APPENDIX K

ACID SULPHATE INVESTIGATION AND SOIL MANAGEMENT PLAN
IRON GATES RESIDENTIAL DEVELOPMENT

Acid Sulfate Investigation and Soil Management Plan

08 JULY 2019
GOLD CORAL PTY LTD
IRON GATES RESIDENTIAL DEVELOPMENT

Acid Sulfate Investigation and Soil Management Plan

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Lachlan Prizeman

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Date
8/07/2019

Revision
01

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REVISIONS

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<th>Description</th>
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<th>Approved by</th>
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<td>08/07/2019</td>
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1 INTRODUCTION

1.1 General Background

An Acid Sulphate Investigation and Soil Management Plan (ASI&SMP) is proposed for the construction of the proposed Iron Gates Residential development.

The ASI&SMP relates specifically to the construction of lot filling and installation of the proposed Sewer and Stormwater services at or below the natural surface level.

Initial investigations undertaken by Coffey Partners International (1995) and Geotech Investigations (2015) included a number Groundwater and Soil investigations, including 21 boreholes, and laboratory testing, both Reports recording the absence of any Actual or Potential Acid Sulfate Soils. Copies of the site Investigation Reports including the laboratory testing results are attached to this Report in the appendices.

As construction involves substantial filling and minimal disturbance of the existing soils on the site and given the absence of AASS or PASS soils recorded in the initial investigations, an Acid Sulphate Management Plan is not considered necessary.

The development site is mapped as Class 3 and Class 5 – Class 3 soils require a preliminary investigation where works greater than 1.0 m below ground level are proposed. The proposed development construction includes excavation and construction of sewer and stormwater services expected to be at a maximum depth of 1.5m.

Acid sulfate soils are not typically found in Class 5 areas. Areas classified as Class 5 are located within 500 metres of adjacent class 1, 2, 3 or 4 land. Works in a class 5 area that are likely to lower the water table below 1 metre AHD on adjacent class 1, 2, 3 or 4 land will trigger the requirement for assessment and may require management.

![Figure 1: Richmond Valley Council Acid Sulfate Soil Mapping](Image)

This investigation and report is based on the Geotechnical, Groundwater and Acid Sulfate Assessment reports developed by Douglas Partners 1991; Coffey Geosciences Pty Ltd (Coffey) 1995; & Geotech Investigations Pty Ltd 2015 - with findings and results of laboratory testing forming the basis for this document herein.
The original site investigation carried out in 1991 by Douglas Partners included a report and laboratory testing of soil samples and identified:

The sandy soils were assessed for potential acid sulphate conditions. The completed laboratory tests indicate that at the sites indicated there is no evidence of (actual) acid sulphate material in any of the test pits. Further, field tests for pH decrease after oxidation in laboratory analysis for total sulphur (%) suggest that there are no potentially acid sulphate soils in any of the samples. These results should be representative of the survey area, according to Morse McVey & Associates. The soil analysis conclude that with respect to limitations imposed by the occurrence of acid sulphate materials, there is no reason why development should not proceed in this area.

The Coffey Groundwater and Acid Sulfate Assessment 1995 also identified a general absence of Acid Sulfate Soils in the 23 borelog tests, this was confirmed by subsequent 5 laboratory testing results and are quoted in the extract below.

5.0 DISCUSSION

5.1 Acid Sulphate Soils

The field qualitative spot testing indicated a general absence or very low concentration of either ferrous monosulphide or pyrite in either the topsoil, sands above the water table or sands below the water table. This was confirmed by the laboratory testing which indicated nil acid sulphate potential and nil acid generating potential for all 5 samples submitted.

### ANALYSIS OF SOIL SAMPLES
**ACID SULPHATE POTENTIAL**
IRON GATES ESTATE, EVANS HEAD
JOB NO. NR862/2

<table>
<thead>
<tr>
<th>SAMPLE REGD. NO.</th>
<th>ANALYSIS</th>
<th>INITIAL pH (1:5)</th>
<th>pH AFTER H2O2 OXID'N</th>
<th>INITIAL SO2</th>
<th>SO2 AFTER OXID'N</th>
<th>PYRITE S</th>
<th>CaCO3</th>
<th>ACID SULPHATE POTENTIAL</th>
<th>ACID GENERATING POTENTIAL</th>
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<td>972997 50M 1.0 - 2.0 CB 944478</td>
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<td>10.</td>
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<td>6.0</td>
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<td>5.2</td>
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<td>&lt;0.2</td>
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<td>NIL</td>
</tr>
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</table>

* Qualitative assessment based solely on % pyrite - not subject to NATA certification.
** Qualitative assessment based on % pyrite, % CaCO3 and pH after oxidation - not subject to NATA certification.

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1.2 Soil Management Plan - Environmental Objectives

As field and laboratory testing by Coffey has indicated low acid generating potential, not actual or potential acid sulfate soil (ASS), specific management measures are not considered necessary for ASS. However, some non sulphuric actual acidity may be present in soils on site, therefore a Site Specific Soil Management Plan and measures will be adopted to deal with "incidental" acid generation where base materials are excavated, drained or dewatered for periods of greater than 24 hours during construction.

The specific environmental objectives of this Site Specific Soil Management plan are to:

- To prevent acid leachate to groundwater resources;
- To prevent acidification of storm water; and
- To prevent acidification of adjacent surface waters.

1.3 Scope of work

Development of a Site Specific Soil Management plan (SMP) having regard to the following:

- New South Wales Acid Sulfate Soils, 2002;
- Review of results identified within the investigation being Coffey Partners International Pty Ltd (Coffey) Geotechnical and Acid Sulfate Assessment report – dated 12th January 1995; and
- Development of a site specific SMP in recognition of the Richmond Valley Local Environmental Plan 2012 – Clause 6.1 for submission and approval to council prior to the commencement of works onsite.

1.4 Site Description & Location

The proposed development is at the Vantage development at Evans Heads. The property description is Lot 276 DP 755624, Lot 277 DP 755624 and Lot 163 on DP831052. The site is bounded by the Evans River and adjoining SEPP 14 Wetlands at the Western end of Iron gates road and lies opposite the Bundjalung National Park on the southern shores of the Evans River.
2 NEW SOUTH WALES LEGISLATION & REFERENCES

To following New South Wales Legislation and references were used in preparation for the development of this report:

- New South Wales Acid Sulfate Soils Manual;
- Richmond Valley Local Environmental Plan 2012 – Clause 6.1 Acid Sulfate Soils, 2012;
- Instructions for the Treatment and Management of Acid Sulfate Soils, EPA 200; and
- QASSIT Guidelines.

3 SOIL MANAGEMENT PLAN

3.1 Sensitive Receivers

Environmental Receivers

The most sensitive environmental receiver is the surface water, which eventually flows to Evans River to then enter the South Pacific Ocean.

Site Personnel

Potential health impacts have been considered as a minor risk for site personnel working closely with excavation and filling activities. Appropriate personnel protective equipment (PPE) (gloves, safety glasses, hard hat, long sleeves and trousers) must be worn at all times.

Surrounding Community and Stakeholders

The surrounding land uses are predominantly residential sections of the Town of Evans Heads approximately 1.2km downstream from the site, Coastal SEPP Wetlands to the East of the site, and the Bundjalung National Park on the southern side of the Evans River.

3.2 Operational Controls

Earthworks / Filling

Prior to the placement of filling earthworks it is recommended that additional ASS testing be carried out to determine whether it is necessary for a guard layer of fine agricultural lime equivalent to 10kg lime per square meter per meter depth of fill be spread over fill areas prior to the placement of any imported fill or soils from the excavation. Liming of the surface of the fill at the rate of 5 kg per square meter and incorporating to a depth of 300 mm may also be recommended following site filling.

Should any potential acid soil (PAS) materials be excavated during construction exposure shall be minimised and contained in an adequately bunded containment area for treatment with lime as required.

Surface water infiltration to groundwater shall be prevented from passing through PAS. Where required lime material shall be placed to intercept infiltration.

Any acid leachate detected during excavation, and earthworks shall be treated by liming at required doses prior to disposal or use on site as engineered fill.

As the proposed development will affect soils below 5m AHD and involves either:

a) The excavation of 100m³ or more of soil or sediment; or
b) The filling of land involving 500m³ or more of material with an average depth of 0.5m or greater,

The following conditions in relation to acid sulphate soil investigation, management plan preparation and submission of documents to council must be complied with.

**Water Usage – construction management**

The use of potable water will not be available for use in activities associated with road and pavement construction, the compaction of fill material or dust suppression. The use of recycled water is encouraged, especially where other alternative sources do not exist. Where recycled water is proposed to be used:

c) The use of the recycled water must be in accordance with any requirements of a developed Recycled Water Safety Plan, which sets out the requirements for transport and use of recycled water;

d) The contractor must first complete a recycled water training course, in accordance with the Safety plan. Proof of completion of the training course will be by issue of a valid certification card;

e) The applicant can only contract to use a recycled water carrier who is accredited and certified by Richmond Valley Council. Accreditation requires current authorised agreement between the water carrier and Richmond Valley; and

f) The water carrier is only allowed to employ certified tanker operator/drivers, who have completed the recycled-water training course and hold a valid certification card.

**Dewatering**

Dewatering activities during site filling and trench excavations shall be undertaken in a controlled manner to prevent acid leachate to waterways, and in accordance with the approved Dewatering Management Plan

**Verification Testing**

Acid Sulphate Soil Assessments by Coffey Partners concluded that soils on site are not actual or potential acid sulphate soils. The results indicate non sulphuric actual acidity may be present within soils onsite and as such general duty of care requires the managing of proposed earthworks.

Verification testing must follow the performance criteria attained for soil that has been treated for neutralisation as stated in Soil Management Guidelines as follows:

1. The neutralising capacity of the treated soil must exceed the existing plus potential acidity of the soil; and
   - Post neutralisation, the soil pH is to be greater than 6.5; and
   - Excess neutralising agent should remain within the soil until all acid generation reactions are complete and the soil has no further capacity to generate acid.
   - The SPOCAS suite or “Chromium” suite is required for the verification testing at a rate of one test per 500 cubic metres.

2. If necessary all treatment of excavated soils shall be within a bunded area of the site filling area prior to final placement.
4 RESPONSIBILITIES

It will be the responsibility of the Site Project Engineer / Construction manager to ensure all site personnel are informed regarding the potential for PAS on site. All site personnel are expected to complete risk awareness training and or induction prior to arriving on site.

5 REPORTING & MONITORING

5.1 Performance Indicators

The pH of waters collected on-site shall be maintained between 6.5 and 8.5.

5.2 Monitoring

Visual Monitoring

At all times visual monitoring should be undertaken to check for signs of contamination, such as:

- Unexplained scalding, degradation or death of vegetation;
- Formation of the mineral jarosite and other acidic salts in exposed or excavated soils;
- Areas of green-blue or extremely clear water indicating high aluminium concentrations;
- A transition to, or an establishment of, a community dominated by acid tolerant species;
- Rust coloured deposits on plants and on the banks of drains; water bodies and watercourses indicating iron precipitates;
- Corrosion of concrete and/or steel structures in contact with soil or water; and
- Black to very coloured waters indicating de-oxygenation;
- Sulfurous smell (rotten egg gas).

Water Quality Monitoring

The water quality monitoring programme is to be undertaken by the principal consultant for pre-construction, during construction and post-construction activities. The principal consultant is responsible for performing and reporting on water quality in accordance with a Construction Site Based Management Plan (CSBMP) developed prior to construction.

Surface and stormwater runoff discharged from the site shall be monitored at discharge locations for pH, salinity, dissolved oxygen, suspended solids, temperature, iron, aluminium, total phosphorus and total nitrogen. All waters discharged are to meet the performance criteria and the environmental values and water quality objectives published within the ANZECC Water Quality Guidelines 2006.

Groundwater resources potentially affected by construction activities shall be monitored for pH, salinity, dissolved oxygen, temperature, iron, aluminium, total phosphorus and total nitrogen.

5.3 Corrective Actions

Non-conformance with this plan shall be documented and a corrective action request (CAR) issued. All CAR’s shall be included in the non-conformance register.
Should a decline in water quality be observed, corrective action shall be undertaken in consultation with Council.

5.4 Reporting

The Contractor shall document any encounter of Potential and Actual ASS and report any such occurrence to the Proponent.

During construction, monthly reports are to be prepared on the water quality monitoring carried out. The reports are to include all test results and a summary of the findings for the period. The reports are to be submitted to council.

Quarterly water quality reports after completion of the development will be prepared and submitted to council for a six month period.
APPENDIX A

GEOTECH INVESTIGATIONS (2015)
OUR REF: JW:jw: GI 2039-a
2 June 2015

Gold Coral Pty Ltd
PO Box 3441
Australia Fair Southport QLD 4215

REPORT ON IN-SITU PERMEABILITY TESTING
IRON GATES DRIVE, EVANS HEAD

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<td>0.5 m (SP) SAND: Fine sand, dry, pale grey</td>
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<tr>
<td></td>
<td>2.2 m (SP) SAND: Fine sand, wet, pale grey</td>
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<td></td>
<td>T.D. 3 m</td>
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<td>Water Table (estimated based on drilling)</td>
<td>2.2 m BSL</td>
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<td>Indicative Drainage Class</td>
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Notes: T.D. – Terminate depth of borehole  BSL – Below existing surface level
$K_{sat}$ – Saturated hydraulic conductivity  $K$ – Permeability
Table 4.2A4 AS 1547 (On-site domestic wastewater management)

For and on behalf of
Geotech Investigations Pty Ltd

James Walle RPEQ (15701), RPEng (Civil), B.Eng (Civil)
Senior Geotechnical Engineer
REPORT ON IN-SITU PERMEABILITY TESTING
IRON GATES DRIVE, EVANS HEAD

Test ID: Test P2

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<td>0.5 m (SP) SAND: Fine sand, moist, pale grey</td>
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<td>1.4 m (SP) SAND: Trace silt, fine sand, moist, dark brown</td>
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<td>1.6 m (SP) SAND: Trace silt, fine sand, moist, dark grey</td>
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<td>T.D. 3 m</td>
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<td>0.6 m BSL</td>
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<td>‘rapidly drained’</td>
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Notes:  
T.D. – Terminate depth of borehole  
BSL – Below existing surface level  
$K_{\text{sat}}$ – Saturated hydraulic conductivity  
$K$ – Permeability  
Table 4.2A4 AS 1547 (On-site domestic wastewater management)

For and on behalf of
Geotech Investigations Pty Ltd

James Walle RPEQ (15701), RPEng (Civil), B.Eng (Civil)
Senior Geotechnical Engineer
Our Ref: JW:jw: GI 2039-c
2 June 2015

Gold Coral Pty Ltd
PO Box 3441
Australia Fair Southport QLD 4215

REPORT ON IN-SITU PERMEABILITY TESTING
IRON GATES DRIVE, EVANS HEAD

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<tr>
<td>1.4 m (SP) SAND: Trace silt, fine sand, wet, dark brown</td>
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<td>T.D. 3 m</td>
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| Water Table (estimated based on drilling) | 0.6 m BSL |

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| Indicative Drainage Class | ‘rapidly drained’ |

Notes:
- T.D. – Terminate depth of borehole
- BSL – Below existing surface level
- $K_{sat}$ – Saturated hydraulic conductivity
- $K$ – Permeability
- Table 4.2A4 AS 1547 (On-site domestic wastewater management)

For and on behalf of
Geotech Investigations Pty Ltd

[Signature]

James Walle  RPEQ (15701), RPEng (Civil), B.Eng (Civil)
Senior Geotechnical Engineer
Our Ref: JW:jw: GI 2039-d
2 June 2015

Gold Coral Pty Ltd
PO Box 3441
Australia Fair Southport QLD 4215

REPORT ON IN-SITU PERMEABILITY TESTING
IRON GATES DRIVE, EVANS HEAD

Test ID: Test P4

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<td>0.7 m (SP) SAND: Trace silt, fine sand, moist, pale grey</td>
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<td>1.7 m (SP) SAND: Trace silt, fine sand, wet, pale grey</td>
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<td>2.0 m (SP) SAND: Trace silt, fine sand, wet, grey brown</td>
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<tr>
<td>T.D.</td>
<td>3 m</td>
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<tr>
<td>Water Table</td>
<td>1.7 m BSL</td>
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<td>(estimated based on drilling)</td>
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Indicative Drainage Class ‘rapidly drained’

Notes: T.D. – Terminate depth of borehole
       BSL – Below existing surface level
       $K_{sat}$ – Saturated hydraulic conductivity
       $K$ – Permeability
       Table 4.2A4 AS 1547 (On-site domestic wastewater management)

For and on behalf of
Geotech Investigations Pty Ltd

James Walle RPEQ (15701), RPEng (Civil), B.Eng (Civil)
Senior Geotechnical Engineer
Our Ref: JW:jw: GI 2039-e  
2 June 2015  

Gold Coral Pty Ltd  
PO Box 3441  
Australia Fair Southport QLD 4215

REPORT ON IN-SITU PERMEABILITY TESTING  
IRON GATES DRIVE, EVANS HEAD

Test ID: Test P5

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<td>Soil Description</td>
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<tr>
<td>0 m (SM) Silty SAND: Fine sand, moist, dark brown</td>
<td></td>
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<tr>
<td>0.6 m (SP) SAND: Trace silt, fine sand, dry, pale grey</td>
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</tr>
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<td>1.4 m (SP) SAND: Trace silt, fine sand, moist to wet, pale grey</td>
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<td>2.4 m (SP) SAND: Trace silt, fine sand, wet, grey brown</td>
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<td>(estimated based on drilling)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Field Test Results</td>
<td>$K_{sat} = 4.2 \text{ m/day} = 176 \text{ mm/hr}$</td>
<td>$K = 4.9 \times 10^{-5} \text{ m/s}$</td>
</tr>
<tr>
<td>Test Hole Depth</td>
<td>1.1 m BSL</td>
<td></td>
</tr>
<tr>
<td>Indicative Drainage Class</td>
<td>‘rapidly drained’</td>
<td></td>
</tr>
</tbody>
</table>

Notes:  T.D. – Terminate depth of borehole  BSL – Below existing surface level  
$K_{sat}$ – Saturated hydraulic conductivity  $K$ – Permeability  
Table 4.2A4 A5 1547 (On-site domestic wastewater management)

For and on behalf of  
Geotech Investigations Pty Ltd

[Signature]  
James Walle  RPEQ (15701), RPEng (Civil), B.Eng (Civil)  
Senior Geotechnical Engineer
REPORT ON IN-SITU PERMEABILITY TESTING
IRON GATES DRIVE, EVANS HEAD

Test ID: Test P6

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<tbody>
<tr>
<td>Test Date</td>
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</tr>
<tr>
<td>Soil Description</td>
<td>0 m (SM) Silty SAND: Fine sand, moist, dark grey</td>
</tr>
<tr>
<td></td>
<td>0.4 m (SP) SAND: Trace silt, fine sand, moist, pale grey</td>
</tr>
<tr>
<td></td>
<td>0.8 m (SM) Silty SAND: Fine sand, moist, dark orange brown</td>
</tr>
<tr>
<td></td>
<td>1.2 m (SM) Silty SAND: Fine sand, moist, grey brown mottled orange brown</td>
</tr>
<tr>
<td></td>
<td>2.7 m (SM) Silty SAND: Fine sand, wet, grey brown mottled orange brown</td>
</tr>
<tr>
<td>T.D.</td>
<td>3 m</td>
</tr>
<tr>
<td>Water Table</td>
<td>2.7 m BSL</td>
</tr>
<tr>
<td>Field Test Results</td>
<td>$K_{sat} = 2.2$ m/day $= 91$ mm/hr</td>
</tr>
<tr>
<td></td>
<td>$K = 2.5 \times 10^{-5}$ m/s</td>
</tr>
<tr>
<td>Test Hole Depth</td>
<td>1.1 m BSL</td>
</tr>
<tr>
<td>Indicative Drainage Class</td>
<td>'well drained'</td>
</tr>
</tbody>
</table>

Notes: T.D. – Terminate depth of borehole   BSL – Below existing surface level   $K_{sat}$ – Saturated hydraulic conductivity   $K$ – Permeability

Table 4.2A4 A5 1547 (On-site domestic wastewater management)

For and on behalf of
Geotech Investigations Pty Ltd

James Walle RPEQ (15701), RPEng (Civil), B.Eng (Civil)
Senior Geotechnical Engineer
REPORT ON IN-SITU PERMEABILITY TESTING
IRON GATES DRIVE, EVANS HEAD

Test ID: Test P7

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<td>25/05/2015</td>
<td></td>
</tr>
<tr>
<td>Soil Description</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 m (SP) SAND: With silt, fine to medium sand, moist, grey brown</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.2 m (SP) SAND: Trace silt, fine sand, moist, pale grey</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.7 m (SM) Silty SAND: Trace clay, fine sand, wet, orange brown</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1 m (SP) SAND: Trace silt, fine sand, wet, dark brown</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T.D. 3 m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Table (estimated based on drilling)</td>
<td>0.7 m BSL</td>
<td></td>
</tr>
<tr>
<td>Field Test Results</td>
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<td>0.87 m BSL</td>
<td></td>
</tr>
<tr>
<td>Indicative Drainage Class</td>
<td>‘rapidly drained’</td>
<td></td>
</tr>
</tbody>
</table>

Notes: T.D. – Terminate depth of borehole   BSL – Below existing surface level
$K_{sat}$ – Saturated hydraulic conductivity   $K$ – Permeability
Table 4.2A4 AS 1547 (On-site domestic wastewater management)

For and on behalf of
Geotech Investigations Pty Ltd

James Walle RPEQ (15701), RPEng (Civil), B.Eng (Civil)
Senior Geotechnical Engineer
Our Ref: JW:jw: GI 2039-h
2 June 2015

Gold Coral Pty Ltd
PO Box 3441
Australia Fair Southport QLD  4215

REPORT ON IN-SITU PERMEABILITY TESTING
IRON GATES DRIVE, EVANS HEAD

Test ID: Test P8

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<td>Test Date</td>
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</tr>
<tr>
<td>Soil Description</td>
<td>0 m (SP) SAND: Trace silt, fine sand, moist, brown</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.4 m (SP) SAND: Trace silt, fine sand, moist, pale grey</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.2 m (SP) SAND: Trace silt, fine sand, wet, pale grey</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.4 m (SM) Silty SAND: Fine sand, wet, dark brown</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.9 m (SP) SAND: Trace silt, fine sand, wet, dark grey / brown</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T.D. 3 m</td>
<td></td>
</tr>
<tr>
<td>Water Table (estimated based on drilling)</td>
<td>0.6 m BSL</td>
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<td>Field Test Results</td>
<td>$K_{\text{sat}} = 2.6 \text{ m/day} = 109 \text{ mm/hr}$</td>
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<td>$K = 3.0 \times 10^{-5} \text{ m/s}$</td>
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<td>Indicative Drainage Class</td>
<td>‘well drained’</td>
<td></td>
</tr>
</tbody>
</table>

Notes: T.D. – Terminate depth of borehole  BSL – Below existing surface level
$K_{\text{sat}}$ – Saturated hydraulic conductivity  K – Permeability
Table 4.2A4 AS 1547 (On-site domestic wastewater management)

For and on behalf of
Geotech Investigations Pty Ltd

James Walle  RPEQ (15701), RPEng (Civil), B.Eng (Civil)
Senior Geotechnical Engineer
REPORT ON IN-SITU PERMEABILITY TESTING
IRON GATES DRIVE, EVANS HEAD

Test ID: Test P9

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<tr>
<td>Soil Description</td>
<td>0 m (SM) Silty SAND: Fine to medium sand, moist, dark grey</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.5 m (SP) SAND: Trace silt, fine sand, moist, pale grey</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.8 m (SM) Silty SAND: With clay, fine sand, wet, dark brown</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.0 m (SM) Silty SAND: Fine sand, wet, dark brown mottled orange brown</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.5 m (SP) SAND: Trace silt, fine sand, wet, dark brown</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T.D. 3 m</td>
<td></td>
</tr>
<tr>
<td>Water Table</td>
<td>0.5 m BSL</td>
<td></td>
</tr>
<tr>
<td>(estimated based on drilling)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Field Test Results</td>
<td>$K_{s} = 18.6 \text{ m/day} = 775 \text{ mm/hr}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$K = 2.2 \times 10^{-4} \text{ m/s}$</td>
<td></td>
</tr>
<tr>
<td>Test Hole Depth</td>
<td>0.07 m BSL</td>
<td></td>
</tr>
<tr>
<td>Indicative Drainage Class</td>
<td>‘rapidly drained’</td>
<td></td>
</tr>
</tbody>
</table>

Notes: T.D. – Terminate depth of borehole  BSL – Below existing surface level  $K_{s}$ – Saturated hydraulic conductivity  K – Permeability  Table 4.2A4 AS 1547 (On-site domestic wastewater management)

For and on behalf of
Geotech Investigations Pty Ltd

James Walle  RPEQ (15701), RPEng (Civil), B.Eng (Civil)
Senior Geotechnical Engineer
APPENDIX B

COFFEY PARTNERS INTERNATIONAL (1995)
W P Brown & Partners Pty Ltd
PO Box 6527
UPPER MT GRAVATT QLD 4122

Attention: Mr Gary Spence

Dear Sir,

RE: IRON GATES ESTATE - STAGE 1A
INVESTIGATION OF PROPOSED OPEN DRAIN

Please find enclosed our report on the geotechnical investigation for a proposed drain at the Iron Gates Estate. The investigation was carried out in general accordance with our proposal NRP294/17-A dated 21st November, 1994.

Should you have any queries regarding the contents of this report, please contact Geoff Drew or the undersigned at our Brisbane office.

For and on behalf of
COFFEY PARTNERS INTERNATIONAL PTY LTD

[Signature]
P. Shaw

Offices and NATA Registered Laboratories located throughout Australia and South East Asia
TABLE OF CONTENTS

1.0  INTRODUCTION                              1
2.0  FIELD INVESTIGATION                      1
3.0  SITE DESCRIPTION                         1
4.0  LABORATORY TESTING                      2
   4.1  Acid Sulphate                          2
   4.2  Particle Size Distribution             2
5.0  DISCUSSION                              3
   5.1  Acid Sulphate Soils                    3
   5.2  Groundwater Movement                   3

Important Information about your Geotechnical Engineering Report

FIGURE

1  Site Plan

APPENDICES

A  Engineering Logs of Boreholes
B  Particle Size Distribution
C  Acid Sulphate Test Results
1.0 INTRODUCTION

It is proposed that an open drain be constructed adjoining the Iron Gates Estate Stage IA development. Coffey Partners International Pty Ltd was commissioned verbally by Mr. Gary Spence of W.P. Brown & Partners Pty Ltd to perform an investigation of the subsurface conditions along the drain alignment. This report contains details of the field investigation and the laboratory chemical and geotechnical testing. Comment is provided on the impact of the proposed drain on a nearby wetland area and the possibility that acid sulphate soils will be exposed during excavation.

2.0 FIELD INVESTIGATION

A total of 9 holes were drilled using hand held (sand) auger equipment on 6th & 7th December, 1994. The holes were advanced to depths of 2m below the existing ground surface at 50m intervals along the alignment of Open Drain No. 1, beginning at approximately ch. 50m. Samples were taken for laboratory testing for acid sulphate soils and for particle size distribution analysis, and standing water levels (SWL) were measured.

Qualitative spot tests for the presence of either ferrous monosulphide or pyrite were performed at each drilling location in the surface layer and in the soils above and below the water table. Engineering logs of the boreholes along with explanation sheets describing the terms and symbols used are presented in Appendix A.

3.0 SITE DESCRIPTION

The site of the proposed drain is a generally flat sandy area with variable tree and grass cover. The ground surface along the alignment has a maximum elevation of about RL3.0m over most of the alignment and, at the end of the alignment, falls from an elevation of RL2.3m to the banks of the Evans River over a distance of 20m. The area comprises beach or coastal dune sands. The estate layout drawings show the proposed drain running from a point close to an area of wetlands directly to the Evans River.

The wetlands are swampy with large areas of surface water, thick weed growth and paperbark trees. Organic clays are reported to occur at approximately 300mm below the surface sands, but their thickness is not known. The topographic mapping of the area shows an elongated feature with a surface elevation a little below the RL2m contour trending south from the Open Space. Surface water within this depression may be either perched on the organic clay layer, or be a 'window' to the water table, or a combination of both in the case of a discontinuous organic clay layer.
4.0 LABORATORY TESTING

4.1 Acid Sulphate

The qualitative spot tests for the presence of acid sulphates all indicated nil to very low concentrations. Three samples from below the water table and two samples from above the water table were submitted for quantitative acid sulphate testing. Summary results of the laboratory testing are set out in Table 1 below, with laboratory test reports in Appendix C.

<table>
<thead>
<tr>
<th>Chainage</th>
<th>Depth (m)</th>
<th>pH initial</th>
<th>pH after oxidation</th>
<th>SO₄ (mg/kg) initial</th>
<th>SO₄ (mg/kg) after oxidation</th>
</tr>
</thead>
<tbody>
<tr>
<td>50m</td>
<td>1.0 - 2.0</td>
<td>5.4</td>
<td>5.6</td>
<td>10</td>
<td>150</td>
</tr>
<tr>
<td>100m</td>
<td>0.7 - 1.5</td>
<td>5.1</td>
<td>6.0</td>
<td>5</td>
<td>125</td>
</tr>
<tr>
<td>250m</td>
<td>1.0 - 2.0</td>
<td>5.5</td>
<td>5.2</td>
<td>&lt;5</td>
<td>75</td>
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<tr>
<td>350m</td>
<td>1.0 - 2.0</td>
<td>5.6</td>
<td>5.2</td>
<td>&lt;5</td>
<td>75</td>
</tr>
<tr>
<td>465m</td>
<td>0.3 - 1.0</td>
<td>5.4</td>
<td>5.0</td>
<td>10</td>
<td>125</td>
</tr>
</tbody>
</table>

Note: Pyrite S concentrations all <0.01%. CaCO₃ concentrations all <0.2%.

4.2 Particle Size Distribution

Field description of the sands gives a grain size in the fine to medium grained range. Laboratory testing indicates less than 5% passing 0.075mm and 98% passing 0.425mm sieves. Laboratory test results can are reported in Appendix B. Coefficient of Uniformity is less than 2, indicating high porosity.
5.0 DISCUSSION

5.1 Acid Sulphate Soils

The field qualitative spot testing indicated a general absence or very low concentration of either ferrous monosulphide or pyrite in either the topsoil, sands above the water table or sands below the water table. This was confirmed by the laboratory testing which indicated nil acid sulphate potential and nil acid generating potential for all 5 samples submitted.

5.2 Groundwater Movement

On the basis of the SWLs measured during the field investigation, a gradient averaging about 1:200 currently exists towards the river from ch.250m with a negligible gradient from ch.250m to ch.465m and an apparent slight lowering at about ch.250m. The water table is of the order of 1m below ground surface over most of the proposed drain alignment so can be said to roughly follow the ground surface contours, as is to be expected under phreatic conditions. Standing water levels in BH1 and BH2 drilled in August 1994 were 0.6m below a ground surface level which is assessed at about RL.2.3m from contours on supplied plans. This indicates that the water table beyond the end of the proposed drain is relatively constant at about RL 1.75m which corresponds to the inferred free water surface level in the wetlands.

An estimated permeability (K) of between 3x10^{-4} cm/sec (2.5m/day) and 4.5x10^{-4} cm/sec (4.0m/day) can be inferred from the particle size characteristics of the sands. Specific Yield is estimated at 0.33. With this permeability and gradient, a steady regional groundwater flow would already be established towards the river, the flow being maintained by both direct infiltration of rainwater and leakage of some surface water from the wetlands area. The proportion of the existing flow attributable to the wetlands source would depend on the permeability and thickness of the organic clay layers underlying the wetlands. Total throughput rates would vary with water table fluctuations resulting from changes in the availability of recharge, especially that deriving from direct infiltration of rainfall.

Design drawings show that the open drain will be excavated to a depth of about 1m below the water table. The effect of this excavation will be a localized lowering of the water table due to the creation of a new line of discharge. Homogeneous fine grained unconfined aquifers of the type encountered here are known to exhibit delayed drainage with the result that the lowering of water table will be gradual and, in the short term, of limited extent. Long term expansion of the zone of influence of the drain is likely to occur only during long periods without recharge. Other factors such as
Evaporation and transpiration could then prove to be of greater importance to the wetlands than any induced drawdowns.

Estimations of drawdown at distances from the drain have been made using methods for estimating flow of groundwater to galleries (Huismann after Edelman). Assumptions made for these calculations are: 1 year (365 days) without recharge, instantaneous drawdown at the gallery of 1m, and aquifer thickness of 1.75m.

**TABLE 2**

Distance-Drawdown Estimations

<table>
<thead>
<tr>
<th>Distance from Drain Centreline (m)</th>
<th>Drawdown (m) at K=3.8m/day</th>
<th>Drawdown (m) at K=2.5m/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>0.87</td>
<td>0.84</td>
</tr>
<tr>
<td>30</td>
<td>0.81</td>
<td>0.76</td>
</tr>
<tr>
<td>40</td>
<td>0.74</td>
<td>0.68</td>
</tr>
<tr>
<td>50</td>
<td>0.68</td>
<td>0.61</td>
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<td>60</td>
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<tr>
<td>100</td>
<td>0.41</td>
<td>0.31</td>
</tr>
</tbody>
</table>

Significantly lower calculated drawdowns at distance from the drain are obtained by reducing the time without recharge (rainfall). Reducing the period without recharge to 100 days (3 months) results in drawdowns at 100m of 0.12m and 0.05m for permeabilities of 3.8 and 2.5m/day respectively.

The organic clay layer noted in the wetlands area was not present at a similar level along the proposed drain, so it can be inferred that it is specific to the wetland area. In this case, there is a high probability that the much lower permeability of the organic clay layer will tend to isolate the wetlands from the drawdown induced by the drain excavation. Even if the isolating effect of the organic clays is less than expected it is likely that any loss of water to the proposed drain would be replaced by groundwater flow from other directions.
Any potential impact of the drain on the area could be reduced if it was possible to modify the overall estate drainage design to allow the invert level of the drain to be raised so that it is closer to the present water table. As the drawdowns were calculated on the basis of a 1m lowering of water level at the drain, proportional adjustments can be made for any alteration in the depth of excavation below the water table. Flow to the drain given the assumptions described above is estimated to be of the order of 0.04m³/day per metre length of excavation after 1 year without significant rainfall recharge.

[Signature]
For and on behalf of
COFFEY PARTNERS INTERNATIONAL PTY LTD
IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL ENGINEERING REPORT

As the client of a consulting geotechnical engineer, you should know that site subsurface conditions cause more construction problems than any other factor. As the Association of Engineering Firms Practicing in the Geosciences offers the following suggestions and observations to help you manage your risk.

A GEOTECHNICAL ENGINEERING REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

Your geotechnical engineering report is based on a subsurface exploration plan designed to consider a unique set of project-specific factors. These factors typically include:
- the general nature of the structure involved, its size, and configuration;
- the location of the structure on the site;
- other improvements, such as access roads, parking lots, and underground utilities;
- and the additional risk created by scope-of-service limitations imposed by the client.

To help avoid costly problems, ask your geotechnical engineer to evaluate how factors that change subsequent to the date of the report may affect the report's recommendations.

Unless your geotechnical engineer indicates otherwise, do not use your geotechnical engineering report:
- when the nature of the proposed structure is changed, for example, if an office building will be erected instead of a parking garage, or a refrigerated warehouse will be built instead of an unrefrigerated one;
- when the size, elevation, or configuration of the proposed structure is altered;
- when the location or orientation of the proposed structure is modified;
- when there is a change of ownership, or
- for application to an adjacent site.

Geotechnical engineers cannot accept responsibility for problems that may occur if they are not consulted after factors considered in their report's development have changed.

SUBSURFACE CONDITIONS CAN CHANGE

A geotechnical engineering report is based on conditions that existed at the time of subsurface exploration. Do not base construction decisions on a geotechnical engineering report whose adequacy may have been affected by time. Speak with your geotechnical consultant to learn if additional tests are advisable before construction starts. Note, too, that additional tests may be required when subsurface conditions are affected by construction operations at, or adjacent to, the site, or by natural events such as floods, earthquakes, or ground water fluctuations. Keep your geotechnical consultant apprised of any such events.

MOST GEOTECHNICAL FINDINGS ARE PROFESSIONAL JUDGMENTS

Site exploration identifies actual subsurface conditions only at those points where samples are taken. The data were extrapolated by your geotechnical engineer who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates. Actual conditions in areas not sampled may differ from those predicted in your report. While nothing can be done to prevent such situations, you and your geotechnical engineer can work together to help minimize their impact. Retaining your geotechnical engineer to observe construction can be particularly beneficial in this respect.

A REPORT'S RECOMMENDATIONS CAN ONLY BE PRELIMINARY

The construction recommendations included in your geotechnical engineer's report are preliminary, because they must be based on the assumption that conditions revealed through selective exploratory sampling are indicative of actual conditions throughout a site. Because actual subsurface conditions can be discerned only during earthwork, you should retain your geotechnical engineer to observe actual conditions and to finalize recommendations. Only the geotechnical engineer who prepared the report is fully familiar with the background information needed to determine whether or not the report's recommendations are valid and whether or not the contractor is abiding by applicable recommendations. The geotechnical engineer who developed your report cannot assume responsibility or liability for the adequacy of the report's recommendations if another party is retained to observe construction.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND PERSONS

Consulting geotechnical engineers prepare reports to meet the specific needs of specific individuals. A report prepared for a civil engineer may not be adequate for a construction contractor or even another civil engineer. Unless indicated otherwise, your geotechnical engineer prepared your report expressly for you and expressly for purposes you indicated. No one other than you should apply this report for its intended purpose without first confering with the geotechnical engineer. No party should apply this report for any purpose other than that originally contemplated without first confering with the geotechnical engineer.

GEONENVIRONMENTAL CONCERNS ARE NOT AT ISSUE

Your geotechnical engineering report is not likely to relate any findings, conclusions, or recommendations
APPENDIX A

ENGINEERING LOGS OF BOREHOLES
### Descriptive Terms

#### Soil Descriptions

**Classification of Material based on Unified Classification System (refer SAA Site Investigation Code AS1726-1975 Add. No. 1 Table D1).**

**Moisture Condition based on appearance of soil:**
- **Dry:** Looks and feels dry; cohesive soils usually hard, powdery or friable, granular soils run freely through hands.
- **Moist:** Soil feels cool, darkened in colour; cohesive soils usually weakened by moisture, granular soils tend to cohere, but one gets no free water on hands on remoulding.
- **Wet:** Soil feels cool, darkened in colour; cohesive soils weakened, granular soils tend to cohere, free water collects on hands when remoulding.

**Consistency based on unconfined compressive strength (Qu) (generally estimated or measured by hand penetrometer):**

<table>
<thead>
<tr>
<th>Term</th>
<th>Very Soft</th>
<th>Soft</th>
<th>Firm</th>
<th>Stiff</th>
<th>Very Stiff</th>
<th>Hard</th>
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<td>Qu kPa</td>
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<td>50</td>
<td>100</td>
<td>200</td>
<td>400</td>
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If soil crumbles on test without meaningful result, it is described as friable.

**Density Index (generally estimated or based on penetrometer results):**

<table>
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<tr>
<th>Term</th>
<th>Very Loose</th>
<th>Loose</th>
<th>Medium Dense</th>
<th>Dense</th>
<th>Very Dense</th>
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<tr>
<td>Density Index</td>
<td>10 %</td>
<td>15</td>
<td>35</td>
<td>65</td>
<td>85</td>
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#### Rock Descriptions

**Weathering based on visual assessment:**

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<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh</td>
<td>Rock substance unaffected by weathering.</td>
</tr>
<tr>
<td>Slightly Weathered</td>
<td>Rock substance affected by weathering to the extent that partial weathering affects the whole of the rock substance.</td>
</tr>
<tr>
<td>Moderately Weathered</td>
<td>Rock substance affected by weathering to the extent that weathering affects the whole of the rock substance and the original colour of the rock is no longer recognisable.</td>
</tr>
<tr>
<td>Highly Weathered</td>
<td>Rock substance affected by weathering to the extent that weathering affects the whole of the rock substance and the original colour of the rock is no longer recognisable.</td>
</tr>
<tr>
<td>Extremely Weathered</td>
<td>Rock substance affected by weathering to the extent that the rock displays all characteristics of weathering.</td>
</tr>
</tbody>
</table>

**Strength based on point load strength index, corrected to 50 mm diameter - I (SI) (refer I.S.R.M., Commission on Standardisation of Laboratory and Field Tests, Suggested Methods for Determining the Uniaxial Compressive Strength of Rock Materials and the Point Load Strength Index, Committee on Laboratory Tests Document No. 10, (Generally estimated; x indicates test result):**

<table>
<thead>
<tr>
<th>Classification</th>
<th>Extremely Low</th>
<th>Very Low</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
<th>Very High</th>
<th>Extremely High</th>
</tr>
</thead>
<tbody>
<tr>
<td>kN/m²</td>
<td>0.02</td>
<td>0.1</td>
<td>0.3</td>
<td>1</td>
<td>3</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

The unconfined compressive strength is typically 20 x 1.550 but the multiplier may range, for different rock types, from as low as 4 to as high as 30.

**Defect Spacing:**

<table>
<thead>
<tr>
<th>Classification</th>
<th>Extremely Close</th>
<th>Very Close</th>
<th>Close</th>
<th>Medium</th>
<th>Wide</th>
<th>Very Wide</th>
<th>Extremely Wide</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spacing m</td>
<td>0.03</td>
<td>0.1</td>
<td>0.3</td>
<td>1</td>
<td>3</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

Defect description uses terms contained on AS1726 table D2 to describe nature of defects (fault, joint, crushed zone, clay seam etc.) and character (roughness, extent, coating etc.).
### Engineering Log - Borehole

**Client:** V.P. BROWN & PARTNERS, PTY LTD  
**Project:** HORN GATE ESTATE - STAGE 1A - EVANS HEAD  
**Borehole Location:** ORANGE-1 - Rooms 08, 09

**Drill hole and Borehole:**  
**Drill Diameter:** 89 mm  
**Drill Orientation:** -00 deg  
**R.L. Surface:** 233 m

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
<th>Samples, Tests, Etc.</th>
<th>Support</th>
<th>Classification</th>
<th>Consistency/Density Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Water table</td>
<td>VS, VS, VS</td>
<td>PS</td>
<td>Sand</td>
<td>VS, VS, VS</td>
</tr>
<tr>
<td>4</td>
<td>Overburden</td>
<td>VS, VS, VS</td>
<td>PS</td>
<td>Sand</td>
<td>VS, VS, VS</td>
</tr>
<tr>
<td>3</td>
<td>Water table</td>
<td>VS, VS, VS</td>
<td>PS</td>
<td>Sand</td>
<td>VS, VS, VS</td>
</tr>
<tr>
<td>2</td>
<td>Soil profile</td>
<td>VS, VS, VS</td>
<td>PS</td>
<td>Sand</td>
<td>VS, VS, VS</td>
</tr>
<tr>
<td>1</td>
<td>Soil profile</td>
<td>VS, VS, VS</td>
<td>PS</td>
<td>Sand</td>
<td>VS, VS, VS</td>
</tr>
</tbody>
</table>

**Borehole HAI Terminated at 2,000 m**

**Observed:**  
- **Acid Soluble Test:** Clear
- **Acid Soluble Test:** Clear
- **Acid Soluble Test:** Clear

**Additional Observations:**
- Sample 1: Sand, fine to medium grained, dark grey, with U.S. soil tests.
- Sample 2: Sand, fine to medium grained, light grey, with a trace of soil tests.
- Sample 3: Sand as above.
### Engineering Log - Borehole

**Client:** V.P. Brown & Partners Pty Ltd  
**Project:** Iron Gates Stage 11 - Evans Head  
**Borehole Location:** UNH No 1 - Approx 300m

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Description</th>
<th>Colour, Texture &amp; Other Components</th>
<th>Structure</th>
<th>Additional Observations</th>
</tr>
</thead>
</table>
| 1          | Slate  
Slate fine to medium grained, dark grey-brown, with some soil inclusions.  
Slate fine to medium grained, brown & light brown, with a trace of soil inclusions. |  
X  
X  
X |  
ACID SULPHATE TEST CLEAR |  
ACID SULPHATE TEST CLEAR |

**Borehole 1142 terminated at 2.00 m**
# Engineering Log - Borehole

**Client:** C.O. Bream & Partners Pty Ltd  
**Project:** Romania Estate - Stage 1A - Evans Head  
**Borehole Location:** South No. 1 - North D. 56A  
**Well Number:** 31  
**Well Completed:** 7.12.97  
**Drilled By:** HE  
**Erected By:** HE

## Borehole M3

<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
<th>Wet Sample</th>
<th>Dry Sample</th>
<th>Consistency/Moisture Index</th>
<th>Moisture</th>
<th>Classification</th>
<th>Spacing</th>
<th>Soil Sampled</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Sand: fine to medium grained, dark greybrown, with some Gill lines.</td>
<td>No</td>
<td>No</td>
<td>Acid Sulphate Test Clear</td>
<td>Water</td>
<td>Soils and Soil</td>
<td>50</td>
<td>Soil Sampled</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>Sand: fine to medium grained, brown, with a trace of Gill lines.</td>
<td></td>
<td></td>
<td>Acid Sulphate Test Clear</td>
<td>Water</td>
<td>Soils and Soil</td>
<td>50</td>
<td>Soil Sampled</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>Sand: as above.</td>
<td></td>
<td></td>
<td>Acid Sulphate Test Clear</td>
<td>Water</td>
<td>Soils and Soil</td>
<td>50</td>
<td>Soil Sampled</td>
<td></td>
</tr>
</tbody>
</table>

Borehole M3 terminated at 2.00 m
### Engineering Log - Borehole

**Client:** K.P. Brown & Partners Pty Ltd  
**Project:** Hornsby Estate - Stage II - Evans Head  
**Borehole Location:** Green Hill 1 - Kao 1 on 150m

<table>
<thead>
<tr>
<th>Hole Diameter</th>
<th>Hole</th>
<th>Length</th>
<th>Date</th>
<th>Cement Type</th>
<th>Material</th>
<th>Soil Type/Principal Particle Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>150mm</td>
<td>150</td>
<td>2.00</td>
<td>12.10</td>
<td>No support</td>
<td>navajo</td>
<td>Sandstone. White, with a trace of bitumen.</td>
</tr>
</tbody>
</table>

**Additional Observations:**

- Acid Sulphate Test Clear
- Acid Sulphate Test Clear
- Acid Sulphate Test Clear

**Support:**

- 150mm over screenings
- 150mm over grouting
- 100mm over grouting
- 100mm over grouting
- 75mm over grouting

**Samples, Tests, Etc.:**

- Unadjusted sample (UAS)
- Disturbed sample (DS)
- Saturated sample (SAT)
- Standard penetration test (SPT) sample (SPT)
- Compacted sample (COM)
- Compacted sample (CMT)
- Compacted sample (CMC)
- Wet sample (WET)
- Wet sample (WET)
- Wet sample (WET)
- Wet sample (WET)
- Wet sample (WET)

**Classification Symbols and Soil Description:**

- Based on analysis classification system
- Based on analysis classification system
- Based on analysis classification system
- Based on analysis classification system
- Based on analysis classification system
- Based on analysis classification system
- Based on analysis classification system
- Based on analysis classification system
- Based on analysis classification system
- Based on analysis classification system
- Based on analysis classification system

**Consistency/Density Index:**

- Very hard
- Very hard
- Very hard
- Very hard
- Very hard
- Very hard
- Very hard
- Very hard
- Very hard
- Very hard

**Moisture:**

- Very dry
- Very dry
- Very dry
- Very dry
- Very dry
- Very dry
- Very dry
- Very dry
- Very dry
- Very dry

**Classification:**

- VS: Very Hard
- S: Soft
- T: Very Hard
- SPT: SPT
- VS: Very Soft
- H: Hard
- FA: Fine Aggregate
- N: Normal
- V: Very Loose
- L: Loose
# Engineering Log

## Borehole Details

- **Client:** W.P. Brown & Partners Pty Ltd
- **Project:** Iron Gate Estate - Stage 1b - Stage 1c
- **Borehole Location:** Stage No.1 - Works on XOD
- **Drill Model and Make:** SANDIUSER
- **Drill Rig:** XR 135 BGS
- **Drill Rig Serial No.:** 1146

## Log Data

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Description</th>
<th>Material</th>
<th>Water Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Sand, 2.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.00</td>
<td>Terminated at 2.00 m</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Additional Observations
- **Acid Sulfate Test:** Clear
- **Acid Sulfate Test:** Clear

## Classification

- **Consistency:** Very stiff
- **Texture:** Hard
- **Moisture:** Dry
- **Soil Type:** Red clay

## Symbols and Soil Description
- **Soil:** Sand
  - Particle Characteristics: Medium grained, dark grey brown, with some silty layers.

## Photographs

- **Photograph A:** Borehole termination at 2.00 m

## Methodology

- **Method:** Sand extraction using a CPTU probe.

## Sample Tests

- **Tests:** Unconsolidated sample, undisturbed sample, SPT, static penetrometer test.
# Engineering Log - Borehole

**Client:** D. B. Norton & Partners Pty Ltd  
**Project:** Iron Gown Estate - Stage 1A  
**Location:**  
**Drill Model and Method:** Sand Auger  
**Drill Diameter:** 610 mm  
**Date:** 96 DEC  
**Depth:** 5.07 m  
**Material:**  
- Soil type: Medium sandy gravelly clay with some silt fines.  
- Colour: Greyish brown.  
**Observation:**  
- Samples tests, etc.  
- Classification:  
  - Sample: Weathered granite.  
  - Consistency/Brittleness Index: S2 very soft.  

---

**Table:**  
<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Material Characteristics</th>
<th>Observation</th>
<th>Additional Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>Medium sandy gravelly clay</td>
<td>Same as above.</td>
<td></td>
</tr>
<tr>
<td>5.07</td>
<td>Sandstone</td>
<td></td>
<td>Acid sulphate test clear</td>
</tr>
</tbody>
</table>

**Borehole No.**  
**Surface:** 2.70 meters  
**Drilled:** 2.00 m  

---

**Diagram:**  
- [Diagram of borehole and samples]  

---

**Legend:**  
- Soil type: Medium sandy gravelly clay  
- Colour: Greyish brown  
- Classification: Weathered granite  
- Consistency/Brittleness Index: S2 very soft
### Engineering Log - Borehole

**Client:** K.P. Brown & Partners P/L

**Project:** KPMG South Bank - Stage 2A - Yvonne Lea

**Borehole Location:** 140 Ml - North Q6-06

#### Drill Notes and Observations

<table>
<thead>
<tr>
<th>Method</th>
<th>Drift</th>
<th>Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>D6</td>
<td></td>
<td>little resistance, progress okay</td>
</tr>
<tr>
<td>T6</td>
<td></td>
<td>good progress</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Samples, Tests, Etc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undisturbed Sample</td>
</tr>
<tr>
<td>Disturbed Sample</td>
</tr>
<tr>
<td>Soil Sample</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand</td>
</tr>
<tr>
<td>Gravel</td>
</tr>
<tr>
<td>Clay</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Consistency/Drainage Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>VS</td>
</tr>
<tr>
<td>V</td>
</tr>
<tr>
<td>F</td>
</tr>
<tr>
<td>S</td>
</tr>
<tr>
<td>H</td>
</tr>
<tr>
<td>L</td>
</tr>
<tr>
<td>D</td>
</tr>
</tbody>
</table>

**Acid Sulfate Test:**
- Test Clear

**Borehole Details**
- Borehole has terminated at 2.00 m
- Date: 12/12/94

**Additional Observations**
- Sand - brown, with a trace of sill lines.
- Sand - brown, with a trace of sill lines.
- Sand - brown, with a trace of sill lines.

**Sheet 1 of 3**
APPENDIX D

PARTICLE SIZE DISTRIBUTION
# Particle Size Distribution

**Client:** WP BROWN & PARTNERS  
**Job No.:** NR865/2  
**Laboratory:** BRISBANE  
**Date:** 05/01/95  
**Test Report:** CB95001.ENG

**Location:** EVANS HEAD  
**Sample Identification:** CB944483 Ch. 300m  
**Test Procedure:** AS1289 C6.1  
**Depth:** 1.0 - 2.0m

## Particle Size Distribution Chart

<table>
<thead>
<tr>
<th>Particle Size (mm)</th>
<th>Percentage Passing</th>
<th>Liquid Limit</th>
<th>Plastic Limit</th>
<th>Plasticity Index</th>
<th>Linear Shrinkage</th>
<th>Particle Density</th>
<th>Natural Moisture</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.002</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.06</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Classification

![Classification Chart]

**Classification:**

- **Gravel**
- **Sand**
- **Silt**
- **Clay**

---

This laboratory is registered by the National Association of Testing Authorities, Australia. The tests reported herein have been performed in accordance with the terms of registration. This document shall not be reproduced except in full without the prior approval of the laboratory.  

Authorized Signature:  

NATA Reg. No. 596

0504
APPENDIX C

ACID SULPHATE TEST RESULTS
Ref. No. 27130
11 January 1995

The Manager,
Coffey Partners International Pty Ltd,
PO Box 108,
Salisbury, Qld 4107

Attention: Mr Brian Booker

Dear Sir,

ANALYSIS OF SOIL SAMPLES
ORDER NO. B17724 - JOB NO. NR8652

Five (5) samples were received for testing on 13 December 19994. The results of analysis
are presented in the Table attached.

Please advise if you have any queries.

Yours faithfully,
SIMMONDS & BRISTOW PTY. LTD.

David Nial
Supervisor - Soils Laboratory

Encl.
Ref. No. 27130  
COFFEY & PARTNERS BRISBANE

ANALYSIS OF SOIL SAMPLES
ACID SULPHATE POTENTIAL
IRON GATES ESTATE, EVANS HEAD
JOB NO. NR865/2

Date Collected: Not Specified
Date Received: 13.12.94
Date Analysed: 13.12.94 - 09.01.95

<table>
<thead>
<tr>
<th>SAMPLE REGD. NO.</th>
<th>ANALYSIS</th>
<th>INITIAL pH (1:5) G050</th>
<th>pH AFTER HO1 OXID'N G050</th>
<th>INITIAL SO4</th>
<th>SO4 AFTER OXID'N</th>
<th>PYRITE S %</th>
<th>CaCO3 SC015 %</th>
<th>ACID POTENTIAL SC120</th>
<th>ACID GENERATING POTENTIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>97297</td>
<td>50M 1.0 - 2.0 CB 944478</td>
<td>5.4</td>
<td>5.6</td>
<td>10.</td>
<td>150.</td>
<td>&lt;0.01</td>
<td>&lt;0.2</td>
<td>NIL</td>
<td>NIL</td>
</tr>
<tr>
<td>97298</td>
<td>150M 0.7 - 1.5 CB 944479</td>
<td>5.1</td>
<td>6.0</td>
<td>5.</td>
<td>125.</td>
<td>&lt;0.01</td>
<td>&lt;0.2</td>
<td>NIL</td>
<td>NIL</td>
</tr>
<tr>
<td>97299</td>
<td>200M 1.0 - 2.0 CB 944480</td>
<td>5.5</td>
<td>5.2</td>
<td>&lt;5.</td>
<td>75.</td>
<td>&lt;0.01</td>
<td>&lt;0.2</td>
<td>NIL</td>
<td>NIL</td>
</tr>
<tr>
<td>97300</td>
<td>350M 1.0 - 2.0 CB 944481</td>
<td>5.6</td>
<td>5.2</td>
<td>&lt;5.</td>
<td>75.</td>
<td>&lt;0.01</td>
<td>&lt;0.2</td>
<td>NIL</td>
<td>NIL</td>
</tr>
<tr>
<td>97301</td>
<td>465M 0.3 - 1.0 CB 944482</td>
<td>5.4</td>
<td>5.0</td>
<td>10.</td>
<td>125.</td>
<td>&lt;0.01</td>
<td>&lt;0.2</td>
<td>NIL</td>
<td>NIL</td>
</tr>
</tbody>
</table>

* Qualitative assessment based solely on % pyrite - not subject to NATA certification.

** Qualitative assessment based on % pyrite, % CaCO3 and pH after oxidation - not subject to NATA certification.

SIMMONDS & BRISTOW PTY LTD
PER C. Leckham
APPENDIX C

DOUGLAS PARTNERS (1991)
Land of slope generally greater than 25-33% presents severe limitations on housing development and are generally best left in a relatively undisturbed state. These lands can, however, be utilised as the back blocks of larger allotments, or, with appropriate geotechnical engineering measures in place, capable of supporting special kinds of development e.g. "pole houses" or multi-level development.

In summary, the terrain over the whole development area consists of central ridge running north-south and rising to a knob of approximately 30 metres above sea level, the ridge comprising approximately a quarter of the whole site area. Slopes running off this central ridge vary from as steep as 15-25% adjacent to the knob with gentler slopes encountered within the central part of the ridge and footslope areas.

Aspect

Aspect is important as it modifies regional climate providing a local climate or a micro-climate. The most desirable aspect for residential living environments is a northerly aspect, and in particular a north-easterly aspect which attracts maximum sunlight and is protected from cold winter westerly winds, and is exposed to cooling summer breezes, the latter which would help to ease the effect of high humidity and high temperatures during summer periods.

Due to the north-south alignment of the central ridge which runs through the centre of the Iron Gates property, the generally flat to rolling topography encountered, the site is capable of enjoying the effects of cooling summer breezes and northerly aspect. The top of the central ridge enjoys some longer range views screened to some extent by existing vegetation. To the east of the central ridge lie lands with an easterly/northerly aspect, with lands to the west of the ridge enjoying a northerly/westerly aspect. Lower lying lands behind existing major vegetation stands would be sheltered from the effects of colder westerly winds. A similar situation applies in the case of the lands to the east of the central ridge system.

Soils and Geology

The coastal landscapes supporting much of the heath land and dune vegetation around Evans Head is understood to have developed during the Quaternary period. These comprise older Pleistocene deposits which formed the undulating plains and swamps away from the coast. The Quaternary marine deposits comprise uniform coarse textured sands with minor accumulations of organic matter in the topsoil. An analysis of the sandy soils of the lower lying parts of the Iron Gates property was undertaken by Morse McVey & Associates, in association with D. J. Douglas & Partners Pty Ltd in 1991. Ten back-hoe pits, ranging in depth from 0.8m to 2.8m were dug and consistent results were obtained, both among the test pits themselves, and based on observations of exposed soil profiles along the river bank.
In general terms, the profile of the sandy soils found on the site consist of a shallow layer of sandy topsoil with organic matter, underlain by fine-to-medium-grained sand. One test pit showed a layer of 200mm thick sandy clay.

The sandy soils were assessed for potential acid sulphate conditions. The completed laboratory tests indicate that at the sites indicated there is no evidence of (actual) acid sulphate material in any of the test pits. Further, field tests for pH decrease after oxidation in laboratory analysis for total sulphur (%) suggest that there are no potentially acid sulphate soils in any of the samples. These results should be representative of the survey area, according to Morse McVey & Associates. The soil analysis conclude that with respect to limitations imposed by the occurrence of acid sulphate materials, there is no reason why development should not proceed in this area.

Sedimentary rocks of the Triassic Clarence-Morton Basin occur along the Iron Gates Road ridge. Soils associated with these areas are shallow podsols with a base geology of shales, sandstones and conglomerates. Quaternary alluvial deposits occur along the river, forming flood plains and terraces.

2.5 VEGETATION

Overview, Past Disturbance of Site

The original vegetation pattern of the Iron Gates property has been affected by the previous history of land use of the site. Those areas which have been subject to significant clearing and/or site disturbance over the years may be summarised as follows:

- **Cleared land**: found over much of the eastern part of the site adjoining the existing dwelling house on the property. This land has been cleared for decades and continued to be maintained in such a condition.
- **Cleared and partly cleared hillside lands**: comprising the larger proportion of the elevated hillside area lying to the north of the existing dwelling house and extending as far as the northern boundary of the site. These lands fall within a corridor of approximate width 150 metres. An additional area of cleared land occurs to the west of the main access track running into the property, situated to the west of the main hill.
- **Disturbed heathland**: previously subject to sand-mining activities, lying in the north-east corner of the property.
APPENDIX L

DEWATERING MANAGEMENT PLAN
IRON GATES RESIDENTIAL DEVELOPMENT
Dewatering Management Plan
08 JULY 2019
This report has been prepared for GOLDCORAL PTY LTD in accordance with the terms and conditions of appointment for Vantage, Evans Head dated March 2019. Arcadis Australia Pacific Pty Limited (ABN 76 104 485 289) cannot accept any responsibility for any use of or reliance on the contents of this report by any third party.
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1 INTRODUCTION ....................................................................................................................... 1
2 DEWATERING METHOD ......................................................................................................... 1
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4 GROUNDWATER MONITORING .......................................................................................... 2
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APPENDICES

APPENDIX A
GEOTECH INVESTIGATIONS (2015)

APPENDIX B
COFFEY PARTNERS INTERNATIONAL (1995)
1 INTRODUCTION

A Dewatering Management Plan (DMP) is proposed for the construction of the proposed Iron Gates development at Evans Head.

The DMP relates specifically to the installation of the proposed Sewer and Stormwater services below the natural water table level. These are the only services expected to be below the existing water table. The deeper sewer and stormwater trench excavations are envisaged to be 1.0 to 2.0m below the lowest finished design levels. Other services are expected to be above the water table.

Initial investigations undertaken by Coffey Partners International and Geotech Investigations included a number Groundwater and Soil investigations including 21 boreholes recording the interception of the Water Table, copies of these investigations can be found attached in the appendices. The groundwater levels varied from RL 2.30m located at the north east corner of the Development to RL 1.87m at the south east corner of the development, approximately 130m from the Evans River. The water table gradient across the site appears to be consistent with the natural ground levels and the fall towards the Evans River. Groundwater was encountered in the boreholes at depths of between 0.5m and 1.5m below the existing ground level. Typically, the standing ground water level would be expected at RL 0.0 to 0.5m with fluctuations of ±0.5m under normal (non-flood) conditions. Rises in groundwater to RL 1.5m to 2.0m (AHD) have been recorded in the immediate area following heavy and prolonged rainfall periods (flood conditions).

Water table levels can be expected to vary with seasonal and climatic conditions. Current finished surface design levels require a minimum flood free level of 3.3m and this will provide additional fill over the existing surface levels of a minimum 1.0m up to 2.0m. This will provide 2.7m to 1.5 m fill depths to the water table and retain the majority of the sewer and stormwater constructions above the water table. This Dewatering Management Plan will provide for the construction of those deeper services.

2 DEWATERING METHOD

It is envisaged that the limit of the excavations will be retained with a system of trench shoring bedded into the underlying indurated sands. A series of spear and or internal well points will be used to lower the water table on the site to a minimum depth of 0.5m below proposed excavation level.

For the proposed development, for only construction of the deeper services, dewatering to approximately 2.0m below existing ground level, will be required. It is expected that dewatering will require only a short term drawdown to about 2.5m depth will be required to enable construction of the services and backfilling of the trenches.

Water collected from the proposed dewatering system shall be directed towards a holding tank or suitably lined sampling pit prior to discharge or re-charging into the existing groundwater table. The holding tank/pit will then be used to monitor/test waters followed by remediation of any waters which are below acceptable discharge quality guidelines.

Water quality criteria must be maintained to those presented as baseline conditions plus or minus 10%, prior to discharge, in accordance with the release criteria for the project. It is proposed to either discharge the extracted groundwater into the adjacent groundwater system or into the existing site drainage system.

Given the extent of the proposed excavation numerous points are available around the perimeter of the site. As the dewatering management requirements for the development will vary during the dewatering operation, it is expected a number of discharge points will be utilised for discharge or recharge of the existing water table. The natural drainage system along the eastern boundary discharges into Evans River approximately 100 to 150m south of the site and will not be used for discharge without strict compliance with the Water quality criteria.
3 DEWATERING EFFECTS

The trench spear pumping system is envisaged to penetrate into the water table sufficient to allow dewatering of the trench alignments. This will limit the dewatering required and minimise the time of construction allowing for the watertable return to its original level.

Controlled recharge pumping may also be undertaken from the drainage system, where required to maintain the water table levels across the adjoining sensitive wetlands and rainforest areas development. The spear or well point pumping systems required to maintain the dewatering whilst installation and backfilling is completed will be dependent upon the groundwater inflows from the trenches, and are envisaged to vary during the relatively short construction period.

The construction period is understood to be in the order of 2 months. Drawdown of the groundwater levels of not more than 1000mm has been calculated to be restricted to a distance of not more than three times the depth of the drawdown, i.e. approximately 25m beyond the dewatering points. Given the location of proposed services this will be well away from the site boundaries any short-term drawdown will be entirely within the site.

On the basis of the original acid sulfate investigations undertaken for the development, and as part of the water table investigations, no acid sulfate soils are present on site in the dewatering zone, and beyond the depth of the excavation and therefore no acid sulfate groundwater conditions will be generated and no acid sulfate soils will be exposed as a result of the dewatering operation.

The effects of drawdown of the water table are not expected to create any adverse environmental impacts and recharging will be not be required to be mandatory unless boundary monitoring bores indicate significant changes and provided all water discharged from site lies within the acceptable range outlined in the ANZECC Water Quality Guidelines, as appropriate.

If subsequent testing of the pH of the water is below the release criteria, the pH can be raised by treatment with hydrated lime or caustic soda or similar. If the DO is below the release criteria aeration of the water at discharge can be undertaken, or an in-line aeration system installed.

The turbidity and suspended solids can be controlled through the use of settling tanks, the addition of slaking agents, flocking agents, geofabric filters and socks and, if required silt curtains at the discharge point. Provided the pH is controlled, it is likely the Fe and Al concentrations will be within the required release criteria.

Noise emissions resulting from the dewatering systems shall comply with the relevant provisions of the Interim Construction Noise Guideline, Protection of the Environment Operations Act 1997. The machinery shall be equipped with high efficiency mufflers and noise attenuated enclosures installed around the pumps if considered necessary.

4 GROUNDWATER MONITORING

4.1 Background Monitoring

Prior to works commencing on site groundwater monitoring wells shall be installed within nominally 20m to 25m of the adjoining Wetlands and Rainforest boundaries where monitoring is to be undertaken. The location of the monitoring wells will be determined on site prior to the commencement of the installation of the dewatering system, to allow optimal positioning of the wells for access throughout the life of the project. A plan will be developed at this stage, identifying the location of the monitoring wells, dewatering construction, locations and discharge retention wall and pump locations.
Background monitoring of the groundwater shall be undertaken weekly for a minimum of 4 weeks prior to the commencement of dewatering on site. The results of the background monitoring will be used to determine the groundwater quality trigger values that will indicate the need for corrective action to be undertaken during the dewatering operation.

The wells will be monitored for groundwater levels, pH, DO, turbidity, conductivity, SS, EC, Fe and Al. As a general guideline a deviation of 10% from the established baseline criteria for two or more of the water quality parameters would be considered a trigger for corrective action, however this should be reassessed depending on the results and consistency of the background monitoring.

4.2 Monitoring During Construction

The following groundwater monitoring frequency shall be adopted during dewatering operations. Daily monitoring of groundwater levels in the boundary standpipes and pH for the first 2-3 weeks. Weekly sampling and testing for pH, DO, temperature, turbidity, conductivity, Fe and Al for the construction period where requiring dewatering. If the monitoring results prove consistent after the first month of monitoring, the sampling frequency could be reduced to fortnightly for the duration of the dewatering operation, subject to Richmond Valley Council approval. Additionally, twice weekly monitoring by visual assessment of the areas external to the site shall be undertaken to ensure no adverse impacts are occurring as a result of the dewatering.

5 DISCHARGE MONITORING

A discharge monitoring program shall be implemented to provide feedback on the effectiveness of the dewatering management strategy and provide early warning should environmental degradation begin. Monitoring will be carried out at the holding tank/pit immediately prior to release into the environment.

The following monitoring frequency is recommended during any dewatering operations:

- Daily - pH, Dissolved Oxygen (DO), Turbidity and Conductivity; and
- Weekly - As above plus Fe, Al, SS.

If the results of monitoring prove consistent, the frequency of monitoring could be reduced, subject to Richmond Valley Council approval.

Prior to release, the groundwater discharge shall meet the ANZECC Water Quality Guidelines for Fresh and Marine Waters (2000) as summarised in Table 5-1 below.
### Table 5-1 Water Quality Criteria

<table>
<thead>
<tr>
<th>INDICATOR RELEASE CRITERIA</th>
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<tr>
<td><strong>ph</strong></td>
</tr>
<tr>
<td>Dissolved Oxygen</td>
</tr>
<tr>
<td>Turbidity</td>
</tr>
<tr>
<td>Suspended Soils</td>
</tr>
<tr>
<td>Pd (soluble)</td>
</tr>
<tr>
<td>Cu (soluble)</td>
</tr>
<tr>
<td>Cr (soluble)</td>
</tr>
<tr>
<td>Fe (soluble)</td>
</tr>
<tr>
<td>Al (soluble)</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

It is requirement that any proposed discharge water complies with the water quality criteria listed above.

### 6 RECOMMENDATIONS

Prior to commencement of dewatering operations on site the results of the background monitoring will be submitted to the Richmond Valley Council. A monthly dewatering report shall be prepared and submitted to Richmond Valley Council. The report shall include, as a minimum, details of the dewatering and retention method, water quality results, treatment required, status of the existing groundwater and any unforeseen issues. The DMP recommendations will be implemented by the Civil construction contractor for the proposed development. A NATA registered Geotechnical or Environmental Engineering shall be engaged by the Civil contractor to undertake the required background monitoring, and discharge monitoring during construction.
APPENDIX A

GEOTECH INVESTIGATIONS (2015)
Our Ref: JW:jw: GI 2039-a  
2 June 2015

Gold Coral Pty Ltd  
PO Box 3441  
Australia Fair Southport QLD  4215

REPORT ON IN-SITU PERMEABILITY TESTING  
IRON GATES DRIVE, EVANS HEAD

Test ID: Test P1

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| Soil Description | 0 m (SM) Silty SAND: Fine sand, moist, grey brown  
0.5 m (SP) SAND: Fine sand, dry, pale grey  
2.2 m (SP) SAND: Fine sand, wet, pale grey  
T.D. 3 m |
| Water Table | 2.2 m BSL  
(estimated based on drilling) |
| Field Test Results | $K_{\text{sat}} = 13.7 \text{ m/day} = 572 \text{ mm/hr}$  
$K = 1.6 \times 10^{-4} \text{ m/s}$ |
| Test Hole Depth | 1.1 m BSL |
| Indicative Drainage Class | ‘rapidly drained’ |

Notes:  
T.D. – Terminate depth of borehole  
BSL – Below existing surface level  
$K_{\text{sat}}$ – Saturated hydraulic conductivity  
K – Permeability  
Table 4.2A4 AS 1547 (On-site domestic wastewater management)

For and on behalf of  
Geotech Investigations Pty Ltd

James Walle  
RPEQ (15701), RPEng (Civil), B.Eng (Civil)  
Senior Geotechnical Engineer
Our Ref: JW:jw: GI 2039-b
2 June 2015

Gold Coral Pty Ltd
PO Box 3441
Australia Fair Southport QLD 4215

REPORT ON IN-SITU PERMEABILITY TESTING
IRON GATES DRIVE, EVANS HEAD

Test ID: Test P2

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<td>Soil Description</td>
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<tr>
<td>0 m (SM) Silty SAND: Fine sand, moist, grey brown</td>
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<td></td>
</tr>
<tr>
<td>0.5 m (SP) SAND: Fine sand, moist, pale grey</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4 m (SP) SAND: Trace silt, fine sand, moist, dark brown</td>
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<td></td>
</tr>
<tr>
<td>1.6 m (SP) SAND: Trace silt, fine sand, moist, dark grey</td>
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<td></td>
</tr>
<tr>
<td>T.D. 3 m</td>
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<td></td>
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<tr>
<td>Water Table</td>
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<td></td>
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<td>(estimated based on drilling)</td>
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<td>Field Test Results</td>
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<tr>
<td>$K_{sat} = 89.5$ m/day = 3728 mm/hr</td>
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<td></td>
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<tr>
<td>$K = 1 \times 10^{-3}$ m/s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test Hole Depth</td>
<td>0.6 m BSL</td>
<td></td>
</tr>
<tr>
<td>Indicative Drainage Class</td>
<td>‘rapidly drained’</td>
<td></td>
</tr>
</tbody>
</table>

Notes: T.D. – Terminate depth of borehole  BSL – Below existing surface level
$K_{sat}$ – Saturated hydraulic conductivity  $K$ – Permeability
Table 4.2A4 AS 1547 (On-site domestic wastewater management)

For and on behalf of

Geotech Investigations Pty Ltd

James Walle RPEQ (15701), RPEng (Civil), B.Eng (Civil)
Senior Geotechnical Engineer
REPORT ON IN-SITU PERMEABILITY TESTING
IRON GATES DRIVE, EVANS HEAD

Test ID: Test P3

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<td>Soil Description</td>
<td>0 m (SP) SAND: With silt, fine sand, moist, grey</td>
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<tr>
<td></td>
<td>0.3 m (SM) Silty SAND: Fine sand, moist, dark brown</td>
</tr>
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<td></td>
<td>0.6 m (SP) SAND: Trace silt, fine sand, wet, pale grey</td>
</tr>
<tr>
<td></td>
<td>1.4 m (SP) SAND: Trace silt, fine sand, wet, dark brown</td>
</tr>
<tr>
<td>T.D. 3 m</td>
<td></td>
</tr>
<tr>
<td>Water Table</td>
<td>0.6 m BSL</td>
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<tr>
<td>(estimated based on drilling)</td>
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<tr>
<td>Field Test Results</td>
<td>$K_{sat} = 16.8 \text{ m/day} = 698 \text{ mm/hr}$ $K = 1.9 \times 10^{-4} \text{ m/s}$</td>
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<td>Test Hole Depth</td>
<td>0.17 m BSL</td>
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<tr>
<td>Indicative Drainage Class</td>
<td>'rapidly drained'</td>
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Notes: T.D. – Terminate depth of borehole
BSL – Below existing surface level
$K_{sat}$ – Saturated hydraulic conductivity
K – Permeability
Table 4.2A4 AS 1547 (On-site domestic wastewater management)

For and on behalf of
Geotech Investigations Pty Ltd

James Walle RPEQ (15701), RPEng (Civil), B.Eng (Civil)
Senior Geotechnical Engineer
Our Ref: JW:jw: GI 2039-d  
2 June 2015  

Gold Coral Pty Ltd  
PO Box 3441  
Australia Fair Southport QLD 4215  

REPORT ON IN-SITU PERMEABILITY TESTING  
IRON GATES DRIVE, EVANS HEAD  

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<td>Soil Description</td>
<td>0 m (SM) Silty SAND: Fine to medium sand, moist, dark brown</td>
<td>0.7 m (SP) SAND: Trace silt, fine sand, moist, pale grey</td>
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<td></td>
<td>1.7 m (SP) SAND: Trace silt, fine sand, wet, pale grey</td>
<td>2.0 m (SP) SAND: Trace silt, fine sand, wet, grey brown</td>
</tr>
</tbody>
</table>

| Water Table | 1.7 m BSL |
| (estimated based on drilling) | |

| Field Test Results | $K_{sat} = 27.0 \text{ m/day} = 1128 \text{ mm/hr}$ | $K = 3.1 \times 10^{-4} \text{ m/s}$ |
| Test Hole Depth | 0.77 m BSL |
| Indicative Drainage Class | ‘rapidly drained’ |

Notes:  
T.D. – Terminate depth of borehole  
BSL – Below existing surface level  
$K_{sat}$ – Saturated hydraulic conductivity  
$K$ – Permeability  
Table 4.2A4 A5 1547 (On-site domestic wastewater management)

For and on behalf of  
Geotech Investigations Pty Ltd

James Walle RPEQ (15701), RPEng (Civil), B.Eng (Civil)  
Senior Geotechnical Engineer
Our Ref: JW:jw: GI 2039-e  
2 June 2015

Gold Coral Pty Ltd  
PO Box 3441  
Australia Fair Southport QLD 4215

REPORT ON IN-SITU PERMEABILITY TESTING  
IRON GATES DRIVE, EVANS HEAD

Test ID: Test P5

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<td>Soil Description</td>
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<td>0 m (SM) Silty SAND: Fine sand, moist, dark brown</td>
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</tr>
<tr>
<td>0.6 m (SP) SAND: Trace silt, fine sand, dry, pale grey</td>
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</tr>
<tr>
<td>1.4 m (SP) SAND: Trace silt, fine sand, moist to wet, pale grey</td>
<td></td>
</tr>
<tr>
<td>2.4 m (SP) SAND: Trace silt, fine sand, wet, grey brown</td>
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<tr>
<td>T.D. 3 m</td>
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</tr>
<tr>
<td>Water Table</td>
<td>1.5 m BSL</td>
</tr>
<tr>
<td>(estimated based on drilling)</td>
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</tr>
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<td>Field Test Results</td>
<td>$K_{sat} = 4.2 \text{ m/day} = 176 \text{ mm/hr}$ $K = 4.9 \times 10^{-5}$ m/s</td>
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<tr>
<td>Test Hole Depth</td>
<td>1.1 m BSL</td>
</tr>
<tr>
<td>Indicative Drainage Class</td>
<td>‘rapidly drained’</td>
</tr>
</tbody>
</table>

Notes: T.D. – Terminate depth of borehole  
BSL – Below existing surface level  
$K_{sat}$ – Saturated hydraulic conductivity  
$K$ – Permeability  
Table 4.2A4 AS 1547 (On-site domestic wastewater management)

For and on behalf of  
Geotech Investigations Pty Ltd

James Walle RPEQ (15701), RPEng (Civil), B.Eng (Civil)
Senior Geotechnical Engineer
Our Ref: JW:jw: GI 2039-f  
2 June 2015

Gold Coral Pty Ltd  
PO Box 3441  
Australia Fair Southport QLD  4215

REPORT ON IN-SITU PERMEABILITY TESTING  
IRON GATES DRIVE, EVANS HEAD

Test ID: Test P6

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<td>Soil Description</td>
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<td>0.4 m (SP) SAND: Trace silt, fine sand, moist, pale grey</td>
</tr>
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<td>0.8 m (SM) Silty SAND: Fine sand, moist, dark orange brown</td>
</tr>
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<td></td>
<td>1.2 m (SM) Silty SAND: Fine sand, moist, grey brown mottled orange brown</td>
</tr>
<tr>
<td></td>
<td>2.7 m (SM) Silty SAND: Fine sand, wet, grey brown mottled orange brown</td>
</tr>
<tr>
<td>T.D. 3 m</td>
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<tr>
<td>Water Table</td>
<td>2.7 m BSL</td>
</tr>
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</table>
| Field Test Results | $K_{sat} = 2.2 \text{ m/day } = 91 \text{ mm/hr} $  
$K = 2.5 \times 10^{-5} \text{ m/s} $ |
| Test Hole Depth| 1.1 m BSL           |
| Indicative Drainage Class | 'well drained' |

Notes:  
- T.D. – Terminate depth of borehole  
- BSL – Below existing surface level  
- $K_{sat}$ – Saturated hydraulic conductivity  
- $K$ – Permeability  
- Table 4.2A4 AS 1547 (On-site domestic wastewater management)

For and on behalf of  
Geotech Investigations Pty Ltd  

James Walle RPEQ (15701), RPEng (Civil), B.Eng (Civil)  
Senior Geotechnical Engineer
Our Ref: JW:jw: GI 2039-g  
2 June 2015

Gold Coral Pty Ltd  
PO Box 3441  
Australia Fair Southport QLD 4215

REPORT ON IN-SITU PERMEABILITY TESTING  
IRON GATES DRIVE, EVANS HEAD

Test ID: Test P7

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<td>Test Date</td>
<td>25/05/2015</td>
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</tbody>
</table>
| Soil Description | 0 m (SP) SAND: With silt, fine to medium sand, moist, grey brown  
0.2 m (SP) SAND: Trace silt, fine sand, moist, pale grey  
0.7 m (SM) Silty SAND: Trace clay, fine sand, wet, orange brown  
1.1 m (SP) SAND: Trace silt, fine sand, wet, dark brown  
T.D. 3 m |
| Water Table | 0.7 m BSL (estimated based on drilling) |
| Field Test Results | $K_{sat} = 7.2 \text{ m/day} = 300 \text{ mm/hr}$  
$K = 8.3 \times 10^{-5} \text{ m/s}$ |
| Test Hole Depth | 0.87 m BSL |
| Indicative Drainage Class | ‘rapidly drained’ |

Notes:  
T.D. – Terminate depth of borehole  
BSL – Below existing surface level  
$K_{sat}$ – Saturated hydraulic conductivity  
K – Permeability  
Table 4.2A4 AS 1547 (On-site domestic wastewater management)

For and on behalf of  
Geotech Investigations Pty Ltd

James Walle RPEQ (15701), RPEng (Civil), B.Eng (Civil)  
Senior Geotechnical Engineer
Our Ref: JW:jw: GI 2039-h
2 June 2015

Gold Coral Pty Ltd
PO Box 3441
Australia Fair Southport QLD 4215

REPORT ON IN-SITU PERMEABILITY TESTING
IRON GATES DRIVE, EVANS HEAD

Test ID: Test P8

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<td>0 m (SP) SAND:</td>
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<td>0.4 m (SP) SAND:</td>
<td>Trace silt, fine sand, moist, pale grey</td>
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<td>1.4 m (SM) Silty SAND:</td>
<td>Fine sand, wet, dark brown</td>
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<td>1.9 m (SP) SAND:</td>
<td>Trace silt, fine sand, wet, dark grey / brown</td>
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<tr>
<td>T.D. 3 m</td>
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<tr>
<td>Water Table</td>
<td>0.6 m BSL</td>
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<tr>
<td>(estimated based on drilling)</td>
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<tr>
<td>Field Test Results</td>
<td>$K_{sat} = 2.6 \text{ m/day} = 109 \text{ mm/hr}$</td>
<td>$K = 3.0 \times 10^{-5} \text{ m/s}$</td>
</tr>
<tr>
<td>Test Hole Depth</td>
<td>0.07 m BSL</td>
<td></td>
</tr>
<tr>
<td>Indicative Drainage Class</td>
<td>'well drained'</td>
<td></td>
</tr>
</tbody>
</table>

Notes: T.D. – Terminate depth of borehole    BSL – Below existing surface level
$K_{sat}$ – Saturated hydraulic conductivity    $K$ – Permeability
Table 4.2A4 AS 1547 (On-site domestic wastewater management)

For and on behalf of
Geotech Investigations Pty Ltd

James Walle RPEQ (15701), RPEng (Civil), B.Eng (Civil)
Senior Geotechnical Engineer
REPORT ON IN-SITU PERMEABILITY TESTING
IRON GATES DRIVE, EVANS HEAD

Test ID: Test P9

<table>
<thead>
<tr>
<th>Location</th>
<th>N: 6778502 E: 540329</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Date</td>
<td>25/05/2015</td>
</tr>
</tbody>
</table>
| Soil Description | 0 m (SM) Silty SAND: Fine to medium sand, moist, dark grey
0.5 m (SP) SAND: Trace silt, fine sand, moist, pale grey
1.8 m (SM) Silty SAND: With clay, fine sand, wet, dark brown
2.0 m (SM) Silty SAND: Fine sand, wet, dark brown mottled orange brown
2.5 m (SP) SAND: Trace silt, fine sand, wet, dark brown
T.D. 3 m |
| Water Table | 0.5 m BSL (estimated based on drilling) |
| Field Test Results | $K_{sat} = 18.6 \text{ m/day} = 775 \text{ mm/hr}$ $K = 2.2 \times 10^{-4} \text{ m/s}$ |
| Test Hole Depth | 0.07 m BSL |
| Indicative Drainage Class | ‘rapidly drained’ |

Notes: T.D. – Terminate depth of borehole
BSL – Below existing surface level
$K_{sat}$ – Saturated hydraulic conductivity
$K$ – Permeability

Table 4.2A4 AS 1547 (On-site domestic wastewater management)

For and on behalf of
Geotech Investigations Pty Ltd

James Walle RPEQ (15701), RPEng (Civil), B.Eng (Civil)
Senior Geotechnical Engineer
APPENDIX B

COFFEY PARTNERS INTERNATIONAL (1995)
NR865/2-B GHD

12th January, 1995

W P Brown & Partners Pty Ltd
PO Box 6527
UPPER MT GRAVATT QLD 4122

Attention: Mr Gary Spence

Dear Sir,

RE: IRON GATES ESTATE - STAGE 1A
INVESTIGATION OF PROPOSED OPEN DRAIN

Please find enclosed our report on the geotechnical investigation for a proposed drain at the Iron Gates Estate. The investigation was carried out in general accordance with our proposal NRP294/17-A dated 21st November, 1994.

Should you have any queries regarding the contents of this report, please contact Geoff Drew or the undersigned at our Brisbane office.

For and on behalf of
COFFEY PARTNERS INTERNATIONAL PTY LTD

[Signature]
P. SHAW

Offices and NATA Registered Laboratories located throughout Australia and South East Asia
TABLE OF CONTENTS

1.0 INTRODUCTION 1
2.0 FIELD INVESTIGATION 1
3.0 SITE DESCRIPTION 1
4.0 LABORATORY TESTING 2
  4.1 Acid Sulphate 2
  4.2 Particle Size Distribution 2
5.0 DISCUSSION 3
  5.1 Acid Sulphate Soils 3
  5.2 Groundwater Movement 3

Important Information about your Geotechnical Engineering Report

FIGURE

1 Site Plan

APPENDICES

A Engineering Logs of Boreholes
B Particle Size Distribution
C Acid Sulphate Test Results
1.0 INTRODUCTION

It is proposed that an open drain be constructed adjoining the Iron Gates Estate Stage 1A development. Coffey Partners International Pty Ltd was commissioned verbally by Mr. Gary Spence of W.P. Brown & Partners Pty Ltd to perform an investigation of the subsurface conditions along the drain alignment. This report contains details of the field investigation and the laboratory chemical and geotechnical testing. Comment is provided on the impact of the proposed drain on a nearby wetland area and the possibility that acid sulphate soils will be exposed during excavation.

2.0 FIELD INVESTIGATION

A total of 9 holes were drilled using hand held (sand) auger equipment on 6th & 7th December, 1994. The holes were advanced to depths of 2m below the existing ground surface at 50m intervals along the alignment of Open Drain No.1, beginning at approximately ch.50m. Samples were taken for laboratory testing for acid sulphate soils and for particle size distribution analysis, and standing water levels (SWL) were measured.

Qualitative spot tests for the presence of either ferrous monosulphide or pyrite were performed at each drilling location in the surface layer and in the soils above and below the water table. Engineering logs of the boreholes along with explanation sheets describing the terms and symbols used are presented in Appendix A.

3.0 SITE DESCRIPTION

The site of the proposed drain is a generally flat sandy area with variable tree and grass cover. The ground surface along the alignment has a maximum elevation of about RL3.0m over most of the alignment and, at the end of the alignment, falls from an elevation of RL2.3m to the banks of the Evans River over a distance of 20m. The area comprises beach or coastal dune sands. The estate layout drawings show the proposed drain running from a point close to an area of wetlands directly to the Evans River.

The wetlands are swampy with large areas of surface water, thick weed growth and paperbark trees. Organic clays are reported to occur at approximately 300mm below the surface sands, but their thickness is not known. The topographic mapping of the area shows an elongated feature with a surface elevation a little below the RL2.0m contour trending south from the Open Space. Surface water within this depression may be either perched on the organic clay layer, or be a 'window' to the water table, or a combination of both in the case of a discontinuous organic clay layer.
4.0 LABORATORY TESTING

4.1 Acid Sulphate

The qualitative spot tests for the presence of acid sulphates all indicated nil to very low concentrations. Three samples from below the water table and two samples from above the water table were submitted for quantitative acid sulphate testing. Summary results of the laboratory testing are set out in Table 1 below, with laboratory test reports in Appendix C.

**TABLE 1**
Summary of Acid Sulphate Testing

<table>
<thead>
<tr>
<th>Chainage</th>
<th>Depth (m)</th>
<th>pH</th>
<th>SO₄ (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>initial</td>
<td>after oxidation</td>
</tr>
<tr>
<td>50m</td>
<td>1.0 - 2.0</td>
<td>5.4</td>
<td>5.6</td>
</tr>
<tr>
<td>100m</td>
<td>0.7 - 1.5</td>
<td>5.1</td>
<td>6.0</td>
</tr>
<tr>
<td>250m</td>
<td>1.0 - 2.0</td>
<td>5.5</td>
<td>5.2</td>
</tr>
<tr>
<td>350m</td>
<td>1.0 - 2.0</td>
<td>5.6</td>
<td>5.2</td>
</tr>
<tr>
<td>465m</td>
<td>0.3 - 1.0</td>
<td>5.4</td>
<td>5.0</td>
</tr>
</tbody>
</table>

Note: Pyrite S concentrations all <0.01%. CaCO₃ concentrations all <0.2%.

4.2 Particle Size Distribution

Field description of the sands gives a grain size in the fine to medium grained range. Laboratory testing indicates less than 5% passing 0.075mm and 98% passing 0.425mm sieves. Laboratory test results can are reported in Appendix B. Coefficient of Uniformity is less than 2, indicating high porosity.
5.0 DISCUSSION

5.1 Acid Sulphate Soils

The field qualitative spot testing indicated a general absence or very low concentration of either ferrous monosulphide or pyrite in either the topsoil, sands above the water table or sands below the water table. This was confirmed by the laboratory testing which indicated nil acid sulphate potential and nil acid generating potential for all 5 samples submitted.

5.2 Groundwater Movement

On the basis of the SWLs measured during the field investigation, a gradient averaging about 1:200 currently exists towards the river from ch.250m with a negligible gradient from ch.250m to ch.465m and an apparent slight mounding at about ch.250m. The water table is of the order of 1m below ground surface over most of the proposed drain alignment so can be said to roughly follow the ground surface contours, as is to be expected under phreatic conditions. Standing water levels in BH1 and BH2 drilled in August 1994 were 0.6m below a ground surface level which is assessed at about RL2.3m from contours on supplied plans. This indicates that the water table beyond the end of the proposed drain is relatively constant at about RL 1.75m which corresponds to the inferred free water surface level in the wetlands.

An estimated permeability (K) of between 3x10⁻⁶ cm/sec (2.5m/day) and 4.5x10⁻³ cm/sec (4.0m/day) can be inferred from the particle size characteristics of the sands. Specific Yield is estimated at 0.33. With this permeability and gradient, a steady regional groundwater flow would already be established towards the river, the flow being maintained by both direct infiltration of rainwater and leakage of some surface water from the wetlands area. The proportion of the existing flow attributable to the wetlands source would depend on the permeability and thickness of the organic clay-layers underlying the wetlands. Total throughput rates would vary with water table fluctuations resulting from changes in the availability of recharge, especially that deriving from direct infiltration of rainfall.

Design drawings show that the open drain will be excavated to a depth of about 1m below the water table. The effect of this excavation will be a localised lowering of the water table due to the creation of a new line of discharge. Homogeneous fine grained unconfined aquifers of the type encountered here are known to exhibit delayed drainage with the result that the lowering of water table will be gradual and, in the short term, of limited extent. Long term expansion of the zone of influence of the drain is likely to occur only during long periods without recharge. Other factors such as
Evaporation and transpiration could then prove to be of greater importance to the wetlands than any induced drawdowns.

Estimations of drawdown at distances from the drain have been made using methods for estimating flow of groundwater to galleries (Huisman after Edelman). Assumptions made for these calculations are: 1 year (365 days) without recharge, instantaneous drawdown at the gallery of 1m, and aquifer thickness of 1.75m.

**TABLE 2**

Distance-Drawdown Estimations

<table>
<thead>
<tr>
<th>Distance from Drain Centreline (m)</th>
<th>Drawdown (m) at</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>K=3.8m/day</td>
</tr>
<tr>
<td>20</td>
<td>0.87</td>
</tr>
<tr>
<td>30</td>
<td>0.81</td>
</tr>
<tr>
<td>40</td>
<td>0.74</td>
</tr>
<tr>
<td>50</td>
<td>0.68</td>
</tr>
<tr>
<td>60</td>
<td>0.62</td>
</tr>
<tr>
<td>80</td>
<td>0.51</td>
</tr>
<tr>
<td>100</td>
<td>0.41</td>
</tr>
</tbody>
</table>

Significantly lower calculated drawdowns at distance from the drain are obtained by reducing the time without recharge (rainfall). Reducing the period without recharge to 100 days (3 months) results in drawdowns at 100m of 0.12m and 0.05m for permeabilities of 3.8 and 2.5m/day respectively.

The organic clay layer noted in the wetlands area was not present at a similar level along the proposed drain, so it can be inferred that it is specific to the wetland area. In this case, there is a high probability that the much lower permeability of the organic clay layer will tend to isolate the wetlands from the drawdowns induced by the drain excavation. Even if the isolating effect of the organic clays is less than expected it is likely that any loss of water to the proposed drain would be replaced by groundwater flow from other directions.
Any potential impact of the drain on the area could be reduced if it was possible to modify the overall estate drainage design to allow the invert level of the drain to be raised so that it is closer to the present water table. As the drawdowns were calculated on the basis of a 1m lowering of water level at the drain, proportional adjustments can be made for any alteration in the depth of excavation below the water table. Flow to the drain given the assumptions described above is estimated to be of the order of 0.04m³/day per metre length of excavation after 1 year without significant rainfall recharge.

[Signature]

For and on behalf of

Coffey Partners International Pty Ltd
IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL ENGINEERING REPORT

As the client of a consulting geotechnical engineer, you should know that site subsurface conditions cause more construction problems than any other factor. ASCE/The Association of Engineering Firms Practicing in the Geosciences offers the following suggestions and observations to help you manage your risks.

A GEOTECHNICAL ENGINEERING REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

Your geotechnical engineering report is based on a subsurface exploration plan designed to consider a unique set of project-specific factors. These factors typically include: the general nature of the structure involved, its size, and configuration; the location of the structure on the site; other improvements, such as access roads, parking lots, and underground utilities; and the additional risk created by scope-of-service limitations imposed by the client. To help avoid costly problems, ask your geotechnical engineer to evaluate how factors that change subsequent to the date of the report may affect the report’s recommendations.

Unless your geotechnical engineer indicates otherwise, do not use your geotechnical engineering report

- when the nature of the proposed structure is changed, for example, if an office building will be erected instead of a parking garage, or a refrigerated warehouse will be built instead of an unrefrigerated one.
- when the size, elevation, or configuration of the proposed structure is altered.
- when the location or orientation of the proposed structure is modified.
- when there is a change of ownership; or
- for application to an adjacent site.

Geotechnical engineers cannot accept responsibility for problems that may occur if they are not consulted after factors considered in their report’s development have changed.

SUBSURFACE CONDITIONS CAN CHANGE

A geotechnical engineering report is based on conditions that existed at the time of subsurface exploration. Do not base construction decisions on a geotechnical engineering report unless additional tests are advisable before construction starts. Additional tests may be required when subsurface conditions are affected by construction operations at or adjacent to the site, or by natural events such as floods, earthquakes, or ground water fluctuations. Keep your geotechnical consultant apprised of any such events.

MOST GEOTECHNICAL FINDINGS ARE PROFESSIONAL JUDGMENTS

Site exploration identifies actual subsurface conditions only at those points where samples are taken. The data were extrapolated by your geotechnical engineer who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates. Actual conditions in areas not sampled may differ from those predicted in your report. While nothing can be done to prevent such situations, you and your geotechnical engineer can work together to help minimize their impact. Retaining your geotechnical engineer to observe construction can be particularly beneficial in this respect.

A REPORT’S RECOMMENDATIONS CAN ONLY BE PRELIMINARY

The construction recommendations included in your geotechnical engineer’s report are preliminary, because they must be based on the assumption that conditions revealed through selective exploratory samplings are indicative of actual conditions throughout a site.

Because actual subsurface conditions can be discerned only during earthwork, you should retain your geotechnical engineer to observe actual conditions and to finalize recommendations. Only the geotechnical engineer who prepared the report can fully familiarize you with the background information needed to determine whether or not the report’s recommendations are valid and whether or not the contractor is abiding by applicable recommendations. The geotechnical engineer who developed your report cannot assume responsibility or liability for the adequacy of the report’s recommendations if another party is retained to observe construction.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND PERSONS

Consulting geotechnical engineers prepare reports to meet the specific needs of specific individuals. A report prepared for a civil engineer may not be adequate for a construction contractor or even another civil engineer.

Unless indicated otherwise, your geotechnical engineer prepared your report expressly for you and expressly for purposes you indicated. No one other than you should apply this report for its intended purpose without first conferring with the geotechnical engineer. No party should apply this report for any purpose other than that originally contemplated without first conferring with the geotechnical engineer.

GEoenvironmental concerns ARE NOT AT ISSUE

Your geotechnical engineering report is not likely to relate any findings, conclusions, or recommendations...
APPENDIX A

ENGINEERING LOGS OF BOREHOLES
descriptive terms
soil and rock

SOIL DESCRIPTIONS:

Classification of material based on Unified Classification System (refer SAA Site Investigation Code AS1726-1975 Add., No. 1 Table D11).

Moisture Condition based on appearance of soil:
- dry: Looks and feels dry; cohesive soils usually hard, powdery or friable, granular soils run freely through hands.
- moist: Soil feels cool, darkened in colour; cohesive soils usually weakened by moisture, granular soils tend to coherence, but one gets no free water on hands on remoulding.
- wet: Soil feels cool, darkened in colour; cohesive soils weakened, granular soils tend to coherence, free water collects on hands when remoulding.

Consistency based on unconfined compressive strength (Qu) (generally estimated or measured by hand penetrometer):

<table>
<thead>
<tr>
<th>term</th>
<th>very soft</th>
<th>soft</th>
<th>firm</th>
<th>stiff</th>
<th>very stiff</th>
<th>hard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qu kPa</td>
<td>25</td>
<td>50</td>
<td>100</td>
<td>200</td>
<td>400</td>
<td></td>
</tr>
</tbody>
</table>

If soil crumbles on test without meaningful result, it is described as friable.

Density Index (generally estimated or based on penetrometer results):

<table>
<thead>
<tr>
<th>term</th>
<th>very loose</th>
<th>loose</th>
<th>medium dense</th>
<th>dense</th>
<th>very dense</th>
</tr>
</thead>
<tbody>
<tr>
<td>density index</td>
<td>10-20%</td>
<td>25%</td>
<td>65%</td>
<td>85%</td>
<td></td>
</tr>
</tbody>
</table>

ROCK DESCRIPTIONS:

Weathering based on visual assessment:

<table>
<thead>
<tr>
<th>term</th>
<th>criterion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh</td>
<td>Rock substance unaffected by weathering.</td>
</tr>
<tr>
<td>Slightly Weathered:</td>
<td>Rock substance affected by weathering to the extent that partial staining or partial discoloration of the rock substance usually by limonite has taken place. The colour and texture of the fresh rock is recognizable; strength properties are essentially those of the fresh rock substance.</td>
</tr>
<tr>
<td>Moderately Weathered:</td>
<td>Rock substance affected by weathering to the extent that staining extends throughout whole of the rock substance and the original colour of the fresh rock is no longer recognizable.</td>
</tr>
<tr>
<td>Highly Weathered:</td>
<td>Rock substance affected by weathering to the extent that limonite staining or bleaching affects the whole of the rock substance and the original colour of the fresh rock is no longer recognizable.</td>
</tr>
<tr>
<td>Extremely Weathered:</td>
<td>Rock substance affected by weathering to the extent that the rock exhibits all properties, i.e., it can be remoulded and can be classified according to the Unified Classification System.</td>
</tr>
</tbody>
</table>

Strength based on point load strength index, corrected to 50 mm diameter - IL 50 (refer IS:2192-1961, Commission on Standardization of Laboratory and Field Tests, Suggested Methods for Determining the Unified Comprehensive Strength of Rock Materials and the Point Load Strength Index in a laboratory test (document No. 11), (generally estimated; x indicates test result).

<table>
<thead>
<tr>
<th>classification of IL 50 MPa</th>
<th>extremely low</th>
<th>very low</th>
<th>low</th>
<th>medium</th>
<th>high</th>
<th>very high</th>
<th>extremely high</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.02</td>
<td>0.1</td>
<td>0.3</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

The unconfined compressive strength is typically about 20 x 1.50 but the multiplier may range, for different rock types, from as low as 4 to a high as 30.

Defect Spacing

<table>
<thead>
<tr>
<th>classification of spacing m</th>
<th>extremely close</th>
<th>very close</th>
<th>close</th>
<th>medium</th>
<th>wide</th>
<th>very wide</th>
<th>extremely wide</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.03</td>
<td>0.1</td>
<td>0.3</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

Defect description uses terms contained on AS1726 (table D2) to describe nature of defect (fault, joint, crushed zone, clay seam etc.) and character (roughness, extent, coating etc.).
# Engineering Log - Borehole

**Client:** V.P. Brown & Partners Pty Ltd

**Project:** Iron Gates Estate - Stage 14 - Evans Head

**Borehole Location:** Crown Rd. 1 - 9999.00E 500.00N

**Drill:** SWAGE Xacier

**Borehole No.:** HAI

**Setup:** -90 Deg

**R.O. Surface:** 2.39 m

## Soil Properties and Particle Characteristics

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Lamination</th>
<th>Structure</th>
<th>Additional Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>D</td>
<td></td>
<td>ACID SOLVATE TEST CLEAN</td>
</tr>
<tr>
<td>1</td>
<td>D</td>
<td></td>
<td>ACID SOLVATE TEST CLEAN</td>
</tr>
<tr>
<td>2</td>
<td>D</td>
<td></td>
<td>ACID SOLVATE TEST CLEAN</td>
</tr>
</tbody>
</table>

**Drill Nose:** 4" x 4"

**Remarks:**

- No support is required at this depth.

**Samples, Tests, Etc.:**

- Undisturbed sample (U)
- Disturbed sample (D)
- Sample recovered (CR)
- Sample rejected (NS)
- Sample with solid core (SC)
- Sample with liquid core (LC)

**Classification:**

- Sand
- Clay
- Silt
- Gravel
- Cinders

**Consistency/Density Index:**

- Very soft
- Soft
- Medium
- Hard
- Very hard
- Stiff
- Very stiff

**Water Table:**

- Water table is not observed.

**Notes:**

- Drilled through clayey to sandy loam.

**Conclusion:**

Borehole HAI terminated at 2.00 m.
# Engineering Log - Borehole

**Client:** W.P. Brown & Partners P/L

**Purpose:** Brown Clues Estate - Stage 1A - Evans Head

**Location:** Clues No. 1 - Approx. Ch 1600

**Grill model and monitoring:** SDO-AG

**Sample:** 90 DEG

<table>
<thead>
<tr>
<th>Depth</th>
<th>Bedrock</th>
<th>Acid sulphate test clean</th>
<th>Acid sulphate test clean</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.00</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Borehole:** WAL terminated at 2.00 m

**Structure and additional observations:**

- **Nature:** Clean
- **Additional Observations:**
  - Sand on surface.
  - Sand to medium grained, brown & light brown, with a trace of silt lines.
  - Sand to medium grained, dark grey-brown, with some silt grains.
  - Sand to medium grained, brown & light brown, with a trace of silt lines.
  - Sand on surface.

**Notes:**

- **Electrical Resistivity:**
  - 100.00 m

**Materials:**

- **Soil Description:**
  - Classification and Soil Description
  - Based on wet soil classification system
  - Moisture
  - D dry
  - M moist
  - W wet
  - YS very dry
  - S salt
  - F fine
  - SL silty
  - PLC very stiff
  - H hard
  - FC fine clays
  - ML medium clay
  - L low
  - ML medium clay
  - AL sandy loam
  - D dense
  - YD very dense

**Support:**

- **Sample Tests Etc.:**
  - Environmental sample
  - Standard penetration test
  - SPT - sample recovered
  - SP tests
  - Soil tests
  - Water table

**Preparation:**

- **Material:**
  - Size, composition, and characteristics
  - Colour, consistency, and other components

**Mud:**

- **R.L. Surface:** 2.00 m O.D.

**Hole:**

- **-200 000:**
  - No support
  - No 4 in 4

**Water:**

- **Water level:**
  - Not measured
  - Water table
  - Water outline

**Gas:**

- **Gas detected:**
  - None

**Recording:**

- **Hole:**
  - Depth: 2.00 m
  - 2.00 m O.D.
  - No support

**Drill:**

- **Drill:**
  - Type: Core
  - Depth: 2.00 m
  - Diameter: 0.00 m
  - Bit: 0.00 m

**Equipment:**

- **Equipment:**
  - Drill rig
  - Type: Core
  - Depth: 2.00 m
  - Diameter: 0.00 m
  - Bit: 0.00 m
# Engineering Log - Borehole

**Client:** V.P. Brown & Partners Pty Ltd  
**Project:** Iron Gates Estate - Stage 1A - Evans Head  
**Borehole Location:** OAPIN No 1 - Approch 00m  

<table>
<thead>
<tr>
<th>Drill Method and Model</th>
<th>Samples, Tests, Etc</th>
<th>N.I.</th>
<th>Soil Type</th>
<th>Classification</th>
<th>Consistency/Density Index</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Material</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil Incompressibility</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Particle Characteristics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colour, Texture and Other Components</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mixture</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Structure and Additional Observations</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Borehole Terminated at:** 2.00 m
## Engineering Log - Borehole

**Client:** K.P. Knox & Partners Pty Ltd  
**Office No.:** 105/2  
**Sheet No.:** 1/1

### Summary
- **Borehole NO.:** 1144  
- **Date:** 05/07/94  
- **Depth:** 2.00 m  
- **Classification:** Sand

### Materials
- **Soil Type:** Sandy soil
- **Color:** Grayish

### Testing and Additional Observations
- **Acid Soluble Test:** Clean
- **Acid Sulfate Test:** Clean
- **Acidity:** Clean

### Method
- **Method:** Soil Sample
- **Description:** Standard Penetration Test

### Samples, Tests, Etc.
- **Samples:** Undisturbed, Saturated
- **Tests:** Standard Penetration Test

### Consistency/Density Index
- **Consistency:** Very Soft
- **Density:** Very Dense

### Data and Measurements
- **Borehole No.:** 1144  
- **Depth:** 2.00 m

---

### Table Data

<table>
<thead>
<tr>
<th>Sample</th>
<th>Testing Method</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Standard Penetration Test</td>
<td>Clean</td>
</tr>
<tr>
<td>2</td>
<td>Acid Soluble Test</td>
<td>Clean</td>
</tr>
<tr>
<td>3</td>
<td>Acid Sulfate Test</td>
<td>Clean</td>
</tr>
</tbody>
</table>

---

### Acknowledgments
- **Modify by:** AS  
- **Checked by:** JD  
- **Approved by:** KH

---

### Additional Notes
- **Client:** K.P. Knox & Partners Pty Ltd  
- **Office No.:** 105/2  
- **Sheet No.:** 1/1  
- **Date:** 05/07/94  
- **Borehole No.:** 1144  
- **Depth:** 2.00 m

---

**0587**
## Engineering Log - Borehole

### Client: K.P. Brown & Partners Pty Ltd

### Project: Iron Gates Estate - Stage 2A - Evans Head

### Borehole Location: Evans Head Map 1 - Section B 20m

#### Drill Method and Equipment: Sand Jigger

<table>
<thead>
<tr>
<th>Hole Number</th>
<th>Diameter</th>
<th>Depth</th>
<th>Materials</th>
<th>Classification</th>
<th>Results</th>
<th>Structure and Additional Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>HAS</td>
<td>2.3 m</td>
<td>0 m</td>
<td>Sand Gravel, Dark Grey-Brown, with some Gravel Inclusions</td>
<td>SP</td>
<td>Silt, fine to medium grained, dark grey-brown, with some Gravel Inclusions</td>
<td>Acid Sulfate Test Clean</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.6 %</td>
<td>Acid Sulfate Test Clean</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.4 %</td>
<td>Acid Sulfate Test Clean</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.3 %</td>
<td>Acid Sulfate Test Clean</td>
</tr>
</tbody>
</table>

Borehole HAS terminated at 2.00 m

---

### Consistency/Density Index

<table>
<thead>
<tr>
<th>Consistency/Density</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>VS</td>
<td>Very Soft</td>
</tr>
<tr>
<td>S</td>
<td>Soft</td>
</tr>
<tr>
<td>F</td>
<td>Firm</td>
</tr>
<tr>
<td>St</td>
<td>Stiff</td>
</tr>
<tr>
<td>VSt</td>
<td>Very Stiff</td>
</tr>
<tr>
<td>H</td>
<td>Hard</td>
</tr>
<tr>
<td>Fa</td>
<td>Faible</td>
</tr>
<tr>
<td>M</td>
<td>Medium</td>
</tr>
<tr>
<td>N</td>
<td>Normal</td>
</tr>
<tr>
<td>L</td>
<td>Loose</td>
</tr>
<tr>
<td>MO</td>
<td>Medium Dense</td>
</tr>
<tr>
<td>O</td>
<td>Open</td>
</tr>
<tr>
<td>DO</td>
<td>Very Dense</td>
</tr>
</tbody>
</table>
# Engineering Log Borehole

<table>
<thead>
<tr>
<th>Borehole No.</th>
<th>1145</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth (m)</td>
<td>2.00</td>
</tr>
<tr>
<td>Material</td>
<td>Sand tone to medium grained, dark gray-brown, with some silt traces.</td>
</tr>
<tr>
<td>Structure and Additional Observations</td>
<td>Acid sulfate test clean</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Layers</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sand tone to medium grained, dark gray-brown, with some silt traces.</td>
</tr>
<tr>
<td>2</td>
<td>Sand tone to medium grained, off-white, with a trace of silt traces.</td>
</tr>
</tbody>
</table>

**Method:**
- Water screening
- Core sampling
- Little resistance

**Sample Tests:**
- Moisture content
- Density sample
- USC sample
- Water entry
- Groundwater level

**Classification:**
- Soil type: Sand
- Material: Medium to coarse grained sand
- Classification: Medium dense

**Consistency:**
- Very dry
- Very stiff
- Hard
- Dense
- Very dense
**Engineering Log - Borehole**

**Client:** K.P. Brown & Partners Pty Ltd

**Project:** Iron Gates Estate - Stage 1A - Egg Pins Head

**Borehole Location:** Mason No. 1 - Karen Rd 250m

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>N.D.</th>
<th>Material</th>
<th>Additional Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1 Surface</td>
<td>2.73 m</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Soil Type:** Medium to dense, grey, with some silty flakes.
- **Structure and Additional Observations:**
  - Acid Sulfate Test: Clean

**Borehole No. Borehole:**

**Borehole Depth:** 2.00 m
APPENDIX B

PARTICLE SIZE DISTRIBUTION
Particle Size Distribution

Client: WP Brown & Partners
Job No: NRB65/2
Principal:
Project: Iron Gates Estate
Location: Evans Head

Sample Identification: CB944404 Ch. 100m
Test Procedures: AS1283 C6.1

Test Report: CB98001.ENG

Depth: 1.0 - 2.0m

A.S. sieve size

<table>
<thead>
<tr>
<th>Particle Size</th>
<th>Millimeters</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.002</td>
<td>0.06</td>
</tr>
<tr>
<td>0.06</td>
<td>2.0</td>
</tr>
<tr>
<td>2.0</td>
<td>60</td>
</tr>
</tbody>
</table>

Sieve Size (mm)

- Clay
- Silt
- Sand
- Gravel
- Pebbles

Liquid Limit

Plastic Limit

Plasticity Index

Linear Stiffness

Particle Density (t/m³)

Natural Moisture (%)

Classification:

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Authorised Signature: [Signature]

NATA Ref No: [Number]

0505
particle size distribution

client: WP BROWN & PARTNERS  job no.: NR065/2
principal:  laboratory: BRISBANE
project: IRON GATES ESTATE  date: 05/01/95
location: EVANS HEAD  test report: CB95001.ENG

sample identification: C8944485 Ch. 50m  depth: 0.4 - 1.0m
test procedure: AS1289 C6.1

This laboratory is registered by the National Association of Testing Authorities, Australia. The test(s) reported herein have been performed in accordance with the terms of registration. This document shall not be reproduced except in full without the prior approval of the laboratory.

Authorized Signature
NATA Reg. No. 536

05 JAN 1995
APPENDIX C

ACID SULPHATE TEST RESULTS
Ref. No. 27130  
11 January 1995

The Manager,  
Coffey Partners International Pty Ltd,  
PO Box 108,  
Salisbury, Qld 4107

Attention: Mr Brian Booker

Dear Sir,

ANALYSIS OF SOIL SAMPLES  
ORDER NO. B17724 - JOB NO. NR865/2

Five (5) samples were received for testing on 13 December 1999. The results of analysis are presented in the Table attached.

Please advise if you have any queries.

Yours faithfully,  
SIMMONDS & BRISTOW PTY. LTD.

[Signature]

David Nial  
Supervisor - Soils Laboratory

Encl.
Ref. No. 27130
COFFEY & PARTNERS BRISBANE

ANALYSIS OF SOIL SAMPLES
ACID SULPHATE POTENTIAL
IRON GATES ESTATE, EVANS HEAD
JOB NO. NR8652

Date Collected: Not Specified
Date Received: 13.12.94
Date Analysed: 13.12.94 - 09.01.95

<table>
<thead>
<tr>
<th>SAMPLE REGD. NO.</th>
<th>ANALYSIS</th>
<th>INITIAL pH (1:5)</th>
<th>pH AFTER H₂O₁ OXID'N</th>
<th>INITIAL SO₄</th>
<th>SO₄ AFTER OXID'N</th>
<th>PYRITE S</th>
<th>CaCO₃</th>
<th>ACID SULPHATE POTENTIAL</th>
<th>ACID GENERATING POTENTIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>S &amp; B METHOD NO.</td>
<td>G090.</td>
<td>SC280.4 mg/kg</td>
<td>SC280.4 mg/kg</td>
<td>%</td>
<td>SC015.</td>
<td>%</td>
<td>SC120.</td>
<td>%</td>
</tr>
<tr>
<td>97297</td>
<td>50M 1.0 - 2.0 CB 944478</td>
<td>5.4</td>
<td>5.6</td>
<td>10.</td>
<td>150.</td>
<td>&lt;0.01</td>
<td>&lt;0.2</td>
<td>NIL</td>
<td>NIL</td>
</tr>
<tr>
<td>97298</td>
<td>150M 0.7 - 1.5 CB 944479</td>
<td>5.1</td>
<td>6.0</td>
<td>5.</td>
<td>125.</td>
<td>&lt;0.01</td>
<td>&lt;0.2</td>
<td>NIL</td>
<td>NIL</td>
</tr>
<tr>
<td>97299</td>
<td>250M 1.0 - 2.0 CB 944480</td>
<td>5.5</td>
<td>5.2</td>
<td>&lt;5.</td>
<td>75.</td>
<td>&lt;0.01</td>
<td>&lt;0.2</td>
<td>NIL</td>
<td>NIL</td>
</tr>
<tr>
<td>97300</td>
<td>350M 1.0 - 2.0 CB 944481</td>
<td>5.6</td>
<td>5.2</td>
<td>&lt;5.</td>
<td>75.</td>
<td>&lt;0.01</td>
<td>&lt;0.2</td>
<td>NIL</td>
<td>NIL</td>
</tr>
<tr>
<td>97301</td>
<td>465M 0.3 - 1.0 CB 944482</td>
<td>5.4</td>
<td>5.0</td>
<td>10.</td>
<td>125.</td>
<td>&lt;0.01</td>
<td>&lt;0.2</td>
<td>NIL</td>
<td>NIL</td>
</tr>
</tbody>
</table>

* Qualitative assessment based solely on % pyrite - not subject to NATA certification.
** Qualitative assessment based on % pyrite, % CaCO₃ and pH after oxidation - not subject to NATA certification.

Sheet 1 of 1

SIMMONDS & BRISTOW PTY LTD
PER C.de Armond
APPENDIX M

ELECTRICAL AND COMMUNICATIONS SUPPLY AVAILABILITY
Re: Electrical and Telecommunications Supply Availability

Dear Sir

I refer to your request to review the availability of electricity supply and communications infrastructure to the proposed 175 lots of the Iron Gates Development. It will be necessary to construct new infrastructure within the development and within Iron Gates Drive to make connection available to the existing electricity and communications infrastructure within Wattle Street near the corner of Cherry Street.

Electricity Supply
When the development was planned for Construction previously the Electricity authority existing at the time was NorthPower. This authority has subsequently been merged and rebadged several times with the current network owner now known as Essential Energy. In September 1996 NorthPower made an offer to supply the development which is attached (File name EE Original 260996.pdf). I have confirmed with Essential Energy that the connection method proposed in 1996 is still appropriate and that supply would be available to the development from a connection point in Wattle Street. It should be noted that the construction of these works has been deregulated since 1996 and Essential Energy would not do the construction work but would supervise its design and installation. On completion of the works (by Authorised Contractors to an approved design) the assets would be gifted to Essential Energy and they would become responsible for the ongoing operation and maintenance of the assets. Essential Energy will not formalise this offer without an approved current DA. See EE Response 170519.pdf. Once the DA is approved EE will formalise the design requirements after receiving an application.

Communications Infrastructure
In a similar manner to Essential Energy NBN do not carry out works within the development but rely on the developer to arrange an authorised design and installation of pit and pipe infrastructure. This is then gifted to NBN prior to land registration. NBN require a contribution from the developer for each connection required as well as a contribution for lead in works to extend the NBN network to the boundary of the pit and pipe installed by the
developer. NBN have made an offer to the developer and is attached as NBN Offer 210817.pdf. This offer establishes an NBN Developer Reference number which is used for the design and construction of the pit and pipe and the contractual payments between the developer and NBN. The next step in this process is to do an NBN design and submit to NBN for Approval.

Summary
In terms of connection availability to the overall development I can confirm that technically nothing has changed since 1996 in terms of the connection points and supply availability. Since this time the administrative procedures, technical standards for the new equipment and mechanism for its installation has changed. None of these changes have affected the concept that supply will be available from both networks provided the necessary installation works are carried out by the developer.

Yours Sincerely

Greg Don
B.Sc., B.E., M.B.A., M.I.E.
Director
Preferred Energy Pty Ltd
Level 3 ASP no 3479
APPENDIX N

SITE ANALYSIS & DESIGN RESPONSE PLANS