

PROJECT

**ACID SULFATE SOIL
ASSESSMENT AND
MANAGEMENT PLAN
ALTITUDE ASPIRE,
TERRANORA
NEW SOUTH WALES**

PREPARED FOR
NEWLAND DEVELOPERS PTY LTD

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CLIENT REFERENCE –

SYNOPSIS This Acid Sulfate Soil Assessment and Management Plan outlines the extent of acid sulfate soils and establishes responsibilities and procedures for the management of acid sulfate soils at Altitude Aspire, Terranora.

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SUMMARY

Gilbert & Sutherland Pty Ltd (G&S) prepared an Acid Sulphate Soils Management Plan (ASSMP), dated November 2010, for the bulk earthworks phase of the development of Altitude Aspire at Terranora, New South Wales. That Report was publicly exhibited as part of the Environmental Assessment, following which a number of submissions were received from State Agencies, Tweed Shire Council (TSC) and members of the public.

As a result of those submissions and to achieve consistency with Tweed Development Control Plan 2008, Section B24 – Area E Urban Release Development Code, the development layout has been amended. This revised Acid Sulfate Soil Assessment and Management Plan (ASSA&MP) has been prepared for Newland Developers Pty Ltd to address the revised layout and the specific issues raised by TSC, NSW Department of Planning and Infrastructure (DOPI) and NSW Office of Water (NOW).

Actual acid sulfate soil (AASS) and potential acid sulfate soil (PASS) is potentially present in the area of alluvial infill in the northern section of the site and adjacent to the SEPP 14 wetland (Terranora Broadwater). This area is mapped as a Class 2 ASS area, meaning that any works that are likely to lower the water table will require an ASSMP. In addition, the Tweed Shire Area E Local Environment Study (LES)¹ identified any disturbance of land with an elevation below 5m Australian Height Datum (AHD) would require an ASSMP under the Acid Sulfate Soils Management Advisory Committee (ASSMAC) guideline.²

In February 2012 G&S undertook an ASS investigation for the bulk earthworks associated with the Altitude Aspire development. This investigation included an assessment of near-surface groundwater in the lower sections of the site. Screening results from the February 2012 assessment indicated the presence of PASS at the site. This was confirmed by laboratory analysis of Chromium Reducible Sulfur. The anticipated extent of ASS has been mapped and will be subject to the provisions of the ASSMP. This includes areas where

¹ *Tweed Area E Local Environmental Study Report No. 2136275A-RPT001Atc* (Parsons Brinckerhoff, 2004).

² Acid Sulfate Soils Management Advisory Committee (ASSMAC) 1998 *Acid Sulfate Soils Assessment Guidelines*.

stormwater treatment measures (bioretention basins) and the Future Broadwater Parkway are proposed within stages 6, 7 and 10.

Soils excavated from the areas identified as PASS and soils with existing acidity will be limed at the maximum prescribed rates of 104.5 and 7.1 kg dry t⁻¹ respectively. Alternatively, phase 2 testing could be conducted to determine liming rates specific to each unit of excavated soil in accordance with the provisions of the ASSMP.

Soils will be treated in bunded treatment pads to neutralise their acid generation potential and then tested to validate lime treatment. Any groundwater movement related to plastic deformation of material underlying fill areas will also be monitored and treated as per the ASSMAC guidelines and the provisions of the ASSMP.

This ASSMP commits the proponent to specific strategies and measures for the identification, treatment and overall management of the site in accordance with best practice management of ASS material. It establishes procedures to ensure that any ASS encountered during road construction, services installation and stormwater device construction works are appropriately identified and treated in accordance with proven management techniques.

This ASSMP establishes a clear management protocol incorporating operational policies, performance criteria, implementation strategies and corrective actions, should they be necessary. The ASSMP identifies who is responsible for each specific aspect of ASS management using a working tabular format with provision for amendment if required.

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GLOSSARY

TERM	MEANING
AASS	Actual Acid Sulfate Soils. These soils are formed when the pyrite in Potential Acid Sulfate Soils oxidises to produce sulfuric acid.
ASS	Acid Sulfate Soils. This is the collective term for both Actual Acid Sulfate Soils and Potential Acid Sulfate Soils.
ASSA	Acid Sulfate Soils Assessment
ASSMAC	Acid Sulfate Soils Management Advisory Committee
ASSMP	Acid Sulfate Soils Management Plan.
CRS	Chromium Reducible Sulfur (CRS) is an analytical method, which quantifies sulfur in an inorganic (i.e. pyritic) form. This method is a suitable test to determine whether the oxidisable sulfur is from organic material or if it is from pyrite, and therefore formed under estuarine conditions.
PASS	Potential Acid Sulfate Soils. These soils contain pyrite and are usually undisturbed. When these soils are exposed the pyrite oxidises to produce sulfuric acid.
TAA	Titrateable Actual Acidity. TAA is a measure of a soil's acidity prior to the complete oxidation of sulfidic material, including both pyritic and organic acidity.
TPA	Titrateable Potential Acidity. TPA is the titrateable oxidisable acidity, calculated from the complete oxidation of the soil.
TSA	Titrateable Sulfidic Acidity. TSA is a measure of the soil acidity resulting from sulfidic material. This is a general indicator of the acidity produced from pyritic material.

LIST OF FIGURES

Drawing No.	Description
Drawing No. 1.1	Site location
Drawing No. 1.2	Proposed Plan of Subdivision
Drawing No. 1.3	Borehole locations
Drawing No. 1.4	Distribution of Acid Sulfate Soils
Drawing No. 1.5	Groundwater contours

1 Introduction

1.1 Background

Gilbert & Sutherland Pty Ltd (G&S) prepared an Acid Sulphate Soils Management Plan (ASSMP), dated November 2010, for the bulk earthworks phase of the development of Altitude Aspire at Terranora, New South Wales. That Report was publicly exhibited as part of the Environmental Assessment, following which a number of submissions were received from State Agencies, Tweed Shire Council (TSC) and members of the public.

As a result of those submissions and to achieve consistency with Tweed Development Control Plan 2008, Section B24 – Area E Urban Release Development Code,³ the development layout has been amended. This revised Acid Sulfate Soil Assessment and Management Plan (ASSA&MP) has been prepared for Newland Developers Pty Ltd to address the revised layout and the specific issues raised by TSC, NSW Department of Planning and Infrastructure (DOPI) and NSW Office of Water (NOW).

The November 2010 ASS desktop assessment conducted by G&S indicated that the area associated with the alluvial infill in the northern section of the site and adjacent to the SEPP 14 wetland (Terranora Broadwater) is mapped as a Class 2 ASS area. The implication of Class 2 land is that any works by which the water table is likely to be lowered will require an ASSMP. In addition, the TSC *Area E Local Environment Study* (LES)⁴ identified any disturbance of land with an elevation below 5m Australian Height Datum (AHD) would require an ASSMP under the New South Wales Acid Sulfate Soils Management Advisory Committee (ASSMAC) Guidelines.⁵

The provisions proposed within this ASSMP for the identification, treatment and overall management of the site reflect best practice management of ASS material.

1.2 Objectives

This report constitutes an ASSA and ASSMP for the bulk earthworks associated with the Altitude Aspire Development at Terranora, New South Wales. The report includes an assessment of near-surface groundwater in the lower sections of the site.

³ Planning Reforms Unit, Adopted 13 December 2011, Area E Urban Release Development Code, Tweed Development Control Plan – Section B24.

⁴ Parsons Brinckerhoff 2004 *Tweed Area E Local Environmental Study Report No. 2136275A-RPT001Atc.*

⁵ Acid Sulfate Soils Management Advisory Committee (ASSMAC) 1998 *Acid Sulfate Soils Assessment Guidelines.*

2 Acid Sulfate Soils Assessment (ASSA)

This assessment aims to address the ASS management requirements associated with bulk earthworks for the Altitude Aspire development. This report details the findings of the desktop assessment conducted in November 2010 and an ASS investigation undertaken by G&S at the site during February 2012.

2.1 Location, area and elevation

The site is approximately 36ha in area and is located off Fraser Drive at Terranora, New South Wales (as shown in Drawing No. 1.1). Site elevations range from approximately RL 0m Australian Height Datum (AHD) to RL 85m AHD.

2.2 Existing development

The majority of the site has been extensively cleared, drained and used for agricultural and or grazing purposes. There are several dwellings and farm sheds on the site.

2.3 Vegetation

Widespread clearing of native vegetation for the purpose of agricultural cropping is evident across much of the subject land. Small pockets of remnant vegetation remain on some of the steeply sloping areas, within gullies and across some of the lower areas of the site. Weed infestation is prolific across areas left fallow and uncropped.

2.4 Topography and drainage

The slopes on the site vary from 0-5% in areas associated with the alluvial zones in the northern parts of the development adjoining the SEPP 14 wetland (Terranora Broadwater) to 15-25 % in the more elevated parts of the site. Runoff from the site flows in a north-easterly or north-westerly direction towards a central ephemeral gully that traverses the site from south to north. This gully directs runoff into the SEPP 14 area, which is essentially flat, semi-tidal and drained by a number of agricultural drains that discharge into the Terranora

Broadwater. Terranora Broadwater adjoins the Tweed River, which discharges into the Pacific Ocean at Tweed Heads.

2.5 Geology / landform element

The site geology is described by the Geological Survey of Queensland Moreton Geology 1:500,000 geology map,⁶ as overlying Quarternary Alluvium, Tertiary Basalt and sections of the Neranleigh-Fernvale beds. These groups consist of; estuarine, flood plain, tidal delta deposits; basalt; and mudstone, shale, greywacke, chert, jasper, conglomerate, basic metavolcanics and pillow lava. The soil landscape belongs to the Carool colluvial landscape group (Morand 1996).⁷ Soil found on the site was characterised by grey, brown and black clay loams and grey and black light clays. These were overlying grey, brown and black medium clays, white, grey and yellow heavy clays, and grey and black sandy clays.

2.6 Development proposal

The proposal involves the construction of a system of roads to provide access to approximately 257 residential lots and 271 lots in total. The balance of the site would be dedicated to open space, a constructed wetland and land zoned environmental protection.

The proposed development is shown on Drawing No. 1.2. The Altitude Aspire Concept Plan proposes the creation of a residential community that will form part of the Terranora Area E Urban Land Release. The development would be completed in stages and would include substantial areas of open space, providing a buffer to the SEPP14 wetland area.

The proposed development would comprise the construction and/or installation of the following components:

- site earthworks
- roads

⁶ Queensland Government (1980) *Geological Survey of Queensland, Moreton Geology, 1:500,000 geology map.*

⁷ Morand D.T. *Soil landscapes of the Murwillumbah – Tweed Heads 1:100000 (Fingal, Pottsville, Green Pidgeon, Tygalum)* NSW Soil Conservation Service pp 30-33.

- stormwater drains
- sewer reticulation mains
- water reticulation mains
- underground electricity distribution cables
- telecommunication cables
- other ancillary services
- dwellings
- landscaping.

Once the development has been completed, all disturbed portions of the site will be rehabilitated or covered by some form of improvement protecting the soils from erosion, hence minimising the transport of suspended solids from the site. These improvements will include structures, paved areas, lawns and landscaping.

2.7 Sampling and testing procedures

An ASS investigation by G&S in February 2012 incorporated a drilling and sampling program across those parts of the site below 5m AHD where disturbance is proposed. In accordance with ASSMAC Guidelines seven boreholes were constructed at spacings of 50 m to 100 m across this area. The number and layout of boreholes was determined in accordance with the two holes per hectare requirement for sites greater than 4ha, as stipulated in the ASSMAC Guidelines. The locations of the boreholes with respect to the development layout are shown on Drawing No. 1.3.

Representative samples were recovered from each soil horizon or a minimum of one sample per 0.50 m to a depth of between 1.65 m and 2.00 m below Natural Surface Level (NSL) using a hand auger. Logging of cores was undertaken with reference to the Australian Soil and Land Survey Field Handbook.⁸ The borelogs are presented in Appendix 1.

2.7.1 Screening procedures

A total of 34 samples were recovered from the seven cores and screened for initial field pH (pH_F)

and pH after oxidation (pH_{FOX}) to determine whether the soils had acid generating potential.

All samples were sealed in plastic geological sampling bags and refrigerated following collection. Field pH (pH_F) and pH after field oxidation with 30% peroxide (pH_{FOX}) was recorded for each sample.

2.7.2 Analytical procedures

A total of 14 samples were selected for analysis using the Chromium Reducible Sulfur ($S_{Cr}\%$) method⁹ (Mazlab in-house method, after Method 22B) of Sullivan *et al* (1998).¹⁰

The Chromium Reducible Sulfur (CRS) method uses chromium reduction to quantify the level of reduced inorganic sulfur compounds and (unlike the POCAS and SPOCAS methods) is essentially unaffected by sulfur in an organic form or from sulfate minerals. This method is a suitable test to determine whether the oxidisable sulfur is from organic material or if it is from pyrite and therefore PASS.

Where pH_F was <5.5 in the samples selected for CRS analysis, the existing acidity was also determined by Titratable Actual Acidity (TAA) analysis.

2.7.3 Groundwater sampling

Three groundwater bores (MW1, MW2 and MW3) were installed and monitored by G&S on 15 February 2012. Bores were located within the alluvial infill land in the lower section of the site focussing on the central drain to examine the shallow surface groundwater.

The locations of all groundwater bores are shown on Drawing No. 1.3. Grid reference and depth of

⁹ The Chromium Reducible Sulfur (CRS) technique utilises the conversion of inorganic S to H_2S by a hot $CrCl_2$ solution. The H_2S generated is trapped in a zinc acetate solution and may be quantified by iodometric titration (Sullivan *et al*, 1998). CRS is an alternative to the Peroxide Oxidisable Sulfur ($S_{POS}\%$) method of the POCAS technique and unlike $S_{POS}\%$ is not subject to significant interference from sulfur in either organic matter or sulfate minerals (Sullivan *et al*. 1998).

¹⁰ Sullivan, L.A., Bush, R., McConchie, D., Lancaster, G., Clark, M., Norris, N., Southon, R. and Saenger, P. (1998) *Chromium Reducible Sulfur SCR – Method 22B*. Miscellaneous Research Methods section 4.9 in NSW Acid Sulfate Soil Manual (1998).

⁸ McDonald, RC, Isbell, RF, Speight, JG, Walker, J and Hopkins, MS 1990, *Australian Soil and Land Survey Field Handbook*, Australian Soil and Land Survey Handbooks, 2nd edn, vol 1, Inkata Press, Melbourne.

all bores used in this study are shown in Table 2.7.3.1.

Table 2.7.3.1 Groundwater monitoring bore details installed at the proposed Altitude Aspire development site on 15 February 2012

Borehole	Easting	Northing	Ground level (mAHD)	Depth (m)
MW1	551337.8199	6877548.9647	2.16	2.00
MW2	551240.5087	6877703.7457	1.21	2.00
MW3	551434.1698	6877599.0357	1.99	2.00

A minimum of three bore volumes was purged from each bore before water sampling. Samples were collected in laboratory-supplied containers and immediately placed into a chilled esky prior to delivery to a NATA-accredited laboratory. A NATA-accredited laboratory for analysis of calcium, magnesium, sodium, potassium, chloride, sulfate, alkalinity, dissolved iron, dissolved aluminium and dissolved manganese.

200 400 600 800
metres

SCALE
1:16 000

ORIENTATION
NORTH

LEGEND
Site boundary

SOURCES
Image base: Google Earth Pro 2012, imagery date 01 October 2010.

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FRASER DRIVE
TERRANORA, NSW
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PTY LTD
DRAWING
SITE LOCATION




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27/02/2012
SCALE
1:16 000
PROJECT NO
10849
DRAWING NO
1.1
REVISION
ORIGIN
DRAWN
SPD
CHECKED
MLF

40 80 120 160 200 metres

SCALE
1:4 000

ORIENTATION
NORTH

LEGEND

-  Site boundaries
-  Stage boundaries
-  Lot boundaries

SOURCES

Image base: Google Earth Pro 2012, imagery date 01 October 2010.

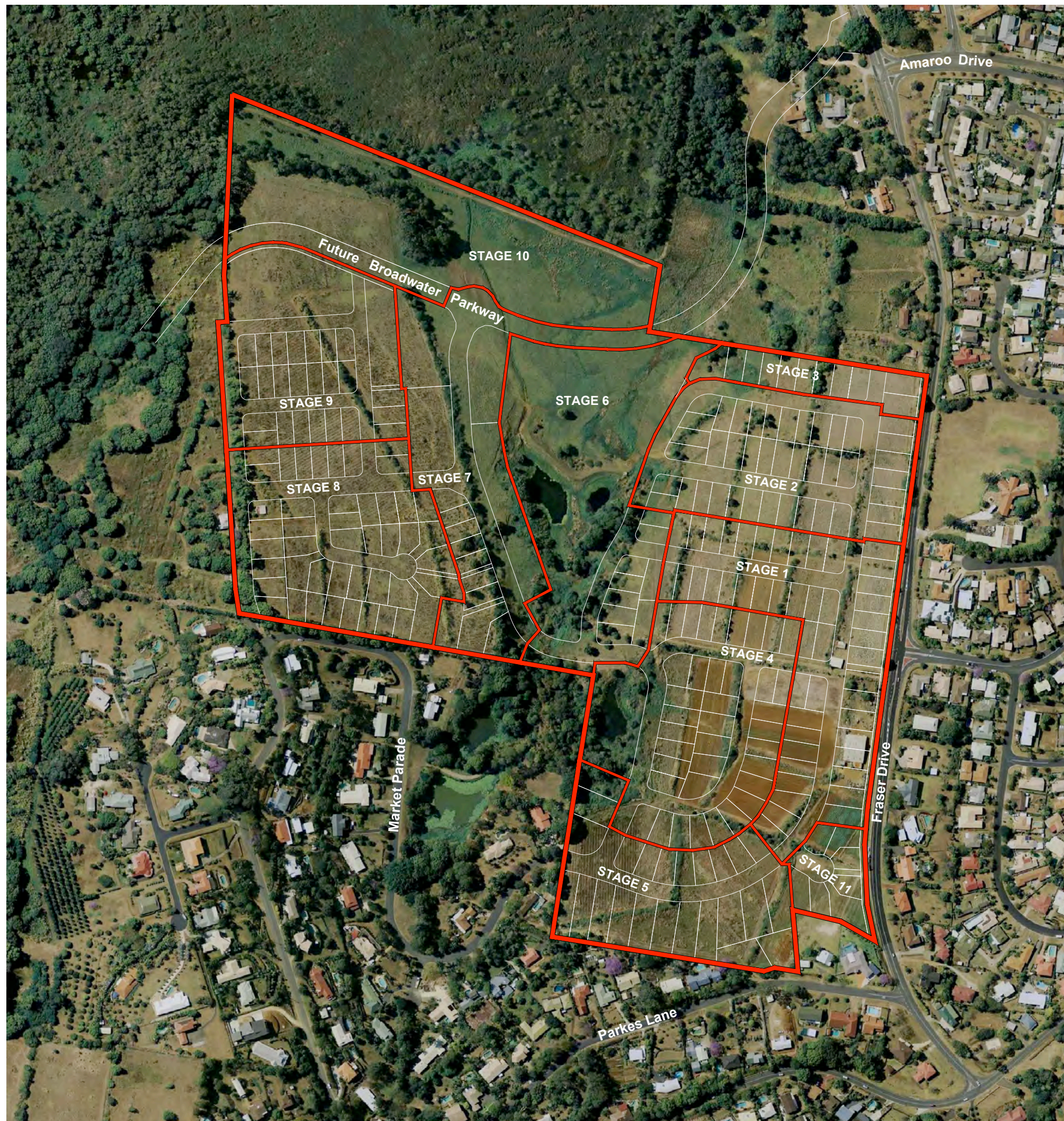
Development layout: B&P SURVEYS, Consulting Surveyors, Drawing number 18779B, Proposed Subdivision, 19 January 2012.

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PROJECT
ALTITUDE ASPIRE
FRASER DRIVE
TERRANORA, NSW

CLIENT
NEWLAND DEVELOPERS
PTY LTD

DRAWING
PROPOSED PLAN
OF SUBDIVISION

DATE 27/02/2012	DRAWN SPD
SCALE 1:4 000	CHECKED MLF
PROJECT NO 10849	DRAWING NO 1.2
	REVISION ORIGIN

40 80 120 160 200
metres

SCALE
1:4 000

ORIENTATION
NORTH

LEGEND

Site boundaries

BH#
Borehole locations

BH#
MW#
Borehole with monitoring well locations

SOURCES

Image base: Google Earth Pro 2012,
imagery date 01 October 2010.

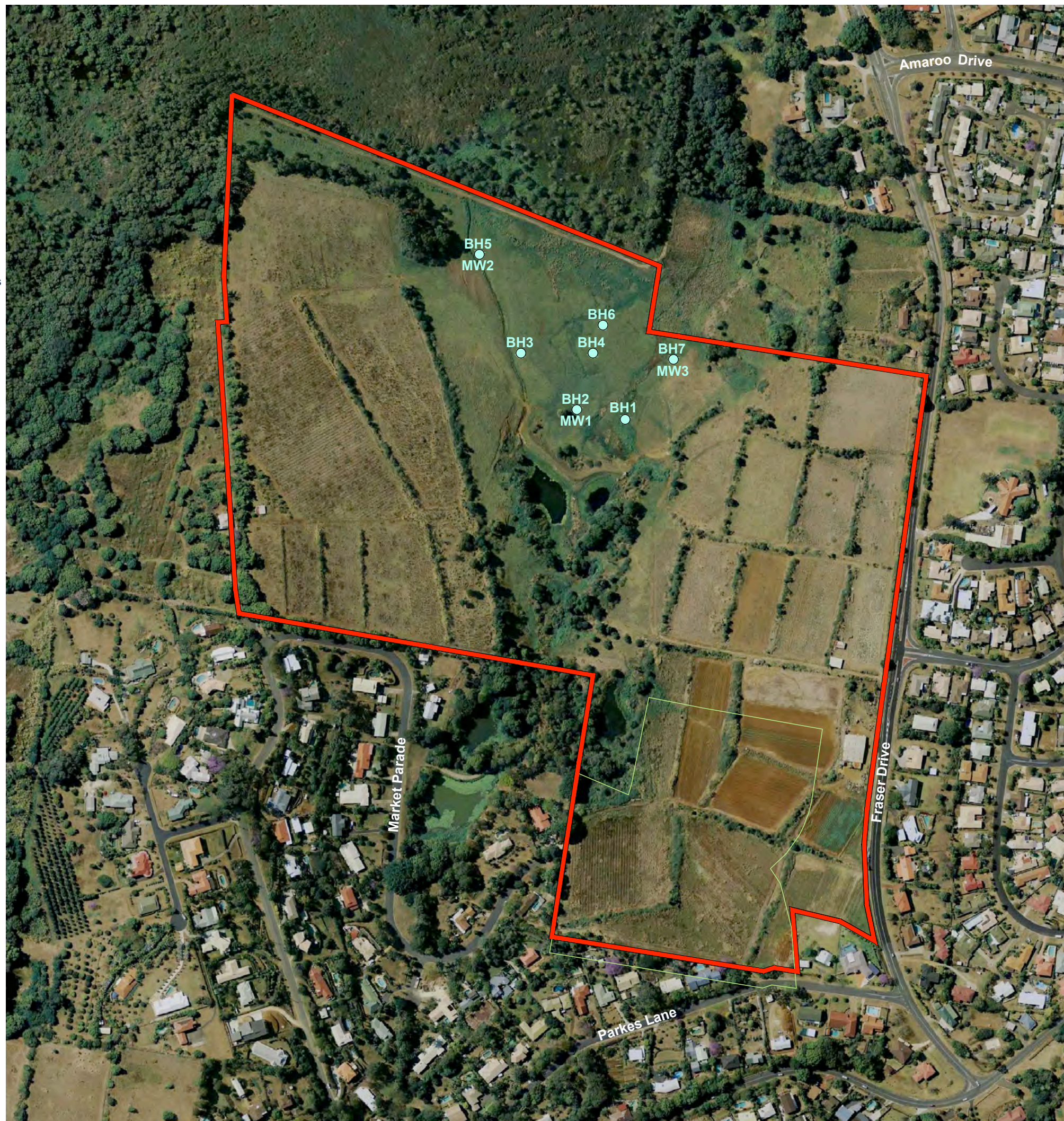
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DRAWING
BOREHOLE LOCATIONS

DATE
27/02/2012

SCALE
1:4 000

PROJECT NO
10849

DRAWN
SPD

CHECKED
MLF

REVISION
ORIGIN

DRAWING NO
1.3

3 Results

This section summarises the findings of the on-site soil investigations undertaken by G&S in February 2012.

3.1 Screening results

Screening results were used to distinguish potential acid sulfate material from non-acid sulfate material based on pH after oxidation and strength of oxidation reaction. The results of screening analysis are presented in Table 3.1.1 (at the end of this section). Laboratory certificates are presented in Appendix 2.

In areas where ASS are likely to occur, a soil exhibiting a field pH (pH_F) of less than 4 is generally considered to be an Actual Acid Sulfate Soil (AASS), indicating that oxidation of sulfides has taken place to some degree within the soil profile. A soil exhibiting a pH after peroxide oxidation (pH_{FOX}) of less than 3 with a slight to violent reaction) is considered to be a Potential Acid Sulfate Soil (PASS) indicating a soil that contains oxidisable sulfidic materials. Those soils exhibiting a pH_{FOX} of >3 , with nil peroxide reaction are in most cases non-PASS material.

In the samples screened, pH_F ranged from 4.6 to 7.6 with none of the 34 tested exhibiting a pH_F of <4 . pH_{FOX} ranged from 1.7 to 4.6 with 12 (35%) of the screened samples exhibiting a $pH_{FOX} <3$. All samples exhibited a high to very high reaction with peroxide.

3.2 Laboratory results and discussion

The ASSMAC guidelines specify %S and TAA action level thresholds of 0.03% and $18 \text{ mol H}^+ \text{ t}^{-1}$ respectively for developments proposing to excavate more than 1000 tonnes of material regardless of texture.¹¹ As the proposed works could involve the excavation of more than 1000 tonnes of mostly clayey material, an action level threshold of 0.03 $S_{Cr}\%$ was applied.

¹¹ Stone, Y., Ahern, C.R. and Blunden, B (1998) Acid Sulfate Soils Manual 1998. Acid Sulfate Soil Management Advisory Committee, Wollongbar, NSW, Australia.

The laboratory analyses results for the 14 samples tested are presented in Table 3.2.1 (following page). The laboratory certificates are presented in Appendix 3. The results indicate the presence of soils with acid sulfate potential in the vicinity of BH4 (1.35-1.60 m and 1.85-2.00 m), BH6 (0.00-0.15 m, 1.50-1.75 m and 1.75-2.00 m) and BH7 (1.80-2.00 m). Acid sulfate potential is demonstrated by %S concentrations above 0.03%. The results ranged from <0.01 to 3.09%.

Soils within four of the boreholes (BH4 to BH7) were found to have acid sulfate potential. If disturbed, these soils would require liming at the maximum prescribed rate of 104.5 kg t^{-1} to neutralise the potential and existing acidity.

The TAA was above the action criteria of $18 \text{ mol H}^+ \text{ t}^{-1}$ in eight of the samples tested. This indicates existing acidity, which is often found where ASS have oxidised (i.e. AASS) but may also reflect inherent acidity in soils containing organic acids or derived from Neranleigh-Fernvale metasediments.

Soils within all seven boreholes were found to have existing acidity. As a precautionary approach, the soils associated with BH1 to BH3 (where no acid sulfate potential was detected) would require liming at the maximum prescribed rate of 7.1 kg t^{-1} and appropriate mixing. The updated ASS map for the site is shown in Drawing No. 1.4.

3.3 Groundwater levels

The description of the standing water level within the lower section of the site is given in Table 3.3.1.

Table 3.3.1 Standing water level for groundwater monitoring bores at the proposed Altitude Aspire development site on 15 February 2012

Borehole	Ground level (mAHD)	Water level (mNSL)	Water level (mAHD)
MW1	2.16	0.44	1.72
MW2	1.21	0.03	1.18
MW3	1.99	0.24	1.75

At the time of monitoring, the standing water level was between 0.03 and 0.44 m below the soil

surface. Recharge of this water table is from the surrounding slopes to the east, south and west and the flow would be expected to discharge towards the agricultural drainage system and the SEPP 14 wetland to the north of the proposed development site. Groundwater contours are shown in Drawing No. 1.5.

3.4 Groundwater chemistry

The analytical results for each parameter are discussed in this section. Complete results tables for each bore are shown in Table 3.4.1 (following pages). Copies of the laboratory certificates and in situ sheets are attached as Appendix 4

The piper plot in Figure 3.4.1 (following pages) shows the relationship between the ratios of major ions of each water sample. These plots were assessed against those generated for G&S's Groundwater Impact Assessment (November, 2010).¹² The 2010 plots are shown for comparison in Figure 3.4.2 (following pages). The plots illustrate that the shallow groundwater associated with the alluvial infill land in the lower section of the site (MW1, MW2 and MW3, sampled February 2012) is not analogous to the deeper groundwater found in the basalt land unit in the upper slope zone (basalt 2b sampled February 2010).

¹² Gilbert & Sutherland (November 2010) *Conceptual Groundwater Impacts Assessment of Proposed Residential Development, Altitude Aspire, Terranora, New South Wales.*

Table 3.1.1 Summary of screening analysis for soil samples collected at the proposed Altitude Aspire development site on 14 and 15 February 2012

Borehole	Depth from NSL (m)	Reaction to H ₂ O ₂	pH _F	pH _{FOX}
BH1	0.00-0.17	V High	4.9	2.7
BH1	0.60-0.75	V High	5.0	3.2
BH1	1.00-1.25	V High	5.0	3.4
BH1	1.40-1.65	V High	5.2	3.8
BH2	0.00-0.25	V High	5.1	3.3
BH2	0.55-0.70	V High	5.4	4.0
BH2	1.10-1.35	V High	5.5	3.9
BH2	1.35-1.60	High	5.9	3.6
BH2	1.60-1.90	V High	5.6	3.2
BH3	0.00-0.15	V High	5.4	3.3
BH3	0.40-0.65	V High	5.3	3.7
BH3	0.90-1.15	V High	5.3	4.1
BH3	1.45-1.70	V High	5.3	3.8
BH3	1.70-1.95	High	5.0	3.6
BH4	0.15-0.25	V High	4.6	2.9
BH4	0.50-0.75	V High	5.8	3.9
BH4	1.05-1.30	V High	6.4	4.6
BH4	1.35-1.60	V High	6.7	2.0
BH4	1.85-2.00	V High	7.6	2.4
BH5	0.00-0.25	V High	5.8	3.7
BH5	0.50-0.75	V High	4.9	2.8
BH5	1.05-1.20	V High	5.7	2.3
BH5	1.35-1.50	V High	5.5	2.5
BH5	1.75-2.00	V High	5.2	3.5
BH6	0.00-0.15	V High	5.9	2.7
BH6	0.40-0.65	V High	5.4	2.6
BH6	0.90-1.15	V High	5.4	3.3
BH6	1.50-1.75	V High	7.2	1.7
BH6	1.75-2.00	V High	7.5	1.7
BH7	0.00-0.25	V High	5.2	3.3
BH7	0.40-0.65	V High	4.9	3.6
BH7	0.90-1.15	V High	5.3	3.7
BH7	1.35-1.60	V High	5.3	3.8
BH7	1.80-2.00	V High	5.7	2.8

Table 3.2.1 Laboratory results for soil samples collected at the proposed Altitude Aspire development site on 14 and 15 February 2012

Borehole	Depth from NSL (m)	pH (KCL)	SCr (%S)	TAA (mol H ⁺ t ⁻¹)	Liming rate (Kg dry t ⁻¹)
BH1	0.00-0.17	4.2	0.01	85	7.1
BH2	0.00-0.25	4.6	0.01	59	4.9
BH3	0.00-0.15	4.8	<0.01	47	3.6
BH4	0.15-0.25	4.2	0.02	68	6.4
BH4	1.05-1.30	5.8	<0.01	7	Nil
BH4	1.35-1.60	5.4	0.67	15	33.7
BH4	1.85-2.00	8.1	2.68	--	68.5
BH5	0.00-0.25	5.7	0.01	25	2.3
BH6	0.00-0.15	4.3	0.19	145	20.5
BH6	0.90-1.15	5	0.01	34	3.2
BH6	1.50-1.75	7.5	3.09	--	104.5
BH6	1.75-2.00	7.8	2.76	--	90.3
BH7	0.00-0.25	4.7	0.01	50	4.5
BH7	1.80-2.00	5	0.03	15	2.6

Table 3.4.1 Summary of laboratory and in situ results for water samples collected at the proposed Altitude Aspire development site on 15 February 2012

Analyte	LOR	MW1	MW2	MW3
Hydroxide Alkalinity as CaCO ₃ (mg L ⁻¹)	1	<1	<1	<1
Carbonate Alkalinity as CaCO ₃ (mg L ⁻¹)	1	<1	<1	<1
Bicarbonate Alkalinity as CaCO ₃ (mg L ⁻¹)	1	33	24	34
Total Alkalinity as CaCO ₃ (mg L ⁻¹)	1	33	24	34
Sulfate as SO ₄ 2- (mg L ⁻¹)	1	48	77	20
Chloride (mg L ⁻¹)	1	60	145	27
Calcium (mg L ⁻¹)	1	9	14	7
Magnesium (mg L ⁻¹)	1	5	10	5
Sodium (mg L ⁻¹)	1	32	101	24
Potassium (mg L ⁻¹)	1	<1	5	<1
Aluminium (mg L ⁻¹)	0.01	<0.01	0.01	0.01
Arsenic (mg L ⁻¹)	0.001	<0.001	<0.001	<0.001
Cadmium (mg L ⁻¹)	0.0001	<0.0001	<0.0001	<0.0001
Chromium (mg L ⁻¹)	0.001	<0.001	<0.001	<0.001
Copper (mg L ⁻¹)	0.001	<0.001	<0.001	<0.001
Nickel (mg L ⁻¹)	0.001	0.004	0.004	0.004
Lead (mg L ⁻¹)	0.001	<0.001	<0.001	<0.001
Zinc (mg L ⁻¹)	0.005	0.017	0.028	0.031
Manganese (mg L ⁻¹)	0.001	1.49	2.78	1.56
Iron (mg L ⁻¹)	0.05	<0.05	19.5	<0.05
Total Anions (meq L ⁻¹)	0.01	2.35	6.17	1.86
Total Cations (meq L ⁻¹)	0.01	2.25	6.04	1.80
EC (µs cm ⁻¹)		296	484	342
pH		5.66	6.32	5.70

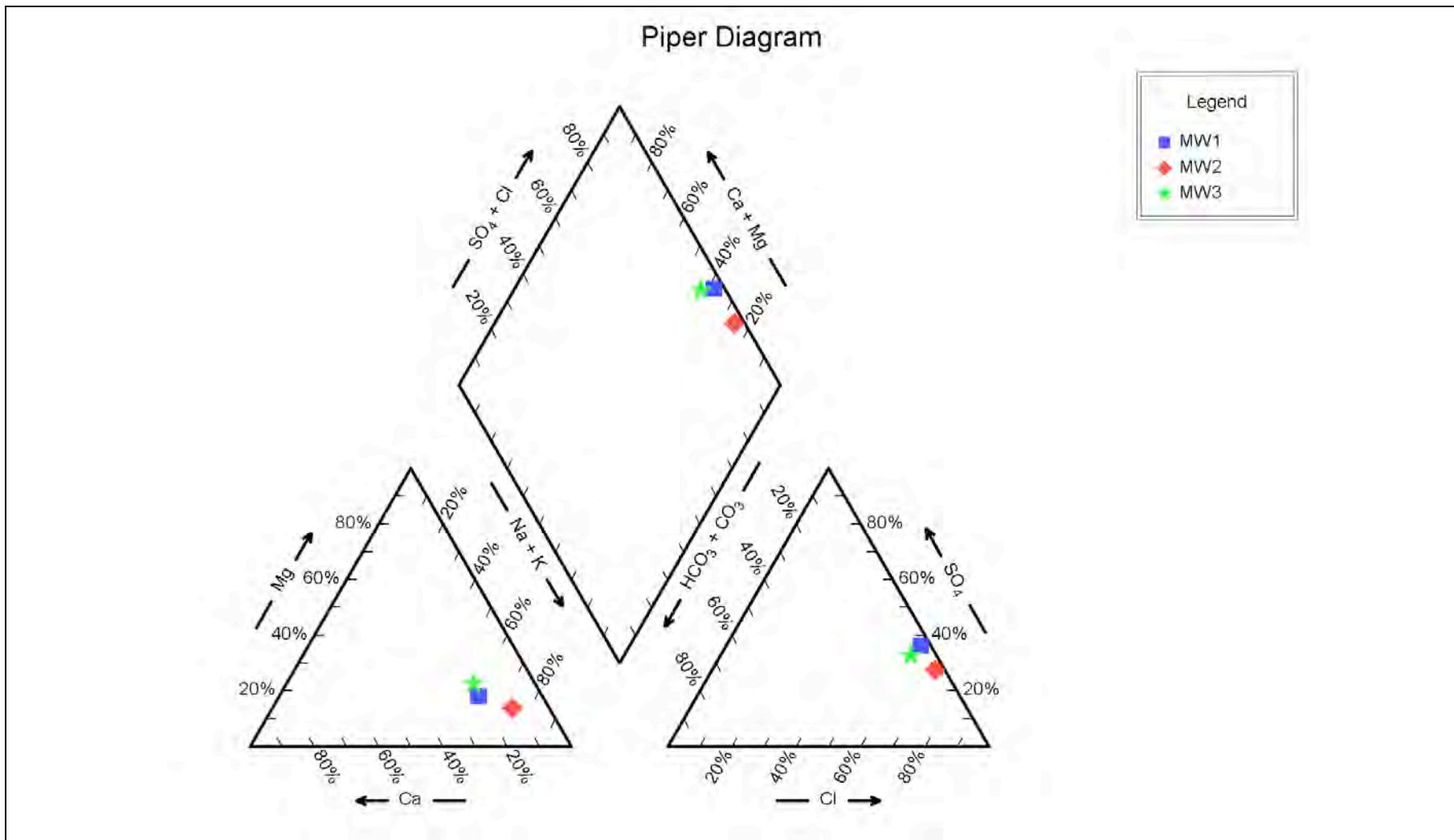


Figure 3.4.1 Piper plot of water chemistry for the three groundwater samples taken at the proposed Altitude Aspire development site on 15 February 2012

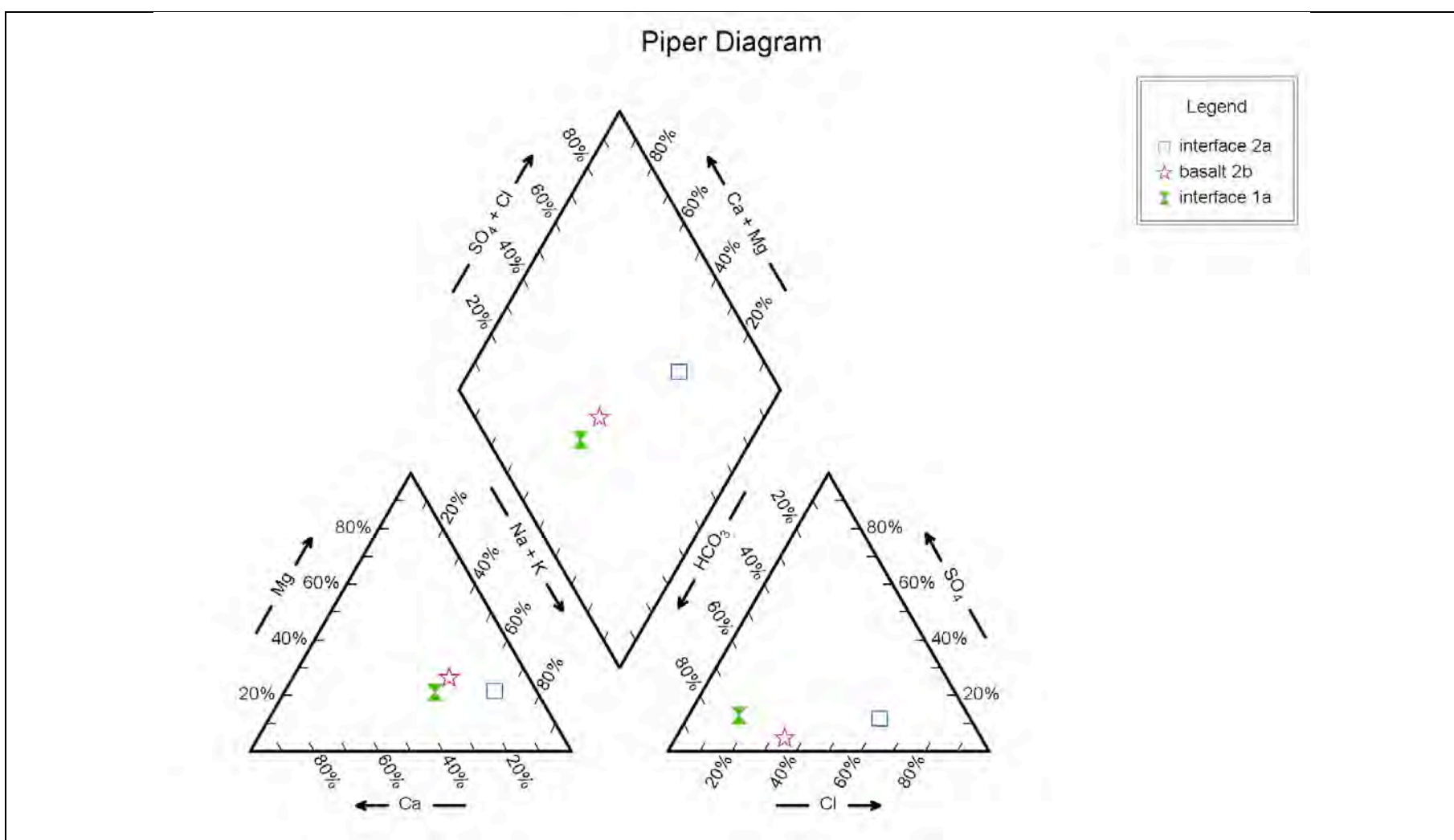







Figure 3.4.2 Piper plot of water chemistry for the three groundwater samples taken at the proposed Altitude Aspire development site in February (interface 2a and basalt 2b) and April (interface 1a) 2010

40 80 120 160 200 metres

SCALE
1:4 000

ORIENTATION
NORTH

LEGEND

-  Site boundaries
-  Stage boundaries
-  Lot boundaries
-  Potential acid sulfate soils
-  Soils with existing acidity

SOURCES

Image base: Google Earth Pro 2012, imagery date 01 October 2010.

Development layout: B&P SURVEYS, Consulting Surveyors, Drawing number 18779B, Proposed Subdivision, 19 January 2012.

CAIRNS
KAWANA
BRISBANE

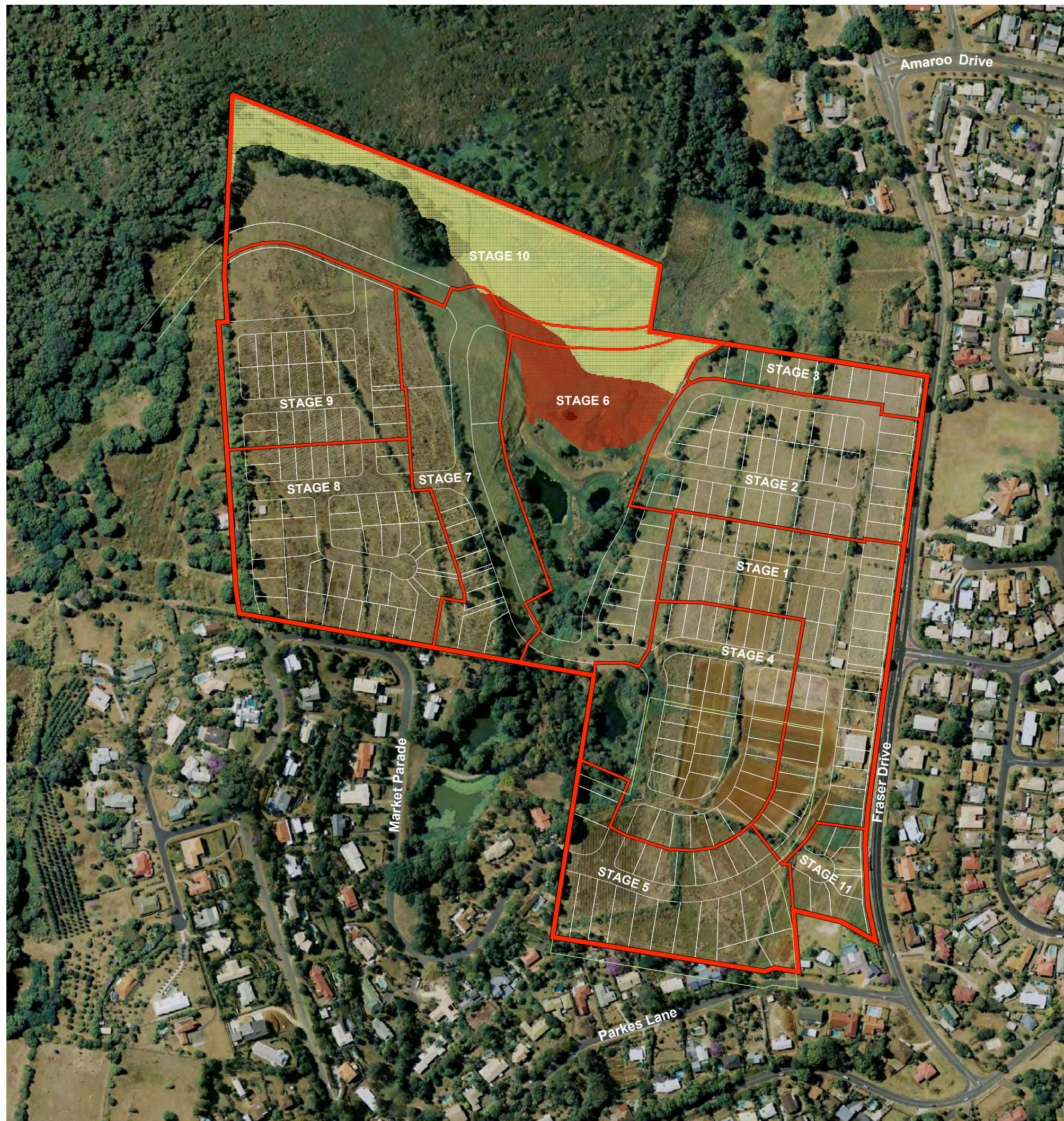
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AGRICULTURE WATER ENVIRONMENT



PROJECT
ALTITUDE ASPIRE
FRASER DRIVE
TERRANORA, NSW

CLIENT
NEWLAND DEVELOPERS
PTY LTD

DRAWING
DISTRIBUTION OF
ACID SULFATE SOILS





DATE 27/02/2012	DRAWN SPD
SCALE 1:4 000	CHECKED MLF
PROJECT NO 10849	DRAWING NO 1.4
	REVISION ORIGIN



SCALE
1:4 000

ORIENTATION
NORTH

LEGEND

-  Site boundaries
-  Monitoring well locations
-  Major contour
(m AHD, Interval = 0.5m)
-  Minor contour
(m AHD, Interval = 0.1m)

SOURCES

Image base: Google Earth Pro 2012,
imagery date 01 October 2010.

Development layout: B&P SURVEYS,
Consulting Surveyors, Drawing number
18778B, Proposed Subdivision, 19
January 2012.

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AGRICULTURE WATER ENVIRONMENT



**GILBERT
SUTHERLAND**

PROJECT
ALTITUDE ASPIRE
FRASER DRIVE
TERRANORA, NSW

CLIENT
NEWLAND DEVELOPERS
PTY LTD

DRAWING
GROUNDWATER CONTOURS

DATE 14/03/2012	DRAWN AJS
SCALE 1:4 000	CHECKED MLF
PROJECT NO 10849	DRAWING NO 1/5
	REVISION ORIGIN

4 Conclusions

4.1 ASSA

The findings of this Altitude Aspire ASSA can be summarised as follows:

- Screening results indicated the presence of PASS at the site.
- The CRS laboratory results confirmed the presence of PASS at the site.
- Treatment of the acidic soils encountered during the investigations will be necessary to meet the requirements of the ASSMAC Guidelines.

A preliminary assessment of the distribution of ASS within the development footprint is shown in Drawing No 1.4. The relevant borelogs are attached in Appendix 1.

The above assessment indicates that ASS management will be necessary during the proposed development works program.

Although the identification of PASS in these key areas is a constraint, management of ASS in accordance with standard management practices will ensure risk is controlled and that any acidic materials excavated are fully treated and managed so as to minimise the opportunity for environmental harm. Therefore, site ASS constraints would not preclude the development proceeding as proposed.

4.2 Groundwater

Given the findings of the ASSA, any excavation and/or filling at the site will need to consider the potential to impact upon shallow groundwater. Prior to any disturbance of the soils in the lower portion of the site (i.e. <5 mAHD) suitable monitoring will need to be undertaken to establish background groundwater characteristics.

Strategies and measures for the management of groundwater during the bulk earthworks associated with the proposal are provided in the following management tables.

5 Acid Sulfate Soil Management Plan (ASSMP)

5.1 ASSMP structure

This ASSMP acknowledges the potential environmental impacts associated with the proposed future disturbance of ASS associated with the Altitude Aspire development at Terranora, NSW and details strategies to mitigate them.

Each control strategy is based upon proven environmental management methods and is presented as a commitment. The commitments made within this document will form the basis of future assessments, which will be made available to the Tweed Shire Council (TSC) for review.

The ASSMP is based on a series of tables for use during the earthworks phase of the proposed development. The person responsible for the implementation of the measures detailed is written on the table itself. The tables then detail the issue, the performance criteria, the implementation strategy, monitoring, auditing, reporting, failure identification and the corrective action. The detachable pages within each section detail the provisions of the ASSMP. The format is presented below for reference purposes.

An objective of the tabular format is to allow for change and allow the ASSMP to be a working document. If items need altering, changes may be made to the individual tables after appropriate consultation with the statutory authorities.

Title

Person responsible	This is the person who has accepted the responsibility of implementing the ASSMP provisions detailed on this page.
Issue	The issue with which the table deals.
Operational policy	The operational policy or management objective that applies to the element.
Performance criteria	Performance criteria (outcomes) for each element of the operation.
Implementation strategy	The strategies or tasks (to nominated operational design standards) that will be implemented to achieve the performance criteria.
Monitoring	The monitoring requirements that will measure actual performance (i.e. specified limits to pre-selected indicators of change).
Auditing	The auditing requirements, which will verify implementation of, agreed construction and operation phase environmental management strategies and compliance with agreed performance criteria.
Reporting	Content, timing and responsibility for reporting and auditing of monitoring results.
Identification of incident or failure	The circumstances under which the agreed performance criteria are unlikely to be met and environmental harm is likely to result.
Corrective action	The action to be implemented in case a performance requirement is not reached and the company(s) responsible for action.

Commitment

What the management has committed the company to.

5.2 General commitments

Commitment 1

The Proponent undertakes to comply with the environmental implementation strategy as contained within the approved Acid Sulfate Soil Management Plan (ASSMP).

Commitment 2

The Proponent undertakes to fulfil all commitments made in this ASSMP and to carry out its activities on the project site in accordance with relevant current statutory requirements and approved amendments.

5.3 Definitions

In this ASSMP the terms have the following meanings;

- ASSMP means the approved Acid Sulfate Soil Management Plan and includes any amendments that may be approved from time to time.
- POEO Act means Protection of the Environment Operations Act 1997.
- Development means the development of the site as defined in a future development application.
- DECCW means the New South Wales Department of Environment, Climate Change and Water.
- TSC means Tweed Shire Council.
- ASSMAC means the Acid Sulfate Soils Management Advisory Committee.
- Proponent means the person undertaking the development of the land and includes the person nominated as having the responsibility for implementing the provisions of the ASSMP.

5.4 Background groundwater monitoring

Groundwater should be assessed prior to any disturbance of the soils in the lower portion of the site (i.e. <5 mAHD) to establish background groundwater characteristics.

Person Responsible	Contractor's Site Manager
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Issue	To determine the existing groundwater conditions at the site (levels and quality) and examine any seasonal variations that may result from increased precipitation. This would serve as 'baseline' data and allow comparison with groundwater level and quality results recorded during the construction and operational phase of works at the site.
Operational policy	To manage excavation activities so that any potential impacts on the current groundwater regime (including levels and quality) are minimised.
Performance criteria	<p>Groundwater level monitoring is to be undertaken on a monthly basis prior to construction works at the subject site.</p> <p>Groundwater quality monitoring will be undertaken monthly for the following parameters:</p> <ul style="list-style-type: none"> • pH (field measurement) • EC (field measurement) • Dissolved oxygen (field measurement) • Temperature (field measurement) <p>Laboratory analysis for the following parameters should also be performed:</p> <ul style="list-style-type: none"> • Calcium • Magnesium • Sodium • Potassium • Chloride • Sulfate • Alkalinity • Dissolved iron • Dissolved aluminium • Dissolved manganese <p>Laboratory analysis for total acidity (titratable) should also be undertaken on a monthly basis to determine the total potential acidity hazard that may be associated with groundwater at the site.</p>
Implementation strategy	<ul style="list-style-type: none"> • Groundwater level monitoring is to be undertaken on a monthly basis from the established monitoring locations prior to the commencement of construction. • Groundwater quality monitoring is to be undertaken on a monthly basis from the established monitoring locations prior to the commencement of

	construction, with analysis performed at a NATA accredited laboratory.
Monitoring	Background groundwater monitoring should be conducted at the monitoring locations for the parameters shown above.
Auditing	The consultant will audit the results and submit a background groundwater quality report to Council prior to the commencement of construction works.
Reporting	A background report to TSC (and copied to DECCW) including raw data, a results summary and a discussion comparing results with ANZECC guidelines.

5.5 Acid sulfate soil identification

Soils excavated from the areas identified as PASS and soils with existing acidity (as shown in Drawing No. 1.4) will be limed at the maximum prescribed rates of 104.5 and 7.1 kg dry t⁻¹ respectively. Alternatively, phase 2 testing could be conducted in accordance with Table 5.5 (below) to determine liming rates specific to each unit of excavated soil.

Person responsible	Site Manager
--------------------	--------------

Issue	Acid sulfate soil identification within all material excavated from the areas identified on Drawing No. 1.4.
Operational policy	To identify ASS during excavation and determine the acid producing potential and liming requirement prior to treatment.
Performance criteria	All ASS are identified and appropriate liming rates calculated prior to treatment.
Implementation strategy	<p>All soils excavated from below the current surface level below 5m AHD for the construction of the development will be sampled according to the following protocol during excavation.</p> <p>Frequency - During excavation a minimum of one soil sample for every 500m³ of excavated material would be collected and subjected to Verification (Phase 2) testing.</p> <p>Sample size - Soil samples of approximately 0.3kg each are to be collected from each soil horizon with a soil profile description recorded.</p> <p>Sampling - Soil samples to be tested on site or collected in sealed containers or plastic geological sampling bags that exclude air.</p> <p>Handling and storage - Samples are to be sent to laboratory or dried within 24 hours.</p> <p>Sample analysis method - All samples are to be analysed for Chromium Reducible Sulfur (CRS) (or equivalent method) and Titratable Actual Acidity (TAA) in accordance with the ASSMAC guidelines.</p>
Monitoring	<p>Laboratory analysis will employ the CRS/TAA Methods (or equivalent) as per the ASSMAC Guidelines.</p> <p>Material tracking shall be undertaken by the site manger or environmental consultant. Records shall be kept of volumes excavated, location of excavated material and ASS testing frequency.</p>
Auditing	<p>Auditing will be undertaken by the site manager and/or the proponent's nominated representative.</p> <p>Alternatively, auditing may be carried out by an independent consultant. The audit should include an inspection of site activities, complaints, corrective actions and reporting to assess compliance with the provisions outlined within the ASSMP.</p>

Reporting	Test results are to be forwarded to the Site Manager as they become available.
Identification of incident or failure	Insufficient sampling or failure to sample as identified by material tracking records and/or test results.
Corrective action	Ensure sufficient sampling and analysis of all excavated soils. Adjust sampling rates as necessary with consent from TSC.

Commitment 3

All PASS and soils with existing acidity excavated from below the current surface level <5m AHD and fill areas subject to >0.5 m filling will be limed at the maximum prescribed rates of 104.5 and 7.1 kg dry t⁻¹ respectively. Alternatively, phase 2 testing could be conducted to determine liming rates specific to each unit of excavated soil.

5.6 Acid sulfate soil treatment

Person responsible	Site Manager
--------------------	--------------

Issue	Acid sulfate soil assessment and treatment.
Operational policy	Excavated ASS will be treated to neutralise their acid generation potential (AGP).
Performance criteria	No material will be covered or removed from the site until validation tests indicate adequate neutralisation of the AGP.
Implementation strategy	<p>Treatment of all excavated soil material is to be conducted in accordance with the provisions below.</p> <p>Lime treatment</p> <ul style="list-style-type: none"> Soils excavated from the areas identified as PASS and soils with existing acidity (as shown in Drawing No. 1.4) will be limed at the maximum prescribed rate of 104.5 and 7.1 kg dry t⁻¹ respectively. Alternatively, soils tested at the rate of one sample per 500m³ of excavated material (as described in Table 5.5) will be treated with lime or neutralising agent to neutralise their equivalent TPA or equivalent oxidisable sulfur concentrations as determined by the results of laboratory testing. In calculating the amount of lime or neutralising agent to be added, a mixing factor for safety of 1.5 will be used. If it can be demonstrated that this safety factor is not needed, this may be reduced with the written agreement of TSC. Excavated material will be placed within bunded fill areas. Bunded treatment areas should be situated taking into account the following considerations: <ul style="list-style-type: none"> treatment pads are not to be located on public land treatment pads are to be protected from upslope surface flows sediment filters should be provided downslope of treatment areas. Material will be placed in tracked lots <300mm and limed at the calculated rate. Lime is to be mixed through the material with a rotary hoe or disc plough. Subsequent fill layers (<300mm) will not be placed within the treatment pad (fill area) until validation results are obtained, indicating the complete neutralisation of the treated material. Materials used to construct bunds will be free from ASS with the bunded area prepared with surface lime at a rate of 5kg/m² of material to be placed. Exposed sides and batters of water features are to be treated with lime immediately following excavation at a rate of 5kg/m².
Monitoring	<p>Validation testing will be performed by assessing oxidisable sulfur (or equivalent method) sampled at the rate of one sample per 500m³ of treated material.</p> <p>Lime delivery dockets are to be retained and made available to the auditor. These dockets will be compared with required lime amounts (as per calculated liming rates) as an indication as to whether liming has occurred at the specified rates.</p>
Auditing	Auditing will be undertaken by the site manager and/or the proponent's nominated representative.

	Alternatively, auditing may be carried out by an independent consultant. The audit should include an inspection of site activities, complaints, corrective actions and reporting to assess compliance with the provisions outlined within the ASSMP.
Reporting	<p>All validation testing results are to be reported to site manager.</p> <p>Records are to be kept on site and should be available for inspection at all times.</p> <p>Records are to be sent to TSC and/or DECCW as required.</p>
Identification of incident or failure	<p>Examination of works for evidence of:</p> <ul style="list-style-type: none"> • yellow efflorescence on soil surface • iron staining of soils or water • sulphurous odour • low pH in water bodies. <p>The acceptance criteria for the placed materials will be:</p> <ul style="list-style-type: none"> • If any single sample exceeds the ASSMAC Guideline threshold then the average of any four consecutive samples shall be equal to or less than the ASSMAC Guideline threshold for that material texture or should exhibit an equal or greater acid neutralising capacity.
Corrective action	<ul style="list-style-type: none"> • Retesting of fill materials using CRS/TAA method (or equivalent). • Any need for additional lime should be managed in accordance with the implementation strategies stated above. • If unforeseen environmental impacts occur due to excavation of ASS (e.g. fish kill) work should cease and TSC should be contacted.

Commitment 4

All ASS material shall be managed in accordance with the above provisions and the ASSMAC guidelines.

5.7 Sediment and erosion control

Person Responsible	Consulting Engineer, Contractor's Site Manager
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Issue	Sediment and erosion control.
Operational policy	To prevent the displacement of sediment and acidic soil material across the site, particularly during rainfall events.
Performance criteria	<p>All excavated ASS material shall be contained in such a manner so as to prevent the displacement of this material across the site.</p> <p>Erosion resulting from on-site activities shall be minimised.</p> <p>All waters shall be treated prior to release offsite to prevent the discharge of sediment laden waters into Terranora Broadwater or surrounding environments.</p> <p>The transport and accumulation of sediment offsite and should be prevented.</p>
Implementation strategy	<p>Erosion and sediment control devices such as (but not limited to) silt fences, bunds and contour drains should be installed prior to commencement of site activities to the reasonable satisfaction of TSC and should be maintained throughout the life of site operations.</p> <p>All exposed areas should have a negative grade toward the onsite excavations (water feature basins).</p> <p>All excavated material will be placed within bunded areas and tested for ASS potential. Materials used to construct bunds will be free from ASS with the bunded area prepared with surface lime at a rate of 5kg/m² of material to be placed.</p> <p>Upslope runoff shall be diverted around any acid sulfate treatment areas or any cleared or disturbed regions of the site in a way that minimises erosion, the size of the upslope catchment and diverts waters to the onsite water feature basins.</p> <p>Runoff from ASS treatment areas or stockpiled material shall be directed to the nearest water treatment basin. Accumulated water shall undergo testing and treatment as per Table 5.8 prior to release from site.</p> <p>Sediment control fences should be constructed at the downslope perimeter of ASS treatment areas and any cleared or disturbed regions of the site.</p> <p>Where possible, the excavation/construction programme shall be scheduled to minimise the potential for soil loss to occur. Where excavation/construction activities cannot be altered, additional controls shall be implemented in the areas of high erosion potential.</p> <p>All erosion and sediment control measures should be maintained at operational capacity until disturbed land is effectively rehabilitated.</p> <p>Stripped topsoil shall be separated from subsoil materials and shall only be stripped from the areas designated on the appropriate plans.</p>

	<p>After undergoing any necessary ASS treatment, soil should be stockpiled taking into account the following considerations:</p> <ul style="list-style-type: none"> • stockpiles are not to be located on roads, road shoulders or any other public land • stockpiles to be protected from upslope surface flows • sediment filters should be provided downslope of stockpiles • all stockpiles should be seeded within a fortnight of final forming with an appropriate seed mix.
Monitoring	Monthly visual inspections will be undertaken to ensure adequate erosion and sedimentation control devices are installed particularly in ASS treatment areas.
Auditing	<p>Auditing will be undertaken by the site manager and/or the proponent's nominated representative.</p> <p>Alternatively, auditing may be carried out by an independent consultant during the construction phase of the development. The audit should include an inspection of site activities, complaints, corrective actions and reporting to assess compliance with the ASSMP.</p>
Reporting	<p>Reporting is required if excessive sedimentation and/or erosion is identified.</p> <p>Full details to be available to the contractor together with suggested corrective actions if required.</p>
Identification of incident or failure	<ul style="list-style-type: none"> • Displacement of ASS material across the site. • Inadequate bunding of ASS treatment areas. • Damaged or failed erosion and sediment control devices.
Corrective action	<p>Identify the source of any displaced material and take the necessary steps required to prevent a recurrence. This may include:</p> <ul style="list-style-type: none"> • the installation of additional erosion and sediment control measures • maintenance of existing controls • a review of work practices to minimise exposed areas and the duration of exposure

Commitment 5

The Proponent will ensure that appropriate and adequate erosion and sediment control measures are installed prior to the commencement of works and are maintained for the duration of the construction works.

5.8 Surface water quality management

Person responsible	Contractor's Site Manager
--------------------	---------------------------

Issue	Surface water quality in the receiving environments surrounding the site including the Terranora Broadwater will not be adversely impacted upon by site operations.		
Operational policy	No adverse impact to the receiving environment shall result from discharge of waters offsite.		
Performance criteria	Surface water quality in the Terranora Broadwater will not be adversely impacted by the development of the site. Where practicable, surface water quality in the receiving environment will be evaluated against the ANZECC (2000) guideline limits for the protection of aquatic ecosystems and/or background levels established for that site.		
	Any surface water discharged from the site shall comply with the following release criteria:		
	Water quality parameter	Release criteria	Criteria type
	pH	6.5 – 9.0	Range
	Dissolved oxygen	>6.0 mg L ⁻¹	Minimum
	Turbidity	<50 NTU	Maximum
Visible oil and grease	None visible	Visible	
Implementation strategy	<ul style="list-style-type: none"> When constructed, surface water quality monitoring shall be undertaken within any water basin for pH, dissolved oxygen (DO) and turbidity prior to the release of any waters off site. Existing surface water conditions shall be maintained outside the construction area. When constructed, surface water flows will be directed towards the nearest water feature basin utilising a negative grade. Sediment and erosion control measures will be installed as detailed in Table 5.7. Reliable in situ monitoring equipment will be used for all monitoring. This equipment will be calibrated prior to each round of monitoring. 		
Monitoring	<ul style="list-style-type: none"> Surface water quality monitoring within any water basins for pH, DO and turbidity to be conducted prior to the release of any waters off site. Daily rainfall to be recorded by the civil contractor. 		
Auditing	<p>Auditing will be undertaken by the site manager and/or the proponent's nominated representative.</p> <p>Alternatively, auditing may be carried out by an independent consultant during the construction phase of the development. The audit should include an inspection of site activities, complaints, corrective actions and reporting to assess compliance with the ASSMP.</p>		

<p>Reporting of monitoring results</p>	<ul style="list-style-type: none"> • Water quality monitoring results to be submitted to TSC as requested. • All results to be kept on site for inspection by local and state government officers at all times.
<p>Identification of incident or failure</p>	<ul style="list-style-type: none"> • Discharge of waters offsite without appropriate testing to ensure the above water quality criteria are met. • Deterioration in surface water quality downstream of the development resulting from site works or the discharge of waters from the development site.
<p>Corrective action</p>	<ul style="list-style-type: none"> • Take necessary steps to address the problem to prevent a recurrence. • Addition of agents such as sodium hydroxide (caustic soda), magnesium hydroxide (magnesia), sodium bicarbonate, calcium bicarbonate (limestone) or calcium hydroxide (lime water) to contained waters as required to maintain the pH within the recommended range. • Addition of gypsum to contained waters as required to reduce suspended solids concentrations. • Discharge from any contained waters will not be allowed until the water quality criteria are reached.

Commitment 6

Management will ensure that any surface water discharged off site is acceptable under the ANZECC (2000) water quality criteria and/or background levels established for that site prior to release from the site.

5.9 Groundwater management

Person Responsible	Contractor's Site Manager
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Issue	Management of groundwater intercepted during the course of excavations.		
Operational policy	Management of groundwater intercepted during the course of excavations to minimise potential impacts to the receiving environment.		
Performance criteria	<ul style="list-style-type: none"> No discharge offsite of groundwater intercepted during the excavation of water features without appropriate testing and treatment as required. No variation in groundwater levels and/or flow direction beyond the effects of drought or flood. 		
Implementation strategy	<p>Groundwater intercepted during excavation shall be retained onsite until the water quality criteria (outlined below) are reached.</p> <p>Limiting of excavations in accordance with Table 5.6.</p> <p>No groundwater shall be discharged from the site until the specified water quality criteria are reached.</p> <p>Reliable in situ monitoring equipment will be used for all monitoring. This equipment will be calibrated prior to each round of monitoring.</p>		
Monitoring	Groundwater encountered during excavations shall be pumped to a holding area monitored prior to release off site (if necessary) for the following parameters:		
	Water quality parameter	Release criteria	Criteria type
	pH	6.5 – 9.0	Range
	Dissolved oxygen	>6.0 mg L ⁻¹	Minimum
	Turbidity	<50 NTU	Maximum
Auditing	<p>Auditing will be undertaken by the site manager and/or the proponent's nominated representative.</p> <p>Alternatively, auditing may be carried out by an independent consultant during the construction phase of the development.</p> <p>The audit should include an inspection of site activities, complaints, corrective actions and reporting to assess compliance with the ASSMP.</p>		
Reporting	<ul style="list-style-type: none"> Water quality monitoring results to be submitted to TSC as requested. All results to be kept on site for inspection by local and state government officers at all times. 		
Identification of incident or failure	<ul style="list-style-type: none"> Discharge of waters offsite without appropriate testing to ensure the above water quality criteria are met. Deterioration in surface water quality downstream of the development resulting from discharge of waters from the development site. 		

	<ul style="list-style-type: none"> • Failure to implement the contingency plan if large volumes of groundwater are encountered during excavation.
Corrective Action	<ul style="list-style-type: none"> • Take necessary steps to address the problem to prevent a recurrence. • Addition of hydrated lime to contained waters as required to maintain the pH within the recommended range. • Addition of gypsum to contained waters as required to reduce suspended solids concentrations. • Discharge of any contained waters will not be permitted until the water quality criteria are reached. • Implement groundwater contingency plan.

Commitment 7

Management will ensure that on-site activities do not impact upon groundwater quality, levels or movement outside of conditions experienced during drought or flood.

5.10 Contractor management

Person Responsible	Consulting Engineer
--------------------	---------------------

Issue	Contractor management.
Operational policy	To ensure the Proponent’s Duty of Care is met by ensuring the Contractor is aware of their responsibilities under the terms of the ASSMP.
Performance criteria	Each contractor shall be fully aware of its responsibilities under the terms of the ASSMP and their obligation to respond to environmental issues arising from construction activities.
Implementation strategy	Monitoring and verifying that the ASSMP is adhered to at all times and taking action if the specifications are not followed. The provision of advice, information and training to contractors and staff with regard to the implementation of the ASSMP.
Monitoring	Weekly site inspections are to be carried out by the site manager or Proponent’s representative to ensure the provisions of the ASSMP are being adequately implemented.
Auditing	Auditing will be undertaken by the site manager and/or the proponent’s nominated representative. Alternatively, auditing may be carried out by an independent consultant. The audit should include an inspection of site activities, complaints, corrective actions and reporting to assess compliance with the provisions outlined within the ASSMP.
Reporting	Full details shall be available to the contractor together with suggested corrective actions (if required).
Identification of incident or failure	Failure to comply with the conditions set out in the ASSMP resulting in environmental harm or unnecessary disturbance to neighbouring land users.
Corrective action	The Proponent has the right to call a halt to any activity being undertaken which is deemed in conflict with the ASSMP.

Commitment 8

All contractors will be managed to ensure compliance with the ASSMP for the duration of the site works.

6 Administration of the ASSMP

6.1 Amendment of the ASSMP

The Proponent may make an application to TSC to amend the provisions of this ASSMP. The application shall:

- be in writing; and
- specify the provisions of the ASSMP to which the application relates; and
- state how the proposed amendments achieve the objectives of the provisions to which the amendments relate.

Tweed Shire Council shall approve the amendment where TSC is satisfied, acting reasonably, that the proposed amendments achieve the objective of the provisions to which the amendment relates.

6.2 Incident management

The Proponent and any person appointed by the Proponent as having responsibility for a control strategy set out in this ASSMP have clearly defined responsibilities under the NSW *Protection of the Environment Operations Act* (1997) to report any incidents likely to cause material or serious environmental harm.

7 Appendix 1 – Borelogs

Borehole: BH1

Project: 10849

Drill Method: Hand Auger

Client: Newman Developers Pty Ltd

Easting: 551284

Depth (m): 1.8

Northing: 6877336

Logged by: JWW

Drilled by: G&S

Drill date: 14.02.12

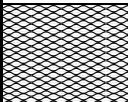
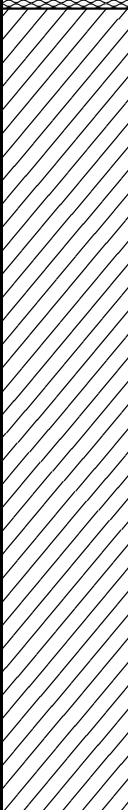
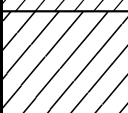
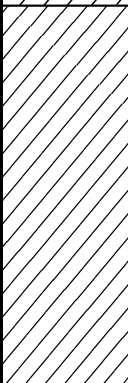


Depth NSL (m)	Drilling		Assays				
	Graphic log	Comments	Sample ID (m)	pH KCl	TAA (molH+/t)	CrS (%S)	ANC (% S Equiv.)
0.1		LOAM, Grey (2.5Y5/1), With 20% dark yellowish brown (10YR4/6) mottles, massive structure, earthy fabric, very weak consistence, 80% fine to medium roots, abrupt to;	0.00-0.17m	4.2	85	0.0001	--
0.2		CLAY LOAM, Bluish grey (5PB5/1), With 5% olive (5Y4/3) mottles, with 5% <5mm charcoal, massive structure, earthy fabric, weak consistence, 5% fine roots, clear to;					
0.3		MEDIUM HEAVY CLAY, Very dark grey (5Y3/1), With yellowish brown (10YR5/4) mottles, massive structure, earthy fabric, firm consistence, abrupt to;					
0.4		HEAVY CLAY, Bluish grey (5PB6/1), With 5% strong brown (7.5YR4/6) mottles, with 10% <5mm white rounded concretions, massive structure, earthy fabric, very firm consistence, <5% fine roots, abrupt to;					
0.5		HEAVY CLAY, Bluish grey (5PB5/1), With 5% yellow (10YR7/8), 5% reddish yellow (7.5YR6/8) and 10% light grey (5Y7/1) mottles, 5% <5mm white rounded concretions, massive structure, earthy fabric, firm consistence, gradual to;					
0.6		HEAVY CLAY, 20% bluish grey (5PB6/1) and 80% strong brown (7.5YR5/6), massive structure, earthy fabric, firm consistence, diffuse to;					
0.7		HEAVY CLAY, Strong brown (7.5YR5/6), Massive structure, earthy fabric, firm consistence, end of hole at 1.8m.					
0.8							
0.9							
1.0							
1.1							
1.2							
1.3							
1.4							
1.5							
1.6							
1.7							
1.8							
1.9							
2.0							
2.1							

Borehole: BH2**Project:** 10849**Drill Method:** Hand Auger**Client:** Newman Developers Pty Ltd**Easting:** 551235**Depth (m):** 2**Northing:** 6877362**Logged by:** JWW**Drilled by:** G&S**Drill date:** 14.02.12

Depth NSL (m)	Drilling		Assays				
	Graphic log	Comments	Sample ID (m)	pH KCl	TAA (molH+/t)	CrS (%S)	ANC (% S Equiv.)
0.1		CLAY LOAM, Light olive brown (2.5Y5/4), With 20% red (5YR4/8) mottles, 5-10mm polyhedral peds, earthy fabric, weak consistence, 50-70% fine roots, clear to;	0.00-0.25m	4.6	59	0.0001	--
0.2							
0.3		LIGHT MEDIUM CLAY, Dark grey (2.5Y4/1), With 15% strong brown (7.5YR5/8) mottles, 10-15% >10mm coarse fragments, massive structure, earthy fabric, weak-firm consistence, 5% fine roots decreasing with depth, watertable at 0.6m, clear to;					
0.4							
0.5							
0.6							
0.7							
0.8							
0.9							
1.0							
1.1		LIGHT CLAY, Brown (10YR4/3), With 5% reddish brown (2.5YR 5/4) and 10% reddish yellow (7.5YR6/6) mottles, 60% >65mm gravels, massive structure, earthy fabric, weak consistence, saturated through gravel seam, abrupt to;					
1.2							
1.3		MEDIUM CLAY, Black (5Y2.5/1), With 10% light greenish grey (5GY8/1) and 10% reddish yellow (7.5YR6/8) mottles, 10-15% >15mm coarse fragments, massive structure, earthy fabric, firm consistence, moist, clear to;					
1.4							
1.5							
1.6							
1.7		LIGHT CLAY , 70% >150mm gravels, massive structure, earthy fabric, weak consistence, saturated cobbles at 1.7m, end of hole at 2.0m.					
1.8							
1.9							
2.0							
2.1							

Borehole: BH3**Project:** 10849**Drill Method:** Hand Auger**Client:** Newman Developers Pty Ltd**Easting:** 551180**Depth (m):** 2**Northing:** 6877402**Logged by:** JWW**Drilled by:** G&S**Drill date:** 14.02.12

Depth NSL (m)	Drilling		Assays				
	Graphic log	Comments	Sample ID (m)	pH KCl	TAA (molH+/t)	CrS (%S)	ANC (% S Equiv.)
0.1		CLAY LOAM, Very dark greyish brown (10YR3/2), With 10% reddish brown (2.5YR4/4) mottles, 16-20mm polyhedral peds, earthy fabric, weak consistence, medium roots, clear to;	0.00-0.15m	4.8	47	<0.01%	--
0.2		MEDIUM CLAY, Dark reddish brown (5YR3/4), With 5% yellowish brown (5YR5/8) and 15% reddish yellow (7.5YR6/8) mottles, 5% >10mm gravels, massive structure, earthy fabric, firm consistence, water at 1.1m, clear to;					
0.3							
0.4							
0.5							
0.6							
0.7							
0.8							
0.9							
1.0							
1.1							
1.2							
1.3							
1.4		LIGHT MEDIUM CLAY, Greyish brown (2.5Y5/2), With 20% red (2.5YR4/8) mottles, 50-60% >25mm gravels, massive structure, earthy fabric, weak consistence, saturated gravel layer, abrupt to;					
1.5							
1.6							
1.7		MEDIUM CLAY, Light yellowish brown (2.5Y6/3), With 30% reddish yellow (7.5YR6/8) mottles, 10% >10mm coarse fragments, massive structure, earthy fabric, firm consistence, end of hole at 2.0m.					
1.8							
1.9							
2.0							
2.1							

Borehole: BH4**Project:** 10849**Drill Method:** Hand Auger**Client:** Newman Developers Pty Ltd**Easting:** 551252**Depth (m):** 2**Northing:** 6877402**Logged by:** JWW**Drilled by:** G&S**Drill date:** 14.02.12

Depth NSL (m)	Drilling		Assays				
	Graphic log	Comments	Sample ID (m)	pH KCl	TAA (molH+/t)	CrS (%S)	ANC (% S Equiv.)
0.1		LIGHT CLAY, Grey (10YR5/1), Massive structure, earthy fabric, firm consistence, 70% medium to fine roots, abrupt to;					
0.2			0.15-0.25m	4.2	68	0.0002	--
0.3							
0.4							
0.5		MEDIUM CLAY, Dark yellowish brown (10YR4/4), With 20% red (10R4/8) mottles, massive structure, earthy fabric, firm consistence, clear to;					
0.6							
0.7							
0.8							
0.9							
1.0							
1.1		MEDIUM CLAY, Strong brown (7.5YR5/6), 20% 20-40mm gravels, massive structure, earthy fabric, firm consistence, abrupt to;					
1.2			1.05-1.30m	5.8	7	<0.01%	--
1.3							
1.4							
1.5			1.35-1.60m	5.4	15	0.0067	--
1.6							
1.7		SANDY CLAY, Black (5Y2.5/1), 20-30% brittle 10-20mm whole shell and shell fragments, massive structure, sandy fabric, weak consistence, end of hole at 2.0m.					
1.8							
1.9							
2.0			1.85-2.00m	8.1	--	0.0268	786
2.1							

Borehole: BH5

Project: 10849

Drill Method: Hand Auger

Client: Newman Developers Pty Ltd

Easting: 551139

Depth (m): 2

Northing: 6877515

Logged by: JWW

Drilled by: G&S

Drill date: 15.02.12



Depth NSL (m)	Drilling		Assays				
	Graphic log	Comments	Sample ID (m)	pH KCl	TAA (molH+/t)	CrS (%S)	ANC (% S Equiv.)
0.1		MEDIUM CLAY LOAM, Very dark greyish brown (10YR3/2), Massive structure, earthy fabric, firm consistence, 80% fine to medium roots in top 100mm, abrupt to;	0.00-0.25m	5.7	25	0.0001	--
0.2							
0.3							
0.4							
0.5							
0.6							
0.7							
0.8							
0.9		LIGHT CLAY, Black (10YR2/1), 5% 5-10mm angular gravel, massive structure, earthy fabric, weak consistence, clear to;					
1.0							
1.1							
1.2		MEDIUM CLAY, Dark grey (5Y4/1), 20% 5-15mm gravel, massive structure, earthy fabric, weak consistence, clear to;					
1.3							
1.4		HEAVY CLAY, White (10YR8/1), With 10% yellow (2.5Y8/6) mottles, massive structure, earthy fabric, weak consistence, clear to;					
1.5							
1.6		HEAVY CLAY, Brownish yellow (10YR6/8), With 10% white (10YR8/1) and 10% red (2.5YR5/8) mottles, massive structure, earthy fabric, weak consistence, end of hole at 2.0m.					
1.7							
1.8							
1.9							
2.0							
2.1							

Borehole: BH6

Project: 10849

Drill Method: Hand Auger

Client: Newman Developers Pty Ltd

Easting: 551262

Depth (m): 2

Northing: 6877430

Logged by: JWW

Drilled by: G&S

Drill date: 15.02.12



Depth NSL (m)	Drilling		Assays				
	Graphic log	Comments	Sample ID (m)	pH KCl	TAA (molH+/t)	CrS (%S)	ANC (% S Equiv.)
0.1		CLAY LOAM, Black (5Y2.5/2), Massive structure, earthy fabric, weak consistence, 80% very fine to fine roots, clear to;	0.00-0.15m	4.3	145	0.0019	--
0.2		CLAY LOAM, Dark olive grey (5Y3/2), Massive structure, earthy fabric, weak consistence, gradual to;					
0.3							
0.4		LIGHT MEDIUM CLAY, Very dark grey (5Y3/1), With 10% weak red (10R4/4) mottles, some fragments of charcoal, massive structure, earthy fabric, weak consistence, clear to;					
0.5							
0.6							
0.7							
0.8							
0.9							
1.0			0.90-1.15m	5.0	34	0.0001	--
1.1							
1.2							
1.3							
1.4							
1.5		CLAYEY SAND, Black (5Y2.5/1), With 5% brownish yellow (10YR6/6) mottles, 10-15% brittle 10-25mm whole shells and shell fragments decreasing in number with depth, massive structure, sandy fabric, weak consistence, end of hole at 2.0m.	1.50-1.75m	7.5	--	0.0309	582
1.6							
1.7							
1.8							
1.9			1.75-2.00m	7.8	--	0.0276	558
2.0							
2.1							

Borehole: BH7**Project:** 10849**Drill Method:** Hand Auger**Client:** Newman Developers Pty Ltd**Easting:** 551333**Depth (m):** 2**Northing:** 6877410**Logged by:** JWW**Drilled by:** G&S**Drill date:** 15.02.12

Depth NSL (m)	Drilling		Assays				
	Graphic log	Comments	Sample ID (m)	pH KCl	TAA (molH+/t)	CrS (%S)	ANC (% S Equiv.)
0.1		CLAY LOAM, Brown (7.5YR4/4), With 20% brown (7.5YR4/1) mottles, massive structure, earthy fabric, weak consistence, medium to fine roots, clear to;	0.00-0.25m	4.7	50	0.0001	--
0.2							
0.3		LIGHT MEDIUM CLAY, Dark grey (7.5YR4/1), With 20% dark reddish brown (2.5YR2.5/4) mottles, massive structure, earthy fabric, firm consistence, fine roots, abrupt to;					
0.4							
0.5							
0.6		MEDIUM CLAY, Grey (7.5YR5/1), With 5% yellow (2.5Y7/8) and 10% red (2.5YR5/8) mottles, 10% >15mm coarse fragments at 0.9m, massive structure, earthy fabric, firm consistence, fine roots, moist at 0.9m, clear to;					
0.7							
0.8							
0.9							
1.0							
1.1							
1.2		SANDY CLAY, Bluish grey (5PB6/1), 2% shells, fine grained sand, massive structure, sandy fabric, weak consistence, end of hole at 2.0m.	1.80-2.00m	5.0	15	0.0003	--
1.3							
1.4							
1.5							
1.6							
1.7							
1.8							
1.9							
2.0							
2.1							

8 Appendix 2 – Soil field screening results

Client: Gilbert & Sutherland
Mazlab Job No: GSM 2231

Project: Terranora, Area E - 10849
Date: 24/02/2012

LABORATORY TEST RESULTS Certificate of Test Results – ASS Screenings

<u>Sample No.</u>	<u>Client I.D</u>	<u>Soil Description</u> (truncated)	<u>Reaction to H₂O₂</u>	<u>Reaction to HCL</u>	<u>pHf</u>	<u>pH fox</u>
29056	BH01 0.00-0.17m	Silty CLAY(CH) grey & brown, traces of organics	V High	Nil	4.9	2.7
29057	BH01 0.60-0.75m	Sandy Silty CLAY(CI) grey, traces of orange-brown	V High	Nil	5.0	3.2
29058	BH01 1.00-1.25m	Silty CLAY(CI) grey, traces of orange-brown	V High	Nil	5.0	3.4
29059	BH01 1.40-1.65m	Silty CLAY(CI) grey & orange-brown	V High	Nil	5.2	3.8
29060	BH02 0.00-0.25m	Silty CLAY(CI) brown, traces of organics	V High	Nil	5.1	3.3
29061	BH02 0.55-0.70m	Silty CLAY(CI) brown, traces of organics	V High	Nil	5.4	4.0
29062	BH02 1.10-1.35m	Silty Sandy CLAY(CI) brown, traces of orange-brown	V High	Nil	5.5	3.9
29063	BH02 1.35-1.60m	Silty CLAY(CI) grey & some brown-orange-brown	High	Nil	5.9	3.6
29064	BH02 1.60-1.90m	Sandy Gravelly CLAY(CL) grey, some brown	V High	Nil	5.6	3.2
29065	BH03 0.00-0.15m	Silty CLAY(CI) brown, traces of orange-brown & organics	V High	Nil	5.4	3.3
29066	BH03 0.40-0.65m	Silty CLAY(CI) brown, traces of orange-brown & organics	V High	Nil	5.3	3.7
29067	BH03 0.90-1.15m	Silty CLAY(CI) brown, traces of orange-brown & organics	V High	Nil	5.3	4.1
29068	BH03 1.45-1.70m	Silty CLAY(CI) grey & brown-orange-brown	V High	Nil	5.3	3.8
29069	BH03 1.70-1.95m	Silty CLAY(CI) grey & some brown-orange-brown	High	Nil	5.0	3.6
29070	BH04 0.15-0.25m	Silty CLAY(CI) brown, traces of grey & orange-brown, with organics	V High	Nil	4.6	2.9
29071	BH04 0.50-0.75m	Silty CLAY(CI) grey & brown	V High	Nil	5.8	3.9
29072	BH04 1.05-1.30m	Clayey Sandy GRAVEL(GP) grey-brown	V High	Nil	6.4	4.6

Checked By:

Date:

Laboratory Test Methods follow procedures described in : QASSIT – Acid Sulphate Soils Laboratory Methods Guidelines – Version 2.1 June 2004

Client: Gilbert & Sutherland
Mazlab Job No: GSM 2231

Project: Terranora, Area E - 10849
Date: 24/02/2012

LABORATORY TEST RESULTS Certificate of Test Results – ASS Screenings

<u>Sample No.</u>	<u>Client I.D</u>	<u>Soil Description</u> (truncated)	<u>Reaction to H₂O₂</u>	<u>Reaction to HCL</u>	<u>pHf</u>	<u>pH fox</u>
29073	BH04 1.35-1.60m	Silty CLAY(CI) grey, traces of orange-brown	V High	Nil	6.7	2.0
29074	BH04 1.85-2.00m	Clayey Sandy GRAVEL(GP) grey-dark grey	V High	V High	7.6	2.4
29075	BH05 0.00-0.25m	Organic Silty CLAY(CI) brown, with root fibres etc	V High	Nil	5.8	3.7
29076	BH05 0.50-0.75m	Silty CLAY(CI) grey & brown, traces of organics	V High	Nil	4.9	2.8
29077	BH05 1.05-1.20m	Silty CLAY(CI) grey	V High	Nil	5.7	2.3
29078	BH05 1.35-1.50m	Silty Gravelly CLAY(CI) grey, light grey-white & light orange-brown	V High	Nil	5.5	2.5
29079	BH05 1.75-2.00m	Silty CLAY(CI) light grey-white, brown, orange-brown & light orange-brown	V High	Nil	5.2	3.5
29080	BH06 0.00-0.15m	Silty CLAY(CI) grey-dark grey/ORGANICS- brown, root fibres etc	V High	Nil	5.9	2.7
29081	BH06 0.40-0.65m	Silty CLAY(CI) grey, traces of organics	V High	Nil	5.4	2.6
29082	BH06 0.90-1.15m	Silty CLAY(CI) grey, traces of brown	V High	Nil	5.4	3.3
29083	BH06 1.50-1.75m	Clayey SAND(SC) grey-dark grey, with shell	V High	V High	7.2	1.7
29084	BH06 1.75-2.00m	Clayey SAND(SC) grey-dark grey, with shell	V High	V High	7.5	1.7
29085	BH07 0.00-0.25m	Silty CLAY(CI) brown, with some organics	V High	Nil	5.2	3.3
29086	BH07 0.40-0.65m	Silty CLAY(CI) brown, traces of grey & orange-brown	V High	Nil	4.9	3.6
29087	BH07 0.90-1.15m	Silty CLAY(CI) grey & brown	V High	Nil	5.3	3.7
29088	BH07 1.35-1.60m	Silty CLAY(CI) grey & brown, traces of orange-brown	V High	Nil	5.3	3.8
29089	BH07 1.80-2.00m	Clayey SAND(SC) grey	V High	Nil	5.7	2.8

Checked By:

Date:

Laboratory Test Methods follow procedures described in : QASSIT – Acid Sulphate Soils Laboratory Methods Guidelines – Version 2.1 June 2004

9 Appendix 3 – Soil laboratory analysis certificates

Client: Gilbert & Sutherland

Project: Terranora, Area E - 10849

Mazlab Job No: GSM 2231

Date: 24/02/2012

LABORATORY TEST RESULTS
Certificate of Test Results – Chromium Reducible Sulphur

<u>Sample No.</u>	<u>Client I.D</u>	<u>Soil Description</u> <small>(truncated)</small>	<u>pH</u> <small>KCL</small>	<u>SCr</u> <small>mol IH+/t</small> <small>%S</small>	<u>TAA</u> <small>mol IH+/t</small> <small>%S</small>	<u>SNAS</u> <small>mol IH+/t</small> <small>%S</small>	<u>ANC</u> <small>mol IH+/t</small> <u>NA=</u> <u>Scr <</u> <u>action</u> <u>limit</u>	<u>Net Acidity</u> <small>mol IH+/t</small> <small>%S</small>	<u>Liming Rate</u> <small>(Kg/ dry t)</small>
29056	BH01 0.00-0.17m	Silty CLAY(CH) grey & brown, traces of organics	4.2	6 0.01%	85 0.14%	<0.02%	- -	91	7.1
29060	BH02 0.00-0.25m	Silty CLAY(CI) brown, traces of organics	4.6	4 0.01%	59 0.09%	- -	- -	63	4.9
29065	BH03 0.00-0.15m	Silty CLAY(CI) brown, traces of orange-brown & organics	4.8	<2 <0.01%	47 0.07%	- -	- -	47	3.6
29070	BH04 0.15-0.25m	Silty CLAY(CI) brown, traces of grey & orange-brown, with organics	4.2	15 0.02%	68 0.11%	<0.02%	- -	83	6.4
29072	BH04 1.05-1.30m	Clayey Sandy GRAVEL(GP) grey-brown	5.8	<2 <0.01%	7 0.01%	- -	- -	7	Nil
29073	BH04 1.35-1.60m	Silty CLAY(CI) grey, traces of orange-brown	5.4	420 0.67%	15 0.02%	- -	- -	435	33.7
29074	BH04 1.85-2.00m	Clayey Sandy GRAVEL(GP) grey-dark grey	8.1	1669 2.68%	- -	- -	786	883	68.5
29075	BH05 0.00-0.25m	Organic Silty CLAY(CI) brown, with root fibres etc	5.7	5 0.01%	25 0.04%	- -	- -	30	2.3
29080	BH06 0.00-0.15m	Silty CLAY(CI) grey-dark grey/ORGANICS- brown, root fibres etc	4.3	120 0.19%	145 0.23%	<0.02%	- -	265	20.5
29082	BH06 0.90-1.15m	Silty CLAY(CI) grey, traces of brown	5.0	7 0.01%	34 0.05%	- -	- -	41	3.2
29083	BH06 1.50-1.75m	Clayey SAND(SC) grey-dark grey, with shell	7.5	1929 3.09%	- -	- -	582	1347	104.5
29084	BH06 1.75-2.00m	Clayey SAND(SC) grey-dark grey, with shell	7.8	1722 2.76%	- -	- -	558	1164	90.3
29085	BH07 0.00-0.25m	Silty CLAY(CI) brown, with some organics	4.7	8 0.01%	50 0.08%	- -	- -	58	4.5
29089	BH07 1.80-2.00m	Clayey SAND(SC) grey	5.0	19 0.03%	15 0.02%	- -	- -	34	2.6

Checked By:

Date:

Laboratory Test Methods follow procedures described in : QASSIT – Acid Sulphate Soils Laboratory Methods Guidelines – Version 2.1 June 2004

10 Appendix 4 – Water laboratory analysis certificate and in situ sheet

CERTIFICATE OF ANALYSIS

<p>Work Order : EB1204601</p> <p>Client : GILBERT & SUTHERLAND PTY LTD</p> <p>Contact : MR CHRIS ANDERSON</p> <p>Address : SUITE 20 115 WICKHAM ST FORTITUDE VALLEY QLD, AUSTRALIA 4006</p> <p>E-mail : anderson.cm@access.gs</p> <p>Telephone : +61 07 38523999</p> <p>Facsimile : +61 07 38523933</p> <p>Project : 10849</p> <p>Order number : ----</p> <p>C-O-C number : ----</p> <p>Sampler : Jack Worcester</p> <p>Site : Terranora Area E</p> <p>Quote number : BN/694/11</p>	<p>Page : 1 of 4</p> <p>Laboratory : Environmental Division Brisbane</p> <p>Contact : Charles Tibbitts</p> <p>Address : 32 Shand Street Stafford QLD Australia 4053</p> <p>E-mail : Charles.Tibbitts@alsglobal.com</p> <p>Telephone : +61 7 3243 7122</p> <p>Facsimile : +61 7 3243 7218</p> <p>QC Level : NEPM 1999 Schedule B(3) and ALS QCS3 requirement</p> <p>Date Samples Received : 17-FEB-2012</p> <p>Issue Date : 28-FEB-2012</p> <p>No. of samples received : 3</p> <p>No. of samples analysed : 3</p>
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This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results



NATA Accredited Laboratory 825

Accredited for compliance with
ISO/IEC 17025.

Signatories

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

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Ankit Joshi	Inorganic Chemist	Sydney Inorganics
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics



General Comments

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

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

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

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

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

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.

LOR = Limit of reporting

^ = This result is computed from individual analyte detections at or above the level of reporting



Analytical Results

Sub-Matrix: SURFACE WATER

Client sample ID

Client sampling date / time

				MW1	MW2	MW3	----	----
				15-FEB-2012 15:00	15-FEB-2012 15:00	15-FEB-2012 15:00	----	----
Compound	CAS Number	LOR	Unit	EB1204601-001	EB1204601-002	EB1204601-003	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	33	24	34	----	----
Total Alkalinity as CaCO3	----	1	mg/L	33	24	34	----	----
ED040F: Dissolved Major Anions								
Sulfur as S	63705-05-5	1	mg/L	13	26	5	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	48	77	20	----	----
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	1	mg/L	60	145	27	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	9	14	7	----	----
Magnesium	7439-95-4	1	mg/L	5	10	5	----	----
Sodium	7440-23-5	1	mg/L	32	101	24	----	----
Potassium	7440-09-7	1	mg/L	<1	5	<1	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	0.01	0.01	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Nickel	7440-02-0	0.001	mg/L	0.004	0.004	0.004	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Zinc	7440-66-6	0.005	mg/L	0.017	0.028	0.031	----	----
Manganese	7439-96-5	0.001	mg/L	1.49	2.78	1.56	----	----
Iron	7439-89-6	0.05	mg/L	<0.05	19.5	<0.05	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	0.03	0.03	0.03	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.9	1.5	2.5	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	0.9	1.5	2.5	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								



Analytical Results

Sub-Matrix: SURFACE WATER

Client sample ID

Client sampling date / time

				MW1	MW2	MW3		
				15-FEB-2012 15:00	15-FEB-2012 15:00	15-FEB-2012 15:00	----	----
Compound	CAS Number	LOR	Unit	EB1204601-001	EB1204601-002	EB1204601-003	----	----
EK071G: Reactive Phosphorus as P by discrete analyser - Continued								
Reactive Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	<0.01	----	----
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	2.35	----	1.86	----	----
Total Anions	----	0.01	meq/L	----	6.17	----	----	----
Total Cations	----	0.01	meq/L	2.25	6.04	1.80	----	----
Ionic Balance	----	0.01	%	----	1.45	----	----	----