

ACID SULFATE SOILS MANAGEMENT PLAN CYGNIA COVE, WATERFORD

Prepared for:

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ABBREVIATIONS

%S	percentage sulfate
µg/L	micrograms per litre
AASS	Actual Acid Sulfate Soil
ADWG	Australian Drinking Water Guidelines
Al	aluminium
ANC	Acid neutralization capacity
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
As	arsenic
ASS	Acid Sulfate Soil
ASSMP	Acid Sulfate Soil Management Plan
ASSMW	Acid Sulfate Soil Monitoring Well
ATA	ATA Environmental
BTEX	Benzene, Toluene, Ethylbenzene and Xylenes
CaCO₃	calcium carbonate
CaCO₃/m³	calcium carbonate per cubic metre
Cd	cadmium
cm	centimetre
Cr	chromium
Cu	copper
DEC	Department of Environment and Conservation
DEWCP	Department of Environment, Water and Catchment Protection

ABBREVIATIONS

DoE	Department of Environment
DWG	Drinking Water Guidelines
EC	Electrical Conductivity
Eh	Oxidation/Reduction Potential
ENV	effective neutralising value
EPA	Environmental Protection Authority
FRP	Filterable reactive phosphorus
FWG	Freshwater Guidelines
GME	Groundwater Monitoring Event
ha	hectare
Hg	mercury
HIL	Health Investigation Level
kg	kilogram
kgCaCO₃/tonne	kilogram(s) of calcium carbonate per tonne
km	kilometre
LOR	Limit of Reporting
LTV	long term trigger value
LWQB	Land and Water Quality Branch
m	metre
m²	square metre
mAHD	metre(s) Australian Height Datum
mBGL	metre(s) below ground level

ABBREVIATIONS

mE	metres East
mg/L	milligrams per litre
mm	millimetre
mN	Metres North
molH⁺/tonne	moles H ⁺ per tonne
MW	Monitoring Well
N	north
NATA	National Association of Testing Authorities
NH₃-N	Free ammonia
NHMRC	National Health and Medical Research Council
Ni	nickel
OC	Organochlorine
OP	Organophosphorous
PAH	Polycyclic Aromatic Hydrocarbon
PASS	Potential Acid Sulfate Soil
Pb	lead
PCB	Polychlorinated Biphenyl
PER	Public Environmental Review
pH_F	field pH
pH_{FOX}	field pH peroxide
pH_{KCl}	pH in potassium chloride
pH_{ox}	pH after peroxide oxidation

ABBREVIATIONS

POS	public open space
S_{CR}	Chromium Reducible Sulfur
SPOCAS	Suspension Peroxide Oxidation Combined Acidity and Sulfur
S_{POS}	Peroxide Oxidisable Sulfur
s-TAA	Titrateable Actual Acidity
STIWG	short-term irrigation water guidelines
STV	short-term trigger value
t/m³	tonne(s) per cubic metre
TAA	titrateable actual acidity
TDS	Total Dissolved Solid
TKN	Total Kjeldahl Nitrogen
TPH	Total Petroleum Hydrocarbon
TSS	Total Suspended Solids
UFI	unique feature identifier
Zn	zinc

1 PURPOSE

1.1 Background and Site Identification

This report presents strategies to manage the acid-generating potential of soils at the Cygnia Cove site (formerly known as East Clontarf), comprising Pt. Lot 83 and Lots 501 and 829 Manning Road, Waterford, which is located south of Manning Road in the suburb of Waterford (Figure 1). The results of previous investigation for the site (2003, 2006 and 2007) are reviewed in this report and have been used to formulate management strategies appropriate to the proposed development works at the site. An ASS Site Summary form is provided as Appendix A, together with copies of the current Certificates of Title for Lots 501, 83, and 829 Manning Road.

The site is located approximately 8km south-east of the Perth central business district, and the area of the site is approximately 20ha. The coordinates of the centre of the site are approximately 395,730mE and 6,457,300mN.

Clontarf Bay on the Canning River forms the southern boundary of the site, and approximately 30% of the site comprises a Resource Enhancement category wetland, which trends east/west along the northern central portion of the site. The wetland drains to Clontarf Bay along a narrow drainage line along the western edge of the site. The proximity of the site to the river, as well as the presence of a wetland on the site, suggested that there was a significant potential for ASS requiring field-based investigations. ATA Environmental accordingly carried out an investigation at the site in 2003, although site subdivision plans were not finalised at that time. Recent changes to the subdivision plans led to additional ASS investigations at the site.

The topography of the site has historically been modified and the original size of the wetland has been reduced. During the 1940s, pine plantations and market gardens were present at the site. Drainage channels have also been created over time and maintained to assist in reducing ground water levels. It is understood that fill material was imported to the site prior to 1968 in order to elevate the area occupied by the Christian Brothers' Clontarf Orphanage playing fields, in the southern portion of the site.

1.2 Previous Investigations

ATA Environmental (ATA) has previously investigated soil and groundwater contamination at the site, as described in the following reports:

- ***Environmental Assessment, East Clontarf, Manning (ATA, 2001)*** ATA Environmental Report 2000/179. Prepared for Trustees of the Christian Brothers, January 2001.
- ***Detailed Soil/Groundwater Contamination and Preliminary Acid Sulphate Soils Investigation, Sampling and Analysis Program (ATA, 2002)*** ATA Environmental Report 2002/147. Prepared for Trustees of the Christian Brothers, December 2002.
- ***Preliminary Acid Sulphate Soils Investigation, East Clontarf, Manning (ATA, 2003a)*** ATA Environmental Report 2003/115. Prepared for Trustees of the Christian Brothers, August 2003.
- ***Detailed Soil and Groundwater Investigation, East Clontarf, Waterford (ATA, 2003b)*** ATA Environmental Report 2002/92. Prepared for Trustees of the Christian Brothers, December 2003.

At the time the investigations were carried out, there was limited formal guidance on ASS available from Western Australian regulatory authorities, primarily comprising “*Draft DEWCP and EPA Guidance on acid sulfate soils*” (DEWCP, 2002). The preliminary acid sulfate soils investigation sampling and analysis plan was reviewed by the Department of Environment (DoE; now Department of Environment and Conservation, DEC) in February 2003, as included in ATA (2003a).

The site was formally assessed under the *Environmental Protection Act 1986*, and a Public Environmental Review (PER) of the proposed development was prepared and released for public comment in June 2004. Information regarding potential acid sulfate soils derived from site investigations was included in the PER, in particular in Section 3.11. Reports associated with the formal assessment process include the following:

- **Clontarf Residential Subdivision, Waterford, Public Environmental Review Environmental Scoping Document Assessment No. 1467 (ATA, 2003c)** ATA Environmental Report 2003/91. Prepared for Trustees of the Christian Brothers, July 2003.
- **Clontarf Residential Subdivision, Waterford, Public Environmental Review (EPA Assessment No. 1467) (ATA, 2003d)** ATA Environmental Report 2003/91, Version 5. Prepared for Trustees of the Christian Brothers, June 2004.
- **Clontarf Residential Subdivision, Waterford, Responses to Submissions (EPA Assessment No. 1467) (ATA, 2004)** ATA Environmental Report 2004/182. Prepared for Trustees of the Christian Brothers, October 2004.
- **Clontarf Residential Subdivision, Waterford, Ministerial Statement No. 692, Section 45C Referral (ATA, 2006)** ATA Environmental Report 2006/82. Prepared for Trustees of the Christian Brothers, April 2006.

Commitments were made by the proponent in the PER document to manage development activities that might disturb ASS to avoid adverse effects on the environment and human health. The Environmental Protection Authority (EPA) released Bulletin 1156 containing its report and recommendations on 6 December 2004 (EPA, 2004a). The Cygnia Cove Residential Development proposal was approved by the Minister for the Environment in Ministerial Statement No. 692 in October 2005, subject to the fulfilment of conditions. Condition 10 of the Ministerial Statement requires the preparation of an Acid Sulfate Soils Management Plan to the satisfaction of the Department of Environment and Conservation (DEC, formerly the Department of Environment, DoE). The purpose of this report is to present site specific information to facilitate clearance by the DEC of Condition 10 of Ministerial Statement No. 692.

1.3 Proposed Site Works

It is proposed to develop the site for residential use with public open space (POS), and as part of the development it is proposed to retain the core of the wetland, as shown in Figure 2. The subdivision plan shown in Figure 2 has been submitted as part of the site subdivision application, and has been approved by the EPA as a part of Section 45C Referral. Remedial works will be required prior to development in order to remove geotechnically unsuitable material (uncontrolled fill) which locally exceeds the DEC's EIL guidelines for metals (DoE, 2003) and contains some asbestos cement sheeting.

Works with the potential to directly disturb ASS material include enhancement of the wetland and non-wetland POS areas, excavation of uncontrolled fill and geotechnically unsuitable material from the

remainder of the site, and linear trenching to install buried services. Indirect disturbance, via dewatering, may be required during bulk earthworks to conduct works to enhance the retained wetland area, and remove geotechnically unsuitable material below the watertable; it may be required during subdivision works to excavate trenches and lay buried services.

1.4 Objective and Scope of Works

The objective of this report is to provide an Acid Sulfate Soil Management Plan (ASSMP) for the site based on the results of the preliminary ASS investigation report (ATA, 2003) and additional investigations. The ASSMP will consider the types of works that are proposed as part of site remedial works and development, propose strategies to manage the identified potential acidity in peaty and silty soils at the site to minimise the release of acidity into the surrounding environment.

Towards this end, the following objectives are incorporated into the ASSMP, as per Commitment 10 in *Clontarf Residential Subdivision, Waterford, Public Environmental Review (EPA Assessment No. 1467)* (ATA, 2003c):

1. The area of ASS soils to be disturbed by excavation or dewatering will be minimised as far as possible.
2. Where ASS must be disturbed:
 - Earthworks will be completed as quickly as possible to minimise the time that the walls and base of excavations are exposed to the atmosphere;
 - Un-neutralised ASS will be stored for only limited periods on on-site bunded hardstand areas constructed from alkaline materials;
 - The quality of groundwater and dewatering effluents will be monitored regularly to ensure early detection of any alteration in water chemistry; and
 - Dewatering effluent will be treated to ensure appropriate water quality is maintained (where applicable).
3. Any excavated soils deemed unsuitable for use on-site will be disposed of/treated off-site at an appropriately licensed facility.

The ASSMP for the site is to be prepared to the satisfaction of the DEC. In order to meet the objective listed above, the scope of works includes the following:

- Review of the results of ASS investigations;
- Description of the proposed site development works, in terms of areas and depths of disturbance via excavation or dewatering;
- Presentation of an ASSMP for the site;
- Submission of the plan to DEC; and
- Implementation of the approved plan during earthworks.

Sites affected or potentially affected by ASS do not necessarily fall within the ambit of the *Contaminated Sites Act 2003*. This Act is only triggered in the event that the presence of the ASS results in contaminants such as metals being present in the soil or groundwater at elevated levels. This elevation

of contaminants can occur due to natural processes (e.g. falling groundwater tables) or management actions such dewatering and excavation of ASS.

Should monitoring undertaken as part of this ASSMP detect elevated levels of contaminants, then appointed the Contaminated Sites Auditor and the DEC will be informed and appropriate contingency measures implemented in agreement with the Auditor and/or the DEC.

2 SITE INVESTIGATION AND SUMMARY OF ISSUES

The following information is summarised from material presented in the reports Detailed Soil/Groundwater Contamination and Preliminary Acid Sulphate Soils Investigation, Sampling and Analysis Program (ATA, 2002), Preliminary Acid Sulphate Soils Investigation, East Clontarf, Manning (ATA, 2003a), and Detailed Soil and Groundwater Investigation, East Clontarf, Waterford (ATA, 2003b). Following presentation of the results is a discussion of the ASS management issues arising from the findings.

2.1 Site Geology and Hydrogeology

The site slopes down towards the Canning River, with a maximum elevation of approximately 9mAHD near Manning Road, 2-3mAHD through wetland areas, and 1mAHD along the foreshore.

The natural surface geology over the majority of the site (excluding the wetland) is mapped by Jordan (1986) as comprising Unit S₈, Bassendean Sand. Unit S₈ is described as fine to medium-grained sub-rounded quartz sand which is very light grey at surface and yellow at depth (Jordan, 1986). The wetland in the north central portion of the site is mapped as comprising Unit S₁₄, Alluvium, which is described as white to pale grey, medium- to coarse-grained quartz sand with abundant shell fragments (Jordan, 1986).

Previous investigations at the site have identified deposits of fill in several areas at the site, including several areas to the south of the wetland and two areas on the northern margin of the wetlands, as shown in Figure 2 of the report *Detailed Soil and Groundwater Investigation, East Clontarf, Waterford* (ATA, 2003b). It is estimated that the uncontrolled fill covers approximately 2ha of the site and varies in thickness between 0.1m and 1.5m (ATA, 2003b).

Natural soils encountered during investigations at the site included sands consistent with the description of Bassendean Sand by Jordan (1986) over large areas of the site. Extensive areas of peat were also identified (described as sandy to clayey peat) extending beneath the current wetland, along the drainage line near the western margin of the site. Geotechnical investigations at the site were used to infer the extent of peat across the site, as shown in Figure 4 of ATA (2002). The extent of peat on that diagram is generally consistent with areas where peat was encountered in the ASS investigation: particularly beneath the wetland and along the western drainage line. However, instead of peat adjacent to the foreshore, ATA identified clayey and silty soils matching the description of Guildford Formation (Jordan, 1986) at shallow depth beneath the Bassendean Sand unit.

2.2 Surface Hydrology

The Stage 2 area contains a large wetland and is located adjacent to the Canning River at Clontarf Bay. A review of the DEC's Swan Coastal Plain Geomorphic dataset indicates that the wetland is designated a Resource Enhancement management category unique feature identifier (consisting of wetlands UFI 13843 and UFI 13845). ATA has conducted site specific investigations into the extent and nature of wetlands at the site, and modified wetland boundaries and classifications have been accepted by the DEC, as shown in Figure 6 of the PER (ATA, 2004).

2.3 Soil Sampling Methodology

2.3.1 2003 Investigations

As discussed in Section 7 of the Sampling and Analysis Program (ATA, 2002), ten sample locations were selected on the basis that an area of approximately 50,000m² were likely to be disturbed via dewatering or excavation works, and using a sample density of two locations per hectare based on Queensland and NSW guidelines (this remains the recommended sample density for sites of at least 4ha area). The sample locations were located in the portions of the site considered to contain peat horizons, and target the areas where this material was anticipated to be disturbed.

Soil sample locations were designated EC ASS 1 to 10, and their locations are shown on Figure 3. Based on a proposed depth of disturbance of 0.5m below the base of the peat, the samples were to be collected to depth of 1.5m below the base of the peat in order to sample to 1m below the maximum depth of disturbance.

Soil sampling was undertaken on 24 May 2003. Samples were collected at 0.25m intervals to 3m depth at the ten proposed locations. A total of 120 samples were collected and subjected to field testing. Based on field observations and field test results, a total of 60 samples were submitted for S_{Cr} and/or SPOCAS analysis.

Although the sampling program was conducted prior to the issuance of formal ASS sampling guidelines in Western Australia, the sample density conforms to current WA guidelines. Additionally, the field testing and laboratory analytical procedures used are still considered appropriate, as is the proportion of samples analysed.

2.3.2 2007 Investigations

Due to changes in the proposed subdivision plan for the site, and to ensure that the available data was representative of the area to be disturbed, an additional four locations were investigated on 16 February 2007. Soil sample locations were designated EC11 to EC14, as shown on Figure 3. Location EC11 was selected to assess the potential future site of a compensation basin; location EC12 was selected to provide more data about the eastern end of the wetland area; location EC13 represents an area which will be modified to create a swan breeding habitat; and location EC14 provides additional information about the western end of the wetland.

As with the 2003 investigations, samples were collected at 0.25m intervals to 3m depth at the four locations. In each instance, this should represent at least 1m beyond the depth of disturbance required. A total of 54 samples were collected and subjected to field testing. Based on field observations and field test results, a total of 22 samples were submitted for SPOCAS analysis.

2.3.3 Additional Soil Investigations

As a result of the review of documentation by the Contaminated Sites Auditor and in order to facilitate the efficient management of peat to be excavated from the eastern wetland, the following additional soil investigations are proposed prior to ground disturbing activities:

1. The area in the eastern wetland that is to be excavated to remove geotechnically unsuitable peat will be subject to additional grid sampling, prior to ground disturbing activities commencing. The objective of this additional sampling is to characterise the spatial distribution of acidity in the peat so that the peat can be assigned average liming rates in blocks. This will allow the peat to be loaded

directly into trucks once it is sufficiently dry with each load be accompanied by documentation giving a pre-calculated acidity and liming rate as guidance to the operator of the treatment site. The sampling will also confirm the vertical extent of peat and acidified soil.

This sampling will be completed in a manner which provides enough information to delineate the vertical and horizontal distribution of acidity in the peat body and also to provide sufficient samples for the volume of material as required by the Landfill Waste Acceptance Guidelines used by the DEC (DoE, 2005).

Sampling will be completed by constructing earthen pads/ramps onto the wetland with clean fill to support a suitable push-type drill rig. A notional sampling grid is included in Figure 6. This grid provides a total of 22 additional sampling points and notionally 440 data points. In practice, the number of locations finally sampled may vary slightly up or down based on-site conditions.

At each sampling location, soil will be sampled at 0.25m intervals to a depth at least 1m below the maximum depth of influence of dewatering in order to provide additional information on the possible influence of the dewatering program. This will coincide with a depth of approximately 1.5m below the base of the peat. All samples will be subjected to Field Testing and based on the Field Test results (any sample with $\text{pH}_{\text{FOX}} < 4$ or where $\Delta\text{pH} > 2$) and an interpretation of soil logs to identify stratigraphic changes in soil type, selected samples will be directed for laboratory testing to determine the acidity and consequent liming rate.

Based on the results of sampling, maps will be prepared which divide the peat into blocks of similar acidity potential. The results and the mapping derived from it will be presented to the Site Auditor to verify that the management approach is appropriate and unlikely to trigger action under the Contaminated Sites legislation.

2. In addition, further soil samples will be taken along the alignment of the deepest level of sewer line on the site. This pipework extends in a westerly direction from Centenary Avenue towards the centre of the site. This sampling is required because the depth of sewer in this small area of the site is sufficient that soil excavation and dewatering impacts associated with its construction may extend beyond 3m below current ground level which was the depth of current investigations. The exact extent of these additional soil investigations will be defined when the sewer design is confirmed and the justification for the extent of sampling provided in the report presenting the results of this sampling (refer Figure 7).

Samples will be taken at 50m intervals along the centreline of the excavation for this sewer over the length of the sewer where the depth of disturbance for the construction of the sewer is greater than 3m below the current ground level. Note that much of the site will be filled above current ground levels and this is the reason why the 3m depth of investigation adopted for the site investigation is sufficient for the majority of the site. Each sample location will be sampled in accordance with the DEC's guidance on the sampling of Acid Sulfate Soils (DoE, 2006). Samples will be directed to a laboratory that is NATA accredited for ASS analysis by the SPOCAS or S_{Cr} methodology.

2.4 Soil Assessment Criteria

Based on guidelines presented in DoE (2006), the criteria utilised to characterise the current state and acid producing potential of the soils and to determine whether or not an Acid Sulfate Soil Management Plan (ASSMP) is required are as follows:

- An ASSMP is required where soils have a net acidity exceeding the Action Criteria of 0.03% sulfur or 18molH⁺/tonne.

In general, soils which have pH_F <4 and/or pH_{FOX} <3 typically have net acidity values which exceed the Action Criteria. Net acidity values are calculated by adding results representing the soil's potential acidity to results representing existing or actual acidity (if any is present). With S_{CR} suite results, the potential acidity is represented by S_{CR} values; with SPOCAS suite results, the potential acidity is represented by the S_{POS} values. For both methods, existing acidity is represented by titratable actual acidity (TAA) values, in appropriate units (i.e. s-TAA for sulfur units).

In determining management requirements, the DEC management guidelines do not distinguish between potential or actual acidity, only net acidity concentration: if the soil exceeds the Action Criteria an ASSMP is required. Accordingly, soil which exceeds the Action Criteria will be described in this report as ASS, without distinction between PASS and AASS.

2.5 Soil Sample Results

The results of the field tests and laboratory analyses are tabulated in Appendix B, together with a description of the soil profile. Interpreted geological cross sections indicating the lithologies encountered during drilling and the distribution of PASS are presented in Figure 4. Additional information for the results of the 2003 investigation, including laboratory certificates and Chain of Custody documentation can be found in ATA (2003a). The laboratory certificates and Chain of Custody documentation for the 2007 results are presented in Appendix C.

Field test results identified one soil interval with pH_F <4 (at EC13, 1.0m). Soils with pH_{FOX} <3 were identified at six locations (locations EC ASS 2 and 6; and EC11 to EC14).

Based on laboratory analytical results, samples from seven locations exceed the DEC action criterion of 0.03%S (locations EC ASS 2, 3, 4, 5, 6, 8, and 10). A summary of the laboratory information is presented in Table 1, together with calculations of net acidity. (S_{Cr} results have been used to calculate net acidity in preference to S_{POS} results, as S_{Cr} is less susceptible to organic interferences).

TABLE 1
SUMMARY OF RESULTS FOR SAMPLES EXCEEDING ACTION
CRITERIA

Sample Location	Depth	S _{POS}	S _{Cr}	s-TAA	Net Acidity	ASS Interval
	(mBGL)	(%S)	(%S)	(%S)	(%S)	(mBGL)
EC ASS 2	2.0	0.25	0.227	<0.02	0.227	1.75-3.0
	2.5	0.292	0.241	<0.02	0.241	
	3.0	0.43	0.377	<0.02	0.377	

TABLE 1
SUMMARY OF RESULTS FOR SAMPLES EXCEEDING ACTION
CRITERIA

Sample Location	Depth	S _{POS}	S _{Cr}	s-TAA	Net Acidity	ASS Interval
	(mBGL)	(%S)	(%S)	(%S)	(%S)	(mBGL)
EC ASS 3	2.5	0.112	0.091	0.03	0.118	2.25-3.0
	3.0	0.169	0.161	<0.02	0.161	
EC ASS 4	2.0	0.099	0.073	<0.02	0.073	1.75-3.0
	2.5	0.094	0.077	<0.02	0.094	
	3.0	0.077	0.068	<0.02	0.077	
EC ASS 5	3.0	-	0.325	0.02	0.344	2.75-3.0
EC ASS 6	0.75	0.263	0.234	<0.02	0.234	0-3.0
	1.0	0.331	0.323	<0.02	0.323	
	1.5	0.233	0.211	<0.02	0.233	
	2.0	0.102	0.091	<0.02	0.102	
	2.3	0.092	0.085	<0.02	0.092	
	3.0	0.095	0.081	<0.02	0.095	
EC ASS 7	1.0	-	<0.02	0.035	0.035	0.75-2.75
	1.5	-	<0.02	0.053	0.053	
	2.0	-	<0.02	0.04	0.04	
	2.5	-	<0.02	0.034	0.034	

TABLE 1
SUMMARY OF RESULTS FOR SAMPLES EXCEEDING ACTION
CRITERIA

Sample Location	Depth	S _{POS}	S _{Cr}	s-TAA	Net Acidity	ASS Interval
	(mBGL)	(%S)	(%S)	(%S)	(%S)	(mBGL)
EC ASS 8	0.5	-	0.032	<0.02	0.032	0-0.75 and 1.25-3.0
	1.5	-	<0.02	0.09	0.088	
	2.0	-	0.043	0.05	0.093	
	2.5	-	0.03	<0.02	0.03	
	3.0	-	0.054	<0.02	0.054	
EC ASS 10	0.5	-	0.052	0.04	0.094	0-1.25 and 1.75-2.75
	1.0	-	0.078	0.03	0.105	
	2.0	-	0.048	<0.02	0.048	
	2.5	-	0.03	<0.02	0.03	
EC11	0.5	0.62	-	<0.02	0.62	0.5-3.0
	1.0	0.16	-	<0.02	0.16	
	1.8	0.30	-	<0.02	0.30	
	2.8	0.04	-	<0.02	0.04	
EC12	0.8	0.05	-	<0.02	0.05	0.5-2.75
	1.3	0.04	-	<0.02	0.04	
	2.3	0.06	-	<0.02	0.06	

TABLE 1
SUMMARY OF RESULTS FOR SAMPLES EXCEEDING ACTION
CRITERIA

Sample Location	Depth	S _{POS}	S _{Cr}	s-TAA	Net Acidity	ASS Interval
	(mBGL)	(%S)	(%S)	(%S)	(%S)	(mBGL)
EC13	1.0	0.06	-	0.03	0.09	0.75-3.0
	1.8	0.04	-	<0.02	0.04	
	2.8	0.03	-	<0.02	0.03	
EC14	0.0	0.15	-	<0.02	0.15	0-1.25
	0.5	1.63	-	0.08	1.71	
	1.0	0.06	-	<0.02	0.06	

The intervals which exceed the action criteria comprise the following soil horizons:

- orange-brown to grey silty sand;
- light brown to grey clay; and
- black peat.

However, there are some horizons of grey silty sand and clays which do not exceed the action criteria. Similarly, not all peaty horizons had measurable acidity. In view of the lack of complete correlation between the various soil horizons and the presence of acidity at levels requiring treatment it will be necessary to use the data in Table 1 and the data collected from the additional site investigations to determine the soils that are at risk rather than adopting rules based on soil types or colours.

Generally, where field test results indicated ASS, the horizons exceed the action criteria. Based on the laboratory results, it is concluded that an ASS Management Plan is required for the site. Management strategies will be discussed in Section 3.

The results from the additional testing described in Section 2.3.3 will be utilised to refine the mapping of ASS on the site and update management strategies. Any changes to the predicted distribution of ASS or proposed management strategies will be discussed with the Site Auditor before implementation to ensure that they do not have implications in terms of causing or exacerbating contamination.

2.6 Groundwater Investigation

Five shallow bores (MW1-MW5) were installed and sampled as part of the Detailed Site Investigation (ATA, 2003b). Two additional groundwater monitoring bores (MW-6 and MW-7) were installed along the southern margin of the site in March 2006 (ATA, 2006) and all seven bores were subject to quarterly

monitoring in 2006 (March 2006, July 2006, September 2006 and December 2006). The locations of the groundwater monitoring wells are shown in Figure 3.

Groundwater levels indicate that groundwater flows in a southerly to slightly south-south-westerly direction (ATA, 2003b). It is noted that the general groundwater flow direction is likely to be influenced by the topography at the boundary between the site and the former landfill to the south-east. This may be either due a slight mounding of the watertable underneath the landfill or to surface run-off from the raised landfill.

Based on the groundwater monitoring undertaken to date, there appears to be little evidence that current or historical on-site activities have contributed to significant groundwater contamination. There is no significant evidence of petroleum hydrocarbons, solvents, pesticides or other toxic organic compounds within groundwater. Marginally elevated concentrations of metals and nitrogen are considered to be associated with the urban land use to the north of the site and as such are considered to be indicative of ubiquitous background levels. This is further supported by the fact that there is no evidence to suggest that contaminant concentrations are greater in down-gradient bores (MW5, MW6 and MW7) when compared to up-gradient bores (MW1, MW2, MW3, MW4) and concentrations of metals exhibited a general decreasing trend throughout the monitoring period. Groundwater within the south-east of the site may be impacted by the former municipal landfill with elevated concentrations of $\text{NH}_3\text{-N}$, TKN, chloride, sulfate, conductivity and zinc recorded within MW4 and MW5. Data suggests that the presence of the uncontrolled fill on the site does not appear to be impacting adversely on groundwater quality.

A comprehensive assessment of analytical results in addition to laboratory certificates, Chain of Custody documentation and borehole logs etc can be found within each respective report.

Note: Six additional shallow groundwater monitoring bores are to be installed to assess the impacts of the earthworks associated with the removal of acid sulfate soils. Two of these bores ASSMW9 and ASSMW11 are intended to provide additional evidence to support the conclusions that on-site land use activities have not contributed to significant groundwater contamination.

2.7 Assessment Criteria

2.7.1 Acid Sulfate Soils

According to DoE (2004), chemical indicators that may indicate that groundwater is being affected by the oxidation of sulfides include the following:

- a chloride/sulfate ratio of less than 2;
- an alkalinity/sulfate ratio of less than 5;
- a pH of less than 5; and
- a soluble aluminium concentration of greater than 1mg/L.

The Swedish Environmental Protection Agency developed a risk ranking scheme to estimate the vulnerability of groundwater to acidification based on alkalinity and pH. The DEC has adapted this scheme, as shown in Table 2.

TABLE 2
VULNERABILITY OF GROUNDWATER TO ACIDIFICATION RISK RANKING SCHEME

Risk Ranking	Alkalinity (mg/L)	pH Range	Description
Low	>60	>6.0	Adequate to maintain pH in most circumstances.
Moderate	30-60	5.5-7.5	Unlikely to maintain a stable pH in areas with significant acid leaching.
High	10-30	5.0-6.0	Unlikely to maintain a stable pH in acid sulfate soil areas.
Very high	<10	<5.0	May be unsuitable for use because of high metal and arsenic concentrations.

After DoE (2004).

2.7.2 Irrigation

Abstracted groundwater is proposed to be allowed to infiltrate and/or used for dust suppression. Further information on the dewatering strategy is provided in Section 4.3. It is therefore proposed to use the short-term irrigation water guideline (STIWG) (values specified in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC and ARMCANZ, 2000). Short-term trigger values are defined by ANZECC and ARMCANZ (2000) as follows:

*“The **short-term** trigger value (STV) is the maximum concentration (mg/L) of contaminant in the irrigation water which can be tolerated for a shorter period of time (20 years) assuming the same maximum annual irrigation loading to soil as for LTV”.*

It is considered that the assumptions used to derive the short-term trigger values are appropriate for the proposed dewatering project although they are inherently conservative.

2.7.3 Australian Drinking Water Guidelines

As the proposed development will be serviced by scheme water, it is not considered necessary to compare the results to the Drinking Water Guidelines (DWGs) of DoE (2003) and NHMRC/ ARMCANZ (2000). However, analytical groundwater data have been compared to the National Health and Medical Research Council Australian Drinking Water Guidelines (ADWG) Health values or Aesthetic values multiplied by a factor of 10 (ADWG x10), as it is proposed to utilise groundwater for non-recreational purposes i.e. reticulation (for the first two years of the development) and dust suppression during earthworks (National Health and Medical Research Council and Natural Resource Management Ministerial Council, 2005).

2.7.4 Fresh Water

Fresh water assessment criteria specified in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC and ARMCANZ, 2000) have also been included for the purposes of

comparison. Where values for more than one type of ecosystem have been provided, the wetland values have been selected.

2.8 Groundwater Results

Given the transient nature of groundwater, it is considered appropriate to assess the most recent groundwater analytical data when undertaking a review of groundwater quality within the vicinity of the site, however, a summary of 2003 groundwater analytical data is provided below for brevity.

2.8.1 2003 Groundwater Monitoring Data

A summary of the relevant laboratory analytical results from the 2003 groundwater monitoring undertaken is presented below.

- No PCBs, OC/OP pesticides, or TPHs were detected in any sample analysed.
- Naphthalene was detected in bore MW4 at 0.09µg/L (below the Fresh Water criterion).
- Elevated concentrations of zinc were recorded in MW3, MW4 and MW5 in excess of the Fresh Water guideline but below STIWG and ADWG.
- MW1, MW2, MW4 and MW5 recorded concentrations of Total Nitrogen in excess Fresh Water/Wetland guidelines but below STIWG.
- All five bores recorded elevated concentrations of phosphorous in excess of Fresh Water/Wetland guidelines but below STIWG.
- MW5 contained recorded an elevated concentration of cadmium in excess of Fresh Water/Wetland guidelines but below ADWG x10.

A comparison of the results to the ASS assessment criteria specified in Section 2.7 indicates that:

- No bore samples have pH values of less than 5 and a comparison of the sample pH values to the values in Table 3 indicates that the vulnerability of groundwater to acidification is classified as "low". This suggests that even if oxidation of sulfides is occurring, the groundwater will maintain its pH in most circumstances.
- No aluminium concentrations exceed 1mg/L (where analysed).

The ratios of chloride to sulfate and alkalinity to sulfate cannot be calculated, as these parameters were not analysed. Comparison of the results to the STIWG and ADWG x10 indicates that all analytes except for pH in bore MW1 comply with the criteria.

2.8.2 2006 Groundwater Monitoring Data

A summary of the relevant laboratory analytical results from the 2006 groundwater monitoring undertaken is provided below.

- No OC/OP pesticides, BTEX, PAHs or TPH carbon chains were recorded above applicable LORs and as such are below guideline values (STIWG and ADWG x10).
- No elevated concentrations of arsenic, barium, cadmium, chromium, copper, manganese, mercury, nickel, lead, selenium or zinc were recorded in excess of applicable guideline values (STIWG and ADWG x10).

- Concentrations of aluminium were below ADWG x10 and STIWG. MW4, MW5 and MW6 (unfiltered) recorded concentrations of aluminium ranging between 1.10mg/L and 2.80mg/L in March 2006. Subsequent monitoring results recorded aluminium concentrations below LOR (<0.1mg/L) in most instances.
- MW5 contained elevated concentrations of Total Nitrogen in excess of STIWG on two occasions (July/September 2006).
- MW3 recorded one marginally elevated concentration of phosphorous (July 2006) in excess of STIWG.

A comparison of the results to the ASS assessment criteria specified in Section 2.7 indicates the following:

- MW4 and MW6 recorded concentrations of ammonia (N) greater than the ASS indicator value of 1mg/l and Fresh Water/Wetland guideline but less than ADWG x10. MW5 recorded elevated concentrations of ammonia (N) greater than ASS indicator value, and Fresh Water/Wetland guidelines and ADWG x10.
- No bore samples have pH values of less than 5.
- Concentrations of iron ranged between 8.30mg/L and 28mg/L and exceeded the ADWG x10 and/or STIWG in three bores (MW4, MW5 and MW6) located in the south-east of the site.
- MW1 and MW7 recorded a ratio of chloride to sulfate less than the ASS indicator value of 2 in March. All subsequent monitoring events recorded a ratio greater than 2. MW3 recorded a ratio of chloride to sulfate of 1.91 in September. All other monitoring events recorded a ratio above the indicator value.
- The ratio of alkalinity to sulfate was less than 5 in all seven bores on at least one occasion over the course of the four monitoring events.
- Comparison of the pH values in all bores to the values in Table 2 indicates that the vulnerability of groundwater to acidification is "low to moderate" as pH generally ranged between 5.5 to >6. MW1, MW4 and MW6 may be classified as areas more vulnerable to ASS with a pH range falling between 5 and 6 (i.e. high risk).
- Comparison of the alkalinity values in all bores to the values in Table 2 indicates that the vulnerability of groundwater to acidification is "low to moderate". Alkalinity values ranged between 20mg/L and 770mg/L with the majority of values falling within the 30mg/L to 60mg/L (moderate risk) range. Soils within the vicinity of MW2 are potentially more susceptible to ASS with alkalinity values ranging between 20mg/L and 25mg/L (i.e. high risk).

2.9 ASS Management Issues

The results summarised above indicate that soil at locations EC ASS 2 to 8, EC ASS 10, and EC11 to EC14 exceed the DEC's Action Criteria, and the preparation of an Acid Sulfate Soils Management Plan (ASSMP) is required. Soils with maximum net acidity concentrations above the ASSMP trigger value were encountered soils located within the east-west portion of the wetland and along the drainage line extending from the wetland to the foreshore along the western edge of the site. Acidity is primarily associated with black peaty material as well as grey silty sands, although there are intervals where such

soils are found but no acidity is identified. Based on the ASS intervals identified in Table 1, which exceed the action criteria of 0.03%S, it is proposed to treat the areas and intervals specified in Figure 5.

It will be necessary to follow soil and groundwater management strategies outlined in Section 3 in order to minimise the generation of acidity due to the disturbance of soil horizons with potential acidity.

3 MANAGEMENT PRACTICES

The following text has been written in a manner suitable for inclusion in tender documentation and includes the following terms:

Principal:	Trustees of the Christian Brothers in Western Australia Incorporated.
Contractor:	Civil earthworks contractor appointed by Trustees of the Christian Brothers.
Principal's Environmental Consultant:	Environmental consultant appointed by Trustees of the Christian Brothers.
Superintendent:	Superintendent appointed by Trustees of the Christian Brothers.

The following management strategy has been developed by ATA Environmental for use at the Cygna Cove site. Any significant changes proposed by the civil earthworks contractor as part of the tender process will require submission to the DEC for approval. The Contractor will be responsible for ensuring that all management measures outlined in the management strategy (or as agreed otherwise) are adhered to for the duration of their contract.

3.1 Soil Management

3.1.1 Liming Rate

Where soils exceeding the DEC's action criteria of 0.03%S are to be disturbed, they will require treatment to ensure they are limed with sufficient alkalinity to neutralise both any actual or potential acidity with a safety factor 2.0. The DEC guidelines provide guidance on calculating the liming rate based on acidity measurements.

Soil sampling to date has not been undertaken in the wetland area due to difficulties in accessing this area of the site. The required liming rate for the peat and other soils excavated from this area of the site will be calculated based on the results of additional investigations as described in Section 2.3.3. Similarly, the results of additional soil investigations along the alignment of areas of deep sewer as described in Section 2.3.3 will be used to determine the required liming rate for soil excavated for construction of the sewer.

For the remainder of the site, a liming rate for the soils has been calculated on the basis of the net acidity results presented in Appendix B. The liming rate calculations are presented in Appendix D, as follows:

- The samples exceeding the Action Criteria were compiled (41 samples).
- The following were calculated: maximum net acidity (1.71%S); mean net acidity (0.17%S); one standard deviation of the net acidity (0.28%S); and mean plus one standard deviation (0.45%S).
- The maximum and mean plus one standard deviation values were compared. Because the maximum is an outlier, nearly 3x greater than the nearest result, it was determined that the mean plus one standard deviation was more representative of the sample results. Only two of the 41 samples exceed the mean plus one standard deviation result.

- The liming rate was calculated by multiplying the mean plus one standard deviation net acidity value (0.45%S) by 46.8, which is the appropriate conversion factor from %S to kgCaCO₃/tonne soil, including a safety factor of 2.0¹.

The 'uncorrected' liming rate is **21kgCaCO₃/tonne of soil**. The calculated liming rate is 'uncorrected' in the sense that it assumes a soil bulk density of 1t/m³, and assumes a finely divided 100% CaCO₃ neutralising material is used. (For example, if the soil has a bulk density of 1.8t/m³, the liming rate becomes 37.8kgCaCO₃/m³, before correcting for the neutralising capacity of the material used.) **Liming rates will need to be corrected for the CaCO₃ content, particle size distribution and bulk density of the material used for neutralisation.**

This conservatively calculated liming rate will be applied to all excavated soils that have been identified as ASS and which will not be sampled in the additional soil investigation programs described in Section 2.3.3

3.1.2 Strategy for Excavation and Treatment of ASS

Where excavation of ASS material is required, it will be undertaken as rapidly as possible to minimise both the dewatering period (if required) and the exposure of soils at the edge and base of excavations to the atmosphere. It is anticipated that dewatering may be required when excavating organic-rich soil from the eastern portion of the wetland, which will subsequently be filled and developed. Excavations and dewatering will be undertaken in a staged fashion to minimise widespread ASS exposure during works.

Excavated ASS soil will be stockpiled on a bunded treatment pad pending treatment, or pending being trucked off-site for treatment (in order to allow it to dewater sufficiently). The bunded pad will be constructed of alkaline material of not less than 300mm thickness. The pad shall be graded to ensure good drainage and all sides shall be bunded with limestone or similar alkaline material to a minimum height of approximately 300mm above the surface of the pad to prevent lateral migration of acidic run-off.

A neutralising agent (such as Aglime) will be mixed with the ASS material at a rate to be advised by the Principal's Environmental Consultant that satisfies the effective neutralising value set by the specified liming rates in the areas where PASS will be encountered, as shown in Figure 5.

In order to correct the calculated liming rate, the following information will be required for the neutralising material proposed for use:

- a. the density of the material;
- b. the calcium carbonate (CaCO₃) content of the material; and
- c. the particle size distribution of the neutralising material.

¹ Coffey Environments contacted the DEC (S.Wong) on 13 January 2010 and it was agreed that the highest net acidity (1.7 %S) should be treated as an outlier. The liming rate provided is considered to be provisional and subject to adjustment based on site specific conditions.

(Information contained in items 'b' and 'c' above is required to allow the effective neutralising value (ENV) to be calculated. If the ENV of the neutralising agent is already known, this information may be used instead of items 'b' and 'c' for consideration).

The method proposed by the Contractor for blending the neutralising agent with the surface and subsurface ASS will be approved by the Superintendent and/or Principal's Environmental Consultant prior to the commencement of the soil treatment operations.

It is anticipated that soil which cannot be re-used on-site (i.e. peaty soil) will be trucked off-site for treatment at an approved facility. This facility will be provided with information about the liming rate required, based on the results of this investigation. Generally, these facilities exceed the provided liming rate (subject to the necessary corrections), to ensure that material does not subsequently require re-treatment, as the cost of handling the soil exceeds the cost of excess lime. To assess that the material has been adequately treated (i.e. the net acidity, including ANC is zero or negative), the facility must submit samples for verification testing in accordance with their management plan, as would happen if material were treated on the development site. Should the verification testing indicate that the neutralising treatment is not fully neutralising acidity in the material delivered from the Cygna Cove site, the treatment facility will modify the liming rate accordingly. Between the initial 'overliming' and the verification testing, it is considered that there are adequate procedures in place to overcome possible difficulties with not having extensive information on the acidity of peaty material from within the wetland and is considered to be prescribed in accordance with DEC guidelines (DEC, 2009).

3.2 Backfilling

The treated ASS may be used as backfill at the site, provided the verification testing results are acceptable. Prior to backfilling with treated ASS, the base and walls of excavations will be lined with 100mm of neutralising agent if the soil in the base of the trench has a pH of less than 5. This neutralising layer may be placed over pipework on the trench floor, and liming of trench walls will be achieved to the degree practicable by hand-sprinkling of material.

Soils identified as containing contaminant concentrations in excess of applicable HIL's/EIL's and any uncontrolled fill material excavated are excluded for re-use on-site. In addition, any unexpected/ previously unidentified contamination encountered shall not be used as backfill material without appropriate chemical analysis and risk assessment to determine its suitability for retention on-site/ identify appropriate disposal routes.

3.3 Dewatering Management Strategy

The Contractor will prepare and submit an outline of its proposed Dewatering Management Plan to address the Dewatering Management Strategy as requested and for approval by the Superintendent prior to award of contract. Guidance on the content of the Dewatering Management Plan is provided in Section 3.3.1. It is intended that the Contractor's Dewatering Management Plan is submitted together with this ASSMP and the appropriate forms to the DEC as part of an application to abstract groundwater.

3.3.1 Dewatering Management Plan

The Contractor's Dewatering Management Plan must include the following information:

- the method of dewatering (eg. dewatering spears, wellpoint dewatering etc);

- the commencement date, duration, anticipated quantity, and frequency of dewatering;
- description of the dewatering effluent treatment (see Section 3.3.2) the Contractor proposes to use;
- proposed size and approximate location of storage or infiltration ponds;
- the alkaline material to be used in the neutralisation pond, the method of application and contingency measures in the event that the pH criterion (6 at the outlet) is not being met; and
- contact details should complaints be received.

Groundwater modelling information will also be required to be undertaken.

3.3.2 Treatment of Dewatering Effluent

Coffey Environments recommend that a dosing tank is used to treat dewatering effluent, providing rapid and reliable neutralisation of extracted water, and to minimise the area required for treatment (in contrast to treatment ponds). In this scenario, effluent will be pumped to a pH dosing tank for addition of a suitable alkaline material to maintain a pH between 6.5 and 8.5, prior to flowing to a storage or infiltration basins. Monitoring will occur at the inlet and outlet of the dosing tank in accordance with Section 4.2.

It is anticipated that dewatering may be required in order to remove geotechnically unsuitable (organic-rich) soil from the eastern lobe of the wetland area, which will be developed. Under the existing hydrological scheme, water in this area enters the site from the north and flows through the wetland before discharging to Clontarf Bay. During dewatering, this and any groundwater encountered will be diverted from the area of active excavations, and run through a dosing tank and settling tank. Treated dewatering effluent may be allowed to infiltrate on-site, or may be used for dust suppression or discharge into the remaining wetland area. Treated dewatering effluent will be assessed against Freshwater Guidelines (FWG) (ANZECC and ARMCANZ, 2000) outlined within (DoE, 2003 and DEC, 2009) based on 95% protection of species level to determine their suitability for discharge into the wetland. It is noted that the re-use of dewatering effluent is proposed as a means of sustaining elevated groundwater levels beneath the site to assist in inhibiting the exposure and resulting oxidation of sulfates in underlying soils.

4 MONITORING

4.1 Soil Verification Testing

The Contractor will liaise with the Principal's Environmental Consultant to arrange for verification testing of the neutralised material prior to re-use of the material. The verification testing will be undertaken by the Principal's Environmental Consultant. The Contractor will allow for a period of 48 hours (excluding weekends) between notifying the Principal's Environmental Consultant and receiving the verification field testing results.

4.2 Water Monitoring Programs

4.2.1 Monitoring Locations

Based on discussions with the Contaminated Sites Auditor it was agreed that the established groundwater monitoring network located on the boundaries of the development site needed to be supplemented by the installation of additional bores in closer proximity to the areas of ASS excavation and associated Dewatering. Figure 3 shows the location of the six (6) additional shallow monitoring bores constructed for the ASS investigation. These monitoring bores have been assigned a prefix of 'ASSMW' but numbered sequentially from eight to avoid any possible confusion with the numbering of the existing seven monitoring bores with the MW prefix (i.e. MW1-MW7 and ASSMW8-ASSMW13).

Coffey has produced a Groundwater Monitoring and Management Plan (Coffey Environments, 2010) which details the historical soil and groundwater analytical data in addition to establishing baseline groundwater conditions based on a groundwater monitoring event (GME) undertaken in September 2008.

In addition, the DEC has requested that an additional groundwater monitoring bore be installed to the west of MW6 and to the east of MW7 (ASSMW14) to facilitate the detection of impacts along the foreshore reserve area. All the groundwater monitoring bores will be sampled prior to the onset of Dewatering or ASS investigation and then in accordance with Table 5 for the duration of the ASS excavation program. Monitoring of the bores will continue at a monthly frequency for 12 months following the cessation of activities with a potential to disturb ASS.

The groundwater monitoring completed under the is Acid Sulfate Soil Management Plan will be undertaken for the purposes of monitoring potential acidification and is not the subject of review by the site Auditor unless acidification process result in changes in soil or water quality to the extent that the contamination status of the site may be impacted. In this event, the Auditor will be advised as described in Tables 6 and 7 and the contingency measures described in the Groundwater Monitoring Plan (Coffey Environments, 2010) will be implemented in consultation with the site Auditor.

For the purposes of this ASSMP, sampling will accord with Table 5.

It is proposed to undertake the following water monitoring during dewatering operations:

- The Contractor will be responsible for continuously monitoring the dewatering discharge rate and volume.
- The Contractor will be responsible for monitoring and recording groundwater levels, pH and total acidity in the groundwater monitoring bores at the site daily. Trigger values for the groundwater levels will be set based on the proposed maximum depth of dewatering, plus 20cm.

- The Contractor will be responsible for daily monitoring and recording of the pH and total acidity of the dewatering effluent. If a dosing tank is used, the water will be sampled from the inlet pond supplying the tank, and the outlet of the tank. The trigger criteria specified in Table 3 should be used to determine the level of treatment required, or if more frequent field monitoring is required. This information should be provided to the Principal's Environmental Consultant on a weekly basis.

TABLE 3
DEWATERING EFFLUENT TRIGGER LEVELS AND RESPONSE ACTIONS

Trigger Levels		Action
pH	TAA ¹	
>6	<40mg/L	Continue daily field measurements of pH and TAA.
<6	<40mg/L	Undertake neutralisation treatment (liming).
>6	>40mg/L	Undertake neutralisation treatment (liming).
<6	<60mg/L	Undertake neutralisation treatment (liming) and aeration to precipitate iron followed by settling/flocculation treatment to settle out precipitates.
<4	>60mg/L	Increase monitoring frequency to twice daily. Increase neutralisation treatment (liming) rate and aeration to precipitate iron followed by settling/flocculation treatment to settle out precipitates. Advise the Principal's Environmental Consultant and the DEC immediately. DEC may advise additional action.

¹ TAA = Total actual acidity

- For the duration of the dewatering program, the Principal's Environmental Consultant will be responsible for sampling and laboratory analysis of bores and dewatering effluent. The bores to be monitored may vary depending on which area of the site is undergoing earthworks and dewatering. The frequency and analytical parameters vary based on field measurements of untreated dewatering effluent as specified in Table 4. Limits of reporting should be selected to meet the most stringent assessment criteria.

TABLE 4
WATER SAMPLE ANALYSIS PARAMETERS

Trigger - Untreated Dewatering Effluent Quality	Action	Monitoring
Total titratable acidity <40mg/L and pH>6	Continue daily field measurements of pH and total titratable acidity.	<u>Daily</u> - field measurement: pH, EC and Total Titratable Acidity. <u>Fortnightly</u> - laboratory analysis: total acidity, total alkalinity, pH.
Total titratable acidity <40mg/L and pH in range 4 to 6	Undertake neutralisation treatment (liming).	<u>Daily</u> - field measurement: pH, EC and Total Titratable Acidity. <u>Weekly</u> - laboratory analysis: total acidity, total alkalinity, pH .
Total Titratable Acidity In Range 40mg/L to 100mg/L and pH>4	Effluent should be aerated to precipitate dissolved iron and directed to a series of settlement basins/trenches or other treatment system to allow removal of iron and other metals. Undertake neutralisation treatment (liming).	<u>Daily</u> - field measurement: pH, EC and Total Titratable Acidity. <u>Weekly</u> - laboratory analysis: total acidity, total alkalinity, pH. <u>Fortnightly</u> - laboratory analysis: total acidity, total alkalinity, pH, sulfate, chloride, total and dissolved iron, total aluminium, dissolved aluminium, total arsenic, total chromium, total cadmium, total manganese, total nickel, total zinc, total selenium, ammoniacal nitrogen, hydrogen sulphide, EC, TSS, TDS, total nitrogen, total phosphorus, FRP. <u>Fortnightly</u> - field measurement: dissolved oxygen, redox potential (Eh).
Total Titratable Acidity >100mg/L, or pH<4	Effluent should be aerated to precipitate dissolved iron and directed to a series of settlement basins/trenches or other treatment system to allow removal of iron and other metals. Increase neutralisation treatment (liming) rate. Advise Land and Water Quality Branch DEC immediately. LWQB may advise appropriate action which may include ceasing dewatering.	<u>Twice daily</u> – field measurement: pH, EC, Total Titratable Acidity. <u>Weekly</u> - laboratory analysis: total acidity, total alkalinity, pH, sulfate, chloride, total and dissolved iron, total and dissolved, aluminium, total arsenic, total chromium, total cadmium, total manganese, total nickel, total zinc, total selenium, ammoniacal nitrogen, hydrogen sulphide, EC, TSS, TDS, total nitrogen, total phosphorus, FRP. <u>Fortnightly</u> - field measurement: dissolved oxygen, Eh. May be required to undertake investigations to determine the size of the “acidic footprint” created and manage this impact appropriately.

- If the dewatering program runs for more than four weeks, the Principal’s Environmental Consultant will be responsible for two-monthly sampling and laboratory analysis of the groundwater monitoring

bores for a total period of six months after the cessation of the dewatering program for the analyte suite utilised during dewatering.

The results of the Contractor's water monitoring programs, along with actions taken to achieve water quality targets, will be reported to the Principal's Environmental Consultant at the end of each week. The Principal's Environmental Consultant will be responsible for providing advice to the Superintendent and/or Contractor regarding the water monitoring results.

The Principal's Environmental Consultant will be responsible for the more detailed groundwater quality monitoring program, reviewing all monitoring results and reporting to the DEC.

At the completion of the dewatering program, the Principal's Environmental Consultant will collect samples of the accumulated sediments at the base of each pond to determine the appropriate decommissioning requirements in accordance with Section 4.3.

4.3 Decommissioning of Treatment Ponds

At the completion of the works, the Principal's Environmental Consultant will collect samples of the accumulated sediments at the base of each pond to determine the appropriate decommissioning requirements.

Sample analytes will include, but not be limited to:

- pH;
- SPOCAS or S_{Cr} ; and
- Metals (Al, As, Cd, Cr, Cu, Hg, Ni, Pb, Zn).

Appropriate decommissioning requirements may include treatment of accumulated sediments in accordance with Section 5.1 and/or landfill disposal.

5 PERFORMANCE INDICATORS

5.1 Soil Verification Assessment Criteria

Neutralised soil will be sampled and subject to field testing. The number of samples required will be determined in accordance with the *Landfill Waste Classification and Waste Definitions, 1996 (As Amended)* (DoE, 2005). Between approximately 10% and 25% of verification samples collected will be submitted for laboratory analysis using the SPOCAS method.

To validate neutralisation, Ahern et al (2004) specify the following criteria:

- $\text{pH}_{\text{ox}} \geq 6.5$;
- $\text{pH}_{\text{KCl}} \geq 5.5$;
- TAA of zero (or below limit of detection);
- Zero or negative net acidity utilising the ANC (divided by the appropriate fineness factor).

Where field test results do not meet the pH criterion, but laboratory results for TAA and ANC indicate that the soil has no actual or net acidity, the soil will be considered appropriately neutralised.

If verification testing results do not comply with the criteria, additional treatment and retesting will be undertaken within 48 hours by the Principal's Environmental Consultant.

Verification results will be reported to the Superintendent and DEC at the completion of the soil treatment operation by the Principal's Environmental Consultant.

5.2 Groundwater Assessment Criteria

The laboratory results of the groundwater and dewatering effluent monitoring programs will be compared to the assessment criteria specified in Section 2.7.

5.3 Surface Water Sampling

Baseline sampling of surface water quality will be commenced prior to remediation or earthworks starting. Sampling will be conducted in the wetland, the drain (two locations and also in the near shore area of the Canning River to provide an indication of the likelihood of surface water discharged from the site impacting on aquatic biota resident in the near shore area of the canning river adjacent to the site. The surface water program will include indicator parameters for acidification processes including:

- pH
- metals (ASS suite)
- Total Acidity
- Chloride
- Sulphate
- Total Alkalinity

If these indicators suggest that acidification is occurring, then a full ASS sampling regime will be implemented for the surface water sample locations. This sampling will continue through the soil remediation program (Contamination and ASS) as part of the Ecotox investigation (see Appendix H of the Baseline Groundwater Monitoring and Management Plan (Coffey Environments, 2010)).

6 REPORTING AND RESPONSIBILITY

The Contractor will prepare and maintain a log of the treatment operation. The log will track the total volume of ASS disturbed, the quantity and type of neutralising agent used, the dates over which the treatment operation ran, and the approximate location of disposal of excavated material. The log will be submitted to the Principal's Environmental Consultant and Superintendent at the end of each week.

The reporting requirements outlined in Table 5 shall be followed.

TABLE 5
SOIL REPORTING REQUIREMENTS

Responsibility	Item	To Whom	Timing
Contractor	<p>The following information for the neutralising material proposed for use in the treatment of ASS:</p> <ol style="list-style-type: none"> 1. a cost rate per unit weight or volume; 2. the density of the material; 3. the calcium carbonate (CaCO_3) content of the material*; and 4. the particle size distribution of the neutralising material*. <p>* Note: This information is required to allow the effective neutralising value (ENV) to be calculated. If the ENV of the neutralising agent is already known, this information may be submitted instead of items (3) and (4) above for consideration.</p>	Superintendent	With Tender submission.
Contractor	A clear method statement of their proposed blending regime.	Superintendent	As requested prior to award of contract.
Contractor	Log of the treatment operation. The log will track the total volume of ASS disturbed, the quantity and type of neutralising agent used, the dates over which the treatment operation ran, and the approximate location of disposal of excavated material.	Principal's Environmental Consultant.	At the end of each week.

TABLE 5
SOIL REPORTING REQUIREMENTS

Responsibility	Item	To Whom	Timing
Principal's Environmental Consultant	Soil verification testing results and advice.	Superintendent/ Contractor	Within 48 hours of receipt of samples (Monday to Friday only).
Principal's Environmental Consultant	Soil verification testing results and advice.	Auditor	Within 48 hours of receipt of samples - in the event that it appears acidification may be affecting the contamination status of the site.
Principal's Environmental Consultant	Soil verification testing results and advice.	DEC	At the end of the soil treatment operation.
Principal's Environmental Consultant	Final report.	DEC	On completion of earthworks and dewatering.

The reporting requirements with respect to groundwater and dewatering effluent outlined in Table 6 shall be followed.

TABLE 6
DEWATERING AND GROUNDWATER REPORTING REQUIREMENTS

Responsibility	Item	To Whom	Timing
Contractor	Dewatering Management Plan	Superintendent	As requested prior to award of contract.
Contractor	Results of the water monitoring programs along with actions taken to achieve water quality targets.	Principal's Environmental Consultant	At the end of each week.

TABLE 6
DEWATERING AND GROUNDWATER REPORTING REQUIREMENTS

Responsibility	Item	To Whom	Timing
Principal's Environmental Consultant	Results of water monitoring programs supplied by the Contractor, and results of water monitoring program implemented by Principal's Environmental Consultant.	DEC	On completion of earthworks and dewatering.
Principal's Environmental Consultant	Advice to the Auditor regarding the water monitoring results.	Auditor	Within 48 hours of receipt of samples - in the event that it appears acidification may be affecting the contamination status of the site.
Principal's Environmental Consultant	Advice to the Contractor regarding the water monitoring results.	Superintendent/ Contractor	On receipt of results.
Principal's Environmental Consultant	Final report.	DEC	On completion of earthworks and dewatering.

7 REFERENCES

Ahern, CR, McElnea, AE, Sullivan, LA (2004) *Acid Sulfate Soils Laboratory Methods Guidelines*. Queensland Department of Natural Resources, Mines, and Energy. Indooroopilly, Queensland.

Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Volume 1 The Guidelines (Chapters 1 to 7). National Water Quality Management Strategy Paper No 4, Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ), Canberra.

ATA Environmental (ATA) (2001) *Environmental Assessment, East Clontarf, Manning*. ATA Environmental Report 2000/181 Final Report. ATA Environmental Report 2000/179. Prepared for Trustees of the Christian Brothers, January 2001.

ATA (2002) *Detailed Soil/Groundwater Contamination and Preliminary Acid Sulphate Soils Investigation, Sampling and Analysis Program*. ATA Environmental Report 2002/147. Prepared for Trustees of the Christian Brothers, December 2002.

ATA (2003a) *Preliminary Acid Sulphate Soils Investigation, East Clontarf, Manning*. ATA Environmental Report 2002/147. ATA Environmental Report 2003/115. Prepared for Trustees of the Christian Brothers, August 2003.

ATA (2003b) *Detailed Soil and Groundwater Investigation, East Clontarf, Waterford*. ATA Environmental Report 2002/92. Prepared for Trustees of the Christian Brothers, December 2003.

ATA (2003c) *Clontarf Residential Subdivision, Waterford, Public Environmental Review Environmental Scoping Document Assessment No. 1467*. ATA Environmental Report 2003/91. Prepared for Trustees of the Christian Brothers, July 2003.

ATA (2003d) *Clontarf Residential Subdivision, Waterford, Public Environmental Review (EPA Assessment No. 1467)*. ATA Environmental Report 2003/91. Prepared for Trustees of the Christian Brothers, June 2004.

ATA (2004) *Clontarf Residential Subdivision, Waterford, Responses to Submissions (EPA Assessment No. 1467)*. ATA Environmental Report 2004/182. Prepared for Trustees of the Christian Brothers, October 2004.

ATA (2006) *Clontarf Residential Subdivision, Waterford, Ministerial Statement No. 692, Section 45C Referral*. ATA Environmental Report 2006/82. Prepared for Trustees of the Christian Brothers, April 2006.

Coffey Environments (2010) *Baseline Groundwater Monitoring and Management Plan, Cygnia Cove, Waterford*. Coffey Environments Report 2010/003 (V2).

Department of Environment (DoE) (2003) *Assessment Levels for Soil, Sediment and Water (Draft)*. Version 3. Contaminated Sites Management Series, Department of Environment (DoE), Perth.

DoE (2004) *Guidance for Groundwater Management in Urban Areas on Acid Sulfate Soils*. Acid Sulfate Soils Guideline Series, Department of Environment (DoE), Perth.

DoE (2005) *Landfill Waste Classification and Waste Definitions, 1996 (As Amended)*. Contaminated Sites Management Series, Department of Environment, Perth.

DoE (2006) *Identification and Investigation of Acid Sulfate Soils and Groundwater*. Acid Sulfate Soils Guideline Series, Department of Environment (DoE), Perth (Draft 2006).

Department of Environment and Conservation (DEC) (2009) *Treatment and Management of Soils and Water in Acid Sulfate Soil Landscapes (draft guidelines)*.

DEWCP (2002) *Draft DEWCP and EPA Guidance on Acid Sulfate Soils*. Department of Environment, Water and Catchment Protection (DEWCP).

Jordan JE (1986) *Armadale, Part Sheets 2033 I and 2133 IV, Perth Metropolitan Region 1:50,000 Environmental Geology Series*. Geological Survey of Western Australia, Perth.

National Health and Medical Research Council and Natural Resource Management Ministerial Council (NHMRC and NRMCC) (2005) - Guidelines of Managing Risks in Recreational Water.

8 STATEMENT OF LIMITATIONS

(please refer over the page)

Important information about your **Coffey** Environmental Report

Uncertainties as to what lies below the ground on potentially contaminated sites can lead to remediation costs blow outs, reduction in the value of the land and to delays in the redevelopment of land. These uncertainties are an inherent part of dealing with land contamination. The following notes have been prepared by Coffey to help you interpret and understand the limitations of your report.

Your report has been written for a specific purpose

Your report has been developed on the basis of a specific purpose as understood by Coffey and applies only to the site or area investigated. For example, the purpose of your report may be:

- To assess the environmental effects of an on-going operation.
- To provide due diligence on behalf of a property vendor.
- To provide due diligence on behalf of a property purchaser.
- To provide information related to redevelopment of the site due to a proposed change in use, for example, industrial use to a residential use.
- To assess the existing baseline environmental, and sometimes geological and hydrological conditions or constraints of a site prior to an activity which may alter the sites environmental, geological or hydrological condition.

For each purpose, a specific approach to the assessment of potential soil and groundwater contamination is required. In most cases, a key objective is to identify, and if possible, quantify risks that both recognised and unrecognised contamination pose to the proposed activity. Such risks may be both financial (for example, clean up costs or limitations to the site use) and physical (for example, potential health risks to users of the site or the general public).

Scope of Investigations

The work was conducted, and the report has been prepared, in response to specific instructions from the client to whom this report is addressed, within practical time and budgetary constraints, and in reliance on certain data and information made available to Coffey. The analyses, evaluations, opinions and conclusions presented in this report are based on those instructions, requirements, data or information, and they could change if such instructions etc. are in fact inaccurate or incomplete.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man and may change with time. For example, groundwater levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of the subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Coffey to be advised how time may have impacted on the project and/or on the property.

Interpretation of factual data

Environmental site assessments identify actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from indirect field measurements and sometimes other reports on the site are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact with respect to the report purpose and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how well qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, parties involved with land acquisition, management and/or redevelopment should retain the services of Coffey through the development and use of the site to identify variances, conduct additional tests if required, and recommend solutions to unexpected conditions or other problems encountered on site.

Important information about your **Coffey** Environmental Report

Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered with redevelopment or on-going use of the site. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. In particular, a due diligence report for a property vendor may not be suitable for satisfying the needs of a purchaser. Your report should not be applied for any purpose other than that originally specified at the time the report was issued.

Interpretation by other professionals

Costly problems can occur when other professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Coffey to work with other professionals who are affected by the report. Have Coffey explain the report implications to professionals affected by them and then review plans and specifications produced to see how they have incorporated the report findings.

Data should not be separated from the report

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way. Logs, figures, laboratory data, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel), field testing and laboratory evaluation of field samples. This information should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Contact Coffey for additional assistance

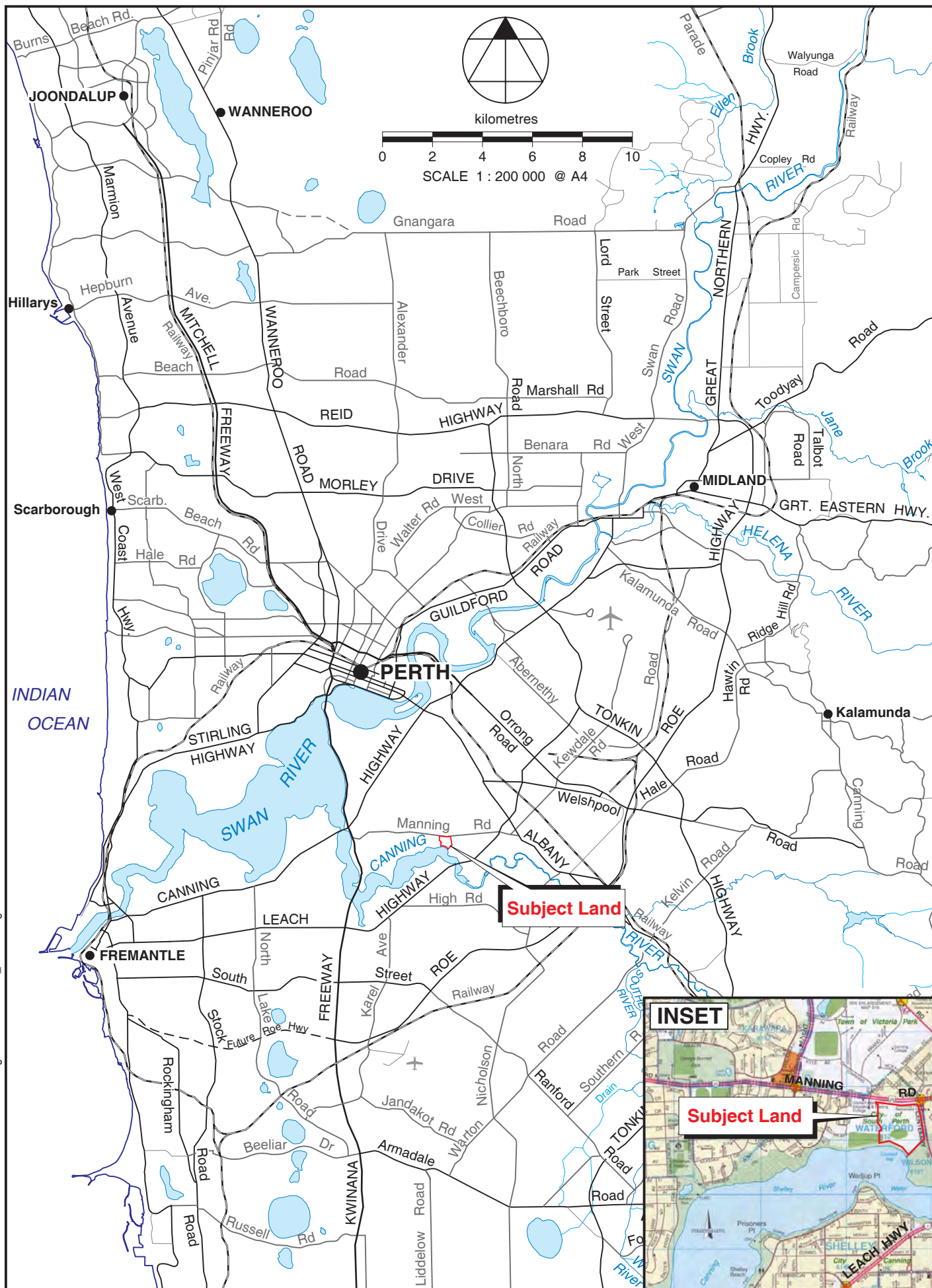
Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to land development and land use. It is common that not all approaches will be necessarily dealt with in your environmental site assessment report due to concepts proposed at that time. As a project progresses through planning and design toward construction and/or maintenance, speak with Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

Responsibility

Environmental reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than other design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Coffey to other parties but are included to identify where Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Coffey closely and do not hesitate to ask any questions you may have.

Figures

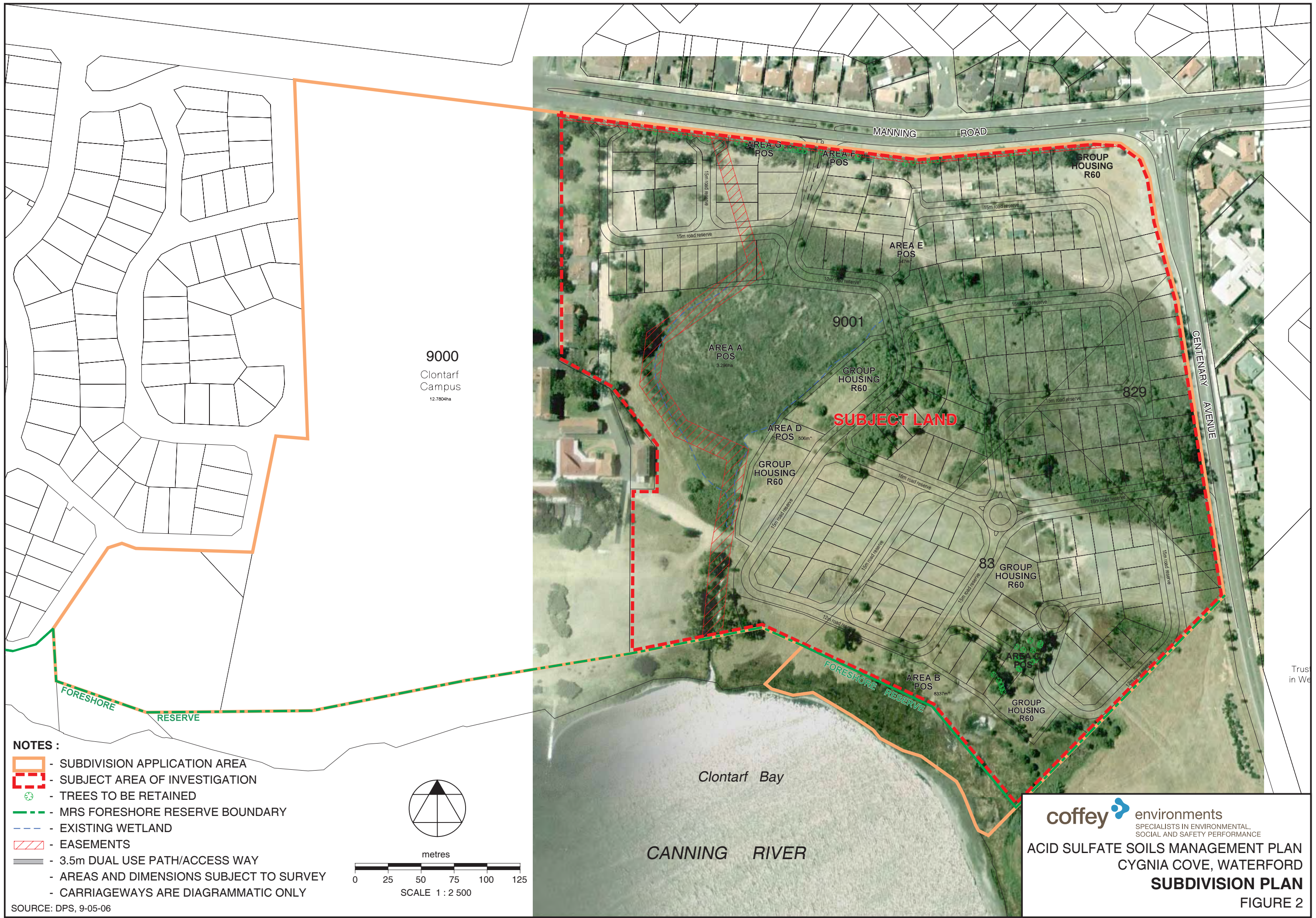
**Acid Sulfate Soils Management Plan
Cygnia Cove, Waterford**



ACID SULFATE SOILS MANAGEMENT PLAN
CYGNIA COVE, WATERFORD

REGIONAL LOCATION

FIGURE 1



NOTES :

- SUBDIVISION APPLICATION AREA
- SUBJECT AREA OF INVESTIGATION
- TREES TO BE RETAINED
- MRS FORESHORE RESERVE BOUNDARY
- EXISTING WETLAND
- EASEMENTS
- 3.5m DUAL USE PATH/ACCESS WAY
- AREAS AND DIMENSIONS SUBJECT TO SURVEY
- CARRIAGEWAYS ARE DIAGRAMMATIC ONLY

SOURCE: DPS, 9-05-06



LEGEND

- Subject Land Boundary
- Section Line A - A' (see Figure 4)
- Monitoring Well Location
- Acid Sulfate Soil Sample Location (2003)
- Acid Sulfate Soil Sample Location (2007)

metres

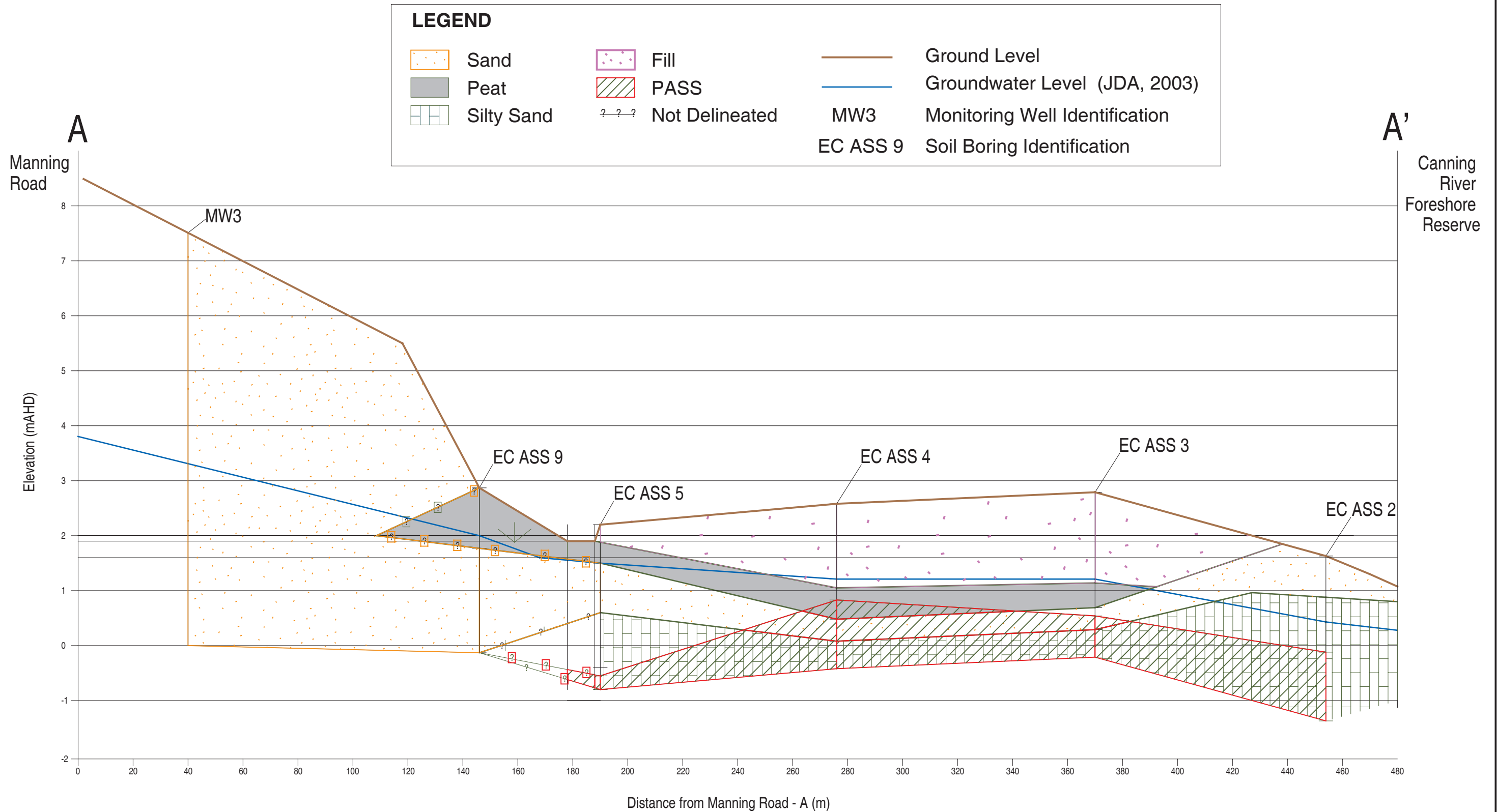
SCALE 1 : 2 000

0 20 40 60 80 100

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**ACID SULFATE SOILS MANAGEMENT PLAN
CYGNIA COVE, WATERFORD
SOIL AND GROUNDWATER
SAMPLING LOCATIONS**

FIGURE 3



FOOTNOTES:

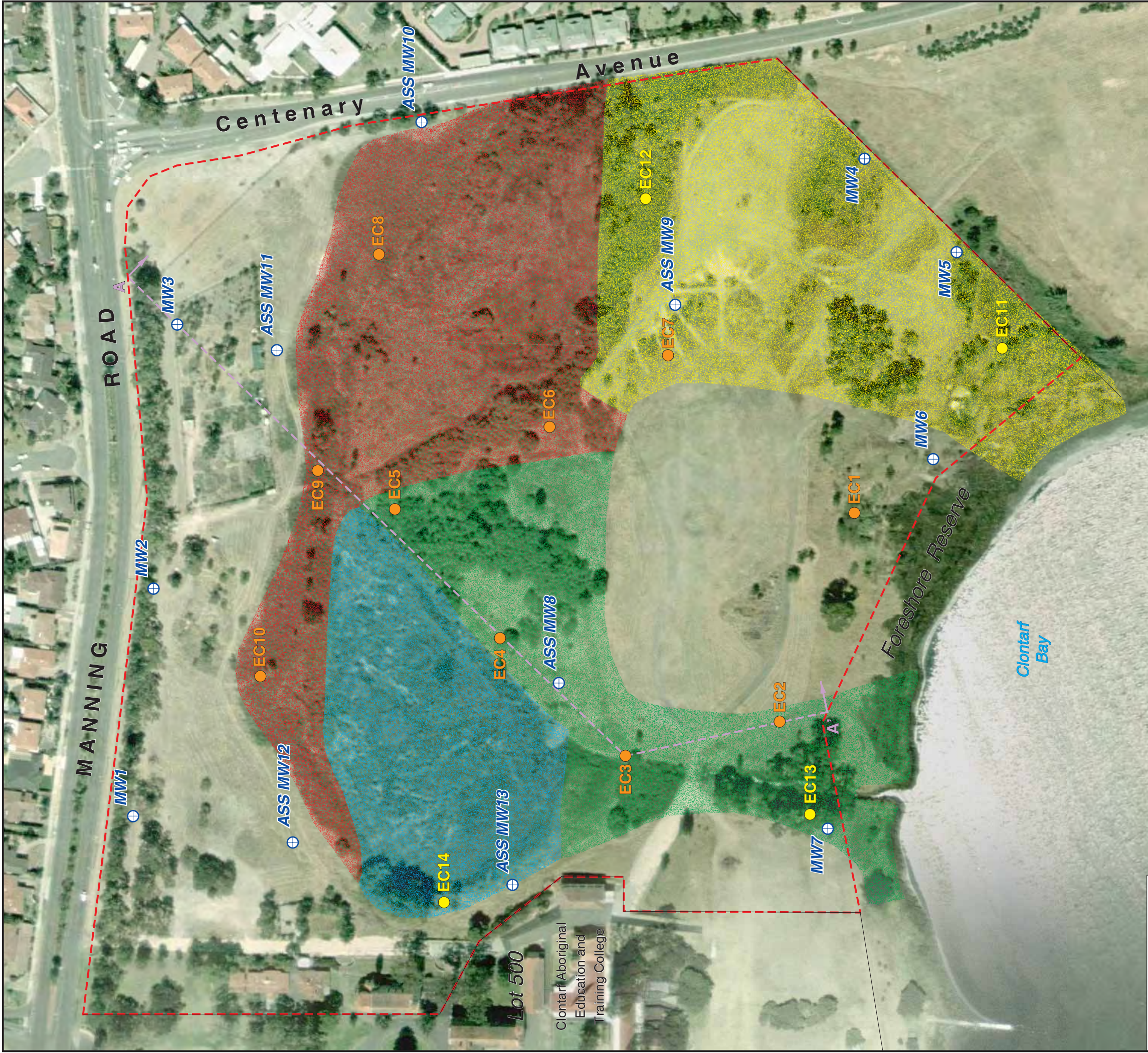
1. Refer to figure 3 for cross section locations
2. The subsurface cross section has been inferred from logs of subsurface conditions encountered in boreholes. Actual subsurface conditions may vary from those indicated in the cross section.
3. Bore locations were surveyed, however topographic heights have been inferred from the design contours.

For location see Figure 3

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ACID SULFATE SOILS MANAGEMENT PLAN
CYGNIA COVE, WATERFORD
INTERPRETED CROSS SECTION

FIGURE 4



LEGEND

- Subject Land Boundary
- Section Line A - A' (see Figure 4)
- Monitoring Well Location
- Acid Sulfate Soil Sample Location (2003)
- Acid Sulfate Soil Sample Location (2007)

ASS AREAS TREATMENT INTERVALS


- 0.0 - 1.25 (base of Peat)
- 0.0 - 3.0
- 0.5 - 3.0
- 1.75 - 3.0

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**ACID SULFATE SOILS MANAGEMENT PLAN
CYGNIA COVE, WATERFORD
ASS AREAS AND
TREATMENT INTERVALS**

FIGURE 5





metres

0 20 40 60 80 100

SCALE 1 : 2 000

LEGEND

Subject Land Boundary

--- A-A'

Section Line A - A' (see Figure 4)

MW7

Monitoring Well Location

● EC1

Acid Sulfate Soil Sample Location (2003)

● EC11

Acid Sulfate Soil Sample Location (2007)

⊗

Additional Acid Sulfate Soil Sample Location


ASS AREAS TREATMENT INTERVALS

0.0 - 1.25 (base of Peat)

0.0 - 3.0

0.5 - 3.0

1.75 - 3.0



ACID SULFATE SOILS MANAGEMENT PLAN
CYGNIA COVE, WATERFORD
ADDITIONAL ACID SULFATE SOIL INVESTIGATION
FIGURE 6

AERIAL PHOTO SOURCE: DOLA, 7-8-03

CAD. SOURCE: PGS HOPE & Partners, 29-5-03



- ### SEWER NOTES
1. THE DRAWINGS SHALL BE READ IN CONJUNCTION WITH THE NOTES AND STANDARD DRAWINGS LISTED ON WATER CORPORATION DWG AA01-3-1
 2. ALL PIPE SIZES IN MILLIMETRES (DIA 150 U.O.S.), ALL DISTANCES AND LEVELS IN METRES.
 3. DISTANCES GIVEN ARE AT THE INTERSECTION OF SEWERS.
 4. THE CONTRACTOR SHALL ENSURE THAT ALL LOTS ARE SERVED WITH HOUSE CONNECTIONS. (DUPLEX LOTS TO HAVE TWO CONNECTIONS).
 5. EARTHWORKS TO BE PLACED AND COMPACTED PRIOR TO CONSTRUCTION OF SEWERS.
 6. ALL CONNECTIONS TO LIVE SEWERS TO BE BY THE WATER CORPORATION AT THE CONTRACTOR'S EXPENSE.
 7. DN 150 TO DN 375 SEWER PIPES TO BE UPVC CLASS SNI, DN 100 PIPES TO BE UPVC SNA. ALL PIPES TO BE SOLVENT CEMENT JOINTED.
 8. INSPECTION SHAFTS AT THE END OF I.S. SEWERS WILL ONLY BE REQUIRED WHEN THE UPSTREAM END OF THE SEWER IS 2m OR DEEPER. WHEN AN INSPECTION SHAFT IS REQUIRED THE SHAFT SHALL BE BROUGHT TO WITHIN 1.5m OF THE SURFACE AND SHOWN ON THE SEWER RETICULATION PLAN AS A I.S.U.
 9. ALL HOUSE CONNECTIONS WHEN LOCATED AT THE END OF A I.O OR I.S SEWER LINE ARE TO BE BROUGHT UP TO 1.0m OF THE SURFACE AND SHALL BE BROUGHT TO 1.0m INSIDE THE BOUNDARY WHEN FROM ROAD RESERVE. ALL OTHER HOUSE CONNECTIONS ARE TO BE BROUGHT UP TO WITHIN 1.0m OF THE SURFACE AND SHALL BE BROUGHT TO 0.5m INSIDE THE BOUNDARY WHEN FROM ROAD RESERVE.
 10. ALL HOUSE CONNECTIONS ARE TO BE LAID AT 1:60 BENEATH ANY PROPOSED RETAINING WALL AND SHALL EXTEND 0.5m CLEAR OF THE REAR OF ALL WALL CONSTRUCTION BEFORE BROUGHT UP PIPEWORK IS INSERTED.
 11. MINIMUM COVER OF SEWERS TO BE 0.9m IN ROAD RESERVES AND 0.75m IN LITS.
 12. ACCESS CHAMBERS LESS THAN 6.0m DEEP SHALL BE PRECAST CONCRETE OR STANDARD BRICK CONSTRUCTION UNLESS NOTED OTHERWISE.
 13. TRAFFICABLE ACCESS CHAMBER COVERS TO BE GATIK TWO PART HEAVY DUTY (B2931) OR SIMILAR APPROVED.
 14. LOCAL AUTHORITY: CITY OF SOUTH PERTH
 15. ALL SEWER ACCESS CHAMBERS HOUSING Ø150 SEWER PIPES TO BE ON A 3.1m ALIGNMENT IN ROAD RESERVE UNLESS OTHERWISE NOTED. ALL SEWER ACCESS CHAMBERS HOUSING Ø300 SEWER PIPES TO BE ON A 3.2m ALIGNMENT UNLESS OTHERWISE NOTED. CO-ORDINATES WILL BE PROVIDED TO SURVEYOR PRIOR TO SETOUT IF REQUESTED.
 16. THE MAXIMUM GROUNDWATER (AAMGL) LEVEL IS ASSUME) TO BE RL 4.90. THE CONTRACTOR IS TO MAKE HIS OWN ASSESSMENT OF THE GROUNDWATER CONDITIONS.
 17. WHERE I.O AND I.S SEWERS TERMINATE WITHIN PROPERTIES A EASEMENT SHALL BE PROVIDED TO WATER CORPORATION'S REQUIREMENTS.
 18. ACCESS CHAMBERS AB554, AB555 & AB556 ARE TRAFFICABLE WITH WATER CORPORATION APPROVED 'LOCK DOWN' COVERS.
 19. LOTS 122, 138 TO 140 AND LOTS 156 TO 158 AND LOTS 116 TO 221 HOUSE CONNECTIONS TO BE BROUGHT INTO THE LOT 3.0m PAST THE ROAD RESERVE BOUNDARY.

- ### LEGEND
- RETICULATION AREA BOUNDARY
 - EXISTING GRAVITY SEWER
 - EXISTING SEWER PRESSURE MAIN
 - FUTURE GRAVITY SEWER
 - PROPOSED GRAVITY SEWER AND ACCESS CHAMBER OR MAINTENANCE SHAFT
 - PROPOSED RUNNING TRAP
 - PROPOSED BOUNDARY TRAP
 - PROPOSED SURFACE CONTOUR
 - EXISTING SURFACE CONTOUR
 - FINISHED LOT PAD LEVEL
 - PROPOSED RETAINING WALL
 - FUTURE RETAINING WALL
 - PIPE DIAMETER (mm)
 - PIPE SLOPE (1 IN 1)
 - PIPE INVERT LEVEL (A.H.D.)
 - PIPE LENGTH (m)
 - ACCESS CHAMBER STANDARD R.C COVER
 - ACCESS CHAMBER TRAFFICABLE COVER
 - ACCESS CHAMBER TRAFFICABLE LOCK DOWN COVER
 - FUTURE LOT PROVIDED WITH PROPERTY CONNECTION BY THIS RETICULATION STAGE (NO CLEARANCES WILL BE SOUGHT UNDER THIS CONTRACT)
 - LOT PROVIDED WITH PROPERTY CONNECTION IN PREVIOUS RETICULATION STAGE (CLEARANCES WILL BE SOUGHT UNDER THIS CONTRACT)
 - HOUSE CONNECTION TO BE BROUGHT INTO THE LOT 3.0m PAST THE ROAD RESERVE BOUNDARY.

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ACID SULFATE SOILS MANAGEMENT PLAN CYGNIA COVE, WATERFORD SEWERAGE RETICULATION PLAN FIGURE 7

SOURCE: TABEC, 08-01-08
CAD No. 2028-01-201
WAPC No. 121124

This plan shall not be used for construction unless issued as rev D and signed as approved.				COPYRIGHT The concepts and information contained in this document are the Copyright of TABEC Pty Ltd. Use or copying of the document in whole or part without the written permission of TABEC Pty Ltd. constitutes an infringement of copyright.				CLIENT RICHARD NOBLE & COMPANY				PROJECT CYGNIA COVE, WATERFORD - STAGE 1				TITLE SEWERAGE RETICULATION PLAN			
DESIGNED NJW				CHECKED CCB				APPROVED DATE				DRAWING NUMBER 2028-01-201				ISSUE A			
A 08.01.08 NJW CCB ISSUED FOR APPROVAL / TENDER.				No. DATE DRAWN APPROVED AMENDMENT				No. DATE DRAWN APPROVED AMENDMENT				No. DATE DRAWN APPROVED AMENDMENT				No. DATE DRAWN APPROVED AMENDMENT			

TABEC
Civil Engineering Consultants
TABEC Pty Ltd ACN 090 796 204
14 Wickham Street, East Perth WA 6004
Telephone 0225 4100, Fax 0225 4198
Email info@tabec.com.au

Appendix A

Site Summary Form and Certificate of Title

Acid Sulfate Soils Management Plan
Cygnia Cove, Waterford



Department of Environment

Site Summary Form (Acid Sulfate Soils Assessment)

For completion by person(s) submitting report(s) for assessment by the Department of Environment (DoE) as per the information requirements of the *Acid Sulfate Soils Guidelines Series*. Completion of this form assists the DoE in maintaining an accurate and consistent record for the site.

Please note: A completed Site Summary Form must accompany each report submitted to the DoE for assessment. Copies of all relevant Certificates of Title must accompany this form.

Site Location Details:

Site Name (e.g. where site may be known by a common/ business name)

Lot No. House No. Street

Suburb State Postcode

Crown Reserve (if applicable)

Certificate(s) of Title (or equivalent)

Where the subject site comprises of multiple certificates of title, please list ALL certificates:.....Above.....

Is a hard copy of Certificate of Title and associated sketch for the site attached? (Y/N)

Current Owner/Occupier Details:

Site Owner (Name and address)

Site Occupier (Name and address)

Site Status (at time of reporting):

Was this report produced to comply with condition(s) set by WAPC or other relevant authority?
If so, please provide a complete copy of the conditions with this submission.

Previous land use (e.g. market gardens, industrial, landfill, marina)

Current land use (e.g. vacant land, residential, market garden, industrial, landfill, marina)

Proposed land use (e.g. high density residential/child care facility, ornamental lake, canal development)

Dewatering (minor or major volume), groundwater abstraction, drainage or other lowering of the water table proposed? If so, has a license been applied for? (If yes, please attach a copy of application)

Dredging proposed?

Proposed volume and maximum depth of soil / sediment disturbance
(For excavation or dredging)

Sufficient to remove peat under residential areas.

Proposed volume and duration of dewatering and radial extent of groundwater cone of depression

Not known yet.

History of Investigation:

Have previous site investigations been undertaken? (Y/N - if yes, please provide details below)

Yes

Report title, date and author:

- *Environmental Assessment, East Clontarf, Manning* (ATA, 2001). ATA Environmental Report 2000/179. Prepared for Trustees of the Christian Brothers, January 2001.
- *Detailed Soil/Groundwater Contamination and Preliminary Acid Sulphate Soils Investigation, Sampling and Analysis Program* (ATA, 2002). ATA Environmental Report 2002/147. Prepared for Trustees of the Christian Brothers, December 2002.
- *Preliminary Acid Sulphate Soils Investigation, East Clontarf, Manning* (ATA, 2003a). ATA Environmental Report 2003/115. Prepared for Trustees of the Christian Brothers, August 2003.
- *Detailed Soil and Groundwater Investigation, East Clontarf, Waterford* (ATA, 2003b). ATA Environmental Report 2002/92. Prepared for Trustees of the Christian Brothers, December 2003.

Are there existing contamination issues at the site?
(If so, provide details)

Yes. Minor areas with soil >EIL in fill and natural soil, local asbestos fibres detected in fill.

Investigation Details:

List components of desktop assessment completed
(e.g. geology, elevation, vegetation, water quality, peat swamp, ASS risk map)

Geology, elevation, review of geotechnical investigation of peaty area, presentation of SAP to DoE

List components of field inspection and screening completed
(e.g. description of soils, iron staining, corrosion, scalds, pH and peroxide field tests, water pH & acidity)

Components of SAP as approved by DoE: 10 holes to 3m, field & laboratory testing of soil. Water analyses.

List laboratory analysis of soils and water for existing acidity and acid generating potential completed
(e.g. SPOCAS, SCR, water quality ASS suite)

Scr & SPOCAS
Contamination water quality assessment

Identified substances and relevant media
(e.g. sulfides in soil, arsenic in soil and/or groundwater, jarosite in soil, iron monosulfides, metal hydroxides)

Some acidity in soil
Water generally meets ST Irrigation values

Where laboratory analysis has been undertaken, is the laboratory NATA accredited for ALL analytes and analytical methodologies used? (Y/N) (If No, why not?)

Yes

Management:

Has an Acid Sulfate Soil Management Plan (ASSMP) been developed?
(If not, why not?)

Yes

Does the ASSMP include management of dewatering?
(If not, why not?)

Yes

Human Health Issues:

Asbestos
(Y/N)

Y

Health Risk
Assessment (e.g.
acidic soil and/or
water, arsenic) (Y/N)

N

Acidification/contamination of
domestic and/or commercial
groundwater abstraction bores (Y/N)

N

Community
health
concerns
identified (Y/N)

N

Air quality
Issues e.g.
H₂S (Y/N)

N

Past/Present Landfill
(Y/N)

Y

Potential human exposure to identified
substances > DoE's Health
Investigation Levels or equivalent (Y/N)

N

Other human
health issues
(Y/N)

N

Specify other health issues.....

Where **YES** is recorded for at least one of the above categories, please submit 2 copies of the report(s) (relevant documentation) to the DoE for referral to the Department of Health.

Community Consultation (as per the DoE's *Community Consultation (June 2002)* guideline)

Community consultation program commenced/proposed (Y/N)

Yes—PER was prepared for site

Are details of consultation program (e.g. Community Consultation Plan) provided in attached report (Y/N)

N

Declaration:

The information presented in this Site Summary Form is a true representation of the information within the attached report(s)/document(s).

Full name (print)

Suzanne Brown

Position held

Senior Environmental Scientist

Signature



Date

14/6/06

Please ensure that a hardcopy of the current Certificate(s) of Title and associated sketch accompanies the Site Summary Form. The DoE cannot proceed with the assessment of the report in the absence of this information.



SILVERMASTER

WESTERN AUSTRALIA

WA

WA

WA

RECORD OF CERTIFICATE OF TITLE

UNDER THE DEPARTMENT OF LANDS ACTS

THIS CERTIFICATE OF TITLE IS A PUBLIC DOCUMENT AND IS NOT VALID UNLESS IT IS SIGNED BY THE REGISTRAR OF DEEDS AND THE DEPARTMENT OF LANDS AND IS REGISTERED IN THE PUBLIC REGISTER OF DEEDS.

THE REGISTRAR OF DEEDS



LAND DESCRIPTION

LOT 100 ON THE PLAN 100/100

REGISTERED PROPRIETOR
GEOFFREY H. HARRIS

THE REGISTRAR OF DEEDS, AS REGISTRAR IN WESTERN AUSTRALIA, AND OF THE DEPARTMENT OF LANDS, MEANING

LIMITATIONS, INTERESTS, EVIDENCE, AND NOTIFICATIONS
IN THE PUBLIC REGISTER OF DEEDS

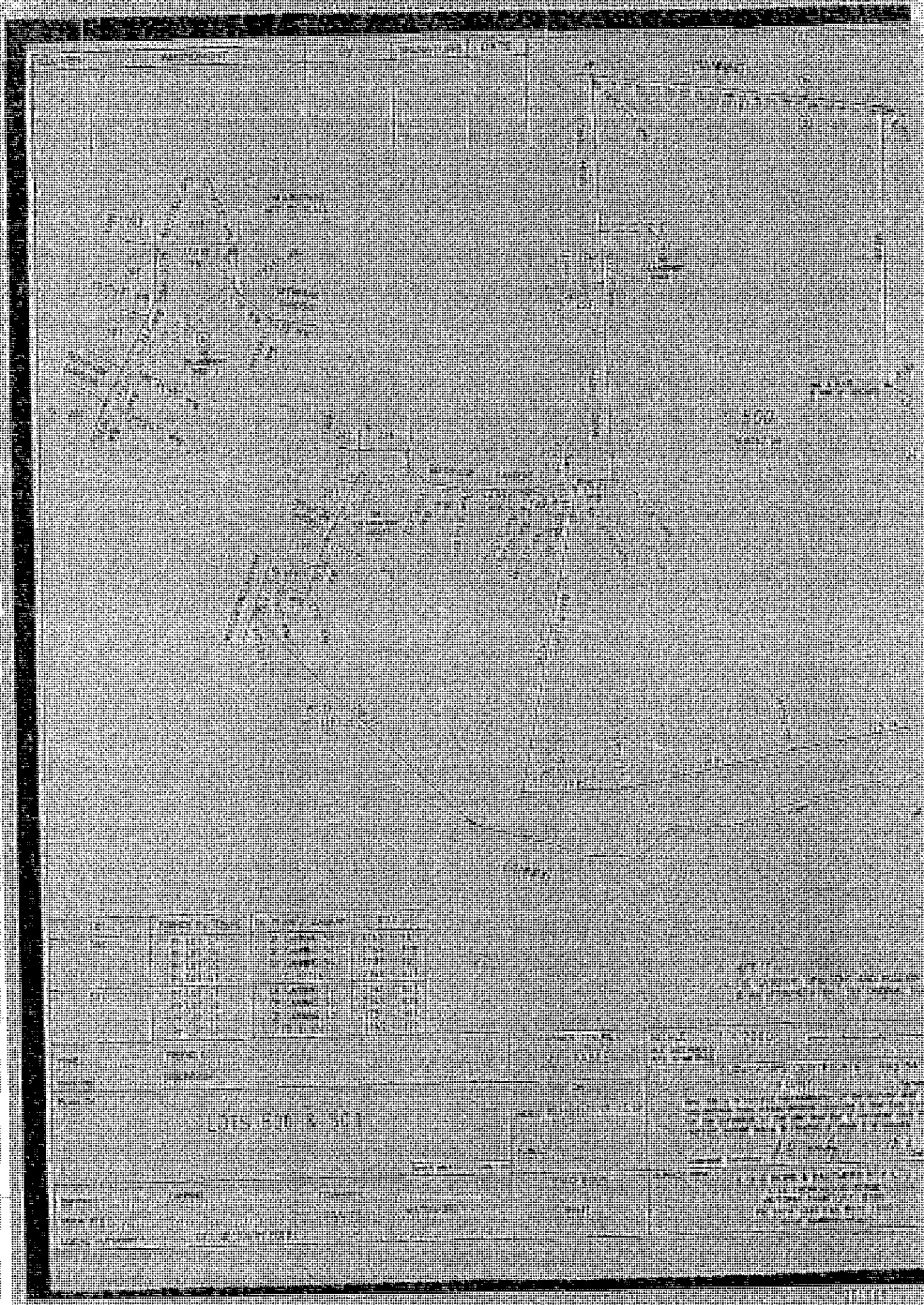
- 1. ANNOTATION: EASEMENT TO CITY OF PERTH FOR THE PURPOSE OF THE CITY OF PERTH ACT 1954, REGISTERED 1954/100.
- 2. EASEMENT: EASEMENT TO THE CITY OF PERTH FOR THE PURPOSE OF THE CITY OF PERTH ACT 1954, REGISTERED 1954/100.
- 3. EASEMENT: EASEMENT TO THE CITY OF PERTH FOR THE PURPOSE OF THE CITY OF PERTH ACT 1954, REGISTERED 1954/100.
- 4. EASEMENT: EASEMENT TO THE CITY OF PERTH FOR THE PURPOSE OF THE CITY OF PERTH ACT 1954, REGISTERED 1954/100.
- 5. EASEMENT: EASEMENT TO THE CITY OF PERTH FOR THE PURPOSE OF THE CITY OF PERTH ACT 1954, REGISTERED 1954/100.
- 6. EASEMENT: EASEMENT TO THE CITY OF PERTH FOR THE PURPOSE OF THE CITY OF PERTH ACT 1954, REGISTERED 1954/100.
- 7. EASEMENT: EASEMENT TO THE CITY OF PERTH FOR THE PURPOSE OF THE CITY OF PERTH ACT 1954, REGISTERED 1954/100.
- 8. EASEMENT: EASEMENT TO THE CITY OF PERTH FOR THE PURPOSE OF THE CITY OF PERTH ACT 1954, REGISTERED 1954/100.
- 9. EASEMENT: EASEMENT TO THE CITY OF PERTH FOR THE PURPOSE OF THE CITY OF PERTH ACT 1954, REGISTERED 1954/100.
- 10. EASEMENT: EASEMENT TO THE CITY OF PERTH FOR THE PURPOSE OF THE CITY OF PERTH ACT 1954, REGISTERED 1954/100.

NOTES: 1. THE REGISTRAR OF DEEDS, AS REGISTRAR IN WESTERN AUSTRALIA, AND OF THE DEPARTMENT OF LANDS, MEANING
2. THE REGISTRAR OF DEEDS, AS REGISTRAR IN WESTERN AUSTRALIA, AND OF THE DEPARTMENT OF LANDS, MEANING
3. THE REGISTRAR OF DEEDS, AS REGISTRAR IN WESTERN AUSTRALIA, AND OF THE DEPARTMENT OF LANDS, MEANING

STATEMENT OF THE REGISTRAR

THE REGISTRAR OF DEEDS, AS REGISTRAR IN WESTERN AUSTRALIA, AND OF THE DEPARTMENT OF LANDS, MEANING
THE REGISTRAR OF DEEDS, AS REGISTRAR IN WESTERN AUSTRALIA, AND OF THE DEPARTMENT OF LANDS, MEANING

DEPARTMENT OF LANDS
PERTH
WESTERN AUSTRALIA
DEPARTMENT OF LANDS
PERTH
WESTERN AUSTRALIA
DEPARTMENT OF LANDS
PERTH
WESTERN AUSTRALIA



30878



CONFIDENTIAL - SECURITY INFORMATION
NOT TO BE RELEASED

CONFIDENTIAL - SECURITY INFORMATION
NOT TO BE RELEASED

CONFIDENTIAL - SECURITY INFORMATION
NOT TO BE RELEASED

CONFIDENTIAL - SECURITY INFORMATION
NOT TO BE RELEASED

500

100

100

WESTERN



AUSTRALIA

REGISTER NUMBER	
83/P2461	
DUPLICATE EDITION	DATE DUPLICATION ISSUED
N/A	N/A

RECORD OF CERTIFICATE OF TITLE
UNDER THE TRANSFER OF LAND ACT 1893

VOLUME
2048FOLIO
181

The person described in the first schedule is the registered proprietor of an estate in fee simple in the land described below subject to the reservations, conditions and depth limit contained in the original grant (if a grant issued) and to the limitations, interests, encumbrances and notifications shown in the second schedule.

J. H. Gale
REGISTRAR OF TITLES



LAND DESCRIPTION:

LOT 83 ON PLAN 2461

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

TRUSTEES OF THE CHRISTIAN BROTHERS IN WESTERN AUSTRALIA INC OF 53 REDMOND STREET,
MANNING

(A P931160) REGISTERED 18 JULY 1995

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

1. THE LAND THE SUBJECT OF THIS CERTIFICATE OF TITLE EXCLUDES ALL PORTIONS OF THE LOT DESCRIBED ABOVE EXCEPT THAT PORTION SHOWN IN THE SKETCH OF THE SUPERSEDED PAPER VERSION OF THIS TITLE. VOL 2048 FOL 181.

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
* Any entries preceded by an asterisk may not appear on the current edition of the duplicate certificate of title.
Lot as described in the land description may be a lot or location

-----END OF CERTIFICATE OF TITLE-----

STATEMENTS:

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND: 2048-181.
PREVIOUS TITLE: 1731-311.
PROPERTY STREET ADDRESS: LOT 83 MANNING RD, WATERFORD.
LOCAL GOVERNMENT AREA: CITY OF SOUTH PERTH.

Superseded - Copy for Sketch Only

Page 1 of 2 pages 2018

ORIGINAL—NOT TO BE REMOVED FROM OFFICE OF TITLES

LT. 37

Application F931160

WESTERN



AUSTRALIA

REGISTER BOOK

VOL.

FOL.

Volume 1731 Folio 311

CERTIFICATE OF TITLE

UNDER THE "TRANSFER OF LAND ACT, 1893" AS AMENDED

CT 2048

181



I certify that the person described in the First Schedule hereto is the registered proprietor of the undermentioned estate in the undermentioned land subject to the easements and encumbrances shown in the Second Schedule hereto.

G Jack

REGISTRAR OF TITLES



Dated 18th July, 1995

ESTATE AND LAND REFERRED TO

Estate in fee simple in portion of Canning Location 1 and being part of Lot 83 on Plan 2451 (Sheet 2), delineated on the map in the Third Schedule hereto.

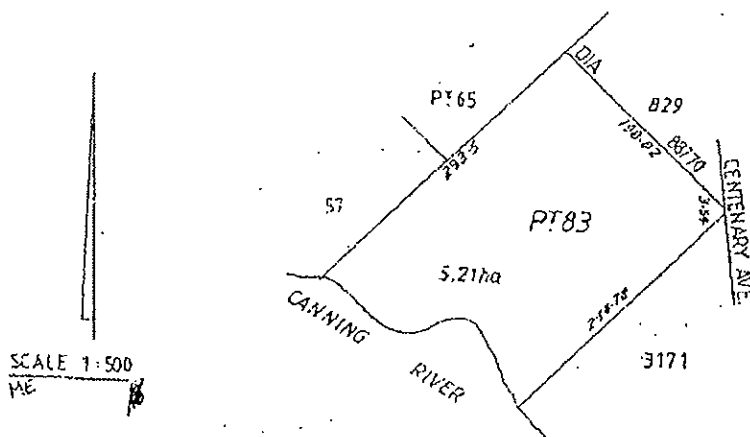
FIRST SCHEDULE (continued overleaf)

Trustees of the Christian Brothers in Western Australia Inc. of 53 Redmond Street, Manning.

SECOND SCHEDULE (continued overleaf)

NIL

THIRD SCHEDULE



WESTERN



AUSTRALIA

REGISTER NUMBER 829/D88770	
DUPLICATE EDITION N/A	DATE DUPLICATE ISSUED N/A

RECORD OF CERTIFICATE OF TITLE UNDER THE TRANSFER OF LAND ACT 1893

VOLUME
2048FOLIO
180

The person described in the first schedule is the registered proprietor of an estate in fee simple in the land described below subject to the reservations, conditions and depth limit contained in the original grant (if a grant issued) and to the limitations, interests, encumbrances and notifications shown in the second schedule.

[Signature]
REGISTRAR OF TITLES



LAND DESCRIPTION:

LOT 829 ON DIAGRAM 88770

REGISTERED PROPRIETOR: (FIRST SCHEDULE)

TRUSTEES OF THE CHRISTIAN BROTHERS IN WESTERN AUSTRALIA INC OF 53 REDMOND STREET,
MANNING

(T 048292) REGISTERED 6 DECEMBER 1995

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS: (SECOND SCHEDULE)

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
* Any entries preceded by an asterisk may not appear on the current edition of the duplicate certificate of title.
Lot as described in the land description may be a lot or location.

-----END OF CERTIFICATE OF TITLE-----

STATEMENTS:

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for legal, surveying or other professional advice.

SKETCH OF LAND:	2048-180.
PREVIOUS TITLE:	1731-311.
PROPERTY STREET ADDRESS:	LOT 829 MANNING RD, WATERFORD.
LOCAL GOVERNMENT AREA:	CITY OF SOUTH PERTH.

Superseded - Copy for Sweden Only

ORIGINAL—NOT TO BE REMOVED FROM OFFICE OF TITLES

LT. 37

Application F931159
Volume 1731 Folio 311

WESTERN



AUSTRALIA

REGISTER BOOK
VOL. FOL.

CERTIFICATE OF TITLE

UNDER THE "TRANSFER OF LAND ACT, 1893" AS AMENDED

CT 2048 180

I certify that the person described in the First Schedule hereto is the registered proprietor of the undermentioned estate in the undermentioned land subject to the easements and encumbrances shown in the Second Schedule hereto.

G. Jack
REGISTRAR OF TITLES



Dated 18th July, 1995

ESTATE AND LAND REFERRED TO

Estate in fee simple in portion of Canning Location 1 and being Lot 829 on Diagram 88770, delineated on the map in the Third Schedule hereto.

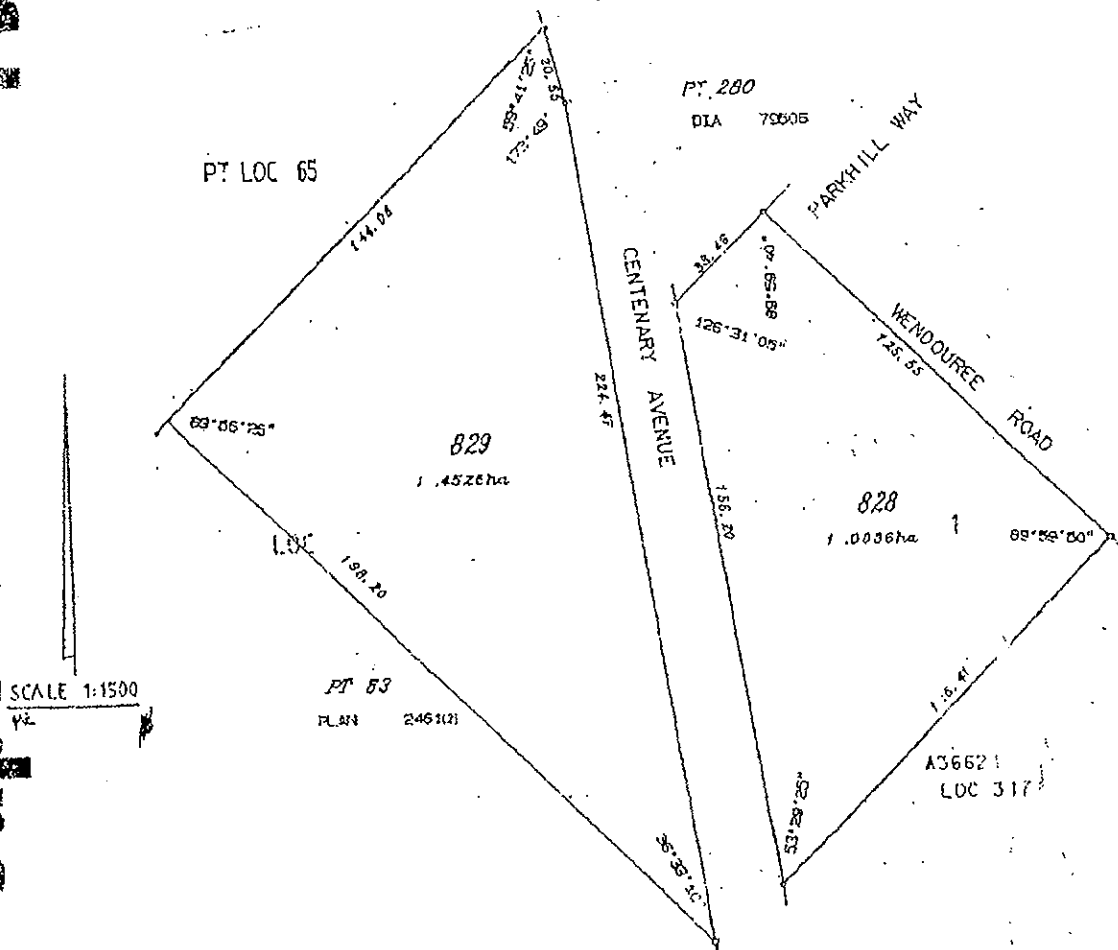
FIRST SCHEDULE (continued overleaf)

~~Trustees of the Christian Brothers in Western Australia Inc. of 53 Redmond Street, Perth~~

SECOND SCHEDULE (continued overleaf)

NIL

THIRD SCHEDULE



NOTE: ENTRIES MAY BE AFFECTED BY SUBSEQUENT ENCUMBRANCES.

007230/2/88-104-L/166

PERSONS ARE CAUTIONED AGAINST ALTERING OR ADDING TO THIS CERTIFICATE OR ANY NOTIFICATION HEREON

2121 RESISTANCE PRIORITIES

Multiple Sclerosis Society of Western Australia (Inc) of Parkhill Way, Wilson

Trustees of The Christian Brothers in Western Australia Inc. of 53 Redmond Street, Manning.

Transfer

Transfer

39153

G4829Z

18.7.95

5.12.95

15 20

5.

7-10-74

X

NOTE: ENTRIES MAY BE AFFECTED BY SUBSEQUENT ENDORSEMENTS

CERTIFICATE OF TITLE VOL. FOL.

208 180

Appendix B
Soil Descriptions and Summary of Results
(2007 Investigations)

**Acid Sulfate Soils Management Plan
Cygnia Cove, Waterford**

Appendix 2
Soil Descriptions and Summary of Results (2007 Investigations)
Cygnia Cove, Waterford

Sample ID		Physical Soil Description			Field Test Results				Acidity (SPOCAS Suite)						
Sample Location ID	Sample Depth (mBGL)	Soil Colour (Hue, Chroma)	Field Texture	Comment	pH _f	pH _{fox}	ΔpH	Reaction Rate	pH _{KCl}	s-TAA	s-TPA	s-TSA	S _{pos}	Net Acidity	Net Acidity Equation
				Units	-	-	-	% S				% S	-		
				Limit of Reporting	0.01	0.01	0.01	-	0.1	0.02	0.02	0.02	0.02	0.02	0.02
				Criteria	<4	<3	3	NV	<4	0.03	NV	NV	0.03	0.03	-
EC11	0.00	Dark Brown (7.5, 3/2)	Organic PEAT & SILT	Vegetation & soil	7.61	5.36	2.3	Strong	-	-	-	-	-	-	-
	0.25	Grey (7.5, 6/2)	Medium SAND & SILT	Saturated	7.62	1.73	5.9	Extreme	6.9	<0.02	<0.02	<0.02	<0.02	<0.02	NA = S _{pos}
	0.50	Grey (7.5, 5/1)	CLAY & SAND		7.54	1.62	5.9	Extreme	5.3	<0.02	0.47	0.46	0.62	0.62	NA = S _{pos} + sTAA
	0.75	Grey (7.5, 5-6/1)	Medium/coarse SAND with SILT, CLAY increases with depth		7.69	2.01	5.7	Extreme	-	-	-	-	-	-	-
	1.00				8.00	1.55	6.5	Extreme	5.3	<0.02	0.14	0.13	0.16	0.16	NA = S _{pos} + sTAA
	1.25				7.95	1.61	6.3	Extreme	-	-	-	-	-	-	-
	1.50				7.98	1.56	6.4	Extreme	-	-	-	-	-	-	-
	1.75				8.05	1.48	6.6	Extreme	5.4	<0.02	0.24	0.24	0.3	0.3	NA = S _{pos} + sTAA
	2.00				8.38	1.62	6.8	Extreme	-	-	-	-	-	-	-
	2.25				8.18	1.52	6.7	Extreme	-	-	-	-	-	-	-
	2.50				8.56	1.80	6.8	Extreme	-	-	-	-	-	-	-
	2.75	Grey (7.5, 6/1)	Firm plastic CLAY	Brown/orange mottling	8.26	5.92	2.3	Extreme	5.7	<0.02	0.02	<0.02	0.04	0.04	NA = S _{pos} + sTAA
	3.00				8.49	6.05	2.4	Extreme	-	-	-	-	-	-	
EC12	0.00	Black (10, 2/1)	Medium to coarse SAND with SILT	Saturated	8.86	4.10	4.8	Slight	-	-	-	-	-	-	-
	0.25				6.75	3.17	3.6	Moderate	6.2	<0.02	0.05	0.05	0.02	0.02	NA = S _{pos} + sTAA
	0.50		6.60		3.41	3.2	Slight	-	-	-	-	-	-	-	
	0.75	V Dark Brown (10, 2/2)	Iron staining	6.17	1.73	4.4	Slight	5.6	<0.02	0.06	0.05	0.05	0.05	NA = S _{pos} + sTAA	
	1.00	Dark Brown (10, 3/3)		6.01	2.07	3.9	Moderate	-	-	-	-	-	-	-	
	1.25			6.23	1.82	4.4	Moderate	5.6	<0.02	0.04	0.03	0.04	0.04	NA = S _{pos} + sTAA	
	1.50			6.12	0.58	5.5	Moderate	-	-	-	-	-	-	-	
	1.75			6.28	1.76	4.5	Slight	-	-	-	-	-	-	-	
	2.00			6.66	1.96	4.7	Slight	-	-	-	-	-	-	-	
	2.25			6.12	1.75	4.4	Moderate	5.5	<0.02	<0.02	<0.02	0.06	0.06	NA = S _{pos}	
	2.50			6.40	1.52	4.9	Strong	-	-	-	-	-	-	-	
	2.75			6.51	1.51	5.0	Slight	-	-	-	-	-	-	-	
	3.00	Brown (7.5, 4/3)			6.64	3.59	3.1	Extreme	5.8	<0.02	0.05	0.05	<0.02	<0.02	NA = S _{pos} + sTAA

Appendix 2
Soil Descriptions and Summary of Results (2007 Investigations)
Cygnia Cove, Waterford

Sample ID		Physical Soil Description			Field Test Results				Acidity (SPOCAS Suite)										
Sample/Location ID	Sample Depth (mBGL)	Soil Colour (Hue, Chroma)	Field Texture	Comment	pH _f	pH _{fox}	ΔpH	Reaction Rate	pH _{KCl}	s-TAA	s-TPA	s-TSA	S _{pos}	Net Acidity	Net Acidity Equation				
					Units				-	-	-	% S				% S	-		
					Limit of Reporting				0.01	0.01	0.01	-	0.1	0.02	0.02	0.02	0.02	0.02	-
					Criteria				<4	<3	3	NV	<4	0.03	NV	NV	0.03	0.03	-
EC13	0.00	Pink-Grey (7.5, 6/1)	Medium SAND with SILT	Saturated Iron staining	7.37	3.12	4.3	Strong	6.1	<0.02	<0.02	<0.02	<0.02	<0.02	NA = S _{pos} + sTAA				
	0.25				6.68	3.10	3.6	Slight	-	-	-	-	-	-	-				
	0.50				6.25	2.82	3.4	Moderate	6.1	<0.02	<0.02	<0.02	<0.02	<0.02	NA = S _{pos}				
	0.75				7.05	3.03	4.0	Moderate	-	-	-	-	-	-	-				
	1.00	V Dark Grey (7.5, 3/1)	Medium to coarse SAND with SILT		3.36	1.42	1.9	Strong	4.8	0.03	0.04	<0.02	0.06	0.09	NA = S _{pos} + sTAA				
	1.25				6.56	1.92	4.6	Extreme	-	-	-	-	-	-	-				
	1.50				6.81	1.03	5.8	Strong	-	-	-	-	-	-	-				
	1.75				6.79	1.97	4.8	Extreme	5.6	<0.02	0.03	0.03	0.04	0.04	NA = S _{pos} + sTAA				
	2.00	Grey-Brown (7.5, 6/1 - 4/2)	6.79		1.96	4.8	Extreme	-	-	-	-	-	-	-	-				
	2.25		6.61		1.21	5.4	Strong	-	-	-	-	-	-	-	-				
	2.50		6.85		1.70	5.2	Moderate	-	-	-	-	-	-	-	-				
	2.75		6.30		1.16	5.1	Extreme	5.7	<0.02	0.03	0.03	0.03	0.03	NA = S _{pos} + sTAA					
	3.00		6.02		1.77	4.3	Extreme	-	-	-	-	-	-	-	-				
EC14	0.00		Black (7.5, 2.5/1)	Sandy PEAT	Brown mottling	6.33	0.96	5.4	Extreme	6.0	<0.02	0.09	0.09	0.15	0.15	NA = S _{pos} + sTAA			
	0.25	6.46				1.07	5.4	Extreme	-	-	-	-	-	-	-				
	0.50	6.78				0.85	5.9	Extreme	5.4	0.08	2.58	2.49	1.63	1.71	NA = S _{pos} + sTAA				
	0.75	6.74				1.07	5.7	Extreme	-	-	-	-	-	-	-				
	1.00	6.66	1.41	5.3		Strong	5.5	<0.02	0.04	0.04	0.06	0.06	NA = S _{pos} + sTAA						
	1.25	6.72	1.26	5.5		Strong	-	-	-	-	-	-	-	-					
	1.50	Light Brown (7.5, 6/4)	Medium SAND with SILT	6.47		2.96	3.5	Slight	5.9	<0.02	<0.02	<0.02	<0.02	<0.02	NA = S _{pos}				
	1.75			6.54		3.55	3.0	Slight	-	-	-	-	-	-	-				
	2.00			6.72		2.84	3.9	Slight	-	-	-	-	-	-	-				
	2.25			6.65		3.53	3.1	Slight	-	-	-	-	-	-	-				
	2.50			6.56		3.44	3.1	Slight	5.9	<0.02	<0.02	<0.02	<0.02	<0.02	NA = S _{pos}				
	2.75			6.87		3.28	3.6	Slight	-	-	-	-	-	-	-				
	3.00			6.08		3.33	2.8	Slight	-	-	-	-	-	-	-				
Quality Control Data																			
EC13	1.75	-	-	-	6.79	1.97	4.8	Extreme	5.6	<0.02	0.03	0.03	0.04	0.04	NA = S _{pos} + sTAA				
	DUP1	-	-	-	6.54	1.81	4.7	Extreme	6.4	<0.02	0.04	0.04	0.05	0.05	NA = S _{pos} + sTAA				
RPD		-	-	-	4%	8%	2%	-	13%	0%	29%	29%	22%	22%	-				
EC14	0.50	-	-	-	6.78	0.85	5.9	Extreme	5.4	0.08	2.58	2.49	1.63	1.71	NA = S _{pos} + sTAA				
	DUP2	-	-	-	6.59	1.01	5.6	Extreme	5.2	0.15	5.63	5.48	4.14	4.29	NA = S _{pos} + sTAA				
RPD		-	-	-	3%	17%	6%	-	4%	61%	74%	75%	87%	86%	-				

¹ Criteria from Draft Identification and Investigation of Acid Sulfate Soils (DoE, 2006). Highlighted results exceed relevant criteria.

Appendix C
Laboratory Certificates and
Chain of Custody Documentation
(2007 Investigations)

**Acid Sulfate Soils Management Plan
Cygnia Cove, Waterford**



Dihorn House
2 Bulwer Street
PERTH WA 6000
Telephone: 08 9328 3488
Facsimile: 08 9328 3588

LABORATORY ANALYSIS & CHAIN OF CUSTODY RECORD


To: ALS Environmental
Address: 10 Hod Way
MALAGA WA 6090
Attention: Shaun Crabb
Telephone: (08) 9209 7655
Facsimile: (08) 9209 7600
Received by: Lisa f
Date received: 18/2/06

Project No.: TCB-2006-007-ASMP
Project: Clontarf
Purchase Order No: 19620
Results required by: 16-Feb-07
Delivery Method: courier
Sent By: S. Brown
Date Delivered: 16/02/2007

Sample Type: Soil ☐ Groundwater ☐ Other: _____

**PLEASE SUPPLY LABORATORY QA/QC DATA AND QUOTE PROJECT NUMBER, PURCHASE
ORDER NUMBER AND DATE ON ALL CORRESPONDENCE
PLEASE PROVIDE A SIGNED CHAIN OF CUSTODY WITH ALL RESULTS**

Sample ID	Date Sampled	Container	Analyses												
			Field Test	SPOCAS Suite Complete	Storage										
1 EC11 0	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>										
2 EC11 0.25	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>										
3 EC11 0.5	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>										
4 EC11 0.75	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>										
5 EC11 1.0	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>										
6 EC11 1.25	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>										
7 EC11 1.5	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>										
8 EC11 1.75	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>										
9 EC11 2.0	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>										
10 EC11 2.25	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>										
11 EC11 2.5	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>										
12 EC11 2.75	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>										
13 EC11 3.0	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>										
14 EC12 0	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>										
15 EC12 0.25	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>										
16 EC12 0.5	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>										
17 EC12 0.75	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>										
18 EC12 1.0	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>										
19 EC12 1.25	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>										
20 EC12 1.5	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>										
21 EC12 1.75	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>										

Environmental Division
Perth
Work Order
EP0700637

 Telephone : 61-8-9209 7655



Dihorn House
2 Bulwer Street
PERTH WA 6000
Telephone: 08 9328 3488
Facsimile: 08 9328 3588

LABORATORY ANALYSIS & CHAIN OF CUSTODY RECORD

To: ALS Environmental
Address: 10 Hod Way
MALAGA WA 6090
Attention: Shaun Crabb
Telephone: (08) 9209 7655
Facsimile: (08) 9209 7600
Received by: Lisa F
Date received: 15/2/07

Project No.: TCB-2006-007-ASMP
Project: Clontarf
Purchase Order No: 19620
Results required by: 16-Feb-07
Delivery Method: courier
Sent By: S. Brown
Date Delivered: 16/02/2007

Sample Type: Soil ☐ Groundwater ☐ Other: _____

PLEASE SUPPLY LABORATORY QA/QC DATA AND QUOTE PROJECT NUMBER, PURCHASE ORDER NUMBER AND DATE ON ALL CORRESPONDENCE
PLEASE PROVIDE A SIGNED CHAIN OF CUSTODY WITH ALL RESULTS

Sample ID	Date Sampled	Container	Analyses										
			Field Test	SPOCAS Suite Complete	Storage								
22 EC12 2.0	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>								
23 EC12 2.25	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>								
24 EC12 2.5	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>								
25 EC12 2.75	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>								
26 EC12 3.0	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>								
27 EC13 0	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>								
28 EC13 0.25	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>								
29 EC13 0.5	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>								
30 EC13 0.75	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>								
31 EC13 1.0	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>								
32 EC13 1.25	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>								
33 EC13 1.5	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>								
34 EC13 1.75	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>								
35 EC13 2.0	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>								
36 EC13 2.25	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>								
37 EC13 2.5	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>								
38 EC13 2.75	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>								
39 EC13 3.0	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>								
40 EC14 0	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>								
41 EC14 0.25	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>								
42 EC14 0.5	16-Feb-07	plastic bag	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>								

LABORATORY ANALYSIS & CHAIN OF CUSTODY RECORD

Project No.: TCB-2006-007-ASMP
Project: Clontarf
Purchase Order No: 19620
Results required by: 16-Feb-07
Delivery Method: courier
Sent By: S. Brown
Date Delivered: 16/02/2007

**PLEASE SUPPLY LABORATORY QA/QC DATA AND QUOTE PROJECT NUMBER, PURCHASE
ORDER NUMBER AND DATE ON ALL CORRESPONDENCE
PLEASE PROVIDE A SIGNED CHAIN OF CUSTODY WITH ALL RESULTS**

[illegible]

PF02(V2)



Dilhorn House
2 Bulwer Street
PERTH WA 6000
Telephone: 08 9328 3488
Facsimile: 08 9328 3588

LABORATORY ANALYSIS & CHAIN OF CUSTODY RECORD

To: ALS Environmental
Address: 10 Hod Way
MALAGA WA 6090
Attention: Shaun Crabb
Telephone: (08) 9209 7655
Facsimile: (08) 9209 7600
Received by: *M Nam's*
Date received: *22/02/07 0846*

Project No.: TCB-2006-007-ASMP
Project: Clontarf
Purchase Order No: 19623
Results required by: 7-Mar-07
Delivery Method: courier
Sent By: S. Brown
Date Delivered: (in storage)

Sample Type: Soil ☒ Groundwater ☐ Other: _____

**PLEASE SUPPLY LABORATORY QA/QC DATA AND QUOTE PROJECT NUMBER, PURCHASE
ORDER NUMBER AND DATE ON ALL CORRESPONDENCE
PLEASE PROVIDE A SIGNED CHAIN OF CUSTODY WITH ALL RESULTS**

Sample ID	Date Sampled	Container	Analyses									
			Field Test	SPOCAS Suite Complete	Storage							
EC11 0	16-Feb-07	plastic bag			✓							
① EC11 0.25	16-Feb-07	plastic bag		✓	✓							
② EC11 0.5	16-Feb-07	plastic bag		✓	✓							
EC11 0.75	16-Feb-07	plastic bag			✓							
③ EC11 1.0	16-Feb-07	plastic bag		✓	✓							
EC11 1.25	16-Feb-07	plastic bag			✓							
EC11 1.5	16-Feb-07	plastic bag			✓							
④ EC11 1.75	16-Feb-07	plastic bag		✓	✓							
EC11 2.0	16-Feb-07	plastic bag			✓							
EC11 2.25	16-Feb-07	plastic bag			✓							
EC11 2.5	16-Feb-07	plastic bag			✓							
⑤ EC11 2.75	16-Feb-07	plastic bag		✓	✓							
EC11 3.0	16-Feb-07	plastic bag			✓							
EC12 0	16-Feb-07	plastic bag			✓							
⑥ EC12 0.25	16-Feb-07	plastic bag		✓	✓							
EC12 0.5	16-Feb-07	plastic bag			✓							
⑦ EC12 0.75	16-Feb-07	plastic bag		✓	✓							
EC12 1.0	16-Feb-07	plastic bag			✓							
⑧ EC12 1.25	16-Feb-07	plastic bag		✓	✓							
EC12 1.5	16-Feb-07	plastic bag			✓							
EC12 1.75	16-Feb-07	plastic bag			✓							

Environmental Division
Perth
Work Order
EP0700755



Telephone : 61-8-9209 7655

PF02(V2)



Dihorn House
2 Bulwer Street
PERTH WA 6000
Telephone: 08 9328 3488
Facsimile: 08 9328 3588

LABORATORY ANALYSIS & CHAIN OF CUSTODY RECORD

To: ALS Environmental

Address: 10 Hod Way
MALAGA WA 6090

Attention: Shaun Crabb

Telephone: (08) 9209 7655

Facsimile: (08) 9209 7600

Received by: *M Harris*Date received: *22/02/07 0846*

Project No.: TCB-2006-007-ASMP

Project: Clontarf

Purchase Order No: 19623

Results required by: 7-Mar-07

Delivery Method: courier

Sent By: S. Brown

Date Delivered: (in storage)

Sample Type:

Soil



Groundwater



Other: _____

**PLEASE SUPPLY LABORATORY QA/QC DATA AND QUOTE PROJECT NUMBER, PURCHASE
ORDER NUMBER AND DATE ON ALL CORRESPONDENCE**

PLEASE PROVIDE A SIGNED CHAIN OF CUSTODY WITH ALL RESULTS

Sample ID	Date Sampled	Container	Analyses											
			Field Test	STOCAS Suite Complete	Storage									
EC12	2.0	16-Feb-07	plastic bag		✓									
9 EC12	2.25	16-Feb-07	plastic bag	✓	✓									
EC12	2.5	16-Feb-07	plastic bag		✓									
EC12	2.75	16-Feb-07	plastic bag		✓									
10 EC12	3.0	16-Feb-07	plastic bag	✓	✓									
11 EC13	0	16-Feb-07	plastic bag	✓	✓									
EC13	0.25	16-Feb-07	plastic bag		✓									
12 EC13	0.5	16-Feb-07	plastic bag	✓	✓									
EC13	0.75	16-Feb-07	plastic bag		✓									
13 EC13	1.0	16-Feb-07	plastic bag	✓	✓									
EC13	1.25	16-Feb-07	plastic bag		✓									
EC13	1.5	16-Feb-07	plastic bag		✓									
14 EC13	1.75	16-Feb-07	plastic bag	✓	✓									
EC13	2.0	16-Feb-07	plastic bag		✓									
EC13	2.25	16-Feb-07	plastic bag		✓									
EC13	2.5	16-Feb-07	plastic bag		✓									
15 EC13	2.75	16-Feb-07	plastic bag	✓	✓									
EC13	3.0	16-Feb-07	plastic bag		✓									
16 EC14	0	16-Feb-07	plastic bag	✓	✓									
EC14	0.25	16-Feb-07	plastic bag		✓									
17 EC14	0.5	16-Feb-07	plastic bag	✓	✓									

PF02(V2)



Dihorn House
2 Bulwer Street
PERTH WA 6000
Telephone: 08 9328 3488
Facsimile: 08 9328 3588

LABORATORY ANALYSIS & CHAIN OF CUSTODY RECORD

To: ALS Environmental
Address: 10 Hod Way
MALAGA WA 6090
Attention: Shaun Crabb
Telephone: (08) 9209 7655
Facsimile: (08) 9209 7600
Received by: *M. Morris*
Date received: *22/2/07 0846*

Project No.: TCB-2006-007-ASMP
Project: Clontarf
Purchase Order No: 19623
Results required by: 7-Mar-07
Delivery Method: courier
Sent By: S. Brown
Date Delivered: (in storage)

Sample Type: Soil ☒ Groundwater ☐ Other: _____

PLEASE SUPPLY LABORATORY QA/QC DATA AND QUOTE PROJECT NUMBER, PURCHASE ORDER NUMBER AND DATE ON ALL CORRESPONDENCE
PLEASE PROVIDE A SIGNED CHAIN OF CUSTODY WITH ALL RESULTS

Sample ID	Date Sampled	Container	Analyses									
			Field Test	SPOCAS Suite Complete	Storage							
EC14 0.75	16-Feb-07	plastic bag			✓							
(18) EC14 1.0	16-Feb-07	plastic bag		✓	✓							
EC14 1.25	16-Feb-07	plastic bag			✓							
(19) EC14 1.5	16-Feb-07	plastic bag		✓	✓							
EC14 1.75	16-Feb-07	plastic bag			✓							
EC14 2.0	16-Feb-07	plastic bag			✓							
EC14 2.25	16-Feb-07	plastic bag			✓							
(20) EC14 2.5	16-Feb-07	plastic bag		✓	✓							
EC14 2.75	16-Feb-07	plastic bag			✓							
EC14 3.0	16-Feb-07	plastic bag			✓							
(21) EC DUP1	16-Feb-07	plastic bag		✓	✓							
(22) EC DUP2	16-Feb-07	plastic bag		✓	✓							



CERTIFICATE OF ANALYSIS

<i>Client</i>	: ATA ENVIRONMENTAL	<i>Laboratory</i>	: Environmental Division Perth	<i>Page</i>	: 1 of 13
<i>Contact</i>	: MS SUSIE BROWN	<i>Contact</i>	: Shaun Crabb	<i>Work Order</i>	: EP0700755
<i>Address</i>	: 2 BULWER STREET PERTH WA AUSTRALIA 6000	<i>Address</i>	: 10 Hod Way Malaga WA Australia 6090		
<i>E-mail</i>	: suzanne.brown@ataenvironmental.com.au	<i>E-mail</i>	: Shaun.Crabb@alsenviro.com		
<i>Telephone</i>	: 08 9328 3488	<i>Telephone</i>	: 61-8-9209 7655		
<i>Facsimile</i>	: 08 9328 3588	<i>Facsimile</i>	: 61-8-9209 7600		
<i>Project</i>	: TCB-2006-007-ASMP Ex EP0700637	<i>Quote number</i>	: BQ PE/005/05	<i>Date received</i>	: 22 Feb 2007
<i>Order number</i>	: 19623			<i>Date issued</i>	: 7 Mar 2007
<i>C-O-C number</i>	: - Not provided -			<i>No. of samples</i>	- Received : 22
<i>Site</i>	: Clontarf				Analysed : 22

ALSE - Excellence in Analytical Testing



NATA Accredited Laboratory
825

This document is issued in
accordance with NATA's
accreditation requirements.

Accredited for compliance with
ISO/IEC 17025.

This document has been electronically signed by those names that appear on this report and are the authorised signatories. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

<i>Signatory</i>	<i>Position</i>	<i>Department</i>
Nikki Cinelli	Acid Sulphate Soils Supervisor	Perth Inorganics - NATA 825 (15847 - Perth)

Comments

This report for the ALSE reference EP0700755 supersedes any previous reports with this reference. Results apply to the samples as submitted. All pages of this report have been checked and approved for release.

This report contains the following information:

- Analytical Results for Samples Submitted
- Surrogate Recovery Data

The analytical procedures used by ALS Environmental have been developed from established internationally-recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported herein. Reference methods from which ALSE methods are based are provided in parenthesis.

When moisture determination has been performed, results are reported on a dry weight basis. When a reported 'less than' result is higher than the LOR, this may be due to primary sample extracts/digestion dilution and/or insufficient sample amount for analysis. Surrogate Recovery Limits are static and based on USEPA SW846 or ALS-QWI/EN38 (in the absence of specified USEPA limits). Where LOR of reported result differ from standard LOR, this may be due to high moisture, reduced sample amount or matrix interference. When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for process purposes. Abbreviations: CAS number = Chemical Abstract Services number, LOR = Limit of Reporting. * Indicates failed Surrogate Recoveries.

Specific comments for Work Order EP0700755

Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime (CaCO_3) and using a safety factor of 1.5 to allow for non-homogeneous mixing and poor reactivity of lime. Conversion to liming rate in $\text{kg/m}^3 = \text{kg/t} \times \text{wet bulk density in t/m}^3$.

Retained Acidity not required because pH KCl greater than or equal to 4.5

Excess ANC not required because pH OX less than 6.5.

Page Number : 3 of 13
 Client : ATA ENVIRONMENTAL
 Work Order : EP0700755



ALS Environmental

Analytical Results

Client Sample ID :				EC11 0.25 SOIL 16 Feb 2007 15:00	EC11 0.5 SOIL 16 Feb 2007 15:00	EC11 1.0 SOIL 16 Feb 2007 15:00	EC11 1.75 SOIL 16 Feb 2007 15:00	EC11 2.75 SOIL 16 Feb 2007 15:00
Sample Matrix Type / Description :								
Sample Date / Time :								
Laboratory Sample ID :				EP0700755-001	EP0700755-002	EP0700755-003	EP0700755-004	EP0700755-005
Analyte	CAS number	LOR	Units					
EA029-A: pH Measurements								
pH KCl (23A)		0.1	pH Unit	6.9	5.3	5.3	5.4	5.7
pH OX (23B)		0.1	pH Unit	4.8	2.3	2.6	2.4	6.2
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)		2	mole H+ / t	<2	8	4	3	8
Titratable Peroxide Acidity (23G)		2	mole H+ / t	<2	294	88	153	14
Titratable Sulfidic Acidity (23H)		2	mole H+ / t	<2	286	83	149	6
sulfidic - Titratable Actual Acidity (s-23F)		0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
sulfidic - Titratable Peroxide Acidity (s-23G)		0.02	% pyrite S	<0.02	0.47	0.14	0.24	0.02
sulfidic - Titratable Sulfidic Acidity (s-23H)		0.02	% pyrite S	<0.02	0.46	0.13	0.24	<0.02
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)		0.02	% S	<0.02	0.10	0.02	0.02	<0.02
Peroxide Sulfur (23De)		0.02	% S	0.03	0.72	0.19	0.32	0.05
Peroxide Oxidisable Sulfur (23E)		0.02	% S	<0.02	0.62	0.16	0.30	0.04
acidity - Peroxide Oxidisable Sulfur (a-23E)		10	mole H+ / t	<10	388	101	184	22
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)		0.02	% Ca	0.03	0.05	0.02	0.02	0.06
Peroxide Calcium (23Wh)		0.02	% Ca	0.03	0.06	<0.02	0.02	0.07
Acid Reacted Calcium (23X)		0.02	% Ca	<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Acid Reacted Calcium (a-23X)		10	mole H+ / t	<10	<10	<10	<10	<10
sulfidic - Acid Reacted Calcium (s-23X)		0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)		0.02	% Mg	<0.02	0.04	<0.02	<0.02	0.11
Peroxide Magnesium (23Tm)		0.02	% Mg	0.03	0.05	<0.02	<0.02	0.13
Acid Reacted Magnesium (23U)		0.02	% Mg	<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Acid Reacted Magnesium (a-23U)		10	mole H+ / t	<10	<10	<10	<10	12
sulfidic - Acid Reacted Magnesium (s-23U)		0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
EA029-H: Acid Base Accounting								
ANC Fineness Factor		0.5		1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)		0.02	% S	<0.02	0.64	0.17	0.30	0.05
Net Acidity (acidity units)		10	mole H+ / t	<10	396	106	188	30
Liming Rate		1	kg CaCO3/t	<1	30	8	14	2

Page Number : 4 of 13
 Client : ATA ENVIRONMENTAL
 Work Order : EP0700755



ALS Environmental

Analytical Results

Analytical Results				Client Sample ID :	EC11	EC11	EC11	EC11	EC11
					0.25	0.5	1.0	1.75	2.75
				Sample Matrix Type / Description :	SOIL	SOIL	SOIL	SOIL	SOIL
				Sample Date / Time :	16 Feb 2007 15:00	16 Feb 2007 15:00	16 Feb 2007 15:00	16 Feb 2007 15:00	16 Feb 2007 15:00
				Laboratory Sample ID :					
Analyte	CAS number	LOR	Units	EP0700755-001	EP0700755-002	EP0700755-003	EP0700755-004	EP0700755-005	
EA029-H: Acid Base Accounting									
Net Acidity excluding ANC (sulfur units)	0.02	% S		<0.02	0.64	0.17	0.30	0.05	
Net Acidity excluding ANC (acidity units)	10	mole H+ / t		<10	396	106	188	30	
Liming Rate excluding ANC	1	kg CaCO3/t		<1	30	8	14	2	

Page Number : 5 of 13
 Client : ATA ENVIRONMENTAL
 Work Order : EP0700755



ALS Environmental

Analytical Results

Client Sample ID :				EC12 0.25 SOIL 16 Feb 2007 15:00	EC12 0.75 SOIL 16 Feb 2007 15:00	EC12 1.25 SOIL 16 Feb 2007 15:00	EC12 2.25 SOIL 16 Feb 2007 15:00	EC12 3.0 SOIL 16 Feb 2007 15:00
Sample Matrix Type / Description :								
Sample Date / Time :								
Laboratory Sample ID :				EP0700755-006	EP0700755-007	EP0700755-008	EP0700755-009	EP0700755-010
Analyte	CAS number	LOR	Units					
EA029-A: pH Measurements								
pH KCl (23A)		0.1	pH Unit	6.2	5.6	5.6	5.5	5.8
pH OX (23B)		0.1	pH Unit	3.0	3.0	3.1	3.0	4.3
EA029-B: Acidity Trail								
Titrateable Actual Acidity (23F)		2	mole H+ / t	<2	4	4	6	<2
Titrateable Peroxide Acidity (23G)		2	mole H+ / t	30	35	22	<2	33
Titrateable Sulfidic Acidity (23H)		2	mole H+ / t	30	31	18	<2	32
sulfidic - Titrateable Actual Acidity (s-23F)		0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
sulfidic - Titrateable Peroxide Acidity (s-23G)		0.02	% pyrite S	0.05	0.06	0.04	<0.02	0.05
sulfidic - Titrateable Sulfidic Acidity (s-23H)		0.02	% pyrite S	0.05	0.05	0.03	<0.02	0.05
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)		0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Peroxide Sulfur (23De)		0.02	% S	0.03	0.06	0.05	0.07	<0.02
Peroxide Oxidisable Sulfur (23E)		0.02	% S	0.02	0.05	0.04	0.06	<0.02
acidity - Peroxide Oxidisable Sulfur (a-23E)		10	mole H+ / t	15	32	27	38	<10
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)		0.02	% Ca	0.04	<0.02	<0.02	<0.02	<0.02
Peroxide Calcium (23Wh)		0.02	% Ca	0.04	<0.02	<0.02	<0.02	<0.02
Acid Reacted Calcium (23X)		0.02	% Ca	<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Acid Reacted Calcium (a-23X)		10	mole H+ / t	<10	<10	<10	<10	<10
sulfidic - Acid Reacted Calcium (s-23X)		0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)		0.02	% Mg	<0.02	<0.02	<0.02	<0.02	<0.02
Peroxide Magnesium (23Tm)		0.02	% Mg	<0.02	<0.02	<0.02	<0.02	<0.02
Acid Reacted Magnesium (23U)		0.02	% Mg	<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Acid Reacted Magnesium (a-23U)		10	mole H+ / t	<10	<10	<10	<10	<10
sulfidic - Acid Reacted Magnesium (s-23U)		0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
EA029-H: Acid Base Accounting								
ANC Fineness Factor		0.5		1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)		0.02	% S	0.02	0.06	0.05	0.07	<0.02
Net Acidity (acidity units)		10	mole H+ / t	15	37	32	44	<10
Liming Rate		1	kg CaCO3/t	1	3	2	3	<1

Page Number : 6 of 13
 Client : ATA ENVIRONMENTAL
 Work Order : EP0700755



ALS Environmental

Analytical Results

Client Sample ID :				EC12 0.25 SOIL 16 Feb 2007 15:00	EC12 0.75 SOIL 16 Feb 2007 15:00	EC12 1.25 SOIL 16 Feb 2007 15:00	EC12 2.25 SOIL 16 Feb 2007 15:00	EC12 3.0 SOIL 16 Feb 2007 15:00
Sample Matrix Type / Description :								
Sample Date / Time :								
Laboratory Sample ID :				EP0700755-006	EP0700755-007	EP0700755-008	EP0700755-009	EP0700755-010
Analyte	CAS number	LOR	Units					
EA029-H: Acid Base Accounting								
Net Acidity excluding ANC (sulfur units)	0.02	% S		0.02	0.06	0.05	0.07	<0.02
Net Acidity excluding ANC (acidity units)	10	mole H+ / t		15	37	32	44	<10
Liming Rate excluding ANC	1	kg CaCO3/t		1	3	2	3	<1

Page Number : 7 of 13
 Client : ATA ENVIRONMENTAL
 Work Order : EP0700755



ALS Environmental

Analytical Results

Client Sample ID :				EC13 0 SOIL 16 Feb 2007 15:00	EC13 0.5 SOIL 16 Feb 2007 15:00	EC13 1.0 SOIL 16 Feb 2007 15:00	EC13 1.75 SOIL 16 Feb 2007 15:00	EC13 2.75 SOIL 16 Feb 2007 15:00
Sample Matrix Type / Description :								
Sample Date / Time :								
Laboratory Sample ID :								
Analyte	CAS number	LOR	Units	EP0700755-011	EP0700755-012	EP0700755-013	EP0700755-014	EP0700755-015
EA029-A: pH Measurements								
pH KCl (23A)		0.1	pH Unit	6.1	6.1	4.8	5.6	5.7
pH OX (23B)		0.1	pH Unit	3.4	3.9	2.9	2.9	3.1
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)		2	mole H+ / t	2	<2	18	<2	<2
Titratable Peroxide Acidity (23G)		2	mole H+ / t	<2	<2	22	21	20
Titratable Sulfidic Acidity (23H)		2	mole H+ / t	<2	<2	4	20	19
sulfidic - Titratable Actual Acidity (s-23F)		0.02	% pyrite S	<0.02	<0.02	0.03	<0.02	<0.02
sulfidic - Titratable Peroxide Acidity (s-23G)		0.02	% pyrite S	<0.02	<0.02	0.04	0.03	0.03
sulfidic - Titratable Sulfidic Acidity (s-23H)		0.02	% pyrite S	<0.02	<0.02	<0.02	0.03	0.03
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)		0.02	% S	<0.02	<0.02	0.04	<0.02	<0.02
Peroxide Sulfur (23De)		0.02	% S	0.02	<0.02	0.10	0.05	0.04
Peroxide Oxidisable Sulfur (23E)		0.02	% S	<0.02	<0.02	0.06	0.04	0.03
acidity - Peroxide Oxidisable Sulfur (a-23E)		10	mole H+ / t	11	<10	35	27	16
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)		0.02	% Ca	0.07	0.03	<0.02	<0.02	<0.02
Peroxide Calcium (23Wh)		0.02	% Ca	0.08	0.03	<0.02	<0.02	<0.02
Acid Reacted Calcium (23X)		0.02	% Ca	<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Acid Reacted Calcium (a-23X)		10	mole H+ / t	<10	<10	<10	<10	<10
sulfidic - Acid Reacted Calcium (s-23X)		0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)		0.02	% Mg	<0.02	<0.02	<0.02	<0.02	<0.02
Peroxide Magnesium (23Tm)		0.02	% Mg	<0.02	<0.02	<0.02	<0.02	<0.02
Acid Reacted Magnesium (23U)		0.02	% Mg	<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Acid Reacted Magnesium (a-23U)		10	mole H+ / t	<10	<10	<10	<10	<10
sulfidic - Acid Reacted Magnesium (s-23U)		0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
EA029-H: Acid Base Accounting								
ANC Fineness Factor		0.5		1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)		0.02	% S	0.02	<0.02	0.08	0.04	0.03
Net Acidity (acidity units)		10	mole H+ / t	13	<10	53	28	17
Liming Rate		1	kg CaCO3/t	<1	<1	4	2	1

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Analytical Results

Analytical Results				Client Sample ID :	EC13 0	EC13 0.5	EC13 1.0	EC13 1.75	EC13 2.75
				Sample Matrix Type / Description :	SOIL	SOIL	SOIL	SOIL	SOIL
				Sample Date / Time :	16 Feb 2007 15:00	16 Feb 2007 15:00	16 Feb 2007 15:00	16 Feb 2007 15:00	16 Feb 2007 15:00
				Laboratory Sample ID :	EP0700755-011	EP0700755-012	EP0700755-013	EP0700755-014	EP0700755-015
Analyte	CAS number	LOR	Units						
EA029-H: Acid Base Accounting									
Net Acidity excluding ANC (sulfur units)		0.02	% S	0.02	<0.02	0.08	0.04	0.03	
Net Acidity excluding ANC (acidity units)		10	mole H+ / t	13	<10	53	28	17	
Liming Rate excluding ANC		1	kg CaCO3/t	<1	<1	4	2	1	

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Analytical Results

Client Sample ID :				EC14 0 SOIL 16 Feb 2007 15:00	EC14 0.5 SOIL 16 Feb 2007 15:00	EC14 1.0 SOIL 16 Feb 2007 15:00	EC14 1.5 SOIL 16 Feb 2007 15:00	EC14 2.5 SOIL 16 Feb 2007 15:00
Sample Matrix Type / Description : Sample Date / Time :								
Laboratory Sample ID :				EP0700755-016	EP0700755-017	EP0700755-018	EP0700755-019	EP0700755-020
Analyte	CAS number	LOR	Units					
EA029-A: pH Measurements								
pH KCl (23A)		0.1	pH Unit	6.0	5.4	5.5	5.9	5.9
pH OX (23B)		0.1	pH Unit	2.8	1.6	2.6	4.4	5.0
EA029-B: Acidity Trail								
Titrateable Actual Acidity (23F)		2	mole H+ / t	<2	53	6	<2	<2
Titrateable Peroxide Acidity (23G)		2	mole H+ / t	56	1610	28	2	<2
Titrateable Sulfidic Acidity (23H)		2	mole H+ / t	56	1560	22	<2	<2
sulfidic - Titrateable Actual Acidity (s-23F)		0.02	% pyrite S	<0.02	0.08	<0.02	<0.02	<0.02
sulfidic - Titrateable Peroxide Acidity (s-23G)		0.02	% pyrite S	0.09	2.58	0.04	<0.02	<0.02
sulfidic - Titrateable Sulfidic Acidity (s-23H)		0.02	% pyrite S	0.09	2.49	0.04	<0.02	<0.02
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)		0.02	% S	<0.02	0.16	<0.02	<0.02	<0.02
Peroxide Sulfur (23De)		0.02	% S	0.16	1.79	0.07	<0.02	<0.02
Peroxide Oxidisable Sulfur (23E)		0.02	% S	0.15	1.63	0.06	<0.02	<0.02
acidity - Peroxide Oxidisable Sulfur (a-23E)		10	mole H+ / t	92	1020	39	<10	<10
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)		0.02	% Ca	0.08	0.51	0.03	<0.02	<0.02
Peroxide Calcium (23Wh)		0.02	% Ca	0.08	0.38	0.03	<0.02	<0.02
Acid Reacted Calcium (23X)		0.02	% Ca	<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Acid Reacted Calcium (a-23X)		10	mole H+ / t	<10	<10	<10	<10	<10
sulfidic - Acid Reacted Calcium (s-23X)		0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)		0.02	% Mg	<0.02	0.04	<0.02	<0.02	<0.02
Peroxide Magnesium (23Tm)		0.02	% Mg	<0.02	0.04	<0.02	<0.02	<0.02
Acid Reacted Magnesium (23U)		0.02	% Mg	<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Acid Reacted Magnesium (a-23U)		10	mole H+ / t	<10	<10	<10	<10	<10
sulfidic - Acid Reacted Magnesium (s-23U)		0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
EA029-H: Acid Base Accounting								
ANC Fineness Factor		0.5		1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)		0.02	% S	0.15	1.72	0.07	<0.02	<0.02
Net Acidity (acidity units)		10	mole H+ / t	92	1070	44	<10	<10
Liming Rate		1	kg CaCO3/t	7	80	3	<1	<1

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Analytical Results

Analytical Results				Client Sample ID :		EC14	EC14	EC14	EC14	EC14
						0	0.5	1.0	1.5	2.5
				Sample Matrix Type / Description :		SOIL	SOIL	SOIL	SOIL	SOIL
				Sample Date / Time :		16 Feb 2007 15:00	16 Feb 2007 15:00	16 Feb 2007 15:00	16 Feb 2007 15:00	16 Feb 2007 15:00
				Laboratory Sample ID :						
Analyte		CAS number	LOR	Units	EP0700755-016	EP0700755-017	EP0700755-018	EP0700755-019	EP0700755-020	
EA029-H: Acid Base Accounting										
Net Acidity excluding ANC (sulfur units)		0.02	% S		0.15	1.72	0.07	<0.02	<0.02	
Net Acidity excluding ANC (acidity units)		10	mole H+ / t		92	1070	44	<10	<10	
Liming Rate excluding ANC		1	kg CaCO3/t		7	80	3	<1	<1	

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Analytical Results

Client Sample ID :				DUP1	DUP2			
Sample Matrix Type / Description :				SOIL	SOIL			
Sample Date / Time :				16 Feb 2007 15:00	16 Feb 2007 15:00			
Laboratory Sample ID :				EP0700755-021	EP0700755-022			
Analyte	CAS number	LOR	Units					
EA029-A: pH Measurements								
pH KCl (23A)		0.1	pH Unit	6.4	5.2			
pH OX (23B)		0.1	pH Unit	3.2	1.4			
EA029-B: Acidity Trail								
Titrateable Actual Acidity (23F)		2	mole H+ / t	<2	96			
Titrateable Peroxide Acidity (23G)		2	mole H+ / t	28	3510			
Titrateable Sulfidic Acidity (23H)		2	mole H+ / t	28	3420			
sulfidic - Titrateable Actual Acidity (s-23F)		0.02	% pyrite S	<0.02	0.15			
sulfidic - Titrateable Peroxide Acidity (s-23G)		0.02	% pyrite S	0.04	5.63			
sulfidic - Titrateable Sulfidic Acidity (s-23H)		0.02	% pyrite S	0.04	5.48			
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)		0.02	% S	<0.02	0.31			
Peroxide Sulfur (23De)		0.02	% S	0.06	4.44			
Peroxide Oxidisable Sulfur (23E)		0.02	% S	0.05	4.14			
acidity - Peroxide Oxidisable Sulfur (a-23E)		10	mole H+ / t	30	2580			
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)		0.02	% Ca	0.02	0.59			
Peroxide Calcium (23Wh)		0.02	% Ca	0.02	0.46			
Acid Reacted Calcium (23X)		0.02	% Ca	<0.02	<0.02			
acidity - Acid Reacted Calcium (a-23X)		10	mole H+ / t	<10	<10			
sulfidic - Acid Reacted Calcium (s-23X)		0.02	% S	<0.02	<0.02			
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)		0.02	% Mg	<0.02	0.05			
Peroxide Magnesium (23Tm)		0.02	% Mg	<0.02	0.05			
Acid Reacted Magnesium (23U)		0.02	% Mg	<0.02	<0.02			
acidity - Acid Reacted Magnesium (a-23U)		10	mole H+ / t	<10	<10			
sulfidic - Acid Reacted Magnesium (s-23U)		0.02	% S	<0.02	<0.02			
EA029-H: Acid Base Accounting								
ANC Fineness Factor		0.5		1.5	1.5			
Net Acidity (sulfur units)		0.02	% S	0.05	4.29			
Net Acidity (acidity units)		10	mole H+ / t	30	2680			
Liming Rate		1	kg CaCO3/t	2	201			
Net Acidity excluding ANC (sulfur units)		0.02	% S	0.05	4.29			

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Analytical Results

Analytical Results				Client Sample ID :		DUP1	DUP2			
				Sample Matrix Type / Description :		SOIL	SOIL			
				Sample Date / Time :		16 Feb 2007 15:00	16 Feb 2007 15:00			
				Laboratory Sample ID :						
Analyte	CAS number	LOR	Units	EP0700755-021	EP0700755-022					
EA029-H: Acid Base Accounting										
Net Acidity excluding ANC (acidity units)	10	mole H+ / t		30	2680					
Liming Rate excluding ANC	1	kg CaCO3/t		2	201					

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Surrogate Control Limits

- No surrogates present on this report.

Appendix D

Liming Rate Calculations

**Acid Sulfate Soils Management Plan
Cygnia Cove, Waterford**

APPENDIX 4
LIMING RATE APPLICATIONS
CYGNIA COVE, WATERFORD

Sample ID		Laboratory Acidity Result				Calculated Acidity	
Sample Location ID	Sample Depth (mBGL)	pH _{KCl}	s-TAA	S _{pos}	S _{cr}	Net Acidity	Net Acidity Equation
		pH Unit	% pyrite S			% S	% S
EC ASS 2	2.0	5.0	<0.02	0.25	0.227	0.25	NA = S _{pos}
	2.5	4.9	<0.02	0.292	0.241	0.292	NA = S _{pos}
	3.0	4.8	<0.02	0.43	0.377	0.43	NA = S _{pos}
EC ASS 3	2.5	4.2	0.03	0.112	0.091	0.118	NA = S _{pos} + s-TAA
	3.0	5.0	<0.02	0.169	0.161	0.161	NA = S _{pos}
EC ASS 4	2.0	6.9	<0.02	0.099	0.073	0.073	NA = S _{pos}
	2.5	5.5	<0.02	0.094	0.077	0.094	NA = S _{pos}
	3.0	5.6	<0.02	0.077	0.068	0.077	NA = S _{pos}
EC ASS 5	3.0	4.9	0.02	-	0.325	0.344	NA = S _{cr}
EC ASS 6	0.75	4.90	<0.02	0.263	0.234	0.234	NA = S _{pos}
	1.0	4.9	<0.02	0.331	0.323	0.323	NA = S _{pos}
	1.5	5.5	<0.02	0.233	0.211	0.233	NA = S _{pos}
	2.0	5.3	<0.02	0.102	0.091	0.102	NA = S _{pos}
	2.3	5.4	<0.02	0.092	0.085	0.092	NA = S _{pos}
	3.0	5.3	<0.02	0.095	0.081	0.095	NA = S _{pos}
EC ASS 7	1.0	4.8	0.035	-	<0.02	0.035	NA = S _{cr} + s-TAA
	1.5	4.5	0.053	-	<0.02	0.053	NA = S _{cr} + s-TAA
	2.0	4.3	0.04	-	<0.02	0.04	NA = S _{cr} + s-TAA
	2.5	4.2	0.034	-	<0.02	0.034	NA = S _{cr} + s-TAA
EC ASS 8	0.5	5.1	<0.02	-	0.032	0.032	NA = S _{cr} + s-TAA
	1.5	4.5	0.09	-	<0.02	0.088	NA = S _{cr} + s-TAA
	2.0	4.6	0.05	-	0.043	0.093	NA = S _{cr} + s-TAA
	2.5	5.0	<0.02	-	0.03	0.03	NA = S _{cr} + s-TAA
	3.0	4.9	<0.02	-	0.054	0.054	NA = S _{cr} + s-TAA
EC ASS 10	0.5	4.7	0.04	-	0.052	0.094	NA = S _{cr} + s-TAA
	1.0	4.7	0.03	-	0.078	0.105	NA = S _{cr} + s-TAA
	2.0	5.0	<0.02	-	0.048	0.048	NA = S _{cr} + s-TAA
	2.5	5.7	<0.02	-	0.03	0.03	NA = S _{cr} + s-TAA
EC11	0.50	5.3	<0.02	0.62	-	0.62	NA = S _{pos} + s-TAA
	1.00	5.3	<0.02	0.16	-	0.16	NA = S _{pos} + s-TAA
	1.75	5.4	<0.02	0.30	-	0.30	NA = S _{pos} + s-TAA
	2.75	5.7	<0.02	0.04	-	0.04	NA = S _{pos} + s-TAA
EC12	0.75	5.6	<0.02	0.05	-	0.05	NA = S _{pos} + s-TAA
	1.25	5.6	<0.02	0.04	-	0.04	NA = S _{pos} + s-TAA
	2.25	5.5	<0.02	0.06	-	0.06	S _{pos}
EC13	1.00	4.8	0.03	0.06	-	0.09	NA = S _{pos} + s-TAA
	1.75	5.6	<0.02	0.04	-	0.04	NA = S _{pos} + s-TAA
	2.75	5.7	<0.02	0.03	-	0.03	NA = S _{pos} + s-TAA
EC14	0.00	6.0	<0.02	0.15	-	0.15	NA = S _{pos} + s-TAA
	0.50	5.4	0.08	1.63	-	1.71	NA = S _{pos} + s-TAA
	1.00	5.5	<0.02	0.06	-	0.06	NA = S _{pos} + s-TAA
LIMING RATE CALCULATIONS							
Number of Samples Exceeding the Action Criteria						41	
Sum of all Net Acidity Results Exceeding the Action Criteria						7.00	
Maximum						1.71	
Mean						0.17	
Standard Deviation						0.28	
Mean + St Dev						0.45	
Conversion Factor (oxidizable %S to kg lime/tonne soil, including 1.5 safety factor)						46.8	
Liming Rate (kg CaCO ₃ /tonne soil)						21.0	
Estimated Bulk Density of Soil (tonnes/m ³)						1.8	
Liming Rate (kg CaCO ₃ /m ³ soil)						37.8	

NOTES: Highlighted samples exceed acidity action criteria.