FLANAGAN CONSULTING GROUP

DEVELOPMENT CONSULTANTS • MANAGERS • ENGINEERS • PLANNERS

PROJECT NO: 5625/04

ACID SULFATE SOIL MANAGEMENT PLAN FOR URBAN LAND DEVELOPMENT AUTHORITY

OONOONBA URBAN LAND DEVELOPMENT AREA

5625/04
R-CD0091
SEPT 2010

ACID SULFATE SOIL MANAGEMENT PLAN

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1.0 INTRODUCTION

1.1 Background

This Acid Sulfate Soil Management Plan (ASSMP) has been prepared to manage acid sulfate soil for the proposed urban development of the Oonoonba Urban Land Development Area (the site). The site is described as Lot 51 on K103928 and its location is shown on Figure 1.

The site is 82.96ha in size and is generally at or below 5m AHD. It is bound by Ross River to the north and west, Fairfield Waters housing estate to the south and the existing Abbott Street road corridor to the east. The study area does not include a portion of the site in the south-east corner designated as future road corridor for the Abbott Street upgrade. A site plan has been included as Figure 2.

Given the site is largely at or below 5m AHD, and significant filling and excavation works will be undertaken as part of the proposed development, an acid sulfate soil investigation was required as per the *State Planning Policy 2/02 Guideline: Acid Sulfate Soil*. This investigation was completed by AECOM in July 2010. The results of the AECOM investigation indicated the presence of actual and potential acid sulfate soil and it is expected more than 500m^3 of acid sulfate soil will be disturbed and/or potentially impacted by filling activities and, as such, an ASSMP is required.

Flanagan Consulting Group (FCG) has been commissioned by the Urban Land Development Authority (ULDA) to develop the ASSMP.

The ASSMP has been based on the results of previous work by AECOM and Douglas Partners in 2010 with reference to the applicable guidelines and legislation.

1.2 Limitations

This ASSMP has been largely based on data collected by AECOM, Douglas Partners and Brazier Motti. FCG has utilised the data collected by other consultants to develop an ASSMP which is considered to adequately address the issues defined by the results of previous investigations.

This ASSMP has largely been developed on the interpretation of AECOM's and Douglas Partners' observations, results and analyses and a limited number of samples which may not represent all subsurface conditions. Where it is considered an unacceptable level of risk is present, FCG has recommended additional work be undertaken to reduce the level of risk of adverse impacts from acid sulfate soil during construction works.

FCG is not responsible for the results reported, work previously conducted by others or site conditions which are different from that reported in the AECOM and Douglas Partners reports.

An ASSMP is a "live" document and should be amended, as required, when new pertinent information becomes available.

2.0 REGULATORY FRAMEWORK

Compliance with a number of legislative and regulatory requirements will be necessary to meet the environmental requirements of the project.

Legislation and guidelines that may be applicable to this ASSMP includes:

- *Environmental Protection Act*, 1994;
- *Environmental Protection (Water) Policy*, 1997;
- *Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils in Queensland*, 1998 (QASSIT guidelines);
- *Queensland Acid Sulfate Soil Technical Manual Soil Management Guidelines*, 2002;
- *Queensland Acid Sulfate Soil Technical Manual Acid Sulfate Soil Laboratory Methods Guidelines*, 2004; and
- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, 2000.

3.0 PREVIOUS WORK

The following documents were reviewed in order to gain available data relating to the soil lithology and acid sulfate soil characteristics of the site:

- *Acid Sulfate Soil Investigation for the Proposed Oonoonba Urban Land Development Site* (AECOM 2010);
- *Factual Report on Geotechnical Investigation – DPI Site Off Abbott Street Oonoonba* (Douglas Partners 2010); and
- *Digital Data Proof Plot Only, Oonoonba DPI Data Compilation* – Drawing number 29060/003A (Brazier Motti 2010).

Raw data contained within these documents was interpreted to derive cross-sectional sketches and ultimately to define the existing acid sulfate soil regime on the site.

3.1 AECOM 2010

AECOM 2010 **(APPENDIX A)** presented the acid sulfate soil test results and was the primary resource used in defining the acid sulfate soil regime. The report outlined potential development activities, general geological and groundwater characteristics and the methodology, results and recommendations of the acid sulfate soil investigation.

The AECOM 2010 investigation comprised:

- Collection of soil samples at 0.25m intervals up to 3m depth at 39 locations as shown on Figure 2;
- Limited lithological description of samples;
- Field tests of pH_f and pH_{FOX} on all samples;
- Selection and submission of 95 samples for analysis for acid base accounting utilising the chromium suite and/or the SPOCAS suite analytical methods; and
- Tabulation of basic lithological descriptions, field and laboratory results and lime treatment rates (kg/t).

AECOM 2010 concluded:

- Groundwater ingress into test pits was observed at 1.5m - 3m below ground surface across the property;
- Approximately 30% of samples had a pH change of >2 indicating the potential for acid sulfate soil;
- No pH_{FOX} values <3 which strongly indicates the presence of potential acid sulfate soil (PASS);
- Distribution of acid sulfate soil does not appear to be confined to specific lithological units;
- Net acidity of actual acid sulfate soil (AASS) located close to surface is at or near action trigger level of 0.03%S;
- Net acidity of actual acid sulfate soil at depth varies more greatly from 0.03%S to 0.37%S;
- The level of treatment of AASS and PASS is likely to be in the range of medium to high due to the probable volume of acid sulfate material that may be disturbed;
- Muddy sands across the site generally have a high acid neutralising capacity which in some areas is sufficient to neutralise the acidity present;
- Dewatering on site, if required, may expose PASS to oxidation and AASS to further oxidation and treatment may be required. Dewatering will require a dewatering management plan; and
- Additional mobilisation of acidity in groundwater may result from fill loading in areas where AASS is present.

AECOM 2010 made the following generalised recommendations:

- An ASSMP should be developed;
- Impacts from the disturbance of shallow acid sulfate soil is considered to have a low environmental risk while dewatering areas where acid sulfate soil is present at depth has a potentially higher environmental risk;
- The management of site runoff and infiltration will require ample consideration during construction; and
- An ASSMP for excavation work should include a comprehensive field testing procedure as acid sulfate soil does not appear to be confined to specific lithologies across the site.

3.2 Douglas Partners 2010

Douglas Partners 2010 **(APPENDIX B)** completed a geotechnical investigation on the site. The report provided information on the subsurface and some groundwater conditions at the site for planning purposes.

The Douglas Partners 2010 geotechnical investigation comprised of 17 static cone penetration tests (CPT) and 8 test pits (TP) with dynamic cone penetrometer tests.

Disturbed and undisturbed samples were collected for geotechnical analysis and logs completed.

3.3 Brazier Motti 2010

Brazier Motti's detailed survey plan **(APPENDIX C)** was used to determine the topographical features of the site and to determine the existing ground surface horizon for the cross-section sketches.

4.0 ACID SULFATE SOIL REGIME ASSESSMENT

4.1 Methodology

FCG have taken the following approach in determining the existing acid sulfate soil regime on site:

- Review and quality assurance assessment of collected raw data;
- Assess and define the lithology and subsurface conditions by cross-correlating results of the acid sulfate analysis with determined lithologies in AECOM 2010 and the results of the CPT or TP logs from Douglas Partners 2010;
- Compile and interpret cross-sections of lithology and acid sulfate soil to assist in defining the acid sulfate soil regime;
- Review cross-sections to compile a plan which shows defined zones of the acid sulfate soil regime; and
- Integration of civil development constraints.

4.2 Results

4.2.1 Review

The number of sample points and analyses in AECOM 2010 are less than that specified in the QASSIT guidelines but were considered sufficient to allow definition of the overall acid sulfate soil regime with a reasonable level of certainty. Additional work (as defined in Section 10) is required in some specific areas to better define the regime and refine the approach and strategies.

Review of AECOM 2010 indicated there were some inconsistencies in their interpretation of actual and potential acid sulfate soil. Where necessary, the classification of actual or potential acid sulfate soil from the laboratory data has been reclassified or reinterpreted to reflect the actual and potential acid sulfate soil as shown in the cross-sections (Figure 3 – Figure 5).

The reclassified samples are listed in the table below:

Sample (Pit ID / Depth)	AECOM Interpretation	FCG Reclassification	Basis for Reclassification
1 / 1.0	PASS	Marginal AASS	pH of 5.7
2 / 0.25	PASS	Marginal AASS	pH of 5.1
2 / 1.25	PASS	Marginal AASS	Isolated with pH of 6.0
6A / 0.25	Marginal PASS	Marginal AASS	pH of 5.4
11 / 0.75	PASS	Marginal AASS	pH of 5.7
13 / 1.5	PASS	Disregarded	Isolated marginal PASS
16B / 1.75	AASS	PASS	Isolated marginal AASS
16B / 2.25	AASS	PASS	Isolated marginal AASS
19 / 0.5	PASS	Marginal AASS	pH of 5.8
28 / 1.0	PASS	Disregarded	Isolated marginal PASS
28 / 2.5	PASS	AASS	pH of 4.7
30 / 0.75	PASS	Disregarded	Isolated marginal PASS

4.2.2 Lithology and Subsurface Conditions

There is a moderate correlation in the lithology between AECOM 2010 and Douglas Partners 2010. Due to the limited number of TP logs and complete geological profiles only a general lithological interpretation can be provided as shown on the cross-sections (Figure 3 – Figure 5).

The subsurface lithology can be summarised as shown in the following table:

Depth	Lithology Characteristic
Surface to 2m AHD	Clayey unit (present only in the vicinity of the drainage line traversing north/south across the site)
Surface to 0m AHD (and underlying clayey unit above)	Silty/sandy unit
0m AHD to beyond -3m AHD:	Clayey unit

Limited information is available to define soil colour and moisture content or groundwater conditions across the site. Intuitively it is reasonable to expect groundwater is likely to be present at 1m - 3m AHD, increasing in depth proximal to Ross River.

4.2.3 Cross-Sections

The transects of three cross-sections (A - A1, B - B1, C - C1) are shown on Figure 2. The three cross-sections have been produced showing inferred lithological boundaries and the inferred actual and potential acid sulfate soil boundaries.

Where a sample location for assessment of acid sulfate soil also had a corresponding TP log or CPT log from the Douglas Partners 2010 report, the sample location was allocated a TP or CPT nomenclature respectively. Where only acid sulfate soil analyses were undertaken and no geotechnical information was available, the sample location was allocated an AS prefix (e.g. AS3).

The cross-sections are shown as Figure 3 (A - A1), Figure 4 (B - B1) and Figure 5 (C–C1).

4.2.4 Zoning

Interpretation of the cross-sections showed there were 4 zones of distinct acid sulfate soil regime as shown on Figure 6 and summarised as follows:

Management Zone A: Marginal actual acid sulphate soil (AASS) at/near ground surface;

Management Zone B: Potential acid sulphate soil (PASS) at 1.25m to more than 3m below ground surface;

Management Zone C: Actual acid sulphate soil (AASS) at a depth of 1.75m to at least 3m below ground surface.

Management Zone D: Potential acid sulfate soil (PASS) at surface to depths of up to 1.5m below ground surface.

A more detailed description of the zones is presented below.

Management Zone A

Zone A contains AASS, generally at 0.03% sulfur and up to 0.04% sulfur, at or near ground level to 1.25m depth below ground level. The AASS in Zone A ranges from 4.5m AHD to 2.75m AHD and is likely a result of disturbance to PASS utilized to create building pads for the existing development on the site.

The near surface AASS in Zone A is marginal and considered to pose a low environmental risk unless large volumes of soil are disturbed. It will likely have a negative impact on vegetative growth if not treated.

It is possible that acid sulfate soil is also present at depth of greater than 3m below ground surface which should be assessed if excavation below 3m depth is to be considered in Zone A.

Management Zone B

Zone B contains PASS (up to 0.17% sulfur) at a depth of 1.25m to 3m below ground level. The PASS in this Zone ranges from 4.5m AHD to 1.5m AHD and is a likely result of disturbance to natural PASS utilized to create building pads and development on the site.

It is considered the environmental risk posed by PASS in Zone B is low to moderate.

Zone C

Zone C contains AASS (up to 0.09% sulfur) at a depth of 1.75m to at least 3m below ground level. The AASS in this Zone ranges from 2m AHD to at least -0.5m AHD. It is unusual to have AASS at depth and the exact reason for its occurrence is unknown. The AASS in Zone C is likely attributable to a lower groundwater level or a previously exposed surface.

AASS in Zone C presents a low to moderate environmental risk. The groundwater regime is not well understood and it is possible preloading and filling in this area may induce a pulse of acidic groundwater which might have an adverse impact on the environment.

Zone D

Zone D contains PASS (up to 0.42% sulfur) at or near ground level to a depth of 1.5m below ground level. PASS in this Zone ranges from 4.5m AHD to 0m AHD and is considered to pose a moderate environmental risk.

4.2.5 Integration of Civil Engineering Constraints

The acid sulfate soil regime was workshopped with the FCG's Civil Design Team to assist incorporation of constraints from civil works. FCG's Civil Design Team provided preliminary information on:

- Development staging;
- Preliminary layout of Stage 1; and
- Likely preload and filling zones.

The FCG Civil Design Team advised the following:

- The proposed development, subject to approval, would commence with Stage 1 along the western boundary of the site and it would be preferred if a treatment area for acid sulfate soil was located proximal to this phase of proposed development;

- Preloading and filling would likely be undertaken in the eastern low-lying area of Zone C;

- Infrastructure for stormwater and drainage would be located close to, or at, surface and minimal excavation would be undertaken; and

- Infrastructure for sewerage may be required to depths of up to 4m below ground surface but was largely undefined at this stage.

5.0 MANAGEMENT STRATEGIES AND PROCEDURES

Section 5.1 contains an overview of general management procedures and the selection of proposed treatment areas to manage neutralisation of acid sulfate materials encountered on site during construction.

Section 5.2 to Section 5.6 specifies the management strategies for each of the management zones (Zone A – Zone D) and strategies for dewatering.

5.1 General Management Procedures

5.1.1 Objectives

The objectives of the management procedures are to:

- Appropriately treat and manage acid sulfate material so as to minimise adverse effects on the natural and built environment (including infrastructure); and
- Comply with conditions of licenses, permits or other approvals issued for the project.

5.1.2 General Strategies

The following principals shall be implemented as a standard operating procedure:

- Excavation of AASS shall be avoided whenever possible during the December to February wet season and if rain is forecast in the following 48 hours;
- Excavated AASS or PASS shall be transported immediately to a treatment pad;
- Excavated AASS shall be transported to a treatment pad, spread out and treated with lime immediately at the rate defined in this plan;

- Excavated PASS shall be transported to a treatment pad, spread out and tested to determine the specific application rate (if required) or treated at a predetermined worst case application rate based on the highest application rate for that zone;
- A general precautionary testing regime can be implemented to include spot tests in areas likely to contain AASS. Spot testing should be undertaken at a rate of 1 in 500m^3 of soil as a minimum;
- Catchment dams located within treatment areas shall be sized to have sufficient capacity to hold a 1-in-2 year storm event;
- Subject to a baseline water quality study, water discharged from the catchment dams shall be between pH6.5 - pH8.5 with turbidity no more then 10% above receiving waters;
- Soil pH kits shall be maintained by site staff and utilised to provide a preliminary determination of the presence of AASS;
- Turbidity meters and water pH meters shall be utilised by site staff to monitor discharges from the catchment dams; and
- Care should be taken to avoid the exposure of PASS through gully, valley or excavation walls as a result of "bulging" effects created during preloading and compaction activities. Any exposed PASS shall be excavated, transported to a treatment pad, spread out and tested to determine the specific application rate and treated if required.

5.1.3 Implementation Measures: In-situ Treatment

Where acid sulfate material is located and confined proximal to the ground surface level, and does not require excavation and equipment access is available, in-situ treatment can be conducted to neutralise actual acidity and/or acid generating potential. Samples shall be collected from in-situ treatment areas and liming rates determined as per QASSIT guidelines. Subject to review and finalisation of development levels this is currently confined to Zone A.

In-situ treatment shall comprise ripping, rotary hoeing or other mechanical mixing to a depth of 0.25m and immediately applying the amount of fine ground agricultural lime (lime) required to neutralise the Net Acidity. The material shall then be mechanically mixed using a rotary hoe or other suitable equipment and allowed to dry until a relatively homogenous, friable layer is produced.

Verification samples (a minimum of 1 sample per 500m^3) shall then be collected and analysed as per QASSIT guidelines to confirm neutralisation. Additional lime treatment and re-verification testing shall be conducted where adequate neutralisation is not confirmed by the initial validation.

5.1.4 Implementation Measures: Treatment of Excavated Acid Sulfate Material

Treatment of acid sulfate material from site excavations and stockpiles shall be conducted within a bunded treatment area. The treatment areas shall be prepared by stripping vegetation, topsoil and soil containing significant amounts of organic material and compacting the surface with a smooth drum roller. An area of at least 2m width shall be left between the treatment areas and bunds to allow collection of run-off and direction to catchment dams.

A guard layer of lime shall be applied to the treatment areas prior to placement of materials at a rate 10 kg/m^2 for each anticipated 1m height of stored material.

The treatment areas shall be divided into a series of identifiable fill lots each covering an area of up to 2000m^2. It is recommended that a detailed earthworks strategy be developed to plan and track movement, treatment and verification of materials.

Excavated materials shall be moved to an identified fill lot where the material shall be spread to a 0.25m thickness and allowed to dry (if required). Non-PASS sand from the site may be blended with wet or clayey materials to improve handling. The overall thickness of the blended material shall not exceed 0.25m thickness. If required, drying shall be enhanced by mechanical methods to create a relatively homogenous, friable material prior to addition of lime for neutralisation.

A composite sample shall be collected as per QASSIT guidelines from each fill lot to evaluate the required liming rate. The composite sample shall be formed by collecting sub-samples (over the full 0.25m depth interval) from three randomly selected locations within the fill lot. Where a significant change of material type, colour or texture is observed within the materials forming a fill lot then additional samples shall be collected and analysed.

Liming rates for each fill lot shall be determined as per QASSIT guidelines. Where more than one sample has been collected and analysed from a fill lot, the highest calculated liming rate shall be used for treatment of the entire lot.

Lime shall be applied to the fill layer surface using a spreader truck. Lime application rates shall be derived from calculated lime rates from samples from each fill lot layer. Where lime spreading over several lots is considered more effective, the highest application rate for the fill lots to be treated shall be used. The method of averaging liming rate values over several lots is **not** to be adopted.

Following lime application the lime shall be mixed into the fill layer using mechanical methods. Verification samples shall then be collected and analysed as per QASSIT Guidelines to confirm adequate neutralisation. Additional lime treatment and re-verification testing shall be conducted where adequate neutralisation is not initially indicated.

5.1.5 Proposed Treatment Areas

In conjunction with FCG's Civil Design Team, two areas were nominated for the purpose of constructing treatment areas for the controlled working and treatment of any disturbed AASS and PASS during construction. These nominated areas are considered "proposed" for the purpose of this ASSMP, as refinement of control measure designs and ground-truthing of natural drainage features in the areas should be undertaken prior to treatment area construction.

Prior to utilisation as a treatment pad the selected area will be compacted and/or have a liner emplaced to achieve an equivalent permeability of 1m of clay at 10^{-9}m/s. Prior to undertaking any treatment, 5kg/m^2 of lime will be applied to the working surface.

The proposed treatment areas have been designed to utilise natural drainage features and basins to control stormwater flow and potential acidic run-off during wet season works in order to minimise the amount of preparatory earthworks required. Locations were selected with due consideration to being distal from Ross River and with water courses between the catchment dam and Ross River. As a contingency for an extreme event, this strategy minimises the risk of environmental harm to the receiving environment from breach of the catchment dam. Furthermore, the nomination of two proposed treatment areas for strategic purposes allows for the staged construction program. Proposed treatment areas 1 and 2 are shown on Figure 6.

Sketches showing the conceptual design layout of proposed treatment areas 1 and 2 have been included as Figure 7 and Figure 8 respectively.

Should additional areas for treatment be required, the following criteria should be utilised in the selection of the additional treatment areas:

- The gradient of the treatment area should be between 1:100 to 1:50 and should be contoured to drain to a containment dam with a holding capacity of a 1-in-2 year storm event;

- The treatment area should be clay/silt with an equivalent permeability less than 1m of clay at 10^{-9}m/s;

- Upgradient water should be diverted around the treatment area and the containment dam;

- Overflow of the containment dam for a greater than 1-in-2 year storm event should discharge into an area which will provide a mixing zone prior to discharge to the receiving environment off-site; and

- Areas containing surface AASS shall be treated in-situ before utilising as a treatment pad.

5.1.6 Monitoring and Reporting

The effectiveness of lime treatment shall be verified at a rate of at least 1 test per 500m^3 or per batch of treated material, whichever is the lesser, as per QASSIT guidelines. The *Contractor's Site Manager* shall be responsible for ensuring tests to determine lime rates and verification are completed for each 500m^3 or batch of treated material. It is recommended that Chromium suite testing be utilised as some natural neutralising capacity is noted in some samples.

The *Contractor's Site Manager* shall conduct an inspection of the proposed treatment areas including bunds and catchment dams on a weekly basis.

The *Contractor's Site Manager* shall maintain a register of testing results and a record of inspections.

A summary report of all test results and inspections shall be compiled by the *Contractor's Site Manager* each week and submitted to the *Project Manager*.

5.2 Management Zone A

In-situ treatment for managing AASS in Zone A shall be implemented where practical. The ground surface is to be ripped using mechanical methods to a depth of 0.25m and 2kg/m^2 of lime treatment shall be applied.

Disturbance of AASS in Zone A should be avoided if possible. Unless additional work is undertaken to define otherwise, any material excavated from ground level to a depth of 1.25m below ground level in Zone A is to be transported to a treatment area and treated with lime at a rate of 5kg/m^2 and validated. This treatment rate has been slightly elevated from the actual rate calculated to minimize the occurrence of validation failures and ultimately reduce the amount of material handling. The cost of the additional lime required is considered nominal as the amount of AASS excavated is anticipated to be minor.

5.3 Management Zone B

Disturbance of PASS in Zone B should be avoided or minimised where possible. Unless additional work is undertaken to define otherwise, material between 1.25m and 3m below ground level if excavated will be required to be transported to a treatment area and tested to determine liming rates, if any. If treatment is required the material shall be treated with lime at the determined rate. Validation of the material following treatment is required.

It should be noted that any future development within Zone B that requires excavation below 4.5m AHD may require PASS to be treated.

5.4 Management Zone C

Disturbance of AASS in Zone C should be avoided or minimized where possible. Unless additional work is undertaken to define otherwise, excavated material between 1.75m to at least 3m below ground level shall require transportation to a treatment area and treated with lime at a rate of 5kg/m^2 and validated. This treatment rate has been slightly elevated from the actual rate calculated to minimize the occurrence of validation failures and ultimately reduce the amount of material handling. The cost of the additional lime required is considered nominal as the amount of AASS excavated is anticipated to be minor.

Caution should be exercised with regard to preloading and filling in the eastern section of Zone C as this may cause the groundwater level to rise and potentially result in an "acid flush" to Ross River. Further work to determine depth of groundwater relative to AASS and the risk of inducing an "acid flush" with preloading is recommended.

It should be noted that any future development within Zone C that requires excavation below 2m AHD may require the treatment of AASS.

5.5 Management Zone D

Disturbance of PASS in Zone D should be avoided or minimised where possible. Unless additional work is undertaken to define otherwise, excavated surface or excavated material to a depth of 1.5m below ground level is required to be transported to a treatment area and tested to determine liming rates, if any. If treatment is required the material shall be treated with lime at the determined rate. Validation of the material following treatment is required.

It should be noted that any future development within Zone D that requires excavation below 4m AHD may require the treatment of PASS.

5.6 Dewatering

As civil development constraints are further defined and the extent of dewatering, preloading and filling known, an assessment of the site's groundwater regime should be undertaken. The groundwater regime assessment should be completed prior to any earthworks commencing in Zone C and with respect to the environmental risk posed by the potential exposure of AASS and PASS to oxidation and likelihood of inducing an "acid flush" to Ross River.

Should dewatering or preloading be required where acid sulfate material is present (i.e. eastern portion of Zone C) a dewatering management plan should be developed and a review of this ASSMP be completed and amended, as necessary. The dewatering management plan should be developed once the groundwater regime and need for dewatering have been defined (i.e. the location, size and depth of infrastructure (e.g. sewerage pump stations) known).

6.0 RESPONSIBILITIES

During construction works, the following levels of responsibility shall exist:

- The *Project Manager* is responsible for ensuring that the requirements of the ASSMP are met;

- The *Contractor's Site Manager* is responsible for ensuring the strategies and procedures prescribed in the ASSMP are implemented at the site in accordance with the specified performance criteria; and

- *All other site personnel* are responsible for implementing strategies and procedures prescribed in the ASSMP, as applicable to their work activities.

7.0 NON-CONFORMANCE AND CORRECTIVE ACTION

A non-conformance is a deemed failure to meet specific performance indicators or deviation from the requirements of the ASSMP.

Performance indicators are as follows:

- Discharge of water from containment dams or off-site which are outside pH6.5 – pH8.5;
- Discharge of water off-site which has a turbidity of more than 10% above receiving off-site receiving waters;
- Actual or potential acid sulphate soil is encountered which is not as defined as per the zones defined in this plan; and
- The management and validation regime is not completed as defined in this plan.

During the construction works, the following procedure is to be followed in the event of a nonconformance:

1. The *Contractor's Site Manager* shall be notified immediately upon the occurrence of a nonconformance;

2. The *Contractor's Site Manager* shall assess the nature of the non-conformance and notify the *Project Manager* immediately if the non-conformance is considered to have caused or could potentially cause environmental harm;

3. Subject to the nature and extent of the non-conformance, the *Contractor's Site Manager* or the *Project Manager* shall issue a work order to halt and/or rectify any environmental harm caused as a result of the non-conformance;

4. Within 3 days of the non-conformance having been reported to the *Contractor's Site Manager*, written notification of the time, date and nature of the non-conformance, plus the corrective action if required, shall be forwarded to the *Project Manager*;

5. The *Project Manager* shall assess the non-conformance report and shall determine the nature of any further corrective action to be taken and shall state the timeframe within which the corrective action is to be implemented;

6. The *Contractor's Site Manager* shall ensure that the corrective action is implemented within the timeframe stipulated by the *Project Manager*.

The nominated *Project Manager* must be a person technically familiar with acid sulfate soil and the potential risks of mismanagement and experienced in the practical management and rehabilitation of acid sulfate soil.

8.0 AUDITING

8.1 Monitoring

The *Project Manager* will be responsible for ensuring that inspections are carried out during earthworks and construction. The inspection program shall aim to ensure that all parties (contractor and sub-contractors) comply with the ASSMP and relevant statutory requirements.

Inspections shall be scheduled to ensure all management procedures and controls are inspected regularly and during critical activities. As a minimum, audits shall be conducted monthly. The frequency of these audits may gradually decrease if a high level of compliance with the ASSMP is evident.

Audits shall also be conducted prior to each forecast major rainfall event and immediately following each rainfall event exceeding 50mm in 48 hours (nominal moderate rainfall event likely to cause surface water flow).

8.2 Reporting and Review

The audit shall take the form of a visual inspection of the site and associated control measures and a review of monitoring data. A written record of auditing undertaken shall be maintained, including details on the date of the audit, activities undertaken, observations made and any non-conformances identified.

Written records of audits completed by the contractor shall be forwarded to the superintendent monthly along with the progress claim.

Specified management procedures in Section 5 of this ASSMP will be subject to review and updated, as required, based on the results of inspections, monitoring and reporting activities.

9.0 COMMUNICATIONS

Communications will be established and maintained with the appropriate regulatory authorities and other stakeholders, organisations or individuals with an identified interest in the project. Notifiable incidents and any scheduled site visit by the regulatory authorities will be reported through appropriate, established channels.

9.1 Training

All equipment operators, supervisors and sub-contractors engaged in excavation and treatment works shall participate in induction training for acid sulfate soil. This training shall be prepared before works commence on site and will be run in conjunction with other site specific inductions.

This training will include basic recognition and identification of AASS and PASS, plus an outline of the requirements of the ASSMP. It is the responsibility of the *Contractor's Site Manager* to verify attendance at induction training prior to commencement of site works.

Arrangements shall be made for appropriate ongoing training of staff by suitably experienced persons or organisations.

The *Project Manager* will coordinate training, maintain training records and assess the effectiveness of training. If an element of training is not effective the *Project Manager* may direct the training to be modified and repeated.

9.2 Community Relations

Any complaints or concerns raised by the general public shall be treated with respect and directed to the *Project Manager* who will direct an appropriate course of action.

The *Project Manager* or nominated representative shall maintain a Complaints Register to record the following information:

- Contact details: Name, address, phone number of party raising the concern;
- Nature of concern: Details of the issue or incident;
- Action taken or required: Details of action proposed or undertaken to address the concern, including time and date;
- Response to action: Was the party raising the concern satisfied with the outcome, if not, what else needs to be done or is it outside of the scope of development works; and
- Prevention of re-occurrence: If the concern relates directly to an operational problem, what action has been taken to ensure the problem will not occur again.

10.0 FURTHER WORKS

The following lists recommended further works which have identified potential to assist in better defining the site's acid sulfate soil regime, reducing risk and/or providing clarity and further defining management procedures:

- Further refinement of civil design and construction methodologies. This includes the volume of earthworks required (excavation, filling, compaction, etc) and the location of deep excavations required for infrastructure such as sewerage pump stations which may require dewatering;

- A groundwater regime investigation. This is particularly important in areas that may require significant fill emplacement and preloading such as the eastern section of Zone C and areas where dewatering for construction works and/or preloading is likely. As little information was available on the site's groundwater regime, the potential environmental impacts of dewatering should be determined and consideration given to the development of dewatering management strategies;

- It is considered the western and southern extent of Zone A may not be as extensive as shown on Figure 6. It is recommended that additional near surface assessment be undertaken to better define this zone and the area of treatment required;

- A baseline surface water quality monitoring program. This program should aim to determine the existing water quality conditions of Ross River and to enable the accurate monitoring of run-off from construction and future development. This monitoring program should specifically consider pH and turbidity parameters;

- Undertake ground-truthing of treatment areas and management control designs prior to construction for alignment with the civil design and construction program.

Consideration should be given to undertaking or commencing the further works listed above prior to the commencement of operational works on site and this ASSMP should be updated to incorporate the new findings.

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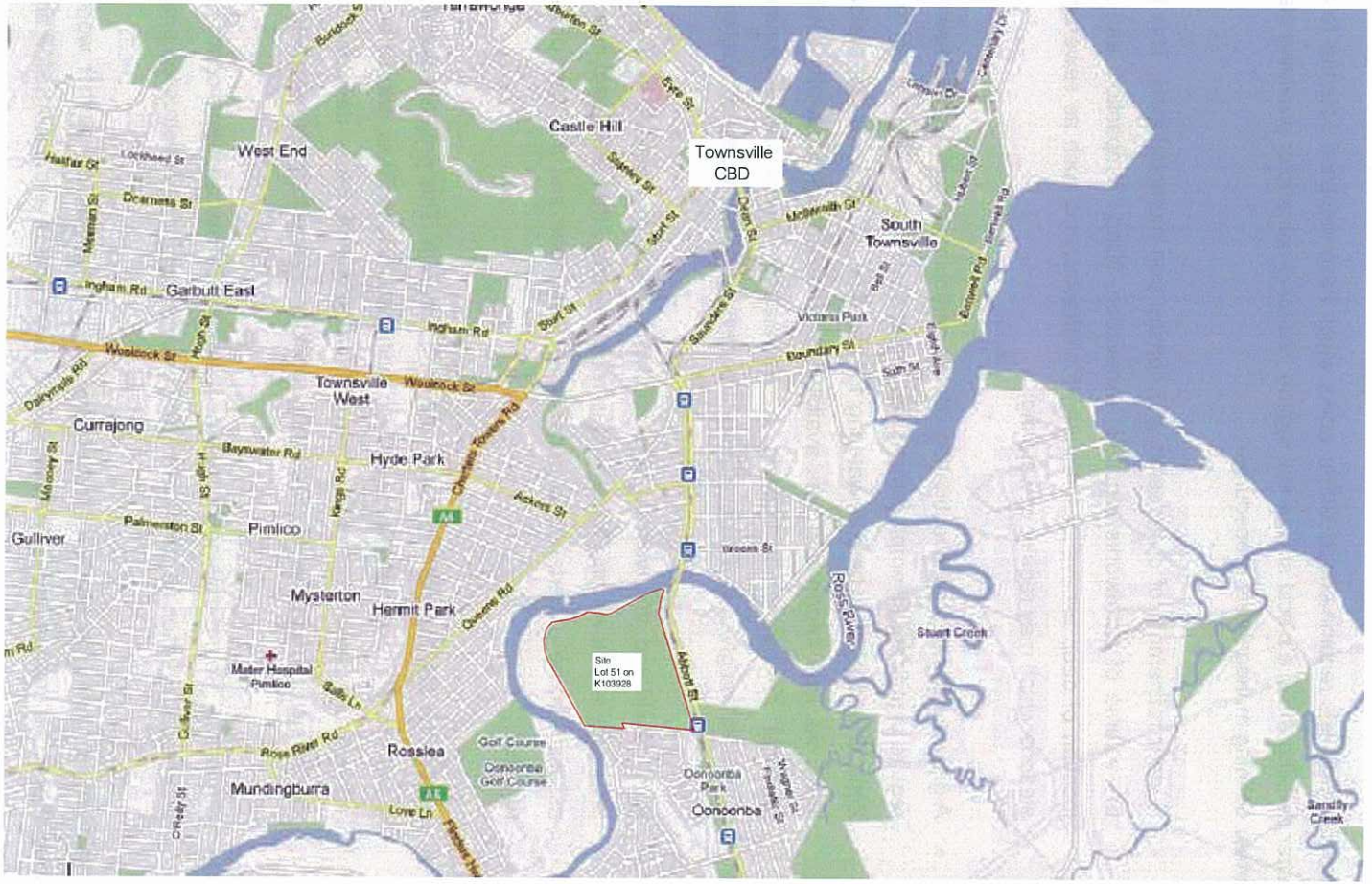

ULDA Development Area
ASS Management Plan

Locality Plan

Figure 1

Scale: NTS

FCG ACAD FILE: 5625AA-FIG.1.DWG

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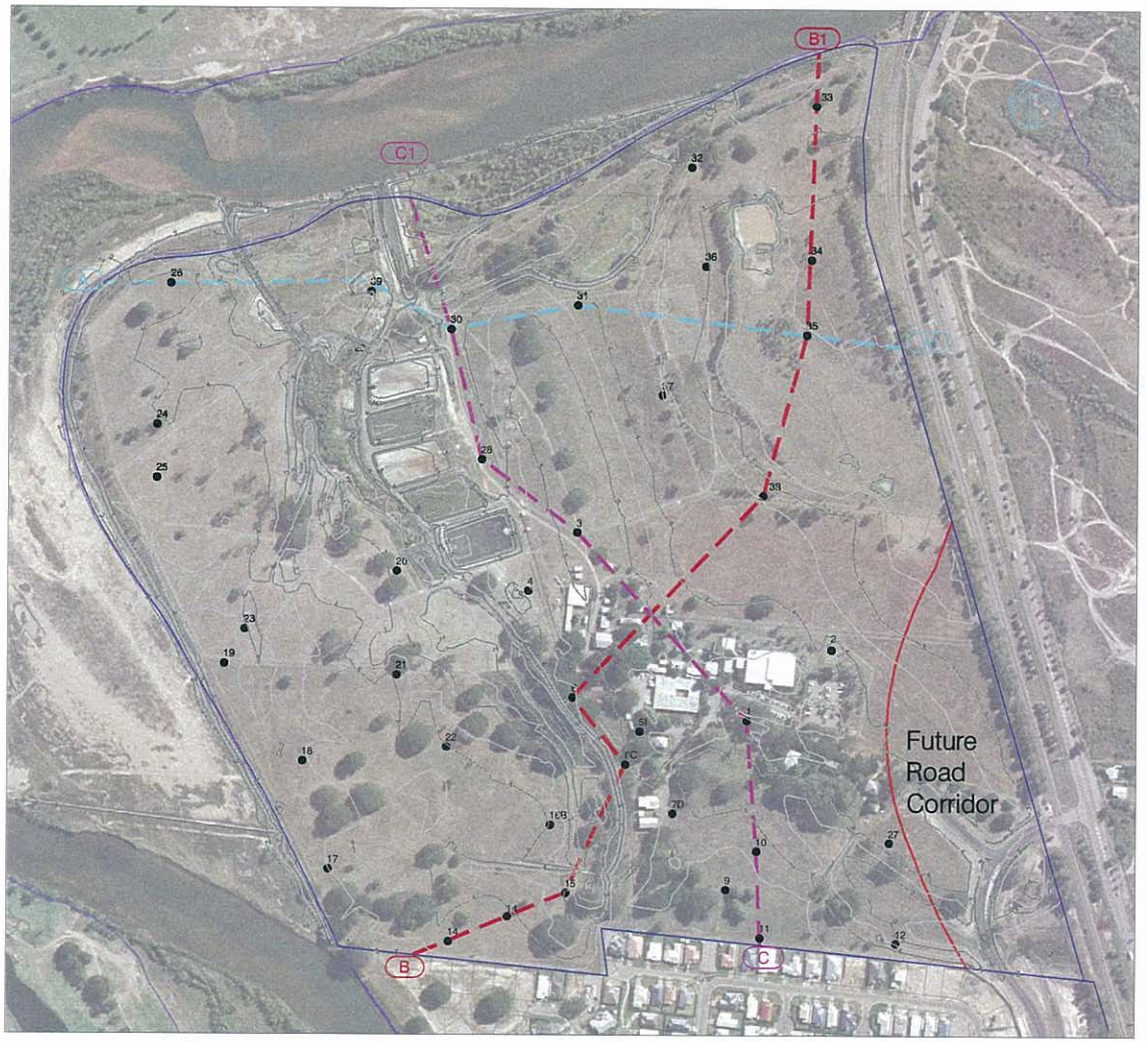

Legned

Cross Section Transects

Test Locations

1:5000 0 50 100 150 200m

ULDA Development Area
ASS Management Plan

SITE PLAN &
CROSS-SECTION TRANSECTS

Figure 2

Scale 1:5000 @ A3 Full Size

FCG ACAD FILE: 5625AB-FIG.2.DWG

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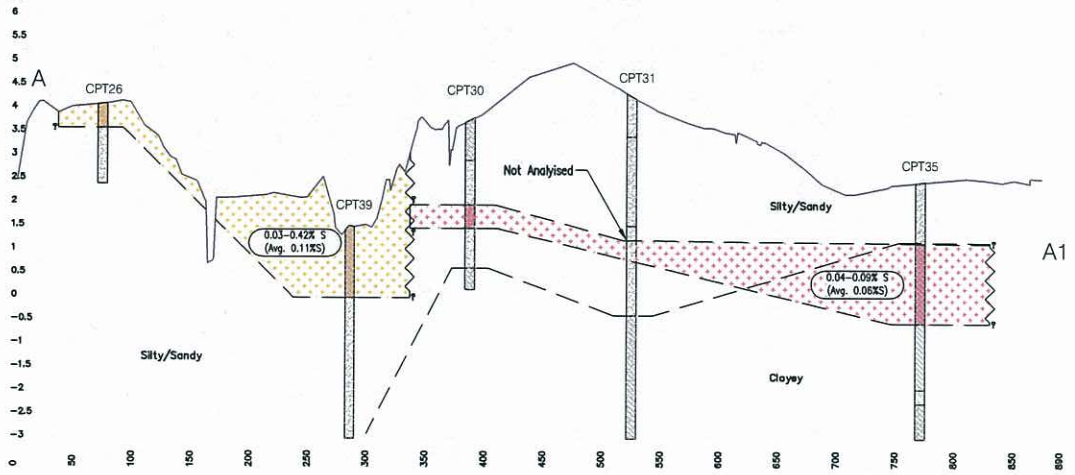

Scale: Vertical 1:100
Horizontal 1:4000

LEGEND:
- Water Level
- Ground Surface
- Sa - Sand
- Si - Silt
- Cl - Clay
- Inferred AASS Zone
- Inferred PASS Zone
- Inferred Lithological Boundary

ULDA Development Area
ASS Management Plan

INTERPRETIVE CROSS-SECTION
Sketch A-A1

Figure 3

Scale - As Shown @ A3 Full Size

FCG ACAD FILE: 5625AC-FIG.03_05.DWG

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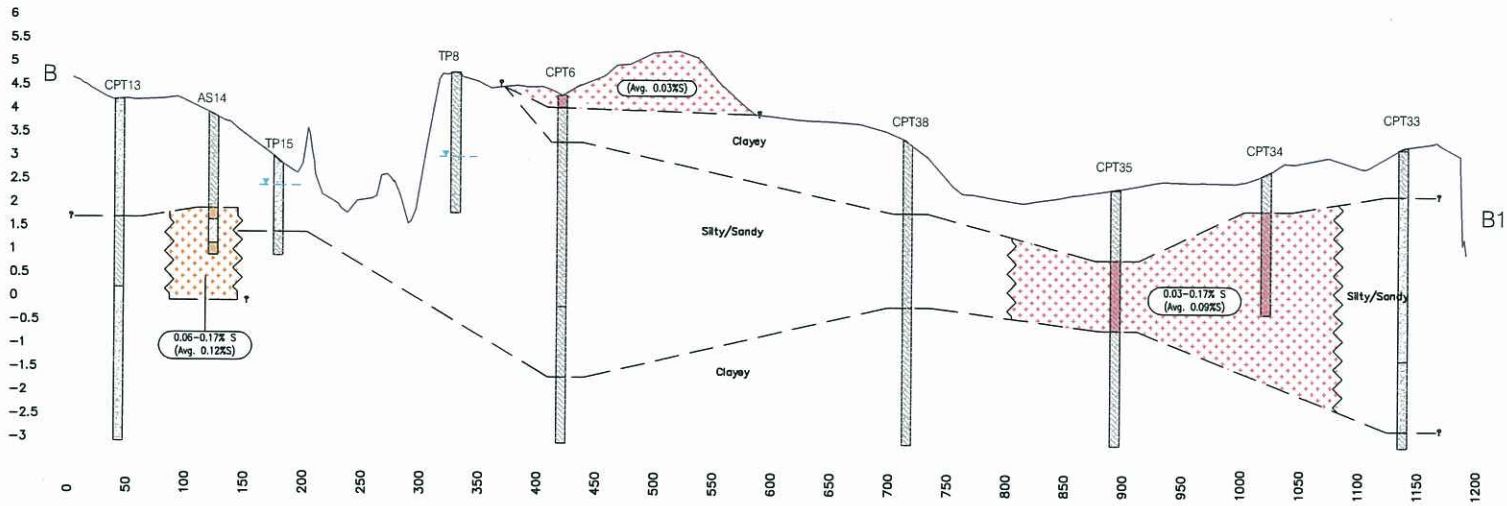


Scale: Vertical 1:100
Horizontal 1:4000

LEGEND:
- Water Level
- Ground Surface
- Sa - Sand
- Si - Silt
- Cl - Clay
- Inferred AASS Zone
- Inferred PASS Zone
- Inferred Lithological Boundary

ULDA Development Area
ASS Management Plan

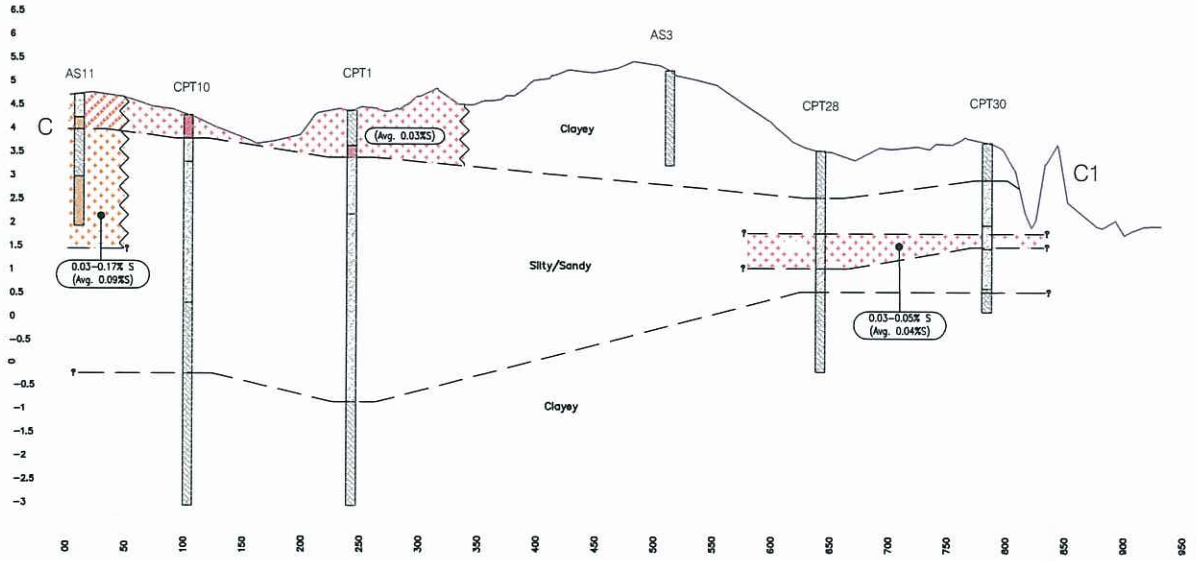
INTERPRETIVE CROSS-SECTION
Sketch B-B1

Figure 4

Scale - As Shown @ A3 Full Size

FCG ACAD FILE: 5625AC-FIG.03_05.DWG

FLANAGAN CONSULTING GROUP



Scale: Vertical 1:100
Horizontal 1:4000

LEGEND:
- Water Level
- Ground Surface
- Sa - Sand
- Si - Silt
- Cl - Clay
- Inferred AASS Zone
- Inferred PASS Zone
- Inferred Lithological Boundary

ULDA Development Area
ASS Management Plan

INTERPRETIVE CROSS-SECTION
Sketch C-C1

Figure 5

Scale - As Shown @ A3 Full Size

FCG ACAD FILE: 5625AC-FIG.03_05.DWG

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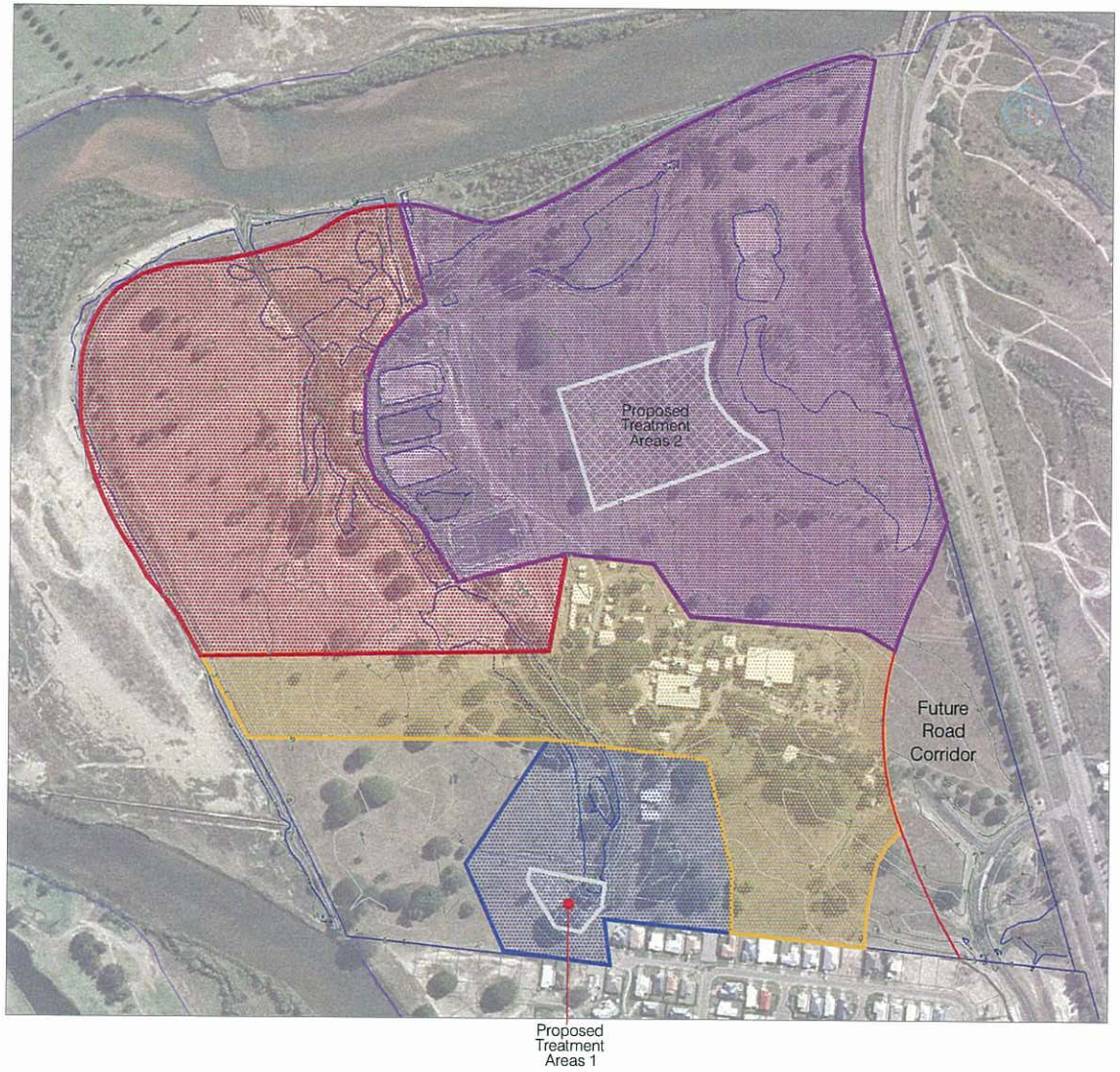

Zone A
Zone B
Zone C
Zone D
Proposed Treatment Areas

1:5000 0 50 100 150 200m

ULDA Development Area
ASS Management Plan

ZONE PLAN

Figure 6

Scale 1:5000 @ A3 Full Size

FCG ACAD FILE: 5625AD-FIG.6.DWG

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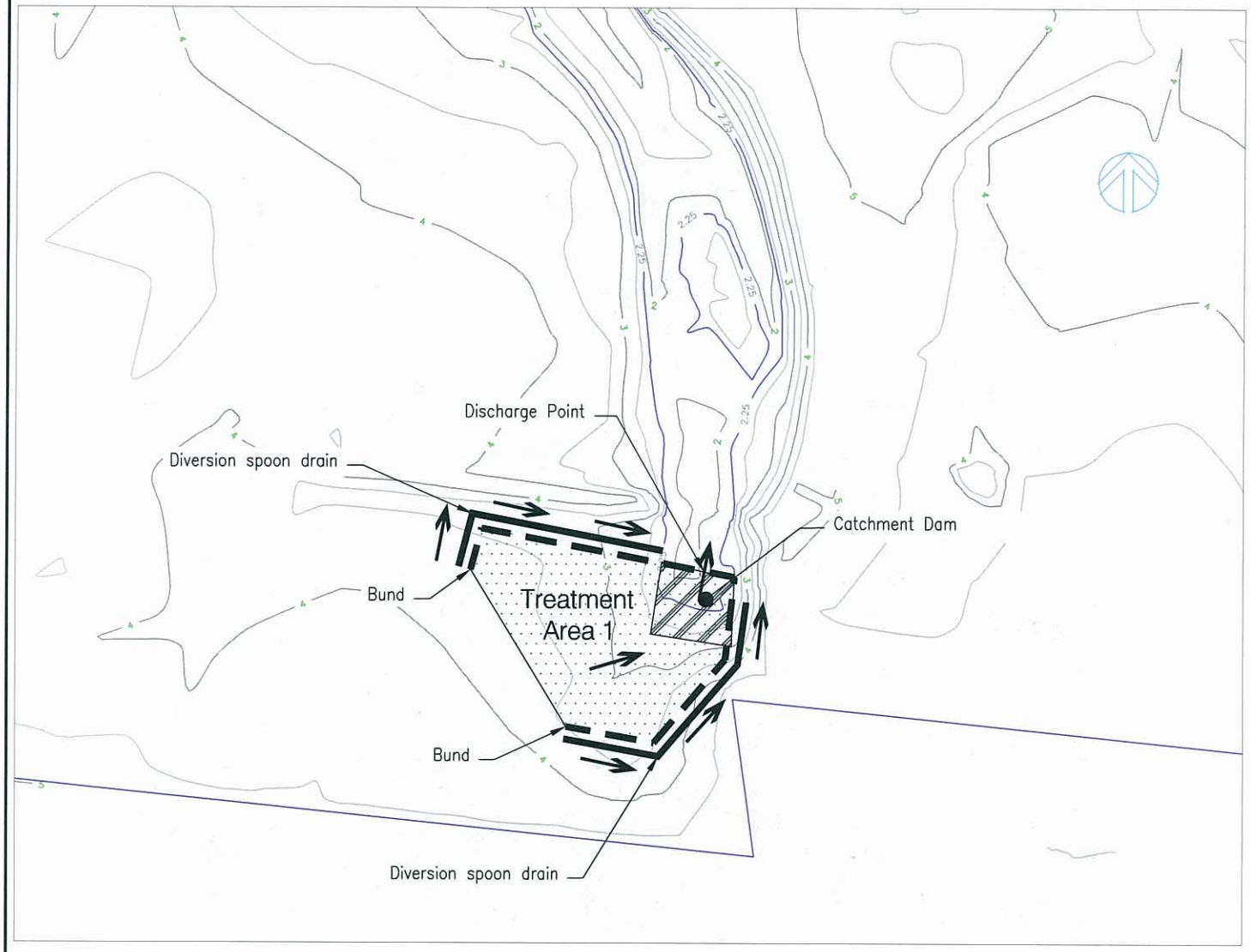


0 10 20 30 40 50m

1:1250

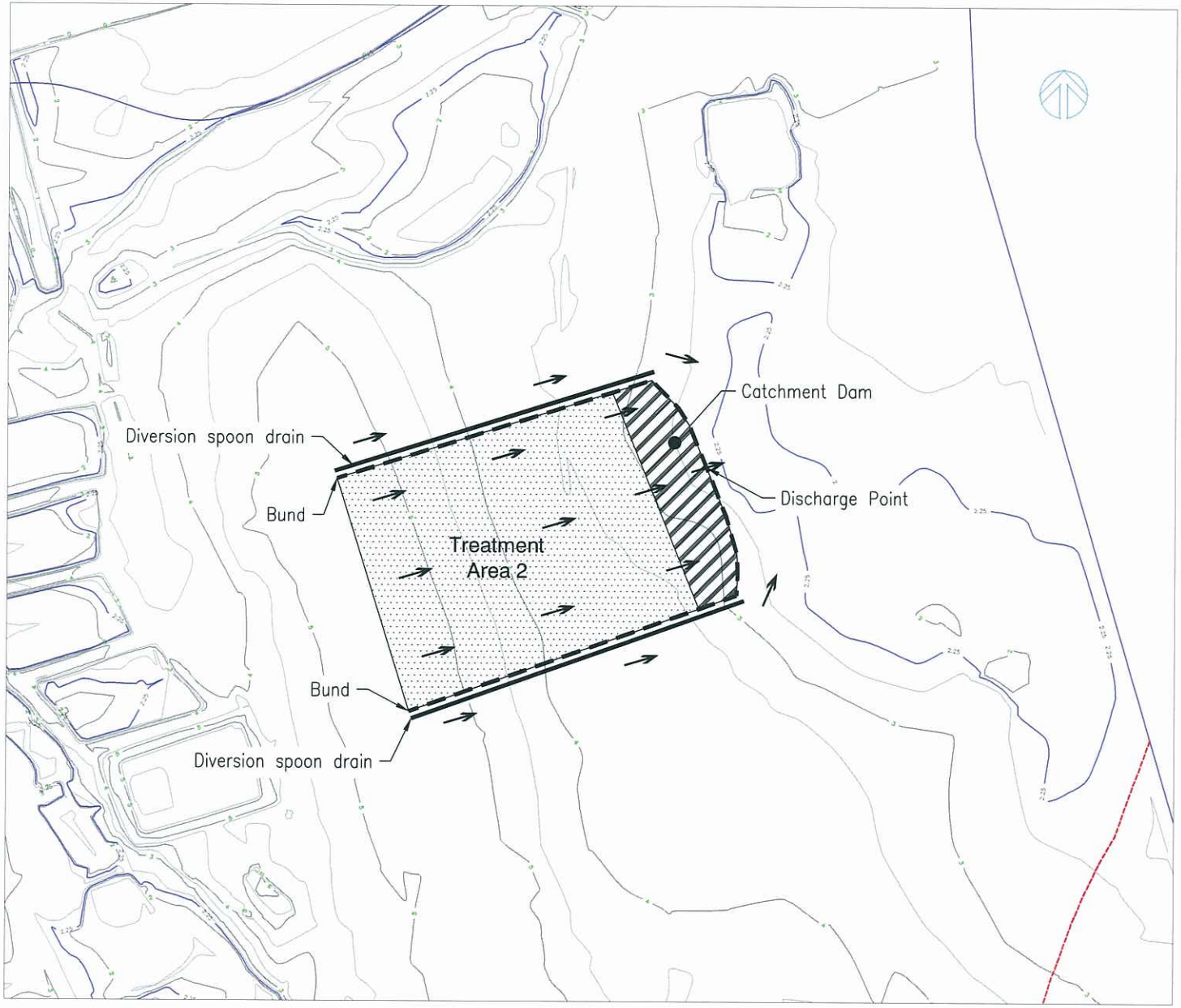
ULDA Development Area
ASS Management Plan

PROPOSED TREATMENT AREA 1

Figure 7

Scale 1:1250 @ A3 Full Size

FCG ACAD FILE: 5625AE-FIG.7 & 8.DWG



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0 20 40 60 80m

1:2000

ULDA Development Area
ASS Management Plan

PROPOSED TREATMENT AREA 2

Figure 8

Scale 1:2000 @ A3 Full Size

FCG ACAD FILE: 5625AE-FIG.7 & 8.DWG