily attributed to the presence of acid sulfate soils, as evidenced by the lithological units and the results from field and laboratory testing. The estuarine and alluvial units, are particularly susceptible to sulfide accumulation, which is common in low-lying, brackish, or coastal depositional settings. These environments typically host high concentrations of sulfides due to historical interactions with saltwater.

7 Acid Sulfate Soils Management Plan

If possible, the disturbance of acid sulfate soils should be **minimised**. Disturbance of acid sulfate soils must follow the procedures outlined in this specific management plan. Based on the findings in this report highlighted above an acid sulfate soils management plan must be followed in accordance with the Kempsey Shire Council guidelines and the New South Wales Department of Environment, Climate Change and Water (DECCW).

7.1 Proposed Works

The proposed subdivision development includes the construction of a stormwater basin within the area identified as having Potential Acid Sulfate Soils (PASS). This area, corresponding to the yellow polygon in Figure 1 and the green-shaded zone in the concept plan, will require excavation to an approximate depth of 2 m. Excavation within the stormwater basin area will likely disturb soils within the Holocene Alluvium (Unit 5) and potentially the underlying Pleistocene Estuarine deposits (Unit 7). Both units have been characterised by elevated s-Net Acidity and varying levels of Chromium Reducible Sulfur (CRS). As such, these soils have the potential to generate acidic leachate if disturbed, oxidised, and exposed to water or air. The management of these disturbed soils will be critical to preventing environmental harm, including acidification of surface and groundwater systems.

Avoiding the disturbance of Potential ASS is the preferred management option but where disturbance cannot be avoided it is recommended that lime treatment of the excavated soils is undertaken.

Construction of working platforms or placement of fill on the Potential ASS may displace the Potential ASS above the water surface, exposing them to oxidation. In addition, excavation works for associated services, shallow foundations, and piled foundations may also encounter Potential ASS below the ground surface

The extent of soil disturbance for the broader subdivision is currently unknown, but the excavation for the basin represents a significant area of potential impact on the identified PASS. **The extent of potential disturbance is not yet known.**

The approximate area of Potential ASS should be delineated and marked with pegs in accordance with Figure 27, and identification through observations of paperbark vegetation and low-lying areas around the drainage swale.

Regular visual monitoring during excavation to note the presence of any grey – blue clays that may represent Potential ASS: *Where encountered excavation works should temporarily cease and an assessment of the excavation be made by a geotechnical professional to assess whether avoidance is feasible*.

Figure 27: Extent of Potential Acid Sulfate Soils Requiring Acid Sulfate Soils Management Plan

7.2 Soil Excavation & Removal

7.2.1 Treating Acid Sulfate Soils

Excavated ASS must be treated with lime prior to removal from the site. Treatment must be undertaken on a bunded hardstand with a perimeter that is a minimum 300mm high. The hardstand must be constructed prior to any excavations and excavated material must be placed on the hardstand only. A maximum excavated material stockpile size of 15m^3 may be treated before removal from site.

Lime treatment pads to be prepared by placement of a 5mm layer of good quality fine agricultural lime on the base and surrounded by an earthen bund. The pads should grade to a low point where potential leachate can be captured within the bunded area for further treatment if required. Multiple pads rather than one large pad may allow improved management of materials with varying water contents. The pads should be located >100m from existing waterway.

Place excavated ASS in layers not exceeding 150mm loose thickness in the treatment pads. Dewatering may be required for soils that are excavated in a wet condition

It is noted that the current EPA position on the disposal of treated ASS is that all treated ASS (pH ≥ 7) that is to be transported off site must be removed to a licensed waste landfill unless a site-specific exemption is granted. It would, however, be appropriate to retain treated ASS on site once verification of the neutralisation of the soils is confirmed. The treated soils could potentially be used for backfilling or used for landscaping purposes on site such as in the outer batter formations, pending geotechnical assessment.

Works in the low lying swamp landscape will require monitoring for displacement of Potential ASS during construction of the rock working platform or placement of fill by a geotechnical professional. Any soils exposed above the water surface by heave or excavation, should be transported to the lime treatment pads.

Treatment is undertaken by placing the excavated material on the hardstand. The required lime dosing is then spread across the stockpile and thoroughly mixed into the excavated material. This should be undertaken as soon as practicable to prevent further oxidation of the soil. Only after completion of the lime treating is the material suitable to be stored off the hardstand or to be removed from site. Untreated ASS must not be stored off the hardstands at any time.

Excavated soils are to be dosed with lime so that the pH is above 5.5 and below 8. A regular chemical testing regime of the soils must be undertaken by a suitably qualified engineer/scientist during mixing to ensure adequate doses of lime have been applied. The management plan process should be documented by the engineer/scientist and kept on record. Lime dosing rates are based off the specific CRS Suite analysis as provided above and have been multiplied by a factor of safety of 1.5 to account for the rate of lime reactivity and the possibility of non-homogenous mixing.

This result indicates that a liming rate of approximately 8kg per tonne of excavated material.

7.2.2 Removal of Treated Acid Sulfate Soils

Prior to the removal of treated acid sulfate soils, the client must determine a waste classification using a chemical assessment in accordance with Step 5 of Part 1 of the Waste Classification Guidelines. If the client does not chemically assess the treated acid sulfate soils, the soil must be classified as hazardous waste.

7.3 General Acid Sulfate Soils Management Strategies

A detailed description of general acid sulfate soils management strategies for working with acid sulfate soils can be found in **Annex E** of this report along with additional details about testing and monitoring of acid sulfate soils.

8 Report Limitations

This report has been prepared by HGS for the specific site and purposes described within this report. HGS will accept no responsibility or liability for the use of this report by any third party, without the express consent of HGS or the Client, or for use at any other site or purpose than that described in this report.

This report and the services provided have been completed in accordance with relevant professional and industry standards of interpretation and analysis. This report must be read in its entirety without separation of pages or sections and without any alterations, other than those provided by HGS.

The scope of the investigation described in this report is based on information and plans provided to HGS by the Client as well as any additional limitations imposed by either the Client and / or site restraints. Such limitations may include but are not limited to budget restraints, the presence of underground services or accessibility issues to a site. Where the report has been prepared for a specific design proposal the information and interpretation may not be relevant if the design proposal is changed. HGS should be consulted if site plans or design proposal is changed as the recommendations and / or opinions presented may not be suitable for the new revisions or variations made.

The conclusions, recommendations and opinions expressed within this report are subject to the specific conditions encountered and the limited geotechnical data gathered at the site during the time of the current investigation. The sub-surface conditions and results presented in this report are indicative of the conditions encountered at the discrete sampling and testing locations within the site at the time of the investigation and within the depths investigated. Variations in ground conditions may exist between the locations that were investigated, and the subsurface profile cannot be inferred or extrapolated from the limited investigation conducted by HGS. For this reason, the report must be regarded as interpretative, rather than a factual document.

Sub-surface conditions are subject to constant change and can vary abruptly as a result of human influences and /or natural geological and / or climatic processes and events. As such, conditions may exist at the site that could not be identified during or may develop after the current investigation has been conducted and as such, may impact the accuracy of this report. HGS should be contacted for further consultation and site re-assessment should sub-surface conditions differ from those conditions identified in this report.

HGS recommends geotechnical reports older than 5 years from the date shown on the report, reports submitted for a previous (unrelated) development application on the site, or sites that have been altered by earthworks be reviewed by a qualified geotechnical consultant to confirm that the scope of the investigation undertaken for the report and the contents of the report are appropriate for the current development being proposed.

We are pleased to present this report and trust that the recommendations provided are sufficient for your present requirements. If you have any further questions about this report, please contact the undersigned.

For and on behalf of

Hunter Geotechnical Services

Reported by:

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Graduate Engineering Geologist
Bachelor of Geology

Reviewed by:

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Bachelor of Engineering (Hon) (Civil)
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Annex A

CLIENT:	King & Campbell	**JOB NO:**	G0840
PROJECT:	Proposed Residential Subdivision	**DRAWN BY:**	DS
LOCATION:	Lot 9 DP1219664157 Arakoon Road, South West Rocks	**DATE:**	13/01/2025
		SCALE:	1:6,000
TITLE:	Investigation Location Plan	**FIGURE NO:**	Figure 1

0 50 100 150 200 m

SIZE: A3

REVISION: 1

HUNTER GEOTECHNICAL SERVICES

LEGEND

Testpit Locations

Kempsey_100K_Coastal_Quaternary_Geological_Sheet_MGAz56

Soil_AcidSulfateSoilRisk_Probability

APP_C_Concept Subdivision Layout - King & Campbell_modified

HUNTER GEOTECHNICAL SERVICES

CLIENT:	King & Campbell	**JOB NO:**	G0840
PROJECT:	Proposed Residential Subdivision	**DRAWN BY:**	DS
LOCATION:	Lot 9 DP1219664157 Arakoon Road, South West Rocks	**DATE:**	13/01/2025
		SCALE:	1:14602.92
TITLE:	Investigation Location Plan - Querternary Mapping	**FIGURE NO:**	Figure 2

0 100 200 300 400 m

SIZE: A3

REVISION: 1

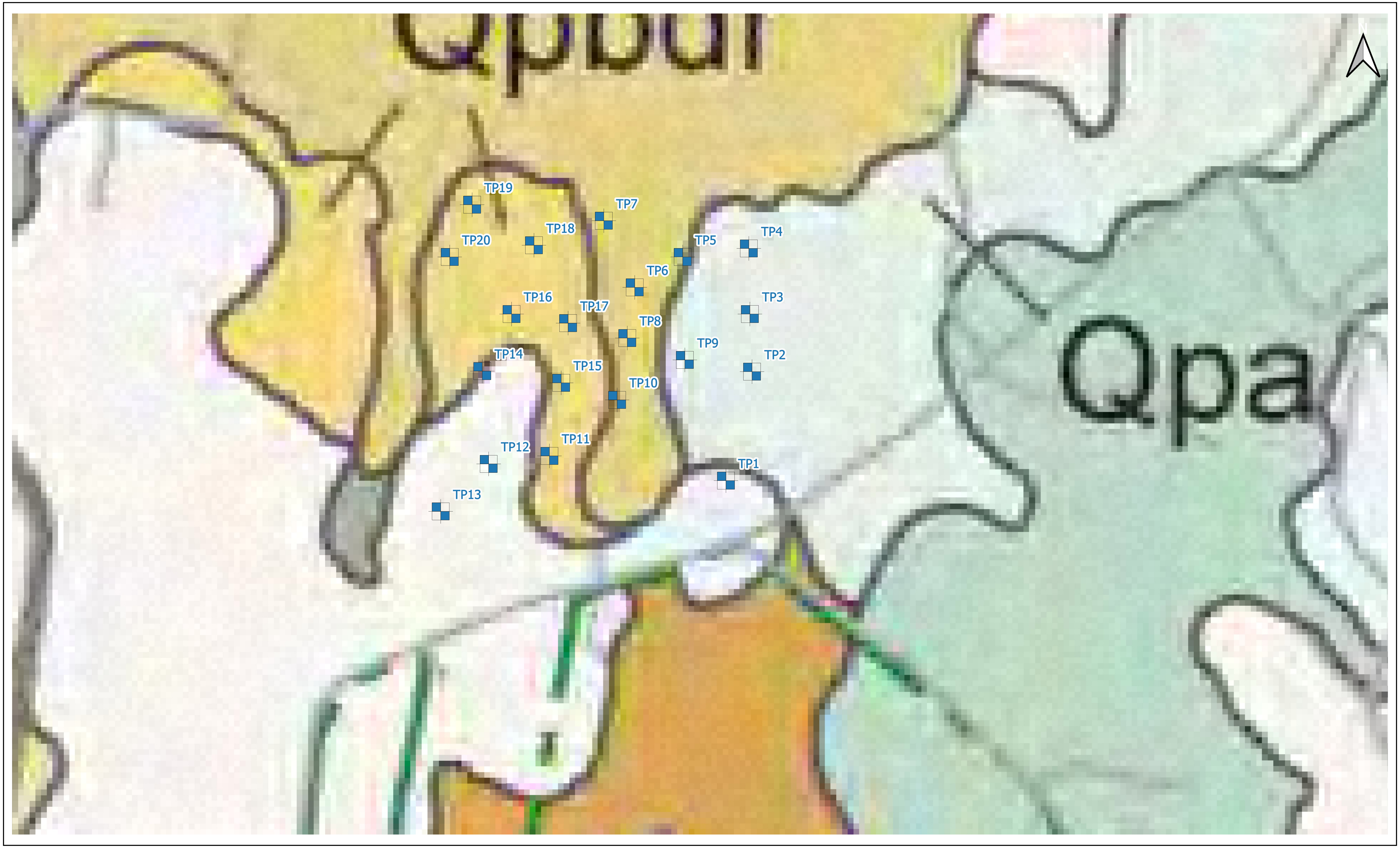
LEGEND

▣ Testpit Locations

Soil_AcidSulfateSoilRisk_Probability

Kempsey_100K_Coastal_Quaternary_Geological_Sheet_MGAz56

APP_C_Concept Subdivision Layout - King & Campbell_modified



HUNTER GEOTECHNICAL SERVICES

CLIENT:	King & Campbell	**JOB NO:**	G0840		
PROJECT:	Proposed Residential Subdivision	**DRAWN BY:**	DS		
LOCATION:	Lot 9 DP1219664157 Arakoon Road, South West Rocks	**DATE:**	13/01/2025		
		SCALE:	1:6,000	**SIZE:**	A3
TITLE:	Investigation Location Plan - Quaternary Mapping	**FIGURE NO:**	Figure 3	**REVISION:**	1

LEGEND

▚ Testpit Locations

Kempsey_100K_Coastal_Quaternary_Geological_Sheet_MGAz56

Soil_AcidSulfateSoilRisk_Probability

APP_C_Concept Subdivision Layout - King & Campbell_modified

Annex B

1 Introduction

The following notes are provided to be used in conjunction with Hunter Geotechnical Services' report to explain the terms and abbreviations used throughout the report.

2 Material Descriptions

Descriptions of soil and rock are generally in accordance with the Unified Soil Classification System and Australian Standard AS1726-2017 – Geotechnical Site Investigations. The descriptions of soil and rock are based on field tests and observations and are independent of any laboratory test results. The data presented throughout this report is as factual as possible. However, some interpretations is unavoidable.

2.1 Unified Soil Classification Group Symbols

Soils are generally assigned one of the following unified soil classification group symbols:

Table 2.1 - Unified Soil Classification Group Symbols

Symbol	Description	Symbol	Description
OH	Organic clays of medium to high plasticity	Pt	Peat and other highly organic soils
OL	Organic silts of low plasticity	CH	Inorganic clays of high plasticity
MH	Inorganic silts of high plasticity	CI	Inorganic clays of low plasticity
ML	Inorganic silts of low plasticity	CL	Inorganic clays of low plasticity
GC	Clayey gravels	SC	Clayey sands
GM	Silty gravels	SM	Silty sands
GP	Poorly graded gravels	SP	Poorly graded sands
GW	Well graded gravels	SW	Well graded sands

2.2 Soil Description

Soils are described in general accordance with AS1726-2017, Section 6.1:

Table 2.2 - Particle Size Definitions (AS1726-2017, Table 1)

Component	Subdivision	Size (mm)
BOULDERS		>200
COBBLES		63 - 200
GRAVEL	Coarse	19 - 63
	Medium	6.7 - 19
	Fine	2.36 - 6.7
SAND	Coarse	0.6 - 2.36
	Medium	0.21 - 0.6
	Fine	0.075 - 0.21
SILT		0.002 - 0.075
CLAY		<0.002

Table 2.3 - Descriptive Terms for Accessory Soil Components (AS1726-2017, Table 2)

Designation of Components	In Coarse Grained Soils				In Fine Grained Soils	
	% Fines	Terminology	% Accessory Coarse Fraction	Terminology	% Sand / Gravel	Terminology
Minor	≤ 5	Add 'trace clay / silt' to description where applicable	≤ 15	Add 'trace sand / gravel' to description where applicable	≤ 15	Add 'trace sand / gravel' to description where applicable
	> 5, ≤ 12	Add 'with clay / silt' to description where applicable	> 15, ≤ 30	Add 'with sand / gravel' to description where applicable	> 15, ≤ 30	Add 'with sand / gravel' to description where applicable
Secondary	> 12	Prefix soil name as 'Silty' or 'Clayey', as applicable	> 30	Prefix soil name as 'Sandy' or 'Gravelly', as applicable	> 30	Prefix soil name as 'Sandy' or 'Gravelly', as applicable

Table 2.4 - Descriptive Terms for Plasticity (AS1726-2017, Table 6)

Descriptive Term	Range of Liquid Limit for SILT	Range of Liquid Limit for CLAY
Non-Plastic	Not applicable	Not applicable
Low Plasticity	≤ 50	≤ 35
Medium Plasticity	Not applicable	> 35 and ≤ 50
High Plasticity	> 50	> 50

Table 2.5 - Moisture Condition (AS1726-2017, Clause 6.1.7 (a))

Material	Term	Abbreviation	Field Description Terms
Coarse Grained Soil	Dry	D	Non-cohesive and free-running
	Moist	M	Soil feels cool, darkened in colour; Soil tends to stick together
	Wet	W	Soil feels cool, darkened in colour; Soil tends to stick together, free water forms when handling
Fine Grained Soil	Moist, dry of plastic limit	w < PL	Hard and friable or powdery
	Moist, near plastic limit	w ≈ PL	Soil can be moulded at a moisture content approximately equal to the plastic limit
	Moist, wet of plastic limit	w > PL	Soil usually weakened and free water forms on hands when handling
	Wet, near liquid limit	w ≈ LL	Near liquid limit
	Wet, wet of liquid limit	w > LL	Wet of liquid limit

Table 2.6 - Consistency Terms for Cohesive Soils (AS1726-2017, Table 11)

Consistency	Abbreviation	Field Guide to Consistency
Very Soft	VS	Exudes between the fingers when squeezed in hand
Soft	S	Can be moulded by light finger pressure
Firm	F	Can be moulded by strong finger pressure
Stiff	St	Cannot be moulded by fingers
Very Stiff	VSt	Can be indented by thumb nail
Hard	H	Can be indented with difficulty by thumb nail
Friable	Fr	Can be easily crumbled or broken into small pieces by hand

Table 2.7 - Relative Density of Non-Cohesive Soils (AS1726-2017, Table 12)

Relative Density	Abbreviation	Density Index (%)
Very Loose	VL	≤ 15
Loose	L	> 15 and ≤ 35
Medium Dense	MD	> 35 and ≤ 65
Dense	D	> 65 and ≤ 85
Very Dense	VD	> 85

Table 2.8 - Soil Origin (AS1726-2017, Clause 6.1.9)

Origin	Description
Residual Soil	Formed directly from in situ weathering of geological formations. These soils no longer retain any visible structure of fabric of the parent soil or rock material.
Extremely weathered material	Formed directly from in situ weathering of geological formations. Although this material is of soil strength, it retains the structure and / or fabric of the parent rock material.
Alluvial soil	Deposited by streams and rivers.
Estuarine soil	Deposited in coastal estuaries, and including sediments carried by inflowing rivers and streams, and tidal currents.
Marine soil	Deposited in a marine environment.
Lacustrine soil	Deposited in freshwater lakes.
Aeolian soil	Carried and deposited by wind.
Colluvial soil	Soil and rock debris transported down slopes by gravity, with or without the assistance of flowing water and generally deposited in gullies or at the base of slopes. Colluvium is often used to refer to thicker deposits such as those formed from landslides, whereas the term 'slopewash' may be use for thinner and more widespread deposits that accumulate gradually over longer geological timeframes.
Topsoil	Surface and / or near surface soils often, but not always, defined by high levels of organic material.
Fill	Material placed by anthropogenic processes.

2.3 Rock Description

Rocks are described in general accordance with AS1726-2017, Clause 6.2.

Table 2.9 - Rock Material Strength Classification (AS1726-2017, Table 19)

Strength	Abbreviation	Field Assessment
Very Low Strength	VLS	Material crumbles under firm blows with sharp end of pick; Can be peeled with sharp knife; Too hard to cut a triaxial sample by hand; Pieces up to 30mm thick can be broken by finger pressure.
Low Strength	LS	Easily scored with a knife; Indentations 1mm to 3mm show in the specimen with firm blows of the pick point; Has dull sound under the hammer; A piece of core 150mm long by 50mm diameter may be broken by hand; Sharp edges of core may be friable and break during handling.
Medium Strength	MS	Readily scored with a knife; A piece of core 150mm long by 50mm diameter can be broken by hand with difficulty.
High Strength	HS	A piece of core 150mm long by 50mm diameter cannot be broken by hand but can be broken by a pick with a single firm blow; Rock rings under hammer.
Very High Strength	VH	Hand specimen breaks with pick after more than one blow; Rock rings under hammer.
Extremely High Strength	EH	Specimen required many blows with geological pick to break through intact material; Rock rings under hammer.

Note: Material with strength less than 'Very Low' shall be described using soil characteristics. The presence of an original rock structure, fabric or texture should be noted, if relevant.

Table 2.10 - Classification of Material Weathering (AS1726-2017, Table 20)

<table>
<tr><th colspan="2">Term</th><th colspan="2">Abbreviation</th><th>Definition</th></tr>
<tr><td colspan="2">Residual Soil</td><td colspan="2">RS</td><td>Material is weathered to such an extent that is has soil properties. Mass structure and material texture and fabric of original rock are no longer visible, but the soil has not been significantly transported. The material is described using soil descriptive terms.</td></tr>
<tr><td colspan="2">Extremely Weathered</td><td colspan="2">XW</td><td>Material is weathered to such an extent that is has soil properties. Mass structure and material structure and fabric of original rock are still visible. The material is described using soil descriptive terms.</td></tr>
<tr><td>Highly Weathered</td><td rowspan="2">Distinctly Weathered</td><td>HW</td><td rowspan="2">DW</td><td>The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognizable. Rock strength is significantly changed by weathering.</td></tr>
<tr><td>Moderately Weathered</td><td>MW</td><td>The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognizable, but shows little or no change of strength from fresh rock.</td></tr>
<tr><td colspan="2">Slightly Weathered</td><td colspan="2">SW</td><td>Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.</td></tr>
<tr><td colspan="2">Fresh</td><td colspan="2">FR</td><td>Rock shows no sign of decomposition of individual minerals or colour changes.</td></tr>
</table>

3 Drilling, In Situ Testing & Sampling Methodology

Table 3.1 - Drilling Methods

Abbreviation	Method
HA	Hand Auger
EX	Excavator bucket
AV	Auger drilling with steel 'V' bit
AT	Auger drilling with tungsten carbide bit
AB	Auger for bulk sampling
WB	Wash bore rotary drilling
NMLC	Rock coring using a NMLC core barrel
HQ	Rock coring using a HQ core barrel

Table 3.2 - Field Sampling and In Situ Testing Key

Abbreviation	In Situ Test
DCP	Dynamic Cone Penetrometer (blows/100mm)
PSP	Perth Sand Penetrometer (blow/100mm)
SPT	Standard Penetrometer Test
PP	Pocket Penetrometer Measurement (kPa)
3,4,5 (example)	SPT blows per 150mm
N=9 (example)	STP 'blow count number' over 300mm after initial 150mm seating
VS	Handheld Shear Vane Measurement (kPa)
CPT	Cone Penetrometer Test
IS50 (D) (A)	Point Load Index Value (reported in MPA) (D) = Diametric (A) = Axial

Abbreviation	Sample Type
U	Undisturbed Sample (50mm)
D	Disturbed Sample
B	Bulk Disturbed Sample
ES	Environmental Sample
W	Water Sample

4 Groundwater Observations

Table 4.1 - Water Comments Key

Water Comment	Symbol
Water Inflow	▶—
Water / drilling fluid loss	—◀
Measurement of standing water level	▼
Water Noted	▽

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Geotechnical Log - Testpit

TP01

UTM	**: 56J**	**Excavator**	**: 2T Excavator**	**Job Number**	**: G0840**
Easting (m)	**: 505222.23**	**Excavator Supplier**	**:**	**Client**	**: King & Campbell**
Northing (m)	**: 6580590.78**	**Logged By**	**: DS**	**Project**	**: Acid Sulfate Assessment**
Ground Elevation	**: Not Surveyed**	**Reviewed By**	**: DS**	**Location**	**: Lot 9 DP1219664,157 Arakoon Road, South West Rocks**
Total Depth	**: 1.9 m BGL**	**Date**	**: 05/12/2024**	**Loc Comment**	**: Road Entry**

General comments: Handy GPS 503221 6580613

Drilling Method	Water	DCP	Testing	Samples			Depth (m)	Graphic Log	Classification Code	Material Description	Moisture	Consistency	Soil Origin	Remarks
			Pocket Penetrometer	Disturbed	Undisturbed	Bulk								
		2					0.1	░	SM	Silty SAND, fine to medium grained, grey to dark grey, with rootlets			Topsoil	
		2						▨		SAND, fine to medium grained, grey.	M		Aeolian	
		3						▨						
		3						▨						
		3		▨			0.5	▨						
		2				▨		▨		SAND, fine to medium grained, siliceous	W		Marine	
		3				▨		▨						
		4						▨						
		5						▨						
		5		▨			1	▨						
		7						▨						
		5						▨						
		5		▨				▨						
		7		▨				▨						
		5		▨				▨						
		6					1.6	▨						
		10		▨				▨		SAND, fine to medium grained, dark grey, non - cemented	W		MARINE - INDURATED	
	▽	11		▨				▨						
		30						▨						

TP01 Terminated at 1.9m (hole collapse)

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Geotechnical Log - Testpit

TP02

UTM	: 56J	**Excavator**	: 2T Excavator	**Job Number**	: G0840
Easting (m)	: 505251.00	**Excavator Supplier**	:	**Client**	: King & Campbell
Northing (m)	: 6580762.00	**Logged By**	: DS	**Project**	: Acid Sulfate Assessment
Ground Elevation	: Not Surveyed	**Reviewed By**	: DS	**Location**	: Lot 9 DP1219664,157 Arakoon Road, South West Rocks
Total Depth	: 2.5 m BGL	**Date**	: 05/12/2024	**Loc Comment**	:

General comments: handy GPS 505251 6580762

Drilling Method	Water	DCP	Testing	Samples			Depth (m)	Graphic Log	Classification Code	Material Description	Moisture	Consistency	Soil Origin	Remarks
			Pocket Penetrometer	Disturbed	Undisturbed	Bulk								General
							0.1			SAND, fine to medium grained, grey.			Topsoil	
							0.4		CI	Sandy CLAY, medium plasticity, grey to dark grey, fine to medium grained sand, humic .	w ≈ PL		Alluvium - Holocene	
			300 280	▨			0.7		CI-CH	Sandy CLAY, medium to high plasticity, dark grey mottled orange, fine to medium grained sand.	w ≈ PL	VSt	Alluvium - Holocene	
	▶		350 300 220 280 240 220 240	▨ ▨		▨	1 2		CH	Silty CLAY, high plasticity, grey mottled orange trace red mottling, with fine to medium jarosite sand .	w ≈ PL	VSt	Alluvium - Pleistocene	1.8 m: very slight water inflow

TP02 Terminated at 2.5m

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Geotechnical Log - Testpit

TP03

UTM	: 56J	**Excavator**	: 2T Excavator	**Job Number**	: G0840
Easting (m)	: 506345.40	**Excavator Supplier**	:	**Client**	: King & Campbell
Northing (m)	: 6580617.02	**Logged By**	: DS	**Project**	: Acid Sulfate Assessment
Ground Elevation	: Not Surveyed	**Reviewed By**	: DS	**Location**	: Lot 9 DP1219664,157 Arakoon Road, South West Rocks
Total Depth	: 2.4 m BGL	**Date**	: 05/12/2024	**Loc Comment**	:

General comments: handy GPS 505233 6586822

Drilling Method	Water	DCP	Testing	Samples			Depth (m)	Graphic Log	Classification Code	Material Description	Moisture	Consistency	Soil Origin	Remarks
			Pocket Penetrometer	Disturbed	Undisturbed	Bulk								
							0.15	▨		SAND, fine to medium grained, grey.			Topsoil	
							0.55	▨	CI	Sandy CLAY, medium plasticity, grey to dark grey, fine to medium grained sand, humic .	w ≈ PL		Alluvium - Holocene	
			300 320 300	▨			0.9	▨	CI	Sandy CLAY, medium plasticity, pale grey and grey mottled orange and red, fine to medium grained sand.	w ≈ PL	VSt	Alluvium - Holocene	
			280 340 1.5 340	▨ ▨			1 2	▨	CH	Silty CLAY, high plasticity, pale grey to grey mottled orange and red, with fine to medium grained sand.	w ≈ PL-w < PL	VSt	Alluvium - Pleistocene	

TP03 Terminated at 2.4m

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Geotechnical Log - Testpit

TP04

UTM	**: 56J**	**Excavator**	**: 2T Excavator**	**Job Number**	**: G0840**
Easting (m)	**: 505265.00**	**Excavator Supplier**	**:**	**Client**	**: King & Campbell**
Northing (m)	**: 6580944.00**	**Logged By**	**: DS**	**Project**	**: Acid Sulfate Assessment**
Ground Elevation	**: Not Surveyed**	**Reviewed By**	**: DS**	**Location**	**: Lot 9 DP1219664,157 Arakoon Road, South West Rocks**
Total Depth	**: 2.4 m BGL**	**Date**	**: 05/12/2024**	**Loc Comment**	**:**

General comments: handy GPS 505265 6580944

Drilling Method	Water	DCP	Testing	Samples			Depth (m)	Graphic Log	Classification Code	Material Description	Moisture	Consistency	Soil Origin	Remarks
			Pocket Penetrometer	Disturbed	Undisturbed	Bulk								
							0.1	▨		SAND, fine to medium grained, grey.			Topsoil	
							0.45	▨	CI	Sandy CLAY, medium plasticity, grey to dark grey, fine to medium grained sand, humic .	w ≈ PL		Alluvium - Holocene	
			280 280 320 300	▨			1 1.2	▨	CI	Sandy CLAY, medium plasticity, pale grey and grey mottled orange and red, fine to medium grained sand.	w ≈ PL	VSt	Alluvium - Holocene	
			380 400 420 410 380 390 380 420 420	▨ ▨			2	▨	CH	Silty CLAY, high plasticity, pale grey to grey mottled orange trace mottled red, with fine to medium grained sand.	w ≈ PL-w < PL	VSt-H	Alluvium - Pleistocene	

TP04 Terminated at 2.4m

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Geotechnical Log - Testpit

TP05

UTM	: 56J	**Excavator**	: 2T Excavator	**Job Number**	: G0840
Easting (m)	: 505116.00	**Excavator Supplier**	:	**Client**	: King & Campbell
Northing (m)	: 6580978.00	**Logged By**	: DS	**Project**	: Acid Sulfate Assessment
Ground Elevation	: Not Surveyed	**Reviewed By**	: DS	**Location**	: Lot 9 DP1219664,157 Arakoon Road, South West Rocks
Total Depth	: 2.8 m BGL	**Date**	: 05/12/2024	**Loc Comment**	:

General comments: handy GPS 505116 6580978

Drilling Method	Water	DCP	Testing Pocket Penetrometer	Samples Disturbed	Undisturbed	Bulk	Depth (m)	Graphic Log	Classification Code	Material Description	Moisture	Consistency	Soil Origin	Remarks
							0.2	▩		SAND, fine to medium grained, grey.			Topsoil	
			110 50	▨			0.45	▧	CI-CH	Silty to sandy CLAY, medium to high plasticity, pale grey mottled orange, fine to medium grained sand, with moist fines .	w ≈ PL	F	Alluvium - Holocene	
			60 100				0.6	▨	CI	Sandy CLAY, medium plasticity, pale grey and grey mottled orange and red, fine to medium grained sand.	w ≈ PL	St	Alluvium - Holocene	
			120 160	▨			1 — 1.2	▧	CI-CH	Silty to sandy CLAY, medium to high plasticity, pale grey mottled orange, fine to medium grained sand, with moist fines .	w ≈ PL	St	Alluvium - Holocene	
			320				1.3	▧	CH	Silty CLAY, high plasticity, pale grey mottled orange, with fine to medium grained sand.	w ≈ PL-w < PL	VSt	Pleistocene - Estuarine	
			280	▨		▨	1.6	▧	CH	Silty CLAY, high plasticity, pale grey mottled orange, with fine to medium grained sand, becoming grey blue with depth .	w ≈ PL-w < PL	VSt	Pleistocene - Estuarine	
			280 300	▨ ▨			2	▧	CH	As above, but trace mottled yellow and orange jarosite .	w ≈ PL-w < PL	VSt	Pleistocene - Estuarine	
										TP05 Terminated at 2.8m				

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Geotechnical Log - Testpit

TP06

UTM : 56J
Easting (m) : 522422.79
Northing (m) : 6580950.62
Ground Elevation : Not Surveyed
Total Depth : 2.8 m BGL

Excavator : 2T Excavator
Excavator Supplier :
Logged By : DS
Reviewed By : DS
Date : 05/12/2024

Job Number : G0840
Client : King & Campbell
Project : Acid Sulfate Assessment
Location : Lot 9 DP1219664,157 Arakoon Road, South West Rocks
Loc Comment :

General comments: handy GPS 505065 6580973

Drilling Method	Water	DCP	Testing Pocket Penetrometer	Samples Disturbed	Undisturbed	Bulk	Depth (m)	Graphic Log	Classification Code	Material Description	Moisture	Consistency	Soil Origin	Remarks
							0.2		ML	Sandy SILT, low plasticity, dark grey, fine to medium grained sand, with rootlets.			Topsoil	
				▨			0.55			Clayey to sandy SAND, fine to medium grained sand, pale grey.	M-w ≈ PL		Alluvium - Holocene	
			100 120 150				0.9		CI-CH	Sandy CLAY, medium to high plasticity, pale grey mottled brown, fine to medium grained sand.	w > PL	St	Pleistocene - Estuarine	
			140 120	▨ ▨			1		CH	Silty CLAY, high plasticity, pale grey to pale brown, with fine to medium grained sand, sulfuric odor .	w ≈ PL-w < PL	St	Pleistocene - Estuarine	
							1.4							
			220				1.55		CH		w ≈ PL-w < PL	VSt	Pleistocene - Estuarine	
	▶		200	▨ ▨			2		SC	As above, but Clayey to silty SAND, fine to coarse grained, pale grey.	M		Pleistocene - Estuarine	
										TP06 Terminated at 2.8m				

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TP07

UTM	: 56J	**Excavator**	: 2T Excavator	**Job Number**	: G0840
Easting (m)	: 505039.00	**Excavator Supplier**	:	**Client**	: King & Campbell
Northing (m)	: 6581013.00	**Logged By**	: DS	**Project**	: Acid Sulfate Assessment
Ground Elevation	: Not Surveyed	**Reviewed By**	: DS	**Location**	: Lot 9 DP1219664,157 Arakoon Road, South West Rocks
Total Depth	: 2.6 m BGL	**Date**	: 05/12/2024	**Loc Comment**	:

General comments: handy GPS 505039 6581013

Drilling Method	Water	DCP	Testing Pocket Penetrometer	Samples Disturbed	Undisturbed	Bulk	Depth (m)	Graphic Log	Classification Code	Material Description	Moisture	Consistency	Soil Origin	Remarks
							0.25		ML	Sandy SILT, low plasticity, dark grey, fine to medium grained sand, with rootlets and humic .	w < PL		Topsoil	
			80 80 100				0.55		CI-CH	Clayey to sandy CLAY, medium to high plasticity, grey mottled orange, fine to medium grained sand.	w > PL	F	Alluvium - Holocene	
			120				1 1.3		CH	Sandy CLAY, high plasticity, pale grey to blue, fine to medium grained sand, sulfuric odor, increasing sand content with depth.	w > PL	St	Pleistocene - Estuarine	
							2		CH	As above, but strong sulfuric odor .	w > PL		Pleistocene - Estuarine	

TP07 Terminated at 2.6m

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Geotechnical Log - Testpit

TP08

UTM	**: 56J**	**Excavator**	**: 2T Excavator**	**Job Number**	**: G0840**
Easting (m)	**: 505063.00**	**Excavator Supplier**	**:**	**Client**	**: King & Campbell**
Northing (m)	**: 6580901.00**	**Logged By**	**: DS**	**Project**	**: Acid Sulfate Assessment**
Ground Elevation	**: Not Surveyed**	**Reviewed By**	**: DS**	**Location**	**: Lot 9 DP1219664,157 Arakoon Road, South West Rocks**
Total Depth	**: 2.5 m BGL**	**Date**	**: 05/12/2024**	**Loc Comment**	**:**

General comments: handy GPS 505063 6580901

Drilling Method	Water	DCP	Testing	Samples			Depth (m)	Graphic Log	Classification Code	Material Description	Moisture	Consistency	Soil Origin	Remarks
			Pocket Penetrometer	Disturbed	Undisturbed	Bulk								
							0.29	▥	ML	Sandy SILT, low plasticity, dark brown to black, fine to medium grained sand, with rootlets and humic .	w < PL		Topsoil	
			120	■			0.9	▨	CI	Clayey to sandy CLAY, medium plasticity, grey / brown, fine to medium grained sand.	w > PL	St	Alluvium - Holocene	
			140 180 140	■			1 1.4	▨	CH	Silty CLAY, high plasticity, pale grey mottled orange, with fine to medium grained sand.	w > PL	St	Pleistocene - Estuarine	
			240 220	■			1.6	▨	CH		w > PL	VSt	Pleistocene - Estuarine	
				■ ■			2	▨	CH	As above, but sulfuric odor .	w > PL	VSt	Pleistocene - Estuarine	

TP08 Terminated at 2.5m

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Geotechnical Log - Testpit

TP09

UTM	: 56J	**Excavator**	: 2T Excavator	**Job Number**	: G0840
Easting (m)	: 505118.00	**Excavator Supplier**	:	**Client**	: King & Campbell
Northing (m)	: 6580812.00	**Logged By**	: DS	**Project**	: Acid Sulfate Assessment
Ground Elevation	: Not Surveyed	**Reviewed By**	: DS	**Location**	: Lot 9 DP1219664,157 Arakoon Road, South West Rocks
Total Depth	: 2.1 m BGL	**Date**	: 05/12/2024	**Loc Comment**	:

General comments: handy GPS 505118 6580812

Drilling Method	Water	DCP	Testing Pocket Penetrometer	Samples Disturbed	Undisturbed	Bulk	Depth (m)	Graphic Log	Classification Code	Material Description	Moisture	Consistency	Soil Origin	Remarks
							0.25	▥	ML	Sandy SILT, low plasticity, dark brown to black, fine to medium grained sand, with rootlets and humic .	w < PL		Topsoil	
			220 205	■ ■		■	0.9	▨	CI	Silty to clayey CLAY, medium plasticity, pale grey, with fine to medium grained sand.	w > PL	VSt	Alluvium - Holocene	
			300 320 280 300	■ ■			1 2	▨	CH	Silty CLAY, high plasticity, pale grey.	w > PL	VSt	Pleistocene - Estuarine	

TP09 Terminated at 2.1m

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Geotechnical Log - Testpit

TP10

UTM	**: 56J**	**Excavator**	**: 2T Excavator**	**Job Number**	**: G0840**
Easting (m)	**: 505076.00**	**Excavator Supplier**	**:**	**Client**	**: King & Campbell**
Northing (m)	**: 6580743.00**	**Logged By**	**: DS**	**Project**	**: Acid Sulfate Assessment**
Ground Elevation	**: Not Surveyed**	**Reviewed By**	**: DS**	**Location**	**: Lot 9 DP1219664,157 Arakoon Road, South West Rocks**
Total Depth	**: 1.8 m BGL**	**Date**	**: 05/12/2024**	**Loc Comment**	**:**

General comments: handy GPS 505076 6580743

Drilling Method	Water	DCP	Testing	Samples			Depth (m)	Graphic Log	Classification Code	Material Description	Moisture	Consistency	Soil Origin	Remarks
			Pocket Penetrometer	Disturbed	Undisturbed	Bulk								
			300				0.35	▤	CL	Silty CLAY, low plasticity, dark brown to brown.	w ≈ PL		Topsoil	
			280	▨		▨	0.8	▨	CI	Sandy to clayey CLAY, medium plasticity, pale grey, fine to medium grained sand, sulfuric odor.	w > PL	VSt	Alluvium - Holocene	
			260 320	▨			1 1.2	▨	CH	Silty CLAY, high plasticity, pale grey.	w > PL	VSt	Pleistocene - Estuarine	
	▽		300	▨ ▨				▨	CI	As above, but Sandy medium plasticity, pale grey, fine to coarse grained sand, sulfuric odor.	w ≈ PL	VSt	Pleistocene - Estuarine	

TP10 Terminated at 1.8m

Hunter Geotechnical Services

2/40 Glenwood Drive, Thornton NSW 2322

Phone: (02) 4966 1844

Geotechnical Log - Testpit

TP11

UTM : 56J
Easting (m) : 504973.00
Northing (m) : 6580686.00
Ground Elevation : Not Surveyed
Total Depth : 2.5 m BGL

Excavator : 2T Excavator
Excavator Supplier :
Logged By : DS
Reviewed By : DS
Date : 05/12/2024

Job Number : G0840
Client : King & Campbell
Project : Acid Sulfate Assessment
Location : Lot 9 DP1219664,157 Arakoon Road, South West Rocks
Loc Comment :

General comments: handy GPS 504973 6580686

			Testing	Samples										Remarks
Drilling Method	Water	DCP	Pocket Penetrometer	Disturbed	Undisturbed	Bulk	Depth (m)	Graphic Log	Classification Code	Material Description	Moisture	Consistency	Soil Origin	General
							0.15		SM	Silty SAND, fine to medium grained, dark grey, with rootlets	w ≈ PL		Topsoil	
							0.8		SW	SAND, fine to medium grained, grey to dark grey.	M-D		Aeolian	0.6 m: tree roots
							1 2		SW	SAND, fine to medium grained, pale grey, silicious	M-D-w > PL		Aeolian	
										TP11 Terminated at 2.5m				

Hunter Geotechnical Services

2/40 Glenwood Drive, Thornton NSW 2322

Phone: (02) 4966 1844

Geotechnical Log - Testpit

TP12

UTM : 56J
Easting (m) : 504896.00
Northing (m) : 6580671.00
Ground Elevation : Not Surveyed
Total Depth : 1.8 m BGL

Excavator : 2T Excavator
Excavator Supplier :
Logged By : DS
Reviewed By : DS
Date : 05/12/2024

Job Number : G0840
Client : King & Campbell
Project : Acid Sulfate Assessment
Location : Lot 9 DP1219664,157 Arakoon Road, South West Rocks
Loc Comment :

General comments: Handy GPS 504896 6580671

Drilling Method	Water	DCP	Testing Pocket Penetrometer	Samples Disturbed	Undisturbed	Bulk	Depth (m)	Graphic Log	Classification Code	Material Description	Moisture	Consistency	Soil Origin	Remarks
							0.1	▨	CI	Sandy CLAY, medium plasticity, pale brown and brown, fine to medium grained sand, with rootlets .			Topsoil	
			300 280 280			▨	0.9	▨	CI	Sandy CLAY, medium plasticity, pale brown / orange mottled orange, grey and red, fine to medium grained sand.	w ≈ PL	VSt	Residual	
			380 360				1 1.3	▧	CH	Silty CLAY, high plasticity, grey mottled red and orange, with fine to medium grained sand.	w ≈ PL	VSt	Residual	
			420 380					▨	CI	Sandy CLAY, medium plasticity, pale grey mottled orange and red, fine to coarse grained sand, trace rock fabric .	w < PL-w ≈ PL	VSt-H	Extremely Weathered Material	

TP12 Terminated at 1.8m

Hunter Geotechnical Services

2/40 Glenwood Drive, Thornton NSW 2322
Phone: (02) 4966 1844

Geotechnical Log - Testpit

TP13

UTM : 56J
Easting (m) : 504797.00
Northing (m) : 6580591.00
Ground Elevation : Not Surveyed
Total Depth : 1.8 m BGL

Excavator : 2T Excavator
Excavator Supplier :
Logged By : DS
Reviewed By : DS
Date : 05/12/2024

Job Number : G0840
Client : King & Campbell
Project : Acid Sulfate Assessment
Location : Lot 9 DP1219664,157 Arakoon Road, South West Rocks
Loc Comment :

General comments: Handy GPS 504797 6580591

Drilling Method	Water	DCP	Testing Pocket Penetrometer	Samples Disturbed	Undisturbed	Bulk	Depth (m)	Graphic Log	Classification Code	Material Description	Moisture	Consistency	Soil Origin	Remarks
							0.1	▩		Sandy CLAY, pale brown to brown, fine to medium grained sand, with rootlets .			Topsoil	
			200 220	▨			0.95	▨	CI	Sandy CLAY, medium plasticity, pale brown to brown, fine to coarse grained sand.		VSt	Residual	
			280 260	▨			1	▨	CI-CH	Silty CLAY, medium to high plasticity, red mottled grey, with fine to medium grained sand.	w ≈ PL	VSt	Residual	

TP13 Terminated at 1.8m

Hunter Geotechnical Services

2/40 Glenwood Drive, Thornton NSW 2322

Phone: (02) 4966 1844

Geotechnical Log - Testpit

TP14

UTM	**: 56J**	**Excavator**	**: 2T Excavator**	**Job Number**	**: G0840**
Easting (m)	**: 504816.00**	**Excavator Supplier**	**:**	**Client**	**: King & Campbell**
Northing (m)	**: 6580685.00**	**Logged By**	**: DS**	**Project**	**: Acid Sulfate Assessment**
Ground Elevation	**: Not Surveyed**	**Reviewed By**	**: DS**	**Location**	**: Lot 9 DP1219664,157 Arakoon Road, South West Rocks**
Total Depth	**: 2 m BGL**	**Date**	**: 05/12/2024**	**Loc Comment**	**:**

General comments: Handy GPS 504816 6580685

Drilling Method	Water	DCP	Testing	Samples			Depth (m)	Graphic Log	Classification Code	Material Description	Moisture	Consistency	Soil Origin	Remarks
			Pocket Penetrometer	Disturbed	Undisturbed	Bulk								
							0.1			Sandy CLAY, pale brown to brown, fine to medium grained sand, with rootlets .			Topsoil	
			220 240 320	▨			1 1.4		CI	Sandy CLAY, medium plasticity, pale brown to brown, fine to coarse grained sand.	w ≈ PL	VSt	Residual	
			280 220 260						CI	Sandy CLAY, medium plasticity, pale brown / brown mottled red, fine to medium grained sand.	w ≈ PL	VSt	Residual	

TP14 Terminated at 2m

Hunter Geotechnical Services

2/40 Glenwood Drive, Thornton NSW 2322
Phone: (02) 4966 1844

Geotechnical Log - Testpit

TP15

UTM	**: 56J**	**Excavator**	**: 2T Excavator**
Easting (m)	**: 504885.00**	**Excavator Supplier**	**:**
Northing (m)	**: 6580711.00**	**Logged By**	**: DS**
Ground Elevation	**: Not Surveyed**	**Reviewed By**	**: DS**
Total Depth	**: 1.8 m BGL**	**Date**	**: 05/12/2024**

Job Number	**: G0840**
Client	**: King & Campbell**
Project	**: Acid Sulfate Assessment**
Location	**: Lot 9 DP1219664,157 Arakoon Road, South West Rocks**
Loc Comment	**:**

General comments: GPS 504885 6580711

Drilling Method	Water	DCP	Testing: Pocket Penetrometer	Samples: Disturbed	Samples: Undisturbed	Samples: Bulk	Depth (m)	Graphic Log	Classification Code	Material Description	Moisture	Consistency	Soil Origin	Remarks
							0.3			Sandy CLAY, brown, fine to medium grained sand.	w < PL		Topsoil	
			220 240	▨ ▨			0.9		CI	Sandy CLAY, medium plasticity, pale brown to brown mottled red, medium grained sand.	w ≈ PL	VSt	Residual	
			300 320	▨			1		CI-CH	CLAY, medium to high plasticity, pale grey mottled orange and red.	w ≈ PL	VSt	Extremely Weathered Material	

TP15 Terminated at 1.8m

Hunter Geotechnical Services

2/40 Glenwood Drive, Thornton NSW 2322

Phone: (02) 4966 1844

Geotechnical Log - Testpit

TP16

UTM	**: 56J**	**Excavator**	**: 2T Excavator**	**Job Number**	**: G0840**
Easting (m)	**: 504831.86**	**Excavator Supplier**	**:**	**Client**	**: King & Campbell**
Northing (m)	**: 6580883.17**	**Logged By**	**: DS**	**Project**	**: Acid Sulfate Assessment**
Ground Elevation	**: Not Surveyed**	**Reviewed By**	**: DS**	**Location**	**: Lot 9 DP1219664,157 Arakoon Road, South West Rocks**
Total Depth	**: 2 m BGL**	**Date**	**: 05/12/2024**	**Loc Comment**	**:**

General comments: GPS 508451 6580885

Drilling Method	Water	DCP	Testing Pocket Penetrometer	Samples Disturbed	Undisturbed	Bulk	Depth (m)	Graphic Log	Classification Code	Material Description	Moisture	Consistency	Soil Origin	Remarks
							0.1		CI	Sandy CLAY, medium plasticity, pale brown to brown, with rootlets .			Topsoil	
			110 80 80				1 1.45		CI	Sandy CLAY, medium plasticity, pale brown to brown, fine to medium grained sand.	w ≈ PL	St	Residual	
			400				1.7		CI-CH	Silty CLAY, medium to high plasticity, pale grey mottled red, with fine to medium grained sand, trace iron oxide cementing .	w ≈ PL	VSt	Extremely Weathered Material	
			420 400 410						CI-CH	As above, but with fine to coarse grained sand, trace iron oxide cementing .	w ≈ PL	H	Extremely Weathered Material	

TP16 Terminated at 2m

Hunter Geotechnical Services

2/40 Glenwood Drive, Thornton NSW 2322

Phone: (02) 4966 1844

Geotechnical Log - Testpit

TP17

UTM : 56J
Easting (m) : 504936.00
Northing (m) : 6580885.00
Ground Elevation : Not Surveyed
Total Depth : 2 m BGL

Excavator : 2T Excavator
Excavator Supplier :
Logged By : DP
Reviewed By : DS
Date : 05/12/2024

Job Number : G0840
Client : King & Campbell
Project : Acid Sulfate Assessment
Location : Lot 9 DP1219664,157 Arakoon Road, South West Rocks
Loc Comment :

Drilling Method	Water	DCP	Testing	Samples			Depth (m)	Graphic Log	Classification Code	Material Description	Moisture	Consistency	Soil Origin	Remarks
			Pocket Penetrometer	Disturbed	Undisturbed	Bulk								
							0.1	▨	CI	Silty CLAY, medium plasticity, brown, with rootlets .			Topsoil	
							0.4	▨	CI	Sandy CLAY, medium plasticity, brown / grey, fine to medium grained sand.	w ≈ PL	VSt	Residual	
			230	■			0.9	▨	CI		w ≈ PL	VSt	Residual	
			200 250 230	■ ■			1 1.5	▨	CI-CH	Sandy CLAY, medium to high plasticity, grey mottled red, fine to coarse grained sand.	w ≈ PL	VSt	Extremely Weathered Material	
			310 250	■				▨	CI-CH	As above, but grey mottled red, with fine sized gravel, gravels as fragments of hw rock .	w ≈ PL	VSt	Extremely Weathered Material	

TP17 Terminated at 2m

Hunter Geotechnical Services

2/40 Glenwood Drive, Thornton NSW 2322

Phone: (02) 4966 1844

Geotechnical Log - Testpit

TP18

UTM	**: 56J**	**Excavator**	**: 2T Excavator**	**Job Number**	**: G0840**
Easting (m)	**: 504901.00**	**Excavator Supplier**	**:**	**Client**	**: King & Campbell**
Northing (m)	**: 6580978.00**	**Logged By**	**: DP**	**Project**	**: Acid Sulfate Assessment**
Ground Elevation	**: Not Surveyed**	**Reviewed By**	**: DS**	**Location**	**: Lot 9 DP1219664,157 Arakoon Road, South West Rocks**
Total Depth	**: 2 m BGL**	**Date**	**: 05/12/2024**	**Loc Comment**	**:**

General comments: GPS 504901 6580978

Drilling Method	Water	DCP	Testing Pocket Penetrometer	Samples Disturbed	Undisturbed	Bulk	Depth (m)	Graphic Log	Classification Code	Material Description	Moisture	Consistency	Soil Origin	Remarks
							0.1		CI	Sandy CLAY, medium plasticity, brown, with rootlets .	w ≈ PL		Topsoil	
			250	▨			0.8		CI-CH	Sandy CLAY, medium to high plasticity, brown / grey mottled orange and dark grey, fine to medium grained sand.	w ≈ PL	VSt	Alluvium - Holocene	
			240 240 360	▨ ▨ ▨			1		CH	Sandy CLAY, high plasticity, dark grey to grey mottled red, orange and dark grey, fine to coarse grained sand, with fine to medium sized gravel.	w ≈ PL	VSt	Alluvium - Pleistocene	

TP18 Terminated at 2m

Hunter Geotechnical Services

2/40 Glenwood Drive, Thornton NSW 2322

Phone: (02) 4966 1844

Geotechnical Log - Testpit

TP19

UTM	: 56J	**Excavator**	: 2T Excavator	**Job Number**	: G0840
Easting (m)	: 504840.00	**Excavator Supplier**	:	**Client**	: King & Campbell
Northing (m)	: 6581048.00	**Logged By**	: DP	**Project**	: Acid Sulfate Assessment
Ground Elevation	: Not Surveyed	**Reviewed By**	: DS	**Location**	: Lot 9 DP1219664,157 Arakoon Road, South West Rocks
Total Depth	: 2 m BGL	**Date**	: 05/12/2024	**Loc Comment**	:

General comments: GPS 504840 6581048

Drilling Method	Water	DCP	Testing: Pocket Penetrometer	Depth (m)	Classification Code	Material Description	Moisture	Consistency	Soil Origin	Remarks
				0.1	CI	Sandy CLAY, medium plasticity, brown, with rootlets .			Topsoil	
			110 150	1	CI	Sandy CLAY, medium plasticity, brown / pale grey, fine to coarse grained sand.	w ≈ PL	F-St	Alluvium - Holocene	
			130	1.4	CI-CH	Sandy CLAY, medium to high plasticity, pale grey mottled dark grey, fine to coarse grained sand.	w ≈ PL	St	Pleistocene - Estuarine	
			190		CI	Sandy CLAY, medium plasticity, dark grey/grey and red.	w ≈ PL	St	Pleistocene - Estuarine	

TP19 Terminated at 2m

Hunter Geotechnical Services

2/40 Glenwood Drive, Thornton NSW 2322
Phone: (02) 4966 1844

Geotechnical Log - Testpit

TP20

UTM	: 56J	**Excavator**	: 2T Excavator	**Job Number**	: G0840
Easting (m)	: 504845.00	**Excavator Supplier**	:	**Client**	: King & Campbell
Northing (m)	: 6580964.00	**Logged By**	: DP	**Project**	: Acid Sulfate Assessment
Ground Elevation	: Not Surveyed	**Reviewed By**	: DS	**Location**	: Lot 9 DP1219664,157 Arakoon Road, South West Rocks
Total Depth	: 2 m BGL	**Date**	: 05/12/2024	**Loc Comment**	:

General comments: GPS 504845 6580964

Drilling Method	Water	DCP	Testing: Pocket Penetrometer	Depth (m)	Classification Code	Material Description	Moisture	Consistency	Soil Origin	Remarks
				0.1	CH	Sandy CLAY, high plasticity, brown.	w ≈ PL-w > PL		Topsoil	
				0.3	CI	Sandy CLAY, medium plasticity, brown to pale grey mottled grey, fine to coarse grained sand, high sand content .	w > PL	F	Alluvium - Holocene	
			50 50	1 1.1	CH	Sandy CLAY, high plasticity, brown / grey / red mottled dark grey, fine to coarse grained sand.	w ≈ PL-w > PL	F	Alluvium - Holocene	
			320	1.5	CI-CH	Sandy CLAY, medium to high plasticity, pale grey mottled dark grey, red/orange, fine to coarse grained sand.	w ≈ PL	St	Pleistocene - Estuarine	
			370		CI	Sandy CLAY, medium plasticity, pale grey mottled dark grey / grey and red/orange, fine to coarse grained sand.	w ≈ PL	VSt	Pleistocene - Estuarine	

TP20 Terminated at 2m

HUNTER
GEOTECHNICAL SERVICES

Annex C

ANALYTICAL REPORT

Accreditation No. 2562

CLIENT DETAILS

Contact	GECS Result
Client	VALLEY CIVILAB PTY LTD
Address	T/A HUNTER GEOTECHNICAL SERVICES PO BOX 3127 THORNTON NSW 2322
Telephone	61 2 49661844
Facsimile	(Not specified)
Email	gecsresults@huntergeo.au
Project	**G0840 - 157 Arakoon Road South West**
Order Number	**HCL2204**
Samples	69

LABORATORY DETAILS

Manager	Shane McDermott
Laboratory	SGS Alexandria Environmental
Address	Unit 16, 33 Maddox St Alexandria NSW 2015
Telephone	+61 2 8594 0400
Facsimile	+61 2 8594 0499
Email	au.environmental.sydney@sgs.com
SGS Reference	**SE275854 R0**
Date Received	16/12/2024
Date Reported	17/12/2024

COMMENTS

Accredited for compliance with ISO/IEC 17025 - Testing. NATA accredited laboratory 2562(4354).

SIGNATORIES

Dong LIANG

Metals/Inorganics Team Leader

Field pH for Acid Sulphate Soil [AN104] Tested: 16/12/2024

PARAMETER	UOM	LOR	TP1/0.4-0.5/05/12/202 4 SOIL - 5/12/2024 SE275854.001	TP1/0.9-1.0/05/12/202 4 SOIL - 5/12/2024 SE275854.002	TP1/1.2-1.5/05/12/202 4 SOIL - 5/12/2024 SE275854.003	TP1/1.6-1.8/05/12/202 4 SOIL - 5/12/2024 SE275854.004	TP2/0.5-0.6/05/12/202 4 SOIL - 5/12/2024 SE275854.005
pHf	pH Units	-	5.0	5.4	5.3	5.4	6.4
pHfox	pH Units	-	2.3	5.9	5.1	4.3	4.8
Reaction Rate (pHfox)*	No unit	-	1	0	0	0	1
pH Difference*	pH Units	-10	2.7	-0.5	0.2	1.1	1.6

PARAMETER	UOM	LOR	TP2/.7-0.8/05/12/2024 SOIL - 5/12/2024 SE275854.006	TP2/1.2-1.4/05/12/202 4 SOIL - 5/12/2024 SE275854.007	TP2/1.8-1.9/05/12/202 4 SOIL - 5/12/2024 SE275854.008	TP3/0.6-0.7/05/12/202 4 SOIL - 5/12/2024 SE275854.009	TP3/1.0-1.1/05/12/202 4 SOIL - 5/12/2024 SE275854.010
pHf	pH Units	-	6.1	6.3	6.3	6.1	6.8
pHfox	pH Units	-	2.7	5.1	5.3	4.7	5.3
Reaction Rate (pHfox)*	No unit	-	3	2	2	1	2
pH Difference*	pH Units	-10	3.4	1.2	1.0	1.4	1.5

PARAMETER	UOM	LOR	TP3/1.7-1.8/05/12/202 4 SOIL - 5/12/2024 SE275854.011	TP4/0.6-0.7/05/12/202 4 SOIL - 5/12/2024 SE275854.012	TP4/1.2-1.3/05/12/202 4 SOIL - 5/12/2024 SE275854.013	TP4/1.9-2.0/05/12/202 4 SOIL - 5/12/2024 SE275854.014	TP5/0.3-0.4/05/12/202 4 SOIL - 5/12/2024 SE275854.015
pHf	pH Units	-	6.3	5.7	5.3	5.1	5.3
pHfox	pH Units	-	5.0	4.4	4.0	4.0	3.7
Reaction Rate (pHfox)*	No unit	-	2	2	1	1	1
pH Difference*	pH Units	-10	1.3	1.3	1.3	1.1	1.6

PARAMETER	UOM	LOR	TP5/0.9-1.0/05/12/202 4 SOIL - 5/12/2024 SE275854.016	TP5/1.4-1.5/05/12/202 4 SOIL - 5/12/2024 SE275854.017	TP5/1.6-1.8/05/12/202 4 SOIL - 5/12/2024 SE275854.018	TP5/2.4-2.5/05/12/202 4 SOIL - 5/12/2024 SE275854.019	TP6/0.4-.5/05/12/2024 SOIL - 5/12/2024 SE275854.020
pHf	pH Units	-	5.2	5.3	5.3	5.2	5.3
pHfox	pH Units	-	3.2	3.7	3.3	4.3	3.3
Reaction Rate (pHfox)*	No unit	-	1	2	2	3	1
pH Difference*	pH Units	-10	2.0	1.5	2.0	0.9	1.9

PARAMETER	UOM	LOR	TP6/0.8-0.9/05/12/202 4 SOIL - 5/12/2024 SE275854.021	TP6/0.9-1.0/05/12/202 4 SOIL - 5/12/2024 SE275854.022	TP6/1.2-1.3/05/12/202 4 SOIL - 5/12/2024 SE275854.023	TP6/1.6-1.7/05/12/202 4 SOIL - 5/12/2024 SE275854.024	TP6/2.0-2.2/05/12/202 4 SOIL - 5/12/2024 SE275854.025
pHf	pH Units	-	5.5	5.4	5.4	5.3	5.3
pHfox	pH Units	-	3.6	3.8	4.0	4.1	4.2
Reaction Rate (pHfox)*	No unit	-	1	1	1	1	1
pH Difference*	pH Units	-10	1.8	1.6	1.4	1.2	1.1

PARAMETER	UOM	LOR	TP7/0.6-.7/05/12/2024 SOIL - 5/12/2024 SE275854.026	TP7/0.9-1.0/05/12/202 4 SOIL - 5/12/2024 SE275854.027	TP7/1.2-1.3/05/12/202 4 SOIL - 5/12/2024 SE275854.028	TP7/1.6-1.7/05/12/202 4 SOIL - 5/12/2024 SE275854.029	TP7/1.9-2.0/05/12/202 4 SOIL - 5/12/2024 SE275854.030
pHf	pH Units	-	4.8	4.7	5.6	5.2	5.2
pHfox	pH Units	-	3.6	3.3	4.6	4.4	4.5
Reaction Rate (pHfox)*	No unit	-	2	2	1	1	1
pH Difference*	pH Units	-10	1.2	1.4	0.9	0.8	0.7

Field pH for Acid Sulphate Soil [AN104] Tested: 16/12/2024 (continued)

PARAMETER	UOM	LOR	TP7/2.4-2.5/05/12/202 4 SOIL - 5/12/2024 SE275854.031	TP8/0.5-0.6/05/12/202 4 SOIL - 5/12/2024 SE275854.032	TP8/1.4-1.5/05/12/202 4 SOIL - 5/12/2024 SE275854.033	TP8/1.8-1.9/05/12/202 4 SOIL - 5/12/2024 SE275854.034	TP8/2.4-2.5/05/12/202 4 SOIL - 5/12/2024 SE275854.035
pHf	pH Units	-	5.0	4.9	5.3	5.3	4.9
pHfox	pH Units	-	4.0	4.3	3.6	3.7	3.8
Reaction Rate (pHfox)*	No unit	-	1	1	1	1	1
pH Difference*	pH Units	-10	1.0	0.6	1.7	1.7	1.1

PARAMETER	UOM	LOR	TP9/1.4-1.5/05/12/202 4 SOIL - 5/12/2024 SE275854.036	TP9/1.9-2.0/05/12/202 4 SOIL - 5/12/2024 SE275854.037	TP10/0.5-0.6/05/12/2 24 SOIL - 5/12/2024 SE275854.038	TP10/0.9-1.0/05/12/2 24 SOIL - 5/12/2024 SE275854.039	TP10/1.2-1.4/05/12/2 24 SOIL - 5/12/2024 SE275854.040
pHf	pH Units	-	4.8	4.8	5.5	5.1	4.8
pHfox	pH Units	-	3.8	4.0	4.4	4.3	5.5
Reaction Rate (pHfox)*	No unit	-	1	1	1	1	0
pH Difference*	pH Units	-10	1.0	0.8	1.1	0.8	-0.7

PARAMETER	UOM	LOR	TP10/1.6-1.7/05/12/2 24 SOIL - 5/12/2024 SE275854.041	TP11/0.5-0.6/05/12/2 24 SOIL - 5/12/2024 SE275854.042	TP11/0.9-1.0/05/12/2 24 SOIL - 5/12/2024 SE275854.043	TP11/1.4-1.5/05/12/2 24 SOIL - 5/12/2024 SE275854.044	TP11/1.9-2.0/05/12/2 24 SOIL - 5/12/2024 SE275854.045
pHf	pH Units	-	5.2	4.8	4.5	4.9	5.1
pHfox	pH Units	-	6.1	3.3	5.8	4.4	4.1
Reaction Rate (pHfox)*	No unit	-	0	0	0	0	0
pH Difference*	pH Units	-10	-0.8	1.5	-1.3	0.5	1.0

PARAMETER	UOM	LOR	TP13/0.5-0.6/05/12/2 24 SOIL - 5/12/2024 SE275854.046	TP13/1.4-1.5/05/12/2 24 SOIL - 5/12/2024 SE275854.047	TP14/1.0-1.1/05/12/2 24 SOIL - 5/12/2024 SE275854.048	TP15/0.5-0.6/05/12/2 24 SOIL - 5/12/2024 SE275854.049	TP15/1.4-1.5/05/12/2 24 SOIL - 5/12/2024 SE275854.050
pHf	pH Units	-	5.5	5.2	5.3	5.1	5.3
pHfox	pH Units	-	3.6	4.0	3.9	3.7	4.0
Reaction Rate (pHfox)*	No unit	-	1	1	1	2	2
pH Difference*	pH Units	-10	1.9	1.2	1.4	1.3	1.3

PARAMETER	UOM	LOR	TP16/0.5-0.6/05/12/2 24 SOIL - 5/12/2024 SE275854.051	TP16/1.0-1.1/05/12/2 24 SOIL - 5/12/2024 SE275854.052	TP16/1.5-1.6/05/12/2 24 SOIL - 5/12/2024 SE275854.053	TP16/1.9-2.0/05/12/2 24 SOIL - 5/12/2024 SE275854.054	TP17/0.4-0.5/05/12/2 24 SOIL - 5/12/2024 SE275854.055
pHf	pH Units	-	5.4	4.4	4.2	4.1	5.0
pHfox	pH Units	-	3.5	3.6	3.4	3.3	3.9
Reaction Rate (pHfox)*	No unit	-	2	0	0	1	2
pH Difference*	pH Units	-10	1.9	0.8	0.8	0.8	1.1

PARAMETER	UOM	LOR	TP17/0.9-1.0/05/12/2 24 SOIL - 5/12/2024 SE275854.056	TP17/1.4-1.5/05/12/2 24 SOIL - 5/12/2024 SE275854.057	TP17/1.8-1.9/05/12/2 24 SOIL - 5/12/2024 SE275854.058	TP18/0.4-0.5/05/12/2 24 SOIL - 5/12/2024 SE275854.059	TP18/0.9-1.0/05/12/2 24 SOIL - 5/12/2024 SE275854.060
pHf	pH Units	-	5.0	5.0	4.9	5.1	5.1
pHfox	pH Units	-	4.1	4.2	4.0	3.7	3.8
Reaction Rate (pHfox)*	No unit	-	1	1	1	3	2
pH Difference*	pH Units	-10	0.8	0.7	0.9	1.3	1.3

Field pH for Acid Sulphate Soil [AN104] Tested: 16/12/2024 (continued)

PARAMETER	UOM	LOR	TP18/1.8-1.9/05/12/2 24 SOIL - 5/12/2024 SE275854.061	TP19/0.4-0.5/05/12/2 24 SOIL - 5/12/2024 SE275854.062	TP19/0.9-1.0/05/12/2 24 SOIL - 5/12/2024 SE275854.063	TP19/1.4-1.5/05/12/2 24 SOIL - 5/12/2024 SE275854.064	TP19/1.8-1.9/05/12/2 24 SOIL - 5/12/2024 SE275854.065
pHf	pH Units	-	5.0	4.9	5.3	5.5	5.6
pHfox	pH Units	-	4.2	3.8	4.0	4.3	4.8
Reaction Rate (pHfox)*	No unit	-	1	1	2	2	1
pH Difference*	pH Units	-10	0.8	1.1	1.2	1.2	0.8

PARAMETER	UOM	LOR	TP20/0.4-0.5/05/12/2 24 SOIL - 5/12/2024 SE275854.066	TP20/0.9-1.0/05/12/2 24 SOIL - 5/12/2024 SE275854.067	TP20/1.3-1.5/05/12/2 24 SOIL - 5/12/2024 SE275854.068	TP20/1.8-1.9/05/12/2 24 SOIL - 5/12/2024 SE275854.069
pHf	pH Units	-	4.3	4.6	4.5	4.6
pHfox	pH Units	-	3.7	3.6	3.4	3.7
Reaction Rate (pHfox)*	No unit	-	1	1	1	3
pH Difference*	pH Units	-10	0.6	1.0	1.1	0.9

METHOD	METHODOLOGY SUMMARY
AN104	pHF is determined on an extract of approximately 2g of as received sample in approximately 10 mL of deionised water with pH determined after standing 30 minutes.
AN104	pHFox is determined on an extract of approximately 2g of as received sample with a few mLs of 30% hydrogen peroxide (adjusted to pH 4.5 to 5.5) with the extract reaction being rated from slight to extreme, with pH determined after reaction is complete and extract has cooled. Referenced to ASS Laboratory Methods Guidelines , method 23Af-Bf, 2004. 0 No Reaction 1 Slight Reaction 2 Moderate Reaction 3 Strong/High Reaction 4 Extreme/Vigorous Reaction (gas evolution and heat generation)

FOOTNOTES

*	NATA accreditation does not cover the performance of this service.	-	Not analysed.	UOM	Unit of Measure.
**	Indicative data, theoretical holding time exceeded.	NVL	Not validated.	LOR	Limit of Reporting.
***	Indicates that both * and ** apply.	IS	Insufficient sample for analysis.	↑↓	Raised/lowered Limit of Reporting.
		LNR	Sample listed, but not received.		

Unless it is reported that sampling has been performed by SGS, the samples have been analysed as received.
Solid samples expressed on a dry weight basis.

Where "Total" analyte groups are reported (for example, Total PAHs, Total OC Pesticides) the total will be calculated as the sum of the individual analytes, with those analytes that are reported as <LOR being assumed to be zero. The summed (Total) limit of reporting is calculated by summing the individual analyte LORs and dividing by two. For example, where 16 individual analytes are being summed and each has an LOR of 0.1 mg/kg, the "Totals" LOR will be 1.6 / 2 (0.8 mg/kg). Where only 2 analytes are being summed, the " Total" LOR will be the sum of those two LORs.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

If reported, measurement uncertainty follow the ± sign after the analytical result and is expressed as the expanded uncertainty calculated using a coverage factor of 2, providing a level of confidence of approximately 95%, unless stated otherwise in the comments section of this report.

Results reported for samples tested under test methods with codes starting with ARS-SOP, radionuclide or gross radioactivity concentrations are expressed in becquerel (Bq) per unit of mass or volume or per wipe as stated on the report. Becquerel is the SI unit for activity and equals one nuclear transformation per second.
Note that in terms of units of radioactivity:

a. 1 Bq is equivalent to 27 pCi
b. 37 MBq is equivalent to 1 mCi

For results reported for samples tested under test methods with codes starting with ARS-SOP, less than (<) values indicate the detection limit for each radionuclide or parameter for the measurement system used. The respective detection limits have been calculated in accordance with ISO 11929.

The QC and MU criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here: www.sgs.com.au/en-gb/environment-health-and-safety.

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ANALYTICAL REPORT

Accreditation No. 2562

CLIENT DETAILS

Contact	GECS Result
Client	VALLEY CIVILAB PTY LTD
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Telephone	61 2 49661844
Facsimile	(Not specified)
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Project	**G0840 - 157 Arakoon Road South West**
Order Number	**HCL2204**
Samples	69

LABORATORY DETAILS

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SGS Reference	**SE275854A R0**
Date Received	23/12/2024
Date Reported	3/1/2025

COMMENTS

Accredited for compliance with ISO/IEC 17025 - Testing. NATA accredited laboratory 2562(4354).

CRS subcontracted to SGS Cairns, 2/58 Comport St, Portsmith QLD 4870, NATA Accreditation Number: 2562, Site Number: 3146. SE275854A.

SIGNATORIES

Moisture Content [AN002]   Tested: 3/1/2025

PARAMETER	UOM	LOR	TP1/0.4-0.5/05/12/202 4 SOIL - 5/12/2024 SE275854A.001	TP2/.7-0.8/05/12/2024 SOIL - 5/12/2024 SE275854A.006	TP3/0.6-0.7/05/12/202 4 SOIL - 5/12/2024 SE275854A.009	TP5/0.3-0.4/05/12/202 4 SOIL - 5/12/2024 SE275854A.015	TP5/1.6-1.8/05/12/202 4 SOIL - 5/12/2024 SE275854A.018
% Moisture	%w/w	0.5	6.1	15	27	15	15

PARAMETER	UOM	LOR	TP6/2.0-2.2/05/12/202 4 SOIL - 5/12/2024 SE275854A.025	TP7/2.4-2.5/05/12/202 4 SOIL - 5/12/2024 SE275854A.031	TP11/0.5-0.6/05/12/20 24 SOIL - 5/12/2024 SE275854A.042	TP13/0.5-0.6/05/12/20 24 SOIL - 5/12/2024 SE275854A.046	TP18/0.9-1.0/05/12/20 24 SOIL - 5/12/2024 SE275854A.060
% Moisture	%w/w	0.5	17	22	7.5	16	21

PARAMETER	UOM	LOR	TP19/1.4-1.5/05/12/20 24 SOIL - 5/12/2024 SE275854A.064	TP20/1.8-1.9/05/12/20 24 SOIL - 5/12/2024 SE275854A.069
% Moisture	%w/w	0.5	31	29

TAA (Titratable Actual Acidity) [AN219] Tested: 3/1/2025

PARAMETER	UOM	LOR	TP1/0.4-0.5/05/12/20 4 SOIL - 5/12/2024 SE275854A.001	TP2/.7-0.8/05/12/202 SOIL - 5/12/2024 SE275854A.006	TP3/0.6-0.7/05/12/20 4 SOIL - 5/12/2024 SE275854A.009	TP5/0.3-0.4/05/12/20 4 SOIL - 5/12/2024 SE275854A.015	TP5/1.6-1.8/05/12/20 4 SOIL - 5/12/2024 SE275854A.018
pH KCl*	pH Units	-	5.3	5.4	5.2	4.8	4.8
Titratable Actual Acidity	kg H2SO4/T	0.25	0.31	0.49	0.67	0.98	0.74
Titratable Actual Acidity (TAA) moles H+/tonne	moles H+/T	5	6	10	14	20	15
Titratable Actual Acidity (TAA) S%w/w	%w/w S	0.01	0.01	0.02	0.02	0.03	0.02
Sulphur (SKCl)	%w/w	0.005	-	-	-	-	-

PARAMETER	UOM	LOR	TP6/2.0-2.2/05/12/20 4 SOIL - 5/12/2024 SE275854A.025	TP7/2.4-2.5/05/12/20 4 SOIL - 5/12/2024 SE275854A.031	TP11/0.5-0.6/05/12/2 24 SOIL - 5/12/2024 SE275854A.042	TP13/0.5-0.6/05/12/2 24 SOIL - 5/12/2024 SE275854A.046	TP18/0.9-1.0/05/12/2 24 SOIL - 5/12/2024 SE275854A.060
pH KCl*	pH Units	-	6.0	4.8	5.4	5.2	4.6
Titratable Actual Acidity	kg H2SO4/T	0.25	<0.25	1.1	0.49	0.74	2.9
Titratable Actual Acidity (TAA) moles H+/tonne	moles H+/T	5	<5	22	10	15	60
Titratable Actual Acidity (TAA) S%w/w	%w/w S	0.01	<0.01	0.04	0.02	0.02	0.10
Sulphur (SKCl)	%w/w	0.005	-	-	-	-	-

PARAMETER	UOM	LOR	TP19/1.4-1.5/05/12/2 24 SOIL - 5/12/2024 SE275854A.064	TP20/1.8-1.9/05/12/2 24 SOIL - 5/12/2024 SE275854A.069
pH KCl*	pH Units	-	4.7	4.6
Titratable Actual Acidity	kg H2SO4/T	0.25	2.6	2.9
Titratable Actual Acidity (TAA) moles H+/tonne	moles H+/T	5	52	60
Titratable Actual Acidity (TAA) S%w/w	%w/w S	0.01	0.08	0.10
Sulphur (SKCl)	%w/w	0.005	-	-

Chromium Reducible Sulfur (CRS) [AN217] Tested: 3/1/2025

PARAMETER	UOM	LOR	TP1/0.4-0.5/05/12/20 4 SOIL - 5/12/2024 SE275854A.001	TP2/.7-0.8/05/12/202 SOIL - 5/12/2024 SE275854A.006	TP3/0.6-0.7/05/12/20 4 SOIL - 5/12/2024 SE275854A.009	TP5/0.3-0.4/05/12/20 4 SOIL - 5/12/2024 SE275854A.015	TP5/1.6-1.8/05/12/20 4 SOIL - 5/12/2024 SE275854A.018
Chromium Reducible Sulfur (Scr)	%	0.005	<0.005	<0.005	<0.005	**0.007**	**0.005**
Chromium Reducible Sulfur (Scr)	moles H+/T	5	<5	<5	<5	<5	<5

PARAMETER	UOM	LOR	TP6/2.0-2.2/05/12/20 4 SOIL - 5/12/2024 SE275854A.025	TP7/2.4-2.5/05/12/20 4 SOIL - 5/12/2024 SE275854A.031	TP11/0.5-0.6/05/12/2 24 SOIL - 5/12/2024 SE275854A.042	TP13/0.5-0.6/05/12/2 24 SOIL - 5/12/2024 SE275854A.046	TP18/0.9-1.0/05/12/2 24 SOIL - 5/12/2024 SE275854A.060
Chromium Reducible Sulfur (Scr)	%	0.005	<0.005	**0.007**	<0.005	<0.005	<0.005
Chromium Reducible Sulfur (Scr)	moles H+/T	5	<5	<5	<5	<5	<5

PARAMETER	UOM	LOR	TP19/1.4-1.5/05/12/2 24 SOIL - 5/12/2024 SE275854A.064	TP20/1.8-1.9/05/12/2 24 SOIL - 5/12/2024 SE275854A.069
Chromium Reducible Sulfur (Scr)	%	0.005	<0.005	<0.005
Chromium Reducible Sulfur (Scr)	moles H+/T	5	<5	<5

HCl Extractable S, Ca and Mg in Soil/Solids ICP OES [AN014] Tested: 3/1/2025

PARAMETER	UOM	LOR	TP1/0.4-0.5/05/12/20 4 SOIL - 5/12/2024 SE275854A.001	TP2/.7-0.8/05/12/202 SOIL - 5/12/2024 SE275854A.006	TP3/0.6-0.7/05/12/20 4 SOIL - 5/12/2024 SE275854A.009	TP5/0.3-0.4/05/12/20 4 SOIL - 5/12/2024 SE275854A.015	TP5/1.6-1.8/05/12/20 4 SOIL - 5/12/2024 SE275854A.018
Acid Soluble Sulfur (SHCl)	%w/w	0.005	-	-	-	-	-

PARAMETER	UOM	LOR	TP6/2.0-2.2/05/12/20 4 SOIL - 5/12/2024 SE275854A.025	TP7/2.4-2.5/05/12/20 4 SOIL - 5/12/2024 SE275854A.031	TP11/0.5-0.6/05/12/2 24 SOIL - 5/12/2024 SE275854A.042	TP13/0.5-0.6/05/12/2 24 SOIL - 5/12/2024 SE275854A.046	TP18/0.9-1.0/05/12/2 24 SOIL - 5/12/2024 SE275854A.060
Acid Soluble Sulfur (SHCl)	%w/w	0.005	-	-	-	-	-

PARAMETER	UOM	LOR	TP19/1.4-1.5/05/12/2 24 SOIL - 5/12/2024 SE275854A.064	TP20/1.8-1.9/05/12/2 24 SOIL - 5/12/2024 SE275854A.069
Acid Soluble Sulfur (SHCl)	%w/w	0.005	-	-

Chromium Suite Net Acidity Calculations [AN220] Tested: 3/1/2025

PARAMETER	UOM	LOR	TP1/0.4-0.5/05/12/202 4 SOIL - 5/12/2024 SE275854A.001	TP2/.7-0.8/05/12/2024 SOIL - 5/12/2024 SE275854A.006	TP3/0.6-0.7/05/12/202 4 SOIL - 5/12/2024 SE275854A.009	TP5/0.3-0.4/05/12/202 4 SOIL - 5/12/2024 SE275854A.015	TP5/1.6-1.8/05/12/202 4 SOIL - 5/12/2024 SE275854A.018
s-Net Acidity	%w/w S	0.005	0.010	0.016	0.022	0.039	0.029
a-Net Acidity	moles H+/T	5	6	10	14	24	18
Liming Rate*	kg CaCO3/T	0.1	NA	NA	NA	1.8	1.4
Verification s-Net Acidity*	%w/w S	-20	0.00	0.00	0.00	0.01	0.01
a-Net Acidity without ANCBT*	moles H+/T	5	6	10	14	24	18
Liming Rate without ANCBT*	kg CaCO3/T	0.1	NA	NA	NA	1.8	1.4
s-Net Acidity without ANC	%w/w S	0.005	0.010	0.016	0.022	0.039	0.029

PARAMETER	UOM	LOR	TP6/2.0-2.2/05/12/202 4 SOIL - 5/12/2024 SE275854A.025	TP7/2.4-2.5/05/12/202 4 SOIL - 5/12/2024 SE275854A.031	TP11/0.5-0.6/05/12/2 24 SOIL - 5/12/2024 SE275854A.042	TP13/0.5-0.6/05/12/2 24 SOIL - 5/12/2024 SE275854A.046	TP18/0.9-1.0/05/12/2 24 SOIL - 5/12/2024 SE275854A.060
s-Net Acidity	%w/w S	0.005	<0.005	0.043	0.016	0.024	0.10
a-Net Acidity	moles H+/T	5	<5	27	10	15	62
Liming Rate*	kg CaCO3/T	0.1	<0.1	2.0	NA	NA	4.7
Verification s-Net Acidity*	%w/w S	-20	0.00	0.01	0.00	0.00	0.00
a-Net Acidity without ANCBT*	moles H+/T	5	<5	27	10	15	62
Liming Rate without ANCBT*	kg CaCO3/T	0.1	<0.1	2.0	NA	NA	4.7
s-Net Acidity without ANC	%w/w S	0.005	0.006	0.043	0.016	0.024	0.10

PARAMETER	UOM	LOR	TP19/1.4-1.5/05/12/2 24 SOIL - 5/12/2024 SE275854A.064	TP20/1.8-1.9/05/12/2 24 SOIL - 5/12/2024 SE275854A.069
s-Net Acidity	%w/w S	0.005	0.088	0.096
a-Net Acidity	moles H+/T	5	55	60
Liming Rate*	kg CaCO3/T	0.1	4.1	4.5
Verification s-Net Acidity*	%w/w S	-20	0.00	0.00
a-Net Acidity without ANCBT*	moles H+/T	5	55	60
Liming Rate without ANCBT*	kg CaCO3/T	0.1	4.1	4.5
s-Net Acidity without ANC	%w/w S	0.005	0.088	0.096

METHOD	METHODOLOGY SUMMARY
AN002	The test is carried out by drying (at either 40°C or 105°C) a known mass of sample in a weighed evaporating basin. After fully dry the sample is re-weighed. Samples such as sludge and sediment having high percentages of moisture will take some time in a drying oven for complete removal of water.
AN014	This method is for the determination of soluble sulfate (SO4-S) by extraction with hydrochloric acid. Sulphides should not react and would normally be expelled. Sulfate as Sulfur is determined by ICP.
AN214	Acid Neutralising Capacity (ANC)or Neutralising Value (NV): The crushed or as received sample is reacted with excess normal acid (HCl) and then back titrated with standard sodium hydroxide to determine the acid consumed. The result is expressed as kg H2SO4/tonne or %CaCO3. Based on AS4969-13.
AN217	Dried pulped sample is mixed with acid and chromium metal in a rapid distillation unit to produce hydrogen sulfide (H2S) which is collected and titrated with iodine (I2(aq)) to measure SCR.
AN219	Dried pulped sample is extracted for 4 hours in a 1 M KCl solution. The ratio of sample to solution is 1:40. The extract is titrated for acidity. Calcium, magnesium, and sulfur are determined by ICP-AES.
AN220	Chromium Suite: Scheme for the calculation of net acidities and liming rates using a Fineness Factor of 1.5.

FOOTNOTES

*	NATA accreditation does not cover the performance of this service.	-	Not analysed.	UOM	Unit of Measure.
		NVL	Not validated.	LOR	Limit of Reporting.
**	Indicative data, theoretical holding time exceeded.	IS	Insufficient sample for analysis.	↑↓	Raised/lowered Limit of Reporting.
		LNR	Sample listed, but not received.		
***	Indicates that both * and ** apply.				

Unless it is reported that sampling has been performed by SGS, the samples have been analysed as received.
Solid samples expressed on a dry weight basis.

Where "Total" analyte groups are reported (for example, Total PAHs, Total OC Pesticides) the total will be calculated as the sum of the individual analytes, with those analytes that are reported as <LOR being assumed to be zero. The summed (Total) limit of reporting is calculated by summing the individual analyte LORs and dividing by two. For example, where 16 individual analytes are being summed and each has an LOR of 0.1 mg/kg, the "Totals" LOR will be 1.6 / 2 (0.8 mg/kg). Where only 2 analytes are being summed, the " Total" LOR will be the sum of those two LORs.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

If reported, measurement uncertainty follow the ± sign after the analytical result and is expressed as the expanded uncertainty calculated using a coverage factor of 2, providing a level of confidence of approximately 95%, unless stated otherwise in the comments section of this report.

Results reported for samples tested under test methods with codes starting with ARS-SOP, radionuclide or gross radioactivity concentrations are expressed in becquerel (Bq) per unit of mass or volume or per wipe as stated on the report. Becquerel is the SI unit for activity and equals one nuclear transformation per second.
Note that in terms of units of radioactivity:

a. 1 Bq is equivalent to 27 pCi
b. 37 MBq is equivalent to 1 mCi

For results reported for samples tested under test methods with codes starting with ARS-SOP, less than (<) values indicate the detection limit for each radionuclide or parameter for the measurement system used. The respective detection limits have been calculated in accordance with ISO 11929.

The QC and MU criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here: www.sgs.com.au/en-gb/environment-health-and-safety.

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HUNTER
GEOTECHNICAL SERVICES

Annex D

1 General Acid Sulfate Soil Management Strategies

In order to minimise the risks that can arise from the excavation of acid sulfate soils, some general acid sulfate management strategies can be followed. These will ensure that the works will be undertaken in a safe and environmentally friendly manner.

For excavation and construction on the site that is not detailed in Section 8 of this report, it is highly recommended that suitably qualified engineer be present during works and that they be carried out in accordance with the following general recommendations.

1.1 Staff Responsibilities

All staff that are involved in the excavation and testing of ASS during any site works should be trained in identifying indicators of ASS. Indicators include iron stains, crystal clear water, a 'rotten egg' type smell from exposed soils, poor vegetation growth, yellow coatings on soil peds. All staff are also to ensure that they adhere to the requirements detailed below.

Managers and supervisors of the site are required to ensure that the site specific controls for ASS are in place, are adequately maintained and are effective. They are also responsible for maintaining a regular monitoring and testing program for the acids sulfate soils at the site and ensuring that all material is suitably treated.

1.2 General Procedures

General requirements for maintaining a safe and environmentally friendly worksite can be found in **Table 1.1** below.

***Table 1.1** - General Procedures for the Management of Acid Sulfate Soils*

Procedure	Requirement
Minimise disturbance of ASS on site	Generally speaking ASS in their natural state pose little to no problem. It's only after they are excavated and exposed to the air do they begin to become a problem. As such, the best way to minimise their impact is to not disturb them from their natural state. There should be an aim to minimise disturbance of acid sulfate soils by limiting where possible the extent of excavations.
Limit the use of de-watering measures	De-watering requires the disposal of treated soil water. There is a high risk of potentially acidic water running off to the surrounding areas. It is best to avoid de-watering during construction and operation if possible.
Minimise spoil exposure time to the air	When acid sulfate soils are exposed to the air they oxidize and can become more acidic. The best course of action is to minimise exposure time to the air. It is recommended that progressive development be undertaken to minimise the exposure of stockpiles.
Dose excavated material and water	All excavated material on site and all water removed must be treated as per Section 8 of this report
Control Leachate	Controls must be in place to minimise the movement of water on site by either containment or diversion. No excavation is to be undertaken during periods of wet weather.
Undertake chemical pH tests	Regular chemical testing must be undertaken on excavated soils and water during treatment and before disposal.

Once groundwater or soilwater leachate and excavated material have been treated as per Section 8 of this report then they may be disposed of offsite. Additional testing may be required for the excavated soils to determine their waste classification prior to removal from site. The local council for the site should be consulted prior to removal to determine the waste classification requirements.

2 Monitoring

Monitoring of the soils, soilwater leachate and groundwater must be undertaken during excavation, treatment and construction. Regular monitoring should be undertaken using pH field testing to determine the effectiveness of the management plan. The field pH test provides information on the likely presence of actual acid sulfate soils.

Soil monitoring should be undertaken using pH field tests on any disturbed material during construction and treatment. Soil testing for pH is to be undertaken on a saturated soil using a spear point pH probe or a field pH metre. It is recommended that pH, soil texture, colour and mottle are recorded for each sample tested. Soils are to be treated to a level of between 5.5 an 8.0. Soils outside this range must not be transported from site or moved around the site.

Groundwater and soilwater leachate should be tested for pH during de-watering and during excavation. De-watering may also require the monitoring of salinity and turbidity as a change in these may have effect on the surrounding environment. The local council to the site should be consulted prior to de-watering as they may require salinity and turbidity testing and a license may be required to dispose of groundwater and soilwater leachate. Groundwater and soilwater leachate pH can be tested using a field pH metre. Discharged groundwater and soilwater leachate must have a pH between 6.5 and 8.5. Water outside this range must not be transported from site or irrigated across the site.

3 Contingency Plan

In case of a failure of the Acid Sulfate Soil Management Plan then the Contingency Plan detailed below should be enacted. The plan is based on the ASSMAC Assessment Guidelines.

3.1 Remedial Action Plan

If the results of field testing during monitoring of the works indicate that the agreed standards are not being achieved then remedial action should be taken. A remedial action plan should be created by the site developer in consultation with the site contractors, field testing personnel, consulting engineers or scientists and relevant government authorities. A new plan should be created and the relevant authorities should be informed as to the new plan and the reasons for the changes.

3.2 Restoration Plan

If the Remedial Action Plan fails then all works should stop immediately and action must be taken to restore the site to a condition equivalent to that before construction began.

Prior to implementation of the restoration plan and assessment must be undertaken to determine where the problem lies. An assessment should be undertaken to determine whether the Acid Sulfate Management Strategies, their implementation or whether no suitable management plan can implemented is the cause of the problem. If further modifications to the Acid Sulfate Soil Management Plan is required then the relevant authorities should be informed as to the new plan and the reasons for the changes.

4 Lime Details

Dosing lime may pose health risks and these must be addressed prior to the use of lime on site. A risk assessment should be undertaken by all individuals involved prior to the use of any lime and a Material Safety Data Sheet should be obtained and distributed for the specific lime being used on the site.