APPENDIX 16

Acid Sulfate Soils Management Plan

Acid Sulfate Soils Management Plan

Main Works Application – Headland Park

Barangaroo Delivery Authority

Barangaroo
Hickson Road, Sydney, NSW

October 2010
JBS41181-15388 rev 1
JBS Environmental Pty Ltd

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List of Abbreviations

A list of the common abbreviations used throughout this report is provided below.

- AASS Actual Acid Sulfate Soils
- ASSMP Acid Sulfate Soil Management Plan
- BDA Barangaroo Delivery Authority
- DECCW NSW Department of Environment, Climate Change, and Water
- JBS JBS Environmental Pty Ltd
- PASS Potential Acid Sulfate Soils
- PQL Practical Quantitation Limit
- QA/QC Quality Assurance/Quality Control

1 Introduction

1.1 Introduction and Background

JBS Environmental Pty Ltd (JBS) was commissioned by the Barangaroo Delivery Authority (BDA) to prepare a Acid Sulfate Soil Management Plan (ASSMP) for the Main Works associated with the Headland Park portion of Barangaroo located at Hickson Road, Sydney, NSW, 2000 (**Figure 1**).

In this Main Works ASSMP, Headland Park is referred to as the "Headland Park Site" and the entire Barangaroo Site is referred to as the "Barangaroo Site", whilst the "Barangaroo Project Site" includes the Barangaroo Site and the adjoining parts of Sussex Street, Hickson Road and Towns Place. The southern part of the Barangaroo Project Site, referred to as the "Stage 1 Development", will be developed for a mixture of commercial, residential and open space uses. The locations of the various parts of the Barangaroo Project Site are shown on **Figure 2**.

Previous investigations undertaken at the Headland Park Site have identified Potential Acid Sulfate Soils (PASS) present within the natural soils overlying sandstone bedrock. These PASS will be disturbed during elements of the Main Works which disturb natural soils overlying bedrock within the Headland Park Site.

1.2 Scope

This Main Works ASSMP is intended to deal with PASS which may be encountered during the Main Works at the Headland Park Site and the adjoining parts of the Barangaroo Project Site. PASS which may be encountered in the Stage 1 Development, and received at the Headland Park Site for placement, are not addressed within this ASSMP and a separate ASSMP must be prepared in the event that PASS are suspected/encountered in the Stage 1 Development.

This Headland Park Main Works ASSMP comprises the following:

- A desktop review of environmental attributes at the Headland Park Site including geological and hydrogeological characteristics;
- A description of acid sulfate soils mitigation strategies incorporating a schedule of work phases to minimise impacts from excavated soils and potential leachate;
- Formulation of a monitoring program for soils and surface water quality designed to provide feedback on the effectiveness of the management strategy and to provide an early warning of the development of any environmental degradation or impact; and
- A description of the contingency procedures to be implemented at the Headland Park Site to deal with unexpected events or in the event of failure of management procedures.

This ASSMP has been prepared in general accordance with the *Acid Sulfate Soil Manual*, NSW Acid Sulfate Soil Management Advisory Committee, August 1998 (ASSMAC 1998).

1.3 Objectives

The objectives of this Main Works ASSMP are to:

- document the actions necessary to minimise and contain impacts to the environment associated with acidity during the removal of any PASS; and
- detail the handling, treatment and management strategies for this material prior to its reuse at the Headland Park Site.

1.4 The Proposed Main Works

The proposed Main Works construction program includes all works required to construct the final landform of the Barangaroo Headland Park site including the Park and Northern Cove. Construction works will include:

- Land formation using fill from Stage 1 of the Barangaroo Development (Lend Lease portion of the site at to the south of the proposed Headland Park Site) ranging from 150,000m^3 identified in the Early Works application (previously assessed in JBS Environmental (2010) 'Air Quality and Health Assessment Early Works – Headland Park Barangaroo Delivery Authority' (JBS, 2010b) and an additional 150,000m^3 as received from the Stage 1 Barangaroo Development and assessed in this Main Works Application, to build the Headland up to finished levels for a nominal 0.8m topsoil layer;
- Construction of structural earth retaining walls using sandstone based materials;
- Creation of a naturalistic shoreline and Northern Cove through excavation / dredging, formation of retaining walls using boulders etc;
- Extraction of sandstone for earth retaining walls and naturalistic shoreline;
- Placement of up to 60,000m^3 of fill materials from the Stage 1 area of the Barangaroo site within the space created by the sandstone extraction;
- General landscaping and planting;
- Construction of a network of pedestrian pathways connecting the foreshore walkway and Merriman St;
- Construction of a shoreline promenade;
- Jetty / viewing platform extending into the Northern Cove from the southern shoreline;
- Construction of a car park within the headland with vehicular access from Towns Place and pedestrian access from various locations within Headland Park;
- Construction of a space area for a future use (as Cultural Facilities) comprising up to 18,000m^2 of floor space with ceiling heights ranging from 3 to 13m; and
- Site remediation works to address limited amounts of contaminated fill material that have been identified on the Headland Park site. These works will be incorporated with the overall excavation activities proposed for the Park.

These activities may involve the disturbance of PASS, particularly in the event of demolition of the Sydney Harbour Control Tunnel, and during cut and fill of the Headland Park.

2 Acid Sulfate Soils

Acid sulfate soils are those that contain iron sulphides. They are typically found in low-lying coastal areas, such as mangroves forests, salt marches, estuaries, tidal lakes and coastal floodplains.

2.1 Potential Acid Sulfate Soil

This is the name given to a layer of permanently waterlogged iron sulfide soil. It is given this name because it has the potential to oxidise and produce sulfuric acid. If left undisturbed the water keeps oxygen away from the iron sulfides and prevents oxidation. In this waterlogged state it is inert and harmless to the environment. Potential acid sulfate soils are usually dark grey in colour.

2.2 Actual Acid Sulfate Soil

If potential acid sulfate soil is exposed to air through land drainage or excavation, the iron sulphides in the soil react with oxygen in the air and produce sulphuric acid. The resulting soil is known as actual acid sulfide soil. Some of the acid can be neutralised by the soil itself, however, most of the acid moves through the soil contaminating the surrounding ground and surface waters.

2.3 Assessment Guidelines

In NSW development of land subject to ASS occurrence is managed in accordance with guidance provided in ASSMAC 1998. **Table 2.1** presents Site Action Criteria (SAC) based on ASS material laboratory analysis results for three broad texture categories. The SAC are based on the percentage of oxidisable sulfur or equivalent acid trail (i.e. titratable actual acidity-TAA or titratable potential acidity-TPA) results. There are two categories based on the scale of the proposed disturbance, with the SAC for small works based upon the texture of the soil material, and the SAC for large scale works adopting the most sensitive SAC from the small works.

Table 2.1 Site Action Criteria based on General Soil Texture Categories (ASSMAC 1998)

Type of material		**Action Criteria 1-1000 tonnes disturbed**		**Action Criteria if more than 1000 tonnes disturbed**	
Texture Range. McDonald at al. (1990)	Approx. clay content (%<0.002 mm)	**Sulfur trail** % S oxidisable (oven-dry basis) e.g. S_{Cr} or S_{pos}	**Acid trail** Mol H^+ /tonne (oven-dry basis) e.g., TPA or TSA	**Sulfur Trail** % S oxidisable (oven-dry basis) e.g. S_{Cr} or S_{pos}	**Acid trail** Mol H^+ /tonne (oven-dry basis) e.g., TPA or TSA
Coarse Texture Sands to loamy sands	≤5	0.03	18	0.03	18
Medium texture Sandy loams to light clay	5-40	0.06	36	0.03	18
Fine texture Medium to Heavy clays and silty clays	≥40	0.1	62	0.03	18

Exceedance of the 'Site Action Criteria' (SAC) attributable to ASS material generally triggers the need to prepare a management plan and are based on the percentage of oxidisable sulfur (or equivalent TPA, TAA) for broad categories of soil.

However, it is noted that other soil properties and constituents may cause acidic conditions in soils that are not related to acid sulfate soil conditions. This may include sources of organic acidity where the soils have a pH of less than 5 and positive titratable actual acidity (TAA) or titratable potential acidity (TPA) but have no detectable sulfur source (i.e. no S%). In this case, exceedance of the Acid Trail SAC is not considered to be a trigger for treatment of these soils.

Given the nature of the works to be undertaken at the Headland Park Site, the SAC adopted will be for large scale works where more than 1000 tonnes of material will be disturbed:

- Sulfur Trail Criteria (S_{pos} or S_{Cr} %) > 0.03%;
- Acid Trail Criteria (TSA, TPA) > 18mol H^+ / tonne soil.

3 Site Details

3.1 Site Identification

The Barangaroo Project Site is located at Hickson Road, Sydney, NSW and is legally referred to as Lots 1, 3, 5 and 6 Deposited Plan (DP) 876514 and includes the adjacent parts of Sussex Street, Hickson Road and Towns Place, as shown in **Figure 1**. The Barangaroo Project Site details are summarised in **Table 3.1** and described in more detail in the following sections.

Table 3.1 Summary Details for the Barangaroo Project Site

Lot/DP	Lots 1, 3, 5 and 6 of Deposited Plan 876514, including adjacent parts of Sussex Street, Hickson Road and Towns Place
Address	Hickson Road Millers Point NSW
Local Government Authority	City of Sydney
Site Zoning	Zone B4 Mixed Use and RE1 Pubic Recreation
Current Use	Vacant/Roadway
Geographical Co-ordinates, Elevation	Easting – 333643m E, Northing – 6251851m S, 2-3m AHD
Site Area	Approximately 22 ha

It is noted that two small portions have been excluded from the Barangaroo Project Site for the purposes of remediation planning including:

- Moore's Wharf (in the far north eastern section of the Headland Park Site); and
- The area immediately surrounding the Port Control Tower.

The location of these areas relative to the Barangaroo Project Site is shown on **Figure 2**, which also shows the location of former structures that were present during the former commercial/industrial site use.

The Headland Park Site is located at the northern part of the Barangaroo Project Site and the details are summarised in **Table 3.2** and described in more detail in the following sections.

Table 3.2 Summary Details for the Headland Park Site

Lot/DP	Lot 1 and Part Lot 5 of Deposited Plan 876514, including adjacent parts of Hickson Road and Towns Place
Address	Hickson Rd Millers Point NSW
Local Government Authority	City of Sydney
Site Zoning	Zone B4 Mixed Use and RE1 Pubic Recreation
Current Use	Vacant
Geographical Co-ordinates, Elevation	Easting – 333547m E, Northing – 6252278m, 2-3m AHD
Site Area	Approximately 8 ha

3.2 Site Condition

The Headland Park Site has an approximate rectangular shape, with the longest boundary in a north-south direction. The far north-eastern portion of the Headland Park Site, known as Moore's Wharf (Ports Services), was reported to contain a large heritage listed sandstone building and this section of the Headland Park Site was recently utilised as a base for marine operations by Sydney Ports Marine Services.

The remainder of the Headland Park Site was previously used for wharfage and storage of materials and was last occupied by Patrick Stevedoring. The large warehouse buildings associated with this former use have been demolished. The surface of the Headland Park Site is generally covered with areas of concrete and asphaltic pavement. The pavement surfaces have been reported as being in generally reasonable condition (ERM 2008a). The Sewage Pumping Station at the north of the Headland Park Site is still present.

The main vehicular access to the Headland Park Site is from a number of gates on Hickson Road on the eastern boundary of the Barangaroo Site, in addition to gates off Towns Place.

3.3 Surrounding Landuse

The surrounding uses of land adjacent to the Headland Park Site have been previously been reported as follows (ERM 2008b[1]):

- North: Immediately to the north is Sydney Harbour;
- East: Immediately to the east is the residential and commercial area of Millers Point (NE), in addition to Hickson Road (SE);
- South: Immediately to the south is the temporary overseas passenger terminal, beyond which lies the Stage 1 Development; and
- West: Immediately to the west is Darling Harbour.

A former gasworks is known to have operated until the 1920s over part of the Stage 1 Development, as shown on **Figure 2**. The former gasworks location is known to continue to the east beneath Hickson Road, and the contaminated gasworks waste material in this area has been identified to contaminate soils and groundwater on the south-eastern portion of the Barangaroo Project Site. This part of the Stage 1 Development, referred to as the Declaration Area in the Early Works RAP, has been declared a Remediation Site by NSW DECCW (Declaration No. 21122, Area No. 3221) under the CLM Act 1997. It is understood that environmental assessment programs are being undertaken on the Stage 1 Development in preparation for remediation.

3.4 Topography

The topography of the Headland Park Site is relatively flat, having been cut and filled for its previous use as a stevedoring facility (ERM 2008b). The Headland Park Site abuts a man-made cliff face on the north-eastern boundary.

3.5 Hydrology

The closest surface water body to the Headland Park Site is Darling Harbour, located immediately adjacent to the west and north of the Headland Park Site (ERM 2008b). Surface water from the Headland Park Site is collected via a sub-surface drainage network, which generally flows toward the Harbour.

3.6 Geology

According to the 1:100 000 Geological Survey of NSW (Sydney) Sheet 9130 (Ed 1) 1983, the Headland Park Site is generally underlain by man-made fill that has been placed over marine sands over Hawkesbury Sandstone, which is described as follows (ERM 2008b):

- Man-made fill may consist of "dredged estuarine sand and mud, demolition rubble, industrial and household waste"; and
- Hawkesbury Sandstone is characterised as "medium to coarse-grained quartz sandstone with very minor shale and laminite lenses".

[1] *Draft Stage 2 Remedial Action Plan for Barangaroo*, Hickson Road, Sydney, ERM, September 2008 (ERM 2008b)

A substantial network of soil sample locations has been previously placed across the Barangaroo Project Site. The general geological profile observed at the Headland Park Site, as reported by previous investigations, is summarised in **Table 3.3**.

Table 3.3 Summary of Observed Site Geology

Lithological Unit	Description	Depth (mbgl)
Hardstanding	Asphalt, bitumen or concrete, generally in good condition with no staining.	0 – 0.46
Road base fill	Very dark grey, dry, loose, medium grained sand to fine gravel, poorly sorted, sub angular, no odours or staining noted.	0 – 0.5
Fill	Silty, gravelly sand, olive brown, grey brown, light yellowish brown, dry to wet, fine to coarse sand, sandstone floaters. Fill material including building rubble, bricks, concrete. Black staining and a hydrocarbon odour and significant contamination have been identified in some boreholes, particularly within and around the former gasworks area.	0 – 18.0
Marine Clay/Sand	Interbedded clayey sand and sandy clay, dark greyish brown, saturated, some shell fragments and organic matter. Sandy clay – soft, high plasticity. Clayey Sandy – loose to dense, fine to coarse sand, low to no plasticity. Contamination has been identified within and around the former gasworks area.	3.0 – 18.4
Marine Clay/Sand	Interbedded clayey sand, sandy clay and sand, light yellowish brown, white, reddish brown or dark greyish brown, saturated. Sandy clay – stiff to hard, medium to high plasticity. Clayey Sandy and sand – loose to dense, fine to coarse sand, low to no plasticity.	4.9 – 32.75
Bedrock	Weathered sandstone, white, light yellowish brown, olive brown and reddish brown, wet, fine to coarse grained, some fracturing noted. Contamination has been identified within and around the former gasworks area.	1.3 – 32.75

It was further reported that some areas along the western foreshore and building footprints were covered by concrete with a thickness up to 0.5 m. A layer of fill was observed in all boreholes and ranged in thickness from 1.3 m on the east of the Barangaroo Project Site to 18 m on the west of the Barangaroo Project Site.

3.7 Hydrogeology

As previously reported (ERM 2008b), information obtained from the (former) Department of Natural Resources (DNR) indicated that 32 registered groundwater bores were situated within a 4 kilometre (km) radius of the Headland Park Site. Review of the groundwater bore information indicated that the bores were used for the following purposes: recreation (8), irrigation (3), and monitoring (22). None of the listed bores were reported to be registered for drinking water purposes. No registered groundwater bores have been reported to be present on or adjacent to the Headland Park Site.

The quality of groundwater on the Headland Park Site has been reported to have been assessed via a network of monitoring wells installed across the Headland Park Site (ERM 2008b). Locations of groundwater monitoring wells are shown on **Figure 6**. Hydrological data indicated that groundwater on the Headland Park Site was strongly influenced by tidal fluctuations, suggesting substantial hydraulic connection with the Harbour potentially due to conduits in the fill material.

The hydrological data suggest that much of the Headland Park Site is likely to be subject to significant seawater flushing. Under typical conditions there is reported to be a likely net groundwater flux towards the Harbour, at a velocity of between 0 and 7.6 m/day (ERM 2008b).

Concentrations of Constituents of Potential Concern (COPCs) in groundwater within the Headland Park Site (which is outside the area of the former gasworks structures on the Stage 1 Development and the adjoining Hickson Road) were generally low and were consistent with what would be expected on an urban site of this nature, as opposed to the

elevated concentrations of contaminants observed within the area of the former gasworks.

3.8 Meteorology

The Sydney area has a humid to temperate climate with a seasonal rainfall maximum during the summer and autumn months. Annual mean rainfall recorded at Sydney (Observatory Hill) is 1212 mm[2].

The area has a history of droughts, which are broken by periods of heavy rainfall resulting in significant recharges to groundwater resources. The 1940s and 1980s and the current decade are observed to be dry periods, while the early 1970s and 1990s were wet periods.

Summer winds are predominantly northeasterly with southerly thunderstorms common. Winter winds are predominantly westerly.

3.9 Acid Sulfate Soils

Investigations have identified that the Headland Park Site is located in an area of potential acid sulfate soils. Testing of soils carried out by Douglas Partners Pty Ltd has identified potential acid sulfate soils. Levels of potential acidity include:

- Total potential acidity – TPA (mol/T): <5 – 270;
- Sulphur in TSA – S_{pos} (%): <0.01 – 0.43; and
- Total sulphidic acidity (mol/T): <10 – 414.

Further, Arup (2010[3]) reported that AECOM analysed five samples from the southern end of the Barangaroo Project Site for sPOCAS. Their results indicated that there was potential for PASS at depth within marine and estuarine deposits. While not directly applicable to the Headland Park, the results indicate caution should be used.

By referring to **Table 2.1**, these results exceed the action criteria where more than 1000 tonnes of material are to be disturbed.

[2] http://www.bom.gov.au/climate/averages/tables/cw_066062.shtml visited 7th May 2010

[3] '*Geotechnical Report – Barangaroo South – Concept Plan Amendment MP06-0162 MOD 4*', Arup Pty Ltd, July 2010 (Arup 2010)

4 Scope of Soil Disturbance Works

The Main Works at the site are expected to include a number of activities which may involve the excavation of PASS:

- Demolition or modification of Sydney Harbour Control Tower:
  - Depending on the option chosen, this phase may consist of demolition and removal of the building, including footings and services, or adaptation of the existing building. Either option may include the disturbance of significant amounts of natural soils;
- Shaping of the shoreline including creation of the Northern Cove.
  - This will require the construction of a new seawall at the planned shoreline, followed by the extraction of approximately 150 000 m^3 of fill materials from behind the original seawall. Depending on the demarcation between fill and underlying soils, and the location of the new shoreline, natural soils may be excavated; and
- Design works for Headland Park.
  - The exact design for the park has yet to be determined and will be dependent upon factors including the availability of fill and the extent of excavations on the site. Details are therefore not currently available, but it is assumed that significant cutting down will occur in some locations and may potentially include the excavation of natural soils.

Material removed from the excavation will require to be managed as per the requirements provided to this ASSMP.

The pumping, handling, and management of groundwater may also be required management as per the requirements of this ASSMP.

PASS which may be encountered in the Stage 1 Development, and received at the Headland Park Site for placement, are not addressed within this ASSMP and a separate ASSMP must be prepared in the event that PASS are suspected/encountered in the Stage 1 Development.

5 Management Procedures

The following steps outline the management procedures to be undertaken during the implementation of the excavation works.

5.1 Material Transport

All excavated natural soils will require to be transferred to a designated ASS treatment area to be constructed at the Headland Park Site. This facility may be constructed during the course of Early Works at the site, but will depend upon the timeline of discovery of ASS on the site.

5.2 Material Storage

Excavated soils shall be transferred immediately to the designated ASS treatment area. This area requires to be operated in accordance with the following provisions during storage and treatment of PASS:

- Run-off/seepage shall be treated with the sump provided to the treatment area by the addition of lime until stored water is pH corrected to the range of pH 6.5-8.5
- Water infiltration of the stockpiled soils within the treatment area is to be minimised through measures as follows;
    - Area to be located on an existing paved area; and
    - Perimeter bunds to control/retain runoff water.

It is noted that a small amount of water within the stockpile is acceptable and may be beneficial in the neutralising process when adding lime, however leachate buildup is problematic and requires additional sampling and treatment prior to release.

5.3 Material Treatment

Acid sulfate soils need to be treated / conditioned within the designated ASS treatment area. Treatment / conditioning shall be by the application of lime.

Materials placed within the designated ASS treatment area shall be placed and spread in layers which will enable lime application and no greater than 300 mm in thickness. Additional layers of material may be placed to create stockpiles. Using the average of the calculations undertaken by the analysing laboratory, and assuming that fine agricultural lime – which has a neutralising value of 100 – is used, lime will require to be added at a minimum rate of **11 kg per tonne** of soils, subject to the monitoring/validation protocols within this ASSMP.

The designated ASS treatment shall be isolated from major external catchments by perimeter drains and/or bunds covered with an impervious layer (concrete, geomembrane, compacted non-ASS clay) with a further layer of fine aglime to neutralize potential leachate migration from material within this area. Infiltration of surface water (rain or drainage) through ASS to groundwater should be prevented, which will be achieved by ensuring the designated ASS treatment area is located on an area of existing pavement.

The designated ASS treatment will consist of five basic zones:

- Pre-treatment stockpile area;

- Treatment pad(s);
- Post-treatment stockpile area;
- Water collection, treatment and holding area; and
- Neutralisation chemical storage area.

The pre-treatment stockpile area will be used for the temporary placement of soils following excavation and prior to spreading within the treatment area. This area should have a storage capacity no greater than the treatment area to prevent the pre-excavation of significant quantities of ASS material exceeding the treatment area capacity. The location of this area should allow reasonable access from the excavation zones to the stockpile area and also access from the stockpile area to the treatment pad(s). Each stockpile should be independently bunded and drained to minimise the spread of potentially acidic leachate from one stockpile to another.

Dependent upon the capacity of the treatment area desired, one or several treatment pads may be designed. Each treatment pad should only have a capacity capable of being managed by a single team of treatment workers and associated machinery within a reasonable time frame to ensure that excessive oxidation of material does not occur during spreading and treatment.

Assuming a spread depth of 0.3 m, a single treatment area of approximately 15 m square could treat approximately 60 m^3 of material per treatment cycle. This area allows for a 1 m buffer between the spread soil and bund to allow for leachate to move out of the soil and be collected at a suitable location within the bunded area. Bunds may be constructed of concrete, compacted non-ASS clay, sand and lime filled sandbags or other suitable materials that are relatively impervious and can be coated with a guard layer of lime to neutralise acidic leachate that may contact the bund.

The treatment pad should be constructed with an impervious base (i.e. concrete/bitumen pavement, hdpe membrane, etc), bunded edges or circumferential drains and a guard layer of aglime. The treatment pads will be constructed where possible as a graded structure to concentrate leachate run-off to one portion of the treatment pad where the leachate can be collected and/or pumped to a treatment/holding tank.

Following treatment of the material within the treatment pad, the material should be transferred to the post treatment stockpile area. Here the validation testing will be completed and the material will remain until verification that the material has been suitably treated. Following receipt of the verification documentation, this material will then be reused on the Headland Park Site.

Diversion drains should be installed to prevent stormwater run-on into the treatment pad or stockpile areas and so increases in the quantity of water requiring neutralisation. Water within the bunded areas will be collected at central points within each area where it can then be pumped to a central holding location. Artificial drains may be constructed with a guard layer of neutralising agent to assist with neutralisation of acidic leachate and runoff. This will act to reduce the total quantities of acidic water requiring treatment within the Headland Park Site.

Dilution of water collected within the treatment area is not an acceptable method of treatment at this site. Contaminants resulting from oxidation of ASS should be collected, treated and/or managed on-site. Water discharges must not have a significant impact on

pH, buffering capacity, colour or ionic composition of the receiving water body (stormwater, groundwater, sewer, etc).

A sufficient supply of aglime will be kept on site at all times for the treatment of acid sulfate soils to be neutralised within the treatment area, for application on exposed excavation faces where ASS is expected or suspected; and for wet weather events where existing applications will require replacement and/or treatment of acidic water is necessary. Receipts, dockets and other field records showing the storage locations of all chemicals and location of all applications of neutralising agents must be kept.

The supply shall be stored in a covered and bunded area to prevent accidental exposure to water and deterioration of the inherent neutralizing capacity. ASS treatment materials should be stored in a manner that minimising the exposure of the materials to wet or humid conditions. Such conditions may result in the clumping or surface crusting of particulate lime which can reduce the level of effectiveness in neutralising water or soil.

5.4 Material Sampling and Analysis

The treated soils stockpiled within the designated ASS treatment area will require sampling and analysis to assess the effectiveness of the treatment works. Sampling of soil shall occur at a minimum of 48 hours after placement and mixing with lime (to allow sufficient time for the reaction to occur).

Soils shall be sampled at a frequency of one sample per 400 tonne. These shall be initially analysed in the field for pH. This will be undertaken by:

- Obtaining approximately 5g of soils within a small test tube;
- Adding 25ml of water to the test tube;
- Mixing soil and water vigorously (leaving top of test tube open); and
- Testing pH using an appropriately calibrated pH meter.

Where pH results are all below pH 5, sampling shall be repeated with submission of samples to a NATA accredited laboratory for analysis. Where acceptable results are received from the laboratory treatment shall be considered to be acceptable.

If results indicate that soil pH is below 5, and laboratory analyses results are unacceptable, additional turning, mixing and lime addition may be required.

It is noted that a pH of 5 has been selected based on the midpoint of the following criteria:

- Definition of acid sulfate soils provided to NSW Acid Sulfate Soil Management Advisory Committee (August 1998) 'Acid Sulfate Soil Manual' as being soils which have a pH <4;
- Optimal soil pH being in the range of 6-8 as defined by ANZECC (1992) Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites'; and
- Acknowledgement that all lime will not react with soils in the initial period subsequent to application.

Selection of a criteria which is sufficiently above the definition of acid sulfate soils and slightly below the range of acceptable soil pH's is considered to be acceptable and sufficient to allow

likely minor additional neutralisation of soils that will occur subsequent to assessment of soil treatment / neutralisation.

5.5 Field Trial

No field trial is considered necessary during the current works given the method for transporting, storing, neutralising, monitoring and reinstating material is well established and will be controlled within a fenced site.

5.6 Groundwater

Excavations may be carried out below the depth of the groundwater table. In light of this, there is a small potential that where oxidation of dewatered spoil materials within the excavation occurs, that groundwater may become acidic. Hence, where groundwater is required to be dewatered, pH monitoring shall be undertaken.

Dewater shall be pumped to a water treatment plant provided to the project, which shall incorporate a pH dosing tank. Groundwater pH in the dosing tank will be continually assessed by a pH meter, and groundwater pH corrected by the additional of lime through an incorporated dosing pump. No treatment of groundwater shall be required where a pH in the range of 6.5-8.5 is recorded.

5.7 Monitoring Program

A monitoring program of soils, surface and subsurface water quality will be incorporated within the project works in accordance with **Table 5.1**.

Table 5.1: Proposed Monitoring Program

On-site receptor	Number of samples (frequency)	Analytes tested	Threshold Criteria	Action (if threshold exceeded)
Treated soils	1 sample per 400 tonne	Field pH meter	pH>5	Add lime (neutralization) and monitor
Discharge from Water Treatment System	One per tank batch	Field pH meter	pH 6.5-8.5	Add lime (neutralization) and monitor
Surface water (downgradient from treatment cell)	Following rainfall (if present downgradient of cells)	Field pH meter	pH 6.5 – 8.5	Neutralize soil within cell, empty cell of leachate and reinstate and repair bunding walls and impervious layer.

5.7.1 Soil Sampling

Soil sampling within the designated ASS treatment area shall be undertaken using a field pH meter. A 1:5 solid : distilled water suspension will be mixed in a test tube and monitored with the use of a field pH meter. During the collection of soil samples, features such as seepage, discolouration and other indications of ASS shall be noted in Field Records.

5.7.2 Water Sampling

Water samples shall only be collected as required. Should groundwater or surface water infiltrate excavation areas, leachate encountered within the designated ASS treatment area or rainfall produce surface water runoff, a water quality meter shall be used to measure pH.

The water quality meter shall be calibrated in accordance with manufacturer specifications and calibration details recorded. Water samples collected for sampling shall be representative of the water column or the body of water being investigated.

5.8 Schedule of Works

The activities to be undertaken for the proposed Main Works associated with natural soils excavated from the Headland Park Site will include, but not limited to, the following:

- Construction of a sufficiently sized designated ASS treatment area prior to commencement of excavation works;
- Excavation of material and immediate transfer to the designated ASS treatment area;
- Addition of neutralising agent (lime); and
- Field sampling of treated material within designated ASS treatment area for pH to demonstrate appropriate treatment;
- Additional assessment/mixing/treatment of soils where pH targets are not met.

6 Health and Safety

6.1 Occupational Health and Safety Management Plan

An Occupational Health and Safety Management Plan (OHSMP) shall be prepared by the contractor prior to mobilisation onto the Headland Park Site for the Early Works program. The Plan shall contain procedures and requirements that are to be implemented as a minimum during the works.

The objectives of the OHSMP are:

- to apply standard procedures that minimises risks resulting from the works;
- to ensure all employees are provided with appropriate training, equipment and support to consistently perform their duties in a safe manner; and
- to have procedures to protect other site workers and the general public.

These objectives will be achieved by:

- assignment of responsibilities;
- an evaluation of hazards;
- establishment of personal protection standards, mandatory safety practices and procedures;
- monitoring of potential hazards and implementation of corrective measures; and
- provision for contingencies that may arise while operations are being conducted at the site.

7 Conclusions

Potential acid sulfate soil conditions have been identified within the Headland Park Site and elements of the proposed Main Works will disturb PASS materials. This ASSMP provides a methodology to manage the risks associated with the proposed activities which, when successfully implemented, will minimise the environmental risks associated with disturbance of the PASS materials.

8 References

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9 Limitations

This report has been prepared for use by the client, Barangaroo Delivery Authority, who has commissioned the works in accordance with the project brief only, and has been based in part on information obtained from the client and other parties.

The advice herein relates only to this project and all results conclusions and recommendations made should be reviewed by a competent person with experience in environmental investigations, before being used for any other purpose.

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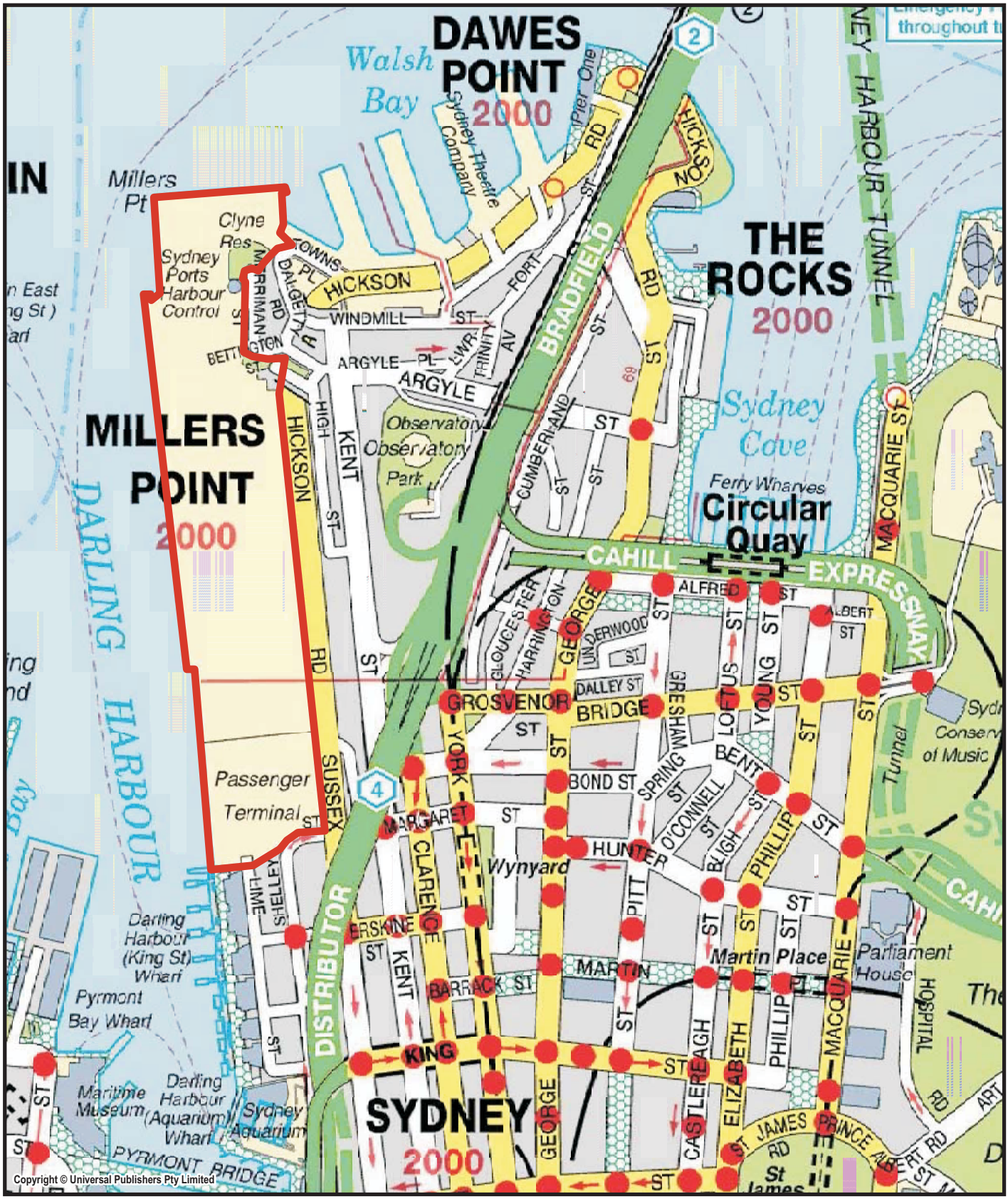
Changes to the subsurface conditions may occur subsequent to the investigations described herein, through natural processes or through the intentional or accidental addition of contaminants. The conclusions and recommendations reached in this report are based on the information obtained at the time of the investigations and supplied by external persons to JBS Environmental.

This report does not provide a complete assessment of the environmental status of the site, and it is limited to the scope defined herein. Should information become available regarding conditions at the site including previously unknown sources of contamination, JBS Environmental Pty Ltd reserves the right to review the report in the context of the additional information.

Figures



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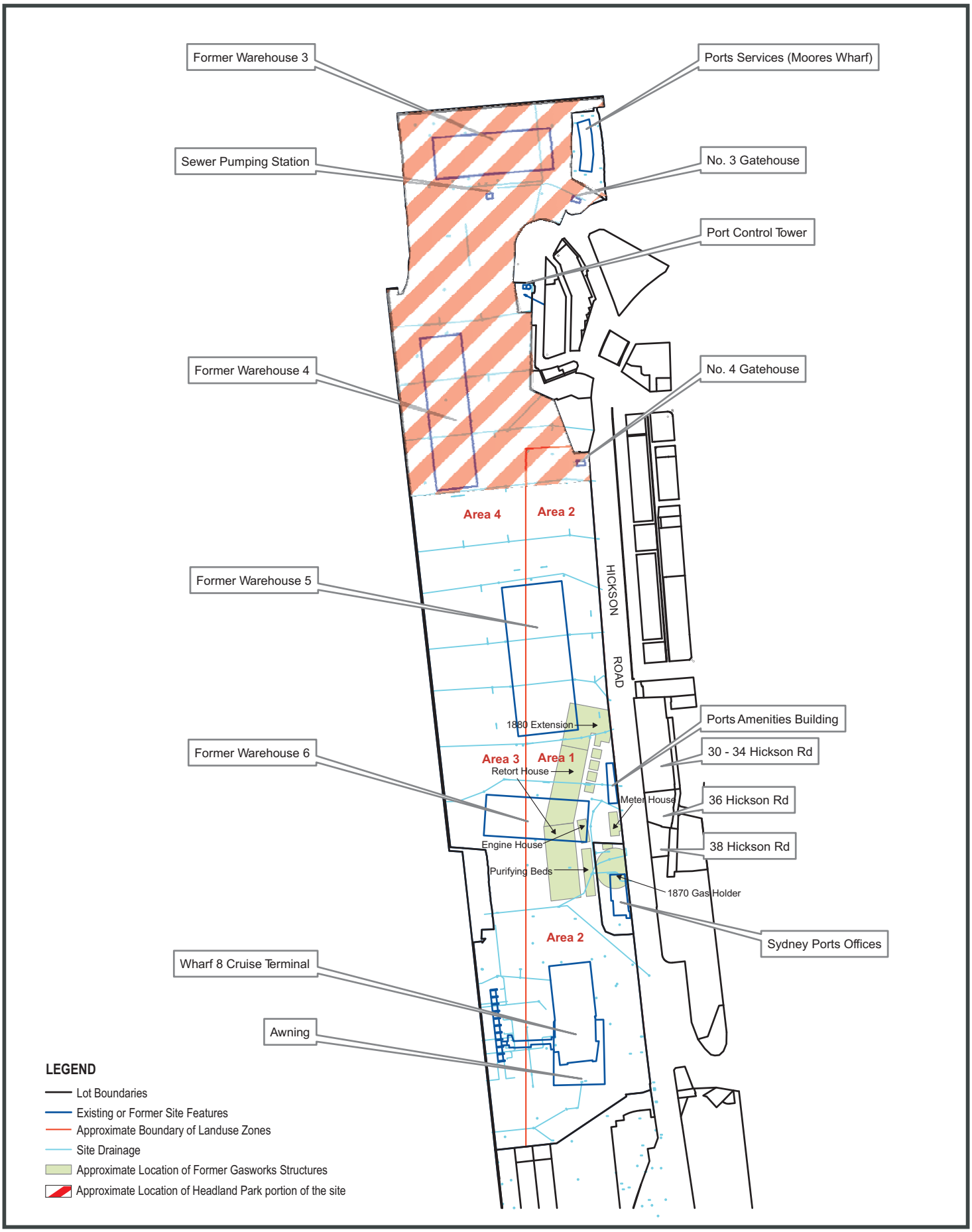
0 250m

Approximate scale

Figure 1 **Location of Barangaroo Site**

ERM (2008)
Note- All locations shown are approximate only



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0 200m

Approximate scale

Figure 2 **Site Boundary / Site Layout**

ERM (2008)
Note- All locations shown are approximate only

Document Status

Rev No.	Author	Reviewer	Approved for Issue		
		Name	Name	Signature	Date
0	Georgia Carthey	Matthew Parkinson	Matthew Parkinson		2/8/2010
1	Michelle Battam	Matthew Parkinson	Matthew Parkinson		7/10/2010