13th January 2021

For the attention:
Philip Zappalla
Senior Planner – Major Assessment
City Development Branch
Council of City of Gold Coast

Dear **Philip Zappalla,**

Objection submission COM/2019/81 - City Plan Acid Sulfate Overlay Code 8.2.1.2 and failure to satisfy Performance Outcome PO1 or PO2

It has come to my attention that the Nucrush quarry development application fails to meet Performance Outcome PO1 and PO2 of the Acid Sulfate Overlay Code 8.2.1.2.

Overview

The City Plan acid sulfate overlay map for the area is reproduced in Attachment A1.

It is also noted that other quarries in the area such as KRA66 Nerang, KRA62 Blue Rock, KRA67 Northern Darlington Range (South and West), (See Attachments A2 and A3) do not have the apparent acid sulfate soil problem as per the Nucrush quarry due mainly it is understood to their increased elevation.

This development application

It is noted that the purpose of the City Plan (V6) 8.2.1.2 Acid sulphate soils overlay code is: *"to protect the natural environment and infrastructure from impacts of acid sulphate soils"* and *"Acid sulphate soils are identified and managed to ensure release of acid and associated metal contaminants does not occur"* (reproduced Attachment B1).

Performance Outcome PO1, states: *"The natural environment, built environment and/or infrastructure is protected by ensuring that soil disturbance or development of land does not result in the release of acid and metal contaminants"* with an acceptable outcome AO1 of *"Does the proposal meet the acceptable outcome?"* (Attachment B1). To the query: *"Does the proposal meet the acceptable outcome?"* The applicant has replied by stating *"The Groundwater Impact Assessment reviews the extent and severity of the acid sulfate soils"*.

Unfortunately, however, the Groundwater Impact Assessment referenced fails to provide the acid sulphate soils investigation in accordance with SC6.2 City Plan policy as required, being merely a list of components found as a result of a limited test (Attachment B2 being a typical result sheet). Although results are shown, the analysis was not thorough enough (see below) and there is no report analysing these results.

There is clearly insufficient information provided to answer Acceptable Outcome AO1: *"Does the proposal meet the acceptable outcome?".* Therefore, Acceptable Outcome AO1 has not been met.

Similarly, performance outcome PO2 states: *"The natural environment, built environment and/or infrastructure is protected by ensuring that soil disturbance or development of land does not result in the release of acid and metal contaminants"* and the acceptable outcome A02 is: *"Development does not: (a) excavate or otherwise remove soil or sediment identified as containing acid sulphate soils; (b) permanently or temporary extract groundwater resulting in aeration of previously saturated acid sulphate soils"* (reproduced in Attachment B1). **As per Performance Outcome PO1 and Acceptable Outcome A01, the Groundwater Impact Assessment referenced, fails to provide any information as to how this Acceptable Outcome will be achieved. Therefore, Acceptable Outcome AO2 has also not been met.**

SC6.2 City Plan Policy - Acid sulphate soils management policy

It is noted the policy objective is *"to prevent the potential impacts of disturbance"* (Attachment D1). By disturbing the acid sulphate soil it is necessary to ensure a thorough acid sulphate soil investigation is undertaken. Unfortunately, I do not believe this has been undertaken:

SC6.2 2 Undertaking an acid sulphate soil investigation and report

This City Plan Policy says: *"An acid sulfate soil investigation as a minimum must:*

a). characterise extent and severity of actual and potential soil acidity by undertaking sampling and analysis in accordance with the Queensland Acid Sulfate Soil Technical Manual.

b). establish the extent of acid sulphate soil risk across the site by undertaking soil sampling in accordance with rates specified. Justification for reduced sampling regimes must be provided.

1. *Boreholes taken to be at least one metre below the depth of the proposed disturbance or to at least two metres. Whichever is the greatest.*
2. *Minimum number of boreholes required as specified below … "*

There are only four bore holes in total: 'MB-01', 'MB-03', 'MB-04s' and 'MB-04d' (Attachment D3). Drilled to depths of: 29m 12m, 8.7m and 12 metres below ground level (mbgl) See Attachment D4. This is ridiculously short of the required target depth of - RL125 or -RL110 or -RL95 (depending on where you read it within the DA).

It is noted in Section 2-2 that the number of bore holes required is for a non-linear subject site (for an area of subject site > 4 hectares) 2 per hectare. With an extractive footprint of 66 hectares that requires 132 boreholes. Why has this requirement not been met? Why is there no justification for why this has not been addressed? Why is it considered that only four clearly inadequate bore holes is acceptable?

Unfortunately it is plain to see these clear requirements have not been met and no justification has been given.

SC6.2 2 Undertaking an acid sulfate soil investigation and report - sulfate soil management plan and City Plan 3 Preparing an acid sulfate soil management plan

There is a clear requirement to submit a sulfate soil management plan (Attachment E1). However, this has not been done. There is no clear reference to acid sulfate in the Groundwater Impact Assessment other than it is listed obscurely in the table of results (Attachment B2).

There is no analysis of the sulfate data whatsoever or whether it is a safe or unsafe level.   However, given that the boreholes were nowhere near deep enough I imagine it would be impossible to ascertain with any certainty.

Groundwater effect

The effect this will have on the groundwater in the area have been somewhat glossed over (Attachment C1).

For instance, based on data in the Main application, this will severely effect the groundwater and will contaminate the water leeching out of the pit walls at a predicted rate of 130 million litres a year (this equates to approximately 52 Olympic swimming pools of water) or one Olympic swimming pools worth of water every week. That is leeched from the water table, artificially lowering from its current level in line with the Coomera River level to 95 metres below it.

But, if you look at the Groundwater Impact Assessment we find the 130 ML/y is the absolute best case and the worst case is 432 ML/yr (Attachment C2). This has now risen from 52 Olympic swimming pools to 173 per yr (or 3.3 every week).   This is not the 4 litres per sec we were led to believe but maybe 13 litres every second. How is this going to get decontaminated and/or dewatered?

As per Attachment C1, it is expected that the radius of influence could be in the region of 1.4km (that's an area in excess of 6 km^2 surrounding the quarry.

The Groundwater Impact Assessment claims: *"the Coomera River will act as a flow boundary limiting the western extent of the radius of influence"* .   However, this is incorrect and highly misleading. The average depth of the Coomera River is believed to be just four metres. With a quarry pit in the region of -95 metres below it *"the Coomera River will **CERTAINLY NOT** act as a flow boundary limiting the western extent of the radius of influence"*.

So it doesn't matter how you attempt to conceal it; approximately 13 litres of water will be leeching into the quarry every second (173 Olympic swimming pools every year), having been potentially exposed to acid sulfates on the way. This contaminated water will then have to be disposed of pretty rapidly which will then be pumped back into the Coomera river. A potential environmental hazard waiting to happen. Or happening continuously for the expected 100 year life of the quarry?

How can this amount of water be successfully decontaminated before being hydraulically pumped into the Coomera River?

It is astounding to note the development application answer to this problem in the Groundwater Impact Assessment, Section 4.9 merely says:

> **7.2 Conceptual model during and after extraction**
>
> The quarry will require dewatering to remain dry. Any water that flows to the quarry would be available for use on site and any excess likely discharged. The conceptual flow diagrams depicted in Figure 7.3 and Figure 7.4 show that the pit will capture groundwater flow from the eastern and southern portion of the project site. The future excavation will capture groundwater all the way to the current divide running along the topographic high.

Therefore, with a terrific amount of potentially contaminated water leeching into the quarry 24 hours a day 7 days a week there is no plan to decontaminate the water. I quote, from Section 4.9 of the Groundwater Impact Assessment (7.2 Conceptual model during and after extraction) of the DA: *"any excess likely discharged".* There will be a lot of excess and this will be a lot of contaminated untreated water discharged into the Coomera River causing unknown long term and short term Environmental consequences. How can this have not been considered? This could be catastrophic for the Coomera River.

Why is this so important?

Acid sulfate soils are safe and harmless when not disturbed. If dug up or drained, they come in contact with oxygen. The pyrite in the soil reacts turning the pyrite into sulphuric acid, which can cause damage to the environment (Attachment F1).

It is noted in the Queensland Acid Sulfate management guidelines that "The disturbance of ASS [Acid Sulfate Soils] should be avoided wherever possible". If not possible "The sensitivity and environmental values of the receiving environment. This includes the conservation, protected or other relevant status of the receiving environment (e.g. fish habitat, marine park, protected wildlife etc" (Attachment F2).

It is noted that the determination of the abundance of ASS involves major costs and an expert in the field such as a Certified Professional Soil Scientist (CPSS). Advice would also be necessary from, for example, hydrologists for groundwater disturbances (Attachment F3). Given the significant cost factor is this why this DA has apparently cut corners in this area? Is this why the bores are just a token gesture and therefore totally inadequate in analysing the local strata?

To minimise risk avoidance strategies are discussed in Attachment F4. This states land uses such as "Extractive Industries" which are likely to result in significant excavation should be avoided in areas with a high probability of containing ASS.

Areas with potential acidity should remain undisturbed and unexcavated (Attachment F5).

The vulnerability of local wildlife is particularly concerning given the proposed hydrologically connectivity to the Coomera River. Coastal environments such as this contain areas of high biodiversity and/or species with high conservation significance. They live in the low pH organic-rich, soft waters. Disturbance and/or treatment of ASS may negatively affect the sensitive balance of these ecosystems (Attachment F6).

Similarly, disturbances of ASS should be avoided in situations where the receiving environment is susceptible to algal blooms. Mobilisation of iron (and other nutrients) by ASS drainage have been identified as a trigger for algal blooms. This is particularly worrying for the freshwater lake in the Coomera River adjoining the quarry (Attachment F7).

The disturbance of ASS should be avoided when the site is adjacent to, or hydrologically connected to groundwater-dependant eco-systems that may be drained as a result of the lowering of the ground water level as proposed (Attachment F8).

Activities that cause groundwater fluctuations and in particular those that permanently lower the watertable, should be avoided as these may expose in situ sulfidic spoils to oxygen. Groundwater in ASS areas are generally saline and high in dissolved iron, making it unsuitable for uncontrolled release to receiving environments. ASS impacts on groundwater can also cause health hazards such as arsenic contamination (Attachment F9).

All extractive industry sites should be hydrologically isolated using bunding and diversion drains. Containment will have to be adopted to neutralise acid levels prior to release (Attachment F10).

Stockpiling of ASS sulphate soils should be avoided for even short term. There is significant environmental risk associated with this (Attachment F11).

There is high risks associated with dewatering and drainage. Lowering of groundwater may expose sulfidic soils to oxygen and generate acidity. Large scale dewatering activities are high risk, requiring physical containment strategies, and no permanent dewatering may be undertaken (Attachment F12).

<u>Conclusion</u>

The required sulphate soil management plan and acid sulfate analysis has not been submitted. This is a clear requirement.

It is particularly important in this particular DA due to the subterranean depth they propose to go and the amount of material displaced which will automatically expose the dormant acid sulphate which when exposed to oxygen will chemically react turning the dormant pyrite into sulphuric acid.

This will severely affect the groundwater and will contaminate the water leeching out of the pit walls at estimates of up to 432 million litres a year. It is astounding to think the only DA reference to this potentially cataclysmic situation is: *"The quarry will require dewatering to remain dry. Any water that flows to the quarry would be available for use on site and any excess likely discharged"*. Absolutely no reference to potential contamination of the water once dormant acid sulfates are exposed.

I find this absolutely outrageous and truly shocking. This development application is once again falling well short of the requirements to ensure the local eco system and environment is not affected by their gargantuan proposals.

Thank you in anticipation,

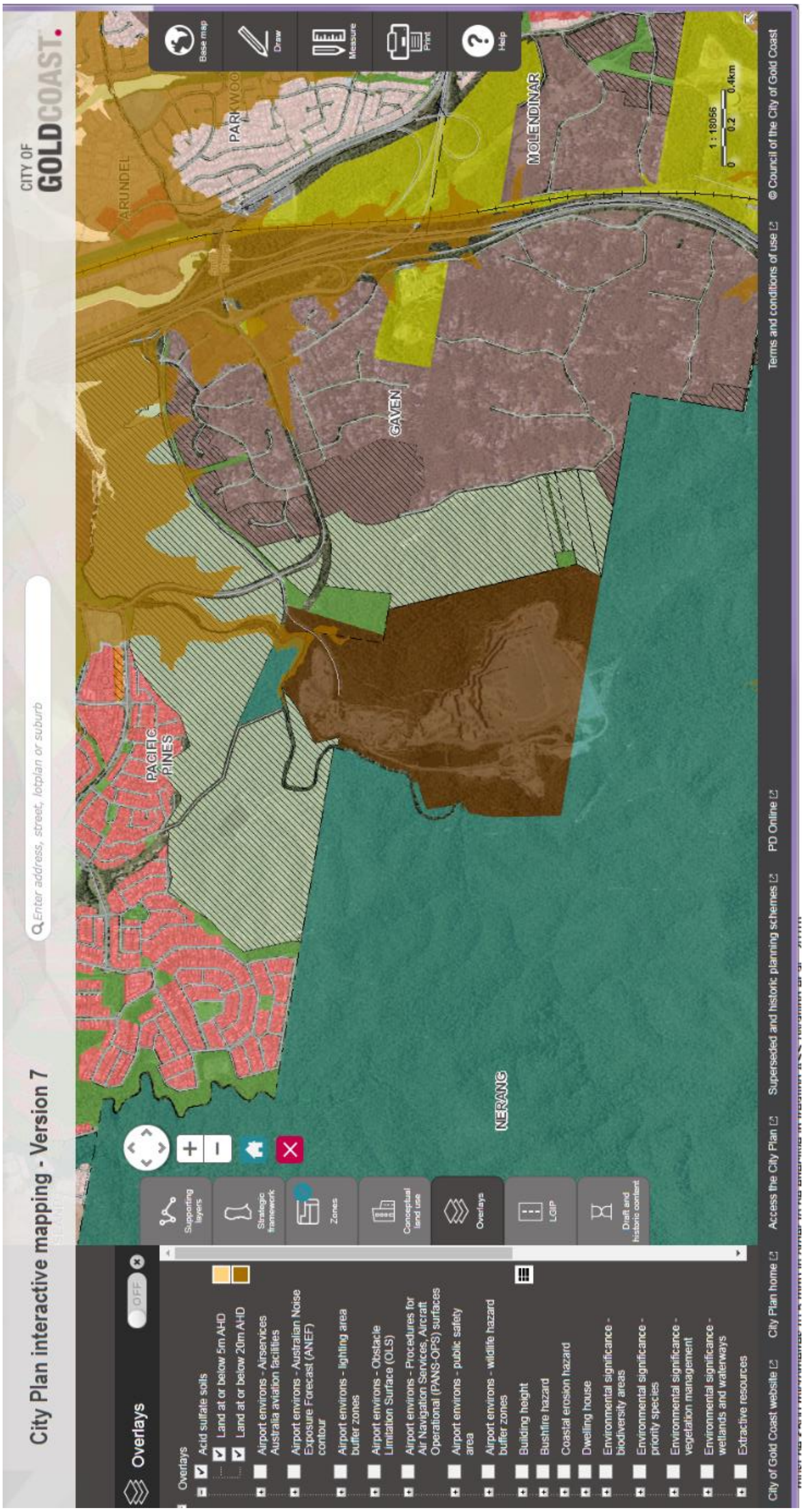
Kind regards

<u>Tony Potter</u>

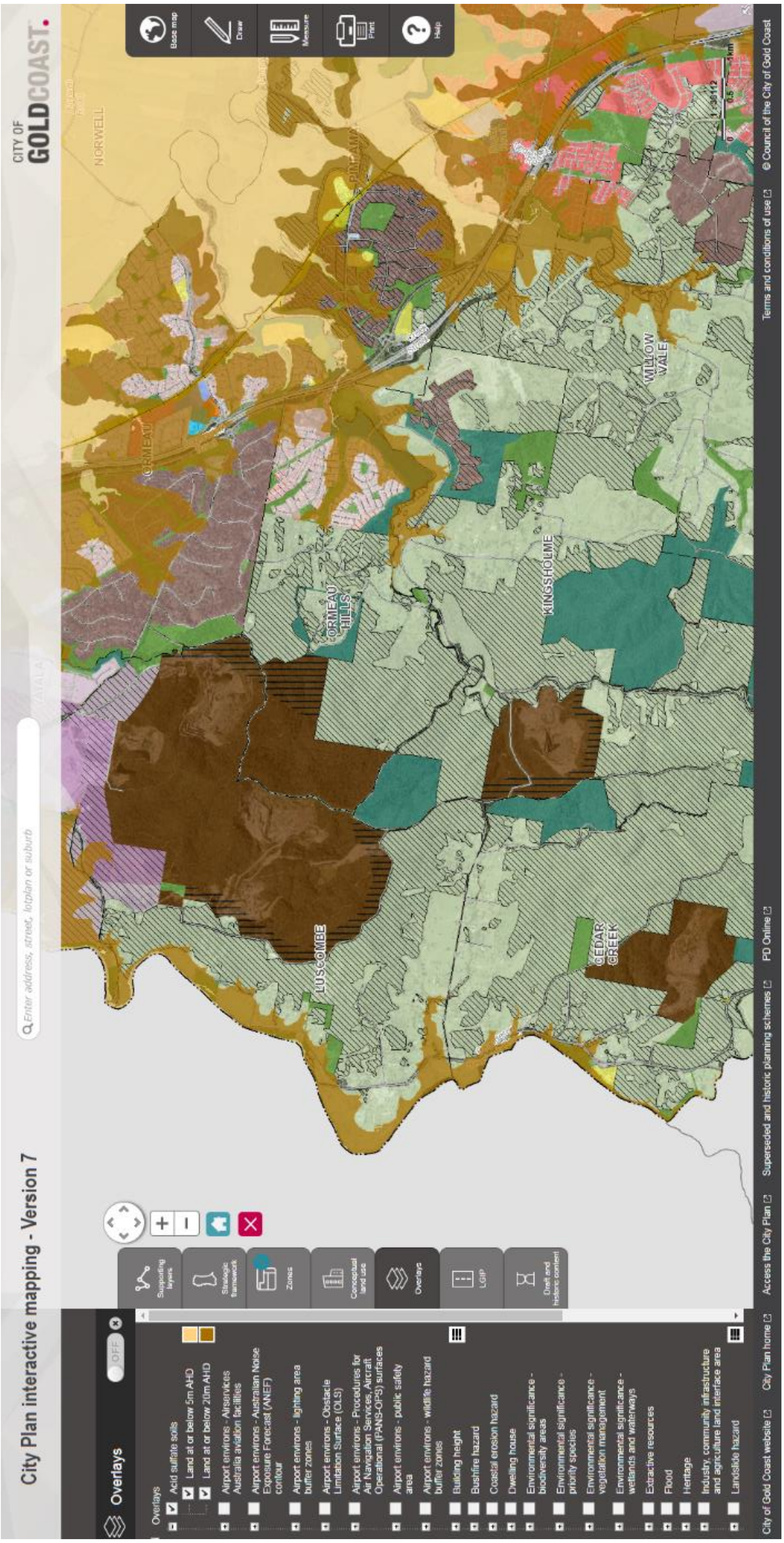
* Disclaimer. Please note my findings are believed correct and are to the best of my ability. However, there may be errors and assumptions I have made that are incorrect. I do not believe this to be the case, but, realise with the vast amounted of submitted data from the applicant, errors and assumptions on my part may occur. Hopefully this is not the case, but please accept my apologises if this is so. Thank you.

Attachment A1 - City Plan map of Nucrush quarry with Acid sulphate shown

Attachment A2 - City Plan map of Nerang Quarry (KRA66) with no Acid sulfate shown



Attachment A3 - City Plan map of Northern Quarries KRA?? And KRA??) with no Acid sulfate shown



Attachment B1 - Acid Sulfate section from main development application

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8.2.1 Acid sulfate soils overlay code

8.2.1.1 Application

This code applies to assessing material change of use, reconfiguring a lot and operational work, for development subject to the Acid sulfate soils overlay where indicated within **Part 5.10 Categories of development and assessment – Overlays.**

When using this code, reference should be made to **Section 5.3.2** and, where applicable, **Section 5.3.3,** in **Part 5**.

8.2.1.2 Purpose

(1) The Acid sulfate soils overlay deals with areas of land identified in a State planning policy as being subject to acid sulfate soils. It may include areas of land identified in the local government area as having potential or actual acid sulfate soils.

(2) The purpose of the Acid sulfate soils overlay code is to protect the natural environment, built environment and infrastructure from impacts of acid sulfate soils.

(3) The purpose of the code will be achieved through the following overall outcomes:

(a) Acid sulfate soils are identified and managed to ensure the release of acid and associated metal contaminants into the environment does not occur.

(b) Buildings and infrastructure are protected from the effects of acid sulfate soils.

8.2.1.3 Specific benchmarks for assessment

Table 8.2.1-1: Acid sulfate soils overlay code – for assessable development

Performance outcomes	Acceptable outcomes	Does the proposal meet the acceptable outcome? **If not, justify how the proposal meets either the performance outcome or overall outcome**	Internal use
Acid sulfate soils			
PO1 The extent and severity of the acid sulfate soils risk is accurately characterised.	**AO1** Acid sulfate soils are identified through an acid sulfate soils investigation, carried out in accordance with **SC6.2 City Plan policy – Acid sulfate soils management**.	Australasian Groundwater and Environmental Consultants Pty Ltd (**AGE**) have been commissioned by the Applicant to conduct a Groundwater Impact Assessment in support of the Oxenford Quarry extractive boundary realignment project. The Groundwater Impact Assessment reviews the extent and severity of the acid sulfate soils. A copy of the Groundwater Impact Assessment report prepared by AGE is made available for review within **Section 4** of this Development Application Package.	
PO2 The natural environment, built environment and/or infrastructure is protected by ensuring that soil disturbance or development of land does not result in the release of acid and metal contaminants.	**AO2** Development does not: (a) excavate or otherwise remove soil or sediment identified as containing acid sulfate soils; (b) permanently or temporarily extract groundwater resulting in aeration of previously saturated acid sulfate soils; or (c) fill land (where at or below 5m AHD) that results in: (i) actual acid sulfate soils being moved below the watertable; or (ii) previously saturated potential acid sulfate soils being aerated. OR Where acid sulfate soils are disturbed, building design, infrastructure and filling/excavation works are managed in accordance with an acid sulfate soils management plan to: (a) protect the natural environment, buildings and infrastructure; and (b) neutralise existing acidity and ensure the release of acid and metal contaminants does not occur. The Acid sulfate soils management plan is to be prepared in accordance with **SC6.2 City Plan policy – Acid sulfate soils management**. **Note: A condition will be included on any approval requiring certification from a suitably qualified and experienced professional. This certification must be submitted to Council confirming that the management of the acid sulfate soils has complied with the approved management plan.**	Please refer to the Groundwater Impact Assessment report prepared by AGE for further information. A copy of this report is made available within **Section 4** of this Development Application Package.	

Attachment B2 - Groundwater Impact Assessment report (typical) from development application

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Page : 4 of 6
Work Order : EB1805915
Client : AUSTRALASIAN GROUNDWATER AND ENVIRONMENTAL CONSULTANTS PTY LTD
Project : G1913 Oxenford

Analytical Results

Sub-Matrix: WATER
(Matrix: WATER)

			Client sample ID	MB-04s	SW-01
			Client sampling date / time	05-Mar-2018 00:00	05-Mar-2018 00:00
Compound	CAS Number	LOR	Unit	EB1805915-002	EB1805915-003
				Result	Result
EA005P: pH by PC Titrator					
pH Value	----	0.01	pH Unit	8.34	----
EA006: Sodium Adsorption Ratio (SAR)					
Sodium Adsorption Ratio	----	0.01	-	7.16	----
EA010P: Conductivity by PC Titrator					
Electrical Conductivity @ 25°C	----	1	µS/cm	2160	----
EA016: Calculated TDS (from Electrical Conductivity)					
Total Dissolved Solids (Calc.)	----	1	mg/L	1400	----
EA065: Total Hardness as CaCO3					
Total Hardness as CaCO3	----	1	mg/L	412	----
ED009: Anions					
Bromide	24959-67-9	0.010	mg/L	0.079	----
ED037P: Alkalinity by PC Titrator					
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	18	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	343	49
Total Alkalinity as CaCO3	----	1	mg/L	360	49
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA					
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	582	5
ED045G: Chloride by Discrete Analyser					
Chloride	16887-00-6	1	mg/L	274	24
ED093F: Dissolved Major Cations					
Calcium	7440-70-2	1	mg/L	81	8
Magnesium	7439-95-4	1	mg/L	51	6
Sodium	7440-23-5	1	mg/L	334	18
Potassium	7440-09-7	1	mg/L	2	2
EG020F: Dissolved Metals by ICP-MS					
Aluminium	7429-90-5	0.01	mg/L	0.01	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	----
Barium	7440-39-3	0.001	mg/L	0.078	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	----
Chromium	7440-47-3	0.001	mg/L	<0.001	----
Cobalt	7440-48-4	0.001	mg/L	0.002	----

Attachment C1 - Groundwater Impact in Main applicatipn

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4.9 Groundwater Impact Assessment – AGE Consultants

Australasian Groundwater and Environmental Consultants Pty Ltd prepared a groundwater impact assessment of the proposal. The report essentially concludes there should be no significant adverse impact in respect to ground water issues.

The post-quarrying conceptual model shows that the water level in the quarry void will likely stabilize to approximately the same elevation as the current Coomera River (that is ~0 m AHD).

The groundwater table within the alluvium will likely recover back to a level that is comparable to current conditions.

Post-closure, the groundwater flow regime will recover approximately back to its pre-development configuration, with the quarry pit only capturing a small portion of the groundwater flow that would have otherwise discharged to the Coomera River under current conditions.

Extraction of the quarrying operations will result in the following changes to the groundwater regime:

- A localised deepening of the existing quarry pit from approximately 5 m AHD to -95 m AHD, which will extend the excavation below the regional groundwater table. This will result in groundwater seepage into the quarry pit and drawdown within the surrounding water bearing Neranleigh-Fernvale Beds rock mass.
- Groundwater inflows of 4 L/s or 130 ML/yr are predicted and are considered more likely to be representative of the magnitude of inflows to be observed during operations.
- The maximum radius of influence is predicted to be approximately 1,400 m but is more likely to be in the order of 700 m from the quarry pit. The maximum predicted radius of influence includes a private water bore (RN 124033), a portion of the Coomera River and approximately 400 m of riparian wetland located upstream of the Gold Coast wave park. Providing there is hydraulic connectivity between the Coomera River, the associated alluvium and the Neranleigh-Fernvale Beds, the Coomera River will act as a flow boundary limiting the western extent of the radius of influence. The riparian wetland located upstream of the Gold Coast wave park is fed by surface water from the Coomera River originating upstream of the Oxenford Quarry.
- The quarrying will not impact surface water flow in the Coomera River or the surface water flow supplying these riparian wetlands. Nucrush will install a new monitoring bore (MB-05) along the project's eastern boundary to monitor groundwater eastwards beyond the project's eastern boundary.

A full copy of the groundwater report is included within section 4 of this development application package.

Groundwater Impact Assessment.pdf 48 / 154

The inflows from Zone 1, the pit walls, varies from 15.1 ML/yr to 72.4 ML/yr when the permeability of the bedrock is varied from 0.001 m/d to 0.01 m/d. The 0.001 m/d value represents the anticipated permeability of the rock at depth, due in large part to the closure of fractures from the overburden pressure. The 0.01 m/d value represents the permeability of the bedrock as measured in the monitoring bores completed for this project.

The inflows from Zone 2, the pit floor, varies from 113.6 ML/yr to 359.2 ML/yr when the permeability of the bedrock is varied from 0.0001 m/d to 0.001 m/d. The 0.0001 m/d value represents low permeability rock at depth, due in large part to the closure of fractures from the overburden pressure. The 0.001 m/d value represents the highest probable floor permeability.

The inflow predictions show that the inflows are predominately from groundwater entering through the pit floor where the Neranleigh_Fernvale Beds are saturated. The inflows predicted by the low bedrock conductivity scenario (i.e. 4 L/s or 130 ML/yr) are considered more likely to be representative of the magnitude of inflows to be observed during operations.

Table 7.2 Analytical results

Scenario	Zone	K_{h1} (m/day) / K_{h2} (m/day)	Radius of influence (m)	Q (L/s)	Q (ML/yr)	Total (ML/yr)
Low bedrock conductivity	1	0.001	700	0.5	15.1	130 (best case)
	2	0.0001	700	3.6	113.6	
High bedrock conductivity	1	0.01	1,418	2.3	72.4	186
	2	0.0001	1,418	3.6	113.6	
High bedrock wall and floor conductivity	1	0.01	1,418	2.3	72.4	432 (worst case)
	2	0.001	1,418	11.4	359.2	

Attachment D1 - SC6.2 City Plan Policy - Acid sulfates soils management

City Plan Version 6

SC6.2 City Plan policy - Acid sulfate soils management

1 Policy objective

The objective of this City Plan policy is to:

(a) provide information and guidance on the sampling and analysis required to identify the extent and severity of the acid sulfate soils risk.

(b) provide information and guidance on how to manage acid sulfate soils to prevent the potential impacts of disturbance.

(c) specify the information required to satisfy the applicable assessment benchmarks of the Acid sulfate soils overlay code.

The policy is designed to ensure that any proposed works, particularly within the coastal lowlands, are fully assessed prior to any disturbance.

1.1 Application

This policy applies where an applicant is preparing an acid sulfate soils investigation or acid sulfate soils management plan where called up by the applicable assessment benchmarks of the Acid sulfate soils overlay code.

1.2 What are acid sulfate soils?

Acid sulfate soils are the common name given to soils containing iron sulfides. Under anaerobic conditions maintained by permanent groundwater, iron sulfides are stable. These soils are known as potential acid sulfate soils. When these soils are disturbed and exposed to air the iron sulfides oxidise and produce sulfuric acid which makes the soil strongly acidic. This acid can mobilise heavy metals, which can have significant adverse effects on human health, the natural environment, built environment and infrastructure. These soils are known as actual acid sulfate soils.

Areas affected by acid sulfate soils are identified with the Acid sulfate soils overlay map.

Attachment D2 - SC6.2.2 City Plan Policy - Acid sulfates soils management - soil investigation and report

City Plan Version 6

2 Undertaking an acid sulfate soil investigation and report

An acid sulfate soils investigation is to be undertaken by a suitably qualified and experienced professional. Where filling is proposed a suitably qualified geotechnical professional must carry out the investigation. The investigation must be undertaken early in the project life to allow redesign of earthworks to avoid or minimise disturbance of acid sulfate soils.

An acid sulfate soil investigation as a minimum must:

(a) characterise extent and severity of actual and potential soil acidity by undertaking sampling and analysis in accordance with the *Queensland Acid Sulfate Soil Technical Manual – Sampling Guidelines and the Queensland Acid Sulfate Soil Technical Manual –Laboratory Methods Guidelines*.

(b) establish the extent of acid sulfate soil risk across the site by undertaking soil sampling in accordance with rates as specified below. Justification for reduced sampling regimes must be provided.

1. Boreholes taken to at least one metre (1m) below the depth of the proposed disturbance or to at least two metres (2m), whichever is greater.
2. Minimum number of boreholes required as specified below. Where sampling provisions overlap the highest sampling number must be utilised.

2-1: Number of boreholes required for sampling based on volume of disturbance (if disturbance area is non-linear).

Volume of disturbance (m^3)	Minimum number of boreholes required
<250m^3	2
251-1,000m^3	3
>1,000m^3	4

2-2: Number of boreholes required for sampling based on area of subject site (if disturbance area is non-linear).

Area of subject site	Minimum number of boreholes required
1-2 hectares	6
2-3 hectares	8
3-4 hectares	10
>4 hectares	2 per hectare

2-3: Number of boreholes required for sampling (if disturbance area is linear).

Nature of disturbance area	Minimum number of boreholes required
Minor width, volume and slope	At 100m intervals
Major width, volume and slope	At 50m intervals

3. Starting from the present soil surface, laboratory analysis is to be undertaken at 0.5m intervals down the borehole horizon.

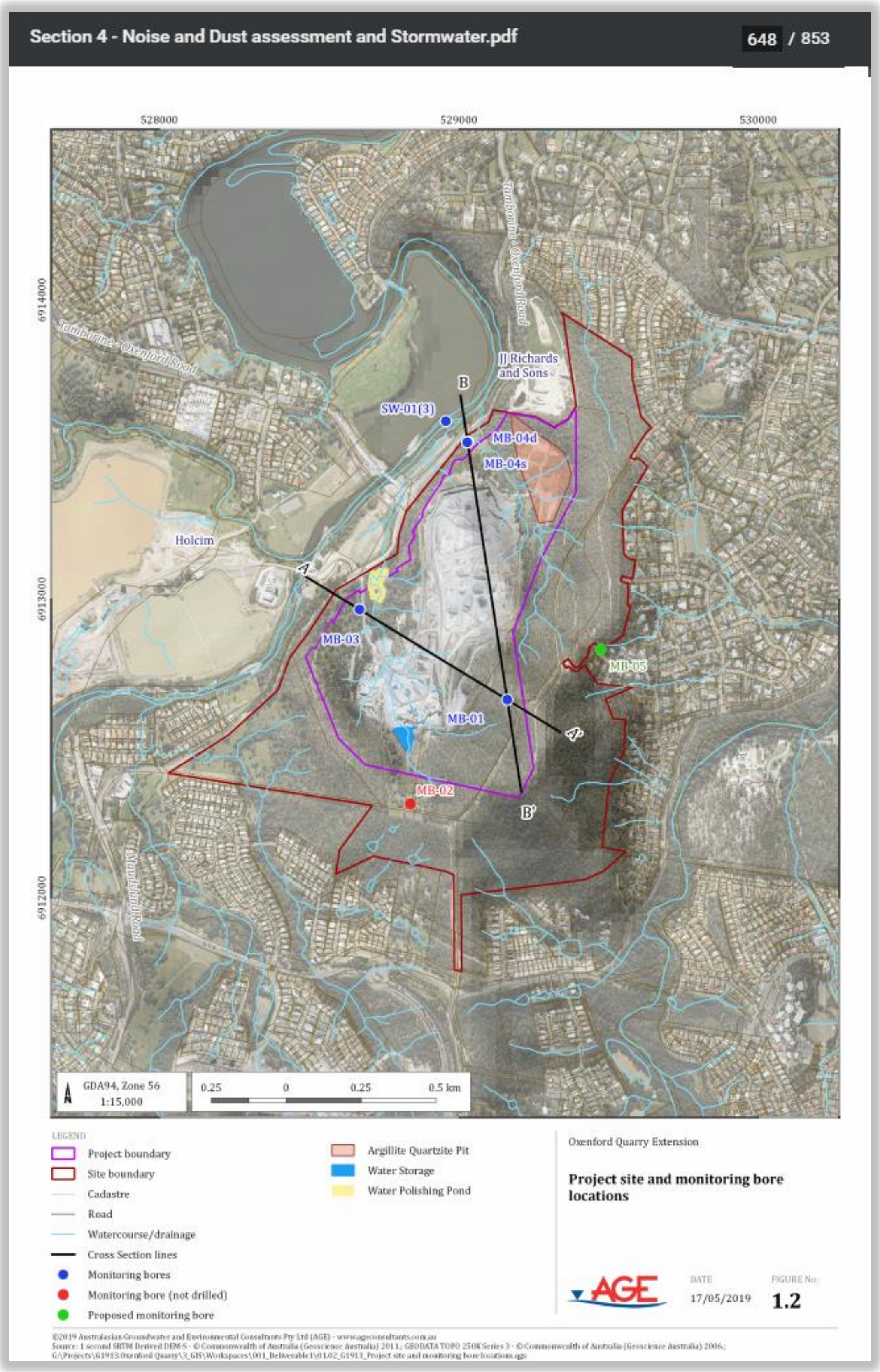
(c) analyse the sites vulnerability to heave and displacement as a result of any filling activities.

(d) analyse the effect of activities such as dewatering or filling on existing groundwater.

(e) describe the potential impacts on surrounding environmental features.

(f) identify location and depth where acid sulfate soils return results above the action criteria as specified below.

<u>Attachment D3 - Map of bore holes</u>



Attachment D4 - Bore details

Section 4 - Noise and Dust assessment and Stormwater.pdf 665 / 853

5.1.2 Monitoring bore drilling

Site investigation by AGE included drilling and construction of four monitoring bores (MB-01, MB-03, MB-04s and MB-04d) at three locations (Figure 1.2). Site MB-02 could not be drilled due to the steep eroded-terrain upslope of the proposed site and deep weak soils at the proposed site preventing vehicle access. The site has retained its designation as MB-02. Drill site selection was principally based on the potential and likelihood of intersecting shallow groundwater within either the weathered bedrock or thin veneer of alluvium.

The monitoring bores were drilled by Numac Drilling using a Boart Longyear DB520 air rotary/auger drill rig under the supervision of a suitably qualified and experienced hydrogeologist. A solid stem auger was used to advance the hole and drill to approximately 3 mbgl, to allow the placement of a surface casing. Air rotary drilling commenced once the surface casing had been grouted in place. Each borehole was advanced until groundwater was encountered and then to a depth sufficient to ensure a measurable groundwater flow into the bore screen. Typically, the bores were advanced a minimum of 3 m below the depth of the first clear groundwater strike. The exception was bore MB-04s, where the total drill depth was achieved using the solid stem auger. All bores were drilled to 125 mm diameter from the surface to their total depth. All of the boreholes intersected fractured (i.e. secondary porosity) Neranleigh-Fernvale Beds.

Each monitoring bore was completed by installing a 3 m length of 50 m slotted Class 12 uPVC screen at the base of the bore hole and then blank Class 12 uPVC casing to approximately 1 m above the ground surface (Table 5.6). The annular space between the screen and borehole wall was filled with 2 mm washed sand, providing a filter between the formation and the well screen. The filter sand was backfilled to at least 1 m above the top of the screened interval. A 1 m thick of hydrated bentonite seal was placed directly above the sand/screened interval. The bore annulus well seal was completed with a 5% bentonite powder/cement grout mixture from the top of the bentonite seal to the ground surface. Each bore was then completed with a steel lockable monument cemented into place.

The completion details for each bore as well as a stratigraphic log of the materials encountered during drilling are presented in Table 5.6 and Appendix B.

Table 5.6 Monitoring bore construction details

Bore_ID	Drill depth (mbgl)	Casing stick up (m)	Screen (mbgl)	Sand filter (mbgl)	Bentonite seal (mbgl)	Standing water level (mbTOC)
MB-01	29	1.01	30.62 - 33.62	28.5 - 33.62	26.5 - 28.5	29.33
MB-03	12	0.95	9 - 12	8 - 12	6 - 8	4.53
MB-04s	8.7	0.873	5.7 - 8.7	4.7 - 8.7	2.7 - 5.7	3.43
MB-04d	12	0.83	10 - 13	9.5 - 13	7.6 - 9.5	3.37

Attachment E1 - SC6.2.2 City Plan Policy - Acid sulfate soil management - sulphate soil management plan

City Plan Version 6

3 Preparing an acid sulfate soil management plan

If an investigation establishes that acid sulfate soils, above the action criteria, are to be disturbed by the proposed development, a comprehensive acid sulfate soil management plan is required. Adverse impacts from the disturbance must be managed by:

(a) neutralising actual acid sulfate soils and preventing the generation acid and metal contaminants.

(b) ensuring surface or groundwater flows containing acid and metal contaminants are treated.

(c) preventing the in-situ oxidation of acid sulfate soils through groundwater level management.

(d) documenting site specific management strategies and reporting requirements within an acid sulfate soil management plan developed in accordance with *Queensland Acid Sulfate Soil Technical Manual - Soil Management Guidelines*.

An acid sulfate soil management plan, as a minimum, shall describe:

(a) the outcomes of acid sulfate soil investigation.

(b) the spatial distribution of the acid sulfate soils risk across the site.

(c) nature of the planned disturbance, volumes of soils to be disturbed and treatment category.

(d) required soil dosage rates and quantity and quality of lime required to mitigate acid leachate.

(e) treatment and management details including blanket liming rates based on highest result, time between exposure and treatment.

(f) containment strategies including location and design of treatment pads, guard layers and settling ponds.

(g) handling and storage of neutralising agents.

(h) monitoring, verification testing and reporting schedules including auditing frequency, performance criteria and corrective action strategies.

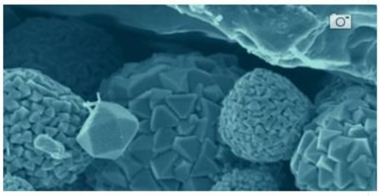
<u>Attachment F1 - Acid sulfates explained</u>

www.qld.gov.au/environment/land/management/soil/acid-sulfate/explained

Queensland Government

Acid sulfate soils explained

Common in many parts of the world, acid sulfate soils are saturated with water, almost oxygen-free and contain microscopic crystals of iron sulfide minerals (commonly pyrite).



Microscopic image of pyrite in soil

Acid sulfate soils are safe and harmless when not disturbed. If acid sulfate soils are dug up or drained they come into contact with oxygen. The pyrite in the soil reacts with the oxygen and oxidises.

This process turns pyrite into sulfuric acid, which can cause damage to the environment and to buildings, roads and other structures.

The acid also attacks soil minerals, releasing metals like aluminium and iron. Rainfall can then wash the acid and metals from the disturbed soil into the surrounding environment.

Read more on the impacts of disturbing acid sulfate soils.

What do acid sulfate soils look like?

When acid sulfate soils are undisturbed, they are dark blue-grey (sometimes black) and wet, with no structure. They are often high in clay, but can be sands or sometimes even gravels.

A healthy mangrove forest, with the dark blue-grey soil colours common to undisturbed acid sulfate soils

When acid sulfate soils are disturbed, the iron released from the pyrite oxidation forms a range of brightly coloured minerals—first yellow, then brown then red. Cracks open up on the soil surface, and the soil shrinks as it dries out. Most importantly, the soil pH drops from nearly neutral to extremely acidic, often below pH 2.

Read more on identifying acid sulfate soils.

In Queensland

Acid sulfate soils can form in parts of inland Queensland where there are appropriate conditions (listed above)—e.g. some of the salt lakes in western Queensland have acid sulfate soils present.

Around 35,000 years ago, the sea level in Queensland was higher and large swamps existed in many places along the coast. Since then, the sea has retreated and newer layers of soil have been transported from the hills, covering the former swamps.

This is why many coastal plains have a layer of acid sulfate soil hidden below the current soil. Coastal areas lower than 5m AHD (Australian Height Datum) are likely to have acid sulfate soils present. Acid sulfate soils can also be found buried beneath newer soils at elevations below 20m AHD.

Acid sulfate soils have only been mapped in some parts of Queensland. However by looking at coastal areas below 20m AHD, estimates about the extent of acid sulfate soil in Queensland can be made.

Around 23,000km^2 of the Queensland coast is likely to contain acid sulfate soils, with around 6600km^2 in catchments that flow to the Great Barrier Reef. By comparison, the area governed by Brisbane City Council is 1367km^2.

Read more on acid sulfate soils reports and maps.

Attachment F2 - Management Principles

queensland-ass-management-guideline-2014.pdf

3. Management principles

The Soil Management Guidelines must be applied by following the eight management principles:

Management principles

1. The disturbance of ASS should be avoided wherever possible.
2. Where disturbance of ASS is unavoidable, preferred management strategies are:
   - minimisation of disturbance
   - neutralisation
   - hydraulic separation of sulfides either on its own or in conjunction with dredging; and
   - strategic reburial (reinterment).

   Other management measures may be considered but must not pose unacceptably high risks.
3. Works should aim to achieve best practice environmental management, when it has been shown that the potential impacts of works involving ASS are manageable, to make sure that the potential short- and long-term environmental impacts are minimised.
4. The material being disturbed (including the in situ ASS and surface water and groundwater systems), and any potentially contaminated waters associated with ASS disturbance, must be considered in developing a management plan for ASS and/or in complying with the general environmental duty.
5. Receiving marine, estuarine, brackish or fresh waters are not to be used as a primary means of diluting and/or neutralising ASS or associated contaminated waters.
6. Management of disturbed ASS is to occur if the ASS action criteria listed in Table 4.1 of these guidelines are reached or exceeded.
7. Placement of untreated ASS above the permanent watertable, with or without containment, is not an acceptable long-term management strategy. For example, soils that are to be stockpiled, disposed of to landfill, used as fill, placed as temporary or permanent cover on land or in waterways, sold or exported off the treatment site or used in earth bunds, that exceed the ASS action criteria listed in Table 4.1 should be treated/managed.
8. The following issues should be considered when formulating ASS environmental management strategies:
   - the sensitivity and environmental values of the receiving environment. This includes the conservation, protected or other relevant status of the receiving environment (e.g. Declared Fish Habitat Area, Marine Park, Coastal Management District and protected wildlife)
   - whether groundwaters and/or surface waters are likely to be directly or indirectly affected
   - the heterogeneity, geochemical and textural properties of soils on site
   - the management and planning strategies of local and/or state government, including statutory planning instruments.

Moving beyond the first management principle of avoidance needs to be justifiable. Short- and long-term environmental and economic costs must be considered. Assessment managers **will expect scientific justification** as part of a development application involving ASS disturbance.

Attachment F3 - Risk Assessment

queensland-ass-management-guideline-2014.pdf

Queensland Acid Sulfate Soils Technical Manual: Soil Management Guideline

4. Risk assessment

Proponents disturbing ASS must assess the risk of disturbance by considering both on- and off-site impacts. The construction, operational and maintenance risks will also need to be evaluated. A risk assessment should be a precursor to any proposal with the potential to disturb ASS. The risk assessment must describe the footprint of all potential impacts and the values and risks within the footprint, including off-site impacts. Values would at least include biodiversity values (flora and fauna, connectivity, etc.), water quality goals and groundwater quality. Risks could include the potential for algal blooms or concrete damage. The risk assessment must consider the ASS management principles (see section 3), particularly the first and lowest-risk principle of avoidance.

Determining whether or not ASS is present at a site and managing ASS appropriately if it needs to be disturbed can involve major costs. These costs may compromise a project's design or economic viability. As such, a thorough ASS investigation (in compliance with the latest sampling guidelines and soil analyses according to the latest Laboratory Methods Guidelines, Ahern et al., 2004, or AS4969, Standards Australia, 2008) is an essential component of a broader risk assessment before making any landuse decisions. The ASS investigation is needed to provide information on the environmental setting, location of and depth to ASS, existing and potential acidity present in the soil, and other soil characteristics. The sampling guidelines contain further information on ASS investigations. Successful ASS management depends on the results of the investigation – and results from the investigation help to determine the most appropriate management strategy for a site.

Project design and construction methodology can also determine project viability. Multiple development scenarios should be considered and methodologies should not be left to contractors to determine alone.

For disturbances greater than 1000 m^3 and/or for disturbances affecting groundwater, a suitably qualified person experienced with ASS should conduct the investigation and develop the management plan. Such a person would be a Certified Professional Soil Scientist (CPSS). Advice from other specialists may also be necessary, for example, hydrogeologists for groundwater disturbances.

Regardless of project size, the possibility of encountering ASS should be considered if the groundwater or the surface drainage patterns will be disturbed. Blocking water flows can cause ASS to dry out and start producing acid.

Small disturbances in high-risk areas can still have considerable impacts if not managed appropriately. Impacts can also be cumulative where several smaller disturbances occur in a catchment. Proponents and regulators should seek to avoid or minimise situations where multiple small ASS disturbances could create complex management issues involving many stakeholders.

Attachment F4 - Avoidance strategies

queensland-ass-management-guideline-2014.pdf

6. Avoidance strategies

The first principle of ASS management is to avoid the disturbance of ASS wherever possible. Avoidance carries the least environmental risk, as iron sulfides are unreactive while they remain in an anoxic, preferably anaerobic (reducing) environment. Just because an ASS is under water does not necessarily mean that there is no risk, as water can contain and transport dissolved oxygen. Avoidance is also often the cheapest option, as the risks and costs associated with long-term discharge of acid, iron or aluminium leachate, the potential for degradation of aquatic ecosystems, remediation costs, delays associated with development approvals and the potential long-term management and monitoring needs may outweigh the benefits of major earthworks.

To apply this principle sensibly, a site-wide ASS investigation must be conducted before any development plans are considered. The results of the investigation allow a proponent to avoid disturbing higher-risk areas, rather than trying to employ higher-risk management strategies to contend with site constraints. This reduces overall environmental risk and is commonly more cost-effective.

In the past, it has not been customary to avoid disturbing ASS, especially since few people accepted that ASS disturbance would cause environmental problems. **Higher community expectations leading to increasingly stringent government policy now require adherence to this avoidance principle.** Documented evidence should be presented, showing that avoiding ASS disturbance has been seriously considered at all sites. A sound case must be made for choosing to disturb ASS, along with a low-risk management plan that is acceptable to regulators. The following section provides guidance on when it is best to avoid ASS.

This is not to say that if a site investigation uncovers areas with existing acidity (e.g. a previously disturbed site) then treatment should be avoided. A treatment plan for such acidified areas will need to be developed and implemented.

6.1 Statutory planning mechanisms to avoid ASS

The principal goals of the National Strategy for the Management of Coastal Acid Sulfate Soils include 'avoid disturbance of coastal ASS' (National Working Party on Acid Sulfate Soils, 2000).

In situations where there is a high probability of ASS occurrence, state and local government planning strategies should, as far as practicable, give preference to land uses that avoid disturbance of ASS. Where disturbance cannot be avoided by these means, planning instruments should require the involvement of planning and assessment staff at a local and/or state government level to oversee proposed development in areas considered high-risk for ASS.

When determining the risk and manageability of a land use or proposal, assessors should consider whether the following features will be involved:

- large and/or deep excavations
- creation of new land (reclamation)
- dredging or similar extractive works
- major change to groundwater systems via extraction, drainage, bunding, surface sealing or placement of heavy fill
- significant change to surface drainage patterns
- temporary or permanent disturbance.

Land uses such as extractive industries, golf courses, marinas, canal estates, agriculture requiring drainage, and land uses with car parking, storage, etc. below ground level – which are likely to result in significant amounts of excavation or filling – should be avoided in areas with a high probability of containing ASS. Local and regional plans should direct such projects away from high-risk ASS areas. Where ASS occurs at a significant depth, the above land uses may not be a problem if they are unlikely to result in the disturbance of ASS layers.

At the time of writing, Queensland legislation manages disturbance of ASS through two primary mechanisms. First, the *Sustainable Planning Act 2009* contains provisions that oversee the creation of statutory planning instruments. These instruments contain powers to direct high-risk development works away from areas likely to contain ASS. These powers may be exercised by setting required planning controls at the local government level, and/or requiring certain development proposals be assessed and approved, conditioned or denied by government. Second, the *Environmental Protection Act 1994* contains provisions requiring assessing authorities to consider potential impacts of ASS when considering applications to undertake activities regulated under that Act ('environmentally relevant activities').

Attachment F5 - Avoidance strategies -avoiding areas with potential acidity

queensland-ass-management-guideline-2014.pdf

Queensland Acid Sulfate Soils Technical Manual: Soil Management Guideline

6. Avoidance strategies

6.2 Avoiding areas with high existing and/or potential acidity

Where the ASS investigation has identified soil or sediment in parts of a site with high existing and/or potential acidity, it is essential to design or redesign a project to avoid disturbing these soils.

In some cases, these disturbances may be manageable but not necessarily sustainable. The long-term costs may outweigh the benefits when the true expense of building treatment pads, spreading and mixing neutralising materials, generating greenhouse gases, reburying or disposal, monitoring on- and off-site, and remediating on- and off-site are calculated.

Areas with high existing and/or potential acidity should remain undisturbed or unexcavated. It may be feasible to place fill over these soils, but existing acidified soils may require remediation as part of development works. Management plans will be required that particularly address any hydrological or geotechnical issues. Such areas can become public and open spaces, parking areas, sports grounds, or similar.

Attachment F6 - Avoidance strategies - Sensitive wildlife

queensland-ass-management-guideline-2014.pdf

Queensland Acid Sulfate Soils Technical Manual: Soil Management Guideline

6. Avoidance strategies

6.3.1 Sensitive wildlife

A precautionary approach is recommended when ASS underlie, are in close proximity to or are hydrologically connected to the habitat of sensitive species. Avoidance is often the only effective management strategy in situations where ASS underlie habitats and ecosystems that contain sensitive wildlife or where off-site disturbances can indirectly impact with these areas. Coastal environments often contain areas of high biodiversity and/or species with high conservation significance – for example, aquatic fauna such as the frogs, fish and other biota that live in the low pH, organic-rich, soft waters of some coastal wetlands. These include pH-sensitive amphibians (e.g. the Wallum froglet and the Cooloola sedgefrog), as well as coastal freshwater fish like the Oxleyan pygmy perch and the Honey Blue-eye. Disturbance and/or treatment of ASS may negatively affect them. Neutralising agents are an essential component of most ASS management proposals and the impacts of using these products in naturally soft acidic freshwater habitats are not adequately understood. What is known is that neutralising agents can alter naturally low pH environments that have organic-sourced acidity and can increase water hardness, causing changes to habitat that ultimately result in species, population and ecological system shifts.

Attachment F7 - Avoidance strategies - Algal blooms

queensland-ass-management-guideline-2014.pdf

Queensland Acid Sulfate Soils Technical Manual: Soil Management Guideline

6. Avoidance strategies

6.3.2 Algal blooms

The disturbance of ASS should be avoided in situations where the receiving environment is susceptible to algal blooms. Mobilisation of iron (and other nutrients of concern) by drainage of ASS and other coastal soils has been identified as a potential source of micronutrients that may trigger or sustain cyanobacterial blooms such as the toxic *Lyngbya majuscula* blooms in Moreton Bay (Ahern, O'Neil, Udy, & Albert, 2006); (Queensland Government, 2011a). *State Planning Policy: State Interest – Water Quality* (Queensland Government, 2013b) discusses policy approaches to be implemented by local government to minimise the release of nutrients of concern, and the document mentions acid sulfate soils information as a key decision-making input.

Attachment F8 - Avoidance strategies - Groundwater dependant Systems

queensland-ass-management-guideline-2014.pdf

Queensland Acid Sulfate Soils Technical Manual: Soil Management Guideline

6. Avoidance strategies

6.3.3 Groundwater-dependent ecosystems

The disturbance of ASS should be avoided when the site is adjacent to, or hydrologically connected to, a groundwater-dependent ecosystem that may be drained as a result of any soil disturbance on site. Management strategies or disturbances that alter the hydrology of adjacent ecosystems may cause temporary or permanent impacts due to the potential oxidation of ASS in dewatered, drained environments. It can be difficult to accurately identify preferred groundwater flow paths to off-site areas without costly and extensive investigations. As such impacts can occur off site, they can be difficult to manage and monitor. The key to managing the impacts relates to the retardation of oxygen transport to the soils, and this is more difficult when the soils that will be drained are located off site. Several types of coastal wetland are host to groundwater-dependent ecosystems such as the patterned fens, black water ecosystems and perched lakes of the Cooloola region and Fraser Island.

Attachment F9 - Minimise Groundwater fluctuations

queensland-ass-management-guideline-2014.pdf

7. Minimisation of disturbance

7.4 Minimise groundwater fluctuations

Activities that cause groundwater fluctuations, and in particular those that permanently lower the watertable, should be avoided as these may expose in situ sulfidic soils to oxygen. Acidity can be brought to the surface when the groundwater rises again, through capillary rise, or as a result of fill emplacement, where reduced soil void space can result in squeezing out of pore water and groundwater. Groundwater in ASS areas is generally saline and high in dissolved iron, making it unsuitable for uncontrolled release to receiving environments. ASS impacts on groundwater can also cause health hazards such as arsenic contamination. While not a recognised issue in Queensland to date, arsenic contamination of groundwater has occurred in Western Australia (Appleyard, Wong, Willis-Jones, Angeloni, & Watkins, 2004). Activities to be avoided include:

- construction of deep drains, canals and other types of artificial water bodies that may change the watertable
- operation of drains which do not have gates or drop boards to maintain groundwater levels
- operation of drains that cause significant water level fluctuations during dry periods
- construction of basements (e.g. car parks) below the watertable that need ongoing pumping to keep dry
- installation of new groundwater extraction bores in ASS areas
- continuing use of existing groundwater extraction bores if they will expose ASS to oxidising conditions, or if that use will result in the discharge of waters containing acid and metals to locations that may result in further contamination of the receiving environment[3]
- unconfined dewatering or drainage of construction sites, mines, aquaculture ponds or sand and gravel extraction pits[4]
- dewatering for installation of infrastructure such as roads, water and sewage mains, underground cabling, etc., particularly where large open trenches are involved
- changes in vegetation from pasture to trees, or replacement of native vegetation with crops that can increase transpiration rates and lower the watertable during dry periods, and/or cause rises in acidic watertables
- construction of on-farm water storages, sediment or nutrient ponds, aquaculture ponds or ponded pastures in ASS.

[3] Controls on overall extraction, and local drawdown from individual bores (through licensing, metering of bore usage, ongoing monitoring) may be appropriate for state and local government to consider.

[4] Sites that need to be dewatered should involve dewatering in small isolated cells, using containment structures such as sheet piling where practical, and ongoing monitoring should be conducted. See section 11.3.

Attachment F10 - Containment

queensland-ass-management-guideline-2014.pdf

Queensland Acid Sulfate Soils Technical Manual: Soil Management Guideline

9.4.3 Containment

All 'dredge-for-fill' and extractive industry sites should be hydrologically isolated using bunding and diversion drains. Surface neutralisation of the earth bunds and diversion drains can also help neutralise any acidic water. Bunds and diversion banks should not be constructed out of untreated ASS or other materials that may be a source of contaminants to the environment. The materials used should have an appropriately low permeability to avoid leakage and designs must also consider wave action, armour protection, provision of discharge weirs and control devices.

The systems in the sand and gravel extractive industry tend to be closed, with the sulfidic fines concentrated in a series of settlement ponds. Management techniques should make sure that there is no discharge from the settlement ponds until the sulfidic fines have settled on the bottom and water quality within the ponds meets license conditions. The location and dimensions of all settlement ponds should also be documented and reported to assessing authorities.

All processing areas should be graded to make sure that all runoff is captured, and treated if necessary. All runoff and leachate escaping the stockpiled areas should be collected and fully treated on site, especially if it to be reused for purposes such as dust suppression. The processing area used in extractive industry operations should be cleaned up at the end of each working day. Any escaped fines that may have been exposed to oxidising conditions should be treated using neutralisation techniques. In non-enclosed dredging operations, it may be necessary to design and install structures to ensure containment of discharge from the site. In some situations, engineering design will need to account for the installation of gates on pipes or weirs that can be closed to prevent discharge if an acidic event is detected. Installation of an alarm system is necessary to make sure the appropriate persons become aware of the acidic event. Action triggers for water containment (e.g. pH <6.5) will need to be developed. Once the water has been neutralised, the gates can then be reopened.

Silt curtains placed in water bodies act as flexible barriers that can help trap any silt, iron floc or other material that may potentially harm the environment. Silt curtains hang down from the surface of the water and need regular maintenance to ensure ongoing effectiveness. Other standard forms of erosion and sediment control common to construction and industrial sites may be employed in containment of ASS.

Attachment F11 - Stockpiling Risks

queensland-ass-management-guideline-2014.pdf

11. High-risk management strategies

Several ASS management strategies involve considerable environmental risk as there is limited documentation of their successful use. Assessment managers may require detailed risk assessment information (potentially including pilot trials) before they can be satisfied that these risks can be effectively managed without impact on the environmental values of the receiving environment. **If sufficient scientific justification cannot be provided, the following activities will not be supported.**

11.1 Stockpiling acid sulfate soils

The risks of stockpiling large volumes of untreated ASS may be high even over the short-term. Stockpiling small volumes of untreated ASS should only be undertaken as a short-term activity. For example:

- Part of a day's extraction of clay may be stockpiled over a weekend before strategic reburial.
- Due to poor weather conditions or problems with obtaining laboratory results, treatment scheduling may be disrupted, leading to the creation of small stockpiles before changes can be made to earthworks programs.

All ASS EM plans must allow extra space in treatment areas for such contingencies.

ASS tip 28: Stockpiling

On becoming aware of an emerging situation that will result in the need for some stockpiling, action should be taken to:

- prevent further increases in stockpile volumes or the duration these remain untreated
- quickly treat the stockpiles that have resulted.

It can be more efficient to treat (and verify) the stockpile as it grows. This will obviate the need to manage the stockpiled soil as recommended in this section.

11.1.1 Environmental risk

The risks associated with stockpiling increase with the rate at which the materials dewater. Coarsely textured, highly permeable, well-sorted sandy soils will drain or dewater at a faster rate than fine-textured, poorly sorted soils. The rate of oxygen transport to the sulfides within sandy soils is likely to be high. The risk will multiply if the pH of the material being stockpiled drops to 4 or less, if there is limited organic matter present, or if the material has high levels of sulfides. The rate of oxidation of these soils can be rapid (hours), particularly in hot conditions.

Note: Oxidation rates are related to temperature, and so the risks increase in hotter conditions.

If soils have been excavated and stockpiled with no regard to layers or horizons of soil that require different liming rates, the soil's spatial predictability will be lost. This increases the risk of incorrect liming rates being applied. Stockpiles will need to be resampled before treatment. Sampling rates may need to be double or triple that of an undisturbed profile, as extrapolation of liming rates from fewer samples would be statistically unreliable.

Substantial quantities of acid can build up in stockpiles if they are left in oxidising conditions for even short periods. Management of acidic leachate can become a concern. Large stockpiles are difficult to neutralise, primarily due to the earthmoving needed. Determining liming rates for such oxidised materials may cost more because tests will need to check the existing and retained acidity as well as the potential acidity. Representative sampling of the stockpile must be performed. Refer to the latest version of the Laboratory Methods Guidelines or AS4969 for information on analysing soils with retained acidity. Generally, the highest laboratory result will need to be employed in calculating treatment rates because of variability within a stockpile and changes due to oxidation.

ASS tip 29: Secondary sulfate salts

Secondary sulfate salts (e.g. jarosite) may dissolve and produce acid with wetting and drying of the stockpiles. Jarosite, and other acid-forming salts, may be 'stores' of acidity that do not need further oxygen to generate acid. These salts may form the main component of acidity in older stockpiles established prior to regulation of ASS disturbance.

Due to varying solubilities, some of these salts may be measured by the titratable actual acidity (TAA) test, while others such as jarosite will need extra testing to measure their retained acidity, for example, suspension peroxide oxidation combined acidity and sulfur (SPOCAS) method or S_{NAS} (net acid-soluble sulfur). Existing and retained acidity are not accounted for by S_{CR}, S_{POS}, or S_{TOS} tests. See the latest Laboratory Methods Guidelines or AS4969.

11.1.2 Management considerations

Stockpiling untreated ASS should be minimised by preparing a detailed earthworks strategy that documents the timing of soil volumes to be moved, treatment locations and capacity of those areas to accept materials. Stockpiling may mean double-handling and increased earthmoving costs. It is important to account for risk from inclement weather and plan for other contingencies.

Short-term stockpiles

The recommended maximum time for which soils can be temporarily stockpiled without treatment is detailed in Table 11-1.

Table 11-1: Indicative maximum periods for short term stockpiling of untreated ASS.

Type of material		Maximum acceptable duration of stockpiling
Texture range National Committee on Soil and Terrain (NCST, 2009)	**Approximate clay content (%)**	
Coarse Sands to loamy sands and peats	< 5	Overnight (18 hours)
Medium Sandy loams to light clays	5−40	2 nights (42 hours)
Fine Medium to heavy clays and silty clays	> 40	3 nights, e.g. a weekend (66 hours)

Under some circumstances these figures may be too conservative, and under others not conservative enough (e.g. during hot weather some sands may begin to oxidise within a matter of hours). It is recommended that appropriate operational delay times be decided (preferably well

before the creation of the stockpile) for the specific circumstances. A guard layer under short-term stockpiles will be needed. A neutralising agent (e.g. aglime) should also be spread over the stockpile to limit the generation of acidity from the surface of the stockpile, but this will not prevent acid exiting the stockpile via leachates emerging near the base. Temporary bunding is needed around the stockpiles to collect any leachate, soil or lime washed off during overnight/weekend storms or rainfall events.

The total volume of material that is placed in short-term stockpiles should not exceed 20% of a day's total extraction, as immediate treatment should be the norm.

Note: These timeframes do not apply to monosulfidic black oozes (MBOs). It is not acceptable to stockpile untreated MBOs under any circumstances.

ASS tip 30: Guard layer rate for stockpiles

The minimum guard layer rate beneath any stockpiled ASS will be 5 kilograms fine aglime per m^2 per vertical metre of fill. Where the highest detected sum of existing and potential acidity is more than 1.0% S-equivalent, the rate will be at minimum 10 kilograms fine aglime per m^2 per vertical metre of fill.

Note: Reapplication of the guard layer will be necessary under areas of repeated temporary stockpiling.

Longer-term stockpiles

Any stockpiling exceeding the above timeframes is unacceptable. If ASS is required to be stored for longer than the above timeframes, it must be fully treated. Regulatory agencies should be notified of the existence of historical stockpiles and consulted on their management. If stockpiles are assessed as likely to cause environmental harm, then voluntary submission of an environmental management program under the *Environmental Protection Act 1994* is recommended. Failure to act on signs of high environmental risk may result in other action being taken under the Act.

Attachment F12 - Dewatering and drainage risksStockpiling Risks

queensland-ass-management-guideline-2014.pdf

11.3 Dewatering and drainage

Earthworks and/or pumping that result in localised drainage or lowering of groundwater may expose sulfidic soils to oxygen and generate acidity as a function of soil type(s), sulfide contents, area exposed and length of time the excavation stays 'dry'. The risk of the dewatering can be assessed using the predicted size of the cone of depression (see ASS tip 31). Large-scale dewatering activities are high-risk, and should not be undertaken without management measures sufficient to reduce risk to levels acceptable to administering authorities. Such measures will necessarily include physical confinement strategies, and no permanent dewatering may be undertaken.

Groundwater drainage or dewatering may start the same acid-generating processes as those described above in section 11.2. It follows that all dewatering operations in ASS areas carry a high environmental risk, except those which cause limited or localised drawdown and promote maintenance of field moisture capacity, minimising sediment oxidation. For example, shallow infrastructure trenching, if it is staged and of short duration, may only cause limited or localised drawdown, and hence carries a lower risk. The risks also decrease if the dry excavation exposes predominantly clayey soils with very low hydraulic conductivity resulting in limited drawdown.

Dewatering ASS in urbanised areas is unacceptable without appropriate management strategies to limit sediment oxidation, due to the potential for acid production and damage to neighbouring buildings and infrastructure.

ASS tip 31: Cone of depression

The cone of depression is the predicted volume of soil around a dewatering point that can become unsaturated (i.e. partially drained) during unconfined dewatering. The eventual cone of depression will be influenced by the permeability of the soil, rainfall events, evapotranspiration, groundwater flow paths and palaeochannels. The acid generation within the cone of depression will be a function of the above factors as well as the duration of the dewatering, the potential and existing acidity and organic matter. In coastal situations, the calculation of the cone of depression is seldom a simple process.

Before dewatering ASS, the extent, location and soil characteristics of the cone of depression should be measured and modelled. This requires a professional hydrogeologist. A preliminary estimate of the cone of depression can be made using the online calculation tool provided by the West Australian Department of Environment Regulation (search at <http://www.der.wa.gov.au>).

Experience indicates that the modelling can sometimes be seriously flawed because the materials surrounding the excavations are rarely homogenous and layers of clays, peat and coffee rock often alternate with sandier deposits. Therefore physical containment will be the expected approach for groundwater disturbances.

Physical containment is rarely perfect, and some leakage may be expected. Some dewatering may result, and contingency plans should be in place to handle the effects of this.