# LandCorp

## Report for Broome North

### Acid Sulfate Soil Desktop Investigation

April 2009

# Contents

# 1. Introduction

## 1.1 General

LandCorp commissioned GHD Pty Ltd (GHD) in March 2009, to undertake a desktop Acid Sulfate Soil (ASS) investigation prior to the subdivision and development of Broome North: Area A and Area B within the Broome town site (Figure 1). This report presents the findings of the desktop investigation and the recommended actions.

## 1.2 Site Details

Area A is approximately 350 ha in size and lies north of the Broome town site. This area is proposed to be subdivided and developed for both residential purposes and as part of the expansion of the existing Blue Haze light industrial subdivision.

Area B is approximately 365 ha in size and lies north of the Broome town site. This area is proposed to be subdivided and developed for mixed purposes including schools, local retail and residential homes.

## 1.3 Methodology

As part of a staged approach, GHD has initially undertaken a desktop investigation to assess the likelihood of ASS occurrence on both areas mentioned. This approach is in accordance with the Department of Environment and Conservation's (DEC) guidelines *Draft* Identification and Investigation of Acid Sulfate Soils (2006).

## 1.4 Proposed Development

The proposed works involve the development of two areas identified as Area A and B. The areas lie adjacent to each other and comprise of the following.

### 1.4.1 Area A

» Approximately 350 ha in size;

» Construction of approximately 600 – 1000 residential dwellings;

» Construction of schools and local retail; and

» Extension of the existing Blue Haze light industrial subdivision.

### 1.4.2 Area B

» Approximately 365 ha in size;

» Construction of approximately 800 residential dwellings; and

» Construction of schools and local retail.

## 1.5 Objectives

The objectives of this desktop ASS investigation are to determine:

- Whether ASS conditions are likely to exist in either of the study areas (Areas A and B) by review of the available published information;
- Identify potential risks associated with development at the Site with respect to ASS; and
- Present recommendations for further actions required.

## 1.6 Scope of Works

The scope of works is outlined below.

- Review of the proposed development in relation to potential implications on ASS;
- Review of surrounding land uses;
- Review of geology and hydrology and hydrogeology in the area;
- Review of an sensitive receptors in the area and potential impacts;
- Assessment of potential impacts to receptors as a result of development; and
- Recommendations with reference to DEC guidelines, *Draft Identification and Investigation of Acid Sulfate Soils (2006)*.

# 2. Information on Acid Sulfate Soils

## 2.1 Background on Acid Sulfate Soils

The classification of ASS includes both actual acid sulfate soils (AASS) and potential acid sulfate soils (PASS). AASS are soils that have acidified and are generating acidity, whereas PASS are soils that have the potential to generate acidity.

ASS are soils containing naturally-occurring, fine-grained metal sulfides typically pyrite ($FeS_2$), formed under saturated, anoxic/reducing conditions. They generally occur in Quaternary (1.8 Ma – Present) marine or estuarine sediments, predominantly confined to coastal lowlands (elevations generally below 5 mAHD). Within these sediments, the majority of soils that present an environmental risk are generally confined to Holocene aged material (<10 000 years). Where these materials have oxidised, they commonly have a mottled appearance (orange and yellow discolouration) due to the oxidised iron minerals.

Although soils described above are typical conditions where ASS occurs, the presence of ASS materials is not limited to these. In Western Australia, ASS materials have been identified in other soil types such as leached sands and silts. Accordingly, for areas where no data is available, the extent of ASS materials should be established through field investigations.

## 2.2 Potential Risks of AAAS and PASS

When PASS are disturbed, either by excavation or lowering of the watertable below natural seasonal levels, the sulfides present are exposed to air, allowing oxidisation and consequently, the formation of sulfuric acid ($H_2SO_4$). Subsequently, surrounding land (soil) and nearby waterways may become acidic (pH<6.5). Under acidic conditions, metals such as aluminium (generally at pH<4.5) and iron, as well as trace heavy metals (including arsenic), become more mobile in the environment and are taken up by infiltrating waters. As a result, surface and/or groundwater concentrations of these metals may reach concentrations which cause acute or chronic toxicity to terrestrial and aquatic plants and animals.

Acidic conditions generated by ASS can also corrode concrete and steel (pipes, bridge abutments, underground services, and other infrastructure) and can result in the rapid deterioration of asphalt surfaces where they overlie AASS or PASS.

## 2.3 Management of ASS

Avoiding or minimising disturbance of ASS are the primary methods of management. Where avoiding disturbance is not possible, management techniques available for ASS can include:

» chemical neutralisation (use of pure fine agricultural lime (AgLime) or a similar neutralising agent).

- anoxic storage or placement of PASS below the water table and beneath clean non-ASS fill; and
- hydraulic separation of pyrite from the soil (high maintenance process suitable for coarse grained sediment).

The addition of agricultural lime is the most common amelioration technique applied to acidic soils, where mechanical mixing is completed by plough or excavator to provide adequate homogeneity of the soil/sediment-lime mix.

## 2.4 Legislative Requirements in Western Australia

The following applies to the site for works involving ASS.

### 2.4.1 Western Australian Planning Bulletin 64

The recently amended *Planning Bulletin 64/2009 (PB 64/09)* aims to provide advice and guidance on matters that should be taken into account in the rezoning, subdivision and development of land containing acid sulfate soils. PB 64/09 requires the identification, assessment and management of soils where:

- The surface elevation is ≤ 5m AHD, and it is proposed to excavate ≥ 100m$^3$ of soil;
- Where the surface elevation is ≥ 5m AHD, and it is proposed to excavate ≥ 100m$^3$, and the excavation depth is ≥ 2m; or
- Where any dewatering works are to be undertaken.

### 2.4.2 Environmental Protection Act 1986

The *Environmental Protection Act 1986* (EP Act 1986) provides for an Environmental Protection Authority, for the prevention, control and abatement of pollution and environmental harm, for the conservation, preservation, protection, enhancement and management of the environment and for matters incidental to or connected with the foregoing.

To prevent environmental harm, the act established under Section 50A, states that, *A person who –*

*(a) causes serious environmental harm; or*

(b) *allows serious environmental harm to be caused*.

*commits an offence*.

Accordingly, all parties to a development must show that the environmental risk associated with the development has been assessed and minimised where possible.

# 3. Results

## 3.1 ASS Risk Mapping

A review of ASS risk mapping (WAPC, 2009) indicates that there is no data available for the proposed sites. It should however be noted that areas of land approximately 1 km south of Area B are classed as a moderate to high risk of ASS occurring within 3 m of the natural soil surface, likely to be related to the influence of Dampier Creek.

Accordingly and as a precautionary measure (given the proximity of both sites to the coastline and Dampier Creek), GHD consider both study areas to have a low to moderate risk of ASS.

## 3.2 Geological/Soil Setting and Topography

The Geological Survey of Western Australia Environmental Geology Series Maps (1982) indicates that the site is situated on a flat to gently undulating plain on the Dampier Peninsula, comprising predominantly of the Pindan soil type. These soils are generally described as, *red sands, fine to medium grained, minor silt content and of Aeolian in origin* (Kenneally *et al.,* 1996), developed during the quaternary period as regolith on desert sandstone.

## 3.3 Hydrological Setting

The study area is located in the Cape Leveque Coast drainage basin (Department of the Environment, Water, Heritage and the Arts, 2008).

Information provided by the Department of Water (DoW) bore search indicates that the there are 6 groundwater wells in a 5 km radius of sites A and B. The depth to water ranged from 0.2 – 4.4 mAHD with an average of 2.2 mAHD.

Due to the reported nature of the geology, surface topography and the proximity of the nearest surface water bodies, it is considered that the sites are located in areas which do not indicate a significant potential to impact surrounding surface water resources.

## 3.4 Previous investigations

GHD has undertaken Preliminary Environmental Impact Assessments (PEIA) and Biological Surveys in Areas A and B (GHD, 2009). A summary of their findings in relation to ASS potential risks are as follows:

- No wetlands or watercourses are located within the study area. Roebuck Bay, an internationally significant wetland (RAMSAR listed site) is located within 10 km of the study area. It is unlikely that this RAMSAR listed site will be impacted by the proposed project;
- No Environmentally Sensitive Areas (ESA) are situated within the Areas A and B;
- Areas A and B are not located within a Public Drinking Water Source Area (PDWSA); and

» Alteration to surface drainage and stormwater runoff. As a result of vegetation clearing and the development of building and hard stands, there will be a reduction in infiltration of surface water to the ground and an increase in runoff from the site.

In summary, previous investigations do not indicate the presence of significant sensitive environmental receptors in the area.

## 3.5 Current Land Use

### 3.5.1 Area A

» Currently dominated by remnant vegetation;

» Water tank located north west of the area;

» Minor light industrial (Blue Haze Industrial Area) toward the east of the site;

» Zoned currently for a number of land uses including tourism, light and service industry, minor rural and other public purposes.

### 3.5.2 Area B

» Currently covered by remnant vegetation;

» Waste disposal site located adjacent north of the area;

» Aerial photography indicates that an abattoir was located on the site, at the end of Locke Street;

» Formally grazed; and

» Currently zoned as general rural.

## 3.6 Review of Aerial Photographs

A review of the aerial photography is presented below.

| | **Area A** | **Area B** |
|---|---|---|
| **1967** | » Mainly remnant vegetation<br>» Small portion of clearing evident to the eastern part of the site<br>» Several roads intersecting the site are now evident. | » Predominantly consists of remnant vegetation<br>» Residential area to the west of the site commencing development<br>» Roads intersecting the area<br>» Minor clearing in the north east area |
| **1982** | » Minor clearing evident to the eastern part of the site<br>» Minor clearing on the western boundary | » Expansion of residential area<br>» Abattoir located in the north east of the site |

| | | |
|---|---|---|
| **1989** | » Mainly consists of remnant vegetation<br>» Further clearing to the east of the site<br>» Commencement of construction for light industrial zone<br>» Some clearing and construction of a road in the north west area of the site for a water tank | » Minor clearing in the vicinity of the abattoir<br>» Waste management facility present to the north of the site<br>» Further construction of roads/tracks evident on the site |
| **2000** | » Mainly consists of remnant vegetation<br>» Completion of light industrial zone on the site<br>» Poultry farm present on the north east boundary | » Clearing of minor area for informal track spanning from the middle of the area to the west |
| **2007** | » No changes evident | » No significant changes<br>» Further expansion of residential areas to the east and west of the area |

In general, both areas have not undergone significant land use changes with the majority of the sites left relatively undisturbed.

Previous and existing land uses are not considered to have disturbed significant amounts of soil and therefore, there is a minimal risk of prior ASS excavation.

# 4. Conclusions and Recommendations

## 4.1 Conclusions

This preliminary investigation has assisted in determination of the potential occurrence of ASS at the Site (Areas A and B).

ASS risk mapping currently does not cover the area of the Site. However, based upon the following information presented in this investigation, it is considered likely that a low to moderate risk of ASS exists for the area.

- Geology indicates *red sands, fine to medium grained, minor silt content and of Aeolian in origin* – considered relatively low risk of ASS;
- Groundwater presumed to be approximately 2 mAHD
- The distal proximity of water bodes and sensitive environmental receptors.

## 4.2 Recommendations

Based on the information available, it is not possible to rule out the presence of ASS on the Site. In order to assess in detail the potential presence and distribution of ASS materials at the Site, it is recommended that the field component provided in the original scope of works is undertaken.

It should be noted that the field component was prepared by GHD based upon the assumption of low to moderate risk of ASS (supported by this preliminary investigation). A limited sampling program is recommended given the low potential risks of ASS impacts.

The field investigation (with reference to DEC, 2006) should include the excavation of approximately 30 test pits in total across areas A and B to depths of 3 m below ground level. A total of 110 soil samples will be collected, of which all shall undergo insitu $pH_f$ and oxidised $pH_{fox}$ analysis. Of these samples, approximately 40% shall undergo acid-base counting in the form of Suspension Peroxide Oxidation and Combined Acidity and Sulfate (SPOCAS). It is further suggested that a proportion of the SPOCAS samples are analysed for Chromium Reducible Sulfur ($S_{cr}$) in order to determine the nature of acidity if present (i.e. organic or inorganic).

Once the detailed field investigation is completed, the appropriate management strategies can be prepared, if required.

# 5. References


Department of Environment (2006). Acid Sulfate Soils Guideline Series. *Draft identification and investigation of acid sulfate soils*. Perth, WA. May, 2006;

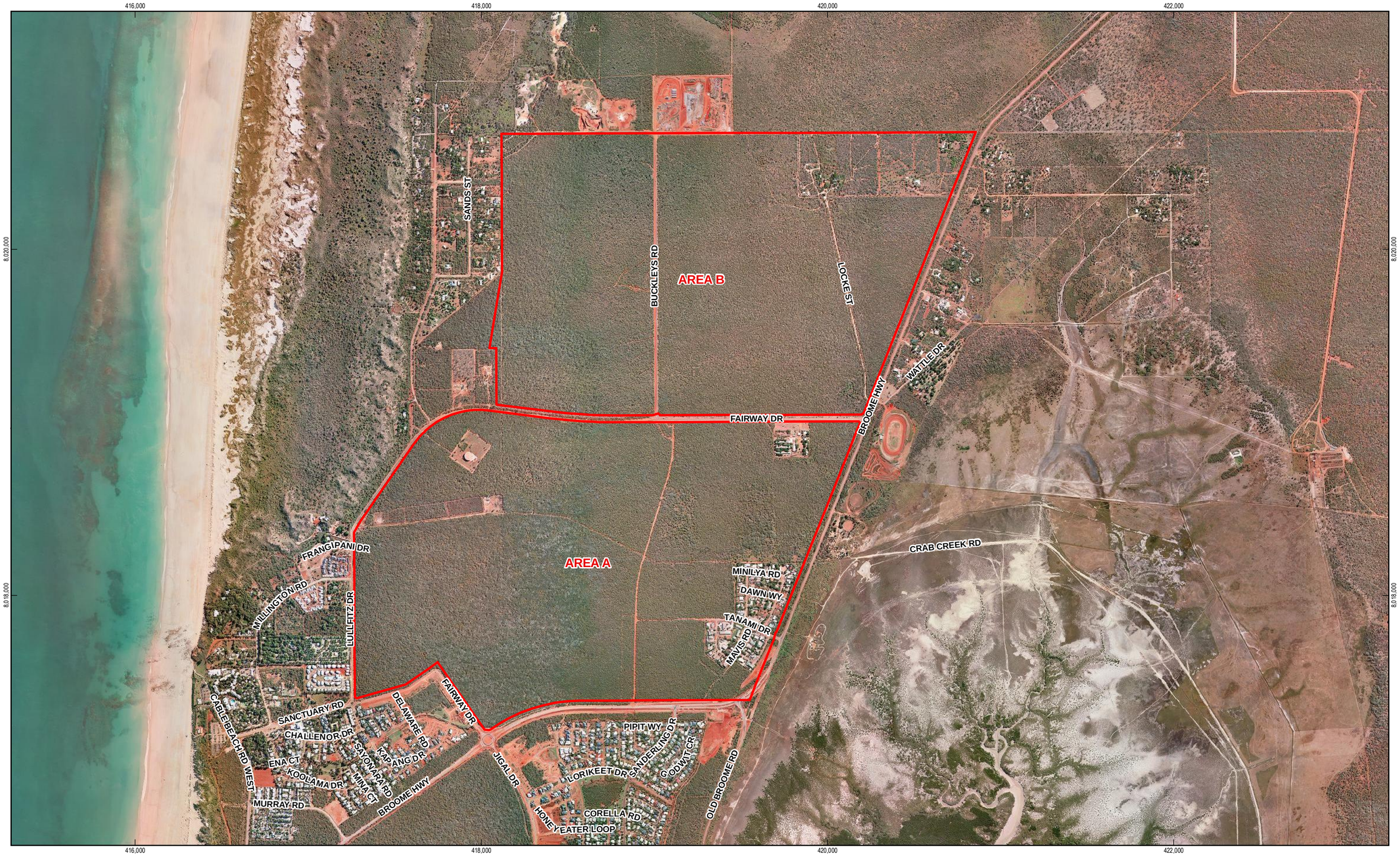
Department of Environment and Conservation (2009). *Draft Treatment and Management of Soils and Water in Acid Sulfate Soil Landscapes*. Perth, WA. January 2009.

Department of the Environment Water Heritage and the Arts (2008a) *My Environment; Broome Search*. Accessed online at: http://www.environment.gov.au/erin/myenvironment/indexhtml on 01/10/08

Geological Survey of Western Australia (1982) *1:250,000 Broome Map Sheet SE51-6*

Kenneally, K.F., Edinger, D.C., and Willing, T. (1996) *Broome and Beyond. Plants and People of the Dampier Peninsula, Kimberley, Western Australia*. CALM, Western Australia.

Western Australian Planning Commission (2003). Planning Bulletin Number 64. *Acid Sulfate Soils*. November, 2009.




1:20,000 (at A3)

0 100 200 400 600 800

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 51

N

LEGEND

Study Area Boundary

Landcorp
Broome Industrial

| | |
|---|---|
| Job Number | 6122611 |
| Revision | 0 |
| Date | 19 MAY 2009 |

# Acid Sulfate Soil Investigation Site Overview

Figure 1

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Data Source: GHD: Study Area Boundary - 20080530; Landgate (SLIP): Broome Townsite June 2007 Mosaic. Created by: K Iralu

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