Bank Street Park
Blackwattle Bay / Tjerruing

SSD-53386706

Appendix Z

Acid Sulfate Soil Management Plan (JBS&G)

December 2023

Infrastructure NSW
Bank Street Park

Acid Sulfate Soil Management Plan

1A-19 Bank Street, Pyrmont NSW

26 October 2023

64669/ 153,913 Rev 1

JBS&G Australia Pty Ltd

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Abbreviations

Term	Definition
AASS	Actual Acid Sulfate Soil
AHD	Australian Height Datum
ASS	Acid Sulfate Soil
ASSMP	Acid Sulfate Soil Management Plan
BGS	Below Ground Surface
CC	Construction Certificate
DA	Development Application/Approval
DCP	Development Control Plan
EPA	NSW Environment Protection Authority
ha	Hectare
LEP	Local Environmental Plan
LOR	Limit of Reporting
PASS	Potential Acid Sulfate Soil
SAC	Site Action Criteria
S_{Cr}%	Chromium Reducible Sulfur (%)
sPOCAS	Suspended Potential Oxidation Combined Acidity and Sulfur (test method)
S_{pos}%	Potential Oxidisable Sulfur
SWL	Standing Water Level
TAA	Total Actual Acidity
TPA	Total Potential Acidity
TSA	Total Sulfidic Acidity

1. Introduction

1.1 Background

JBS&G Australia Pty Ltd (JBS&G) was engaged by Infrastructure NSW (INSW, the client) to provide environmental services in relation to the identification, assessment and management of Acid Sulfate Soils (ASS) to support a State Significant Development Application (SSDA) for a new waterfront public park within Blackwattle Bay, to be known as Bank Street Park (State Significant Development (SSD-53386706)). Bank Street Park is located at 1A-19 Bank Street, Pyrmont on the shoreline of Tjerruing Blackwattle Bay and adjacent areas of Blackwattle Bay.

Bank Street Park comprises 13 individual lots formally identified as Lot 1 in Deposited Plan (DP) 188671, Lot 1 in DP439245, Lot 1 in DP85206, Lots 1 and 2 in DP1089643, Lots 19 – 22 in DP803159, Lots 5-6 in DP803160, Part Lot 5 in DP1209992, Part Lot 107 in DP 1076596 and part Bank Street road reserve (inclusive of the existing Anzac Bridge pylon footprint, for which it is not anticipated any specific work will be required). The 'Site' as being the relevant lots within the red line in the attached Figures has been defined for the purposes of this investigation report to exclude Part Lot 5 in DP1209992, Part Lot 107 in DP 1076596 and part Bank Street road reserve and comprises an area of approximately 1.1 ha. The 'broader site area' comprises the proposed extent of works, including the area covered by the purple line, inclusive of the water based portion (Part Lot 5 in DP1209992, Part Lot 107 in DP 1076596) and current public domain areas (part Bank Street road reserve) the subject of street improvements. The Site and broader site area are shown in **Figures 1 and 2A.**

Bank Street Park forms part of the Blackwattle Bay Precinct (BWBP), which is an area of predominantly government owned land located on the western edge of the Pyrmont Peninsula and adjoining the waters of Blackwattle Bay. The precinct was rezoned in December 2022 to facilitate a new mixed-use community, providing for around 2,000 new residents and 5,600 new jobs and creating a vibrant 24/7 economy. Updated planning and land use controls were incorporated into the Sydney Local Environmental Plan 2012, along with site specific design guidance in the *Blackwattle Bay Design Guidelines*.

A critical part of the BWBP is the high quality public domain which includes a series of parks and open spaces connected by a foreshore promenade. Bank Street Park will bring new active and passive recreation uses into a unique park environment, catering for both existing and future communities in the vicinity.

Review of the *Prospect/Parramatta River 1:25 000 Acid Sulfate Soil Risk Map Sheets 9130N3*, undertaken as part of Detailed Site Investigation (DSI, JBS&G 2023[1]), indicated the site is located in an area of disturbed terrain, including areas historically impacted by reclamation of low-lying swamps for urban development. Blackwattle Bay comprises an area of 'high probability' of ASS within bottom sediments. In such areas, there is the potential for severe environmental risk if bottom sediments are disturbed by activities such as dredging. The DSI also identified that the land is an area classified as Class 1 or Class 2 ASS under the *Sydney Local Environment Plan* 2013 (City of Sydney 2012), which requires development consent for any works and works below the natural ground surface, or for works by which the water table is likely to be lowered.

An acid sulfate soil investigation was subsequently conducted on the land based portion ('Site') of the site during the DSI (JBS&G 2023) to assess the likelihood of encountering Potential Acid Sulfate Soils (PASS) or ASS during future development works. The investigation reported several areas of subsurface soil/fill and natural material characteristic of ASS/PASS. In addition, previous

[1] *Bank Street Park, Detailed Site Investigation, 1A-19 Bank Street, Pyrmont NSW*, JBS&G Australia Pty Ltd, 64669/151,386 Rev 0 - Draft, 18 August 2023 (JBS&G 2023)

investigations as discussed in JBS&G (2023) have previously been conducted across the broader Blackwattle Bay Precinct that consider all sediments within the bay to comprise ASS/PASS.

The Acid Sulfate Soil Management Plan (ASSMP) applies to the broader site area comprising the land based portion and the bay/harbour area and is required in response to the findings and recommendations of JBS&G (2023) and the relevant requirements outlined in section 15 (Ground and Water Conditions) within the Planning Secretary's Environmental Assessments Requirements (SEARs) issued on 11 May 2023 for application SSD-53386706 such that appropriate decisions can be made in development of the land use design.

This ASSMP has been prepared with consideration to the requirements of Section 15 within the SEARs and with consideration to the National Acid Sulfate Soils Guidance (DAWR 2018[2]). Given the proposed works may include the generation of excess material, consideration has also been given to a future classification for off-site disposal of soils under the NSW EPA *Waste Classification Guidelines* (EPA 2014a[3] and 2014b[4]).

1.2 Aims and Objectives

The aim of this ASSMP which applies to the broader site area comprising the land based portion and the bay/harbour area is to outline management techniques that may be employed to mitigate the potential environmental impacts associated with the risk of disturbance of ASS/PASS during the proposed site construction/development works. Specifically, the objectives of this ASSMP are to document:

- The known and anticipated site sub-surface characteristics that will be encountered during future ground disturbance/excavation works to support design and implementation of future ASS investigation and management activities;
- A monitoring and sampling strategy to be implemented prior to and during the proposed ground disturbance activities so that ASS may be appropriately identified and managed during all works that may result in disturbance of known and/or suspected ASS material;
- Evaluation of potential ASS management opportunities and constraints resulting in the identification of a preferred management strategy/ies;
- Procedures for the management and validation of ASS treatment during the future site ground disturbance/excavation works, to minimise the potential for adverse environmental impacts as a result of the ASS disturbance activities; and
- Outline the necessary off-site disposal requirements for potential ASS spoil as may be generated during the proposed works.

1.3 Proposed Development

JBS&G understands that development consent is being sought for a recreation area for the primary purpose of a public park. The concept design plan is provided in **Figure 3**, where works will generally involve limited reshaping of existing site levels, however noting the deepest anticipated excavation on the land based site portion extends to more than 3.5 m in depth in the southeast portion of the site according to the cut to fill plan provided by the client. Based on information as provided, the current bay works may result in limited disturbance of sediments, as specifically associated with installation of new driven piles to support overwater structures and construction of a new sandstone block wall in a limited portion of the land/water interface.

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[2] *National Acid Sulfate Soil Guidance*. Australian Government Department of Agriculture and Water Resources (DAWR), June 2018 (AGDAW, 2018)

[3] *Waste Classification Guidelines Part 1: Classifying Waste*. NSW EPA 2014 (EPA 2014a)

[4] *Waste Classification Guidelines, Part 4: Acid Sulfate Soils*. NSW EPA (EPA 2014b)

The public park will comprise the following:

- Site preparation works, including tree removal, earthworks and remediation to facilitate proposed use;
- Demolition of three existing buildings at 1-3 Bank Street;
- New and adapted facilities for community use, including:
    - New single storey building to accommodate flexible community space, café, and marina office/store facilities, with green roof and photovoltaics;
    - Adaptive reuse of Building D for public amenities, bin and other storage;
    - Boat launching ramp and pontoon for passive watercraft, including dragon boats and kayaks;
    - Boat storage building with change facilities for dragon boat users with publicly accessible rooftop deck.
- Public domain works including:
    - 'Interpretation Garden' in existing building 'ruins' at 1-3 Bank Street;
    - Split level foreshore promenade;
    - Multi-purpose court with edge seating and partial fence;
    - Nature-based inclusive playspace for ages 2-12;
    - Fitness equipment;
    - Public plaza and grassed open space areas;
    - New tree plantings and planter beds;
    - Public art, wayfinding and interpretative signage, lighting, bike parking and seating.
- Harbour works including:
    - Overwater boardwalk;
    - Land/water interface works, including sandstone terracing into water and support structure, to improve marine habitat;
    - Demolition and construction of a new timber launching ramp for dragon boats;
    - Kayak/passive craft pontoon; and
    - Restoration, repair and alterations to the existing seawall for new stormwater outlets.
- Works to Bank Street road reserve, including:
    - Road space reallocation to provide separated cycleway;
    - Cycleway transition to Bank Street to continue south as part of future works;
    - Reinstatement of existing on-street parallel parking;
    - Tree planting;
    - Accessible parking space; and
    - Loading zone adjacent 1-3 Bank Street.

1.4 Environmental Assessments Requirements

The site contamination investigation is required in response to the relevant requirements outlined in section 15 (Ground and Water Conditions) within the SEARs issued on 11 May 2023 for application SSD-53386706 such that appropriate decisions can be made in development of the land use design. **Table 1.1** below addresses the relevant SEARS requirements and provides a project response.

Table 1.1: Summary Site Details

Item	Environmental Assessments Requirements
SEARs Section 15 (Groundwater and Water Conditions)	Assess potential impacts on soil resources and related infrastructure and riparian lands on and near the site, including soil erosion, salinity, and acid sulfate soils. The EIS must map features relevant to water and soils including acid sulfate soils, rivers, streams, wetlands, estuaries, groundwater and groundwater dependent ecosystems, and proposed intake and discharge locations. The EIS must describe background conditions for any water resource likely to be affected by the development, including existing surface and groundwater, hydrology, including volume, frequency and quality of discharges at proposed intake and discharge locations. Provide a Surface and Groundwater Impact Assessment that: • describes any works/activities that may intercept, extract, use, divert or receive surface water and/or groundwater. This includes the description of any development, activities or structures that will intercept, interfere with or remove groundwater, both temporary and permanent. • details of the water balance including quantity, quality and source and take for the life of the project and post closure where applicable. This is to include water taken directly and indirectly, and the relevant water source where water entitlements are required to account for the water take. If the water is to be taken from an alternative source confirmation should be provided by the supplier that the appropriate volumes can be obtained. • details of Water Access Licences (WALs) held to account for any take of water where required, or demonstration that WALs can be obtained prior to take of water occurring. This should include an assessment of the current market depth where water entitlement is required to be purchased. Any exemptions or exclusions to requiring approvals or licenses under the Water Management Act 2000 should be detailed by the proponent. • assesses potential impacts on: • surface water resources (quality and quantity) including related infrastructure, hydrology, dependent ecosystems, drainage lines, downstream assets and watercourses. • groundwater resources in accordance with the *Groundwater Guidelines*. • identifies and assesses all works/activities located on waterfront land including an assessment against Guidelines for Controlled Activities on Waterfront Land (NRAR 2018). • mitigates the effects of proposed stormwater and wastewater management during and after construction on hydrological attributes such as volumes, flow rates, management methods and re-use options. • identifies the proposed monitoring of hydrological attributes. Assess the impact on the Sydney Metro West substratum directly beneath the land including: • details of any proposed penetrative subsurface investigations (e.g. boreholes) 2m or deeper to be drilled within the first or second protection reserve • consideration of the Sydney Metro Underground Corridor Protection Guidelines and Sydney Metro at Grade and Elevated Sections Guidelines.

2. Site Conditions

2.1 Site Identification and Description

The Site and broader site area location are shown on **Figure 1**. The extent of the Site and associated cadastral boundaries and features are shown on **Figure 2**. The Site and broader site area details are summarised in **Table 2.1** and described in detail in the following sections.

Table 2.1: Site Details

The Site - Lot / DP Property Identification and Ownership	The site is comprised of the following legal properties: • Lot 1 in DP188671- Transport for NSW • Lot 1 in DP439245 - Infrastructure NSW • Lot 1 in DP85206 - Transport for NSW • Lots 1 and 2 in DP1089643 – Infrastructure NSW • Lots 19 - 22 in DP803159 - Transport for NSW • Lots 5 and 6 in DP803160 - Transport for NSW
The broader site area - Lot / DP Property Identification and Ownership	The broader site area is comprised of the following added legal properties: • Part Lot 5 in DP1209992 – Roads and Maritime Services (Transport for NSW) • Part Lot 107 in DP1076596 – Transport for NSW • Part Bank Street road reserve – Transport for NSW (City of Sydney Council)
Local Government Area	City of Sydney Council
Approximate Geographical Coordinates (MGA 56)	As shown on **Figure 2**
Current Site Zoning	RE1 Public Recreation under City of Sydney Local Environmental Plan (LEP) 2012 and Zone 1 Maritime Waters under Section 6.27 of State Environmental Planning Policy (Biodiversity and Conservation) 2021
Current Use	Lots 5-6 in DP803160 and Part Lot 20 in DP803159 – Vacant Lot 19, Part Lot 20, Lot 21 and Lot 22in DP803159 – Blackwattle Bay Marina Lot 1 in DP 188671, Lot 1 in DP85206, Lot 1 in DP439245 and Lots 1-2 in DP1089643 – Vacant Part Lot 5 in DP 1209992- Blackwattle Bay Part Lot 107 in DP1076596 - Blackwattle Bay Part Bank Street road reserve – Public road
Previous Use	Holding yard, Blackwattle Marina, industrial purposes and public road
Proposed Use	Public open space / Public park and community facility
Site Area	Approximately 1.1 ha

2.2 Site Condition

A detailed Site and broader site area description and environmental setting are provided in JBS&G (2023).

2.2.1 Desktop Review of Published Regional Information

Review of the *Prospect/Parramatta River 1:25 000 Acid Sulfate Soil Risk Map Sheets 9130N3* indicates that the majority of the Site is located within an area classed as 'disturbed terrain'. Areas having this classification typically include filled areas which often occur following reclamation of low lying swamps for urban development. Other areas with this classification may include areas which have been mined, dredged, or have undergone heavy ground disturbance through general urban development. Soil investigation is required to assess these areas for acid sulfate potential.

Blackwattle Bay comprises an area of 'high probability' of acid sulfate soils (ASS) within bottom sediments. In such areas, there is the potential for severe environmental risk if bottom sediments are disturbed by activities such as dredging.

2.2.2 Investigation Data – Site Geology and Acid Sulfate Soil Conditions

Reference to the *1:100 000 Geological Landscape Map for Sydney* (Herbert C., 1983[5]) indicated that the site is underlain by three geological types:

- Man-made fill typically comprising dredged estuarine sand and mud, demolition rubble, industrial and household waste;
- Quaternary aged silty to peaty quartz sand, silt and clay deposits with ferruginous and humic cementation in places and with common shell layers; and
- Hawkesbury Sandstone typically characterised as medium to coarse-grained quartz sandstone with very minor shale and laminate lenses.

Site characteristics as reported in JBS&G (2023) encountered fill material at all sample locations that typically ranged in depths from approximately 0.0-6.0 m below ground surface (bgs). The fill generally comprised silty sand, gravelly sand, clayey sand, clayey sand, sandy gravel, sandy clay, sandstone and ash, ranging in colour between brown, dark brown, grey and black with inclusions of slag, ash, charcoal, seashells, wood, gypsum, brick, sandstone and concrete fragments. Six boreholes did not reach the extent of fill material for the following reasons:

- BH01: borehole advanced via hand auger due to limited accessibility and refused on a potential concrete or sandstone obstruction at 0.4 m bgs;
- BH02: borehole advanced via hand auger due to limited accessibility and terminated at 1.0 m bgs;
- BH06: borehole advanced via hand auger due to presence of electrical services and terminated at 1.0 m bgs;
- BH07: refusal on a potential concrete obstruction at 5.5 m bgs;
- BH09: borehole advanced via hand auger due to presence of electrical easement and terminated at 0.3 m bgs due to presence of electrical services; and
- BH12: borehole advanced to the programmed depth.

Fill material was underlain by natural grey/brown/red/ sandy clay, grey/brown/red/grey gravelly sand and clayey gravelly sand and grey/yellow/brown/white/red sandstone. Seepage was observed during drilling at four sampling locations (BH04, BH07, BH08 and BH12) with the depth ranging between 3.0 m bgs (BH04) and 4.7 m bgs (BH12).

Representative fill material and natural soils were the subject of field ASS testing in accordance with the field testing procedure presented in the ASSMAC (1998[6]), with field pH_f and pH_{fox} tests recorded. The soils with the greatest indicated potential for acid generation were subsequently sent to a laboratory for ASS testing (sPOCAS) to provide the most conservative answers with regard to threshold levels for liming and associated liming rates.

PB (2009[7]) noted potential indicators of ASS comprising odorous marine sediments with seashells in boreholes located within marine sediments in Blackwattle Bay south of the site. Similar observations were reported in JBS&G (2015[8]) and EIS (2017[9]); however no samples were analysed at a laboratory

[5] *Sydney 1:100 000 Geological Sheet 9130,* Herbert C., 1983, 1st edition. Geological Survey of New South Wales, Sydney.
[6] *Acid Sulfate Soil Manual 1998*, Stone, Y, Ahern C R, and Blunden B. Acid Sulfate Soil Management Advisory Committee, Wollongbar, NSW, Australia (1998)
[7] *Environmental Site Investigation, Blackwattle Bay Maritime Precinct, Blackwattle Bay Maritime Precinct, NSW*. March 2009, Parsons Brinckerhoff (PB 2009)
[8] T*he Bays Precinct Urban Transformation Area – Environmental Site Assessment,* 18 November 2015, JBS&G Australia Pty Ltd, Rev 1 (JBS&G 2015)
[9] *Contamination Investigation The Bays Precinct - Separable Portion 1, Blackwattle Bay, Pyrmont, NSW*, Environmental Investigation Services, Reference: E29245KletRev1-SP1, EIS (2017)

to confirm the nature of acid generation potential. As documented in JBS&G (2015), marine sediments underlying the bay and underlying fill material behind sea walls bordering Blackwattle Bay have previously been identified via laboratory characterisation as PASS. As such, for the purposes of this ASSMP, it has been assumed that all sediments as may be encountered within the bay and underlying fill material to the rear of seawalls in proximity of the site comprises PASS material.

2.2.3 Investigation Data – ASS Laboratory Data

Site investigation activities completed by JBS&G (2023) included the analysis of representative samples of Site fill and natural soil/sediment for Suspended Potential Oxidation Combined Acidity and Sulfur (sPOCAS) by a NATA accredited laboratory to confirm ASS characteristics. Samples were selected for analysis based on physical characteristics and field pH_f and pH_{fox} tests results, with the laboratory analysis results compared to site assessment criteria (**Section 3.2**) adopted from ASSMAC (1998).

Assessment of the collated laboratory analysis results against ASSMAC criteria identified the following:

- Several areas of subsurface soil/fill and natural material present within the Site portion are characteristic of ASS, comprising material located in proximity to the Blackwattle Bay waterfront site boundary (**Figure 4**):
    - black sand and brown clayey gravelly sand at BH12;
    - dark brown/black clayey sand at BH07; and
    - brown gravelly sand at BH04;
- The material represented by the positive results generally ranged in depth from approximately 5.0 to 6.0 m bgs;
- Natural profile soil/sandstone across the balance of the site has been characterised by collected data as non-PASS material; and
- Based on the results of the investigation, assessment of fill material situated above the groundwater table has not been identified as PASS.

2.2.4 Potential Acid Sulfate Soil Assessment Conclusions

Based on the proposed site plans and with consideration to the proposed development details, the following has been identified with regard to the requirements for management of the potential acid sulfate soil risks at the site:

- The proposed development works will not disturb a large volumes of soil, with the majority of works proposed to be above the existing water table (sitting at approximately 1.6-3.4 m bgs), with limited excavations potentially extending past the water table to a maximum depth exceeding 3.5 m bgs in the southern portion of the site;
- Any works with the potential to result in ground disturbance at depths below the water table undertaken in proximity of the site foreshore boundary, or result in lowering of the groundwater table in these areas of the site should be completed under the oversight of the ASSMP;
- In addition, given the assumed position that all sediments within the bay comprise PASS, activities, including pile removal/installation and sea wall construction works as proposed, have the potential to result in minor disturbance of PASS material. On this basis, these works also require to be completed under the oversight of the ASSMP;
- Where PASS material is exposed or disturbed as a result of site activities, the acid generation potential will be addressed via lime stabilisation. Following successful completion of the

neutralisation process, the treated soils are no longer considered to be ASS materials and so may be reused on site as engineered fill material (where appropriate);

- Any identified PASS in excess of site requirements will require treatment and classification by reference to EPA (2014) *Waste Classification Guidelines* prior to offsite disposal; and
- Given the age of the fill material at the site and the potential variability, whilst specific management of fill material has not been identified as necessary at this point, appropriate contingencies should be planned to enable implementation of environmental controls in the event that small areas of additional marine/alluvial soil (as in-situ natural material or placed fill material) are disturbed that require management. These contingencies are addressed in **Section 6.**

3. Acid Sulfate Soil General Information

3.1 Acid Sulfate Soil Background

ASS is a common name given to naturally occurring sediments and soils containing iron sulfides (generally as iron sulfide or iron disulfide). These soil profiles are typically located in coastal, low-lying alluvial or estuarine areas such as mangroves, salt marshes, coastal rivers and creeks, estuaries, tidal lakes and coastal floodplains where historical iron rich sediment deposition in the presence of a sulfate source (commonly salt water), organic matter and microbial action over time has resulted in the formation of particular environmental conditions. ASS are predominantly encountered in areas with an elevation of less than 5 m Australian Height Datum (AHD) and may be found close to the ground level or at depth in the soil profile where continued deposition has resulted in raising of the ground levels.

Changes in environmental conditions which result in the exposure of these materials to air, via excavation or drainage of subsurface soils, can lead to the reaction of the iron sulfides with oxygen, causing the generation of sulfuric acid. This may result in significant environmental and infrastructure damage if the produced acid is spread by groundwater or surface water.

ASS consist of two major categories:

- Actual Acid Sulfate Soils (AASS) are soils that have been exposed to oxygen which has caused the oxidation of iron sulfides to form sulfuric acid. Some of this acid is commonly neutralised by other soil particles in a process known as buffering, however the excess acid is spread by water movement through the soil; and
- Potential Acid Sulfate Soils (PASS) are soils which contain iron sulfides, which have not been oxidised. These soils are generally kept from contact with air by permanent waterlogging or the density of the soil profile and so are relatively stable, or in equilibrium. In this state the soils are generally non-acidic and are considered harmless to the environment. However, oxidation of such soils through disturbance has the potential to generate acid.

Commonly, an acid sulfate soil profile will consist of a combination of both AASS and PASS material as a result of ongoing chemical reactions in response to environmental changes including groundwater fluctuations and seasonal soil moisture changes.

The following types of site activities may result in disturbance of ASS (both AASS and PASS) during urban development:

- Bulk excavation works to achieve basement levels, installation of drainage infrastructure, alteration of existing site levels to achieve modified ground levels, dredging or otherwise mobilisation such that sediment may become oxidised, etc.;
- Dewatering activities associated with construction works proposed at elevations below the standing water table, for example, installation of drainage infrastructure, etc., which may result in ASS beyond the excavation extent becoming exposed to oxygen due to a lowering of groundwater levels, thereby generating acidic conditions; and
- Generation of spoil which may return ASS to the ground surface associated with foundation construction works, including piling spoil during bored pile installation activities, directional drilling works for infrastructure services installation, etc.

In NSW, development of land subject to ASS occurrence is managed at a planning level in accordance with the *Acid Sulfate Soil Manual* (1998) prepared by the Acid Sulfate Soil Management Advisory Committee (ASSMAC). Local Environmental Plans (LEP) provide a regulatory regime for the sustainable management of acid sulfate soils in the coastal zone. The ASS Manual provides guidance on the assessment of acid sulfate soil conditions and appropriate management strategies for

development of ASS identified land. It is noted that National Acid Sulfate Soils Guidance (DAWR 2018) provides updated advice with regard to the technical aspects of ASSMAC (1998) and where inconsistencies occur, reference should be made to DAWR (2018).

3.2 Laboratory Assessment Guidelines

The assessment of site soil conditions with respect to ASS occurrence is completed in accordance with the guidance provided in ASSMAC (1998)/DAWR (2018). The requirement to manage soils for ASS is evaluated by comparison of laboratory analysis results with Site Action Criteria (SAC) developed based on three broad soil 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 scale (i.e. less than 1000 tonnes) works based upon the texture of the soil material, and the SAC for large scale works adopting the most sensitive SAC being the SAC for coarse textured soils in small scale works.

Table 3.1 ASSMAC Site Action Criteria based on General Soil Texture Categories

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 SAC attributable to ASS material generally triggers the need to prepare a management plan and is 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 does not trigger treatment of these soils (DAWR 2018e[10]).

3.3 Other Regulatory Guidance

In addition to ASSMAC (1998), this management plan has been prepared with reference to the following:

- *Waste Classification Guidelines Part 1: Classifying Waste* (EPA 2014a);
- *Waste Classification Guidelines Part 4: Acid Sulfate Soils* (EPA 2014b);
- *Contaminated Sites: Guidelines for NSW Site Auditor Scheme*, 3rd Edition, October 2017 (EPA 2017); and
- *Protection of the Environment Operations Act* 1997 (POEO Act) and associated regulations.

[10] *Guideline for the Dredging of Acid Sulfate Soil Sediments and Associated Dredge Spoil Management, Australian Government Department of Agriculture and Water Resources, June 2018 (DAWR 2018e)*

Note is also made of the National Acid Sulfate Soil Guidance issued in June 2018 by the Australian Government Department of Agriculture and Water Resources (DAWR), including:

- *National Acid Sulfate Soil Guidance: A Synthesis* (DAWR 2018a);
- *National Strategy for the Management of Coastal Acid Sulfate Soils* (DAWR 2018b);
- *National Acid Sulfate Soils Sampling and Identification Methods Manual (DAWR 2018c);*
- *National Acid Sulfate Soils Sampling and Laboratory Methods Manual (DAWR 2018d); and*
- *Guideline for the Dredging of Acid Sulfate Soil Sediments and Associated Dredge Spoil Management (DAWR 2018e).*

4. Management Procedures

The aim of the following management procedures is to identify ASS/PASS material and implement appropriate mitigation measures such that the potential environmental impacts associated with disturbance of ASS/PASS during the proposed site construction works may be appropriately managed. Specifically, the objectives are to provide:

- A methodology for the identification of materials requiring management;
- Protocols for the on-site treatment and management of ASS/PASS materials and associated leachate water (as required) during the proposed works;
- Excavation inspection and validation assessment protocols to be implemented during the proposed works such that the extent of ASS/PASS material may be delineated from non-ASS/PASS material (overlying non-ASS/PASS material, residual soils, etc) to enable off-site disposal of the balance of excavated material without the need for lime stabilisation;
- Water and soil quality targets for the excavation, treatment and removal of material encountered during the proposed works; and
- A contingency framework in the event that additional ASS/PASS conditions are encountered during the site works or the proposed treatment strategy fails.

4.1 Scope of Soil/Sediment Disturbance Activities

The proposed development works are anticipated to include the removal of existing site infrastructure, excavation/installation of footings, fixtures and foundations including new foreshore walk (overwater) infrastructure, and installation of underground services, all of which may require the excavation or otherwise disturbance of fill material, natural soils and sediments that may comprise ASS or PASS. It is noted that the final scope of ASS/PASS disturbance activities will be evaluated upon finalisation of the construction requirements/methodologies to be implemented during the works, particularly in relation to the proposed sea wall works.

4.2 Investigation of Occurrence of ASS and/or PASS Material

Based on the existing site characterisation information, it is broadly anticipated that fill material encountered above the water table will comprise non-PASS and does not require further assessment and/or management during construction works that result in their disturbance.

Fill material situated beneath the groundwater table and/or natural soils and sediments may either be assumed to comprise ASS/PASS and as such require treatment upon exposure/excavation, or alternatively, further targeted investigation of site conditions may be undertaken either prior to the commencement of ground disturbance activities and/or sequentially as areas of disturbance extend across the site such that specific material requiring management may be identified and treatment requirements established as separate to non-ASS material.

Where further characterisation is to be implemented, the fill and natural soils assessment activities should be undertaken by an appropriately qualified environmental consultant in accordance with the general philosophies outlined in ASSMP (1998)/ DAWR (2018) with regard to the identification of ASS/PASS material:

- In transitional zones between areas of likely disturbance and those of no disturbance, sufficient sampling should be completed to ensure management requirements may be suitably understood prior to commencement of works. Each sampling location should be extended to the depth of disturbance;
- Visual inspection and sampling of representative soil profiles of damp to saturated soil/sediments at a frequency of no less than one sample per 1 m per metre depth interval,

or discrete strata, ateach sampling location. Each sample should be the subject of field pH_f and pH_{fox} tests;

- Based on the inspection and field-testing results, no less than one sample per 1 metre per material type per area/material type should subsequently be selected for sPOCAS or chromium reducible sulfur (S_{Cr}) laboratory analysis to confirm the presence/absence of ASS/PASS material requiring management;
- Based upon the results of the field and laboratory analysis program, advice on the lateral and vertical extent of ASS/PASS requiring management will be provided to the Principal Contractor. In addition, the laboratory data will be used to identify anticipated liming requirements for ASS/PASS material types at the site (where appropriate); and
- The results of the assessment will provide a line of evidence for the validation of material beyond the ASS/PASS zone (if identified) for characterisation of the balance of surrounding/overlying soils as non-ASS material.

4.3 Evaluation of Potential Management Strategies

Where the presence of ASS has been identified, evaluation of options to minimise the level of disturbance and to mitigate the potential impact of disturbance (if necessary) of the materials is required. As per ASSMP (1998)/DAWR (2018), potential mitigation approaches have been identified:

- Avoid ASS materials being encountered during works by not undertaking the proposed excavation works into ASS/PASS soils, or by altering the proposed development plans (i.e. removing excavation/piling requirements);
- Where encountering ASS/PASS during works cannot be avoided, manage the potential for acid generation by neutralising disturbed materials, preventing movement of acid impacted water, and the use of suitable construction materials;
- If ASS/PASS materials have previously been disturbed, undertake works to mitigate the existing conditions, minimise the production of further acid during the proposed works and rehabilitate impacted areas;
- Treat soil by allowing full oxidation of the sulfide component under controlled conditions followed by flushing the acid from the soil with water and neutralisation of the subsequent leachate;
- Avoid using untreated ASS/PASS materials as fill material in non-ASS areas by either leaving material on-site, or managing the potential for acid generation prior to material being transported from the site of origin; and/or
- Reburial of ASS/PASS materials beneath the permanent water table or beneath a dense soil profile which excludes oxygen exposure such as an engineered clay cap. This may be undertaken on-site if there are low lying areas where reburial and consequential flooding of the soil profile or construction of a suitable capping layer can be undertaken as part of development works, or at an alternative off-site location provided that sufficient stabilisation of material is undertaken to minimise acid generation during transportation and handling.

The potential suitability of the various options is further discussed in the following sections.

4.3.1 Avoidance Strategies

Avoidance of ASS/PASS disturbance is generally considered to be the preferred means of ASS/PASS risk management where such actions can be achieved. Considering the proposed development of the Bank Street Park, it is considered avoidance of ASS/PASS has been achieved to the extent practicable.

With regard to disturbance of sediment within the water portion of the site, wherever possible, measures will be undertaken to minimise the risk of oxidation of the sediments underlying the water column. Where construction works are required that may result in disturbance of bay surface or near-surface sediments, management procedures will be implemented to minimise the lateral scale and depth of sediment mobilisation/disturbance.

4.3.2 Management by Neutralisation

Neutralisation techniques can be used to treat ASS by the addition of chemicals that react with the produced acid to ensure that acid is not released from the treated material. The neutralisation activities should result in the pH of the disturbed materials (water, sediment and/or soil) being between 5.5 to 7.5 and requires that ASS material disturbed during site activities be treated with the preferred neutralising agent.

Laboratory analysis is used to assess the levels of existing and/or actual acidity and indicates the level of neutralising capacity required to react with all potential acidity that may be generated during/following disturbance of the ASS material.

The potential uncertainty associated with the quantity of neutralising capacity to be added is commonly managed by the use of a factor of safety of 1.2 or 2 depending upon the level of uncertainty.

Sufficient capacity in terms of a suitable treatment area, machinery, budget to purchase the neutralising agent and time is necessary to successfully implement ASS neutralisation. Implementation of environmental controls is also necessary to ensure that all potentially acidic leachate produced during the treatment process is captured and appropriately managed. This can be done with sand bags or silt fencing placed around the excavated materials to ensure water can be treated and neutralised prior to either evaporation, use as dust suppression or placement back into the excavation.

For the purposes of this plan, the neutralising chemical is assumed to be high quality agricultural lime (aglime). Further details on other potential neutralising agents are provided in **Section 4.4.2**.

During works, a sufficient quantity of aglime will be required to be kept on site at all times. A sufficient quantity will be based on requirements for: the treatment of ASS to be neutralised within the treatment area; 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 as 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.

ASS management by neutralisation is considered to be a suitable option for the proposed works associated with the Site and where sediments are generated at the ground/water surface (rather than at the bay sediment bed level) as:

- Material disturbed to achieve construction of the lower ground level, foundations or similar will subsequently be surplus to development requirements, and as such neutralisation of the material following excavation will not affect the construction program (material may be set aside for treatment by others dependent upon available space, whilst construction works continue, following which the material will be disposed of off-site);
- The piling works are presumed to generate only minimal volumes of material, and can be treated as it is generated in a separate portion of the site;
- Once the volume of ASS/PASS material has been appropriately estimated, discussions with the Principal Contractor will be required to determine whether there is appropriate treatment space on site;

- Appropriate machinery to mix the soil and neutralisation chemicals can be supplied by the civil works/earthworks contractors completing works on site; and
- Following successful completion of the neutralisation process, the treated soils are no longer considered to be ASS materials and so may be removed off-site as waste.

4.3.3 Full Oxidation and Leachate Collection

Although not a preferred option, in the event that the acid production potential is relatively low, or there is a relatively low quantity of material to be treated, consideration may be given to the excavation and exposure of the soils to promote full oxidation. This option requires the implementation of environmental controls to ensure that all acid produced is flushed from the soil as leachate. Similar to management by neutralisation, a suitable treatment area is necessary where material can be spread and reworked to allow oxygen to react with the sulfides in the soil and where all leachate produced can be captured and treated by neutralisation.

This method is considered not to be a viable option for the proposed works as the process of soil oxidation may take extended periods (weeks to months) to reach completion. There is also a significant level of uncertainty in the volumes of leachate that would require neutralisation and disposal due to climatic variation, including rainfall events. Given the currently unknown anticipated volume of material requiring treatment, the limited available space to complete such works, and the requirement to potentially maintain environmental controls for a long period, this option is considered undesirable when compared to the relatively low cost of neutralisation chemicals as discussed in **Section 4.3.2** above.

4.3.4 Reburial of ASS Material

Strategic reburial or interment techniques can be used to manage ASS/PASS material by prevention of oxidation through permanent storage in an anoxic environment. These techniques are often adopted where areas are available for reburial and cost savings can be achieved by avoiding soil handling labour and neutralisation chemical costs. An alternative method of achieving reburial is over excavation of non-acid sulfate soil materials followed by reinstatement of the excavation with potential ASS material. Potential reburial sites must have a permanent groundwater table level above the proposed top of the reburial cell or alternatively measures to minimise oxygen exposure to ensure that the material is returned to an anoxic environment.

Reburial may occur within the site or alternatively, where appropriate licences are obtained, at a site lawfully able to accept this material in accordance with the requirements of EPA (2014).

Excavation of ASS and creation of re-interment voids must be staged to ensure that adequate space is available for all ASS materials to be adequately reburied below a permanent water table and that the ASS will not be buried in conditions that may cause the formation of acidic conditions. A maximum period of time between the commencement of disturbance and completion of interment works of approximately 48 hours should be adopted in all instances. If the material is to remain exposed for longer the 24 hours the pH levels should be monitored every 12 hours to ensure acid conditions are not developing.

On this site, given the proposed development works consist of ground disturbance/excavation works generally above the current water table, strategic reburial of PASS without neutralisation is considered unlikely to be a practicable management option. Where material is considered to be PASS but is otherwise non-contaminated (ie. virgin excavated natural material, VENM), the feasibility of off-site disposal of material to a facility able to lawfully rebury the material will be undertaken prior to the commencement of works.

4.3.5 Separation Techniques

Separation techniques are increasingly being implemented to reduce the quantity of PASS material requiring treatment in areas where works include the disturbance of large quantities of PASS. These activities include the removal of fine ASS particles including pyrite and monosulfides from coarser grained soil particles. This results in two material streams, concentrated 'ASS fines' and non-ASS material which can be removed from the management process. Management of ASS fines would then involve implementation of other ASS management techniques such as reburial, neutralisation, etc.

Separation is typically implemented by creating a soil slurry where fine particles can be suspended in solution away from heavier soil particles using methods such as sluicing or cycloning. Typically, such methods require suitably grained soils such as sand or non-consolidated sediments and a significant water source to implement the separation.

Environmental controls are required during the separation processes to ensure that the PASS fines do not undergo oxidation prior to the implementation of other management measures and validation of the non-ASS stream would then be necessary to confirm that the ASS fines have been adequately removed.

On this site, separation techniques are considered not to be a viable management option as these techniques cannot be used as a standalone management option and as such the ASS fines once separated would still require further treatment.

4.3.6 Selection of Preferred Management Strategies

Evaluation of potential management strategies has identified that the use of neutralisation techniques where disturbance cannot be avoided is considered the most appropriate technique for this site.

Management measures for excavated PASS material will include the application of neutralisation chemicals to site generated materials (excavated material, piling spoil, etc), neutralisation of exposed excavation faces during works and neutralisation of any groundwater seepage and drainage leachate produced during the excavation and treatment works. Following validation to confirm the acid generation potential of the material has been appropriately neutralised, the material will either be set aside for use as engineered fill material within the development site (if required), or alternatively, will require off-site disposal as per the requirements of EPA (2014). In the event that otherwise non-contaminated natural soil PASS is generated as excess to site requirements, consideration may be given to off-site disposal to a facility lawfully able to rebury the material without requirement for the on-site neutralisation step.

4.4 General Site Management Strategy

The site management strategy to be implemented during works which may disturb ASS/PASS materials will ensure the following:

- Adequate treatment of ASS/PASS material such that there is sufficient acid neutralizing capacity and no net acidity following stabilization (as measured through appropriate field testing and laboratory validation);
- Water discharged from the excavation and treatment areas (including run-off, water from dewatering and leachate) is neutral and discharged to stormwater once it has been shown to meet the criteria specified in this plan or alternatively, shall be reused on site for dust suppression, or removed off site as liquid waste;
- Groundwater quality indicators and levels are not significantly changed beyond the construction footprint from the existing levels/quality during excavation activities and are re-established after the completion of construction works; and

- Implementation of additional assessment procedures during earthworks operations for the effective treatment and management of any drained, disturbed or excavated acid sulfate soils.

4.4.1 Pre-disturbance Works

Subsequent to the additional investigation activities identified in **Section 4.2**, and prior to the commencement of ground disturbance/excavation works which may disturb ASS/PASS materials at the site, including activities with the potential to disturb sediments and/or generate spoil, the following preparations should be considered:

- The sequencing of proposed demolition, sediment disturbance, excavation, piling, services installation and other activities should be planned in detail taking into account the time and space necessary to complete the ASS/PASS management activities outlined in this document. The planning should provide a contingency for treatment of additional quantities of materials in the event that the proposed works require additional excavation extents to those currently identified and/or the quantity of ASS/PASS material generated is greater than anticipated during implementation of the site works, or heavy rainfall events result in significant additional quantities of collected impacted water; and
- The actual areas of ASS/PASS occurrence where disturbance/excavation will occur during each stage of works (demolition, excavation, piling, services installation, etc.) as part of the site activities should be identified and suitable location(s) for treatment areas and/or storage of treatment bins close to the areas of disturbance identified (e.g. adjacent the excavation). Based on the proposed works, the available space for treatment and the approximate volume anticipated to be disturbed, staging of the disturbance activities should then be planned such that sufficient drying and mixing time can be achieved for all materials needing treatment. The staging should also allow for adequate time to obtain the results of verification testing before the material is placed at the final location or removed from the site.

4.4.2 Neutralisation Chemicals

An evaluation of potential neutralisation chemicals should be undertaken during the planning process and appropriate quantities of the preferred chemicals sourced for the duration of the site activities. For the purposes of this plan, the neutralising chemical is assumed to be high quality agricultural lime (aglime). The aglime should be fine ground (<1 mm) calcium carbonate ($CaCO_3$) or calcite (limestone or marble powder). In the event that neutralising products other than high quality aglime are selected for use in this project, there are several issues that should be considered:

- Is there any potential environmental risk associated with use of the compounds (i.e. other components that may contaminate water, result in a much higher pH value (i.e. hydrated lime), stain treatment areas, etc); and
- Will the neutralising agent be of comparable effectiveness or will properties including: neutralising value, effective neutralising capacity, solubility, pH, chemical components, moisture content, impurities and particle size; require the quantity of agent addition to be varied by a consistent factor.

It is recommended that small scale treatment trials be implemented prior to broad scale implementation of alternative neutralising compounds. The small scale trials should document the effectiveness of the revised approach in terms of the time, cost, availability, suitability, etc.

4.4.3 Treatment Area Design

As noted above, the treatment area should be situated in an appropriate location(s) with respect to site disturbance activities. In addition, consideration should also be given to the ease with which

environmental controls can be implemented and potential requirement for off-site disposal of the material once stabilised and validated.

Small Quantities

For small scale disturbance activities, it is anticipated that a large lined skip bin or suitable structure could be used as a 'treatment cell' to minimise the potential for release of acidic leachate or partially treated soil.

Significant Excavation Quantities

Should quantities of material disturbed in a staged manner exceed that able to be managed in a large skip bin, a treatment area should be established with consideration of the following:

- The treatment areas should be established separate to the area of disturbance but able to be accessed from the area of disturbance by plant/vehicles transporting the material to be treated and material to be removed from the treatment area at the completion of stabilisation activities;
- The treatment areas should be sufficiently large to facilitate a pre-treatment stockpile area, a treatment pad, water/sediment collection and treatment measures, post treatment stockpile storage area and lime storage area;
- The treatment area should be isolated from major external surface water catchments, including overland surface water flow and potential flood water, excavation flooding by rainfall events, by ground surface contouring, installation of perimeter drains or bunds covered with an impervious layer (concrete, geomembrane, compacted non-ASS clay, etc.);
- A layer of lime stabilised soil should be prepared on the ground surface within the treatment area that will act to neutralise any acidic water that my infiltrate the ground surface during treatment activities. The minimum application should be no less than 5 kg lime/m^2 of treatment area. This application should not be taken into account when material to be treated is placed within the treatment area as the neutralisation capacity of these added chemicals will decrease with time as a result of formation of an insoluble iron coating and it is difficult to ensure that there has been adequate mixing of the neutralising agent within the soil added to the site;
- Pre-treatment and post-treatment stockpile areas should be separately bunded or drained to minimise the potential for re-acidification of treated material;
- The treatment pad should be of a size that would allow treatment of material by a single machine over a reasonable timeframe to minimise the oxidation of material during spreading and treatment. Assuming the material the subject of treatment is spread to a depth of approximately 0.3 m, a single treatment area 10 m by 20 m could treat 60 m^3 of material per treatment cycle. Should capacity to treat more material be required, two or three treatment pads could be established, separated by a suitable width to allow for excavator movement between the bunds of each pad;
- The bund surrounding each treatment pad 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 base of the treatment pad should be surfaced with concrete, asphaltic concrete, or soil mixed with lime as discussed above. This base should be graded where possible at a minimum fall of 1° to facilitate drainage of leachate such that it can be collected and/or pumped to a treatment/holding tank;
- Once well mixed with a suitable quantity of neutralisation agent, the material should be transferred to the post treatment stockpile area. Here the validation testing will be

completed, and the material will remain until receipt of the validation results. The material will then be cleared for beneficial reuse within the site, or alternatively for off-site disposal to landfill;

- Surface water flows will be diverted around the treatment area where possible. Water falling within the various portions of the treatment area will be collected at appropriate locations and transferred either to a holding tank or artificial detention basin. The water quality will be monitored to ensure only water of suitable quality is discharged from the treatment area of the 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 from the site must not have a significant impact on pH, buffering capacity, turbidity, colour or ionic composition of the receiving water body (stormwater, groundwater, sewer, etc) as per the requirements of the POEO Act (1997);
- A sufficient supply of aglime should be kept on site at all times for the treatment of ASS 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; and
- 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 minimise 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.

4.4.4 General Site Management

All soils/sediments from areas/during activities which have been identified in this ASSMP as having the potential for disturbance of PASS/ASS must be treated as ASS material until such time as the material is demonstrated to be non-ASS material or treatment effectively reduces the risk associated with the material and validation results meet the relevant specifications.

ASS/PASS materials that have been excavated (or otherwise brought to the ground surface) should be separated from the non-ASS/PASS material and immediately transferred to the treatment area as soon as practicable to minimise the quantity of soil, sediments and/or groundwater requiring treatment and the risk of environmental harm to the site and/or down-gradient receptors.

Bunding, diversion drains, contaminated water treatment/containment etc may be used to contain surface water run-off from ASS/PASS disturbance zones and subsequent storage and treatment areas. However, ASS/PASS materials must not be used in the construction of bunds and other diversion devices.

Equipment used in the treatment of ASS shall be washed with an alkaline solution at the completion of each work period to minimize corrosion of equipment.

4.4.5 Excavation Works

Excavation works should be undertaken in the following manner:

- Any material identified as non-ASS/PASS (via existing site characterisation works, or as determined through additional investigations as detailed in **Section 4.2**) is to be removed from within the ASS zone footprint and treatment area;
- Sediments or materials identified as ASS, or suspected to comprise physical properties indicative of ASS should be assumed to be ASS unless demonstrated otherwise. All

excavated natural sediment material brought to the ground/water surface should be transferred immediately to the treatment area;

- Works including disturbance of ASS/PASS material/sediments will be subject to field testing upon initial exposure of each natural soil horizon. Field testing will include pH_f and post peroxide pH_{fox}, with both required to meet the validation criteria of pH 5.5 to be considered non-ASS soil. Alternatively, dependent upon the scheduling of the excavation works, laboratory pre-testing of soils from this zone may be undertaken using sPOCAS or S_{Cr} methods. If either the field criteria or laboratory analysis results indicate the material is considered to be ASS/PASS, then the material will require treatment as discussed in the following section;
- At the completion of the day's activities, where excavation works result in the exposure of known or suspected ASS, a guard layer of fine aglime will be applied to the base of the excavation at a rate of 5 kg lime/m^2 of exposed soil. If the base of the excavation is to remain exposed for an extended period (i.e. more than three days) the lime coating should be checked and re-limed as necessary. Alternatively, the lime may be covered with a layer of compacted non-ASS material at least 0.3 m in thickness. It is noted that this will not be required during piling works;
- All cut batters/exposed faces potentially including ASS, (i.e. faces at the edge of excavation faces, etc), shall be coated with fine aglime at a rate of 5 kg/m^2 and the lime coating should be checked and re-limed as necessary on a daily basis during periods of dewatering, whilst the faces are temporarily exposed and/or following wet weather events.

4.4.6 Treatment of Excavated PASS Material

Treatment of ASS/PASS soils will comprise the addition of sufficient quantities of finely ground neutralising agent to treat all oxidisable S% and actual acidity and provide a factor of safety to compensate for potential impurities in the neutralising agent, non-homogenous mixing and limitations to the solubility of the neutralising agent. This will need to be determined on the basis of analysis data collected as per **Section 4.2**.

The excavated ASS/PASS material will be immediately transferred to the treatment area and placed either in a stockpile within the pre-treatment stockpile area or immediately on the treatment pad. Treatment of excavated material should occur within one day of excavation of the material.

If stockpiled, the material should be formed into a conical stockpile to minimise the exposure of the material to air. In the event of significant wet weather periods, the stockpiles should be covered with builder's plastic or similar to limit the infiltration of rainfall into the stockpiles.

The excavated ASS/PASS material should be treated as soon as practicable and within one day of excavation.

If site conditions require the stockpiling of material for longer than 24 hours, the stockpiles should be treated with a guard layer of aglime of 5 kg lime/ m^2 per vertical metre of soil in the stockpile. This would result in a two metre high stockpile requiring an application of 10 kg lime/m^2 surface area. The stockpile should then be covered with an impervious surface (i.e. builder's plastic) that covers the top and sides of the stockpile to minimise drying by wind and sun and to prevent rainfall entering the stockpile.

Irrespective of whether the material is placed within a skip bin or a treatment pad, mixing of the lime and soil mixture may be undertaken by harrowing, rotary hoeing, using an excavator shaker bucket to blend the material, the use of a pug mill or similar equipment. Care shall be taken to ensure that mixing occurs throughout the depth of the layer/throughout the binned material. The

soil must be managed to achieve a consistency that will allow for thorough mixing of the soil and neutralising agent to ensure that the effective neutralisation occurs.

This may require mechanical turning of material and breaking up of soil to provide for adequate mixing of soil particles and lime. In some instances, drying of the disturbed material (with associated management of any acidic leachate and other resulting contaminants) may be required for the material to be workable. Drying should not be undertaken during foreseeable wet weather events due to the increased risk of runoff flushing acid from the material and into uncontrolled areas.

Following mixing, aglime shall be spread at a rate of approximately 5 kg lime/m^2 around the toe of the treated soil, around a 1 m perimeter between the toe of the material and across the exposed face of the bund to neutralise any leachate released from the soil. Once the soil has sufficiently dried that no more leachate is being released, the material should be turned to ensure that all leachate is released from the treatment area.

On completion of mixing the soil and lime, field testing can be undertaken approximately 48 hours following. If neutralisation has occurred and been confirmed, soil samples can be collected for confirmation from the laboratory that the ASS/PASS material has been sufficiently neutralised. Soil can then be placed back within the excavation or disposed of offsite as waste.

4.4.7 Direct Off-site Disposal of 'VENM' Material of PASS

Where PASS material is identified as otherwise non-contaminated and pH_f concentrations exceed approximately 6.5, there is the potential that such materials may be directly disposed of from the site without on-site treatment. At the time of preparation of this ASSMP, facilities inclusive of Dunmore Quarry may accept unimpacted natural material characterised as PASS, subject to receipt of the material for reburial in accordance with the terms of its licence and EPA (2014) *Waste Classification Guidelines, Part 4: Acid Sulfate Soils*. It is noted that such facilities cannot accept fill material, or material comprising mixed fill and natural PASS and as such, this option may be limited to in ground excavations where sufficient volumes of such material require off-site disposal to make this option feasible.

4.4.8 Water Management During Treatment

Surface drainage and groundwater that comes into contact with ASS/PASS materials has the potential to become acidic and contaminated with heavy metals leached from the acidified soil. Sources of water may include ground surface drainage associated with rainfall, dewatering product produced during the excavation works, leachate produced during treatment of excavated soils, and groundwater inflow into open excavations.

In general, soil and water at the site is required to be managed under an earthworks Soil and Water Management Plan to be prepared for the site prior to the commencement of site works. However, in addition to these requirements, water from within the treatment area will be required to be collected, assessed and if necessary, treated prior to discharge from the site. Once pH, suspended sediment and contaminant concentrations are considered suitable for discharge from the site, the water may be used for dust suppression at the site and/or released from the site.

Additional water holding tanks may be necessary in the vicinity of the treatment works zones to store collected water prior to treatment. The water holding capacity directly related to the acid sulfate soil excavation and treatment areas should be maintained at a minimum quantity associated with a 1 in 10 year rainfall event to ensure that sufficient capacity is available to store all potentially acidic water that may be generated during site works.

Water will be neutralised, where required by the addition of lime (or equivalent alkaline product) within a dedicated treatment tank or lined detention basin. Lime shall be added incrementally and thoroughly mixed within the treatment vessel. Approximate lime application rates based on initial pH are provided in **Table 4.1** below.

Table 4.1 Treatment of Acidic Dewater

Water pH	Agricultural Lime / 1000L Water
0.5	11.7kg
1.0	3.7kg
1.5	1.2kg
2.0	0.37kg
2.5	0.12kg
3.0	37g
3.5	12g
4.0	4g
4.5	1.2g
5.0	0.37g
5.5	0.12g

Lime addition and mixing shall continue until the pH of the water is within the range of 6.5 – 8.5.

In the event water volumes greater than the capacity of the water treatment holding capacity are produced during the ASS management activities, consideration should be given to off-site disposal of water via a licensed contractor or treatment of water using neutralisation chemical dosing within holding tanks prior to re-irrigation of open excavations once the pH of the water has been demonstrated to be suitable.

4.4.9 Validation of Treated PASS Material

Following the application and mixing of lime to the ASS/PASS, the material should be allowed to stand for a minimum of 48 hours prior to validation assessment. The soil would be assessed to establish post neutralisation conditions and establish whether the following performance criteria have been achieved:

- Post neutralisation, the soil pH is greater than pH 5.5 (and preferably less than 9);
- The neutralising capacity of the treated soil must exceed the sum of the TAA and TPA of the soil, i.e. there is no net acidity in the soil as measured by sPOCAS / S_{Cr} < 0.03%S; and
- Excess neutralising potential should remain in the soil as all acid generation reactions may not be complete and so the soil may still have further capacity to generate acidity.

Validation testing using field tests to measure the soil/water pH shall be undertaken at a rate of ten samples per treatment batch (to a maximum quantity of 100 m^3, or a rate of 1 sample per 20 m^3). Field testing will include pH_f and post treatment peroxide pH_{fox}, with both required to meet the post neutralisation criteria noted above for all samples per treatment batch.

In the presence of positive field validation tests, laboratory analysis of validation samples may be employed to determine the level of net acidity and confirm that the treatment has been successful, or provide an indication of the quantity of further aglime application necessary to neutralise the soil.

Confirmatory laboratory analysis (pH and sPOCAS / S_{Cr}) will be undertaken at a rate of one sample per treatment batch (to a maximum quantity of 100 m^3, or a rate of 1 sample per 100 m^3 for larger quantities). The samples obtained for laboratory analysis may be obtained by compositing three subsamples obtained from the treatment material to provide a broader indication of net acidity levels. All samples will be obtained from no less than 0.1 m below the stockpile surface at the time of sampling to ensure representative samples are obtained for field testing/laboratory analysis.

If negative field tests occur but the confirmatory laboratory analysis results indicate that there is still net acidity, a further application of aglime will be mixed with material to ensure additional neutralisation capacity, prior to further confirmatory analysis.

Following receipt and logging of the successful laboratory validation results, the material may then be released for beneficial reuse of material at the site, or alternatively, for off-site disposal. In the

event that the laboratory results indicate that the stockpile requires further treatment, the material should be treated as required prior to re-sampling.

4.4.10 Site Condition Monitoring

It is anticipated that monitoring of conditions will be undertaken by both the site contractors and an appropriately qualified consultant to ensure that the appropriate environmental controls are in place and the treatment strategy is minimising the environmental risk associated with the ASS materials.

The following inspection/monitoring regime will be implemented during the site works period and documented as appropriate to demonstrate compliance with this ASSMP:

- Stockpiles of material will be inspected daily by the site contractors with pH measurements of any retained leachate taken and recorded where required. In the event that leachate is significantly acidic (pH < 5.0), the stockpiled material will be returned to the pre-treatment area until the laboratory results are available and the quantity of required additional lime application is known;
- In the event that an on-site sump/detention basin is used to manage water ingress, surface water monitoring points will be sampled and field tested and the pH recorded every day by site contractors during active site activities and weekly during periods where no active ground works are being undertaken within the ASS area; and
- All treated excavation faces to be retained for more than three days will be inspected on the third morning and lime reapplied as necessary each following morning.

Regular inspection of all excavation and treatment areas will be undertaken to identify potential indications of ASS oxidation. These inspections should note:

- Unexplained scalding, corrosion or degradation of onsite steel equipment and concrete paved surfaces;
- Formation of the mineral jarosite or other acidic salts in exposed or excavated soils;
- Areas of surface water blue-green, blue-white in colour or extremely clarified indicating high concentrations of aluminium;
- Rust coloured deposits on excavation faces, in drainage paths, on bunds, channels, etc indicating iron precipitates; and
- Such inspections should also identify the presence of unusual odours, including strong organic or sulfurous smells (i.e. rotten egg gas).

4.4.11 Removal of Neutralised ASS Material from the site

Only material confirmed to be below the criteria listed in **Section 4.4.8** will be considered as stabilised ASS material for potential reuse within or removal from site. Once stabilised, the material will be provided a final waste classification as per the requirements of EPA (2014) for off-site disposal to a lawful facility. A final round of field pH testing should be undertaken prior to loading of the trucks to ensure that pH levels remain above 6. Should material continue to have a high moisture content, consideration may be given to off-site removal as liquid waste as per EPA (2014).

5. Responsibilities

The selection of samples for environmental analysis as per **Section 4.2** shall be undertaken by a suitably qualified and experienced environmental or geotechnical consultant. Results of analysis shall be assessed and evaluated by a suitably qualified and experienced consultant.

Implementation of the physical treatment, material management and environmental controls portions of this ASSMP will be the responsibility of the site contractor engaged to complete remediation and/or construction works within the site. The monitoring of conditions, unless otherwise specified in the monitoring sections will be the responsibility of a suitable qualified environmental consultant who will regularly inspect the site, the treatment area and treatment activities and implement the validation assessments to document compliance with this ASSMP.

The contractor should appoint a foreman or other responsible employee to undertake the appropriate monitoring activities as designated in this ASSMP. This person should be appropriately trained by the environmental consultant in all actions to be completed by the contractor. Where doubt arises concerning the results of the inspections or of field test validity, the environmental consultant should be contacted for verification of appropriate actions.

The contractor is not authorised to make any changes to this ASSMP or implement unapproved variations to the treatment and/or monitoring protocols outlined in this document unless explicit written approval is obtained from the environmental consultant prior to implementation of the changes.

Where ambiguity or conflicts in procedures arise, it is the contractor's responsibility to seek clarification on appropriate actions from the environmental consultant.

ASS mitigation measures should be documented as they apply to all individual works activities to be undertaken at the site. All persons responsible for the works activities should be made aware of their responsibilities in writing and suitable ASS management training should be provided to those persons to ensure that the responsibilities can be achieved.

Where contingency actions are necessary, or in the event that non-compliance with the ASSMP is identified by the contractor, the environmental consultant should be immediately informed in writing. The environmental consultant will then be obliged to provide a timely response documenting the necessary corrective actions.

6. Contingencies

In the event of unexpected events, including the identification of additional PASS zones at the site, or the failure of management measures as described in this ASSMP, the associated environmental risk will be managed by the evaluation and implementation of the contingency procedures and mitigation strategies.

6.1.1 Additional Acid Sulfate Soil Identification

In the event that site excavation works encounter the potential for additional acid sulfate soil areas at the site, identified by visual cues, field testing or laboratory analysis, the additional areas will be treated as per the PASS material treatment protocols. If the material is to be excavated as part of the development works, the excavation will be undertaken in stages with suitable volumes to allow for the completion of the neutralisation treatment process prior to excavation of the next stage.

If the proposed works do not require excavation of the identified material, exposed surfaces will be treated with a guard layer of lime upon exposure. Groundwater seepage will be monitored and neutralising agents added as necessary to manage the potentially acidic leachate produced.

6.1.2 Failure of Initial Acid Neutralisation Treatment

As described in **Section 4.4.8,** following the treatment of materials within the treatment area, validation sampling will be completed to assess the success of the neutralisation process prior to removal of the material from the holding area. In the event that the validation testing indicates that neutralisation of the material is incomplete (i.e. pH<6), a further application of lime and repeat of the treatment procedure will be undertaken prior to further validation assessment. If the proposed techniques fail, further consideration may be given to alternative management strategies as outlined in **Section 4.3**.

6.1.3 Significant Acidification of Surface Water

Monitoring of contained water conditions within the site will be undertaken prior to the commencement of site disturbance activities and during the period of disturbance as ASS/PASS conditions identified as outlined in **Section 4.4.9**. Should the works identify the acidification of contained water within the site not directly related to the treatment area, all works associated with the potential disturbance of ASS at the site shall cease until the unexpected source of the acidification is identified and remedied. It is noted that given the relative neutralising capacity of sea water and also comparative water volumes, direct monitoring of pH conditions within the bay is not considered necessary.

Upon identification of unexpected acidified detained water conditions, all active soil exposure areas will require to be limed with a guard layer of at least 5 kg lime/m^2 exposed soil and all treatment areas will be checked to ensure that leachate and water migration is not occurring onto exposed soils or into surface water drainage channels at the site. If these activities identify a source of the increased acidity, remedial actions will be implemented to prevent the further occurrence of acidification at the site.

If these activities do not identify the source of the added acidity, or alternatively, if conditions are not corrected by the addition of lime, consideration may be required to the construction of a subsurface limestone treatment trench along the site boundary to neutralise groundwater prior to movement off-site. The design of such a barrier will be highly dependent upon the stage of the disturbance works at the site and extent of the acidic plume identified in this section of the site. Disturbance works within the ASS area should not recommence until the barrier has been installed to limit the generation of additional acidic groundwater.

7. Conclusions

Site characterisation assessment data available for subsurface conditions across the broader site area comprising the land based portion and the harbour area has identified the occurrence of ASS/PASS material at depth, primarily below the water table at depths ranging approximately between 5.0 and 6.0 m bgs in fill material and natural soil.

Where existing and future assessment data identifies the presence of ASS/PASS materials that may be disturbed, the measures identified in this ASSMP provide appropriate procedures to manage the risks associated with the proposed activities. If successfully implemented, these measures will minimise the environmental risks associated with disturbance of the PASS materials.

8. Limitations

This report has been prepared for use by the client 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.

JBS&G accepts no liability for use or interpretation by any person or body other than the client who commissioned the works. This report should not be reproduced without prior approval by the client or amended in any way without prior approval by JBS&G, and should not be relied upon by other parties, who should make their own enquires.

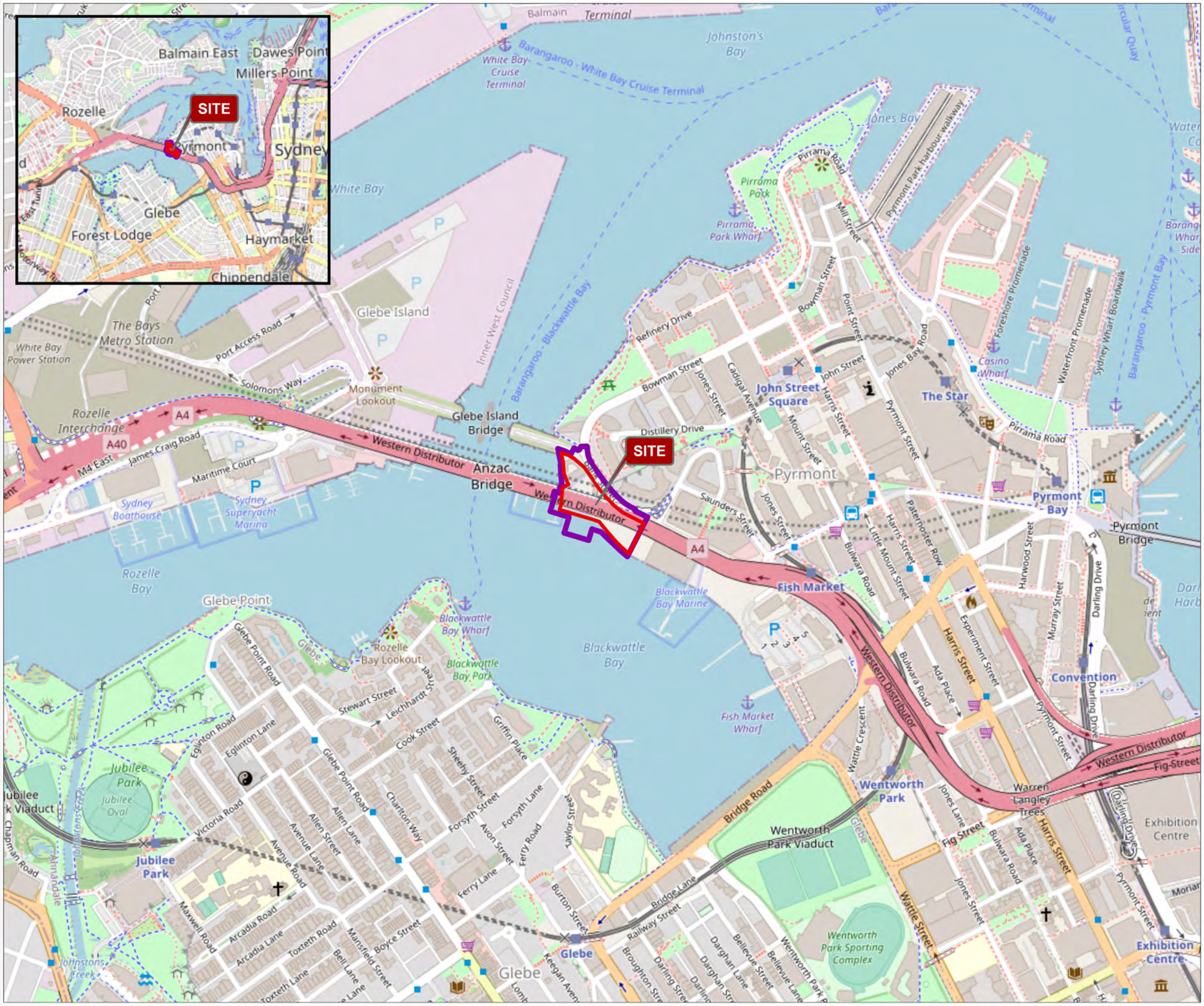
Sampling and chemical analysis of environmental media is based on appropriate guidance documents made and approved by the relevant regulatory authorities. Conclusions arising from the review and assessment of environmental data are based on the sampling and analysis considered appropriate based on the regulatory requirements.

Limited sampling and laboratory analyses were undertaken as part of the investigations undertaken, as described herein. Ground conditions between sampling locations and media may vary, and this should be considered when extrapolating between sampling points. Chemical analytes are based on the information detailed in the site history. Further chemicals or categories of chemicals may exist at the site, which were not identified in the site history, and which may not be expected at the site.

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.

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&G reserves the right to review the report in the context of the additional information.

Figures



Legend:
- Site Area
- Broader Site Area

JBS&G

Job No: 64669

Client: Infrastructure NSW

Version: R05 Rev 1	Date 26/10/2023
Drawn By: LJ	Checked By: MN

Scale 1:10,000

0 100 200
metres

Coord. Sys. GDA 1994 MGA Zone 56

1-19 Bank Street
Pyrmont, NSW

SITE LOCATION

FIGURE 1

File Name: 64669_BanksStPark_R05_Rev1

Legend:

- Site Area
- Broader Site Area
- NSW Cadastre
- Building Footprint

JBS&G

Job No: 64669

Client: Infrastructure NSW

Version: R05 Rev 1	Date 26/10/2023
Drawn By: LJ	Checked By: MN

Scale 1:1,200

0 10 20

metres

Coord. Sys. GDA 1994 MGA Zone 56

1-19 Bank Street
Pyrmont, NSW

SITE LAYOUT

FIGURE 2

File Name: 64669_BanksStPark_R05_Rev1
Reference: Nearmap www.nearmap.com 20230316

2.4 Concept Plan

Legend

1	Glebe Island Bridge - potential pedestrian and cycle connection	7	Loading zone on Bank Street	13	Seating shelters amongst planting	19	Nature-based inclusive playspace for ages 2-12	25	Potential future kayak storage / kiosk	31	Sandstone blocks terracing into water to improve marine habitat
2	Existing vegetation retained and supplemented	8	Seating and planting in existing building 'ruins'	14	Outdoor seating area to cafe	20	Fitness equipment	26	Anzac Bridge pylon	32	Split level promenade with trees and seating
3	Stair access to Glebe Island Bridge	9	New building with community facilities cafe kiosk and marina facilities	15	Bank Street with parallel parking and separated cycleway	21	Multi-purpose court	27	Deck over dragon boat storage	33	Existing mature trees retained with embankment down to adjacent property
4	Widened verge	10	PV and planting on roof	16	Open lawn area	22	Edge seating and fence to court	28	Boardwalk	34	Future boardwalk and promenade connection (outside of scope)
5	Amenities and storage in adaptively re-used building	11	Graded walkway access to plaza	17	Primary pathway across park	23	Substation and bridge pylons	29	Kayak launch jetty	35	Pedestrian link as part of future development (outside of scope)
6	Plaza	12	Substation retained	18	Cycleway transition to street - to continue south as part of future works	24	Marina	30	Dragon boat ramp		

JBS&G

Job No: 64669

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Version: R05 Rev 1	Date 26/10/2023
Drawn By: LJ	Checked By: MN

Scale

0 10 20
metres

Coord. Sys.

1-19 Bank Street
Pyrmont, NSW

CONCEPT PLAN

FIGURE 3

File Name: 64669_BanksStPark_R05_Rev1
Reference: Client Provided | Bank Street Park Design Report (OCULUS, 2023)

Legend:

- Site Area
- Broader Site Area
- NSW Cadastre
- Soil Sample Location
- Groundwater Sample Location

JBS&G

Job No: 64669

Client: Infrastructure NSW

Version: R05 Rev 1	Date 26/10/2023
Drawn By: LJ	Checked By: MN

Scale 1:1,200

0 10 20

metres

Coord. Sys. GDA 1994 MGA Zone 56

1-19 Bank Street
Pyrmont, NSW

SAMPLING LOCATIONS

FIGURE 4

File Name: 64669_BanksStPark_R05_Rev1
Reference: Nearmap www.nearmap.com 20230316

Document Distribution

Rev No.	Copies	Recipient	Date
0	1 x electronic	Belinda Lewis via email: belinda.lewis@infrastructure.nsw.gov.au	30 August 2023
0	1 x electronic	Belinda Lewis via email: belinda.lewis@infrastructure.nsw.gov.au	20 October 2023
1	1 x electronic	Belinda Lewis via email: belinda.lewis@infrastructure.nsw.gov.au	26 October 2023

Document Status

Rev No.	Author	Reviewer	Approved for Issue		
		Name	Name	Signature	Date
0	Milad Noujaim	Joanne Rosner	Joanne Rosner	Draft for Client Review	30 August 2023
0	Milad Noujaim	Joanne Rosner	Joanne Rosner		20 October 2023
1	Milad Noujaim	Joanne Rosner	Joanne Rosner		26 October 2023

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