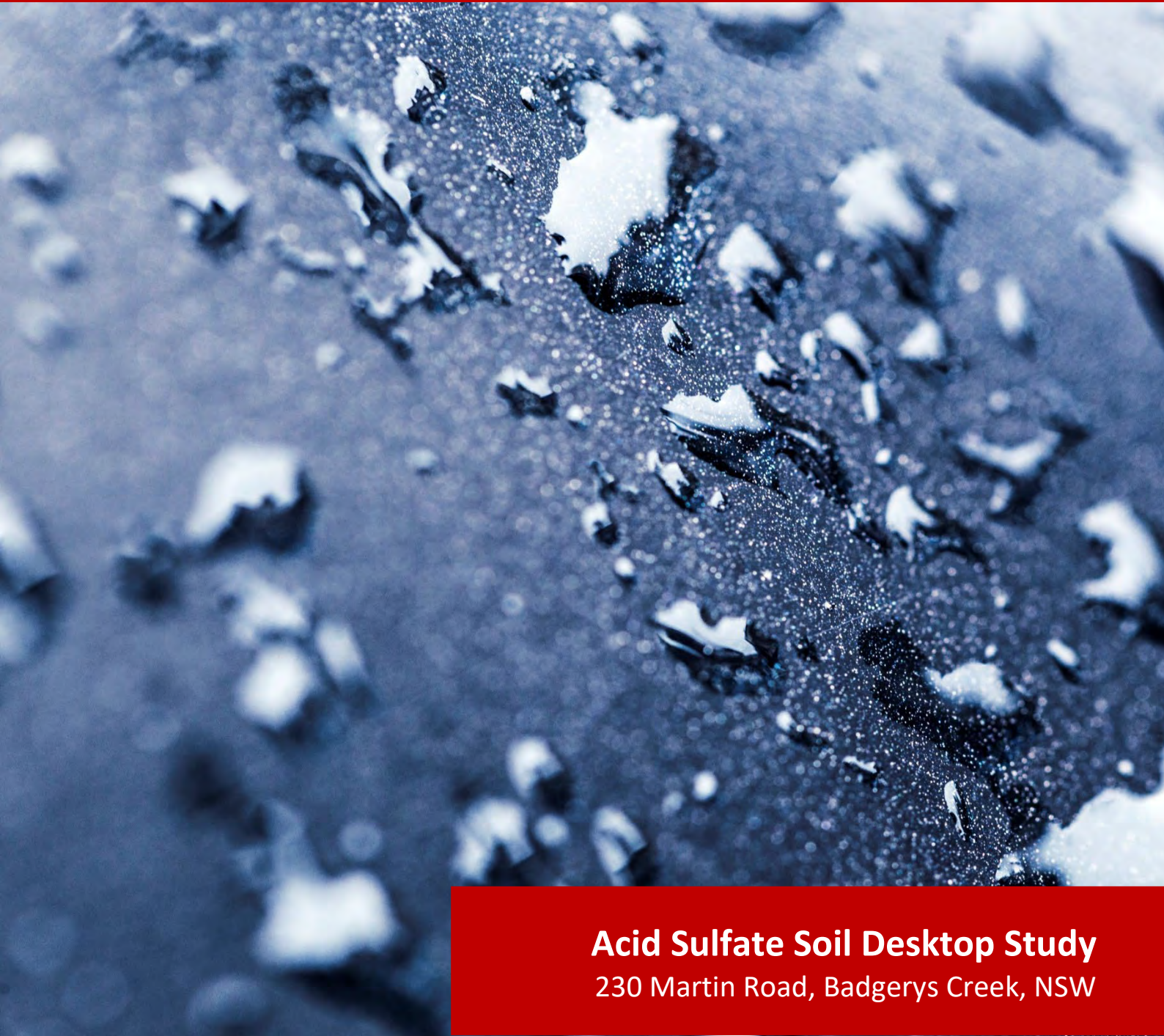




**Acid Sulfate Soil Desktop Study**  
230 Martin Road, Badgerys Creek, NSW

Prepared for: EMKC Cubed Pty Ltd  
EP3390.003 29 October 2025



## 230 Martin Road - SECRETARY'S ENVIRONMENTAL ASSESSMENT REQUIREMENTS Matrix

Table 1 below sets out the Secretary's Environmental Assessment Requirements (SEARs) for the project. A consultant is identified against each SEAR matter. Each identified consultant will be responsible for addressing the relevant matter as part of the preparation of the State Significant Development Application (SSDA).

Table 2 sets out the additional Agency requirements and the consultant responsible for addressing these as part of the SSDA.

Table 1 SEARs requirements and responsible consultant

| Item / Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Responsibility |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| General Requirements                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                |
| <ul style="list-style-type: none"><li>▪ Soils – an assessment of potential impacts on soil resources and riparian land on and near the site that includes:<ul style="list-style-type: none"><li>– A description of and assessment of potential impacts on soil resources and riparian land on and near the site, including impacts on the Wianamatta – South Creek riparian corridor, soil erosion, salinity and acid sulfate soils.</li><li>– Details of earthworks, including cut and fill volumes, demonstrating consideration of the Connecting with Country Framework (2023) and landscape-led design</li><li>– Description of the proposed erosion and sediment controls during construction</li><li>– a geotechnical assessment that provides a comprehensive analysis of the development capability of the site.</li></ul></li></ul> | Sections 2, 4  |

Table 2 Agency requirements and responsible consultant

| Item / Description                                                                                              | Document Reference |
|-----------------------------------------------------------------------------------------------------------------|--------------------|
| <b>Department of Planning and Environment (Biodiversity and Conservation)</b>                                   |                    |
| <b>Water and Soils</b><br><br>1. The EIS must map the following features relevant to water and soils including: |                    |

- |                                                                                                                                                                                                                                                                                                                             |                     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| <ul style="list-style-type: none"><li>a. Acid sulfate soils (Class 1,2,3 or 4 on the Acid Sulfate Soil Planning Map)</li><li>b. Rivers, streams, wetlands and estuaries</li><li>c. Wetlands</li><li>d. Groundwater</li><li>e. Groundwater dependent ecosystems</li><li>f. Proposed intake and discharge locations</li></ul> | <p>a) Section 2</p> |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|

# Acid Sulfate Soil Desktop Study

230 Martin Road, Badgerys Creek, NSW

EMKC Cubed Pty Ltd  
Level 11, 37 York Street  
Sydney NSW 2000

29 October 2025

Our Ref: EP3390.003

## LIMITATIONS

This Acid Sulfate Soil Desktop Study was conducted on the behalf of EMKC Cubed Pty Ltd for the purpose/s stated in **Section 1**.

EP Risk has prepared this document in good faith, but is unable to provide certification outside of areas over which EP Risk had some control or were reasonably able to check. The report also relies upon information provided by third parties. EP Risk has undertaken all practical steps to confirm the reliability of the information provided by third parties and do not accept any liability for false or misleading information provided by these parties.

It is not possible in an Acid Sulfate Soil Desktop Study to present all data, which could be of interest to all readers of this report. Readers are referred to any referenced investigation reports for further data.

Users of this document should satisfy themselves concerning its application to, and where necessary seek expert advice in respect to, their situation.

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| Version | Author     | Date       | Reviewer    | Date       | Quality Review | Date       |
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# 1 Introduction

EP Risk Management Pty Ltd (EP Risk) was engaged by EMKC Cubed Pty Ltd (EMKC) to prepare an Acid Sulfate Soil Desktop Study (the Assessment) for 230 Martin Road, Badgerys Creek, NSW (the Site). The Site is legally described as Lot A in Deposited Plan (DP) 406215 and is shown in **Figure 1**.

The proposal seeks approval for two (2) contemporary warehouse or distribution centre buildings at 230 Martin Road, Badgerys Creek. Specifically, the development will comprise:

- Site clearance works, including the removal of existing structures and trees.
- Bulk earthworks and the installation and augmentation of utilities infrastructure and other services.
- Construction and operational use of two warehouse or distribution centres containing ancillary offices, amenities and manufacturing use (in lot 1 only) with associated, parking, landscaping and access.
- Other ancillary works.

EP Risk was requested by the client to prepare an ASSMP in accordance with the requirements of section 5, “Environmental Health”, of the Planning Secretary’s Environmental Assessment Requirements (SEARs) for the Site.

## 1.1 Objective and Scope

The objective of the ASSMP is to assess the potential for acid sulfate soil (ASS) at the Site and to ensure that water quality, soil runoff, site wastewater, potential water contamination associated with ASS are considered and effectively managed during the Proposed Development.

## 1.2 Site Identification

Pertinent Site identification details are presented in **Table 1**.

| Table 1 - Site Identification                      |                                                          |
|----------------------------------------------------|----------------------------------------------------------|
| Item                                               | Description                                              |
| Site Address                                       | 230 Martin Road, Badgerys Creek, NSW ( <b>Figure 1</b> ) |
| Legal Description                                  | Lot A in DP 406215                                       |
| Approximate Assessment Area (Development Boundary) | 8 ha                                                     |
| Approximate Site Area                              | 24 ha                                                    |
| Site Owner                                         | EMKC Cubed Pty Ltd                                       |
| Municipality                                       | Liverpool City Council (Council)                         |
| Site Zoning                                        | Enterprise (ENT) and Environment and Recreation (ENZ)    |

## 1.3 Legal and Other Requirements

The following statutory provisions and guidelines are applicable to the Proposed Works, with regards to the Assessment:

- Liverpool LEP 2008 (accessed 03 November 2023), Part 7.7 Acid Sulfate Soils.
- National Acid Sulfate Soils Guidance “National Acid Sulfate Soils Sampling and Identification Methods Manual” 2018 (National ASS Guidance 2018).
- Stone, Y, Ahern C R, and Blunden N (1998). Acid Sulfate Soil Manual 1998. Acid Sulfate Soil Management Advisory Committee, Wollongbar, NSW, Australia (NSW ASS Manual 1998).

## 2 Site Condition and Surrounding Environment

The site comprises of an irregular shaped portion of land bound by Martin Road to the west, South Creek to the east, a composting facility immediately to the north and rural residential / agricultural properties south of the Site. The Site currently has an existing shed with two (2) shipping containers located in the northwestern portion of the site. A dam located in the northern central portion of the site.

The Site is relatively flat with a slight slope down to the north-east towards South Creek. The elevation of the Site ranged from 48 to 56 metres above the Australian Height Datum (mAHD).

Site vegetation comprised of thick spongy grass, along with established mature trees scattered across the eastern portion of the Site along South Creek.

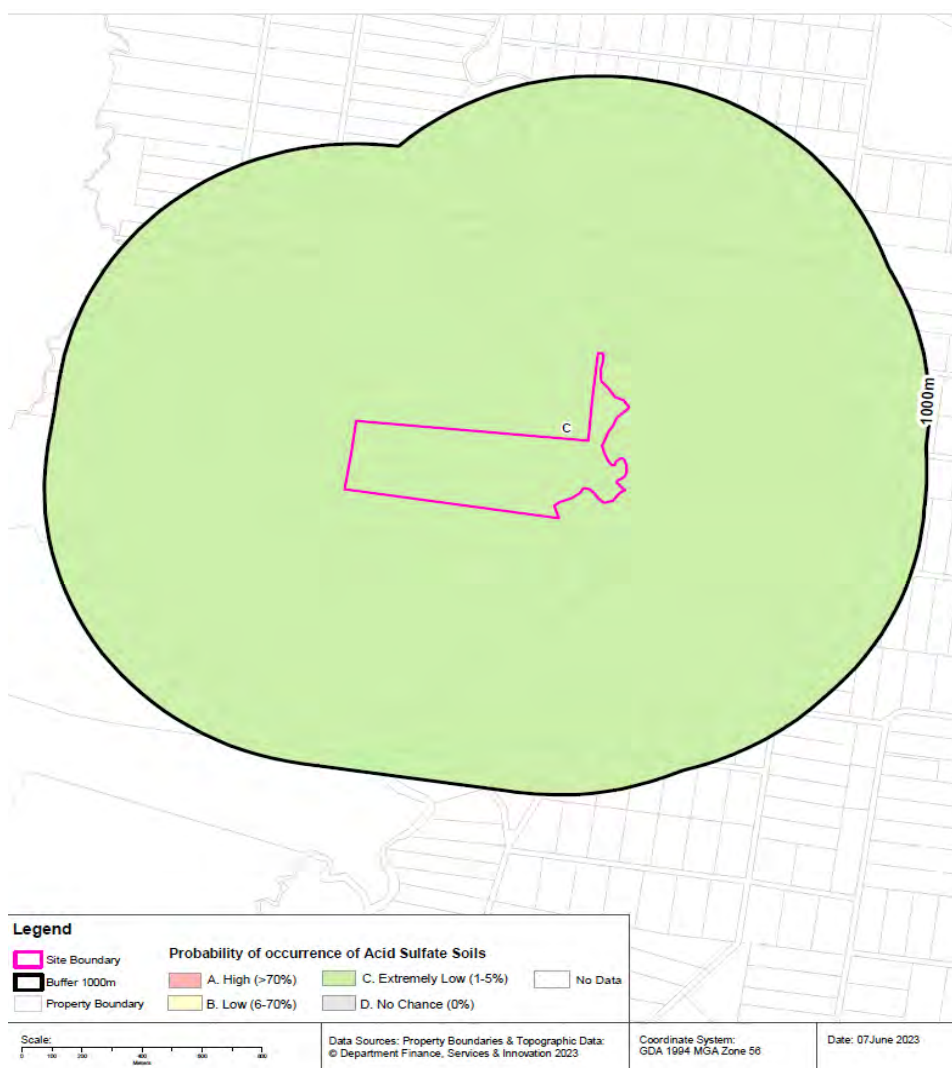
The Site location is shown in **Figure 1**.



**Figure 1. Site Location**

Based upon a review of the Environmental Planning Instrument Acid Sulfate Soil Risk Map provided by Lotsearch (2023<sup>1</sup>), the Site is not located within a published acid sulfate soil zone. Based on a search of the Atlas of Australian ASS database (**Figure 2**), the Site was identified to be within a Class C category for acid sulfate soils. The Class C category is considered to have an extremely low probability of ASS occurrence (1-5% chance) with occurrences in small, localised areas.

<sup>1</sup> Lotsearch Enviro Pro (Lotsearch 2023), 230 Martin Road, Badgerys Creek, NSW, 2555, reference: LS044558 EP, dated 07 June.



**Figure 2. Acid Sulfate Soil Risk Map**

Based on geological data sourced from Department Finance, Services & Innovation 2023 Geological Map (Lotsearch 2023), the Site is underlain by Alluvial floodplain deposits (Quaternary) and Bringelly Shale (Middle Triassic). Alluvial floodplain deposits are categorized by Silt, very fine- to medium grained lithic to quartz-rich sand, clay. The dominant lithology consists of clastic sediment. Bringelly Shale is categorized by Shale, carbonaceous claystone, laminite, lithic sandstone, rare coal, the dominant lithology being shale.

Based on the NSW Department of Industry, Resources and Energy, Site soil landscapes have been identified to comprise of 9030sc. For the soil landscape 9030sc (South Creek), the landscape is described as having floodplains, valley flats and drainage depressions of the channels on the Cumberland Plain. Usually flat with incised channels; mainly cleared. Some limitations of the South Creek soils include flood hazard, seasonal waterlogging, localised permanently high-water tables, localised water erosion hazard and localised surface movement potential.

### 3 Previous Investigations

The Site has historically been used for agricultural purposes. The following previous investigations relevant to this assessment have been prepared for the Proposed Development and to support the State Significant Development Application (SSDA):

- EP Risk (2023) Detailed Site Investigation, 230 Martin Road, Badgerys Creek, NSW (ref: EP3390.001, dated 20.12.23).
- Fortify Geotech (2023) Proposed Industrial Development, 230 Martin Road, Badgerys Creek, NSW, Geotechnical Investigation (ref: JS/S204 09.11.2023)

#### **EP Risk (2023) Detailed Site Investigation**

EP Risk reviewed the Atlas of Australian ASS database completed by Lotsearch (2023<sup>2</sup>) and identified the following:

*'The Site is identified as Class C Acid Sulfate Soils, extremely low probability (1-5%).'*

#### **Fortify (2023) Geotechnical Investigation**

In general, the subsurface conditions encountered in the twenty (20) test pits undertaken can be summarised as follows:

- TOPSOIL FILL / FILL (Unit 1) 0.0 / 0.25m to 0.1m / 0.5m:
  - Gravelly CLAYEY SILTY SAND, fine to coarse grained, low to medium plasticity, brown, grass roots, roots, trace anthropogenic material (plastic), fine to medium size gravels, dry, loose to medium dense, firm.
- FILL (Unit 2) 0.0 / 0.45m: to 0.45 / 1.6m:
  - GRAVELLY SAND, SILTY SANDY CLAY, fine to coarse grained, low to medium plasticity, brown, dark brown, grey, trace orange and red, fine to coarse size gravels, trace anthropogenic material (gravels, brick, plastic), dry, medium dense.
- ALLUVIAL / RESIDUAL SOIL (Unit 3) 0.1m / 1.6m to 1.7m/ >2.0m:
  - SANDY CLAY, GRAVELLY SILTY CLAY, low to medium plasticity, fine to coarse grained, red, brown, grey and orange mottling, fine to medium size gravels, trace ironstone gravels, firm to very stiff, dense.
- WEATHERED BEDROCK (Unit 4) Below 1.7m / 1.8m:
  - SANDSTONE, SHALE: extremely weathered (XW), excavates as SILTY CLAYEY GRAVEL, GRAVELLY SAND trace CLAY & CLAYEY SANDY GRAVEL.

No groundwater was reported during the Site DSI and geotechnical investigation. It should be noted that groundwater conditions will likely vary with seasonal and weather conditions and during construction when drainage conditions will vary.

---

<sup>2</sup>Lotsearch Enviro Pro (Lotsearch 2023), 230 Martin Road, Badgerys Creek, NSW, 2555, reference: LS044558 EP, dated 07 June.

## 4 Proposed Disturbance Activity

The Site is proposed to be redeveloped into industrial land use (Proposed Development), which will be subject to Development Application (DA).

The proposal seeks approval for two contemporary warehouse or distribution centre buildings at 230 Martin Road, Badgerys Creek. Specifically, the development will comprise:

- Site clearance works, including the removal of existing structures and trees
- Bulk earthworks and the installation and augmentation of utilities infrastructure and other services
- Construction and operational use of two warehouse or distribution centres containing ancillary offices, amenities and manufacturing use (in lot 1 only) with associated, parking, landscaping and access
- Other ancillary works

It is noted that the Proposed Development footprint is located inside the Class C (Low probability) acid sulfate soil risk zone.

## 5 Acid Sulfate Soil Assessment

Development consent is required for works beyond 1 m below natural ground surface or works by which the water table is likely to be lowered beyond 1 m below ground surface in Class C areas. This requirement is waived where a preliminary assessment is undertaken.

The ASSMAC (1998) Manual provides details of the four-step assessment process to be adopted in a preliminary assessment. A summary of the four-step process is provided as **Table 2**.

**Table 2 – Preliminary Assessment Process**

| Step | Description                                                        | Outcome                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|------|--------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Check the acid sulfate soil maps                                   | The Atlas of Australian ASS database completed by Lotsearch (2023) contains an acid sulfate soil risk map ( <b>Figure 2</b> ) with probability of occurrence.<br><br>With reference to <b>Figure 2</b> , the Site is not located in an acid sulfate soil risk zone.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 2    | Check to see if the area meets the geomorphic or site criteria     | <p>ASSMAC (1998) requires that a desktop assessment should be undertaken to check if the location meets the geomorphic or site description criteria detailed below:</p> <p><b>a. Are the sediments of recent geological age?</b><br/>With reference to the Property Boundaries &amp; Topographic Data from Department Finance, Services &amp; Innovation 2023 Geological Map, the sediments in the eastern portion of the Site, consist of Quaternary alluvial floodplains which are of recent age. However, the remainder of the Site in the development footprint is located in Middle Triassic Age Bringelly Shale, which is from the Mesozoic epoch, which is not of recent geological age.</p> <p><b>b. Are soil horizons less than 5m?</b><br/>Based upon the information received, the soil horizons are located between 44 and 58 m AHD and are well above 5 mAHd.</p> <p><b>c. Marine or estuarine sediments and tidal lakes?</b><br/>Marine or estuarine sediments and tidal lakes are not located in the Proposed Development footprint.</p> <p><b>d. In coastal wetlands or black swamp areas; waterlogged or scaled areas; interdune swales or coastal sand dunes?</b><br/>These are not located in the Proposed Development footprint.</p> <p><b>e. In areas where the dominant vegetation is mangroves, reeds, rushes and other swamp-tolerant or marine vegetation such as swamp mahogany, paperbark and swamp oak?</b><br/>These vegetation types are not located in the Proposed Development footprint.</p> <p><b>f. In areas identified in geological descriptions or in maps as bearing sulfide minerals, coal deposits or former marine shales / sediments?</b><br/>These sediment types are not located in the Proposed Development footprint.</p> <p><b>g. In with deep older estuarine sediments &gt;10 metres below ground surface, Holocene or Pleistocene age?</b><br/>Based upon a review of the Civil drawings, there is no excavation to depths greater than 10 metres below ground surface proposed of the Site.<br/><br/>As the proposed activities do not meet the geomorphic criteria and the developable portion is not mapped as having a probability of acid sulfate soils being present, it is considered that there is a low likelihood of acid sulfate soil being present and step 3 is not warranted.</p> |
| 3    | Analyse soil and water indicators                                  | Not warranted based upon the findings of <b>Step 2</b> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 4    | Chemical analysis to confirm acid sulfate soils and “action levels | Not warranted based upon the findings of <b>Step 2</b> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

## 6 Conclusion

EP Risk was engaged by EMKC<sup>3</sup> to prepare an Acid Sulfate Soil Desktop Study for the Site (the Assessment). It is understood that the Site is proposed to be redeveloped into industrial land use with two (2) warehouses and car parking in the western portion of the Site.

The Site including the proposed developable portion of the Site is not mapped within an acid sulfate soil risk zone.

The preliminary assessment process provided in ASSMAC (1998) was adopted and identified that the developable portion where soils are to be disturbed is not located within an acid sulfate soil risk zone, nor does it contain geomorphic conditions that are indicative of the presence of acid sulfate soil. Therefore, further soil sampling and analytical testing for the presence of acid sulfate soil is not required prior to the proposed excavation and construction works.

Based upon the results of the Acid Sulfate Desktop Study, there is a low risk of acid sulfate soil being present at the Site and therefore an acid sulfate soil management plan is not required.

An acid sulfate soil management plan has been provided as **Appendix B**, should indicators of acid sulfate soil be identified as an unexpected find during the Proposed Development.

# Appendix A

## ACID SULFATE SOIL MANAGEMENT PLAN

## Acid Sulfate Soil Management Plan

The results of the desktop acid sulfate soil assessment indicate a low risk of acid sulfate soil at the Site and therefore an acid sulfate soil management plan is not required.

However, should indicators of potential acid sulfate soil be identified during soil disturbance works as an unexpected find, an appropriately qualified environmental scientist / engineer should be contacted to inspect the site. EP Risk propose the following acid sulfate soil management plan should be adopted for any unexpected finds of acid sulfate soil.

### Acid Sulfate Soil Indicators and Assessment Criteria

The following ASS indicators and assessment criteria are based on the National ASS Guidance 2018 and with consideration to the NSW Acid Sulfate Soil Manual.

#### Field Screening

Acid sulfate soils generally consist of clays and sands containing pyritic material and are usually found in estuarine areas. The field indicators of ASS include:

- pH readings measured in the field of less than 4;
- Iron staining on any drain surfaces;
- Unusually clear or milky green water discharge;
- Iron mottling of soil in the subsurface; and
- Corrosion of concrete or steel structures.

Undisturbed soil which contains iron sulfides or sulfidic material, which have not been exposed to air and oxidised, generally waterlogged, and have a pH of 4 or more and may be neutral or slightly alkaline are known as potential acid sulfate soil (PASS). The following may also be indicators of PASS:

- Presence of any sulfurous odours;
- pH following oxidation with 30% hydrogen peroxide ( $\text{H}_2\text{O}_2$ ) is less than 3;
- Strength of the oxidation reaction; and
- Lowering of the pH by at least 1 unit.

#### Soil Analytical Testing

The above field screening observations are used to guide selection of samples for laboratory analysis. Soil samples submitted for laboratory analysis are tested using chromium reducible sulfur (CRS) method and the results assessed against the criteria shown in **Table B1** for the disturbance of <1,000 or >1,000 tonnes (National ASS Guidance 2018).

| Table A1 - Soil Assessment Criteria             |                              |                                                 |                                                            |                                                 |                                                            |
|-------------------------------------------------|------------------------------|-------------------------------------------------|------------------------------------------------------------|-------------------------------------------------|------------------------------------------------------------|
| Texture Range                                   | Approximate Clay Content (%) | 1-1,000 tonne Material Disturbed                |                                                            | >1,000 tonne Material Disturbed                 |                                                            |
|                                                 |                              | Sulfur Trail                                    | Acid Trail                                                 | Sulfur Trail                                    | Acid Trail                                                 |
|                                                 |                              | % S oxidisable <sup>1</sup><br>(oven-dry basis) | Mol H <sup>+</sup> /tonne <sup>2</sup><br>(oven-dry basis) | % S oxidisable <sup>1</sup><br>(oven-dry basis) | Mol H <sup>+</sup> /tonne <sup>2</sup><br>(oven-dry basis) |
| <b>Coarse and Peats</b><br>Sands to loamy sands | < 5                          | ≥ 0.03                                          | ≥ 18                                                       | ≥ 0.03                                          | ≥ 18                                                       |
| <b>Medium</b><br>Clayey sand to light clays     | 5-40                         | ≥ 0.06                                          | ≥ 36                                                       |                                                 |                                                            |
| <b>Fine</b><br>Light medium to heavy clays      | > 40                         | ≥ 0.1                                           | ≥ 62                                                       |                                                 |                                                            |

<sup>1</sup> % S – measure of reduced inorganic sulfur (using the Scr or peroxide oxidisable sulfur (SPOS) methods) expressed as a percentage of the weight of dry soil analysed. Can also be used as an 'equivalent sulfur unit' when comparing the results of tests expressed in other units e.g. peroxide oxidisable sulfur (SPOS) or total oxidisable sulfur (STOS).

<sup>2</sup> mol H<sup>+</sup>/tonne – measure of acidity, expressed as the number of moles of hydrogen cations per tonne of oven-dry soil material. A mole is 6.022x10<sup>23</sup> atoms of a given substance.

## Leachate Criteria

The treatment and management of surface water flows from areas containing ASS to prevent leaching of acidic waters and metal contaminants into the environment should maintain the present surface water quality. The discharge of surface water should be done so in accordance with NSW EPA, WaterNSW and Council requirements. In the absence of site-specific criteria, the minimum requirements are presented in **Table B2**.

| Table A2 - Adopted Leachate Criteria |                                             |                              |
|--------------------------------------|---------------------------------------------|------------------------------|
| Indicator                            | Fresh Water                                 | Marine Water                 |
| pH                                   | 6.5-8.0                                     | 8.0-8.4 and <0.2 unit charge |
| Suspended Solids                     | Not Defined                                 |                              |
| Turbidity (NTU)                      | 1-20                                        | 0.5-10                       |
| Dissolved Oxygen (field measured, %) | 110                                         |                              |
| Oil and Grease                       | None visible or detected                    |                              |
| Iron Floc and Scum                   | None visible or detected in discharge water |                              |

## Results

To assess site conditions and whether ASS exist on the Site, soil analytical results are required to be compared to published action criteria. The adopted framework against which the soil analytical results are compared, is detailed in **Table A1**.

As no data is currently available for review, it is recommended that assessment of the Site is undertaken prior to any soil disturbance works to enable characterisation of ASS and development of liming rates. The proposed soil sampling methodology is provided below.

### Soil Sampling Methodology

A minimum of four sampling locations are required per hectare within the Proposed Development footprint to assess the presence of ASS, in accordance with the recommended sampling density in the National ASS Guidance 2018.

Soil sampling should be conducted as follows:

- Boreholes are to be advanced to a minimum depth of 1.0 m below the maximum depth of the proposed excavations.
- Soil to be logged in accordance with AS1726.
- Soil samples are to be collected from four borehole locations across the Site, with samples collected at 1 m increments, or at horizon changes, to the maximum investigation depth 1 m below the depth of excavation.
- Soil samples to be collected using dedicated, disposable nitrile gloves and assessed for visual and olfactory signs of ASS (incl. grey staining, iron oxide and hydrogen sulphide odour).
- Samples to be collected into sealable bags, double bagged with the sample details and an individual identification added to the label. The samples must be frozen at the laboratory in accordance with laboratory protocol.
- The sample containers to be preserved on ice immediately after sampling and during shipment to a National Association of Testing Authorities (NATA) accredited laboratory under appropriate chain-of-custody documentation.

### Analytical Testing

A NATA accredited laboratory is required for the analysis of representative samples from all four boreholes. The laboratory analysis should be undertaken in accordance with **Table A3**.

| Table A3 - Analytical Testing    |                                                                                                                                                                                                          |
|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Sample Location                  | Analytical Testing                                                                                                                                                                                       |
| Borehole Sample locations (four) | <ul style="list-style-type: none"> <li>• pH<sub>F</sub>/pH<sub>FOX</sub> (every 0.5m depth interval)</li> <li>• Chromium Reducible Sulfur Suite (selected based upon field screening results)</li> </ul> |

# Acid Sulfate Soil Management

## Assigning Roles and Responsibilities

The key stakeholders responsible for the implementation of the control measures outlined in the ASSMP are presented in **Table A4**.

| Table A4 - Roles and Responsibilities |       |                                                                                                                                                                                                                                                                                                               |
|---------------------------------------|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Role                                  | Party | Responsibilities                                                                                                                                                                                                                                                                                              |
| Principal                             | Owner | To engage the consultants and contractors and undertake all stakeholder management and to conduct ASS Assessment and verification sampling.                                                                                                                                                                   |
| Contractor                            | TBA   | To carry out the civil works associated with the Proposed Works and ensure compliance with the ASSMP any work health and safety controls and construction environment management plan (CEMP). The Contractor must maintain written records of activities undertaken each day and manage any unexpected finds. |
| Sub-contractors                       | TBA   | Toolbox meetings will be conducted with all subcontractors which will include an ASS component outlining the adopted management measures to address ASS.                                                                                                                                                      |
| Environmental Consultant              | TBA   | Conduct ASS Assessment to determine liming rates. To validate all stockpiles and managed soils by sampling and analytical testing to prepare a validation report.                                                                                                                                             |

## Environmental Impacts

The potential impacts of ASS from the Proposed construction include:

- Exposing ASS to air in the vicinity of surface drains, basins or sensitive receptors causing oxidation and a release of acid into the environment.
- Leaching of acid into the environment at treatment sites.
- Excavations and bulk earthworks to design subgrade level.
- Installation of piles for the developments foundations through the ASS impacted soil layers.
- Any activities that have potential to lower the water table may enhance the oxidation of sediments. Where excavation is below the water table and into ASS material, drawdown of the water table may expose ASS material. This can result in the oxidation of ASS and acid generation.

Elements of the Proposed Development will be designed to minimise excavations where practicable, however, excavations will be required and do have potential to intercept ASS.

## Minimisation of Disturbance

Where disturbance of ASS cannot be avoided, there are a number of strategies that can be implemented to minimise disturbance to ASS. These strategies include:

- Designing earthworks to consider areas containing low or negligible levels of existing and potential acidity.

- Keeping earthworks shallow (viable when ASS is located within deeper soil profiles).
- Minimising groundwater fluctuations by avoiding the following:
  - deep drains/canals/artificial water bodies that may change the water table;
  - installation of groundwater extraction bores or continuing the use of existing groundwater bores;
  - dewatering for installation of infrastructure such as road, water and sewerage mains and underground cabling;
  - changing vegetation from pasture to deep rooted large trees; and
- Filling (under the supervision of a geotechnical consultant) to compress and dewater saturated ASS material before construction but keeping the soil in anoxic conditions.
- When practicable, excavation works in ASS areas and soil treatment should be conducted during dry periods to minimise risk of overflow from heavy or sudden rain events.

### Neutralisation and Treatment

Neutralisation involves the application and mixing of a sufficient amount of alkaline materials into the soil to neutralise all existing acidity that may be present, and all potential acidity that could be generated from complete oxidation. Usually, neutralisation involves the excavation of ASS which must be stored and treated in a contained area. There can be significant risks to the environment if neutralisation is poorly managed.

There are a several different methods for carrying out neutralisation of ASS, including:

- Batch processing where the excavated ASS is spread out in a thin layer and the neutralising material is spread on top. The two materials are then mechanically mixed together.
- Continuous processing where a mixing machine (such as a pug mill) is used, and the soil and neutralising agent is fed into the machine.

The preferred neutralising agent is fine agricultural lime (aglime) with not less than 95% fine grained calcium carbonate. Other common neutralising agents include hydrated lime, quick lime, and sodium bicarbonate. Sandy soil can be mixed with neutralising agents with ease, but high plasticity clay soil requires significant areas and additional time to allow adequate mixing and reaction.

As there is insufficient data on ASS conditions an ASS Assessment is required to determine liming rates by the sampling and analytical testing of soil samples.

### Construction of the Soil Treatment Area

Prior to commencing the neutralisation works, a soil treatment area will be constructed in the vicinity of the earthworks. The soil treatment area should be:

- Constructed as far as practicable from any drainage channels.
- Designed and sized to accommodate the anticipated volumes of spoil produced from the excavation works.
- Barricaded and appropriate signage erected.
- Bunded to a height of approximately 0.3 m and appropriate sediment controls installed to prevent runoff and sediment migration.
- Designed such that overland flow is diverted.

- Constructed with a guard layer comprising of a neutralising agent as described in the QLD ASS Technical Manual (2014).

The minimum guard layer rate will be 5 kg aglime/m<sup>2</sup> per vertical meter of fill material. If the highest detected sum of existing and potential acidity is greater than 1% S-equivalent, the guard layer rate will be a minimum of 10 kg aglime/m<sup>2</sup> per vertical metre of fill.

### Stockpiling Soils

It is recommended that on-site monitoring is carried out during any deeper excavation earthworks carried out on Site so that disturbance of ASS can be identified, and ASS soils can be segregated, stockpiled and treated. The management of stockpiled soils within the soil treatment area will be required as follows:

- All excavated soils containing ASS should be segregated from the spoil and stockpiled separately.
- The residence time for short term stockpiling of soils within the soil treatment area should not exceed recommended periods detailed in the QLD ASS Technical Manual (2014) as presented in **Table A5**.
- If ASS is required to be stockpiled for longer time frames than those presented in **Table A5**, then it must be fully treated.

| <b>Table A5 - Indicative Residence Time for Soil in Soil Treatment Area</b> |                                     |                                        |
|-----------------------------------------------------------------------------|-------------------------------------|----------------------------------------|
| <b>Texture</b>                                                              | <b>Approximate Clay Content (%)</b> | <b>Duration of Stockpiling (hours)</b> |
| <b>Coarse and Peats</b><br>Sands to loamy sands                             | < 5                                 | 18                                     |
| <b>Medium</b><br>Clayey sand to light clays                                 | 5-40                                | 42                                     |
| <b>Fine</b><br>Light medium to heavy clays                                  | > 40                                | 66                                     |

Additional measures to minimise short term effects of oxidation of stockpiles during the Proposed Development works include:

- Spreading aglime over the surface of the stockpile to limit the generation of acidity from the surface of the stockpile where it is considered likely the stockpile will contain ASS. The results of previous validation testing can be used as a guide to the likely presence of existing or potential ASS within the stockpile.
- Soils within the soil treatment area should be kept moist, but not saturated to minimise oxidation prior to treatment.
- All soils should be covered with tarpaulins or geomembrane to mitigate generation of leachate within the soil treatment area.

### Monitoring

If disturbance of ASS is suspected to have occurred, parameters may need to be monitored daily. More frequent monitoring may also be required to assess the impact of events such as heavy rainfall. The monitoring program should be developed by the Environmental Consultant in conjunction with the Project Contractor. Measurement and testing equipment should be operated by personnel experienced in water and soil sampling using

appropriately maintained and calibrated test equipment. The action criteria for treatment are summarised in **Table A6**.

| Table A6 - Monitoring Program Action Criteria |                                                                   |                                                                                                                               |
|-----------------------------------------------|-------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| Media                                         | Indicator                                                         | Action                                                                                                                        |
| Water                                         | 6.5 < pH < 8.5 or +/- 0.2 units of adjacent surface water bodies. | pH outside this range is not suitable for discharge to the surrounding environment and requires treatment prior to discharge. |
| Soil                                          | pH < 4                                                            | Indicates the excavated material is oxidising and would require treatment with lime to neutralise the acidity.                |

### Soil Treatment

The treatment option for soil is neutralisation as follows:

- Stockpile the excavated spoil on the central portion of the guard layer.
- Mechanically break up any clods, add aglime and mix. The aglime should be thoroughly mixed with the soil using an appropriate mechanical device such as an excavator (or other alternatives as appropriate).
- Dosing rates of aglime to be in accordance with the results of chromium reducible sulfur testing.
- It is recommended progressive neutralisation of stockpiled soil is undertaken to minimise the size of the soil treatment area.
- Additional liming may be required should the results indicate the neutralisation has not been achieved.

### Water treatment

Surface water (i.e., water pooled within bunded/treatment areas) with the potential to become acidic as a result of interaction with the treatment area or excavations will be treated and monitored as follows:

- Surface water accumulated in excavations or the treatment area will be tested for pH. If the pH is outside the range of 6.5 – 8.5 then the water will be neutralised with the addition of agricultural lime or hydrated lime.
- Records of water discharged from Site shall be maintained.
- Backfilling excavations, completion of footings as soon as possible to minimise the oxidation of in-situ soils exposed within the excavations.
- Minimise the drainage of soils by limiting any groundwater drawdown within excavations to the absolute minimum required to complete the excavation safely. Seepage entering the excavation should be minimised through the use of physical barriers. Treatment of water from dewatering activities may be required subject to further testing.
- Where material is to be transported to the treatment area via public roads, wheel cleaning facilities will be established at site exits to prevent off-site contamination during transport.
- Material will be transported within trucks with secure tailgates.
- Records of transport including individual truck details and quantity transport will be retained at the Project Office.

- At the end of each transport shift an inspection of the transport route will be undertaken by the Supervisor to determine if material has been spilt. Where material has been spilt on public roads it will be removed immediately.

When run-off accumulates, water quality will be monitored regularly during the construction period, particularly following substantial rainfall events. Retained water will be sampled, tested, and treated to the parameters in **Table 3** and **Table 7** prior to discharge.

### Sampling and Testing

It is recommended the following inspections and testing should be undertaken:

- Inspections and testing of stockpile spoil within the treatment area at least every 1-2 days (depending upon the soil type and with reference to **Table A6** to determine whether the addition of aglime is required.
- If it is determined aglime application is required, it is to be done so as per the dosing rates determined from proposed testing. Mixing the treated soil is to be undertaken in accordance with the timelines provided in **Table A6**.
- Inspections of stockpiles for visual signs of seepage impacted by ASS including milky waters, iron staining and sulfur odour should be undertaken daily.
- Collection of verification soil samples per the following sampling density in accordance with the National ASS Guidance 2018:
  - o volume of stockpile < 250 m<sup>3</sup> – 2 samples;
  - o volume of stockpile 251 - 500 m<sup>3</sup> – 3 samples;
  - o volume of stockpile 1,000 m<sup>3</sup> – 4 samples; and
  - o volume of stockpile > 1,000 m<sup>3</sup> – 4 samples plus one per additional 500 m<sup>3</sup>.
- Verification testing for the success of the soil neutralisation is to be carried out in accordance with the National ASS Guidance 2018, including testing of each sample for the CRS suite by a NATA accredited laboratory.

### Performance Criteria

The assessment criteria outlined in **Table A1** must be adopted for performance assessment for the successful neutralisation of treated ASS. ASS that has been treated by neutralisation techniques and has not met these criteria must be re-treated and re-tested until the above performance criteria are met. These performance criteria equate to there being no positive calculated net acidity in the soil above the adopted criteria following treatment. The neutralisation management strategy is most effective when soil and neutralising agents are completely homogenised, which may not be fully achievable for large volumes of soil, especially when moist and/or clayey.

## Reporting

The following details should be recorded during the soil treatment process and reported in a final Acid Sulfate Soil Validation Report:

- Total final volumes and dimensions of disturbed ASS.
- Where dewatering was involved, final location, extent and duration of dewatering and details of testing and groundwater management strategies applied.
- Details of soil management strategies undertaken at the site (including evidence of specific management measures such as waste tracking, photographic evidence of neutralisation and of bunded treatment pads).
- Details of surface water management strategies undertaken at the Site.
- Location of any off-site disposal of ASS and evidence of treatment on-site and waste classification prior to lawful disposal.
- Summary of verification testing results for material treated.
- Location and maps of areas used for strategic burial of treated ASS, with depth below finished surface and details of safety margin below the permanent water table.
- Summary of monitoring results for surface water and groundwater (with an emphasis on trends in water quality).
- In appendices, full results of monitoring and verification testing regimes.
- A discussion of the effectiveness of management strategies employed at the Site.
- Details of any incidence of nonconformity with the Environment Management Plan and corrective actions taken.
- A discussion of any potential risks to the environment or human health.
- Proposed future monitoring and/or reporting programs.
- Proposed remediation measures if needed.

A record of these observations, calculations and soil monitoring results should be provided to the client for each day an inspection is undertaken. At the completion of works a final closure report will be prepared detailing the above information.

## Contingency Plan

A number of contingency measures for the soil treatment works have been provided in **Table A7**.

| Table A7 - Contingency Plan                                    |                                                                 |                                                                                                                                                 |
|----------------------------------------------------------------|-----------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| Scenario                                                       | Consequence                                                     | Contingency Measures                                                                                                                            |
| Under liming of ASS                                            | Potential for acid generation and impact to sensitive receptors | Addition of more aglime with additional chromium reducible sulfur testing to determine additional liming rate (if required)                     |
| Over liming of ASS                                             | High pH may cause environmental impact                          | Mix over limed soil with ASS to reduce pH levels to within adopted criteria                                                                     |
| Volume of ASS exceeds treatment area                           | Delays to earthworks                                            | Increase size of soil treatment area                                                                                                            |
| Observations of ASS leachate production in soil treatment area | Loss of containment of leachate                                 | Conduct aglime treatment and apply leachate back to stockpile                                                                                   |
| Heavy rain causing ponding of water within treatment area      | Damage to bunding and sediment controls                         | Testing of water for adopted action criteria and treatment if exceedance of relevant criteria. Irrigation of validated water to adjacent areas. |
| pH values increase in surrounding water bodies                 | Potential for acid generation and impact to sensitive receptors | Increase monitoring frequency and submit samples to laboratory for analysis. If continues, notify relevant statutory authority.                 |

