

CITY OF MELVILLE ACID SULFATE SOILS GUIDELINES



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1 INTRODUCTION

The City of Melville is a local government area of 52km² located 8km south of the Perth CBD. It contains a number of significant biodiversity assets that are under threat. The City of Melville's Natural Areas Asset Management Plan (NAAMP) identifies Acid Sulphate Soils (ASS) as a significant threat to the cities biodiversity values (City of Melville, 2011). The objective of this guidance is to provide key information on reducing the threat and managing ASS.

1.1 What are Acid Sulphate Soils

ASS is naturally occurring soil, sediment or organic substrates (e.g. peat) that are formed under waterlogged conditions. These soils contain iron sulfide minerals (predominantly as the mineral pyrite (FeS₂)) or their oxidation products. In an undisturbed state below the water table, acid sulfate soils are benign. However, if the soils are drained, excavated or exposed to air by a lowering of the water table, the sulfides react with oxygen to form sulfuric acid (H₂SO₄). Release of this sulfuric acid from the soil can in turn release iron, aluminium, and other heavy metals (particularly arsenic) into soil, surface water and groundwater (Department of Environment Regulation, 2015).

In addition to soils that fit the traditional description of ASS, some other types of soils or subsurface substrates, whilst perhaps not fitting the traditional description, nonetheless have some acid generating potential and can release a significant amount of acidity and/or iron when disturbed (Department of Environment Regulation, 2015).

1.2 Activities with the potential to cause oxidation of Acid Sulphate Soils

Projects and developments in ASS risk areas which involve excavation, lowering of the water table (temporarily or permanently), compaction of saturated soils or sediments and/or lateral displacement of previously saturated sediments, may adversely disturb ASS (Department of Environment Regulation, 2015).

The types of development that may cause ASS problems include (Department of Environment Regulation, 2015):

- developments involving disturbance to wetlands, mangrove swamps, salt marshes, lakes and waterways;
- dewatering operations (including those of minor scale);
- compacting saturated soils or sediments;
- drainage works;
- groundwater pumping;
- ditching for mosquito control;
- artificially deepening lakes, waterways and wetlands;
- de-sludging or otherwise cleaning open drains;
- laterally displacing previously saturated sediments, resulting in ground water extrusion and aeration of ASS;
- coastal developments, such as residential estates, canal estates, tourist developments, marinas, golf courses;
- estate and underground infrastructure development (including installation of sewage pipework and pump station infrastructure);
- major infrastructure projects, such as bridges, roads, tunnels, port facilities, flood gates, dams, railways and flood mitigation works;
- major development projects involving construction at depths at and beyond the standing ground water table;
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- removal or mining of sulfidic peat;
- mining and quarrying operations, including the extraction of sand or gravel;
- dredging operations;
- rural drainage which lowers the water table;
- aquaculture developments, such as prawn farms in mangrove communities; and
- disturbance of areas that have been previously irrigated with wastewater or treated wastewater.

1.3 Potential impacts due to disturbance of Acid Sulphate Soils

The acid and metals mobilised through the oxidation of ASS can create significant environmental, social and economic impacts including: killing vegetation; contaminating groundwater and surface water with acid, arsenic, heavy metals and other contaminants (Mosley et.al., 2014a-d); killing aquatic life and loss of biodiversity in wetlands and waterways; corrosion of concrete and steel structures to the point of failure; and negative impacts on recreation, tourism, human health and visual amenity (Department of Environment Regulation, 2015).

The environmental, social and economic consequences that may result include (Department of Environment Regulation, 2015):

- soil and water acidification (lowering of pH);
- adverse changes to the quality of soil and water (groundwater, surface water, wetlands, watercourses and estuaries);
- degradation of wetlands, water-dependent ecosystems and ecosystem services;
- loss of habitat ecosystem complexity and biodiversity;
- invasion and dominance of wetlands and waterways by acid-tolerant water plants and plankton species;
- reduction of soil stability and fertility;
- loss of/deterioration in quality of water sources for irrigation and human use by increasing acidity and heavy metal concentrations;
- acid surface scalds in discharge areas;
- loss of visual amenity caused by rust coloured stains, scums and slimes from iron precipitates;
- risk of long-term infrastructure damage through acidic water corroding metallic and concrete structures (concrete cancer) such as roads, bridges, pumps, sub-surface pipes, retaining walls, brick course work and foundations;
- blocked reticulation systems and other small pipe systems due to iron precipitates;
- acidification of surface water bodies increasing mosquito breeding, which may increase the prevalence of mosquito-borne diseases; and
- increased financial burden of treating and rehabilitating affected areas and maintenance of infrastructure.

The impacts of ASS leachate may persist over a long time, or peak seasonally (after dry periods with the first drought-breaking rains). In some areas of Australia, ASS drained 100 years ago is still releasing acid (Sammut, 2000).

2 RISK

The types of development that may cause ASS problems include:

- coastal developments, such as residential estates, canal estates, tourist developments, marinas, golf courses;
- estate and underground infrastructure development (including installation of sewage pipework and pump station infrastructure);
- major infrastructure projects, such as bridges, roads, tunnels, port facilities, flood gates, dams, railways and flood mitigation works;
- major development projects involving construction at depths at and beyond the standing groundwatertable;
- developments involving disturbance to wetlands, mangrove swamps, salt marshes, lakes and waterways;
- dewatering operations (including those of minor scale);
- compacting saturated soils or sediments;
- drainage works such as urban drains;
- groundwater pumping;
- artificially deepening lakes, waterways and wetlands;
- de-sludging or otherwise cleaning open drains;
- removal of sulfidic peat;
- mining and quarrying operations, including the extraction of sand or gravel;
- dredging operations;
- drainage which lowers the watertable;
- laterally displacing previously saturated sediments, resulting in groundwater extrusion and aeration of ASS, and;
- disturbance of areas that have been previously irrigated with wastewater or treated wastewater.

2.1 RISK AREAS

Department of Environment Regulation (DER) Guidelines for Acid Sulphate Soil can be found on the DER website at <https://www.der.wa.gov.au/your-environment/acid-sulfate-soils/69-ass-guidelines>.

The DER *Guideline for identification and investigation of acid sulfate soils and acidic landscapes (June 2015)* should be referred to for a comprehensive list of where ASS and other potentially acid generating soils are located. In addition GIS maps of ASS risk areas including localities of concern within the City of Melville are accessible via Landgate's Shared Land Information Platform (SLIP Enabler) which allows download of the latest datasets to your own PC or server. Using the SLIP Enabler infrastructure, WA Atlas provides a free mapviewer service for accessing public data and can be accessed publicly at <https://www2.landgate.wa.gov.au/bmvf/app/waatlas/> (Department of Environment Regulation, 2015).

An indicative map showing the location of ASS within the City of Melville is shown in Figure 1. This map should not replace using the DER guideline and viewing the location on DER's online GIS software available at <https://www2.landgate.wa.gov.au/bmvf/app/waatlas/>.

These high risk areas within the City of Melville include:

- Piney Lakes
- Attadale Foreshore
- Booragoon Lake
- Blue Gum Lake
- Bateman Reserve and Kwinana Freeway intersection
- Richard Lewis Reserve
- Bull Creek/Brockman Park
- Trevor Gribble Park
- Marmion Lake

Foreshore areas and within the suburbs of Leeming and Bull Creek are at moderate risk or ASS occurrence.

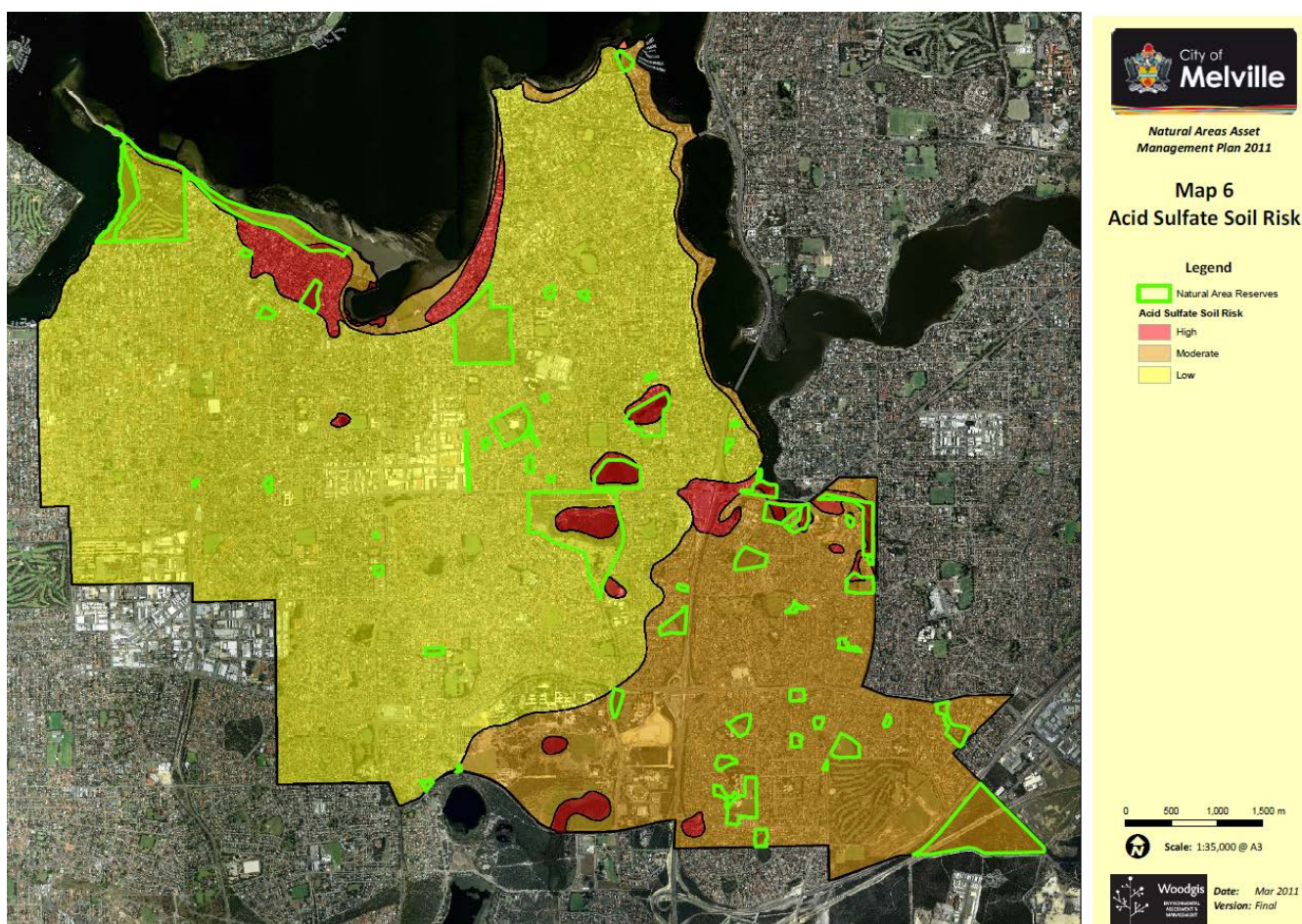


Figure 1: Indicative map of ASS with City of Melville.

3 THREAT PREVENTION, ELIMINATION, CONTAINMENT AND MANAGEMENT

In order to avoid the environmental, social and economic impacts of disturbing ASS, the Department of Environment Regulation (DER) Acid Sulfate Soils Guideline Series and Western Australian Planning Commission's (WAPC) *Acid Sulfate Soils Planning Guidelines* shall be followed for all activities within the City of Melville. These Guidelines contains the State Government recommendations on how to best manage the threat of ASS. The DER Guideline Series includes the following documents:

- *Guidelines for identification and investigation of acid sulfate soils and acidic landscapes (June 2015).*
- *Treatment and management of soils and water in acid sulfate soil landscapes (DER 2015).*

Groundwater remediation is expensive and time-consuming, hence good management is extremely important in ASS areas to avoid creating a problem that requires remediation.

The City of Melville's preferred way to manage the threat of ASS is avoidance of soil disturbance where risk of ASS is present. Where disturbance is unavoidable, ASS shall always be identified and managed in accordance with the DER ASS guidelines. **Where ASS is not managed in accordance with DER guidelines this may result in DER taking action under the *Environmental Protection Act 1986 and/or the Contaminated Sites Act 2003.***

3.1 Investigation and Assessment Process

The required steps in any ASS investigation and assessment are outlined in DER's *Guidelines for identification and investigation of acid sulfate soils and acidic landscapes (June 2015)* and WA Planning Commission's *Acid Sulphate Soils Planning Guidelines* and shall be followed for all disturbances within the City of Melville.

3.2 On-site Management Measures

Wherever ASS is to be disturbed, comprehensive management measures will need to be implemented based on the level of risk associated with the disturbance. Factors that may influence the level of risk include the nature, magnitude and duration of the proposed ASS disturbance, the soil characteristics and the sensitivity of the surrounding environment.

The disturbance of ASS during typical land development projects (e.g. residential developments) should be staged so that the area disturbed at any one time is limited and the potential effects are easily managed. The essential components of a management strategy for the disturbance of ASS during typical land development projects are outlined below.

N.B. Monitoring programs - it is important to note that the purpose of the monitoring requirements described below is to provide ongoing management information. The reporting of the monitoring programs should therefore not be seen as purely an administrative task.

There needs to be ongoing review and interpretation (by suitably qualified personnel appointed by the project's proponent) of data collected during site works to ensure

early detection of trends so that management can be adapted and/or contingency measures implemented. If trend analysis of monitoring data indicates deterioration in soil, surface water or groundwater quality further disturbance/dewatering should cease immediately and DER should be informed.

3.2.1 Soil

Soil management measures will need to be undertaken where the volume of ASS to be disturbed is greater than 100m³. For disturbances of ASS (greater than 100m³) the management should include:

- staging of disturbance such that the potential effects on any area disturbed at any one time are limited and easily managed;
- staging of earthworks program to minimise the amount of time that ASS are exposed to the atmosphere (i.e. minimise the time that excavations are left open);
- provision of bunding of the site using non-ASS material to collect all site runoff during earthworks;
- management of stockpiles of excavated soils;
- monitoring of pH and total acidity of any pools of water collected within bunds and treatment of water to keep the pH in the range 6.5–8.5 and acidity < 40mg/L CaCO₃, with reference to see 3.3.7 Dewatering effluent monitoring of the DER guideline for *Treatment and management of soil and water in acid sulfate soil landscapes (June 2015)*;
- treatment of soils according to their existing (actual) plus potential acidity with the appropriate amount of neutralising material;
- validation of soil treatment;
- development of an ASS management plan (ASSMP) and submission of the ASSMP to DER for approval before the commencement of site works (**please allow 45 days for DER to complete its review and provide comment on the ASSMP; ASS-disturbing site works should not commence until DER comment has been received**);
- submission of an initial closure report to DER; and
- remedial actions to restore soil quality, if needed.

3.2.2 Dewatering

3.2.2.1 Dewatering management level 1a - radial extent of groundwater cone of depression <50m

Where dewatering will be undertaken in an area underlain by ASS where the predicted radius of the cone of depression of the watertable is less than 50 metres, the management measures that should be implemented include (but are not necessarily limited to):

- staging of earthworks and dewatering program to minimise the duration and magnitude of dewatering (to limit the amount of time that ASS are exposed to the atmosphere);
- management of dewatering effluent in accordance with Section 3.3.7 Dewatering effluent monitoring of the DER guideline for *Treatment and management of soil and water in acid sulfate soil landscapes (June 2015)*;
- watertable level monitoring to ensure that the actual radial extent of the groundwater cone of depression is less than 50 metres;

- if the actual radial extent of the groundwater cone of depression exceeds 50 metres and the duration of the dewatering operation exceeds seven days, the additional dewatering management measures outlined in Section 3.2.3 of this guideline should be implemented (**DER should be advised in this case**);
- development of an ASSMP and submission of the ASSMP to DER for approval before commencement of site works (**please allow 45 days for DER to review and provide comment on the ASSMP; site works cannot commence until the ASSMP has been approved by DER**);
- submission of an initial closure report to DER; and
- remedial actions to restore groundwater quality, if needed.

3.2.2.2 Dewatering management level 1b - duration of dewatering less than seven days

Where dewatering will be undertaken in an area underlain by ASS for a total duration of less than seven days, the management measures that should be implemented include (but are not necessarily limited to):

- staging of earthworks and dewatering program to minimise the duration and magnitude of dewatering (to limit the amount of time that ASS are exposed to the atmosphere);
- management of the dewatering program to minimise the lateral and vertical extent of groundwater drawdown (to limit the volume of ASS exposed to the atmosphere (see Section 3.2 of the DER Guideline for *Treatment and management of soil and water in acid sulfate soil landscapes (June 2015)* for further information));
- calculation of the radius of the groundwater cone of depression;
- management of dewatering effluent in accordance with Table 7 of the DER Guideline for *Treatment and management of soil and water in acid sulfate soil landscapes (June 2015)*;
- watertable level monitoring to ensure that the actual radial extent of the groundwater cone of depression is not more than that predicted from calculations;
- if the actual duration of dewatering exceeds seven days and the radial extent of the groundwater cone of depression is greater than 50 metres, as the additional dewatering control measures outlined in Section 6.2.3 of the DER Guideline for *Treatment and management of soil and water in acid sulfate soil landscapes (June 2015)* (**DER should be advised in this instance**);
- development of an ASSMP and submission of the ASSMP to DER for approval before commencement of site works (**please allow 45 days for DER to complete its review and provide comment on the ASSMP; site works that might disturb ASS materials should not commence until DER comment has been received**);
- submission of an initial closure report to DER; and
- remedial actions to restore groundwater quality to be undertaken if needed.

3.2.2.3 Dewatering management level 2 - duration of dewatering greater than seven days with a radial extent of the cone of groundwater depression greater than 50 metres

Where dewatering will be undertaken in an area underlain by ASS for a total duration of greater than seven days or where the predicted radius of the cone of depression of the watertable exceeds 50 metres, the management measures that should be implemented include (but are not necessarily limited to):

- staging of disturbance such that the potential effects on any area disturbed at any one time are limited and easily managed;
- staging of earthworks and dewatering program to minimise the duration and magnitude of dewatering (to limit the amount of time that ASS are exposed to the atmosphere);
- management of the dewatering program to minimise the lateral and vertical extent of groundwater drawdown (to limit the volume of ASS exposed to the atmosphere, see Section 3.2 of the guideline for *Treatment and management of soil and water in acid sulfate soil landscapes (June 2015)*);
- calculation and modelling of the radius of the groundwater cone of depression;
- limiting the radius of the groundwater cone of depression to less than 100 metres;
- baseline laboratory groundwater quality data collected before the commencement of dewatering operations (this may involve more than one monitoring event to ensure the data are representative and to capture seasonal variations);
- installation of groundwater monitoring bores up-gradient and down-gradient of dewatering location (bores must be appropriately positioned to enable them to be used to assess any impacts of dewatering on groundwater level and quality);
- management of dewatering effluent in accordance with Table 6 of the DER guideline for *Treatment and management of soil and water in acid sulfate soil landscapes (June 2015)*;
- watertable level monitoring to ensure that watertable drawdown does not exceed 10 centimetres at a distance of 100 metres from the dewatering location;
- groundwater pH, standing water levels, EC, redox, DO, total titratable acidity and total alkalinity monitored in the field every second day during the dewatering operation and continued until it can be shown that groundwater levels have returned to normal elevations;
- groundwater samples collected for laboratory analysis at fortnightly intervals during the dewatering operation;
- laboratory groundwater quality analytical suite including: total acidity, total alkalinity, sulfate, chloride, dissolved aluminium (filtered), dissolved arsenic (filtered), dissolved chromium (filtered), dissolved cadmium (filtered), dissolved iron (filtered), dissolved manganese (filtered), dissolved nickel (filtered), dissolved zinc (filtered), dissolved selenium (filtered), ammoniacal nitrogen, TDS, total nitrogen, total phosphorus, filterable reactive phosphorus (FRP);
- Treatment and management of soil and water in acid sulfate soil landscapes (June 2015)
- development of an ASSMP and submission of the ASSMP to DER for approval before commencement of site works (**please allow 45 days for DER to complete its review and provide comment on the ASSMP; ASS-disturbing site works should not commence until DER comment has been received**);
- immediate cessation of dewatering operations if the results of groundwater and/or dewatering effluent monitoring indicate any deterioration in groundwater quality;
- remediation of groundwater if the results of the groundwater quality monitoring program indicate that any environmental impact has occurred as a result of project works;

- laboratory groundwater quality data collected after finalisation of dewatering operations;
- results of the groundwater and effluent water quality and water level monitoring program reported within an initial closure report for the project along with a discussion of any environmental impacts observed;
- groundwater samples collected from all groundwater monitoring bores for laboratory analysis at intervals of one month to two months for a period of at least six months, including at least one groundwater monitoring event taken at the time of highest seasonal groundwater levels following completion of the dewatering operation (the period of monitoring needed will increase with increasing magnitude and duration of the dewatering operation);
- results of the post-dewatering groundwater quality monitoring program reported within a post-dewatering monitoring closure report for the project along with a discussion of any environmental impacts observed (potential requirements for continued monitoring and/or remediation will be assessed after DER reviews this post-dewatering monitoring closure report); and
- remedial actions undertaken to restore groundwater quality, if needed.

3.2.3 Contingency planning

Contingency planning involves outlining mitigation measures to prevent predicted impacts. The planned contingency measures should be risk-based and practical and will be linked with water quality trigger levels for management responses. If there is significant delay between a trigger level being reached and the mitigation measures being implemented, this could result in unacceptable damage to sensitive receptors. The proposed mitigation measures should be established with consultation with DER at an earlier stage before site work commences so that they can be implemented without delay.

Groundwater trigger levels may vary throughout the project due to changes in groundwater quality caused by seasonal variations.

If statistical techniques are adopted to determine acceptable trigger levels (e.g. using mean and/or standard deviations), sufficient background monitoring data should be collected to develop a good understanding of the groundwater system. If the measured values of a certain parameter shows an increasing trend (i.e. decline in groundwater quality) over the monitoring period, the trigger level should be based on the 'best case' results or should not be established using this data until the trend is normalised.

3.2.4 Preparation of an ASSMP

An ASSMP should:

- outline the strategies that will be used to manage potential impacts of development works that have the potential to disturb ASS materials on a site.
- be structured to address the key environmental management measures that will be used to mitigate or manage ASS disturbance both on-site and in proximity to the site for the life of the development.
- be accompanied by the results of the ASS investigations and should include contingency measures.
- be submitted to DER for review and approval before the commencement of any acid sulfate soil disturbing site works.

For further information on the format of an ASSMP see Section 7 and 8 of DER Guideline for *Treatment and management of soil and water in acid sulfate soil landscapes (June 2015)*.

3.3 Remediation Measures

Once disturbed Acid Sulphate Soils can be expensive and time-consuming to remediate, hence early identification and good management is extremely important in ASS areas to avoid creating a problem that requires remediation.

3.3.1 Neutralising acidic bodies of water (DER, 2015b)

There is a range of neutralisation products available that can be used to treat acid waters. The rate of application of these products for treating acid water should be carefully calculated in accordance with DER ASS Guidelines to avoid the possibility of 'overshooting' (i.e. making water too alkaline). Usually the optimum water condition is pH 6.5–8.5 and total acidity < 40mg/L.

Products that can be used:

- The most suitable material for neutralising water acidity is agricultural lime (calcium carbonate) as it is inexpensive, will not make water excessively alkaline if applied in excess and will help increase the acid-base buffering capacity of the water. Aglime is generally not harmful to plants, livestock, humans and most aquatic species. The limitation of its application is its insolubility in water, although it is more soluble in strongly acid water. Using aglime to increase the pH of water can be slow and costly.
- More soluble neutralising agents such as sodium bicarbonate (NaHCO_3) are quick to act and not subject to pH overshoot. However Sodium bicarbonate should be used with caution so as not to cause an increase in the salinity/sodicity of the local environment.
- Other cheaper, fairly soluble neutralising agents include hydrated lime (Ca(OH)_2) and quick lime (CaO) but they are difficult to manage and can result in excessively high pH. It is recommended that they should **NOT** be used because of the risk of making water highly alkaline if used in excess. This can create a health and safety risk for workers applying the chemicals to lakes and drains and for the public who may come into contact with the highly alkaline water. Very alkaline water may also severely damage aquatic organisms in lakes and fringing vegetation and may affect the health of water birds. When using these strongly alkaline materials, strict protocols must be established for their safe use, handling and monitoring to prevent adverse effects on the receiving environment.

Soluble or caustic neutralising agents such as hydrated lime or sodium hydroxide (pH 12–14), can quickly increase the pH and should be used with caution.

It should be noted that when neutralising acid water, no safety factor is used. Monitoring of pH and total titratable acidity should be carried out regularly during neutralisation procedures and for a suitable period afterwards to verify the appropriate levels have been achieved and maintained.

3.4 Roles and Responsibilities

The roles and responsibilities associated with the management of ASS within the City of Melville are summarised in Table 2 (below).

Table 2: ASS management roles and responsibilities

Project Stage	Role	Responsible Person
Planning	ASS shall be considered in all planning decisions to avoid potential adverse effects on the natural and built environment.	Project Manager
	Undertake ASS investigations at each stage of the planning process as prescribed in the Western Australian Planning Commission's (WAPC) <i>Acid Sulfate Soils Planning Guidelines</i> and DER <i>Guidelines for identification and investigation of acid sulfate soils and acidic landscapes (June 2015)</i> .	Project Manager
	For all disturbance and development within the City of Melville complete a <i>WA Planning Commission – Acid Sulphate Soils Self Assessment Form</i> and submit the completed form to the Department of Environment Regulation (DER).	Project Manager
	Employ planning strategies in areas with a high risk of ASS that, as far as practicable, give preference to land uses that avoid or minimise disturbance of ASS.	Urban Planning/Environmental Services
	Wherever ASS are to be disturbed during land development, implement comprehensive management and monitoring measures based on the level of risk associated with the disturbance. In accordance with Section 3.1-3.4 of this document	Project Manager

	Focus 'dry lot' developments in areas adjacent to coastline or estuaries where the watertable is less than about three metres deep.	Urban Planning
	Avoid activities that result in groundwater fluctuations and, in particular, permanent lowering of the watertable leading to exposure of in situ sulfidic soils to oxygen.	Project Manager
	Ensure appropriate environmental approvals are obtained prior to commencing dewatering operations.	Project Manager (with advice from Environmental Services)
	Complete an adequate investigation to assess the nature and spatial distribution of potential ASS of the project site if at high or moderate risk.	Project Manager
	If present, conduct adequate investigation to determine the most appropriate ASS management strategy.	Project Manager
	Develop an ASS Management Plan including submission to DER for approval.	Project Manager (with advice from Environmental Services)
	Where long-term soil stockpiling is required provide the proposed management strategy to DER for review and comment before the commencement of stockpiling.	Project Manager
	Where dewatering is required develop a dewatering and groundwater management plan for approval by DER in accordance with Section 3.3 of DER guideline <i>Identification and investigation of acid sulfate soils and acidic landscapes</i> (DER, 2015).	Project Manager
	Conduct site assessment in accordance with DER	Project Manager

	guideline <i>Identification and investigation of acid sulfate soils and acidic landscapes</i> (DER, 2015).	
	Investigate techniques that reduce or eliminate the exposure of ASS to air and/or neutralise acidity.	Environmental Services
	Where disturbance of lakes and construction of open drains are proposed and cannot be avoided, undertake management and remediation measures, in accordance with DER ASS Guidelines.	Project Manager in conjunction with Environmental Services (if it is a natural wetland, creek or river involved)
	Where residential subdivision and watered council parks and verges are planned in areas at risk of ASS, investigate methods for controlling groundwater drawdown as per alternatives listed in DER ASS Guidelines. i.e placing covenants on titles preventing residents from installing groundwater bores, making areas high density housing and using alternative water sources.	Project Manager
Planning and Construction	Ensure adequate field and laboratory QA/QC for ASS soil and water sampling.	Project Manager
	Where stockpiling of ASS and topsoil is required in the short or medium term, ensure the time in stockpile does not exceed that specified in DER guideline <i>Treatment and management of soil and water in acid sulfate soil landscapes</i> (DER, 2015).	Project Manager
Construction	Manage ASS in accordance with DER Guidelines.	Project Manager
	Undertake laboratory testing (validation) to ensure ASS control measures are effective.	Project Manager
Post Development	In areas prone to	Environmental Services

	acidification annually test water quality in lakes and open drains that drain to wetlands and waterways for evidence of acidification and heavy metal leaching. In accordance with DER ASS Guidelines.	
	Where acidified leachate is detected in lakes and open drains investigate methods to control acidity, as prescribed in DER ASS Guidelines, i.e. installing aerobic wetlands, compost wetlands, oxic and anoxic, and neutralisation.	Environmental Services
	Where there is evidence of groundwater acidification i.e. plant deaths and iron staining undertake testing o groundwater to establish the extent and severity of acidification, as per DER Guidelines.	Environmental Services in conjunction with land manager
	Where ASS generated groundwater contamination is identified investigate methods to reduce groundwater draw down as prescribed in DER ASS Guidelines. i.e. place memorials on land titles controlling the installation and use of groundwater bores.	Irrigation Supervisor in conjunction with Water Corporation
	Where significant oxidation of sulphide minerals has occurred investigate remediation measures as prescribed in DER ASS Guidelines. i.e. placing hardstand areas over the area where the watertable has been disturbed, installation of Permeable Reactive barriers, and use of subsurface slurry walls.	Parks and Environment

4 LIMITATIONS OF RISK ASSOCIATED WITH IMPLEMENTATION

Limitations of risk associated with the implementation for these guidelines are as follows:

4.1 Avoidance

Avoidance of ASS risk areas when planning developments and disturbance can significantly reduce or eliminate costly management of ASS. All effort should be taken in the initial part of this procedure to avoid the disturbance activity in the first place. All other management options incur a higher level of risk.

4.2 Impacts of remedial solutions

Care needs to be taken to get the correct dose of lime if this technique is to be used. Overdosing natural waterways with hydrated lime can cause similar environmental impacts to acid conditions. There is potential to damage estuarine and wetland ecosystems as some metals and metalloids are as soluble in very alkaline conditions as under acidic conditions.

5 KEY PERFORMANCE INDICATORS

5.1 Development

- (1) All works conducted by City of Melville staff and contractors are conducted in accordance with Department of Environment Regulation (DER) *Acid Sulphate Soils Guideline Series (June 2015)* and Western Australian Planning Commission's (WAPC) *Acid Sulfate Soils Planning Guidelines*.
- (2) A *WA Planning Commission – Acid Sulphate Soils Self Assessment Form* is completed and submitted to the Department of Environment Regulation (DER) for all disturbance and development within the City of Melville likely to impact on ASS.
- (3) Acid sulfate soils is considered in all planning decisions to avoid potential adverse effects on the natural and built environment.
- (4) Disturbance of acid sulfate soils is avoided wherever practicable.
- (5) Where the disturbance of acid sulfate soils is unavoidable, subdivision and development is undertaken in a manner that:
 - mitigates the potential adverse effects on the natural and built environment using the most appropriate mitigation strategies and management techniques; and
 - achieves acceptable soil and water quality outcomes.

5.2 Surface Water Quality

- (1) Annual testing for evidence of surface water acidification and heavy metal leaching is undertaken in wetlands and open drains draining to environmentally sensitive areas as per DER Guidelines.
- (2) Where annual testing of water in wetlands and open drains detects pollution from ASS, consideration is given to remedial measures to control acidity

5.3 Groundwater Quality

- (3) Testing of groundwater quality in areas where there is evidence of groundwater acidification is undertaken to confirm extent and severity of acidification, as per DER Guidelines.

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