Douglas Partners
Geotechnics | Environment | Groundwater

Report on
Acid Sulfate Soil Management Plan

Botany Rail Duplication Project
EIS Section Mascot

Prepared for
John Holland Pty Ltd

Project 207996.00
November 2021

Integrated Practical Solutions

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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

	Signature	Date
Author	[signature]	01 November 2021
Reviewer	[signature]	01 November 2021

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Report on Acid Sulfate Soil Management Plan
Botany Rail Duplication Project
EIS Section Mascot

1. Introduction

Douglas Partners Pty Ltd (DP) has been engaged by John Holland Pty Ltd (JH) to prepare this acid sulfate soil management plan (ASSMP) for the Botany Rail Duplication at Mascot (the site). The site is shown on Drawing 1, Appendix A.

The ASSMP has been produced in accordance with DP's proposal P0207996.00 dated 23 August 2021.

The purpose of this ASSMP is to provide management methods and procedures to minimise environmental impacts resulting from the disturbance of acid sulfate soils (ASS). This ASSMP provides neutralisation and treatment methods, verification testing requirements, emergency response procedures and groundwater and leachate management procedures.

This report must be read in conjunction with all appendices including the notes provided in Appendix B.

2. Site Information

Site Address	The rail corridor between King Street, EIS Section Mascot and Stephen Road, Botany.
Legal Description	Parts of Lot 9, Deposited Plan (D.P.) 747022; Lot 201, D.P.777213; Lot 57, D.P.648872; Lot 55, D.P.608871; Lot 3, D.P.747022; Lot 7, D.P.1184596; Lot 1, D.P. 794238; Lots 8 and 10, D.P.1184711; Lots 1 and 2, D.P. 127031; Lot 10 and 11, D.P.9868; Lot 9, D.P.1184711; Lot 1, D.P.127045; Lot 1, D.P.127046; Lots 82 and 83, D.P. 9868; Lot 48, D.P.734879; Lot 12, D.P.776213; Lots 1 and 2, D.P.1164763; Lot 2, D.P.721704; Lot 1, D.P.1215723; Lot 1, D.P.836603, Lot 11, D.P.1184896, Lot 1, D.P.1173140, Lot 1, D.P.957659, Lots 23 to 27 Section K, D.P.939785 and Lot 2, D.P.1175903.
Length	Approximately 3 km.
Zoning	Zone SP2 Infrastructure (Railway). Zone SP2 Infrastructure (Airport). Zone SP2 Infrastructure (Classified Road). Zone B5 Business Development. IN1 - General Industrial.

Local Council Area	Bayside Council.
Current Use	Rail corridor.
Surrounding Uses	Predominantly commercial / industrial, including Sydney Airport, with some pockets of residential areas.
Regional Topography	The topography slopes gently down towards the south-west.
Site Topography	The rail lines are relatively level at approximately 10 m AHD (Australian Height Datum) however some sections are raised on embankments.
Soil Landscape	Located along the boundary between the aeolian Tuggerah soil landscape comprising coastal dune fields and disturbed terrain to the west and south.
Geology	Quaternary estuarine, and coastal dune and lake deposits overlying Hawkesbury Sandstone. Anthropogenic deposits are present to the west and south of the site.
Acid Sulfate Soils	Located along the boundary between an area of low probability of acid sulfate soils (ASS) and disturbed terrain to the west and south. There is a high probability of ASS associated with the Mill Stream sediments (Drawing R.002.2A, Appendix A).
Surface Water	Alexandra Canal is located approximately 1 km to the north-west of the site and the site crosses the Mill Stream towards to the south of the site.
Groundwater	A shallow perched groundwater table is present within the Quaternary deposits and a deeper confined groundwater table is present at depth within the sandstone.

3. Background on Acid Sulfate Soils

ASS are naturally occurring sediments that contain iron sulfides, primarily pyrite, commonly deposited in estuarine environments. The occurrence of ASS is associated with areas or regions that have previously been or are currently estuarine environments. Due to changes in sea level or geomorphologic changes to coastal systems, these sediments are often overlain by terrestrial sediments.

When ASS are exposed to air (e.g., due to bulk excavation or dewatering), the oxygen reacts with iron sulfides in the sediment, producing sulfuric acid. This acid can be produced in large quantities and is highly mobile in water. The sulfuric acid can drain into waterways causing severe short and long term socio-economic and environmental impacts, including damage to man-made structures and natural ecosystems.

ASS can either be classified as 'actual acid sulfate soils' (AASS) which are soils that have already reacted with oxygen to produce acid, or PASS. PASS are soils containing iron sulfide that have not been exposed to oxygen (e.g., soils below the water table). PASS therefore have not produced sulfuric acid but have the potential to do so if exposure to oxygen occurs. For the purposes of this report the term PASS is only used for soils which meet the requirements of EPA *Waste Classification Guidelines* (2014) Part 4 as summarised in Appendix C.

ASS field and laboratory based Action Criteria for determining if soils are classified as PASS / AASS are provided in Section C2.0, Appendix C.

4. Proposed Development

Australian Rail Track Corporation (ARTC) proposes to construct and operate a new second track within the existing rail line between Mascot and Botany. The Botany Rail Duplication would increase freight rail capacity to and from Port Botany. The location of the site is shown on Drawing R.002.1A, Appendix A. The project is State significant infrastructure in accordance with Division 5.2 of the NSW Environmental Planning and Assessment Act 1979 (EP&A Act).

The project involves:

- Track duplication - constructing a new track predominantly within the rail corridor for a distance of approximately three kilometres;
- Track realignment (slewing) and upgrading - moving some sections of track sideways (slewing) and upgrading some sections of track to improve the alignment of both tracks and minimise impacts to adjoining land uses;
- New crossovers - constructing new rail crossovers to maintain and improve access at two locations (totalling four new crossovers);
- Bridge work - constructing new bridge structures at Mill Stream, Southern Cross Drive, O'Riordan Street and Robey Street (adjacent to the existing bridges), and re-constructing the existing bridge structures at Robey Street and O'Riordan Street; and
- Embankment / retaining structures - construction of a new embankment and retaining structures adjacent to Qantas Drive between Robey and O'Riordan streets and a new embankment between the Mill Stream and Botany Road bridges.

Ancillary work would include bi-directional signalling upgrades, drainage work and protecting / relocating utilities. It is understood that excavations will generally be within 2 m of the ground surface with the exception of piled foundations at the bridge abutments.

The piling works for the above bridge works may encounter acid sulfate soils at depth.

5. Guidelines and Assessment Criteria

This ASSMP is devised on the basis of the following guidelines and reference documents endorsed by EPA and with reference to other national guidelines where considered appropriate:

- Acid Sulfate Soils Management Advisory Committee (ASSMAC) Acid Sulfate Soils Management Guidelines (1998) (ASSMAC, 1998);
- Dear, S-E., Ahern, C. R., O'Brien, L. E., Dobos, S. K., McElnea, A. E., Moore, N. G. & Watling, K. M., 2014. Queensland Acid Sulfate Soil Technical Manual: Soil Management Guidelines. Brisbane: Department of Science, Information Technology, Innovation and the Arts, Queensland Government (Dear *et al* 2014);
- NSW Environment Protection Authority (EPA) Waste Classification Guidelines (2014) (EPA, 2014);
- Sullivan, L, Ward, N, Toppler, N and Lancaster, G 2018, National Acid Sulfate Soils Guidance: National acid sulfate soils identification and laboratory methods manual, Department of Agriculture and Water Resources, Canberra, ACT. CC BY 4.0 (Sullivan *et a*l 2018a);
- Sullivan, L, Ward, N, Toppler, N and Lancaster, G 2018, National Acid Sulfate Soils guidance: National acid sulfate soils sampling and identification methods manual, Department of Agriculture and Water Resources, Canberra ACT. CC BY 4.0 (Sullivan *et al* 2018b); and
- QASSIT/Qld NRM&E/SCU/NatCASS/QASSMAC/ASSMAC Acid Sulfate Soils Laboratory Methods Guidelines Version 2.1 - June 2004. Published by Department of Natural Resources, Mines and Energy, Indooroopilly, Queensland, Australia (Qld NRM&E, 2004) (this guideline supersedes the laboratory section of ASSMAC, 1998).

The assessment criteria adopted for this ASSMP for determination of the presence of PASS / ASS and the verification criteria for treated PASS / ASS are provided in Appendix C.

6. ASS Management

6.1 Management Options

ASSMAC (1998) provides the following potential management options:

- Non-excavation or minimal earthworks;
- On-site treatment, followed by off-site disposal;
- On-site treatment, followed by on-site re-use;
- Off-site treatment and disposal;
- On-site reburial without treatment (PASS only);
- Off-site reburial without treatment (PASS only); and
- Separation of ASS fines.

Based on the proposed development and discussions with the client / contractor DP understands that on-site treatment and disposal has been identified as the preferred appropriate management option, in accordance with the relevant guidelines and reference materials.

6.2 Proposed Management Strategy - On-site Treatment and Disposal

The general process for the treatment of ASS is as follows:

- Prepare a treatment pad as described in Section 6.3;
- Manage ASS during stockpiling and treatment to minimise dust and leachate generation (e.g., by covering, or lightly conditioning with water). If wet weather prevails, stop works and cover the stockpiled soil with plastic sheeting to reduce the formation of leachate;
- Transport ASS requiring treatment and placement on the guard layer of the treatment pad;
- Spread the P/ASS over the guard layer in layers of up to 0.3 m thick, leaving a 1 m flat area between the toe of the spread soil and the containment bund or drain. When spreading the first soil layer, care should be taken not to churn up the guard layer; and
- Apply agricultural lime (commonly known as aglime) over the 0.3 m layer at the minimum lime dosing rate and harrow/ mix thoroughly. Use of rotary plough equipment (e.g., auger bucket) may be appropriate for cohesive soils, where adequate mixing is difficult to achieve. Note: If ASS materials are too wet, adequate mixing of aglime cannot be achieved and soils may require a period of drying prior to mixing.

Completion of validation testing (as outlined in Appendix C) to confirm that the ASS have been adequately neutralised in each layer prior to placement of the next layer to be treated. If validation testing indicates that additional neutralisation is required, add additional aglime (at an appropriate liming rate) and mix as described above;

- Continue the spreading / liming / harrowing / verification cycle for each 0.3 m layer until excavation is finished;
- When validation testing indicates that the ASS have been adequately neutralised, the soil may be removed from the treatment pad for disposal off-site in accordance with the waste classification; and
- When validation testing indicates the ASS have been adequately neutralised, subject to geotechnical suitability, the soil may be removed from the treatment pad for on-site reuse in accordance with the site management plan / RAP; and
- Management of groundwater may also be required where groundwater is impacted by the works as outlined in Section 7 and Appendix F.

6.3 Preparation of Treatment Pads

The key features of the treatment area and design considerations are summarised below and shown in Figure 1 below:

- Treatment pad area - The treatment pad should be of an appropriate area for the volume of soil to be treated/stored, and should be prepared on relatively level or gently sloping ground to minimise the risk of potential instability issues, with a fall to the local drainage sump;
- Pad location - The pad should be located as far as practical from any potential ecological receptors (such as drainage lines) which enter the stormwater system;
- Lining - An approved compacted clay layer (at least two layers to a combined compacted thickness of 0.5 m) or an approved geosynthetic liner (such as HDPE sheeting) should be used to line the pad. Where the subgrade soils comprise low permeability clay, no geosynthetic lining will be required;
- Guard Layer - A guard layer of fine agricultural lime ('aglime') should be applied over the clay subgrade or lining to neutralise downward seepage. This guard layer of lime should be applied at a rate of 5 kg of lime per m^2 of surface;
- The guard layer should be re-applied following removal of treated soils prior to addition of untreated ASS;
- NOTE: if the stockpiled soils on the treatment pad are expected to be greater than 3 m in height, it is recommended that the guard layer be applied as a base guard layer, with interim guard layers through the height of the stockpile; and
- Bunding - The treatment pad should be bunded to contain and collect potential leachate runoff within the treatment pad area and to prevent surface water from entering the treatment pad. The inner bund slopes should be lined to prevent leachate seeping into the ground surface, and sized to prevent overflow of untreated leachate onto the site.

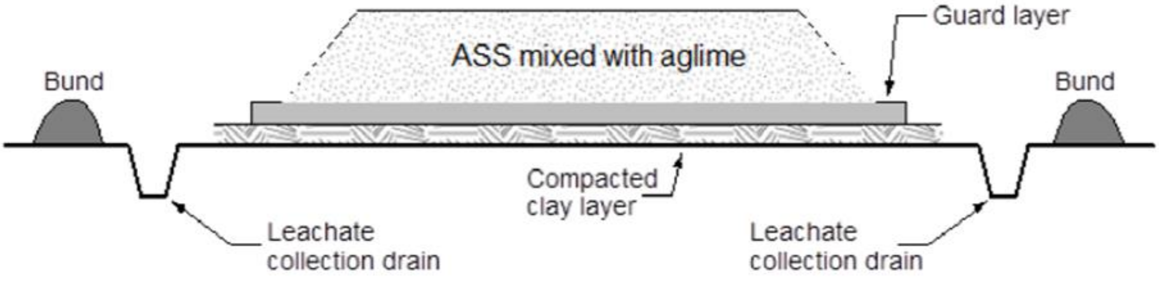


Figure 1: Schematic cross-section of a treatment pad, including clay layer, guard layer, leachate collection drain and bunding

6.4 Liming Rate

Liming rates to be calculated in accordance with Appendix E.

6.5 Neutralising Materials

Agricultural lime, commonly known as aglime, is the preferred neutralisation material for the management of ASS, as this material is usually the cheapest and most readily available product for acid neutralisation. Furthermore, aglime is slightly alkaline (pH of 8.5 to 9), non-corrosive, of low solubility and does not present handling problems.

Aglime comprises calcium carbonate ($CaCO_3$), typically made from limestone that has been finely ground and sieved to a fine powder. Aglime with the following properties are the preferred neutralising agent:

- Purity of at least 95% or better (i.e., NV > 95, where NV is the neutralising value, a term used to rate the neutralising power of different forms of materials relative to pure, fine calcium carbonate which is designated NV = 100); and
- Fine ground (at least <1 mm) and dry, as texture and moisture can decrease the effective NV.

Aglime requires no special handling, however, it would be advisable to cover any aglime stockpiles with a tarpaulin both to minimise wind erosion and wetting, as the material is more difficult to spread when wet.

Due to its low solubility in water, aglime is not suitable for the neutralisation of leachate, which requires a product with a very quick reaction and high solubility. The most suitable neutralising agent for leachate and retained drainage water is slaked lime or quicklime (calcium hydroxide). This is made by treating burnt lime (calcium oxide) with water (slaking) and comes as a fine white powder. It has a typical NV of about 135. Due to its very strong alkalinity (pH or about 12.5 to 13), slaked lime or quicklime should not be allowed to come into contact with the skin or be inhaled.

6.6 Validation Testing of Treated Soils

Validation testing to assess whether ASS have been adequately neutralised will be undertaken by means of the following:

- Screening tests (pHF and pHFOX) at the frequencies detailed in Table 1; and
- Chromium suite of testing OR SPOCAS suite of testing at the frequencies detailed in Table 1.

The SPOCAS method is not recommended for soil materials with organic matter contents greater than 0.6% organic carbon, as the organic matter in many soil materials with organic carbon contents greater than 0.6 % is capable of producing false positive identifications when using the SPOCAS method.

SPOCAS method is not recommended for soil materials with organic matter contents greater than 0.6% organic carbon, as the organic matter in many soil materials with organic carbon contents greater than 0.6 % is capable of producing false positive identifications when using the SPOS method. The sulfur from organic matter, even at these relatively low concentrations, can be erroneously included in the SPOS determination at levels that exceed action criteria.

Based on a "Category VH" treatment level, verification testing of the ASS and leachate water (if present) is required to be conducted after the addition of lime to test whether or not mixing has been adequate, and to reduce the risk of acidic water being returned to watercourses. The verification testing frequency is presented in Table 1.

Table 1: Verification Testing Frequency

Test	Frequency
Field test: pHF and pHFox screening Laboratory analysis: SPOCAS suite/ Chromium suite (preferred)	• One sample / soil type; OR • One sample / 500 m^3 of treated soil (whichever is the greater frequency); AND • At least one sample / 200 mm to 300 mm deep soil treatment layer

In addition, the pH of all ponded leachate water around the confines of the treatment bunds should be measured daily and results assessed against the criteria provided in Table 2. The soil and water contained within the bunded treatment area should not be removed until the target values presented in Table 2 below have been achieved. Treatment of deeper soil layers should not be commenced until the existing surface layer has been validated and removed.

Table 2: Target Levels of Neutralised Soil and Water

Test	Component	Target Level
Monitoring of water	pH	$6.5 < pH < 8.5$
	Turbidity	To comply with either values determined in consultation with the Authority or less than local background levels (baseline monitoring required).
	Aluminium (Al) and Iron (Fe)	Establish local water quality data prior to site disturbance and ensure that these values are not exceeded.
	Dissolved Oxygen	To comply with either values determined in consultation with the Authority or less than local background levels (baseline monitoring required).
Field screening of soil	pH_F	$5.5 < pH_F \leq 8.5$
Acid based accounting of soil (SPOCAS suite OR Chromium Suite)	Net acidity (using appropriate fine factor)[a]	Zero or negative
	pH_{KCL}	$pH_{KCL} \geq 6.5$
	TAA	Zero

[a] determined using equations C1 / C2 / C3, Appendix E

It should be noted that laboratory tests will require at least four days turnaround, possibly longer, and hence sufficient time should be allowed in the treatment programme for such verification testing. Only appropriately skilled staff should collect and test verification samples. In addition to normal regular supervision of the soil management process, it is suggested that formal inspections be undertaken.

6.7 Alternate Strategy or Contingency Plan

Where the proposed primary management option is not possible, or practical, alternate or contingency strategies may be considered. These options are outlined in Appendix D.

7. Groundwater and Leachate Management

Water is the main mechanism by which acid and metals from oxidised ASS are mobilised and transported. Careful management of water is therefore paramount to effective management of potential adverse impacts from ASS. Management is required to provide control of treated waters for discharge, and provide some margin for unattended weekend or holiday periods as well as heavy rain periods.

The groundwater and leachate management strategies are provided in Appendix F.

8. General Site Monitoring

It is recommended that prior to commencement of works, a Construction Environmental Management Plan (CEMP) should be developed. The CEMP should also include a programme for general site monitoring pertinent to the ASS. A typical monitoring programme is provided in Table 1 below and should be implemented by the responsible parties.

Table 1: General Monitoring Requirements

Task	Frequency	Standard	Reporting/Record Keeping	Responsibility
Site inspection	Daily	Visual/olfactory signs of ASS	File note	Site supervisor
Site inspection	Monthly	Visual/olfactory signs of ASS	File Note	Project Manager
Monitoring of disturbed excavations that are in ASS	Daily	Visual until backfilled	File note	Site supervisor
Monitoring of ASS treatment	Daily	Visual	File note and results of pH testing to be	Site supervisor

Task	Frequency	Standard	Reporting/Record Keeping	Responsibility
area/s		Daily pH testing until results show ASS or leachate has been neutralised (refer Section 4 and 12 for criteria and testing requirements)	recorded in field sheets	
Dewatering excavation in ASS	Prior to planned discharge	Treated and tested to demonstrate compliance with EPL requirements prior to discharge	Field sheets and permit to discharge	Site supervisor/environmental consultant

9. Emergency Incident Response Plan

Construction activities which may cause potential environmental threats are summarised in Table 2 below together with recommendations for "Emergency Response Procedures".

Table 2: Emergency Response Procedures

Construction Activity	Potential Environmental Threat	Emergency Response
Excavations	Flooding of open excavation causing adjacent groundwater levels to rise, leading to potential acid leachate once the excavation is drained	• Inform site supervisor and project manager / environmental consultant; • Determine pH of groundwater / floodwater in excavation; • Correct groundwater / floodwater pH by application of slaked lime to bring pH in range of 6.5 to 8.5; and • Drain pit to tanks / ponds for water quality assessment prior to discharge.
Treatment / Neutralisation	Soil washes or slips outside of bunded treatment area	• Inform site foreman and project manager / environmental officer; • Estimate volume of material breaching bund; • Conduct pH analysis of adjacent watercourses (if any) and correct pH if potentially impacted; • Remove escaped soil into a bunded treatment area; and • Over-excavate impacted area to 0.2 m depth, apply and mix lime at rate as for guard layers (5 kg lime per m^2 of surface).

	Breach in containment bund	• Inform site foreman and project manager/ environmental officer; • Close breach in bund; • Conduct pH analysis of adjacent watercourses (if any); and • Correct pH in any adjacent watercourse (if required).

For all construction activity incidents which pose an environmental threat, an incident report must be completed in order that:

- The cause of the incident may be determined;
- Additional control measures may be implemented; and
- Work procedures may be modified to reduce the likelihood of the incident re-occurring.

10. Reporting and Record Keeping

With reference to Dear *et al* (2014), it is good practise for the contractor to maintain a record of treatment of acid sulfate soils. Such records should include the following details:

- Date;
- Location / area;
- Time of excavation;
- Neutralisation process undertaken;
- Lime rate utilised;
- Results of monitoring;
- Disposal location; and
- Tonnages and disposal / transfer dockets (if applicable).

A record should also be maintained confirming contingency measures and additional treatment if undertaken. A final report should be issued upon completion of the works presenting the monitoring regime and results, and confirming that adverse environmental impact has not occurred during the works.

11. Conclusions

This ASSMP provides recommendations to determine if PASS / ASS will be encountered during the proposed works.

If ASS / PASS are encountered then the ASS management procedures provided herein will be enacted to minimise the impact of ASS on the environment.

12. References

- Acid Sulfate Soils Management Advisory Committee (ASSMAC) Acid Sulfate Soils Management Guidelines (1998) (ASSMAC, 1998).
- Ahern CR McElnea AE, Sullivan LA, Acid Sulfate Soils Laboratory Methods Guidelines, Queensland Department of Natural Resources, Mines and Energy, Indooroopilly, Queensland, Australia, June 2004.
- Dear, S-E., Ahern, C. R., O'Brien, L. E., Dobos, S. K., McElnea, A. E., Moore, N. G. & Watling, K. M., 2014. Queensland Acid Sulfate Soil Technical Manual: Soil Management Guidelines. Brisbane: Department of Science, Information Technology, Innovation and the Arts, Queensland Government (Dear *et al* 2014).
- Geological Survey of NSW Sydney, 1:100 000 Geology Sheet.
- NSW Environment Protection Authority (EPA) Waste Classification Guidelines (2014) (EPA, 2014).
- NSW Roads and Traffic Authority (RTA) Technical Guideline: Guidelines for the Management of Acid Sulfate Materials: Acid Sulfate Soils, Acid Sulfate Rock and Monosulfidic Black Ooze (RTA, 2005).
- Soil Conservation Service of NSW, Sydney 1:100 000 Sheet.
- Stone, Y, Ahern C R, and Blunder B, NSW Acid Sulfate Soil Manual, Acid Sulfate Advisory Committee, Wollongbar, NSW, Australia, August 1998.
- Sullivan, L, Ward, N, Toppler, N and Lancaster, G 2018, National Acid Sulfate Soils Guidance: National acid sulfate soils identification and laboratory methods manual, Department of Agriculture and Water Resources, Canberra, ACT. CC BY 4.0 (Sullivan *et a*l 2018a).
- Sullivan, L, Ward, N, Toppler, N and Lancaster, G 2018, National Acid Sulfate Soils guidance: National acid sulfate soils sampling and identification methods manual, Department of Agriculture and Water Resources, Canberra ACT. CC BY 4.0 (Sullivan *et al* 2018b).
- QASSIT/Qld NRM&E/SCU/NatCASS/QASSMAC/ASSMAC Acid Sulfate Soils Laboratory Methods Guidelines Version 2.1 – June 2004. Published by Department of Natural Resources, Mines and Energy, Indooroopilly, Queensland, Australia (Qld NRM&E, 2004) (this guideline supersedes the laboratory section of ASSMAC, 1998).

13. Limitations

Douglas Partners (DP) has prepared this report for this project for the Botany Rail Duplication in accordance with DP's proposal dated 23 August 2021 and acceptance received from John Holland Pty Ltd dated 1 October 2021. The work was carried out under Short Form Consultancy Agreement 7642-003. This report is provided for the exclusive use of John Holland Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The assessment of atypical safety hazards arising from this advice is restricted to the (geotechnical / environmental / groundwater) components set out in this report and based on known project conditions and stated design advice and assumptions. While some recommendations for safe controls may be provided, detailed 'safety in design' assessment is outside the current scope of this report and requires additional project data and assessment.

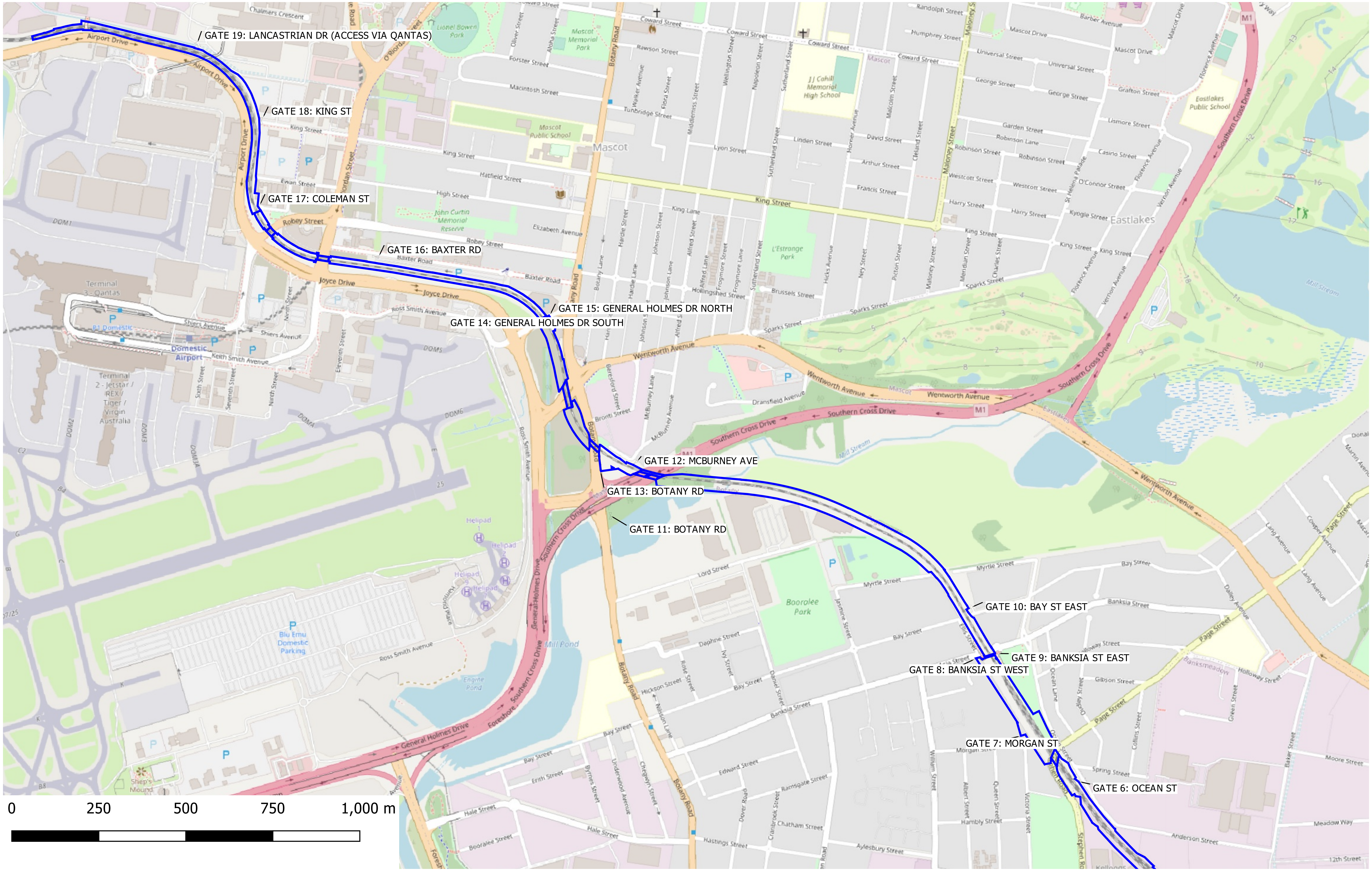
This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

Douglas Partners Pty Ltd

Appendix A

Drawings



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Geotechnics | Environment | Groundwater

CLIENT: JOHN HOLLAND PTY LTD		TITLE:	**SITE OVERVIEW**
OFFICE: Sydney	DRAWN BY: NLE		**BOTANY RAIL DUPLICATION**
SCALE: 1:10000 @ A3	DATE: 12.10.2021		**MASCOT**

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PROJECT No:	207996.00
DRAWING No:	R.002.1A
REVISION:	DftA

Appendix B

Notes About this Report

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

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This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Appendix C

Action Criteria and Verification of Treatment

Appendix C
Action Criteria and Treatment Verification
Botany Rail Duplication: EIS Section Mascot

C1.0 Introduction

This appendix details the acid sulfate soil action criteria, acid sulfate soil treatment verification criteria, equations for net acidity and waste classification criteria. The action criteria are based on Sullivan *et al* (2018b).

C2.0 Action Criteria

The following section provides the action criteria to determine if the soil is classified as ASS and therefore if acid sulfate soil management is required.

C2.1 Field Screening

Field screening indicators do not form part of the Assessment Criteria as such but can be used to provide an indication of the ASS status and to assist in selecting samples for laboratory testing.

Field screening is indicative only and can give false positive and false negative indications of the presence of ASS. False positives can be caused by organic matter, which often "froths" during oxidation. False negatives can be caused by shells in the soil. Indicators of ASS from field screening comprise:

- Field pH is less than or equal to pH 4;
- pHfox is less than 3.5;
- A decrease of more than 1 pH unit from the field pH to the pHfox;
- Bubbling, production of heat or release of sulphur odours during pHfox testing; and
- Change in colour from grey to brown tones during oxidation.

C2.2 Laboratory Analysis

The action criteria trigger are the basis for determining if a ASSMP is required. They are based on Net Acidity. As clay content tends to influence a soil's natural buffering capacity, the action criteria are grouped by three broad texture categories – coarse, medium and fine. If the Net Acidity of any individual soil tested is equal to or greater than the action criterion a detailed ASS management will need to be prepared.

The test results can be used to evaluate the presence/ absence of ASS in accordance. If the results indicate the absence of ASS treatment is not required. The following Table C1 provides the action criteria.

Table C1: Action Criteria

Type of Material		Net Acidity#			
		1-1000 t Materials Disturbed		>1000 t Materials Disturbed	
Texture Range (NCST 2009)*	Approximate Clay Content %)	% S-equiv (oven dried basis)	Mol H+/t (oven dried basis)	% S-equiv (oven dried basis)	Mol H+/t (oven dried basis)
Fine: Light medium to heavy clay	>40	≥ 0.1	≥ 62	≥ 0.03	≥ 18
Medium: Clayey sand to light clays	5-40	≥ 0.06	≥ 36	≥ 0.03	≥ 18
Coarse and Peats: Sands to loamy sands	<5	≥ 0.03	≥ 18	≥ 0.03	≥ 18

* If bulk density values are not available for the conversion of cubic meters to tonnes of soil, then the default bulk densities based on the soil texture in Table C2, may be used.

Net Acidity can only include a soil material's measured Acid Neutralising Capacity where this measure has been corroborated by other data (for example slab incubation data) that demonstrates the soil material does not experience acidification during complete oxidation under field conditions (Equation C1). Where the Acid Neutralising Capacity has not been corroborated, the Net Acidity must be determined using Equation C2.

Table C2: Default bulk densities based on soil texture.

Texture	Bulk Density (t/m^3)
Sand	1.8
Loamy Sand	1.8
Sandy Loam	1.7
Loam	1.6
Silty Loam	1.5
Clay Loam	1.5
Clay	1.4
Peat	1.0

C3.0 Verification of Treatment

The following section provides the equations and methods of verifying that the neutralisation treatment has been successful / completed.

C3.1 Field Screening

Field screening results will be considered to be acceptable when the results are below the adopted criteria. When soils do meet the following criteria, confirmatory laboratory testing should be undertaken.

- Field pH (pH_F) is ≥ 5.5 (but ideally between pH 6.5 and 8.5); and
- pHfox ≥ 6.5.

C3.2 Laboratory Testing

The soil will be considered successfully treated where:

- pHkCl is ≥ 6.5;
- (total actual acidity) TAA = 0; and
- Net acidity ≤ 0. Net Acidity must be determined by one of the methods outlined in Section D3.2.1

C3.2.1 Net Acidity

Net Acidity is the quantitative measure of the acidity hazard of ASS. It is determined from an Acid Base Accounting (ABA) approach using one of the equations below and based on the chromium suite of testing. Equations C1 and C2 are used to determine the net acidity prior to treatment of ASS and therefore if acid sulfate soil treatment and / or management plan is required. Equation C3 is used to determine the neutralisation treatment has been successful.

- Equation C1 - when the effectiveness of a soil's measured Acid Neutralising Capacity has been corroborated by other data demonstrating the soil does not experience acidification during complete oxidation under field conditions, or
- Equation C2 - when the effectiveness of a soil's measured Acid Neutralising Capacity has not been corroborated by other data, or
- Equation C3 – when the effectiveness of a management approach involving the addition of liming materials is being verified post treatment via calculation of the Verification Net Acidity.

Equation C1 Net Acidity whereby acid neutralising capacity (ANC) has been corroborated by other data.

Net Acidity = potential sulfidic acidity + actual acidity + retained acidity - Acid Neutralising Capacity

Net Acidity (%S) = Scr + S-TAA at pH 6.5 + SNAS - s-ANCBT

Equation C2 Net Acidity whereby ANC has not been corroborated by other data.

Net Acidity (%S) = potential sulfidic acidity + actual acidity + retained acidity

Net Acidity (%S) = Scr + S-TAA at pH 6.5 + SNAS

Equation C3 Verification Net Acidity.

Verification Net Acidity = potential sulfidic acidity + actual acidity + retained acidity – (post neutralised Acid Neutralising Capacity – pre neutralised Acid Neutralising Capacity)

Verification Net Acidity (%S) = Scr + S-TAA at pH 6.5 + SNAS – (ANCBT of treated material – ANCBT of untreated material)

C4.0 Off-Site Disposal Requirements

Prior to disposal off-site the soil must be classified in accordance with the relevant guidelines.

C4.1 Virgin Excavated Natural Material

The POEO Act defines virgin excavated natural material (VENM) as:

'*natural material (such as clay, gravel, sand, soil or rock fines):*

(a) That has been excavated or quarried from areas that are not contaminated with manufactured chemicals, or with process residues, as a result of industrial, commercial, mining or agricultural activities; and

(b) That does not contain any sulfidic ores or soils or any other waste.

and includes excavated natural material that meets such criteria for virgin excavated natural material as may be approved for the time being pursuant to an EPA Gazettal notice.'

PASS / ASS and treated PASS / ASS cannot be classified as VENM.

C4.2 Waste Classification

If soil is proposed to be disposed to landfill (post treatment), it must be classified in accordance with the POEO Act, including the current guidelines, namely the NSW EPA Waste Classification Guidelines (2014) (EPA, 2014).

C4.3 Disposal as PASS

Further guidance for the disposal of untreated natural material as PASS is provided in Appendix D of this ASSMP.

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Appendix D

Contingency Management Options

Appendix D

Contingency Options to On-Site Treatment

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D1.0 Introduction

This Appendix provides the contingency options to the selected management option.

D2.0 Reburial On-Site

Where possible (and if practical to do so) the ASS can be reburied on site, below the water line / water table provided the soil meets the definition of PASS and the soil is reburied within 24 hours, before the soil has a chance to oxidise.

For the purpose of this ASSMP PASS are defined by NSW Environment Protection Authority (EPA) Waste Classification Guidelines (2014) (EPA, 2014) Part 4 (Acid Sulfate Soils). PASS are defined as:

- They 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 soils.

Where VENM is defined as:

The Protection of the Environment Operations Act 1997 (POEO Act) defines virgin excavated natural material (VENM) as:

'natural material (such as clay, gravel, sand, soil or rock fines):

(a) that has been excavated or quarried from areas that are not contaminated with manufactured chemicals, or with process residues, as a result of industrial, commercial, mining or agricultural activities and

(b) that does not contain any sulfidic ores or soils or any other waste and includes excavated natural material that meets such criteria for virgin excavated natural material as may be approved for the time being pursuant to an EPA Gazettal notice.'

D3.0 Off-Site Treatment and Disposal

Where on site treatment of PASS is not possible and / or practical then off-site treatment at a facility appropriately licenced to accept and treat such soil can be considered. The below general procedure should be followed for off-site treatment:

- Loading the soil into trucks. Note if the soils are wet, they will be heavier than soils as normally transported at field moisture. This should be taken into consideration when loading trucks to ensure that trucks are not overloaded;
- Transport must be conducted in a sealed truck which prevents water leaking from the truck during transport;
- Completion of site records of the above and all information required by the treatment facility, and provision of copies of these records to the treatment facility;
- Transporting of soil to the treatment facility;
- Once the ASS have been accepted by treatment facility they will treat and manage it in accordance with ASSMAC (1998) and their EPL conditions, subject to the verification procedures documented herein;
- Verification of the treatment of the ASS and classification of the soil by an Environmental Consultant in; and
- Transport of the treated, classified ASS to the final receiving site/ disposal facility.

D4.0 Off-Site Disposal as PASS

D4.1 PASS Criteria

EPA (2014), Part 4 states that ‘Potential ASS may be disposed of in water below the permanent water table, provided:

- The soils meet the definition of VENM in all aspects other than the presence of sulfidic soils or ores;
- The pH of soils in their undisturbed state is pH 5.5 or more;
- The soil has not dried out or undergone any oxidation of its sulfidic minerals;
- Soil is received at the disposal point within 16 hours of excavation, and kept wet at all times between excavation and reburial at the disposal point;
- Appropriate records are provided to the receiving site with every truck load confirming that it meets the above criteria; and
- The receiving site meets its obligations under EPA (2014) and its Licence conditions.

For the purposes of this ASSMP, potential acid sulfate soils (PASS) are defined in accordance with the NSW Environment Protection Authority (EPA) Waste Classification Guidelines (2014) (EPA, 2014) Part 4 (Acid Sulfate Soils).

This classification is applicable for direct disposal of untreated PASS to a landfill licenced by the EPA to accept PASS.

D4.2 Disposal as PASS

The below works will be undertaken by appropriately trained staff:

- Agreement with receiving site on acceptance times for trucks, and allowable time lapse between excavation and acceptance by receiving site;
- Soils will be kept wet at all times, and should be sprayed with water if required to keep them wet;
- Recording of the excavation date, time and source chainage of the excavated soil;
- Inspection of the excavated soil for moisture content, material texture/ signs of contamination concern, such as anthropogenic odours, staining or inclusions by all personnel involved in the management / handling of the spoil;
- If signs of anthropogenic impact or fill are observed, the soil will not be pre-classified as PASS, and the soil will be segregated for further assessment;
- Measuring the pH in at least one sample per 50 m3, or a minimum of 10 per shift, using a calibrated pH meter in accordance;
- If the pH is less than or equal to 6.5, the soil will not be classified as PASS, and the soil will be segregated for further assessment and treatment);
- Loading the soil into trucks and ensuring the soil is moist enough to prevent it drying out during transport. Note: due to the soils being wet, they will be heavier than soils as normally transported at field moisture (PASS estimated to be approximately 2 t/m3). This should be taken into consideration when loading trucks to ensure that trucks are not overloaded;
- Soil should be loaded and transported as soon as possible to minimise the risk of oxidisation, which prevents it from being classified as PASS;
- Transport must be conducted in a sealed truck which prevents water leaking from the truck during transport;
- Completion of site records of the above;
- Completion of records of all information required by the receiving site, and provision of copies of these records to the receiving site, including copies sent with the truck driver for the load being carried;
- Transporting of soil meeting the PASS requirements to of the receiving site within 16 hours of excavation (or earlier if required by the receiving site);
- Once the PASS have been accepted by the receiving site they are required to manage it in accordance with the their EPL conditions. It is not the role of this document to discuss management of soil once they have been accepted by the receiving site; and
- Any soil which is rejected by receiving will be transported back to the site and managed in accordance with the ASSMP.

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Appendix E

Liming Rate Calculation

Appendix E
Liming Rate Equations
Botany Rail Duplication: EIS Section Mascot

E1.0 Introduction

This Appendix provides the equations for the calculation of liming rates.

E2.0 Liming Rates

The required liming rate can be calculated from one of the following formulas.

Equation F1:
Neutralising Material Required (kg $CaCO_3$/tonne soil) = (Net acidity (mol H+/t) / 19.98) x FOS x 100/ENV

Equation F2:
Neutralising Material Required (kg $CaCO_3/m^3$ soil) = D (tonne/m^3) x (Net acidity (mol H+/t) / 19.98) x FOS x 100/ENV

Where:

- Net acidity (mol H+/t) is derived using the 95% UCL of the Net Acidity (%S) using the methods in Appendix C;
- 19.98 converts to kg $CaCO_3$/tonne;
- FOS (factor of safety) = a minimum value of 1.5 needs to be adopted, although values of up to 2 can be suitable;
  - ENV = Effective Neutralising Value (e.g., Approx. 98% for fine (0.3 mm grain size) ag lime with an NV of 98%).
  - D = bulk density, site specific results can be used, or the bulk densities in Table 2 of Appendix C should be used.

Notes:

- The ENV is calculated based on the molecular weight, particle size and purity of the neutralising agent and should be assessed for proposed materials in accordance with ASSMAC (1998).
- Natural net acidity must not be used.

An initial liming rate based on the laboratory result calculation (excluding ANC) is considered appropriate based on it including a safety factor of 1.5 and the use of ag lime with an NV of at least 98% and a grain size of less than 0.5 mm.

Depending upon the source of the aglime and ultimately the representative ENV of the aglime selected, the minimum lime dosing rate may be increased or decreased. Prior to the commencement of works, the minimum lime dosing rate should be finalised following review of the ENV of the selected ag-lime.

The liming rate to be calculated from the analytical results should therefore be considered as a "starting point", and pH monitoring should be conducted during treatment to assess the progress of the neutralisation, and need for additional mixing and/ or addition of ag lime. Soil will only be considered to have been successfully treated when all soil has been verified in accordance with Appendix C.

E3.0 References

- Acid Sulfate Soils Management Advisory Committee (ASSMAC) Acid Sulfate Soils Management Guidelines (1998) (ASSMAC, 1998); and
- Sullivan, L, Ward, N, Toppler, N and Lancaster, G 2018, National Acid Sulfate Soils Guidance: National acid sulfate soils identification and laboratory methods manual, Department of Agriculture and Water Resources, Canberra, ACT. CC BY 4.0 (Sullivan et al 2018a).

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Appendix F

Water and Groundwater Management

Appendix F
Water and Groundwater Management
Botany Rail Duplication: EIS Section Mascot

F1.0 Introduction

Water is the main mechanism by which acid and metals from oxidised ASS are mobilised and transported. Careful management of water is therefore paramount to effective management of potential adverse impacts from ASS. Management is required to provide control of treated waters for discharge, and provide some margin for unattended weekend or holiday periods as well as heavy rain periods.

The below sections provide potential strategies for management, assessment and disposal of water leaching from ASS, surface water and water from groundwater dewatering.

F1.1 Leachate and Surface Water Collection

All water that has been in contact with ASS / assumed ASS must be managed, assessed, treated and appropriately disposed of in accordance with consent conditions / EPL / dewatering management plan / other.

Dewatering and Extracted Groundwater

In general, risks associated with dewatering in areas underlain by ASS include:

- Acidification of in situ soils drained within the dewatering cone of depression and difficulties associated with neutralising these in situ soils (this can also impact the possible PASS classification of some soils);
- Acidification of groundwater remaining within the dewatering cone of depression after the system has re-flooded;
- Iron, aluminium and heavy metal contamination of groundwater arising from mobilisation of these compounds under low pH conditions; and
- Acidification and contamination of surface water bodies which receive groundwater.

It is considered that there is the potential to expose soils within the proposed excavation areas to air which will allow some acidification to take place. However, the water and ASS from within these areas will be removed and treated, mitigating associated risks.

The dewatering should be designed to not significantly affect groundwater levels outside of the cut-off structures, and therefore the potential for oxidation of ASS outside of the excavation areas is expected to be limited.

The following dewatering risk management methods are recommended for the project:

- Drawdown outside of the excavation areas should be minimised; and
- Monitoring, treatment and disposal of water from dewatering effluent.

Water Storage and Treatment

Water from dewatering and the ASS leachate should either be pumped directly to an on-site treatment plant for treatment or should be stored in a tank or lined drains/ detention basin prior to assessment / treatment.

At a minimum, the combined storage should be designed to store enough water to contain leachate and extracted water from a 1 in 10-year (1 hour) storm event.

Water Assessment for Disposal

All water which has potentially come into contact with ASS requires assessment (and if necessary treatment). Minimum recommended monitoring is provided in Table G1, below.

Table F1: Suggested Water Monitoring Frequencies and Target Levels for Disposal to Stormwater

<table>
<tr><th>Test</th><th>Frequency</th><th>Target Level for Disposal to Stormwater</th></tr>
<tr><td>pH</td><td rowspan="3">Water detention basin/ tank:
• During storage/ treatment as required to allow timely treatment;
• Less than 24 hours prior to any planned discharge;
• Daily during discharge period.
• For unplanned discharges (i.e. due to rain), within 5 days of the cessation of the rainfall event
Treatment Plant:
• During storage/ treatment as required to allow timely treatment; and
• Daily during discharge period.</td><td>• pH 6.5 to 8.5</td></tr>
<tr><td>Total Suspended Solids (TSS)</td><td>• ≤50 mg/L or equivalent turbidity measure (in NTU) where a statistical correlation between the TSS and turbidity has been determined</td></tr>
<tr><td>Oil and Grease</td><td>• None observable</td></tr>
<tr><td>Iron (total and soluble)</td><td>Laboratory analysis:
• Immediately prior to disposal; and
• Weekly checks during discharge period; and
• As required based on visual observations; and

Visual assessment of discolouration:
• Daily during discharge</td><td>• No obvious sign of iron staining/ settlement
• ≤0.3 mg/L filterable iron
• ≤0.8 µg/L filterable Aluminium @ < pH 6.5
• ≤55 µg/L filterable Aluminium @ > pH 6.5</td></tr>
</table>

Test	Frequency	Target Level for Disposal to Stormwater
Potential contaminants [including VOC, PAH, TRH, BTEX, PFAS and metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc)]	Laboratory analysis: • One round of testing before first disposal of ASS impacted water; • If first round of testing exceeds target levels then further testing prior to disposal is required	• ANZG (2018) Trigger Levels for 95% / 99% Level of Protection for marine ecosystems if no licence conditions are available

Notes:

Notes:	VOC	Volatile organic compounds
	PAH	Polycyclic aromatic hydrocarbons
	BTEX	Benzene, toluene, ethylbenzene, xylenes
	TRH	Total recoverable hydrocarbons
	OCP	Organochlorine pesticides

Treatment

General

The potential impacts of ASS on water generally comprise a decrease in pH, possible elevated TSS/ turbidity, iron and other metals.

Treatment of water from construction sites is commonly required for pH and TSS. Aeration and removal of TSS also generally decreases metal concentrations in the water. Therefore, an on-site water treatment plant is considered likely to be suitable for treatment of ASS impacted water that has not been oxidised.

An alternate treatment method for pH is provided in Section G1.5.2 in case treatment of excess water above the capacity of the treatment plant is required.

If a suitable treatment method for man-made contaminants in the water (e.g., VOC, PAH, TRH, BTEX, OCP, metals etc) cannot be implemented, an alternate disposal method may be required (e.g., trucking off-site to a liquid waste disposal facility or disposal to sewer in accordance with a specific Trade Waste Agreement which would need to be obtained from Sydney Water).

Alternate pH Treatment Method

It is noted that aglime is generally not suitable for the treatment of leachate due to its low solubility in water. A commercial pH adjustment product can be used, or else slaked lime as discussed below.

Alternative neutralisation materials include calcined magnesia (magnesium hydroxide, burnt magnesite, or magnesia) and calcium hydroxide (commonly called slaked or hydrated lime).

Calcined magnesia (magnesium hydroxide, burnt magnesite, or magnesia) is the recommended neutralising agent as it produces a two-step reaction, which proceeds rapidly at acidic pH and slows down as higher pH is approached, and hence reduces the potential for over-neutralisation. It should be added to the leachate as a slurry and mixing achieved via use of an agitator.

A calcium hydroxide (commonly called slaked or hydrated lime) solution can be produced by stirring calcium oxide (commonly called quicklime) into water, in a container of sufficient volume (for example, a plastic 200 litre drum). The slurry should be allowed to settle, and the clear solution (which will be caustic, with a pH of approximately 12.5 to 13) can be pumped or sprayed into the standing water in small amounts, with some agitation and monitoring. This procedure should be continued until the pH is adjusted to acceptable levels. Adequate care should be taken not to "overshoot" the desired pH with calcium hydroxide.

Quicklime is very reactive, and relatively corrosive (due to its caustic nature). When quicklime is mixed with water, the resulting reaction generates heat. Therefore, if utilised, the material should be added in increments to a large amount of water to control the reaction. Slaked or quicklime should not be allowed to come into contact with the skin or be inhaled during use.

The amount of neutraliser required to be added to the discharged groundwater can be calculated from the equation below:

Equation G1:

$$\textit{Alkali Material Required (kg)} = \frac{M_{Alkali} \times 10^{-pH\ initial}}{2 \times 10^{3}} \times V$$

Where:

M_{Alkali} = *molecular weight of alkali material (g/mole)* (*molecular weight of slaked lime ($Ca(OH)_2$) = 74 g/mole.*)

pH initial = *initial pH of leachate*

V = *volume of leachate (litres)*

As a guide, the approximate quantities of slaked lime required to neutralise acidic water are provided in Table G2.

Table F2: Approximate Liming Rates for Water (based on slaked lime (kg of $Ca(OH)_2$))

Water pH	Volume		
	10 m^3	50 m^3	100 m^3
2	3.7	18.5	37
3	0.37	1.85	3.7
4	0.037	0.185	0.37
5	0.0037	0.0185	0.037
6	0.00037	0.00185	0.0037

Water Discharge

Following treatment (if required) the water should be assessed to determine if it meets the EPL conditions / discharge criteria. Water meeting the conditions can then be disposed of accordingly.

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