eiaustralia

Contamination | Remediation | Geotechnical

LEAMAC & CORONATION

Moore Point Precinct Review Study - Part 2: Preliminary Acid Sulfate Soil Management Plan

Newbridge & Bridges Roads, Liverpool, NSW

E22882.E14_Rev1
9 April 2020

Document Control

Report Title:	Moore Point Precinct Review Study - Part 2: Preliminary Acid Sulfate Soil Management Plan
Report No:	E22882.E14_Rev1

Copies	Recipient
1 Soft Copy (PDF – Secured, issued by email)	Mr Max Clinton LEAMAC & CORONATION Suite 3703, Level 37 1 Macquarie Place SYDNEY NSW 2000
2 Original (Saved to Digital Archives) (Z:\07 - Projects\E22882_Leamac Properties_Moorebank_GA_PSI\05_Deliverables\Work in Progress\E22882.E14 ASSMP\E22882.E14_RevA Precinct ASSMP DH.docx)	EI Australia Suite 6.01 55 Miller Street PYRMONT NSW 2009

Author	Technical Reviewer
	 **per**
WARWICK HAYES **Environmental Scientist**	**DARREN HANVEY** **Principal Geo-Environmental Engineer**

Revision	Details	Date	Amended By
A	Draft	30 August 2019	
0	Final Report	6 April 2020	N. Kontos
1	Addition of Executive Summary	9 April 2020	N. Kontos

Table of Contents

Schedule of Tables

Appendices

Executive Summary

This report has been prepared by EI Australia Pty Ltd (EI) on behalf of Leamac and Coronation to develop a preliminary, precinct Acid-Sulfate Soil Management Plan in relation to a Planning Proposal at Moore Point, Liverpool (the site).

The site is located east of Liverpool CBD on the opposite side of the Georges River and north of Newbridge Road. It provides a site area of 38.5 hectares (approx.) and is currently developed with industrial uses. There is nothing contained within this report to preclude rezoning.

The site is situated within Liverpool Collaboration Area's Georges River North precinct and is subject to the priorities and actions of the Liverpool Place Strategy (Strategy), which was released by the Greater Sydney Commission (GSC) in December 2018. Refer to the figure below:

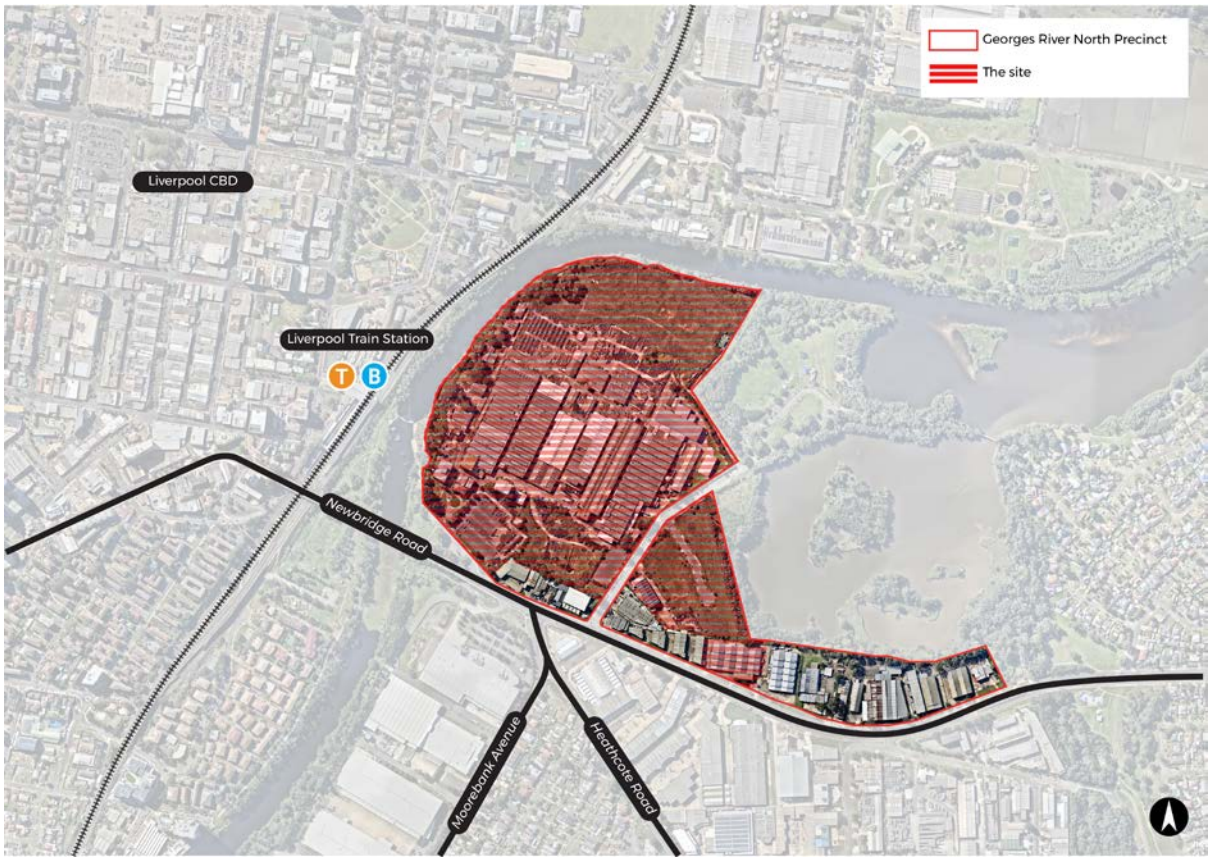


***Figure ES-1** – Site aerial (Source: Nearmap modified by Mecone)*

The Strategy states that by 2036 Liverpool will be a rejuvenated river city, offering diverse and growing residential and employment opportunities. Major health, education and retail precincts, and a mixture of open spaces and parklands alongside the Georges River, will create a rich mix of jobs and workplaces, public spaces, shops and entertainment.

Under the Strategy the site is identified as 'mixed use', which comprises:

> *'a mixture of commercial, retail, residential and community uses that provide sustainable employment, that is complementary to, and not in competition with, the commercial core'*

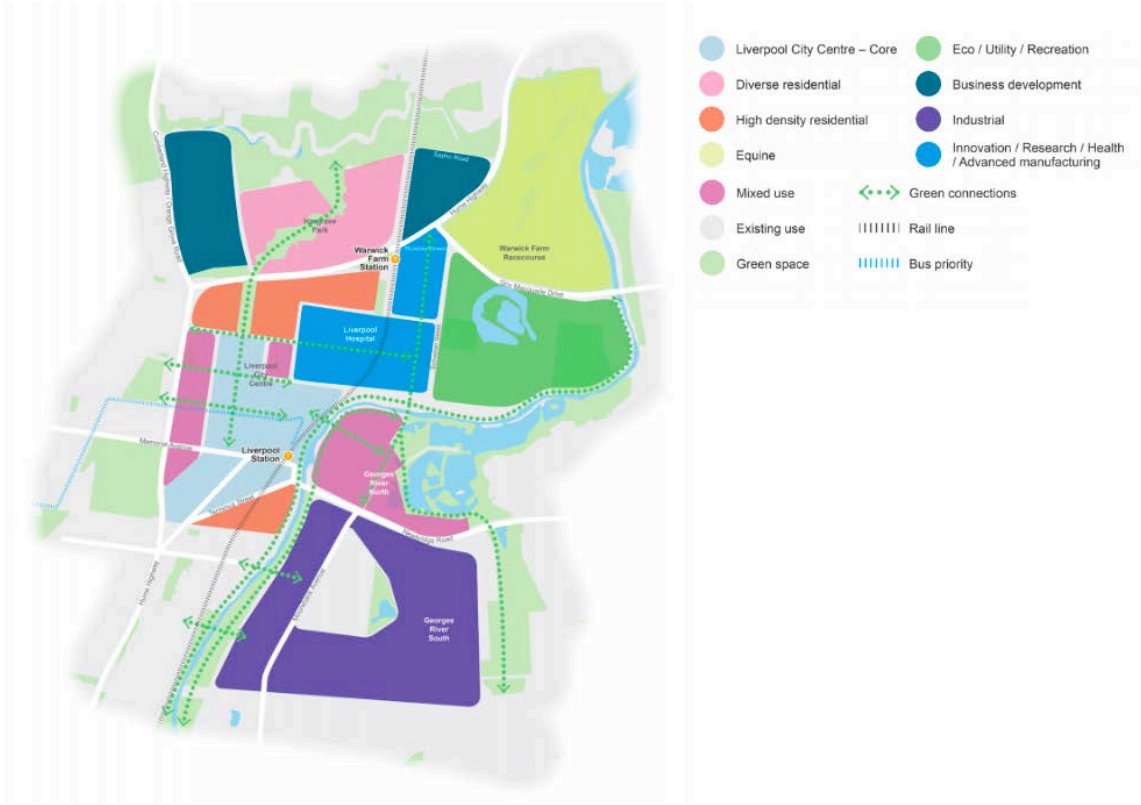


***Figure ES-2** – A Place Strategy for Liverpool (Source: Liverpool Collaboration Area Place Strategy 2018)*

The 2019 Annual report summary for Liverpool Collaboration Area highlighted key steps commenced and completed to address the imperatives acknowledged in the Strategy to accelerate the delivery of the Collaboration Area. These included:

- Engagement with TfNSW to prepare the Liverpool Place-based Integrated Transport Strategy and accelerated investment; and
- Flood studies and flooplain risk management plan completed by Liverpool City Council.

The land uses reflected in the Strategy are reinforced in Liverpool City Council's Local Strategic Planning Statement (LSPS), which identifies the site for investigation as residential/mixed use to support the CBD and Innovation Precinct in tandem with linking open space and green corridors.

The LSPS provides the following short to medium term action (12-24 months) specific to the Georges River North precinct:

> *Action 11.2 – Investigate amendments to LEP to rezone River precinct north of Newbridge Road (Moore Point) as a mixed-use zone to support the Liverpool CBD and Innovation Precinct, with an extensive open space system and cross-river linkages (short to medium term)*

The Planning Proposal involves the creation of a mixed use precinct, providing new homes, jobs and open space adjoining the Georges River and connecting to Liverpool CBD. Key features of the proposal include:

Adaptive re-use of existing heritage;

Foreshore embellishments and new open spaces;

Educational and cultural facilities;

Connections to Liverpool CBD and Train Station; and

Transport, intersection and collector road improvements.

The Planning Proposal aligns with the priorities of Government and the implementation phase of the Place Strategy by facilitating the transformation of the Collaboration Area with new jobs, infrastructure, green spaces and housing. The Planning Proposal responds to The Pulse of Greater Sydney's performance indicators, which sit under the following key themes:

Infrastructure and Collaboration

The Planning Proposal will facilitate additional jobs, education and housing in close proximity to Liverpool CBD and Train Station. The proposal will support additional medium and long-term housing supply in Liverpool CBD through diverse and new housing products. The proposal supports the continual expansion and growth of Liverpool Innovation precinct and nearby health infrastructure, with potential to provide complementary uses near Liverpool Hospital and educational and cultural facilities on the site.

Productivity

The Planning Proposal supports the growth of the thirty-minute city, ensuring Liverpool emerges as a premier CBD in the Western City. The proposal provides capacity for new transport infrastructure on the site, road and intersection upgrades and locating density near major transport infrastructure (Liverpool Train Station and Badgery's Creek Aerotropolis). The proposal encourages additional business activity and investment in Liverpool by providing new commercial uses that will complement Liverpool CBD.

Liveability

The Planning Proposal significantly improves upon the existing use of the site by creating walkable places for people to live work and play. This includes foreshore embellishments to the Georges River, improved connections across the Georges River and adaptive re-use of existing heritage items. These measures will contribute to Sydney's Green Grid, improve access to services in Liverpool CBD and establish a community that celebrates identity and place.

Sustainability

The Planning Proposal addresses the urban heat island effect by significantly increasing the quantum of green space on the site for active and passive recreational use. The proposal will provide new parks and green connections to surrounding open spaces including Haigh Park, which will contribute to the urban tree canopy of the area.

Overall, the Planning Proposal represents a clear and consistent strategic line of site with the priorities of government. It meets the performance indicators, priorities and objectives expressed in the District Plan, Place Strategy, LSPS and The Pulse of Greater Sydney.

Nothing contained in the body of this report/assessment would preclude the Planning Proposal from rezoning and gazettal for residential/mixed use purposes.

Acid-Sulfate Soil Management Plan

The purpose of this study is to provide guidance for the management of acid-sulfate soils (ASS) and potential ASS (PASS) that may be encountered during site preparation and construction works undertaken as part of the envisaged Precinct Land Use and Infrastructure Strategy.

In this preliminary precinct ASSMP the risk of encountering ASS or PASS is considered, various management options are detailed and general procedures for the management of excavated and in situ ASS are provided. Guidance for the management of groundwater and stormwater to prevent adverse impacts associated with ASS is also provided, in addition to a contingency plan for mitigating risks associated with unforeseen issues that may arise during plan implementation and ground disturbance works.

1. INTRODUCTION

1.1 Overview

Leamac and Coronation Group ("the Client") engaged EI Australia (EI) to prepare a Preliminary Acid Sulfate Soil Management Plan (preliminary ASSMP) for the Moore Point Precinct, Liverpool NSW ("the Precinct").

The Precinct, formerly known as the Liverpool Waterfront, is situated about 26km south west of the Sydney central business district, within the Local Government Area of Liverpool City Council. With a total approximate area of 38.5 hectares (Ha), it is located within a portion of the Liverpool Collaboration Area, identified as Georges River North (Area 10). It is bound by Georges River to the north and west, Newbridge Road to the south and the recreational area comprising Haigh Park, Lake Moore and associated islands to the east (**Figures 1 and 2**, **Appendix A**).

Part 1 of the Moore Point Precinct Review Study (reported separately) involved a review of available land contamination data and soil conditions, presenting potential remedial options with indicative costs, to make the land suitable for a range of land uses. Part 2 (this document) presents a preliminary acid sulfate soil management plan for the Precinct, reported under a separate cover.

At the time of completing this plan, the Precinct was occupied by multiple buildings (mostly commercial / industrial), hardstand areas and vegetation. Based on information provided in the Greater Sydney Commission's 2018 Collaboration Area, *Liverpool Place Strategy*, the Precinct will undergo redevelopment for a range of mixed uses, including high density residential, recreational, commercial and industrial, with roads and public and communal open spaces. Bulk excavations for the provision of basement (car parking) facilities will be performed to depths up to 5.5-6m below ground level (BGL).

EI understands that this preliminary ASSMP is required by the Client as part of a *Precinct Land Use and Infrastructure Strategy* for the New South Wales Department of Planning & Environment ("the Department"). As actual investigation for the presence of acid sulfate soils (ASSs) within the Precinct had not been undertaken at the time of preparing this document, this plan must be considered as preliminary and any construction activities within ASSs would require specific direction. Intrusive investigation is needed to establish the extent of any ASS within the Precinct and any such investigation should result in a more specific ASSMP suited to the corresponding outcomes. Further investigations may be performed at the development application stage.

1.2 Project Purpose and Objectives

The purpose of this study is to provide guidance for the management of acid-sulfate soils (ASS) and potential ASS (PASS) that may be encountered during site preparation and construction works undertaken as part of the envisaged Precinct Land Use and Infrastructure Strategy. The objectives of this preliminary ASSMP are therefore to:

- consider the risk of encountering acid sulfate soils during the proposed development of the Precinct; and
- provide general procedures for the management of excavated and *in situ* acid sulfate soils.

1.3 Scope of Works

In order to achieve the above objectives and with reference to the ASSMAC (1998) *Acid Sulfate Soil Manual*, the scope of works includes:

- A description of the Precinct, focusing on its soil attributes, utilising information from ASS risk maps, the Liverpool Local Environment Plan 2008 and previous environmental reports for the Precinct;
- A description of the potential impacts caused by the proposed activities;
- Description of the management options and procedures to be undertaken in an ASS area, which when implemented will prevent, or minimise, the release of acid leachates;
- Presentation of a focussed monitoring program, covering soil, surface water and groundwater;
- Procedures for reporting and consultation with co-ordinating authorities; and
- A description of the contingency measures to be implemented in the case of failure of management procedures.

2. SITE DESCRIPTION

2.1 Identification, Location and Physical Setting

The Precinct identification details and associated information are presented in **Table 2-1**, as well as **Figures A.1** and **A.2** (**Appendix A**).

Table 2-1 Site Identification, Location and Zoning

Attribute	Description
Location	About 26 km south west of Sydney CBD. The Precinct forms the Georges River North Place, in east central part (Area 10) of the Liverpool Collaboration Area, as shown in **Figure A.1** (**Appendix A**). Precinct bound by Georges River to the north and west, Newbridge Road to the south, and the recreational area comprising Haigh Park, Lake Moore and the Bulba-Bideen Islands to the east (**Figure A.2**, **Appendix A**). North-eastern corner of Precinct (as per GDA94-MGA56): Easting: 309185.085; Northing: 6244487.434 (Source: http://maps.six.nsw.gov.au)
Precinct Area	Approximately 38.5 Ha
Lots and Deposited Plans (DPs)	Precinct comprised of numerous cadastral parcels. Refer to **Figure A.2** (**Appendix A**) for their identification.
State Survey Marks	Four State Survey (SS) marks are situated in close proximity to the Precinct: SS141031 (north east of the Precinct) located in vacant / cleared land, SS167461 (east) on Bridges Road and SS176047 and SS31250D (south) located on the corner of Bridges Road and Newbridge Road. (Source: http://maps.six.nsw.gov.au)
Local Government Authority	Liverpool City Council
Parish	St Luke
County	Cumberland
Current Zoning	*IN2 - Light Industrial* (Liverpool Local Environment Plan 2008)
General Description	Flat, low-lying, river flood plain. Occupied by multiple buildings (mostly commercial / industrial), hardstand areas and vegetation.

2.2 Regional Setting

A summary of the local topography, regional geology, hydrogeology and soil landscape information are presented in **Table 2-2**.

Table 2-2 Summary of Topography, Geology, Hydrogeology and Soil Landscape

Attribute	Description
Ground Topography	Generally flat and level, the middle to northern parts being man-made (disturbed / filled) terrain. Elevations range from 7.0m Australian Height Datum (AHD) at the north western boundary, to 9.0m AHD at the eastern boundary.

Drainage	Drainage is likely to be consistent with the general slope of the Precinct. Stormwater expected to be collected by pit and pipe drainage, and discharge either directly into the Georges River, or into the municipal stormwater system.
Regional Geology	According to the GSNSW (1983) *Penrith 1:100 000 Geological Sheet 9130*, the Precinct is underlain by fluvial and estuarine sediments (*Qha*), which consist of quartz sand, silty sand, silt and clay, overlying the Liverpool sub-group of Wianamatta Shales comprising Bringelly Shale, Minchinbury Sandstone and Ashfield Shale (broadly described as shale with some sandstone beds).
Soil Landscape	The natural soils are dominated by Quaternary-aged sedimentary deposits associated with the Georges River, further described as fluvial, medium-grained quartzose sand, clay and silt (Chapman and Murphy, 1989).
Depth to Groundwater	Based on previous investigations of the Precinct, groundwater can be expected from 5.2-7m BGL (3.3-1.4m AHD). Groundwater is inferred to flow in a north / north westerly direction, towards the Georges River.

3. DESKTOP REVIEW

3.1 Acid Sulfate Soil

Acid sulfate soils (ASSs) are naturally occurring sediments containing iron monosulfides and/or iron disulfide minerals. As ASSs are naturally occurring, their presence is not related to site boundaries or anthropogenic contamination, but rather regions previously suitable for their deposition. Characteristics of ASS typically include:

- Sediments of Holocene geological age (up to 10,000 years old).
- Formation in soil horizons at an elevation of less than 5m AHD.
- Formation in marine or estuarine sediments and tidal lakes.
- Formation in coastal wetlands or back swamp areas, waterlogged or scalded areas, interdune swales or coastal sand dunes.
- Formation where the dominant vegetation is mangroves, reeds, rushes and other swamp tolerant and marine vegetation.
- Potential presence in areas identified as bearing sulfide minerals, coal deposits or former marine shales/sediments.
- Potential presence in deeper older estuarine sediments greater than 10m below the ground surface of Holocene or Pleistocene age.
- Visual and olfactory indicators may include sulfidic odours, bright yellow, yellow or straw-coloured mottling and pore space or coatings that could indicate the presence of jarosite, goethite or other similar acid producing sulfate minerals.
- May be indicated by the presence of shells, organic matter and dark reddish streaks that would indicate the presence of iron oxides.
- May be indicated by the presence of dark grey or black monosulfidic sediments or material showing the characteristics of fluvial bottom sediments or sediments deposited in a lacustrine environment.

When ASSs are exposed to air (e.g. due to bulk excavation or dewatering), the oxygen reacts with the iron sulfides in the sediment, producing sulfuric acid. This exposure to air, oxidation, produces hydrogen ions in excess of the sediment's capacity to neutralise the acidity resulting in soils with pH of 5.5 or less. These soils can usually be identified by the presence of pale yellow mottles and coatings of jarosite.

The acid can sometimes be produced in large quantities and drain into waterways causing severe short and long term socio-economic and environmental impacts, including damage to manmade structures and natural ecosystems.

ASSs can either be classified as actual acid sulfate soil (AASS), which is soil that has already reacted with oxygen to produce acid, or potential acid sulfate soil (PASS), which is soil that contains iron sulfide, but has not been exposed to oxygen (e.g. soil below the water table) and therefore has not produced sulfuric acid (although it has the potential to do so). AASS and PASS are often found in the same soil profile, with AASS generally overlying PASS horizons. The field pH of PASS in their undisturbed state is 5.5 or more (usually neutral or slightly alkaline).

3.2 Liverpool Local Environmental Plan 2008

According to Division 2, Section 7.7 of the Liverpool Local Environmental Plan (LEP) 2008, development consent is required to carry out works where the works occur within that Class of land as follows:

Table 3-1 Liverpool LEP 2008 Land Class for Acid Sulfate Soil

Class of land	Works
1	Any works.
2	Works below the natural ground surface. Works by which the watertable is likely to be lowered.
3	Works more than 1m below the natural ground surface. Works by which the watertable is likely to be lowered more than 1m below the natural ground surface.
4	Works more than 2m below the natural ground surface. Works by which the watertable is likely to be lowered more than 2m below the natural ground surface.
5	Works within 500m of adjacent Class 1, 2, 3 or 4 land that is below 5m Australian Height Datum, or by which the watertable is likely to be lowered below 1m Australian Height Datum on adjacent Class 1, 2, 3 or 4 land.

Development consent is not required for the stated reasons in Clauses (3), (4), (5) and (6) of Division 2, Section 7.7 of the LEP 2008, (paraphrased) as follows:

- Preliminary assessment of the proposed works prepared in accordance with the Acid Sulfate Soils Manual indicates that an ASSMP need not carried out for the works, and
- The preliminary assessment has been provided to the Consent Authority and the Consent Authority has confirmed the assessment by notice in writing to the person carrying out the works.
- Where works are being carried out by a Public Authority that are either emergency works, routine management works, minor work that costs less than $20,000 (other than drainage work).

Under Clause 6, development consent is not required to carry out any works unless:

- the works involve the disturbance of more than 1 tonne of soil, or
- the works are likely to lower the watertable.

According to the Liverpool LEP 2008 and associated *ASS Planning Maps* (1:5,000 scale; Sheets ASS-011, ASS-012 and ASS-014), the majority of the precinct lies within *Class 5* land, while portions of precinct parcels nominated as C, D, M, N, O, P, Q, T, U, V, W and X shown on **Figure 2** lie within *Class 3* land. A copy of the LEP 2008 ASS planning map is reproduced on **Figure 3**.

3.3 Department of Land and Water Conservation ASS Risk Map

According to the Department of Land and Water Conservation *Liverpool Acid Sulfate Soil Risk Map* (Map 9030S2, Edition 2, 1:25,000 scale), the Precinct lies within the following two class descriptions (**Figure 3**):

- Majority of the precinct: *No Known Occurrence*, meaning acid sulfate soils are not known or expected to occur. Environmental risk is stated as: “Land management activities are not likely to be affected by ASS materials”.

- Portions of precinct parcels nominated as C, D, M, N, O, P, Q, T, U, V, W and X: *Ep1 - Estuarine Plain (1-2m AHD)*,with *High Probability* of ASS occurrence within 1m of the ground surface. The typical landform is low alluvial plains, estuarine sandplains, estuarine swamps and supratidal flats. The environmental risk is stated as: "Severe environmental risk if acid sulfate soil materials are disturbed by activities such as shallow drainage, excavation or clearing".

Although not within the Precinct lands, it is important to note that Lake Moore sediments are mapped as *Em - Estuarine Bottom Sediments* below water level. Their environmental risk is stated as: "Severe environmental risk if bottom sediments are disturbed by activities such as dredging".

3.4 Summary of ASS Mapping

On the basis of the Liverpool LEP 2008 *ASS Planning Maps* and Department of Land and Water Conservation *Liverpool Acid Sulfate Soil Risk Map*, there is a high probability of ASSs within portions of precinct parcels nominated C, D, M, N, O, P, Q, T, U, V, W and X (**Figures 2** and **3**).

3.5 Previous Investigations

Numerous environmental reports have been completed for the Precinct, or part thereof, dating back to 1999. These were also reviewed for the EI (2019) *Moore Point Precinct Review Study – Part 1: Remedial Strategy Review* (EI Ref. E22882.E09). Of those reports, the following contained information relating to soil composition.

***Area A** (11 Bridges Road (Lot 201 in DP 1009044; 6.13 hectares))*

- Soil & Groundwater Consulting (2007) *Environmental Site Assessment – Phase 1 and 2; Metal Manufacturers Site, 11 Bridges Road, Moorebank, New South Wales* (S&G Ref: SG071485 RP01 Revision 1; 14 December 2007); and
- Jeffery & Katauskas Pty Ltd (2013) *Report to Proactive Property (NSW) Pty Ltd on Geotechnical Investigation for Proposed Warehouse Development at 11 Bridges Road, Moorebank, NSW* (JKG Ref: 27021Zrpt; 2 December 2013).

***Area B** (3 Bridges Road (Lot 200 in DP 1009044; 16.65 hectares) and 5-9 Bridges Road (Lot 100 in DP 775780; 4.17 hectares))*

- AGC Woodward-Clyde Pty Ltd (1999) *Phase 1 Environmental Due Diligence*; *1 Heathcote Road, Liverpool NSW* (AGC W-C Ref: A8602126\0001; 8 January 1999);
- Benbow Environmental (2013) *Environmental Site Assessment Factory 2 Coolant Release; Report for Prysmian Group Liverpool NSW* (BE Ref: 121081_Rep_Final; 30 January 2013);
- Environmental Strategies (2013a) *Supplementary Soil and Groundwater Investigation; Prysmian Power Cables & Systems Australia Pty Ltd* (ES Ref: 10355RP01, 20 June 2013);
- Environmental Strategies (2013b) *Letter Report: Hydrocarbon Impacted Soil - Former Leaky In-Ground Pit, Factory 2; Prysmian Power Cables & Systems Australia Pty Ltd, 1 Heathcote Road, Liverpool, NSW* (ES Ref: 10355L01; 8 August 2013);
- Zoic Environmental Pty Ltd (2013) *Site Audit Report (SAR) and Site Audit Statement (SAS); Factory 2 Coolant Release; 1 Heathcote Road, Liverpool NSW, Prysmian Power Cables & Systems Australia Pty Ltd* (Zoic Ref: 13080 final; 20 December 2013);
- EI Australia (2015a) *Preliminary Site Investigation; 5-9 Bridges Road, Moorebank NSW* (EI Ref: E22745 AA_Rev0; 13 November 2015); which reviewed the following GDH Pty Ltd report:

  - GHD Pty Ltd (2005) *Environmental Site Assessment; 5-9 Bridges Road, Moorebank NSW* (GDH Ref. 2113524/Moorebank_R001; April 2005);

- EI Australia (2016a) *Preliminary Site Investigation with Limited Sampling; 3 Bridges Road, Moorebank NSW* (EI Ref: E22882 AA_Rev0; 30 March 2016);
- EI Australia (2016c) *Preliminary Site Investigation; Liverpool Waterfront, 3-11 Bridges Road, Moorebank NSW* (EI Ref: E22882 AD_Rev1; 22 November 2016); and
- EI Australia (2016d) *Geotechnical Assessment Report; 3-11 Bridges Road, Moorebank NSW* (EI Ref: E22882 GA; 13 January 2017).

None of these previous reports actually confirmed the presence of ASSs on the Precinct. No samples were laboratory analysed specifically for ASS parameters.

In the absence of confirmatory data and in keeping with the rationale for this preliminary ASSMP, EI has assumed there is a high probability of the presence for ASS materials, at least in localised areas of precinct parcels C, D, M, N, O, P, Q, T, U, V, W and X. This is based on:

- The filling layers, typically 2-4m thick and up to 12m BGL across the Precinct, could contain dredged sediments from the Georges River, Lake Moore and the Bulba-Bideen Islands;
- The natural (previously undisturbed) soils beneath the filling layers were at <5m AHD elevation; and
- The natural soils included Quaternary-aged, alluvial (estuarine) silty sands and clays, which could contain sulfidic minerals;

4. ACID SULFATE SOIL RISK AND IMPACTS

4.1 Soil Disturbance

The Precinct will undergo redevelopment for a range of mixed uses, including high density residential, recreational, commercial and industrial, with roads and public and communal open spaces. Bulk excavations for the provision of basement (car parking) facilities will be performed to depths up to 5.5-6m BGL.

The following infrastructure construction activities include sub-surface excavations typically greater than 1m below the ground surface:

- Surface trenching for installation of pipelines;
- Excavations for basement construction;
- Piling works; and
- Localised groundwater dewatering.

These activities undertaken in areas classified with high probability of ASS, or confirmed as containing ASS, should be considered high risk areas.

The Precinct development will involve disturbance of large amounts of soils (>1000 tonnes). In accordance with Section 4.3, *Assessment Guidelines* of the ASSMAC (1998) *Acid Sulfate Soil Manual*, "for projects that disturb >1000 tonnes of ASSs with ≥0.03% oxidisable sulfur or equivalent existing acidity, a detailed management plan and development consent will be required". ASS management for the Precinct will most likely equate to *Very High Treatment*, as >5 tonnes of lime will be needed (Table 4.5, *Assessment Guidelines* (ASSMAC, 1998)).

4.2 Potential Construction Issues and Effects

The presence / extent of ASSs across the Precinct has not yet been investigated. Intrusive investigations in accordance with the ASSMAC (1998) *Acid Sulfate Soil Manual* are required to determine this well in advance of Precinct construction works, so that management controls are in place. Assuming that ASSs are present, the following construction issues and effects need to be considered prior to excavation and construction in an ASS environment so that appropriate solutions can be designed and implemented:

- Volume of excavated soil identified as being ASS;
- Physical characteristics of the ASSs, such as grain size and natural buffering capacity;
- Time that ASSs are exposed to air;
- Rate of oxidation and transport of the oxidation products;
- Exposure and oxidation rates of excavated material;
- Discharge of acidic leachates into groundwater and the Georges River; and
- Theoretical liming rates (neutralisation requirement, or dosage).

Many aquatic organisms are sensitive to acid drainage. The environmental impacts include:

- Dissolved aluminium and iron in leachate can be poisonous to fish and aquatic plants; and
- Sulfate salts can increase the salinity of the receiving water (a particular issue for freshwater systems).

Effective control of ASSs and any acidic leachates will require suitable identification and monitoring programs. Appropriate contingencies are also needed, as back up should proposed management measures be inadequate, or unexpected finds emerge.

5. MANAGEMENT OF ACID SULFATE SOIL

5.1 Management Options Overview

ASS management options for the development in accordance with the EPA (2014) *Waste Classification Guidelines* (Part 4: Acid Sulfate Soils), include:

- Avoid, where possible, any disturbance of PASS/AASS. This approach requires careful planning and investigation, which considers the deepest excavation elevations (including lift pits, services and piling) and relating them to the occurrence of potential ASS sediments.
- If disturbance of PASS/AASS cannot be avoided, four potential options are considered:
    - Option 1 - Excavation of PASS and disposal beneath the water table at a NSW EPA licensed premise, prior to oxidisation.
    - Option 2 - Excavation, on-site neutralisation and disposal of neutralised PASS/AASS at a NSW EPA licensed premise.
    - Option 3 - Excavation, on-site neutralisation and onsite re-use of neutralised PASS/AASS, subject to characterisation and assessment of risks.
    - Option 4 - Excavation, on-site neutralisation and off-site re-use of neutralised PASS/AASS, subject to characterisation and assessment of risks, as well as regulatory (Council and/or EPA) approval.

Excavations of PASS/AASS must be supervised by a suitably qualified environmental consultant, to monitor and validate PASS/AASS management, re-use, and/or disposal.

The four options where disturbance of PASS is unavoidable are further described below.

5.2 Option 1 – Excavation and Landfill Disposal Below Water Table

This option involves excavation of PASS only, no neutralisation undertaken, and disposal under the water table at a licensed landfill within 24 hours of excavation. It is not a suitable option where AASS is present.

For the disposal of PASS below the water table at a suitably licensed landfill facility, the PASS must be excavated, transported and deposited in a highly organised and timely manner, the permitted period being no greater than 24 hours, in accordance with the EPA (2014) *Waste Classification Guidelines* (Part 4: Acid Sulfate Soils).

A number of conditions and controls must be satisfied for disposal of PASS beneath the water table to be a viable option:

- There must be a suitably licenced landfill within a reasonable distance to the site, to ensure the procedure can be carried out within 24 hours;
- The PASS should not have been impacted by contaminants; and
- The pH of soils on excavation and immediately prior to disposal has not experienced a significant change (not <5.5).

This management option is considered to be suitable for the proposed excavation works where soils underlying the Precinct are PASS. Sequencing management and control of all excavation works will require careful consideration to prevent oxidization of PASS. Key time constraints required in the management of PASS are:

- 24 hours - PASS must be excavated, transported and deposited below the water at a licensed facility.

- 16 hours - PASS must be received at the proposed disposal point within 16 hours of being dug up.
- 8 hours - PASS must be disposed of within 8 hours of their receipt at a landfill.

5.2.1 Excavation and Handling for Off-site Landfill Disposal under Water table

Excavations should be carried out in a carefully managed and controlled sequence, designed to minimise the amount of PASS disturbed and exposed at any one time. The excavations should also be carried out so that potentially acidic water within the area of disturbance cannot migrate uncontrollably.

The following recommendations are provided in relation to excavation of PASS for the purpose of off-site disposal below the permanent water table at a NSW EPA licenced facility.

1 The surface must be stripped and any existing PASS-free fill materials shall be excavated and removed or stored separately in stockpiles with adequate environmental protection measures as part of the Construction Environment Management Plan. Care must be taken to confirm that surface fill is not mixed with PASS material. The sides of the excavation shall also be stripped a further 200mm to ensure potential PASS-free materials do not fall into excavations and cross contaminate PASS materials beneath.

2 Once overlying fill soils are removed, the exposed (natural) surface shall be inspected by a qualified environmental consultant and a representative of the receiving landfill facility, prior to excavation of PASS.

3 When surface clearance is granted, PASS materials shall be excavated to the required depth and loaded directly onto waiting trucks with sealed trays and/or placed directly into a designated Containment Area to prevent spillage, egress or leakage of water/leachate during handling and transportation.

4 Each truckload shall be inspected and verification testing for pH shall be carried out to confirm soil pH does not fall below 5.5 prior to leaving the site.

5 Verification testing is required to demonstrate that materials with existing acidity are not being reburied. Should field pH fall below 5.5, the materials from that truck shall remain on-site and lime neutralisation techniques shall proceed as described in **Section 5.3.2**.

6 PASS must be kept wet at all times during excavation and subsequent handling, transport and storage until they can be disposed. They must be received at the proposed disposal point within 16 hours of being dug up.

7 Where excavated PASS cannot meet disposal timelines, or it fails to meet PASS definition, it must be neutralised immediately in accordance with Option 2.

5.2.2 Transportation

Transport of PASS material to the receiving landfill facility for the purpose of disposing below the water table shall take place immediately and must be received within 16 hours of being dug up. Vehicles should have sealed trays for moisture control.

If either the 24 hour or 16 hour timeline cannot be achieved, or the landfill cannot dispose of the PASS within 8 hours of receipt, the PASS must be stockpiled in a designated Containment Area and undergo lime neutralisation techniques, followed by disposal at a licenced facility.

5.2.3 Disposal of PASS

Landfill facilities in NSW that are licenced to dispose PASS as waste below the permanent water table in accordance with the EPA (2014) *Waste Classification Guidelines* (Part 4: Acid Sulfate Soils) are able to do so if the PASS meets the following criteria:

- Disposal occurs before the PASSs have had a chance to oxidise (i.e. within 24 hours of excavation); and

- The soils meet the definition of *virgin excavated natural material* (VENM) under the *Protection of the Environment Operations Act 1997*, even though they contain sulfidic ores or soil.

In addition to the above requirements:

- PASS must be disposed within 8 hours of their receipt at the receiving landfill facility, and kept wet at all times until their burial at least 2m below the lowest historical level of the water table at the disposal site.
- PASS must be received at the proposed disposal point within 16 hours of being dug up.
- The pH of the water at the landfill into which the PASS is placed must not be less than pH 6.0 at any time. Landfill licence conditions require the occupiers of PASS disposal sites to regularly monitor the pH of ground and surface waters at their premises.
- PASS material should have a pH greater than 5.5, both immediately following excavation and immediately prior to disposal beneath the permanent water table. Where soil pH is less than 5.5, it is not considered eligible for disposal below the water table and must be considered as AASS, to be treated by neutralisation and then chemically assessed as per the EPA (2014) *Waste Classification Guidelines*, prior to disposal at an appropriate (alternative) landfill.

5.2.4 Documentation

Documentation must be provided to the occupier of the landfill for each truckload of PASS received, indicating that the soil excavation, transport and handling have been conducted in accordance with ASSMAC (1998) and EPA (2014) guidelines, thus preventing the generation of acid. Information to be included in documentation should entail:

- pH of each load of soil received at the source site and immediately prior to its placement under water, using the test method(s) in ASSMAC (1998), specifically methods 21A and/or 21AF;
- details of the source site;
- details of the transporter;
- date and time of the extraction of the PASS;
- pH of the PASS at time of extraction;
- name and details of the person classifying the material as PASS;
- satisfactory review and confirmation by a representative from the landfill of geotechnical and contamination reports pertaining to the source site; and
- confirmation of an inspection of the source site by a representative of the licensed landfill.

5.3 Option 2 – Excavation, Neutralisation, Landfill Disposal

This option involves the excavation, on-site neutralisation, transport and land-based disposal of PASS and/or AASS at an approved NSW EPA licenced facility. This may be necessary in circumstances where the required timelines for PASS cannot be met, or the PASS cannot be immediately placed in trucks for off-site disposal, and/or where the soil does not comply with VENM certification. The processes required for this option are outlined below.

5.3.1 Excavation and Handling for On-site Neutralisation

Excavations should be carried out in a carefully managed and controlled sequence, designed to reduce to a minimum the amount of PASS disturbed and exposed at any one time. The excavation should also be carried out so that potentially acidic water within the excavation cannot migrate from the excavations.

The following recommendations are provided in relation to excavation of ASS for the purpose of on-site neutralisation with lime.

1 ASS materials shall be excavated to the required depth and deposited into a designated Containment Area located in close proximity for neutralisation.

2 The designated Containment Area should consist of:

- A low permeability, bunded area (minimum 150mm walls) to prevent surface run-off from entering the Containment Area and a minimum 300m thick treatment pad base of adequate size to contain and treat the volume of excavated PASS/AASS. The size of the containment area must be a function of the anticipated excavation, treatment, and disposal rate.
- The Containment Area should be lined with two layers of low density polyethylene (LDPE) sheeting, with no leakage at overlaps, and backfilled with compacted fine grained crushed limestone, or other appropriate neutralisation material. The level of compaction used should produce an appropriately low permeability base to prevent infiltration of leachate.
- Leachate management for the Containment Area should include:
    - Slight slope of the constructed base, to encourage water and leachate to drain to a lower point for collection;
    - Installation of leachate collection pipe(s) and treatment systems; and
    - Construction of supplementary erosion and sediment control structures.

3 If neutralising cannot be performed on PASS/AASS materials within the Containment Area immediately, plastic sheeting shall be placed over the stockpile to reduce oxidation; however, this should be only be considered in unusual circumstances.

4 The ASS should be spread out within the confines of the designated Containment Area in a maximum 0.3m deep layer, over a thin bed of lime, and allowed to dry. Once dried, a layer of lime should be placed by hand and/or excavator bucket over the contained PASS/AASS and a light-weight rotary hoe (or similar) should be used to mix in the lime and aerate the soil (to allow oxidation).

5 The excavated PASS/AASS will continue to be placed within the Containment Area in 0.3m deep lifts as the excavation proceeds and undergo regular sampling to validate the treatment rates.

6 On completion of lime neutralisation and prior to disposal, field pH testing on representative samples must be performed to ensure that sufficient neutralisation has occurred (i.e. pH >5.5). Selected samples will also be analysed for Suspension Peroxide Oxidation Combined Acidity and Sulfate (SPOCAS) - the testing rate for a designated area to be determined following the initial results and/or any available investigation data. Once the pH is above 5.5 and the sulfur and acid trails are below the levels specified in **Table 5.1** of **Section 5.7**, the soil can be considered neutralised.

7 Following treatment and validation, a Waste Classification Certificate must be prepared in accordance with the EPA (2014) *Waste Classification Guidelines* by the Environmental Consultant, to enable off-site disposal at a licensed landfill. The certificate must incorporate the results of the acid sulfate testing, as well as the analytical data for any other chemicals of concern.

8 Adequate water management will be required during the works, to contain any potential acid leachate and to prevent clean storm/surface water from coming into contact with disturbed soil and/or leachate. Groundwater and storm water management are described in **Section 5.10**.

5.3.2 Determination of Lime Requirement

EI note the liming requirements are likely to vary across the Precinct, and PASS investigation (SPOCAS testing) is required to ascertain both the extent of ASSs and liming requirements.

The quantity of lime required to neutralise the theoretical maximum amount of acid that could be generated from complete oxidation of soil sulfides can be determined through the following calculation (based on SPOCAS results; *Ref*. Table 4.6, *Assessment Guidelines* (ASSMAC, 1998)):

Lime requirement (kg $CaCO_3$ / tonne material) = S_{pos} x 30.59 x 1.5

where S_{pos} is the average peroxide oxidisable sulfur concentration (in % w/w);

30.59 is the theoretical stoichiometric conversion factor; and

1.5 represents the minimum industry safety factor (based on the expected bulk density).

5.4 Option 3 – Excavation, Neutralisation, On-site Re-use

This option involves the excavation of PASS, on-site neutralisation and re-burial on another part of the Precinct within 24 hours of excavation. It is not suitable where AASS is confirmed to be present.

This option may be necessary in circumstances where the required timelines for PASS cannot be met, or the PASS cannot be immediately placed in trucks for off-site disposal. The processes required for this option are outlined in Section 5.3 above, except that the treated soil will be retained on-site.

The treated soil material is to be re-used onsite only where it is geotechnically and environmentally feasible to do so. The area selected for burial should be a specified location (identified on a site plan), where future disturbance will be limited (e.g. beneath basement slabs or pavements, encapsulated in a clay-lined mound or cell). .

The re-use of treated ASS on the Precinct would require the following to be confirmed:

- The material is not impacted by contaminants, such that it poses no risks to human health and/or the environment. This shall require the completion of a rigorous testing program, involving analyses for contaminants of potential concern (both total and water-leachable), as well as ASS parameters.
- The acid producing potential of the ASS has been sufficiently neutralised.
- Written approval has been obtained from the NSW EPA and Liverpool Council.
- The soil material is geotechnically suitable for use, which may require consultation with the appointed Structural / Geotechnical Engineer(s).

5.5 Option 4 – Excavation, Neutralisation, Off-site Re-use

This option involves the excavation of PASS, on-site neutralisation and re-burial on another development property external to the Precinct within 24 hours of excavation. It is not suitable where AASS is confirmed to be present.

This option may be necessary in circumstances where the required timelines for PASS cannot be met, or the PASS cannot be immediately placed in trucks for off-site disposal. The processes required for this option are outlined in Sections 5.3 and 5.4 above, except that the treated soil will be reused on an external property undergoing (re)development.

The treated soil material is to be re-used on the designated (external) site only where it is geotechnically and environmentally feasible to do so. The area selected for burial should be a specified location (identified on a site plan), where future disturbance will be limited (e.g. beneath basement slabs or pavements, encapsulated in a clay-lined mound or cell).

The re-use of treated ASS on such a site would require the following to be confirmed:

- The material is not impacted by contaminants, such that it poses no risks to human health and/or the environment. This shall require the completion of a rigorous testing program, involving analyses for contaminants of potential concern (both total and water-leachable), as well as ASS parameters.
- The acid producing potential of the ASS has been sufficiently neutralised.
- The treated material complies with a Specific Resource Recovery Exemption, as authorised by the NSW EPA.
- Written approval has been obtained from the NSW EPA and Liverpool Council, prior to the off-site transport of any treated material.
- The soil material is geotechnically suitable for use, which may require consultation with the appointed Structural / Geotechnical Engineer(s) responsible for the development of the external site.

5.6 Monitoring and Assessment During Excavation Works

Soil excavated and exposed during the development will be field tested for pH (pH_f and pH_{fox}), using standard techniques. Where soil is found to be acidic (pH_f <5.5) and/or have a significant potential to oxidise (pH_{fox} <3), it will be managed as ASS, and where required, neutralised at the prescribe rate via the addition of agricultural lime.

Analysis of the soil following lime treatment will be undertaken to ensure neutral pH conditions have been achieved. Results will be compared with background levels and laboratory data (e.g. theoretical liming rates), to evaluate the success of control (neutralisation) procedures. Any leachate generated within the ASS storage area shall be sampled and discharged subject to compliance with water disposal requirements.

5.7 Laboratory Analysis

Standard, approved laboratory methods have been developed for the routine analysis of soil samples. The most common method for ASS testing is Suspension Peroxide Oxidation Combined Acidity and Sulfate (SPOCAS). Such testing will be performed to confirm the presence of ASS.

The ASSMAC (1998) oxidisable sulphur (sulfur trail) and potential acidity (acid trail) criteria which trigger ASS management are grouped into three broad categories, based on clay content of the soil. For this site, the action criteria for the disturbance of more than 1000 tonnes of coarse textured (sandy) soils are recommended (**Table 5-1**). Note, these criteria also apply for medium and fine (>40% clay-dominated) textured soils, where more than 1000 tonnes are disturbed.

Table 5-1 Summary SPOCAS Action Criteria

Texture	Approximate Clay Content	Sulphur Trail sPOS (%)	Acid Trail TPA (mol H^+/tonne)
Coarse Texture Sands to Loamy Sands	<5.0%	0.03	18

5.8 Treatment of Acid Sulfate Soil

The excavation activities associated with the development may generate ASS-related issues, which will need to be addressed. For management purposes, the highest result by either the sulfur or the acid trail is generally used as the confirmation and amount of ASS present, unless mitigating factors are pre-identified (e.g. the quantity, fineness and reactivity of neutralising material such as shell, etc).

The procedures set out below are to be implemented in the event that natural materials are excavated and exposed to air (and not immediately disposed off-site to landfill at potential ASSs). They are conservative and should ensure that any incremental increases in soil / groundwater are negligible.

5.9 Management of *In Situ* Acid Sulfate Soil

For every day that an excavated (ASS) surface is in an exposed state, soil pH shall be monitored by in-field testing of representative samples. Where soil pH falls below 5.5, lime will be applied to the ASS horizon(s). Plastic sheeting can be placed over the corresponding surface (where possible) to reduce the oxidation rate.

5.10 Groundwater and Stormwater Management and Disposal

Surface and groundwater associated with ASS within the excavations, or any leachate in the Containment Area, will be tested for pH (by simple field indicator tests). The pH should be between 6.5 and 8.5. If pH is outside this range, then treatment of the water will be performed by:

- mixing with AASS awaiting treatment, in the case of alkaline water (pH >8.5); or
- mixing with lime, in the case of acidic water (pH<6.5).

Once the testing of treated water indicates its pH is between 6.5 and 8.5, the water can be considered neutralised and suitable for discharge (in accordance with relevant water authority requirements). Treated water that does not meet the criteria as listed above must be retreated and retested until it meets the test criteria.

A Storm and Groundwater Management Strategy should be implemented for the excavation works, and include the following:

- Methods for dewatering the excavation if required;
- Volumes of groundwater expected the be produced during dewatering;
- Storage of any pumped groundwater and stormwater;
- Monitoring requirements for pumped groundwater and stormwater;
- Discharge methods of water; and
- Procedure of record keeping detailing monitoring results, discharge times and volumes.

The following should be included in the Storm and Groundwater Management Plan, considering the ASS present onsite:

- The depth of dewatering should be minimised to reduce the generation of AASS and or acidic conditions. The dewatering and excavation should be staged over short durations to reduce the time and volume of ASS exposed to oxidation in the excavation. This is an important consideration if below the permanent groundwater table disposal is to be used to manage the ASS.
- Approvals for the disposal of groundwater and stormwater may need to be obtained from Council, WaterNSW, Sydney Water and any other relevant authority, considering that the Precinct contains ASS.
- Water from the excavation and stormwater should be collected in portable tanks or a suitably designed engineered pond where samples can be obtained for analysis.
- Prior to disposal, the pH of the water should be in the range of 6.5 to 8.5. If the pH is outside this range some treatment may be required prior to disposal (as per above).
- Groundwater pH should be monitored on a regular basis throughout the excavation and construction period. Treatment may be necessary to address a change in pH levels.

- The approvals for disposal from the relevant authorities may require that further contaminants may also need to be screened.

Stormwater should be diverted away from excavations and stockpiles by a series of bunds to be retained until excavations are backfilled or until permanent stormwater infrastructure is installed on the site. Management measures for the Precinct should include:

- Stormwater diversion bunds around excavations and designated Containment Areas (as required).
- Minimising surface disturbance and maximising the retention of existing surface cover (pavements, vegetation) during the works.
- Construction of sediment controls downstream of any diversion bunds, hardstand and traffic areas to minimise the off-site migration of sediment.
- Vehicular access is to be stabilised to prevent tracking of mud onto roads and footpaths. Soil, earth and mud shall be removed from the roadway by sweeping, shovelling or a means other than washing on a daily basis or as required.

Groundwater Management

The removal (pumping) of any groundwater from an excavation area may cause alterations to the existing groundwater table. Extracted groundwater should be pumped to a holding vessel for assessment of pH and electrical conductivity (EC) characteristics during the dewatering process. Extracted water should be treated with lime to display a pH level of pH 6.5-8.5, prior to off-site disposal. Powdered lime should be added to the water by hand and/or excavator bucket and mixed. Field pH testing on representative samples should be performed to ensure that sufficient neutralisation has occurred, prior to disposal.

In addition to the above, an appropriately designed truck wash area will be required to capture liquids and solids generated, prior to vehicles exiting the Precinct. Treatment and neutralisation of liquids and solids shall be in accordance with the corresponding methods described above.

Groundwater Disposal

It is anticipated that extracted groundwater from the dewatering process will be disposed to the municipal stormwater system. Any permits / licences from Council and WaterNSW shall be obtained prior to discharging to the municipal stormwater system.

Water for disposal will be tested routinely (weekly intervals) for the duration of dewatering activities, to ensure that no change to the quality of water entering the stormwater system, with the results made available to Council or WaterNSW on request. Should it be found that groundwater quality is not suitable for disposal to the stormwater system, groundwater treatment or a Sydney Water permit to dispose to sewer shall be required prior to disposal.

Water quality monitoring for disposal to the municipal stormwater system shall include the following:

- Daily monitoring of field parameters (pH, EC, dissolved oxygen (DO), temperature and turbidity) in the treated discharge water using data logging equipment.
- Weekly sampling and laboratory analysis of treated groundwater water for suspended solids, dissolved metals (aluminium, arsenic, cadmium, chromium, copper, iron, lead, nickel, zinc and mercury), TRHs, BTEX, VOCs, PAHs, total nitrogen and total phosphorus. Laboratory results should be compared to freshwater trigger values provided in ANZG (2018) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* for slightly - moderately disturbed systems to provide a 95% level of species protection.
- Weekly sampling shall be performed by a suitably qualified Environmental Consultant, with samples submitted to a NATA accredited laboratory for analysis of the above parameters.

5.11 Consultation and Records

During the development of the/a final ASS management plan, due regard is to be given to the following organisations:

- NSW EPA concerning their requirements with respect to the various pollution control issues/associated with the project and the detail required in the acid sulfate soil management plan;
- Department of Planning concerning the extent of ASS in the local region; and
- DA Compliance and the handling requirement for ASS situations.

A file will be established to store all hard copy records associated with the final Acid Sulfate Soil Management for the project. All analysis and monitoring information will be stored electronically to permit ease of access and data interpretation.

5.12 Contingency Measures

Contingency procedures that may occur during the project could include:

- Extended rainfall generating excessive water to be analysed, treated (if required) and disposed of prior to installation activities recommencing.
- The control procedures detailed in the plan will accommodate this contingency. The timeframe needed to recover the excessive water may extend the period during which the trench or excavation is open increasing the potential for acid generation and therefore requiring more careful consideration.
- Extended Delays due to equipment failure, leaving trenches or excavations and material extracted open to oxidation.
- The control procedure requires the addition of lime sufficient to neutralise the total potential acidity of the excavated waste. A safety factor of 1.5 is included in the calculation of lime required which should ensure sufficient neutralising capacity should the excavation be open for greater than the planned period. The oxidation of the walls and base of the excavation should also be considered in regards to engineering design.
- Spillage of Acid Sulfate Soil.
- Spillage of Acid Sulfate Soil should be collected and transferred to the acid soil storage facility as soon as practicable to ensure surface soil or groundwater is not adversely impacted.

A contingency plan is detailed below in Table 5-2. The plan provides a list of potential events that may arise during bulk excavation and the actions to be undertaken if unexpected conditions occur.

Table 5-2 Contingency Plan

Unexpected Condition	Action
Potential ASS identified at unexpected depths	• Stop excavations; • Have material assess by an environmental consultant for the presence of ASS; • Follow management procedures adopted in the ASSMP.
Neutralisation of ASS was not effective	• Re-assess liming rates and add additional lime to material; and • Re-test material to check neutralisation

Unexpected Condition	Action
Neutralisation of ASS indicates that too much lime has been added and soil are alkaline	• Remediate soil before use; • Remediation comprises mixing additional ASS with the material, i.e. use excess lime to neutralise more ASS; and • Re-test material to check neutralisation
Bunded ASS treatment area is damaged	• Repair bund as soon as practicable; • Clean-up any ASS that escaped the treatment area and place back into the treatment area; and • Check surrounding area for impact form the ASS or leachate, and undertake remedial action as required.
Groundwater level falls below the top of areas defined as containing PASS	• Stop dewatering; • Review PASS exposure by checking the ASS and Non-ASS interface in the affected area; • Determine potential causes by reviewing construction practises, weather, baseline groundwater monitoring data, and performing additional groundwater monitoring as necessary on groundwater monitoring present at the Precinct; • Review and confirm mitigation measures to be implemented, including: i. Maintain PASS soil moisture levels through targeted groundwater recharge; ii. adjusting the construction activities or schedule; and iii. Treatment of additional PASS in treatment area.

6. STATEMENT OF LIMITATIONS

This plan has been prepared for the inclusion of a Planning Proposal, on behalf of Leamac & Coronation Property Group, who is the only intended beneficiary of EI's work. The scope of this plan is limited to that agreed with LAC JV Pty Ltd.

No other party should rely on the document without the prior written consent of EI, and EI undertakes no duty, or accepts any responsibility or liability, to any third party who purports to rely upon this document without EI's approval.

In preparing this management plan, EI used a degree of care and skill ordinarily exercised by reputable members of the environmental industry in Australia. No other warranty, expressed or implied, is made or intended. Each section of this plan must be read in conjunction with the whole of this document, including its appendices.

EI's professional opinions are reasonable and based on its professional judgment, experience, training and results from analytical data. EI may also have relied upon information provided by the Client and other third parties to prepare this document, some of which may not have been verified by EI.

REFERENCES

ASSMAC (1998) *Acid Sulfate Soil Assessment Guidelines*, Section 2 of the *Acid Sulfate Soil Manual*. Acid Sulfate Soil Management Advisory Committee (ASSMAC), Wollongbar, NSW, Australia, 28 August 1998.

ANZECC/ARMCANZ (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, October 2000.

ANZG (2018) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, Australian and New Zealand Governments and Australian State and Territory Governments, Canberra ACT, Australia, August 2018

Chapman GA and Murphy CL (1989) *Soil Landscapes of the Penrith 1:100 000 Sheet*. Soil Conservation Service of NSW, September 1989.

EPA (2014) *Waste Classification Guidelines*. NSW Environmental Protection Authority, November 2014.

Department of Land and Water Conservation (1997) *Liverpool Acid Sulfate Soil Risk Map*, Map 9030S2, Edition 2 (1:25,000 scale).

GSNSW (1983) *Penrith 1:100 000 Geological Sheet 9130* (1st edition). Geological Survey of New South Wales, 1983.

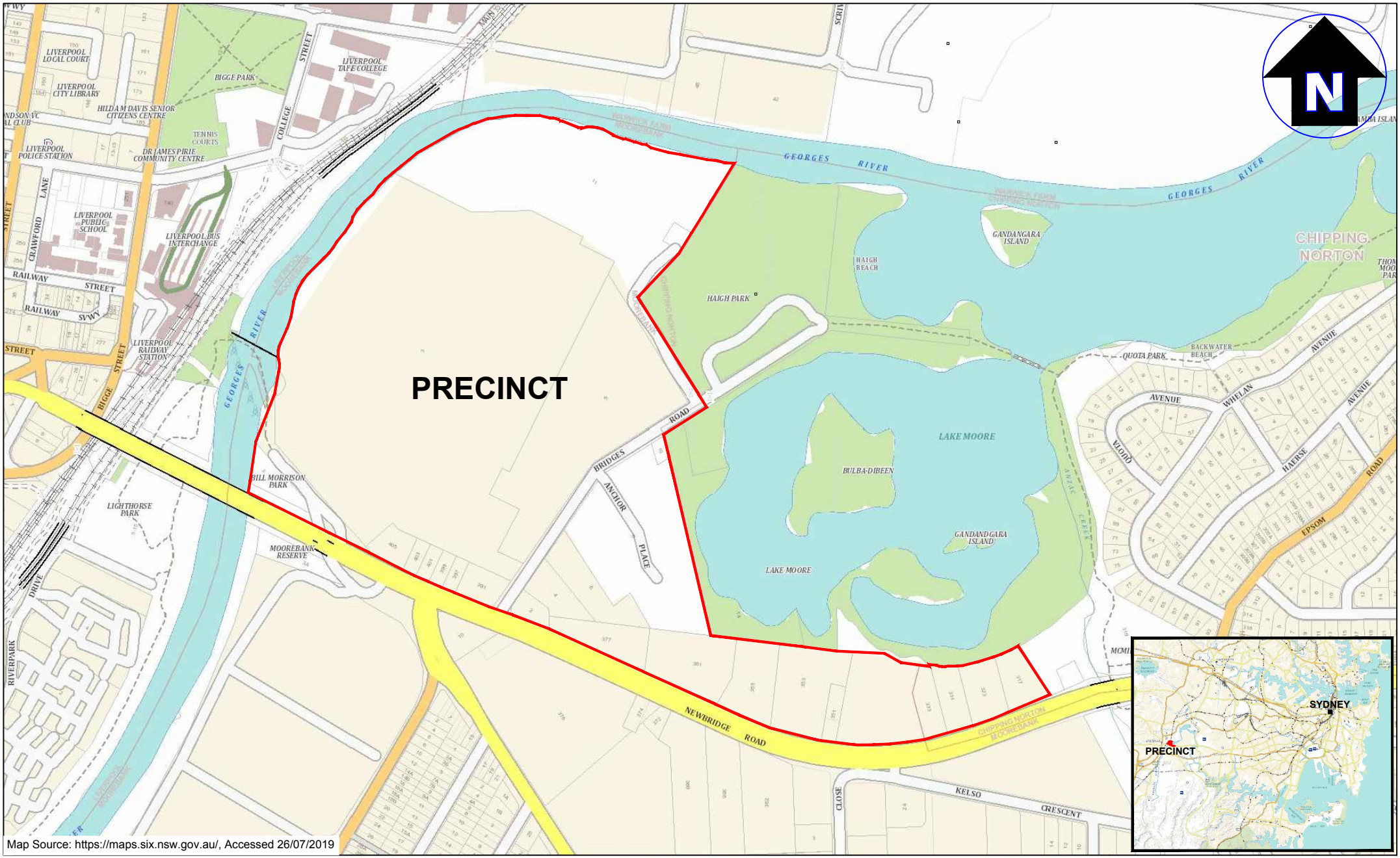
Naylor SD, Chapman GA, Atkinson G, Murphy CL, Tulau MJ, Flewin TC, Milford HB and Morand DT (1998) *Guidelines for the Use of Acid Sulfate Soil Risk Maps* (2nd Edition). Department of Land and Water Conservation, Sydney.

Liverpool Local Environmental Plan 2008, No 403, Acid Sulfate Soil Planning Maps (1:5,000 scale; Sheets ASS-011, ASS-012 and ASS-014).

ABBREVIATIONS

AHD	Australian Height Datum
ASS	Acid sulfate soil
AASS	Actual acid sulfate soil
BGL	Below ground level
EI	EI Australia
EPA	Environmental Protection Authority
km	Kilometres
LAC JV P/L	More Point Land Owner Group and/or Leamac & Coronation Property, for the purposes of this report
m	Metres
mAHD	Metres relative to Australian Height Datum
mBGL	Metres below ground level
NSW	New South Wales
OEH	Office of Environment and Heritage, NSW (formerly DEC, DECC, DECCW)
PASS	Potential acid sulfate soil
pH	Measure of the acidity or basicity of an aqueous solution
PQL	Practical Quantitation Limit
QA/QC	Quality Assurance / Quality Control
SRA	Sample receipt advice (document confirming laboratory receipt of samples)
TDS	Total dissolved solids (a measure of water salinity)

Appendix A - Figures



Map Source: https://maps.six.nsw.gov.au/, Accessed 26/07/2019

eiaustralia
Contamination | Remediation | Geotechnical
Suite 6.01, 55 Miller Street, PYRMONT 2009
Ph (02) 9516 0722 Fax (02) 9518 5088

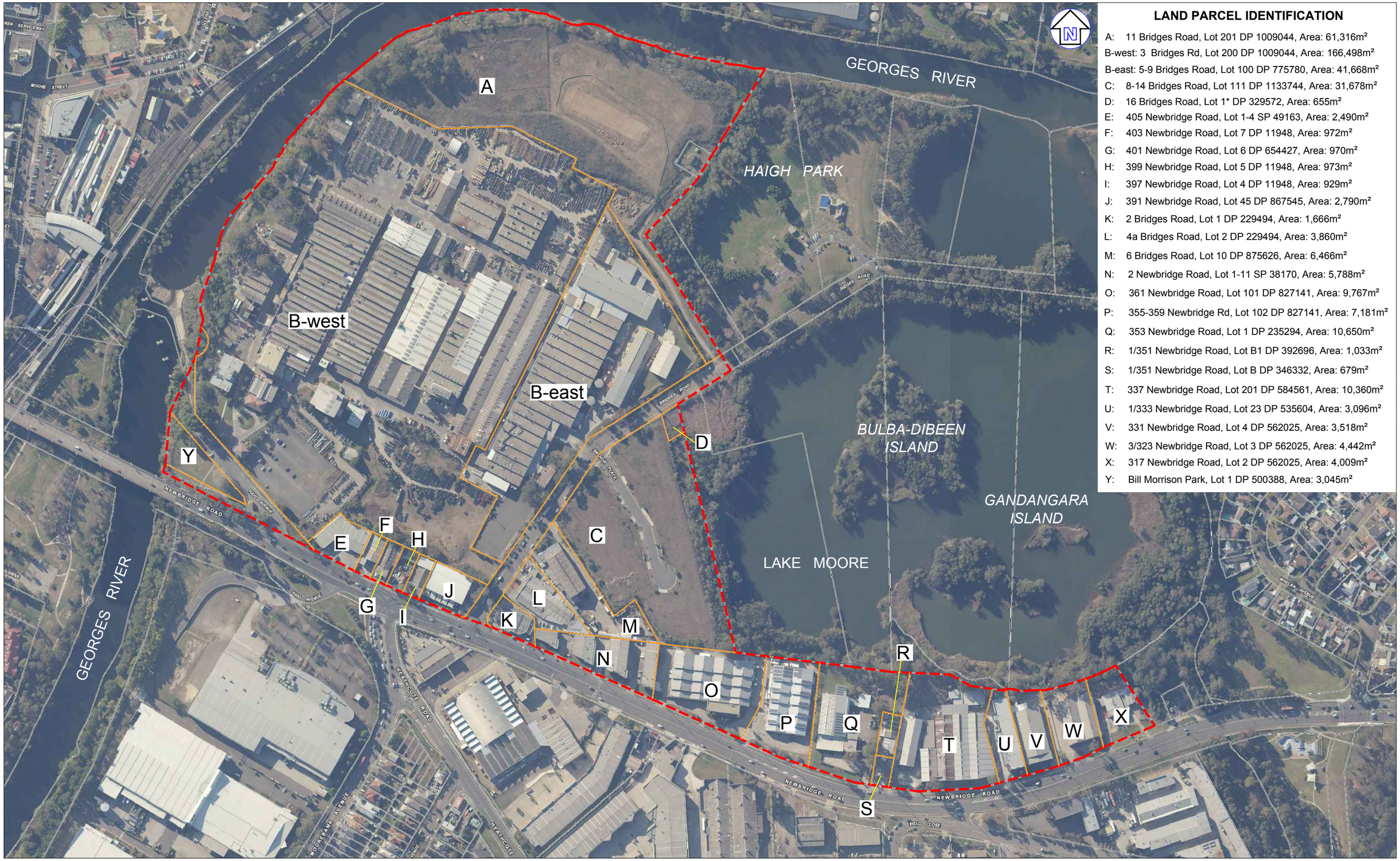
Drawn:	M.G.
Approved:	-
Date:	26-07-19
Scale:	Not To Scale

LAC JV Pty Ltd

Moore Point Precinct Review Study
Part 2: Preliminary Acid Sulfate Soil Management Plan
Newbridge & Bridges Roads, Liverpool NSW
Precinct Locality Map

Figure: 1

Project: E22882.E14



LAND PARCEL IDENTIFICATION

A: 11 Bridges Road, Lot 201 DP 1009044, Area: 61,316m²
B-west: 3 Bridges Rd, Lot 200 DP 1009044, Area: 166,498m²
B-east: 5-9 Bridges Road, Lot 100 DP 775780, Area: 41,668m²
C: 8-14 Bridges Road, Lot 111 DP 1133744, Area: 31,678m²
D: 16 Bridges Road, Lot 1* DP 329572, Area: 655m²
E: 405 Newbridge Road, Lot 1-4 SP 49163, Area: 2,490m²
F: 403 Newbridge Road, Lot 7 DP 11948, Area: 972m²
G: 401 Newbridge Road, Lot 6 DP 654427, Area: 970m²
H: 399 Newbridge Road, Lot 5 DP 11948, Area: 973m²
I: 397 Newbridge Road, Lot 4 DP 11948, Area: 929m²
J: 391 Newbridge Road, Lot 45 DP 867545, Area: 2,790m²
K: 2 Bridges Road, Lot 1 DP 229494, Area: 1,666m²
L: 4a Bridges Road, Lot 2 DP 229494, Area: 3,860m²
M: 6 Bridges Road, Lot 10 DP 875626, Area: 6,466m²
N: 2 Newbridge Road, Lot 1-11 SP 38170, Area: 5,788m²
O: 361 Newbridge Road, Lot 101 DP 827141, Area: 9,767m²
P: 355-359 Newbridge Rd, Lot 102 DP 827141, Area: 7,181m²
Q: 353 Newbridge Road, Lot 1 DP 235294, Area: 10,650m²
R: 1/351 Newbridge Road, Lot B1 DP 392696, Area: 1,033m²
S: 1/351 Newbridge Road, Lot B DP 346332, Area: 679m²
T: 337 Newbridge Road, Lot 201 DP 584561, Area: 10,360m²
U: 1/333 Newbridge Road, Lot 23 DP 535604, Area: 3,096m²
V: 331 Newbridge Road, Lot 4 DP 562025, Area: 3,518m²
W: 3/323 Newbridge Road, Lot 3 DP 562025, Area: 4,442m²
X: 317 Newbridge Road, Lot 2 DP 562025, Area: 4,009m²
Y: Bill Morrison Park, Lot 1 DP 500388, Area: 3,045m²

Photo Source: https://maps.six.nsw.gov.au, Accessed 17/07/2019

LEGEND
- Approximate precinct boundary
- Approximate lot boundaries

0 50 100 150 200 250
Approx. Scale (m)

eiaustralia
Contamination | Remediation | Geotechnical
Suite 6.01, 55 Miller Street, PYRMONT 2009
Ph (02) 9516 0722 Fax (02) 9518 5088

Drawn:	M.G.
Approved:	-
Date:	26-07-19

LAC JV Pty Ltd
Moore Point Precinct Review Study
Part 2: Preliminary Acid Sulfate Soil Management Plan
Newbridge & Bridges Roads, Liverpool NSW

Land Parcel Identification

Figure: 2

Project: E22882.E14

MAP A Legend

Map Class Description	Depth to Acid sulfate Soil Materials		Environmental Risk
High Probability High probability of occurence of acid sulfate soil materials within the soil profile. The environment of deposition has been suitable for the formation of acid sulfate soil materials. Acid sulfate soil materials are widespread or sporadic and may be buried by alluvium or windblown sediments.	Em Below water level	Bottom Sediments.	Severe environmental risk if bottom sediments are disturbed by activities such as dredging.
	Ep0	At or near the ground surface.	Severe environmental risk if acid sulfate soil materials are disturbed by activities such as shallow drainage, excavation or clearing.
	Ep1	Within 1 metre of the ground surface.	Severe environmental risk if acid sulfate soil materials are disturbed by activities such as shallow drainage, excavation or clearing.
		Between 1 and 3 metres below the ground surface.	Environmental risk if acid sulfate soil materials are disturbed by activities such as deep excavation for pipelines, dams or deep drains.
		Greater than 3 metres below the ground surface.*	Environmental risk if acid sulfate soil materials are disturbed by activities such as deep excavations, -e.g., large structure foundations or deep dams.
Low Probability Low probability of occurence of acid sulfate soil materials within the soil profile. The environment of deposition has generally not been suitable for the formation of acid sulfate soil materials. Soil materials are often Pleistocene in age. Acid sulfate soil materials, if present, are sporadic and may be buried by alluvium or windblown sediments.	Below water level	Bottom sediments.	The majority of these landforms are not expected to contain acid sulfate soil materials. Therefore, land management is generally not affected by acid sulfate soils. However, highly localized occurrences may be found, especially near boundaries with environments with a high probability of occurrence. Disturbance of these soil materials will result in an environmental risk that will vary with elevation and depth of disturbance.
		At or near the ground surface.	
		Within 1 metre of the ground surface.	
		Between 1 and 3 metres below the ground surface.	
	Ap4	Greater than 3 metres below the ground surface.*	
No Known Occurrence Acid sulfate soils are not known or expected to occur in these environments.		No known occurrences of acid sulfate soil materials.	Land management activities not likely to be affected by acid sulfate soil materials.
Disturbed Terrain	X4	Disturbed terrain (above 4m elevation) may include filled areas, which often occur during reclamation of low lying swamps for urban development. Other disturbed terrain includes areas which have been mined or dredged, or have undergone heavy ground disturbance through general urban development or construction of dams or levees. Soil investigations are required to assess these areas for acid sulfate potential.	

*Deep occurrences of acid sulfate soil materials not able to be confirmed by field inspection and sampling.

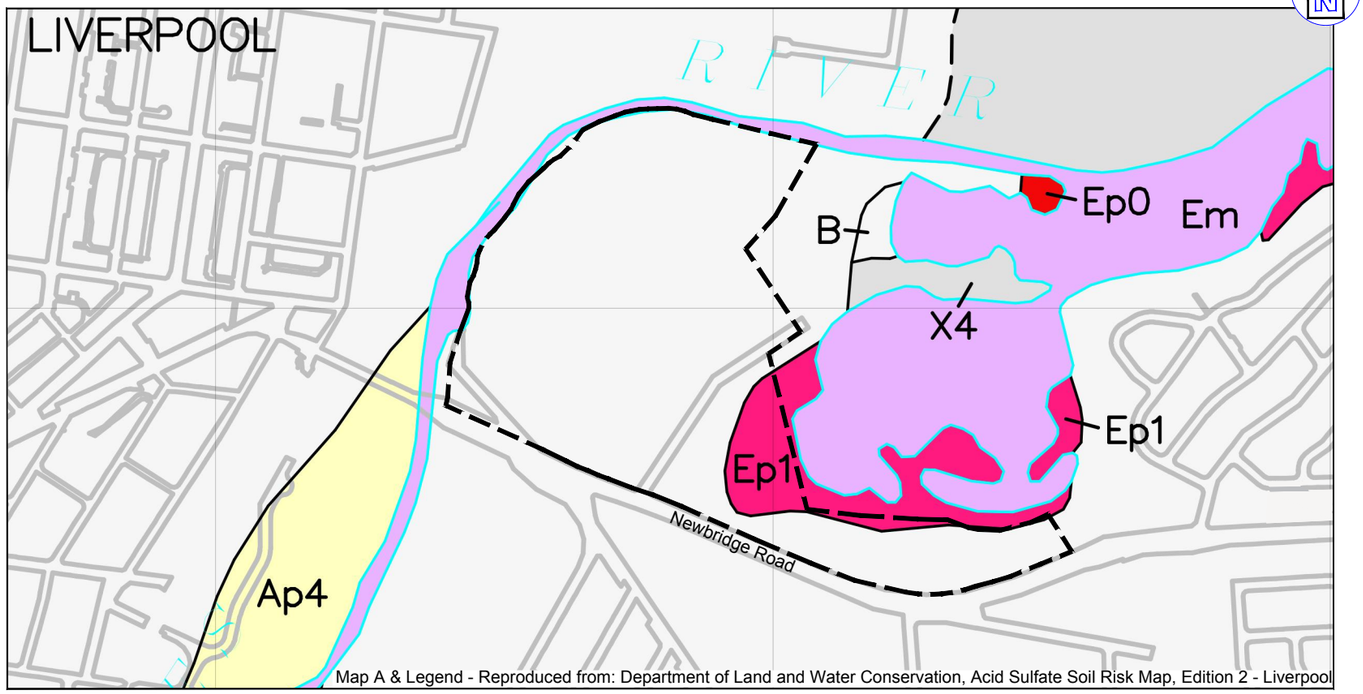
MAP B Legend

Colour Legend	Class of Land	Works
1	Class 1	Any works.
2	Class 2	Works below the natural ground surface. Works by which the watertable is likely to be lowered.
3	Class 3	Works more than 1m below natural ground surface. Works by which the watertable is likely to be lowered more than 1m below natural ground surface.
4	Class 4	Works more than 2m below natural ground surface. Works by which the watertable is likely to be lowered more than 2m below natural ground surface.
5	Class 5	Works within 500m of adjacent Class 1, 2, 3 or 4 land that is below 5m AHD by which the water table is likely to be lowered 1m AHD on adjacent Class 1, 2, 3 or 4 land.

Cadastre

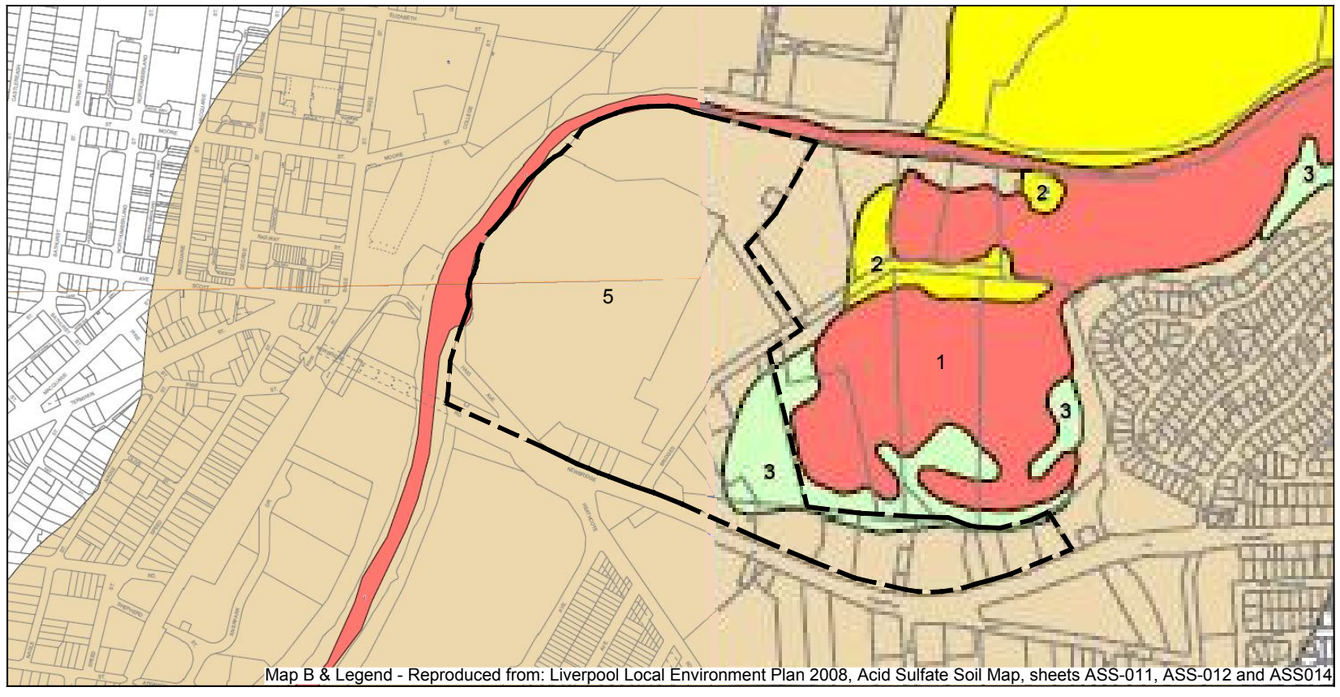
Cadastre 15/8/2008 © Dept of Lands

MAP A



Map A & Legend - Reproduced from: Department of Land and Water Conservation, Acid Sulfate Soil Risk Map, Edition 2 - Liverpool

MAP B



Map B & Legend - Reproduced from: Liverpool Local Environment Plan 2008, Acid Sulfate Soil Map, sheets ASS-011, ASS-012 and ASS014

LEGEND

Approximate precinct boundary

0 50 250 500 1000
Approx. Scale (m)

eiaustralia
Contamination | Remediation | Geotechnical
Suite 6.01, 55 Miller Street, PYRMONT 2009
Ph (02) 9516 0722 Fax (02) 9518 5088

Drawn:	M.G.
Approved:	-
Date:	26-07-19

LAC JV Pty Ltd
Moore Point Precinct Review Study
Part 2: Preliminary Acid Sulfate Soil Management Plan
Newbridge & Bridges Roads, Liverpool NSW

Acid Sulfate Soil Maps

Figure: 3

Project: E22882.E14