



SHUTE HARBOUR
MARINA

Acid Sulfate Soil Management Plan

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SHUTE HARBOUR MARINA DEVELOPMENT ACID SULFATE SOIL MANAGEMENT PLAN

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EXECUTIVE SUMMARY

An Acid Sulfate Soil investigation as part of the original Environmental Impact Statement was undertaken by Cardno Ullman & Nolan (2005), formerly Ullman & Nolan, at the proposed project area to determine the potential for acid sulfate soils in disturbed marine sediments associated with the construction and operation of the Shute Harbour Marina Resort.

The Shute Harbour Marina Resort is a proposal to develop a marina complex incorporating residential, tourism and commercial land uses at Shute Harbour, near Airlie in North Queensland.

Soil samples, measured under laboratory conditions in accordance with relevant guidelines, identified marine sediments, as dredge spoil and reclamation fill, as having negative net acidity indicating a high neutralising capacity.

Considering the assessable development requirements of Government Agencies and the sensitivity of the receiving environment, this Acid Sulfate Soil Management Plan has been prepared in the event that field and soil assessment of dredging spoil identifies potential acid sulfate soils or actual acid sulfate soils.

Acid Sulfate Soil treatment and management policy, performance objectives, control measures and monitoring requirements have been proposed based on the geotechnical findings on which this plan has been based.

The Acid Sulfate Soil Management Plan has been prepared to ensure no significant adverse impact on the sensitive receiving environment occurs as a result of acid sulfate soil disturbance.

Through this Acid Sulfate Soil Management Plan, should environmental harm be caused or threatened, the operator can demonstrate that all reasonable and practicable measures have been taken to comply with relevant conditions of approval and the general environmental duty.

1. INTRODUCTION

Cardno (Qld) Pty Ltd (Cardno) has been commissioned by Shute Harbour Marina Development Pty Ltd (the Proponent) to prepare an Acid Sulfate Soil Management Plan (ASSMP) for the proposed Shute Harbour Marina Resort (SHMR) located within the Whitsunday Regional Shire of Queensland. Figure 1 provides a locality plan defining the project area.

The ASSMP has been prepared to inform the Environmental Impact Statement (EIS) required by the Queensland Coordinator General for the proposed SHMR and as such will form the basis for Local, State and Federal approval decision making.

The development proposal involves excavating material below 5 m AHD including material from below Mean High Water Springs (MHWS) which may involve the disturbance of acid sulfate soils (ASS) potentially located within the project area.

The ASSMP has been prepared based on the findings by Ullman & Nolan Technical Services Pty Ltd (January 2005) presented in a report titled "*Shute Harbour Marina – Report on Acid Sulfate Soils and Sediment Contamination Investigation*". The Cardno Ullman & Nolan report is attached as Appendix I2 of the EIS.

This report identified that the need to manage ASS is unlikely on account of the excess acid neutralising capacity of the marine sediments however that this would need to be verified by validation monitoring during the excavation of marine sediments and that a management plan should be available in the event that the acid neutralising capacity of sediments is found to be insufficient.

An assessment of the potential impact of proposed works on the receiving environment has been determined for which this ASSMP has been prepared. Impacts which may result from ASS disturbance in relation to the SHMR proposal include:

- oxidisation of ASS in excavated marine sediments resulting in acid production and potential release of heavy metals contaminating fill;
- changing water chemistry of Shute Harbour due to uncontrolled run-off of acidic waters, heavy metals, and acid leaching to groundwater resources; and
- disease and mortality of flora and fauna species within Shute Harbour.

The aim of this ASSMP is to provide appropriate treatment and management strategies including validation monitoring to minimise the potential impact on the receiving environment from the SHMR proposal.

In addition, section 4.4 of the (then) Whitsunday Shire Council (Council) Planning Scheme requires the preparation of an ASSMP when assessable development involves disturbance of soils below 5 m AHD in a coastal location. It is recommended that such an ASSMP should include, but not limited to:

- an ASS map of the area;
- a detailed description of the depth and location of all the ASS identified;
- the methodology used for sampling and field and laboratory soil analysis;
- the ASS management practices to be implemented to minimise the creation, or further production of acid sulfate having regard to such issues as neutralisation, stockpiling, burial/capping and leachate, and that will achieve any or all of the following:
 - prevent the oxidation of pyrite;

- treat or manage the ASS (which may include burial, neutralisation, and separation and treatment)
 - prevent, control or minimise the escape of acid sulfate leachate to the surrounding environment; and
 - allow for the neutralisation of acid leachate from ASS.
- the monitoring and reporting procedures to be established and implemented;
 - performance criteria to assess the effectiveness of the ASS management and monitoring programme; and
 - response (including rectification) procedures in emergency situations or where other cases of non-compliance are identified.

This ASSMP has been prepared to inform ASS management requirements in the event that the acid neutralising capacity is not sufficient to prevent acid production from disturbed marine sediments during construction of the SHMR to mitigate potentially adverse impacts on the receiving environment.

It is the intention of this ASSMP that the procedure for the treatment and management of ASS is implemented when positive sulfate tests are recorded from the ongoing ASS field assessment.

This ASSMP has been prepared with reference to the following guidelines.

- *Queensland Acid Sulfate Soil Technical Manual – Soil Management Guidelines, Version 3.8* (Queensland Government, November 2002).
- *Queensland Government State Planning Policy 2/02 Version 2– Planning and Managing Development involving Acid Sulfate Soils* (SPP 2/02).
- *Instructions for the Treatment and Management of Acid Sulfate Soils* (Queensland Government, July 2001).
- *Acid Sulfate Soils Management Plans for Queensland* (Dear et al, June 2000).
- *Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils in Queensland* (CR Ahern, MR Ahern and B Powel, October 1998).

2. DEVELOPMENT PROPOSAL

The Proponent proposes to develop a marina complex incorporating tourism, residential and commercial land uses at Shute Harbour, Airlie in North Queensland, on leasehold land described as Lot 2 on Plan SP117389 and on adjacent land under water where a permit to occupy has been granted (the project area).

The proposed development includes:

- reclaiming tidal land for the purposes of constructing tourism, residential and commercial precincts (including internal roads and infrastructure) and supplementary car park;
- construction of a solid breakwater;
- dredging of the marina basin to - 5.2 metres AHD to accommodate a 669 berth marina; and
- dredging of the access channel into the proposed marina.

The commercial and tourism precinct will incorporate a four star tourism resort, retail area, marina amenities, carpark, and landscaped open space on reclaimed land in the north and north-eastern portion of the project area. The residential precinct consists of 117 lots on reclaimed land and an isthmus projecting into the harbour in the western portion of the site.

The marina will consist of floating pontoons supported by driven piles and will include a fuel dock and sewage pump-out facility. The layout of the proposed development is attached as Figure 2.

Civil engineering works occurring over approximately 2 years will include the following steps:

- clearing of fringing mangrove vegetation;
- construction of a stormwater diversion channel;
- construction of a solid breakwater;
- reclaiming land using sheet pile revetment walls;
- piling works;
- dredging of Marina Basin to a depth of -5.2 metres using a cutter suction dredge;
- marina fit out; and
- infrastructure works including road works and services.

Ongoing maintenance dredging of the marina and access channel will be required every 5-7 years, depending on siltation rates. Spoil from maintenance dredging will be dewatered and dried on the landscaped open space area located on the isthmus.

Buildings associated with mixed land uses will thereafter be constructed in the project area on reclaimed land. Design of buildings and structures has not yet been completed but the multimedia presentation provides detailed concept images of the proposed development form.

3. LOCATION DESCRIPTION

3.1 Regional Context

The SHMR project area is situated on the Whitsunday Shire coastline, on Queensland's central coast. The project area is located 10km south-west of Airlie Beach, 35km north-east of the Bruce Highway and a 30 minute or 2 hour drive from the Proserpine and Mackay airport respectively. The location of the SHMR site is shown on Figure 1.

The regional geology is described in the 1:250,000 Geological Series Sheet for Proserpine. The geology of the area is typical of the surrounding Whitsunday area, comprising volcanoclastic sediments interlain with intermediate volcanic flows and minor intrusions. The rocks form part of the Whitsunday Volcanic Province, an early Cretaceous aged sequence.

3.2 Local Context

The project area located within the Great Barrier Reef World Heritage Area and Habitat Protection Zone of the Great Barrier Reef Coast Marine Park.

The project area is also surrounded by areas of conservation significance which are as follows.

- The Habitat Protection Zone of the Great Barrier Reef Marine Park.
- The Conway National Park to the north of the site which is protected by the *Nature Conservation Act 1992* in order to provide a foundation for spiritual, scientific, educational, recreational and visitor opportunities, all of which must be environmentally compatible (World Conservation Union (IUCN) 1994 definition).

3.3 Site Description

The SHMR will be established on land within the coastal zone which encompasses 45.2 hectares of lease land and seabed, the latter under a permit to occupy. The land where development is occurring is described as Lot 2 on SP117389, Parish of Conway, County of Carlisle in the Whitsunday Shire.

No development is occurring on land above the Proserpine-Shute Harbour Road that is part of Lot 2 and includes Lot 273 on Plan HR 1757 which will be surrendered to the State. This land is a natural retention basin and will capture runoff from Conway National Park to the north which will be diverted around the development releasing as clean stormwater to Shute Harbour.

In short the project area is bound by:

- Proserpine-Shute Harbour Road to the north, with land on the opposite side of the road forming part of the lease land bounded by Conway National Park;
- an existing motel, residential dwelling and the Shute Harbour Transit Facility to the east;
- a marina salvage operation to the west; and
- the Great Barrier Reef Marine Park seaward of the landward boundary to the south.

Changes to relative sea and land levels have resulted in the site becoming drowned during the Tertiary Period. Overlying the basement rock at and below the shoreline is recent to Holocene aged marine sediments ("marine muds") underlain by competent residential soils. The marine muds are comprised of principally soft, dark grey, medium plasticity silty clays with shells and coral fragments described as gravely clayey sand. They vary in thickness from zero at the head of the beach to in excess of 10m at the southern boundary of the site.

The residual soils both onshore and offshore comprise mainly of stiff, medium plasticity clayey sand. Residual soils are typically some 2 metres thick.

The local geological bedrock typically consists of rhyolite, andesite, and a sequence of very similar lava flows. Bedrock is typically red-brown to blue-grey in colour, often porphyritic with small white anhedral phenocrysts or plagioclase. The lava is highly fractured, with fractures only a few centimetres apart. The rhyolite and andesite is less fractured.

Tidal waters overflow a narrow wavecut platform, beach and seabed with Mean High Water Springs (MHWS) located at 1.33 metres AHD. The seabed is sparsely vegetated with *Halophila ovalis* and *Halodule univervis* seagrass. Mangrove communities fringe the shoreline with patches of salt marsh occurring on rocky ground up to the Highest Astronomical Tide (HAT) level located at 2.35 metres AHD. Beyond this intertidal zone, the land is vacant and vegetated with remnant terrestrial vegetation. This part of the land rises in a gentle slope to Proserpine-Shute Harbour Road.

Part of the site is currently used as a mooring location for recreational boats with the majority of the site inaccessible due to depth restrictions.

4. GEOTECHNICAL INVESTIGATION

A borehole investigation in accordance with the recommended guidelines was undertaken across the project area in 2005 including both onshore and offshore areas, the intertidal zone and the proposed access channel.

Borehole logging as part of this geotechnical assessment has described the depth, moisture, consistency and visual characteristics of each soil profile according to the Australian soil and land survey field handbook and Australian soil classification.

The sampling methodology, analysis results and investigation findings are provided in the report by Cardno Ullman & Nolan (2005) attached as Appendix I2 of the EIS.

The ASS investigation involved the drilling and sampling of 51 boreholes south of Proserpine-Shute Harbour Road to a depth of - 6.2 metres AHD or refusal, which corresponds to 1.0 metre below the proposed disturbance depth in the proposed dredge areas.

The location of boreholes is presented in Figure 3 of this ASSMP. The geo-morphological profile determined out to the furthest boreholes can be expected to continue to the limit of lease and therefore boreholes are representative of the works area.

The sampling for ASS was undertaken using the Chromium Reducible Sulfur method (S_{CR}) which is a more suitable analysis technique for marine sediment sampling than the Suspension Peroxide Oxidation Combined Acidity and Sulfate method (SPOCAS).

Laboratory results all exhibited negative net acidity which indicates soils have a naturally high acid neutralising capacity (ANC). This result is also below the Action Criteria threshold of 0.03% equivalent sulphur (%S) in SPP 2/02.

A summary of laboratory results are attached as Appendix A of this ASSMP. Full laboratory results are given in Appendix I2 to the EIS.

These findings are consistent with the Council ASS overlay under the Planning Scheme which does not identify any ASS in the proposed development footprint.

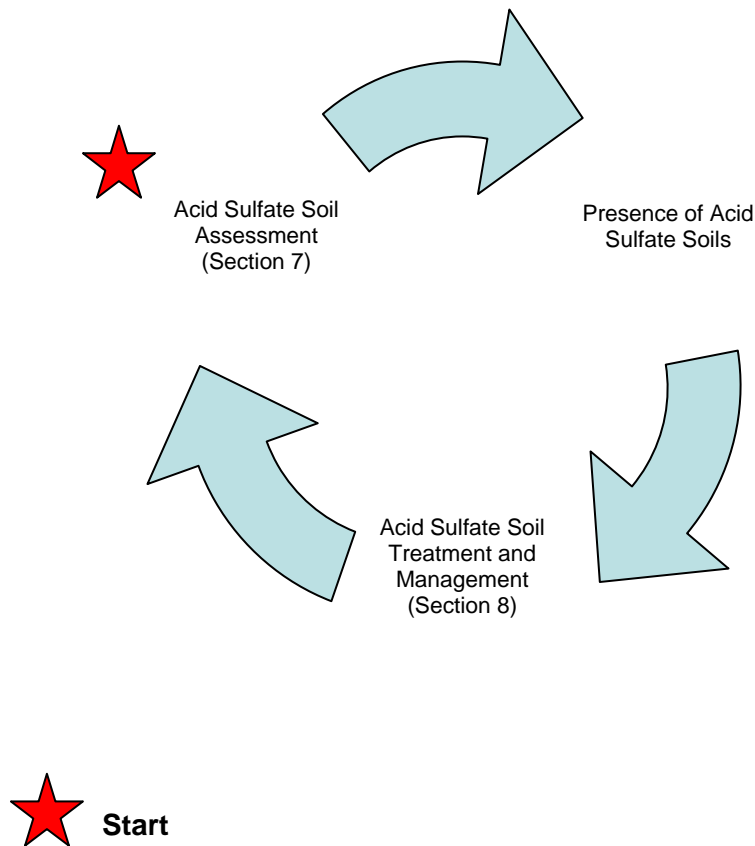
In conclusion the results from laboratory testing for ASS identify no treatment is required however given State and Local assessment requirements, treatment and management strategies (refer to Section 8) have been prepared in the event that the proposed ASS Field Assessment during marina excavation detects the presence of ASS. The ASS Field Assessment is detailed in Section 7 of this ASSMP.

5. MANAGEMENT FRAMEWORK

This ASSMP has been prepared to enable the Proponent to fulfil their statutory requirements.

This ASSMP has been prepared such that the treatment and management strategies for ASS are triggered in the event an ASS Assessment identifies the presence of ASS, given the extensive geotechnical investigation and findings across the project area.

The framework for implementing this ASSMP is given below.



6. RESPONSIBILITY OF THE CONTRACTOR

The Contractor(s) for marina dredging and platform building shall conduct operations in accordance with this ASSMP. Prior to the commencement of works, the Contractor shall provide the following information to the Proponent.

- Contractor's environmental policy.
- Names and responsibilities of supervisory staff involved with the implementation of the ASSMP when required.
- Schedule of site inspections (and personnel responsible) to identify environmental problems, and maintenance actions to remedy any environmental problems identified.
- An "Incidents, Complaints and Enquiries Register", in which all environmental problems identified during inspections and monitoring, and complaints/enquiries received are recorded and acted upon.
- Environmental Training Plan and Training Record Plan for all personnel involved in development of the site.

The Contractor is to maintain the Incidents, Complaints and Enquiries Register which lists the date of the incident or complaint/enquiry and the type of incident or complaint/enquiry. For each incident and/or complaint, a record log is to be completed reporting the following:

- date of incident;
- nature of incident and associated information;
- location of incident;
- name of personnel or complainant which reported incident;
- employee who received notice of incident;
- project Manager's review and comment;
- recommended action to resolve incident;
- list of organisations to be contacted with regard to incident;
- outcome of actions undertaken subsequent to incident being recorded; and
- date of resolution of incident.

Each incident is to be assigned a number to be entered in the Incidents, Complaints and Enquires Register. The Proponent is to be notified of incidents which have the potential to cause environmental harm using a Corrective Action Request (CAR) Form (attached as Appendix B).

Council and the Environment Protection Agency must be notified by the Proponent (or the Registered Operator for the site) by telephone or fax within 24 hours of becoming aware of the emergency or incident resulting in a release of contaminants not in accordance, or reasonably expected to be in accordance with this ASSMP.

7. ACID SULFATE SOIL FIELD ASSESSMENT

7.1 Policy

To minimise as much as reasonably practicable the detrimental impact on the receiving environment from ASS exposure through effective identification.

To comply with the *Environmental Protection Act 1994* to take all reasonable and practicable measures to prevent or minimise environmental harm and to manage ASS in accordance with the *Queensland Acid Sulfate Soil Technical Manual, Soil Management Guidelines* and SPP 2/02.

7.2 Implementation

ASS Field Assessment is required as part of the construction methodology to identify ASS and confirm soils excavated and used for fill have sufficient ANC such that soils do not require treatment and management as per Section 8 of this ASSMP.

In the event ASS soils are exposed which do not have sufficient ANC, Section 8 of this ASSMP hereafter applies and treatment and management strategies contained therein adopted.

7.3 Identification of ASS

Potential ASS (PASS) and Actual ASS (AASS), collectively referred to as ASS, are soils containing iron sulphide and exist in an anaerobic state. Upon exposure to oxygen the iron sulphide is converted to iron sulfate, simultaneously releasing acid. When soils release unacceptable quantities of acid, when compared against the Action Criteria in SPP 2/02, detailed treatment and management as detailed in section 8 of this ASSMP is critical.

It is a requirement of this ASS Field Assessment to determine the presence of PASS or AASS in a daily monitoring program through visually characterising soils and screening using field pH tests (both pH_F and pH_{FOX}).

The field pH tests (both pH_F and pH_{FOX}) should be conducted at 0.25 m intervals on the soil profile, ensuring at least one test per horizon. It is recommended that field tests be conducted on-site. If the tests can't be performed on-site, tests should be conducted within 24 hours of soil sample collection, ensuring appropriate sample handling procedures. Samples suspected of containing monosulfides should undergo field pH testing immediately in the field.

7.3.1 pH Field Test

The procedure for the field pH test (pH_F) is documented in section H of the *Acid Sulfate Soils Laboratory Methods Guidelines* published by the Queensland Department of Natural Resources, Mines and Energy, Indooroopilly, Queensland, Australia.

The procedure for the pH_F test is provided below.

1. Calibrate battery powered field pH meter according to manufacturer's instructions.
2. Prepare the test tubes in the test tube rack. Use of separate racks for the pH_F and pH_{FOX} tests is recommended as contamination may occur when the pH_{FOX} reactions are violent. As the soil: water paste is inclined to stick to the walls of tubes, it is best to use shallow, broad test tubes as this makes cleaning easier.

3. Conduct tests at intervals on the soil profile of 0.25 m or at least one test per horizon whichever is lesser.
4. Remove approximately 1 teaspoon of soil from the profile. Place approximately ½ teaspoon of that soil into the pH_F test tube and place ½ teaspoon of the soil into the pH_{FOX} test tube for the corresponding depth test. It is important that these two sub-samples come from the same depth and that they are similar in characteristics. For example, DO NOT take ½ teaspoon of soil from the 0–0.25m depth that is grey mud, while selecting ½ teaspoon from the same depth that is a yellow mottled sample. These will obviously give different results independent of the type of test conducted.
5. Place enough deionised water (or demineralised water if deionised water is not available; never use tap water) in the pH_F test tube to make a paste similar to ‘grout mix’ or ‘white sauce’, stirring the soil: water paste with a skewer, strong tooth pick or similar to ensure all soil ‘lumps’ are removed. Do not leave the soil samples in the test tubes without water for more than 10 minutes. This will reduce the risk of sulfide oxidation—the pH_F is designed to indicate the existing pH of a soil in the field; any oxidation subsequent to the soil’s removal from the ground will not reflect the true field pH. In some instances, in less than 5 minutes, monosulfidic material may start to oxidise and substantially affect the pH_F results.
6. Immediately place the spear point electrode (preferred method) into the test tube, ensuring that the spear point is totally submerged in the soil: water paste. Never stir the paste with the electrode. This will damage the semi-permeable glass membrane.
7. Measure the pH_F using a pH meter with spear point electrode.
8. Wait for the reading to stabilise and record the pH measurement.
9. All measurements should be recorded on a data sheet.

7.3.2 Field pH Peroxide Test (pH_{FOX})

The procedure for the field pH peroxide test (pH_{FOX}) is documented in section H of the Acid Sulfate Soils Laboratory Methods Guidelines published by the Queensland Department of Natural Resources, Mines and Energy, Indooroopilly, Queensland, Australia.

The procedure for the pH_{FOX} test is provided below.

1. Adjust the pH of the hydrogen peroxide to pH 4.5–5.5 before going into the field. This can be done by adding a few drops of dilute NaOH stirring and checking the pH with the electrode regularly until the correct range is reached. NaOH is highly caustic so safety precautions must be exercised. NaOH can raise the pH quickly or slowly, so the pH needs to be monitored. Recheck the pH after allowing the peroxide to stand for 15 minutes. Do NOT buffer a large quantity of hydrogen peroxide at one time. Only buffer the amount to be used in the field for about a month. This must be kept in a fridge, well labelled with only small quantities to be taken into the field at one time. This will ensure the longevity of the peroxide. Further, over time, the pH of the peroxide that has already been buffered may change. It is important to check the pH of the peroxide in the morning before departing to the field. Having a small quantity of NaOH in the field kit is recommended so the peroxide can be buffered if required.
2. Calibrate battery powered field pH meter according to manufacturer’s instructions.
3. Prepare the test tubes in the test tube rack as for pH_F test. It is important to use heat-resistant test tubes for the pH_{FOX} test as the reaction can generate considerable heat (up to 90°C). It is recommended that a tall, wide tube be used for this test as considerable bubbling may occur, particularly on highly sulfidic or organic samples.

4. Conduct pH_{FOX} tests at intervals on the soil profile of 0.25 m or at least one per horizon whichever is lesser.
5. From the teaspoon of soil previously collected for the pH_F test, place approximately ½ teaspoon of the soil into the pH_{FOX} test tube for the corresponding depth test. It is important that these two sub-samples come from the same depth and that they are similar in characteristics. For example, DO NOT take ½ teaspoon of soil from the 0–0.25m depth that is grey mud, while selecting ½ teaspoon from the same depth that is a yellow mottled sample. These will obviously give different results independent of the type of test conducted.
6. Add a few millilitres of 30% H₂O₂ (adjusted to pH 4.5–5.5) to the soil (sufficient to cover the soil with peroxide) and stir the mixture. Do NOT add the peroxide to the test tube in which the pH_F test was conducted, that is, the pH_{FOX} test tube should not have any deionised water in it. Beakers can be used, however glass is usually easily broken when conducting field work, and when multiple tests are being conducted it is difficult to handle large beaker sizes efficiently. Do NOT add more than a few millilitres at a time. This will prevent overflow and wastage of peroxide. A day's supply of peroxide should be allowed to reach room temperature prior to use (cold peroxide from the fridge may be too slow to react).
7. Rate the reaction of soil and peroxide using a XXXX scale (see below and Table 1).
8. Ideally, allow approximately 15 minutes for any reactions to occur. If substantial sulfides occur, the reaction will be vigorous and may occur almost instantly. In this case, it may not be necessary to stir the mixture. Careful watch will be needed in the early stages to ensure that there is no cross contamination of samples in the test tube rack. If the reaction is violent and the soil: peroxide mix is escaping from the test tube, a small amount of deionised water (or demineralised water; not tap water) can be added (using a wash bottle) to cool and calm the reaction. Usually this controls overflow. Do NOT add too much deionised water as this may dilute the mixture and affect the pH value. It is important to only use a small amount of soil otherwise violent reactions will overflow and the sample will be lost.
9. Steps 6 to 8 may be repeated until the soil: peroxide mixture reaction has slowed. This will ensure that most of the sulfides have reacted. In the lab this procedure would be repeated until no further reaction occurs, however in the field, best judgement is recommended. Usually one or two extra additions of a few millilitres of peroxide are sufficient.
10. If there is no initial reaction, individual test tubes containing the soil: peroxide mixture can be placed into a container of hot water (especially in cooler weather) or in direct sunlight. This will encourage the initial reaction to occur. When the sample starts to 'bubble', remove the test tube immediately from the hot water and replace into test tube rack.
11. Wait for the soil: peroxide mixture to cool (may take up to 10 minutes). The reactions often exceed 90°C. Placing an electrode into these high temperature situations may result in physical damage and inaccurate readings. Check the temperature range of the pH meter and probe to see what temperature is suitable. Note that a more exact pH is achieved if a temperature probe is also used, however this may be impractical in some field situations.
12. Use an electronic pH meter (preferred method) to measure the pH_{FOX}. Place a spear point electrode into the test tube, ensuring that the spear point is totally submerged in the soil: peroxide mixture. Never stir the mixture with the electrode. This will damage the semipermeable glass membrane.
13. Wait for the reading to stabilise and record the pH_{FOX} measurement.
14. All measurements should be recorded on a data sheet.

The rate of the reaction generally indicates the level of sulfides present, but depends also on texture and other soil constituents. A soil containing very little sulfides may only rate an 'X' however a soil containing high levels of sulfides (remember the exact level of sulfides cannot be determined using the pH_{FOX} test) is more likely to rate a 'XXXX' although there are exceptions. This rating scale alone should not be used to identify ASS. It is not a very reliable feature in isolation as there are other factors including manganese and organic acids which may trigger reactions. Reactions with organic matter tend to be more 'frothing' and don't tend to generate as much heat as sulfidic reactions. Manganese reactions will be quite extreme, but don't tend to lower the pH_{FOX}. Table 1 indicates the reaction scale for pH_{FOX} tests.

Table 1 Soil reaction rating scale for the pH_{FOX}

Reaction Scale	Rate of Reaction
X	Slight reaction
XX	Moderate reaction
XXX	High reaction
XXXX	Very vigorous reaction, gas evolution and heat generation commonly >80°C

7.3.3 Field Investigation

The characteristics of PASS are as follows:

- often have a pH close to neutral (6.5–7.5);
- contain unoxidised iron sulfides;
- are usually soft, sticky and saturated with water;
- are usually gel-like muds but can include wet sands and gravels;
- presence of shell; and
- a sulfurous smell (e.g. hydrogen sulfide or 'rotten egg' gas).

Water pH is usually neutral but may be acidic in adjacent streams, drains, and groundwater.

AASS have already undergone oxidation to produce acid, resulting in a soil pH of less than 4. If these soils still contain sulfides, they have the potential to produce more acid if allowed to oxidise further. This would be identified by a further decrease in pH reflected in the pH_{FOX} field test.

The characteristics of AASS are as follows:

- contain oxidised iron sulfides;
- vary in texture;
- often contain jarosite (a yellow and/or red mottle produced as a by-product of the oxidation process);
- often contain corroded shell's; and
- release a sulfurous odour (e.g. hydrogen sulfide or 'rotten egg' gas).

Water and landscape characteristics can also be used to identify AASS including:

- water of pH <5.5 (and particularly below 4.5);
- unusually clear or milky blue-green drain water flowing from or within the project area typically from aluminium released by ASS acting as a flocculating agent;
- extensive iron stains on any drain or ponded water surface;

-
- unexplained dead, dying, stunted vegetation¹;
 - a transition to, or establishment of, a community dominated by acid tolerant species;
 - scalded or bare low-lying areas¹; and
 - corrosion of concrete and/or steel structures¹.

¹ *May also be due to excessive salinity or to salinity in combination with AASS*

7.4 Laboratory Testing

In the event field investigations identify PASS or AASS, samples at a minimum rate of one test per 1000m^3 should be measured under laboratory conditions using the S_{CR} method to determine net acidity and appropriate liming rate. The reduction in the sample intensity is proposed given the findings of the extensive geotechnical investigation and quantity of spoil.

A safety factor of 1.5 shall be used when determining the quantity of lime to be added to treat ASS.

The presence of ASS shall be determined by comparing the equivalent sulfur (%S) to the texture based Action Criteria of oxidisable sulfur presented in Table 2.

Table 2 Action Criteria

Type of Material		Action Criteria (1-1000 tonnes disturbed)		Action Criteria (>1000 tonnes disturbed)	
		Existing + Potential Acidity		Existing + Potential Acidity	
Texture Range	Approx. Clay Content	Sulfur Trail (%S) Net Acidity	Acid Trail (mol H ⁺ /t) Total Potential Acidity	Sulfur Trail (%S)	Acid Trail (mol H ⁺ /t)
Coarse Texture (Sands to loamy sands)	≤5%	0.03	18	0.03	18
Medium Texture (Sandy loams to light clays)	5%-40%	0.06	36	0.03	18
Fine Texture (Medium to heavy clays and silty clays)	≥40%	0.10	62	0.03	18

Samples exhibiting net acidity greater than 0.03% and Total Potential Acidity of more than 18 H⁺/t must then be treated as ASS and spoil thereafter managed in accordance with section 8 of this ASSMP.

8. ACID SULFATE SOIL TREATMENT AND MANAGEMENT

8.1 Policy

To minimise as much as reasonably practicable the detrimental impact on the receiving environment from ASS exposure through the effective treatment and management.

To comply with the *Environmental Protection Act 1994* to take all reasonable and practicable measures to prevent or minimise environmental harm and to manage acid sulfate soils in accordance with the *Queensland Acid Sulfate Soil Technical Manual, Soil Management Guidelines* and SPP 2/02.

8.2 Implementation

Performance objectives, mitigation strategies and monitoring requirements presented hereafter are relevant in the event the presence of ASS is determined through field investigation and laboratory analysis in accordance with Section 7 of this ASSMP.

Through validation monitoring five consecutive (laboratory) sample results with equivalent sulfur below the Action Criteria provides evidence for no further treatment and management specifications and the ASS Field Assessment methodology thereafter applies (refer to Section 7 in accordance with the management framework outlined in section 5 of this ASSMP).

8.3 Performance Objectives

The objectives of ASS treatment and management are to ensure that:

- there is adequate treatment of ASS through validation monitoring (such that soils have sufficient ANC measured through appropriate field soil testing and laboratory verification). Soils having sufficient ANC achieve the target criteria specified in Table 3; and
- water runoff from spoil disposal areas and dewatering and drying spoil for fill purposes shall comply with the release limits specified in Table 4.

8.4 Mitigation Strategies

Management of both excavated and in-situ ASS are required under this section to ensure that the impacts from disturbance of ASS are mitigated to comply with performance objectives.

The SPP 2/02 identifies the following common strategies and options available to manage ASS.

- Avoidance.
- Minimisation of disturbance.
- Neutralisation.
- Strategic reburial (or reinterment).
- Hydraulic separation techniques.

The most appropriate mitigation strategy, given the size, complexity and components of the development proposal, and the proximity to and sensitivity of the receiving environment, is “neutralisation”.

The neutralisation process involves the addition of neutralising agents to ensure acid generated is collected, neutralised, and that any metals mobilised by the acid are also contained.

8.4.1 Neutralisation of Excavated ASS

- All cut batters shall be coated with fine agricultural lime (aglime) at the rate of 5kg/m² and the lime coating should be checked and re-limed as necessary on a daily basis during site establishment and marina excavation and reclamation.
- The base of all fill areas where potential ASS is to be managed shall be treated with a guard layer of 5kg/m² of fine aglime per metre depth of fill prior to the placement of any reclaimed material to neutralise downward seepage of acidic drainage water. This application may need to be increased depending on stockpile height and actual and potential acidity of the ASS as determined through laboratory testing. Alternatively, ASS shall be placed on an impervious layer. For highly permeable soils, the option of placement of an impervious layer should be adopted where practicable.
- All material to be excavated from the site below a level of 5.0 m AHD shall be subject to validation testing.
- All excavation and treatment areas shall be isolated from major external catchments by perimeter drains and/or bunds covered with an impervious layer or a layer of fine aglime to neutralise leachate migrating from the stockpiled material.
- Engineer-designed erosion and sediment protection measures must be installed in accordance with the Institute of Engineers (Qld Division) Manual for Erosion and Sediment Controls (1996) and which will adequately contain runoff from all areas of land used for treatment of ASS. Erosion and sediment protection measures shall be designed with regard to soil properties and erosion risk.

Particle size distribution tests have been undertaken for each material classified to provide an indication of erodibility. The soft marine muds have an estimated permeability of 10-7m/s (based on grading and plasticity characteristics), and low to moderate dispersibility.

- Soils shall be stockpiled for no more than 48 hours prior to neutralisation.
- Soil must be sufficiently dry before liming is commenced so that the aglime can be thoroughly mixed through the soil. Soil should be dried by spreading and leaving open to the atmosphere. Drying can be accelerated by regular aeration by turning with an excavator or backhoe. Drying should be carried out on a guard layer within the fill area and protected from stormwater ingress.
- Aglime rates should be as determined through validation testing.
- Mixing of ASS material with aglime shall be carried out by spreading the soil in layers of not more than 300-500mm thick using an agricultural spreader and disc plough, rotary hoe or similar. Care shall be taken to ensure that mixing occurs throughout the depth of the layer prior to placement of new material.
- Following the successful treatment of the soil (as determined through the validation testing), the material shall be compacted and the next layer of excavated material to be treated shall be placed over the already treated material. This process shall be continued until the required compaction and site elevation is achieved.
- Equipment used in the treatment of ASS shall be washed to prevent corrosion.
- A treatment basin will be constructed, of a sufficient size, to capture acid leachate and runoff from treatment areas and shall incorporate:

- a lime 'slurry' mixing tank and dosing system for regulating dosing or retained waters as required; and
- an automatic pH monitoring system.

8.5 Neutralising Materials

- A sufficient supply of aglime shall be kept on site at all times for the treatment of ASS.
- The aglime should be fine ground (< 1mm) calcium carbonate (CaCO₃) or calcite (limestone or marble).
- Dolomitic aglime, or magnesium-blend aglime, should not be used as these materials impose environmental risks from overdosing with the potential to damage estuarine ecosystems.
- The supply shall be stored in a covered and bunded area to prevent accidental release to waters and deterioration of neutralising capacity.
- A reasonable quantity of calcium hydroxide solution (hydrated lime) shall be kept on site at all times for treatment of acidic waters contained by the treatment basin. The supply shall be stored in a covered and bunded area to prevent accidental release to the receiving environment.

8.6 Validation Testing

- Validation testing shall be carried out at a minimum rate of one test per 250m³ under laboratory conditions using the S_{CR} method to determine net acidity and appropriate liming rate until five consecutive laboratory results record equivalent sulfur below the Action Criteria, evidence for no further treatment and management specifications (refer to Section 7 treatment and management tasks in this instance).
- A safety factor of 1.5 shall be used when determining the quantity of aglime to be added to neutralise ASS.
- Validation testing shall be carried out in accordance with the *Acid Sulfate Soils Laboratory Methods Guidelines* (June 2004).
- Samples for laboratory analysis will be obtained by aggregating material from three separate locations within the subject quantity of excavated or treated soil.
- Treated (and mixed) soil shall be tested at a minimum rate of one test per 500m³ to determine compliance with target levels in Table 3.

Table 3 Target Levels of Neutralised Soils

Test	Target Level
Field pH/ SPOCAS/ S _{CR} suite	<ul style="list-style-type: none"> • pH >6 • Net acidity < 0.03 %S
Field peroxide pH	<ul style="list-style-type: none"> • No change in colour • No effervescence • No release of sulfurous odour • No depression in pH below field pH • pH > 3

8.7 Water Discharges

- All water generated from the development platform and fill areas shall be contained, tested and treated (if necessary) in a treatment basin prior to discharge or re-use on site.
- Poned water shall be tested for pH on a daily basis using an automatic pH monitoring system, with no water discharged from site unless it complies with the release criteria specified in Table 4.
- Treatment of ponded water may include the addition of flocculating agents to reduce the suspended solids concentration, in addition to the mixing of hydrated lime to control pH.

Table 4 Water Quality Release Criteria

Water Quality Parameter	Release Criteria
pH	6.5 – 8.5
Suspended Solids	< 50 mg/L
Oil and grease	No visible film No detectable odour
Iron floc and scum	None visible
Floating matter	None visible

- A baseline water quality program will be established prior to and during marina construction as per the Construction Environmental Management Plan. The details of this monitoring program will be presented in the EIS.

8.8 Monitoring

- The Contractor shall employ suitably qualified personnel during all earthwork operations to supervise and monitor ASS treatment and management so as to comply with this ASSMP. These personnel shall be trained in the recognition of ASS.
- The Contractor shall monitor the project area on a daily basis for evidence of:
 - iron staining at fill areas and batters;
 - colour change of site waters to pale blue-green or crystal clear;
 - yellow efflorescence on soil surface; and
 - sulfurous odour.
- Validation testing shall be undertaken in accordance with section 8.6 of this ASSMP.
- Water quality discharge monitoring shall be undertaken in accordance with section 8.7 of this ASSMP.

8.9 Records

- Aglime delivery dockets are to be collected and checked against calculated amounts of aglime used.
- Records of how and where neutralising agent was used on site must be kept in a dedicated register.

- Records of monitoring results must be maintained in a dedicated register to allow for trend analysis and environmental reporting to Administering Authorities as per approval conditions.

8.10 Corrective Action

The following steps shall be taken to address non-compliances with this ASSMP.

1. The Site Staff shall take appropriate steps to contain released material.
2. The Contractor shall be notified and will make an initial assessment of the severity of the release and the nature of the silt material.
3. The Contractor shall notify the Proponent of the accidental release of acidic material.
4. The Contractor shall take steps to treat and manage the acidic material in accordance with this plan or otherwise in accordance with Government requirements (should Government requirements differ with regard to this plan it shall be reviewed and amended to achieve compliance). A record log shall be incorporated into the Incidents, Complaints and Enquiries Register.
5. The Contractor shall assess the work procedures and/or cause of the non-compliance and implement any changes deemed to be appropriate, in consultation with the Site Manager to prevent reoccurrence of a similar incident in the future. A CAR shall be completed and forwarded to the Proponent who will notify the regulating authorities.
6. The Contractor shall make an assessment of the area to confirm the success of the corrective action(s) and whether additional works are required.

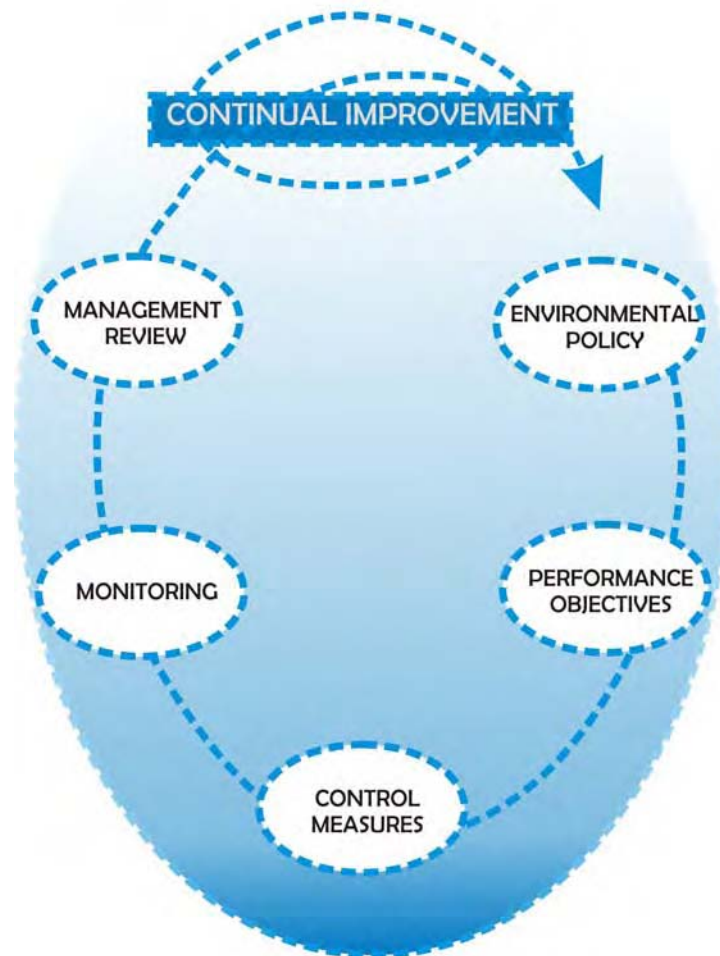
9. SYSTEM REVIEW

The suitability, adequacy and effectiveness of this ASSMP must be reviewed annually following a continual improvement procedure. The review should consider the following matters.

- Suitability of the objectives.
- The extent to which the objectives have been met.
- Monitoring results (validation monitoring and water monitoring).
- Audit findings.
- Technical reviews.
- Changes to organisational structure, plant and equipment, or procedures and practices.

The ASSMP must not be implemented or amended in a way that causes environmental harm.

Details of any significant amendment to the ASSMP shall be provided to the Administering Authority at the time of Annual Return or as otherwise conditioned for.

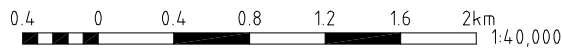


FIGURES

- Figure 1** **Site Locality**
- Figure 2** **Development Proposal**
- Figure 3** **Borehole Locality Plan**



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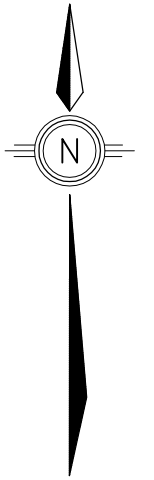
FIGURE 1 REGIONAL LOCALITY

Rev: Orig. Date: 17 July 2008

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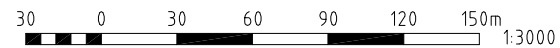
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LEGEND

 Proposed Lease Boundary



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FIGURE 2
DEVELOPMENT PROPOSAL

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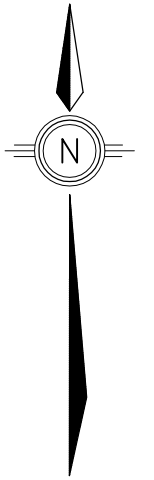
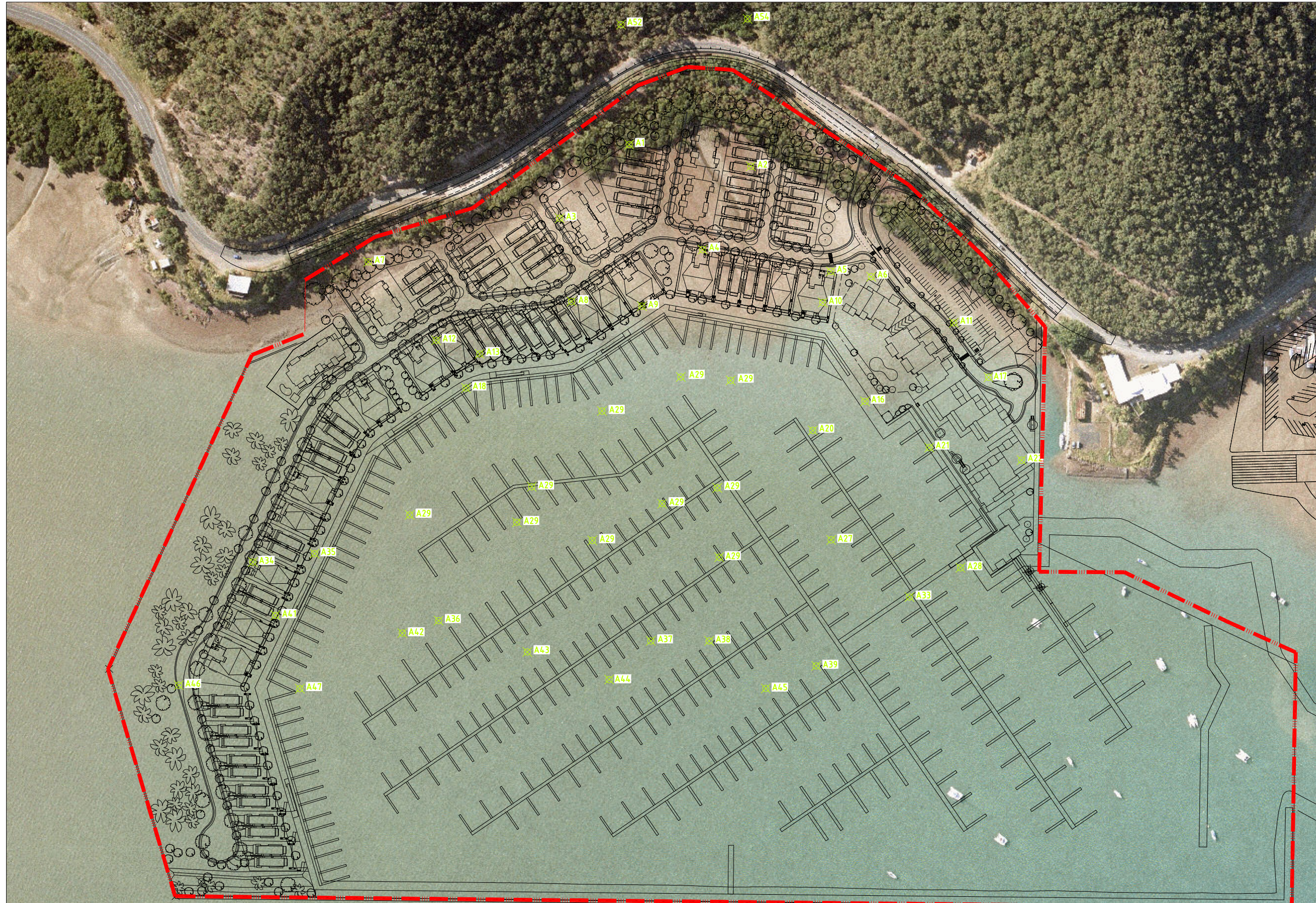
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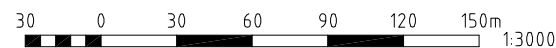
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PRINT DATE: 21 October, 2008 - 9:33am



LEGEND

- Proposed Lease Boundary
- Borehole location



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Shute Harbour Marina Development Pty Ltd
CAD FILE: I:\7800-41\ACAD\Acid Sulfate Soil Management Plan\Figure 3 - Borehole locality plan_v2.dwg
XREF's: Master Plan July 2008

Scale 1:3000 (A3)

**FIGURE 3
BOREHOLE LOCALITY PLAN**

Project No.: 7800/41

PRINT DATE: 21 October, 2008 - 9:36am

APPENDIX A

Summary of Laboratory ASS Test Results

SHUTE HARBOUR LABORATORY ASS RESULTS SUMMARY



PAGE 11

3rd November 2004

ID	TESTING	pH KCl	s-TAA %S	S Cr %S	s-RAS %S	ANC BT %S	ANC CARB %S	ABA (1)		
								Net Acid %S	Liming (kg lime/m ³)	
A1	A1 0-0.5 m	CHROMIUM SUITE	8.41	0	0.11		0.59		-0.28	NA
	A1 0.5-0.9 m	CHROMIUM SUITE	8.41	0	0.11		0.85		-0.46	NA
	A1 0.9-1.4 m	CHROMIUM SUITE	8.74	0	0.19		2.08		-1.20	NA
	A1 1.4-2.0 m	CHROMIUM SUITE	8.75	0	0.18		2.05		-1.19	NA
A2	A2 0-0.5 m	CHROMIUM SUITE + ANCCarb	8.77	0	<0.01		1.44	3.74	-0.95	NA
	A2 0.5-0.8 m	CHROMIUM SUITE + ANCCarb	9.09	0	0.04		1.37	3.23	-0.87	NA
	A2 0.8-1.3 m	CHROMIUM SUITE + ANCCarb	8.99	0	0.15		2.25	3.47	-1.35	NA
	A2 1.3-1.8 m	CHROMIUM SUITE + ANCCarb	9.02	0	0.07		1.10	2.52	-0.66	NA
A3	A3 0-0.5 m	CHROMIUM SUITE + ANCCarb	9.23	0	0.06		3.61	9.86	-2.35	NA
	A3 0.5-0.9 m	CHROMIUM SUITE + ANCCarb	8.86	0	0.24		8.49	13.57	-5.42	NA
	A3 0.9-1.3 m	CHROMIUM SUITE + ANCCarb	8.84	0	0.28		2.15	8.82	-1.15	NA
	A3 1.3-1.35 m	CHROMIUM SUITE + ANCCarb	8.27	0	0.14		0.62	1.59	-0.27	NA
A4	A 4 0.6-1.1 m	Scr + ANCCarb			0.08			15.33	-10.14	NA
	A 4 1.1-1.6 m	Scr			0.11			14.11	-9.29	NA
	A 4 1.6-2.1 m	Scr + ANCCarb			0.18			12.88	-8.41	NA
	A 4 2.1-2.6 m	Scr			0.25			9.95	-6.38	NA
	A 4 2.6-3.1 m	Scr + ANCCarb			0.34			7.01	-4.33	NA
	A 4 3.0-3.5 m	Scr + ANCCarb			0.19			10.54	-6.84	NA
	A 4 3.5-3.75 m	Scr + ANCCarb			0.16			1.58	-0.89	NA
A5	A5 0-0.5 m	CHROMIUM SUITE + ANCCarb	9.08	0	0.04		4.02	11.78	-2.64	NA
	A5 0.5-1.2 m	CHROMIUM SUITE + ANCCarb	9.08	0	0.06		4.03	13.57	-2.63	NA
	A5 1.2-1.7 m	CHROMIUM SUITE + ANCCarb	9.04	0	0.09		5.02	15.61	-3.26	NA
	A5 1.7-2.0 m	CHROMIUM SUITE + ANCCarb	8.82	0	0.15		5.94	14.62	-3.81	NA
A6	A6 0-0.5 m	CHROMIUM SUITE + ANCCarb	9.07	0	0.06		3.92	18.91	-2.55	NA
	A6 0.5-1.0 m	CHROMIUM SUITE + ANCCarb	8.9	0	0.13		4.71	19.46	-3.01	NA
	A6 1.0-1.6 m	CHROMIUM SUITE + ANCCarb	8.72	0	0.21		3.75	17.05	-2.29	NA
A7	A 7 0-0.5 m	Scr + ANCCarb			0.11			13.97	-9.20	NA
	A 7 0.5-1.0 m	Scr + ANCCarb			0.18			12.20	-7.95	NA
A8	A 8 0-0.5 m	CHROMIUM SUITE	8.94	0	0.06		12.76		-8.45	NA
	A 8 0.5-1.0 m	Scr			0.11		10.24		-6.72	NA
	A 8 1.0-1.5 m	CHROMIUM SUITE	8.78	0	0.09		7.72		-5.06	NA
	A 8 1.5-2.0 m	CHROMIUM SUITE	8.43	0	0.17		4.51		-2.84	NA
	A 8 2.0-2.5 m	CHROMIUM SUITE	8.7	0	0.21		3.86		-2.36	NA
	A 8 2.5-3.0 m	CHROMIUM SUITE	8.5	0	0.22		3.71		-2.25	NA
	A 8 3.0-3.5 m	CHROMIUM SUITE	8.27	0	0.29		4.49		-2.70	NA
	A 8 3.5-3.8 m	CHROMIUM SUITE	8.18	0	0.3		3.37		-1.95	NA
A9	A 9 0-0.5 m	Scr			0.04			9.20	-6.09	NA
	A 9 0.5-1.0 m	Scr + ANCCarb			0.07			9.20	-6.06	NA
	A 9 1.0-1.5 m	Scr + ANCCarb			0.12			7.79	-5.07	NA
	A 9 1.5-2.0 m	Scr + ANCCarb			0.15			5.47	-3.50	NA
	A 9 2.0-2.5 m	Scr + ANCCarb			0.19			4.83	-3.03	NA
	A 9 2.5-3.0 m	Scr + ANCCarb			0.19			2.74	-1.64	NA
	A 9 3.0-3.5 m	Scr + ANCCarb			0.24			2.32	-1.31	NA
A 9 3.5-4.15 m	Scr + ANCCarb			0.19			1.81	-1.02	NA	
A10	A10 0-0.4 m	CHROMIUM SUITE	8.95	0	0.2		8.97		-5.78	NA
	A10 0.4-0.9 m	CHROMIUM SUITE	8.61	0	0.24		7.05		-4.46	NA
	A10 0.9-1.4 m	CHROMIUM SUITE	8.55	0	0.26		6.85		-4.31	NA
	A10 1.4-2.0 m	CHROMIUM SUITE	8.56	0	0.32		5.95		-3.65	NA
A11	A11 0-0.5 m	CHROMIUM SUITE + ANCCarb	9.07	0	0.17		5.81	17.13	-3.70	NA
	A11 0.5-0.7 m	CHROMIUM SUITE + ANCCarb	9.04	0	0.11		5.19	19.84	-3.35	NA
	A11 0.7-1.2 m	CHROMIUM SUITE + ANCCarb	8.71	0	0.22		4.07	14.50	-2.49	NA
	A11 1.2-1.7 m	CHROMIUM SUITE + ANCCarb	8.68	0	0.22		4.52	16.31	-2.79	NA
	A11 1.7-2.0 m	CHROMIUM SUITE + ANCCarb	8.54	0	0.33		6.81	11.40	-4.21	NA
A12	A 12 0-0.5 m	Scr + ANCCarb			0.07			18.14	-12.02	NA
	A 12 0.5-1.0 m	Scr			0.12			11.85	-7.78	NA
	A 12 1.0-1.5 m	Scr + ANCCarb			0.16			5.55	-3.54	NA
	A 12 1.5-2.0 m	Scr + ANCCarb			0.12			7.65	-4.98	NA
	A 12 2.0-2.5 m	Scr + ANCCarb			0.14			5.39	-3.45	NA
	A 12 2.5-3.0 m	Scr + ANCCarb			0.25			3.14	-1.84	NA
	A 12 3.0-3.5 m	Scr + ANCCarb			0.22			4.19	-2.57	NA
A 12 3.5-3.75 m	Scr + ANCCarb			0.26			3.74	-2.23	NA	

CHROMIUM SUITE ACID BASE ACCOUNTING

ANC figures in italics are extrapolated

ABA (1) = Scr - (ANCbt or ANCCarb/1.5)

SHUTE HARBOUR LABORATORY ASS RESULTS SUMMARY



PAGE 12

3rd November 2004

ID	TESTING	pH KCl	s-TAA %S	S Cr %S	s-RAS %S	ANC BT %S	ANC CARB %S	ABA (1)					
								Net Acid %S	Liming (kg lime/m3)				
A13	A 13 0-0.5 m	CHROMIUM SUITE	8.43	0	0.07		11.61		-7.67	NA			
	A 13 0.5-1.0 m								Scr	0.11	10.12	-6.64	NA
	A 13 1.0-1.5 m								CHROMIUM SUITE	0.13	8.63	-5.62	NA
	A 13 1.5-2.0 m								CHROMIUM SUITE	0.19	5.95	-3.78	NA
	A 13 2.0-2.5 m								CHROMIUM SUITE	0.2	0.46	-0.11	NA
	A 13 2.5-3.0 m								CHROMIUM SUITE	0.16	3.16	-1.95	NA
	A 13 3.0-3.5 m								CHROMIUM SUITE	0.23	1.95	-1.07	NA
A 13 3.5-3.75 m	CHROMIUM SUITE	0.22	2.55	-1.48	NA								
A14	A14 0-0.6 m	CHROMIUM SUITE	8.61	0	0.08		12.46		-8.23	NA			
	A14 0.6-1.1 m	CHROMIUM SUITE	8.53	0	0.15		7.75		-5.02	NA			
	A14 1.1-1.6 m	CHROMIUM SUITE	8.48	0	0.18		7.20		-4.62	NA			
	A14 1.6-2.1 m	CHROMIUM SUITE	8.61	0	0.34		5.68		-3.45	NA			
	A14 2.1-2.6 m	CHROMIUM SUITE	8.32	0	0.18		3.74		-2.31	NA			
	A14 2.6-3.1 m	CHROMIUM SUITE	8.39	0	0.52		2.78		-1.33	NA			
A15	A 15 0-0.5 m	Scr			0.14			8.10	-5.26	NA			
	A 15 0.5-1.0 m	Scr + ANCCarb			0.26			8.10	-5.14	NA			
	A 15 1.0-1.5 m	Scr + ANCCarb			0.24			7.10	-4.49	NA			
	A 15 1.5-2.0 m	Scr + ANCCarb			0.25			6.30	-3.95	NA			
	A 15 2.0-2.5 m	Scr + ANCCarb			0.28			4.06	-2.43	NA			
	A 15 2.5-3.0 m	Scr + ANCCarb			0.33			2.80	-1.54	NA			
	A 15 3.0-3.5 m	Scr + ANCCarb			0.51			2.86	-1.40	NA			
A16	A 16 0-0.5 m	Scr + ANCCarb			0.07			16.25	-10.76	NA			
	A 16 0.5-1.0 m	Scr			0.15			12.60	-8.25	NA			
	A 16 1.0-1.5 m	Scr + ANCCarb			<0.01			8.95	-5.96	NA			
	A 16 1.5-2.0 m	Scr			0.21			6.49	-4.11	NA			
	A 16 2.0-2.5 m	Scr + ANCCarb			0.43			4.02	-2.25	NA			
	A 16 2.5-3.0 m	Scr			0.45			3.10	-1.61	NA			
	A 16 3.0-3.5 m	Scr + ANCCarb			0.56			2.17	-0.89	NA			
A 16 3.5-3.75 m	Scr + ANCCarb			0.57			2.86	-1.34	NA				
A17	A17 0-0.5 m	CHROMIUM SUITE	8.53	0	0.14		7.76		-5.03	NA			
	A17 0.5-1.0 m	CHROMIUM SUITE	8.51	0	0.2		6.85		-4.37	NA			
	A17 1.0-1.5 m	CHROMIUM SUITE	8.62	0	0.18		6.57		-4.20	NA			
	A17 1.5-2.0 m	CHROMIUM SUITE	8.57	0	0.18		6.85		-4.39	NA			
	A17 2.0-2.5 m	CHROMIUM SUITE	8.4	0	0.25		6.05		-3.78	NA			
	A17 2.5-3.0 m	CHROMIUM SUITE	8.42	0	0.24		3.10		-1.83	NA			
	A17 3.0-3.5 m	CHROMIUM SUITE	8.24	0	0.3		2.82		-1.58	NA			
A18	A 18 0-0.5 m	CHROMIUM SUITE	8.94	0	0.24		12.50		-8.09	NA			
	A 18 0.5-1.0 m	Scr			0.13		9.38		-6.12	NA			
	A 18 1.0-1.5 m	CHROMIUM SUITE	8.6	0	0.16		6.26		-4.01	NA			
	A 18 1.5-2.0 m	Scr			0.35		4.74		-2.81	NA			
	A 18 2.0-2.5 m	CHROMIUM SUITE	8.3	0	0.27		3.21		-1.87	NA			
	A 18 2.5-3.0 m	Scr			0.38		2.61		-1.36	NA			
	A 18 3.0-3.5 m	CHROMIUM SUITE	8.29	0	0.19		2.01		-1.15	NA			
A 18 3.5-3.75 m	CHROMIUM SUITE	8.17	0	0.26		2.52		-1.42	NA				
A19	A19 0-0.5 m	CHROMIUM SUITE	8.66	0	0.1		10.46		-6.87	NA			
	A19 0.5-1.0 m	CHROMIUM SUITE	8.25	0	0.33		3.80		-2.20	NA			
	A19 1.0-1.5 m	CHROMIUM SUITE	8.62	0	0.15		8.90		-5.78	NA			
	A19 1.5-2.0 m	CHROMIUM SUITE	8.41	0	0.17		7.16		-4.60	NA			
	A19 2.0-2.5 m	CHROMIUM SUITE	8.35	0	0.31		4.60		-2.76	NA			
	A19 2.5-3.0 m	CHROMIUM SUITE	8.34	0	0.36		2.80		-1.51	NA			
	A19 3.0-3.5 m	CHROMIUM SUITE	8.1	0	0.31		2.29		-1.22	NA			
A20	A 20 0-0.5 m	Scr			0.09		6.62		-4.32	NA			
	A 20 0.5-1.0 m	CHROMIUM SUITE	8.7	0	0.11		6.62		-4.30	NA			
	A 20 1.0-1.5 m	Scr			0.29		5.27		-3.22	NA			
	A 20 1.5-2.0 m	CHROMIUM SUITE	8.39	0	0.29		3.92		-2.32	NA			
	A 20 2.0-2.5 m	Scr			0.46		4.03		-2.22	NA			
	A 20 2.5-3.0 m	CHROMIUM SUITE	8.38	0	0.32		4.13		-2.43	NA			
	A 20 3.0-3.5 m	CHROMIUM SUITE	7.9	0	0.33		2.09		-1.06	NA			
A21	A 21 0-0.5 m	Scr + ANCCarb			0.07			19.10	-12.66	NA			
	A 21 0.5-1.0 m	Scr			0.13			13.11	-8.61	NA			
	A 21 1.0-1.5 m	Scr + ANCCarb			0.13			7.12	-4.62	NA			
	A 21 1.5-2.0 m	Scr + ANCCarb			0.18			5.28	-3.34	NA			
	A 21 2.0-2.5 m	Scr + ANCCarb			0.19			2.61	-1.55	NA			
	A 21 2.5-3.0 m	Scr + ANCCarb			0.21			1.82	-1.00	NA			
	A 21 3.0-3.5 m	Scr + ANCCarb			0.16			1.60	-0.91	NA			

CHROMIUM SUITE ACID BASE ACCOUNTING

ANC figures in italics are extrapolated

ABA (1) = Scr - (ANCbt or ANCCarb/1.5)

SHUTE HARBOUR LABORATORY ASS RESULTS SUMMARY



3rd November 2004

ID	TESTING	pH KCl	s-TAA %S	S Cr %S	s-RAS %S	ANC BT %S	ANC CARB %S	ABA (1)	
								Net Acid %S	Liming (kg lime/m3)
A22	A 22 0-0.5 m	Scr		0.09		6.56		-4.28	NA
	A 22 0.5-1.0 m	CHROMIUM SUITE	8.5	0	0.18	6.56		-4.19	NA
	A 22 1.0-1.5 m	CHROMIUM SUITE	8.71	0	0.25	5.81		-3.62	NA
	A 22 1.5-2.0 m	CHROMIUM SUITE	8.4	0	0.21	3.84		-2.35	NA
	A 22 2.0-2.5 m	CHROMIUM SUITE	8.31	0	0.24	3.17		-1.87	NA
	A 22 2.5-3.0 m	CHROMIUM SUITE	8.27	0	0.09	3.08		-1.96	NA
	A 22 3.0-3.5 m	CHROMIUM SUITE	8.24	0	0.21	2.40		-1.39	NA
A23	A 23 0-0.5 m	CHROMIUM SUITE	8.84	0	0.08	8.01		-5.26	NA
	A 23 0.5-1.0 m	Scr		0.18		7.21		-4.62	NA
	A 23 1.0-1.5 m	CHROMIUM SUITE	8.6	0	0.19	6.40		-4.08	NA
	A 23 1.5-2.0 m	Scr		0.28		5.16		-3.16	NA
	A 23 2.0-2.5 m	CHROMIUM SUITE	8.43	0	0.43	3.92		-2.18	NA
	A 23 2.5-3.0 m	Scr		0.31		3.27		-1.87	NA
	A 23 3.0-3.5 m	CHROMIUM SUITE	8.3	0	0.33	2.62		-1.42	NA
	A 23 3.5-4.0 m	Scr		0.36		2.45		-1.27	NA
A 23 4.0-4.25 m	CHROMIUM SUITE	8.11	0	0.34	2.27		-1.17	NA	
A24	A 24 0-0.5 m	CHROMIUM SUITE	8.95	0	0.08	10.52		-6.93	NA
	A 24 0.5-1.0 m	Scr		0.15		7.22		-4.66	NA
	A 24 1.0-1.5 m	CHROMIUM SUITE	8.48	0	0.2	3.92		-2.41	NA
	A 24 1.5-2.0 m	Scr		0.24		3.64		-2.18	NA
	A 24 2.0-2.5 m	CHROMIUM SUITE	8.48	0	0.23	3.35		-2.00	NA
	A 24 2.5-3.0 m	Scr		0.36		3.02		-1.65	NA
	A 24 3.0-3.5 m	CHROMIUM SUITE	8.4	0	0.16	2.68		-1.63	NA
A25	A 25 0-0.5 m	Scr + ANCCarb		0.12			13.29	-8.74	NA
	A 25 0.5-1.0 m	Scr		0.17			10.31	-6.70	NA
	A 25 1.0-1.5 m	Scr + ANCCarb		0.32			7.32	-4.56	NA
	A 25 1.5-2.0 m	Scr		0.35			5.90	-3.58	NA
	A 25 2.0-2.5 m	Scr + ANCCarb		0.42			4.47	-2.56	NA
	A 25 2.5-3.0 m	Scr + ANCCarb		0.47			2.66	-1.30	NA
	A 25 3.0-3.5 m	Scr + ANCCarb		0.53			2.77	-1.32	NA
A26	A 26 0-0.5 m	Scr + ANCCarb		0.12			15.81	-10.42	NA
	A 26 0.5-1.0 m	Scr		0.34			10.92	-6.94	NA
	A 26 1.0-1.5 m	Scr + ANCCarb		0.64			6.03	-3.38	NA
	A 26 1.5-2.0 m	Scr		0.67			4.62	-2.41	NA
	A 26 2.0-2.5 m	Scr + ANCCarb		0.83			3.20	-1.30	NA
	A 26 2.5-3.0 m	Scr + ANCCarb		0.84			3.16	-1.27	NA
	A 26 3.0-3.25 m	Scr + ANCCarb		0.79			2.99	-1.20	NA
A27	A 27 0-0.5 m	Scr + ANCCarb		0.05			14.34	-9.51	NA
	A 27 0.5-1.0 m	Scr		0.16			10.91	-7.11	NA
	A 27 1.0-1.5 m	Scr + ANCCarb		0.34			7.48	-4.65	NA
	A 27 1.5-2.0 m	Scr		0.39			5.51	-3.28	NA
	A 27 2.0-2.5 m	Scr + ANCCarb		0.36			3.53	-1.99	NA
	A 27 2.5-3.0 m	Scr		0.48			2.94	-1.48	NA
	A 27 3.0-3.5 m	Scr + ANCCarb		0.42			2.34	-1.14	NA
A28	A 28 0-0.5 m	Scr		0.18			10.44	-6.78	NA
	A 28 0.5-1.0 m	Scr + ANCCarb		0.19			10.44	-6.77	NA
	A 28 1.0-1.5 m	Scr		0.24			8.43	-5.38	NA
	A 28 1.5-2.0 m	Scr + ANCCarb		0.28			6.42	-4.00	NA
	A 28 2.0-2.5 m	Scr		0.59			4.98	-2.73	NA
	A 28 2.5-3.0 m	Scr + ANCCarb		0.62			3.53	-1.73	NA
	A 28 3.0-3.5 m	Scr + ANCCarb		0.72			3.01	-1.29	NA
A29	A 29 0-0.5 m	Scr		0.23		6.03		-3.79	NA
	A 29 0.5-1.0 m	CHROMIUM SUITE	8.08	0	0.12	6.03		-3.90	NA
	A 29 1.0-1.5 m	Scr		0.36		5.22		-3.12	NA
	A 29 1.5-2.0 m	CHROMIUM SUITE	8.28	0	0.19	4.40		-2.74	NA
	A 29 2.0-2.5 m	Scr		0.55		3.82		-1.99	NA
	A 29 2.5-3.0 m	CHROMIUM SUITE	7.88	0	0.93	3.23		-1.22	NA
	A 29 3.0-3.5 m	CHROMIUM SUITE	7.83	0	1.01	2.88		-0.91	NA
A 29 3.5-3.75 m	CHROMIUM SUITE	8.01	0	0.94	2.56		-0.77	NA	
A30	A 30 0-0.5 m	CHROMIUM SUITE	8.48	0	0.19	4.88		-3.06	NA
	A 30 0.5-1.0 m	Scr		0.13		5.16		-3.31	NA
	A 30 1.0-1.5 m	CHROMIUM SUITE	8.21	0	0.39	5.43		-3.23	NA
	A 30 1.5-2.0 m	Scr		0.23		4.98		-3.09	NA
	A 30 2.0-2.5 m	CHROMIUM SUITE	7.68	0	0.56	4.52		-2.45	NA
	A 30 2.5-3.0 m	CHROMIUM SUITE	7.9	0	0.61	3.81		-1.93	NA
	A 30 3.0-3.5 m	CHROMIUM SUITE	8.06	0	0.62	3.40		-1.65	NA

CHROMIUM SUITE ACID BASE ACCOUNTING

ANC figures in italics are extrapolated

ABA (1) = Scr - (ANCbt or ANCCarb/1.5)

SHUTE HARBOUR LABORATORY ASS RESULTS SUMMARY



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ID	TESTING	pH KCl	s-TAA %S	S Cr %S	s-RAS %S	ANC BT %S	ANC CARB %S	ABA (1)	
								Net Acid %S	Liming (kg lime/m3)
A31	A 31 0-0.5 m			0.12			11.29	-7.41	NA
	A 31 0.5-1.0 m			0.15			11.29	-7.38	NA
	A 31 1.0-1.5 m			0.27			8.80	-5.59	NA
	A 31 1.5-2.0 m			0.32			6.30	-3.88	NA
	A 31 2.0-2.5 m			0.41			5.47	-3.24	NA
	A 31 2.5-3.0 m			0.44			4.64	-2.65	NA
	A 31 3.0-3.5 m			0.5			3.84	-2.06	NA
A32	A 32 0-0.5 m	8.67	0	0.15		5.18		-3.30	NA
	A 32 0.5-1.0 m			0.24		4.99		-3.09	NA
	A 32 1.0-1.5 m	8.3	0	0.49		4.80		-2.71	NA
	A 32 1.5-2.0 m			0.39		3.76		-2.12	NA
	A 32 2.0-2.5 m	8.1	0	0.63		2.72		-1.18	NA
	A 32 2.5-3.0 m	7.72	0	0.67		5.47		-2.98	NA
	A 32 3.0-3.5 m	7.71	0	0.81		1.98		-0.51	NA
A33	A 33 0-0.5 m			0.1		8.54		-5.59	NA
	A 33 0.5-1.0 m	8.67	0	0.26		8.54		-5.43	NA
	A 33 1.0-1.5 m			0.27		6.66		-4.17	NA
	A 33 1.5-2.0 m	8.43	0	0.55		4.77		-2.63	NA
	A 33 2.0-2.5 m			0.44		3.71		-2.03	NA
	A 33 2.5-3.0 m	8.27	0	0.29		2.64		-1.47	NA
	A 33 3.0-3.25 m	8.16	0	0.12		2.20		-1.35	NA
A34	A 34 0-0.5 m			0.24			9.26	-5.93	NA
	A 34 0.5-1.0 m			0.28			8.55	-5.42	NA
	A 34 1.0-1.5 m			0.41			7.83	-4.81	NA
	A 34 1.5-2.0 m			0.6			6.18	-3.52	NA
	A 34 2.0-2.5 m			0.72			4.53	-2.30	NA
	A 34 2.5-3.0 m			0.87			3.36	-1.37	NA
	A 34 3.0-3.5 m			0.57			1.90	-0.70	NA
	A 34 3.5-4.0 m			0.82			2.61	-0.92	NA
A35	A 35 0-0.5 m			0.24			10.20	-6.56	NA
	A 35 0.5-1.0 m			0.22			10.20	-6.58	NA
	A 35 1.0-1.5 m			0.41			8.07	-4.97	NA
	A 35 1.5-2.0 m			0.44			5.93	-3.51	NA
	A 35 2.0-2.5 m			0.65			4.48	-2.34	NA
	A 35 2.5-3.0 m			0.55			3.90	-2.05	NA
	A 35 3.0-3.5 m			0.78			3.17	-1.33	NA
	A 35 3.5-3.75 m			0.88			3.48	-1.44	NA
A36	A 36 0-0.5 m			0.07			10.18	-6.72	NA
	A 36 0.5-1.0 m			0.18			10.18	-6.61	NA
	A 36 1.0-1.5 m			0.22			6.90	-4.38	NA
	A 36 1.5-2.0 m			0.2			3.61	-2.21	NA
	A 36 2.0-2.5 m			0.45			5.23	-3.04	NA
	A 36 2.5-3.0 m			0.42			4.80	-2.78	NA
	A 36 3.0-3.5 m			0.43			4.60	-2.64	NA
	A37	A 37 0-0.5 m			0.12		4.82		-3.09
A37 0.5-1.0 m		7.98	0	0.2		4.82		-3.01	NA
A 37 1.0-1.5 m				0.28		4.23		-2.54	NA
A 37 1.5-2.0 m		7.87	0	0.19		3.63		-2.23	NA
A 37 2.0-2.5 m		7.74	0	0.25		3.29		-1.94	NA
A 37 2.5-3.0 m		7.74	0	0.35		3.28		-1.84	NA
A 37 3.0-3.5 m		7.62	0	0.84		2.62		-0.91	NA
A38	A 38 0-0.5 m	8.06	0	0.19		4.73		-2.96	NA
	A 38 0.5-1.0 m			0.4		4.85		-2.83	NA
	A 38 1.0-1.5 m	8.01	0	0.2		4.96		-3.11	NA
	A 38 1.5-2.0 m			0.37		4.48		-2.62	NA
	A 38 2.0-2.5 m	7.78	0	0.58		4.00		-2.09	NA
	A 38 2.5-3.0 m	7.21	0	0.35		2.23		-1.14	NA
	A 38 3.0-3.5 m	7.94	0	0.46		2.79		-1.40	NA
A39	A 39 0-0.5 m			0.07			10.99	-7.26	NA
	A 39 0.5-1.0 m			0.16			10.99	-7.17	NA
	A 39 1.0-1.5 m			0.29			8.41	-5.31	NA
	A 39 1.5-2.0 m			0.36			5.82	-3.52	NA
	A 39 2.0-2.5 m			0.27			4.96	-3.03	NA
	A 39 2.5-3.0 m			0.46			4.09	-2.27	NA
	A 39 3.0-3.25 m			0.27			3.21	-1.87	NA

CHROMIUM SUITE ACID BASE ACCOUNTING

ANC figures in italics are extrapolated

ABA (1) = Scr - (ANCbt or ANCCarb/1.5)

SHUTE HARBOUR LABORATORY ASS RESULTS SUMMARY



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ID	TESTING	pH KCl	s-TAA %S	S Cr %S	s-RAS %S	ANC BT %S	ANC CARB %S	ABA (1)	
								Net Acid %S	Liming (kg lime/m3)
A40	A 40 0-0.5 m	9.13	0	0.05		6.30		-4.15	NA
	A 40 0.5-1.0 m			0.06		11.44		-7.57	NA
	A 40 1.0-1.5 m	8.77	0	0.15		16.58		-10.90	NA
	A 40 1.5-2.0 m	9.23	0	0.14		8.23		-5.35	NA
	A 40 2.0-2.5 m	8.52	0	0.17		2.48		-1.48	NA
	A 40 2.5-3.0 m	8.35	0	0.24		2.60		-1.49	NA
A41	A 41 0-0.5 m			0.11			7.84	-5.12	NA
	A 41 0.5-1.0 m			0.2			7.84	-5.03	NA
	A 41 1.0-1.5 m			0.39			6.79	-4.13	NA
	A 41 1.5-2.0 m			0.31			5.73	-3.51	NA
	A 41 2.0-2.5 m			0.35			5.08	-3.03	NA
	A 41 2.5-3.0 m			0.38			4.42	-2.57	NA
	A 41 3.0-3.5 m			0.56			3.51	-1.78	NA
	A 41 3.5-3.75 m			0.67			2.60	-1.06	NA
A42	A 42 0-0.5 m	8.37	0	0.25		4.89		-3.01	NA
	A 42 0.5-1.0 m	8.8	0	0.26		4.87		-2.99	NA
	A 42 1.0-1.5 m			0.46	4.85	-2.77	NA		
	A 42 1.5-2.0 m	8.02	0	0.28		4.18		-2.51	NA
	A 42 2.0-2.5 m			0.66	3.51	-1.68	NA		
	A 42 2.5-3.0 m	7.73	0	0.48		3.16		-1.63	NA
	A 42 3.0-3.5 m			0.8	2.81	-1.07	NA		
	A 42 3.5-3.75 m	7.96	0	0.85		2.38		-0.74	NA
A43	A 43 0-0.5 m			0.09			10.96	-7.22	NA
	A 43 0.5-1.0 m			0.12			9.55	-6.24	NA
	A 43 1.0-1.5 m			0.25			8.13	-5.17	NA
	A 43 1.5-2.0 m			0.24			6.29	-3.95	NA
	A 43 2.0-2.5 m			0.31			4.45	-2.66	NA
	A 43 2.5-3.0 m			0.45			3.98	-2.20	NA
	A 43 3.0-3.5 m			0.45			3.50	-1.88	NA
A44	A 44 0-0.5 m			0.11			8.48	-5.54	NA
	A 44 0.5-1.0 m			0.14			8.48	-5.51	NA
	A 44 1.0-1.5 m			0.34			6.94	-4.29	NA
	A 44 1.5-2.0 m			0.37			5.98	-3.62	NA
	A 44 2.0-2.5 m			0.48			4.40	-2.45	NA
	A 44 2.5-3.0 m			0.39			3.76	-2.12	NA
	A 44 3.0-3.5 m			0.54			3.91	-2.07	NA
A45	A 45 0-0.5 m			0.04			12.49	-8.29	NA
	A 45 0.5-1.0 m			0.15			12.20	-7.98	NA
	A 45 1.0-1.5 m			0.22			6.94	-4.41	NA
	A 45 1.5-2.0 m			0.35			5.51	-3.32	NA
	A 45 2.0-2.5 m			0.41			4.21	-2.40	NA
	A 45 2.5-3.0 m			0.46			4.80	-2.74	NA
	A 45 3.0-3.25 m			0.32			3.48	-2.00	NA
	A46			A 46 0-0.5 m					0.15
A 46 0.5-1.0 m		0.17	7.24	-4.66	NA				
A 46 1.0-1.5 m		0.23	6.27	-3.95	NA				
A 46 1.5-2.0 m		0.18	5.30	-3.35	NA				
A 46 2.0-2.5 m		0.39	4.29	-2.47	NA				
A 46 2.5-3.0 m		0.41	3.28	-1.78	NA				
A 46 3.0-3.5 m		0.27	2.97	-1.71	NA				
A 46 3.5-4.0 m		0.25	2.46	-1.39	NA				
A47	A 47 0-0.5 m			0.07			8.06	-5.30	NA
	A 47 0.5-1.0 m			0.11			8.37	-5.47	NA
	A 47 1.0-1.5 m			0.19			6.69	-4.27	NA
	A 47 1.5-2.0 m			0.38			6.16	-3.73	NA
	A 47 2.0-2.5 m			0.3			4.20	-2.50	NA
	A 47 2.5-3.0 m			0.52			3.27	-1.66	NA
	A 47 3.0-3.5 m			0.58			2.68	-1.21	NA
	A 47 3.5-3.75 m			0.64			2.31	-0.90	NA
A48	A 48 0-0.5 m			0.1			5.59	-3.63	NA
	A 48 0.5-1.0 m			0.28			5.59	-3.45	NA
	A 48 1.0-1.5 m			0.4			4.58	-2.65	NA
	A 48 1.5-2.0 m			0.48			3.57	-1.90	NA
	A 48 2.0-2.5 m			0.54			2.97	-1.44	NA
	A 48 2.5-3.0 m			0.55			2.92	-1.40	NA
	A 48 3.0-3.5 m			0.6			2.41	-1.01	NA
	A 48 3.5-3.75 m			0.59			2.39	-1.00	NA

CHROMIUM SUITE ACID BASE ACCOUNTING

ANC figures in italics are extrapolated

ABA (1) = Scr - (ANCbt or ANCCarb/1.5)

SHUTE HARBOUR LABORATORY ASS RESULTS SUMMARY



3rd November 2004

ID	TESTING	pH KCl	s-TAA %S	S Cr %S	s-RAS %S	ANC BT %S	ANC CARB %S	ABA (1)	
								Net Acid %S	Liming (kg lime/m3)
A49	A 49 0-0.5 m	8.9	0	0.1		4.18		-2.69	NA
	A 49 0.5-1.0 m			Scr		0.28		3.93	-2.34
	A 49 1.0-1.5 m	8.5	0	0.41		3.68		-2.04	NA
	A 49 1.5-2.0 m			Scr		0.44		4.74	-2.72
	A 49 2.0-2.5 m	8.28	0	0.44		5.80		-3.43	NA
	A 49 2.5-3.0 m			CHROMIUM SUITE		0.46		2.64	-1.30
	A 49 3.0-3.5 m	8.21	0	0.55		2.29		-0.98	NA
	A 49 3.5-3.75 m			CHROMIUM SUITE		0.55		2.42	-1.06
A50	A 50 0-0.5 m	8.68	0	0.1		5.71		-3.71	NA
	A 50 0.5-1.0 m			CHROMIUM SUITE		0.22		5.71	-3.59
	A 50 1.0-1.5 m	8.34	0	0.3		4.57		-2.75	NA
	A 50 1.5-2.0 m			CHROMIUM SUITE		0.37		3.43	-1.92
	A 50 2.0-2.5 m	8.26	0	0.46		3.14		-1.63	NA
	A 50 2.5-3.0 m			CHROMIUM SUITE		0.52		2.85	-1.38
	A 50 3.0-3.5 m	8.27	0	0.5		2.96		-1.47	NA
	A 50 3.5-3.75 m			CHROMIUM SUITE		0.49		2.52	-1.19
A51	A 51 0-0.5 m	8.85	0	0.09		4.92		-3.19	NA
	A 51 0.5-1.0 m			Scr		0.2		4.41	-2.74
	A 51 1.0-1.5 m	8.44	0	0.33		3.89		-2.26	NA
	A 51 1.5-2.0 m			Scr		0.39		3.71	-2.08
	A 51 2.0-2.5 m	8.31	0	0.47		3.53		-1.88	NA
	A 51 2.5-3.0 m			CHROMIUM SUITE		0.46		3.04	-1.57
	A 51 3.0-3.5 m	CHROMIUM SUITE	8.2	0	0.5			3.09	-1.56
A52	A 52 0.0-0.15 m	4.76	0.04	<0.01	<0.01			0.04	NA
A53	A 53 0.0-0.15 m	5.45	0.02	<0.01	<0.01			0.02	NA
A54	A 54 0.0-0.3 m	5.68	0.01	<0.01	<0.01			0.01	NA

CHROMIUM SUITE ACID BASE ACCOUNTING

ANC figures in italics are extrapolated

$$ABA (1) = Scr - (ANCbt \text{ or } ANCCarb/1.5)$$

APPENDIX B

Corrective Action Request Form

CORRECTIVE ACTION REQUEST

Report No: _____

Date: _____

DETAILS OF NON-CONFORMANCE:

Inspected by:

DETAILS OF PROPOSED ACTION

Passed to Principal (as applicable):y/n
Reply required by:

Date:

PRINCIPAL ADVICE (as required):

Date action required by (if applicable):
Signed:

Date:

AUTHORITY TO PROCEED

Sign:

Date:

ACTION CARRIED OUT

Sign:

Date:

ELEMENT RE-INSPECTED BY

Sign:

Date:

COPY ISSUED TO PROPONENT

Date:

Sign: