MANAGEMENT PLAN

ACID SULFATE SOIL
ENVIRONMENTAL MANAGEMENT PLAN
FOR FINES

Holcim Salt Ash Sand Operations
8 Oakvale Drive,
Salt Ash, NEW SOUTH WALES

PSK Environmental

Submitted to:

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Acid Sulfate Soil Environmental Management Plan for Fines Holcim Salt Ash Sand Operations

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DOCUMENT REVISION

The following table outlines revisions made to this document. Revisions to the document are made to reflect changes to environmental procedures, or environmental management. The Environmental Management Plan (EMP) should be viewed as a ‘living document’. Any significant changes to the Acid Sulfate Soil (ASS) EMP must be discussed with, and approved by, a suitably qualified person.

REVISON	DATE	DOCUMENT STATUS
0	11 June 2025	Preliminarily Draft
1	10 July 2025	Completed Draft
2	31 July 2025	Final

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LIST OF ACRONYMS

Aglime	Agricultural Limestone
AHD	Australian Height Datum
ANC	Acid Neutralising Capacity
ASLP	Australian Standard Leaching Procedure
ASS	Acid Sulfate Soils
CPSS	Certified Professional Soil Scientist
CRS	Chromium Reducible Sulfur
DA	Development Approval
DCT	Deep Cone Thickener
EC	Electrical Conductivity
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
ENV	ENV Solutions
EO	Environmental Officer
EPA	Environmental Protection Authority
FOS	Factor of Safety
GWMP	Groundwater Management Plan
Holcim	Holcim (Australia) Pty Ltd
ITP	Inspection and Test Plan
KCl	Potassium Chloride
KLC	Kinetic Leach Columns
LEAF	Leaching Environmental Assessment Framework
LOR	Limit of Reporting
NATA	National Association of Testing Authorities
NSW	New South Wales
NV	Neutralising Value
OH&S	Occupational Health & Safety
QASSIT	Queensland Acid Sulfate Soil Technical Manual
RSP-ASS	Registered Soil Practitioner - Acid Sulfate Soil
RZM	Rutile & Zircon Mines
SEM	Scanning Electron Microscopy
S_{NAS}	Net Acid Soluble Sulfur
SSD	State Significant Development
TAA	Titratable Actual Acidity
tpa	Tonnes per annum
t/hr	Tonnes per hour
µm	Micrometre
VENM	Virgin Excavated Natural Material
WHS	Work Health and Safety

1.0 INTRODUCTION

This Environmental Management Plan (EMP) has been prepared for Holcim (Australia) Pty Ltd (Holcim) to provide management measures for Acid Sulfate Soils (ASS) present in the fines at the Salt Ash Sand Operations, located at 8 Oakvale Drive, Salt Ash, NSW. The quarry is located on Lot 4 on DP774726, Salt Ash, New South Wales ('the Site') and occupies an area of 47.81 hectares (ha). The Site location is presented in **Figure 1.**

Holcim owns and operates the Holcim Salt Ash Sand Operations, a long-standing quarry that extracts, processes and transports sand products for use in the production of industrial and construction materials such as glass and concrete. The quarry has been in operation since 1980. It is understood that sand is currently extracted to 5 metres (m) Australian Height Datum (AHD) under existing development consents within the Stockton Sandbeds, with no current approved extraction below the water table. Holcim is seeking approval to expand extractive operations, including extraction below the water table.

This report has been prepared based on the findings of an ASS Investigation completed for the site by Geosyntec Consultants Pty Ltd (Geosyntec 2025).

A Groundwater Management Plan (GWMP) has also been prepared for the Site (ENV Solutions [ENV] 2025).

1.1 Approvals

The existing operation is permitted under several Development Approvals (DA), with DA 5499-91 allowing sand extraction to 5 m AHD. A significant sand resource remains below this currently permitted extraction height.

In December 2020, Holcim lodged a State Significant Development Application (SSD) to obtain approval to extend and increase the depth of the existing operation to extract and process up to 550,000 tonnes of sand per annum (tpa) for up to 30 years (SSD-9099356). Furthermore, SSD-9099356 requested approval to receive of up to 200,000 tpa of sand from Anna Bay, Tanilba Bay and Cabbage Tree Road Quarries, the importation of Virgin Excavated Natural Material (VENM) for bank and ground stability and the continuation of existing processes, including rehabilitation.

1.2 Proposed Project

Holcim is seeking to extend the sand extraction depth to approximately 30 m below the groundwater table (-28 m AHD), resulting in the extraction and processing of a minimum of 10,000,000 tonnes of sand from the quarry over the life span of operations. The plant will process 1,000 tonnes per hour (t/h) of slurry to generate 300 t/h of dry sand. Hydrocyclones will be used to separate the <75 µm particles sand fraction from the ≥75 µm particles.

The project involves progressive extraction of sand over seven operational stages with Stage 1 situated approximately in the centre of the Site. The dredge would commence immediately south of the processing area of the quarry and will then progressively extract sand in a southerly direction away from the processing plant in a staged process (**Plate 1** and **Plate 2**). The dredge pond area at the final stage, Stage 7, will be 29.25 ha (**Plate 2**).

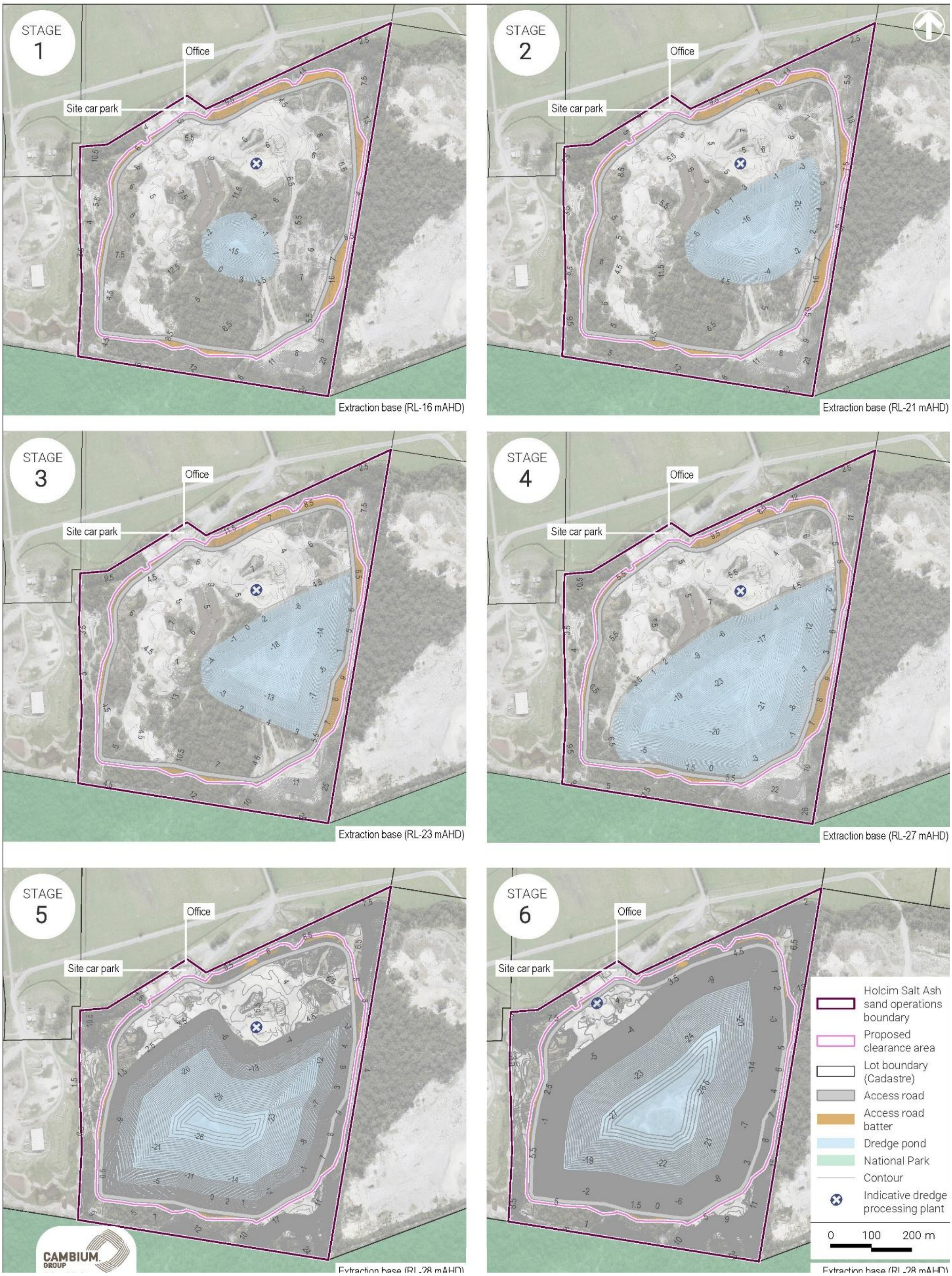

Plate 1. Sand Extraction Stages 1-6 (from Geosyntec 2025)

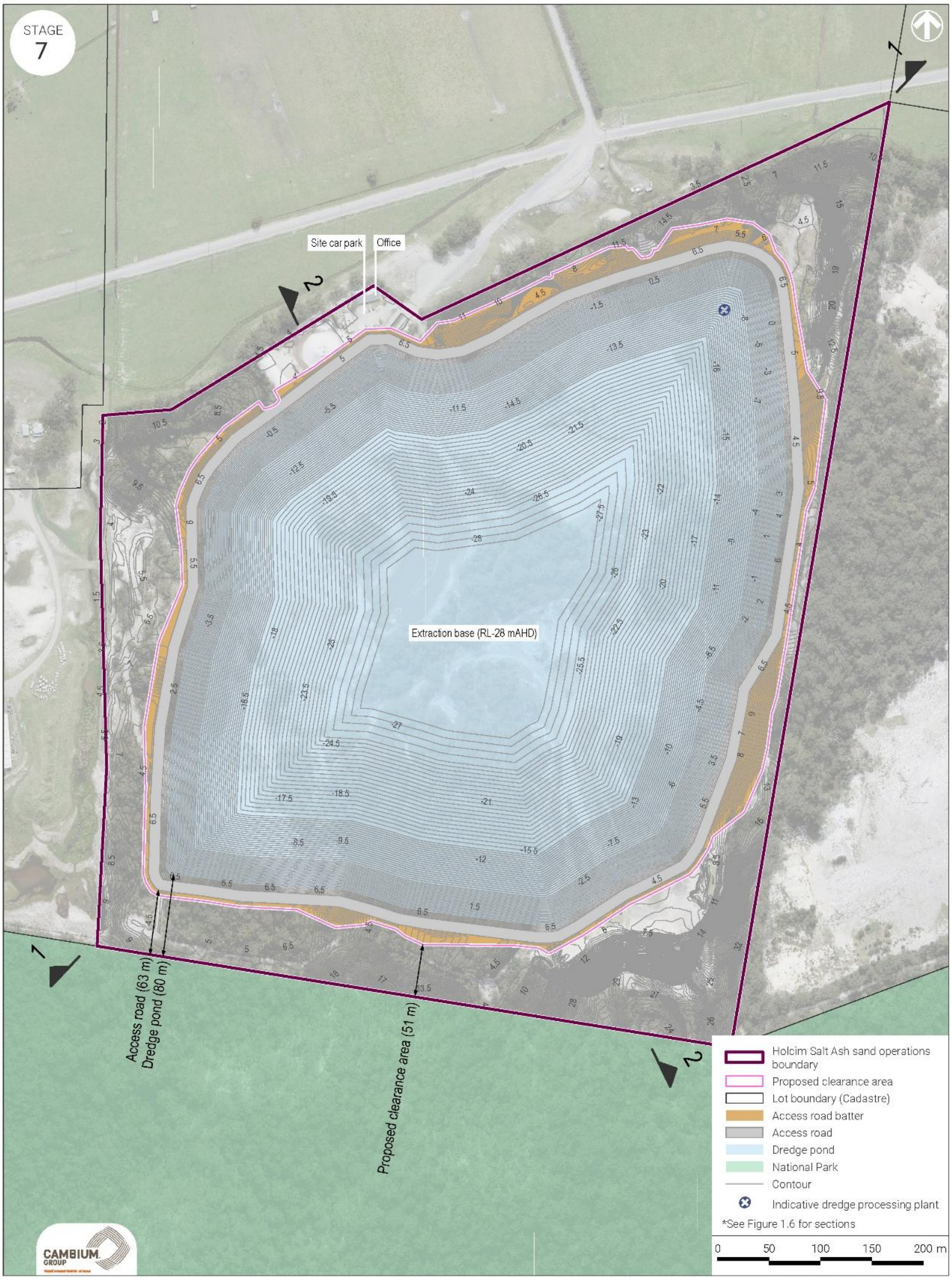

Plate 2. Sand Extraction Stage 7 (from Geosyntec 2025)

1.2.1 Sand Resource

The soil at the Site was characterised as predominantly quartz rich silica sand soils, which were classified by previous studies into three distinct stratigraphic units based on changes in soil texture, composition and colour: D1, D1/D2, and D3 (**Table 1**).

Table 1. Summary of Stratigraphy (extracted from Geosyntec 2025)

Unit	Unit Thickness (m)	Generalised Description	Depth to Top of Unit (m)	Depth to Base of Unit (m)
D1	2 to 8.6	Sand: Fine to medium grained, grey Silty Sand: Fine grained, grey	0	2 to 8.6
D1/D2	0.3 to 4.2	Clay to Sandy Clay: low to medium plasticity, dark grey, fine to medium grained sand, shell fragments. Clayey Sand: fine to medium grained, dark grey, with clay.	2 to 8.6	2.5 to 9.6
D2	2 to 15	Sand: Fine to medium grained, grey Sand: Medium grained, grey, trace fine gravel, dark grey.	2.5 to 9.6	8 to 20
D3	>20	Silty Sand: Fine grained, dark grey, trace gravel. Sand: Fine to medium grained, grey.	8 to 20	Not penetrated

Note: Unit D1/D2 was not present along the northwest boundary of the site.

The total volume of sand to be extracted per Stage and from each unit is provided in **Table 2.**

Table 2. Total Volume of Sand Extracted per Stage (Provided by Holcim)

Stratigraphic Unit	Stages													
	1		2		3		4		5		6		7	
	Volume (m^3)	Volume (t)	Volume (m^3)	Volume (t)	Volume (m^3)	Volume (t)	Volume (m^3)	Volume (t)	Volume (m^3)	Volume (t)	Volume (m^3)	Volume (t)	Volume (m^3)	Volume (t)
D1	178,668	285,869	286,732	458,771	118,623	189,797	489,553	783,285	374,467	599,147	358,045	572,872	160,374	256,598
D2	105,259	168,414	225,360	360,576	92,520	148,032	636,871	1,018,994	489,649	783,438	358,491	573,586	197,051	315,282
D3	11,969	19,150	179,401	287,042	121,634	194,614	489,405	783,048	408,112	652,979	731,672	1,170,675	275,346	440,554
Total	295,896	473,434	691,493	1,106,389	332,777	532,443	1,615,829	2,585,326	1,272,228	2,035,565	1,448,208	2,317,133	632,771	1,012,434

Notes:

A bulk density of 1.6 t/m^3 has been applied

Refer **Plate 1** and **Plate 2** for the location of each Stage

1.3 Objectives

The objectives of this EMP are to:

- provide a framework to manage ASS impacts of sand extraction in regards to the fines and prevent environmental harm cause by ASS generated from fines,
- provide strategies aimed at minimising avoidable environmental harm cause by ASS from fines, and
- comply with the relevant statutory environmental requirements and industry best practise.

1.4 Technical and Regulatory Framework

The principal guidelines, specifications and policy documents relevant to this Plan include:

- Dear SE, Williams KM, McElnea AE, Ahern CR, Dobos SK, Moore NG, and O'Brien LE (2024). *Queensland Acid Sulfate Soil Technical Manual, Soil Management Guidelines, Version 5.1*. ('*Soil Management Guidelines V5.1')*
- Department of Environment Regulation, Western Australia (2015). Treatment and management of soil and water in acid sulfate soil landscapes.
- Simpson, SL, Mosley, L, Batley, GE and Shand, P 2018, *National Acid sulfate soils guidance: Guidelines for the dredging of acid sulfate soil sediments and associated dredge spoil management*, Department of Agriculture and Water Resources, Canberra, ACT. CC BY 4.0
- Stone, Y., Ahern, C.R., and Blunden, B. (Eds.). (1998). *Acid Sulfate Soils Manual*. Wollongbar, NSW: Acid Sulfate Soil Management Advisory Committee (ASSMAC).
- Sullivan, L, Ward, N, Toppler, N and Lancaster, G 2018, *National Acid Sulfate Soils guidance: National* acid *sulfate soils sampling and identification methods manual*, Department of Agriculture and Water Resources, Canberra ACT. CC BY 4.0.
- Sullivan, L, Ward, N, Toppler, N and Lancaster, G 2018, *National Acid Sulfate Soils Guidance: National* acid *sulfate soils identification and laboratory methods manual*, Department of Agriculture and Water Resources, Canberra, ACT. CC BY 4.0.

This ASS EMP utilises the guidance in the *Soil Management Guidelines V5.1* (Dear et al 2024), which is considered the best practice guideline for the management of ASS in Australia.

1.5 Surface Water Bodies

As documented in the GWMP (ENV 2025), Tilligerry Creek, a hydraulically 'gaining' creek and a receptor for regional groundwater discharge originating from both north and south of the creek, is situated approximately 900 m north-north-east of the site at its closest point. Near the Site, Tilligerry Creek is expected to support predominantly freshwater ecosystems, as it lies upstream of the tidal influence from the lower estuary to which it connects.

Geographically, Tilligerry Creek separates the Tomaree and Tilligerry peninsulas and drains low-lying areas including Salt Ash, Bobs Farm, Tanilba Bay, and Mallabula. Tilligerry Creek flows into Karuah River located approximately 15 km to the north-east of the Site followed by Port Stephens, a tide-dominated estuarine inlet that opens to the Pacific Ocean near the township of Shoal Bay.

Management of the ASS is to be undertaken in order to minimize the risk of impact to the surface water receptors.

2.0 ACID SULFATE SOIL SUMMARY

2.1 Acid Sulfate Soil Mapping

The Site is mapped as L4: Low probability >3 m below the ground surface on the Acid Sulfate Soils Risk Mapping available on the eSpade V2.2 viewer data source State Government of New South Wales (NSW) and NSW Department of Climate Change, Energy, the Environment and Water 1998.

The site is mapped as Class 4 under the Port Stephens Local Environment Plan 2013. Class 4 lands require that for Works more than 2 metres below the natural ground surface and/or Works by which the water table is likely to be lowered more than 2 metres below the natural ground surface development consent must not be granted unless an ASS management plan has been prepared for the proposed works and has been provided to the consent authority, or a preliminary assessment of the proposed works indicates that an acid sulfate soil management plan is not required for the works.

Given that works will extend to a depth of greater than 2 metres below the natural ground surface, the requirement for an ASS EMP is triggered (this document).

2.2 Investigations of Acid Sulfate Soils

In 2024, Geosyntec (2024) drilled a total of 24 boreholes across the footprint of the proposed sand extraction area, ranging in depth from 8 to 36 m below ground level (bgl), with a target depth of 1 m below the proposed extraction depth. An additional five boreholes were located immediately outside of the disturbance footprint. Geosyntec (2024) undertook qualitative analysis (i.e. field screening) on samples collected at intervals of 0.5 m and quantitative analysis (i.e. Chromium Reducible Sulfur [CRS]) generally on samples collected at intervals 1 m in the D1, D2 and D3 layers and every 0.5m in the D1/D2 layer. All samples commissioned for analysis were located below the groundwater table which is understood to generally be within 5 m of the ground surface, or 1 m bgl in areas of the Site where dry extraction of the sand has been completed. The ASS results are summarised in **Section 2.3.**

The Geosyntec investigations followed earlier preliminary ASS investigations by Geoterra (2022) who advanced six boreholes within the proposed sand extraction area to a depth of 15 m depth. Geoterra (2022) obtained samples from above the groundwater table and these are discussed in **Section 2.4**.

2.3 Soil Acidity Regime – Below the Water Table

The soil acidity regime of the D1, D1/D2, D2 and D3 stratigraphic units was developed following completion of an ASS field investigation and reported by Geosyntec (2025). The soil acidity regime is summarised in **Table 3** and below.

Table 3. Net Acidity for Each Unit using 50th, 95th and 100th Percentile Net Acidity Values (after Geosyntec 2025)

Unit	Thickness (m)^	Estimated Volume (m^3)^	% of Total Volume^	Volume of unit with net acidity (excluding ANC) >0.03%S w/w^ (m^3)	% of Total Volume^	Percentile	Net Acidity (without ANC) %S w/w	Net Acidity (without ANC) mol H^+/t
D1	2-8.6	1,469,000	23.1	112,100	1.8	50	0.016	9.4
						95	0.160	98.5
						100	0.730	455.3
D1/D2	0.3-4.2	389,000	6.1	345,000	5.4	50	0.245	152.8
						95	1.01	629.9
						100	1.20	748.4
D2	2-15	2,243,000	35.3	1,458,300	23.0	50	0.036	22.5
						95	0.124	77.6
						100	0.420	262.0
D3[1]	>20	2,253,000	35.5	1,002,200	15.8	50	0.029	18.1
						95	0.123	76.7
						100	0.330	336.8
TOTAL		6,354,000						

Notes:

^ Data from Geosyntec (2025)

[1] The net acidity for D3 includes ANC, as the ANC has been corroborated by kinetic leach tests. However, the volume of net acidity >0.03%S w/w was calculated using net acidity (excluding ANC) by Geosyntec (2025).

2.3.1 D1

Lithological unit D1 consists of fine to medium grained, grey sand and fine grained, grey silty sand with a thickness between 2 m and 8.6 m.

The acidity in D1 consists of actual acidity, indicating previous oxidation of sulfides, as well as residual potential acidity. The D1 layer reported some neutralising capacity in seven out of 64 samples, with Acid Neutralising Capacity (ANC) values ranging from less than the laboratory limit of reporting (LOR) to 0.3%S equivalent. The maximum reported net acidity (excluding ANC) for D1 (i.e. 100th percentile) was 0.730%S (455.3 mol H^+/t). The 95th percentile net acidity (excluding ANC) was 0.160%S (98.5 mol H^+/t). These values exceed the action criteria presented in Table 1.1 of Sullivan et al (2018) for coarse textured soils, for a disturbance of >1,000 tonnes of material, of 0.03%S w/w (18 mol H^+/t).

2.3.2 D1/D2

This layer is located at the interface between D1 and D2 and comprises dark grey, low to medium plasticity clay to sandy clay, containing fine to medium grained sand, shell fragments. In addition, fine to medium grained, dark grey clayey sand, with clay, also forms part of this layer. D1/D2 is situated below the water table and is 0.3 m to 4.2 m thick.

As with layer D1, the acidity D1/D2 is a combination of actual and potential acidity. Approximately 20% of the samples (13 samples) contained neutralising capacity, with ANC reported between 0.1 to 1.3%S equivalent. The maximum reported net acidity (excluding ANC) for D1/D2 was 1.2%S (748.4 mol H^+/t). The 95th percentile of the net acidity (excluding ANC) was 1.01%S (629.9 mol H^+/t). These values exceed the action criteria of 0.03%S w/w (18 mol H^+/t).

2.3.3 D2

Layer D2 consists of fine to medium grained, grey sand and medium grained, grey, sand with trace fine dark grey gravel. D2 is located below the water table with a thickness between 2 m to 15 m.

In layer D2, the acidity is dominated by potential acidity (<LOR to 0.33%S), with actual acidity still being present (<LOR to 0.08%S). ANC was present in 14 samples (7%) ranging from 0.6 to 0.91%S equivalent. The maximum reported net acidity (excluding ANC) for D2 was 0.420%S (262.0 mol H^+/t). The 95th percentile of the net acidity (excluding ANC) was 0.124%S (77.6 mol H^+/t). These values exceed the action criteria of 0.03%S w/w (18 mol H^+/t).

2.3.4 D3

This final layer with a thickness of more than 20 m contains fine grained, dark grey silty sands with trace gravel, and fine to medium grained, grey sand.

The acidity in D3 is present predominantly as potential acidity (<LOR to 0.54%S), but low levels of actual acidity was reported to a maximum of 0.01%S. ANC was reported in approximately a third of the samples (48 samples out of 149) ranging from less than the LOR to 3.4%S equivalent. The ANC of the D3 layer was corroborated with kinetic leach testing and thus, in accordance with the Sullivan et al. (2018), was included in calculations of net acidity.

The maximum reported net acidity (including ANC) for D3 was 0.330%S (336.8 mol H^+/t). The 95th percentile of the net acidity (including ANC) was 0.123%S (76.7 mol H^+/t). These values exceed the action criteria of 0.03%S w/w (18 mol H^+/t).

2.3.5 Pyrite Morphology

Limited analysis using scanning electron microscopy identified that sulfides in the soils exist as single crystal pyrite grains typically measuring between 5-20 µm in diameter (Geosyntec 2025). These pyrite grains are free and not bound to any other mineral phase. From their size, pyrite will be present in the <75 µm fraction of the material.

2.3.6 Groundwater Quality

Based on the Geosyntec (2025) report, the water table in unit D1 was encountered between 0.5 and 6.6 m bgl. Groundwater flow is towards the northwest.

Geosyntec (2025) field results indicate that groundwater quality at the Site is generally fresh, with Electrical Conductivity (EC) values typically ranging from 139 to 633 µS/cm, and is characterised by acidic to neutral pH conditions, ranging from 5.04 to 6.93. Based on the field measurements, the groundwater redox condition is likely to be reducing.

Total alkalinity ranges from 11 to 240 mg/L as $CaCO_3$, with bicarbonate being the dominant species, but buffering capacity is limited, particularly in units D2 and D3. The major ion chemistry generally identified two distinct water types present at the site: a sodium (Na)-chloride (Cl) signature in the shallow aquifer (D1), and a calcium (Ca)-bicarbonate (HCO_3) signature (in D2 and D3).

From the analysis of sulfate, chloride and alkalinity ratios in groundwater, Geosyntec (2025) concluded there is evidence that groundwater has already been affected by the oxidation of sulfides across the Site.

Iron concentrations were generally elevated in all units with maximum total iron (Fe) and ferrous iron (Fe^{2+}) concentrations of 13,000 µg/L. Dissolved aluminium (Al) concentrations ranged from 10 to 1,200 µg/L with the highest concentrations generally associated with unit D2. Based on Geosyntec's (2025) Tier 1 Groundwater Screening Assessment, concentration of Al, zinc (Zn), Copper (Cu) and arsenic (As) exceeded the adopted ecological criteria whilst Al and As also exceeded the adopted human health criteria.

2.3.7 Metal Leachability

Aqua regia digest analysis results (Geosyntec 2025) indicated that Al, As, barium (Ba), beryllium (Be), chromium (Cr), cobalt (Co), Cu, Fe, manganese (Mn), molybdenum (Mo), nickel (Ni), lead (Pb), strontium (Sr), and Zn were present in the soil matrix. When exposed to a range of pH (LEAF 1313), it was determined that of these metals, Al, Cr, Cu, Fe, Ni, Pb and Zn, were also leachable at high pH (alkaline conditions). This amphoteric behaviour demonstrates the importance of maintaining circumneutral pH conditions to minimise mobilisation of metals from soils to groundwater. Leaching Environmental Assessment Framework (LEAF) testing also provided evidence of the lack of sufficient buffering capacity of the soils.

An initial quantification of the leachability of these elements was assessed via adoption of the Australian Standard Leaching Procedure (ASLP) method with de-ionised water as the leach fluid. The results (Geosyntec 2025) indicate that when the soils came into contact with water, measurable concentrations of metals were released from the soils despite the large liquid to solid ratio used (solid: liquid, 1:20). The suite of elements with measurable concentrations in the ASLP were Al, As, Ba, Co, Fe, Mn, Ni, Pb, strontium (Sr), and Zn. Of these, Al, Fe and Mn were the elements leaching at the highest concentrations. Iron concentrations from D1/D2 were reported at very high levels (26 000 mg/L).

Kinetic Leach Columns (KLC) experiments were undertaken over a minimum period of 21 weeks. However, given that the samples had oxidised prior to commencement of the experiments, the reliability of the test results is reduced.

A better understanding of metal leachability under site-specific conditions is required to assess potential impacts to groundwater.

2.3.8 Liming Rates

The Geosyntec (2025) report specifies liming rates that would be required for the sand if it were excavated and treated without separation of the fines. The liming rates are summarised in **Table 4** and are based on Net Acidity (excluding ANC). The amount of agricultural limestone (aglime) required to manage the washed sand or fines (if required) will be different to values presented and should be determined if aglime treatment is required.

Table 4. Liming Rates for Each Unit using 50th, 95th and 100th Percentile Net Acidity Values (after Geosyntec 2025)

Unit	Thickness (m)	Percentile	Liming rate (aglime) kg $CaCO_3$/t	Liming rate (aglime) kg aglime/t
D1	2-8.6	50	0.5	0.7
		95	4.9	7.8
		100	22.8	36.0
D1/D2	0.3-4.2	50	7.6	12.1
		95	31.53	49.7
		100	37.5	59.1
D2	2-15	50	1.1	1.8
		95	3.78	5.9
		100	13.1	20.7
D3[1]	>20	50	0.9	1.4
		95	3.8	6.1
		100	10.3	16.3

Notes:
Calculations adopt a safety factor of 1.5 and an aglime neutralising value of 95
[1] The net acidity in D3 includes ANC, as the ANC has been corroborated by kinetic leach testing.

For the D1 layer, the 95th percentile liming rate, which is typically adopted by the best practice ASS management guidelines, i.e., the *Queensland Acid Sulfate Soil Technical Manual - Soil Management Guidelines V5.1* (Dear et al 2024) when large variations in data are observed, is 7.8 kg aglime/tonne. All liming rates are calculated using a factor of safety (FOS) of 1.5 and an effective aglime neutralising value of 95.

For the D1/D2 layer, the 95th percentile liming rate for the D1/D2 layer is 49.7 kg aglime/tonne, reflecting the higher concentrations of pyritic fines in this soil unit.

For the D2 and D3 layers, the 95th percentile liming rates were 5.9 kg aglime/tonne and 6.1 kg aglime/tonne, respectively. The liming rate for the D3 layers includes ANC given that the ANC has been corroborated via kinetic leach column testing.

2.4 Soil Acidity Regime – Above the Water Table

Geosyntec's (2025) investigation was limited to soils below the groundwater table. They stated that 'Surface soils (D1) are Fe rich and are acidic although they have a low risk of being acid sulfate soils'.

Geoterra (2022) conducted preliminary ASS analysis on composite samples obtained from above the groundwater table at six borehole locations. Six samples were analysed by the CRS method. The preliminary results indicated an absence of detectable S_{CR} in four samples, at a level of reporting of 0.005 %S, and low levels of S_{CR} (up to 0.007 %S in two samples). All samples returned low concentrations of Titratable Actual Acidity (TAA; i.e., <5 mol H^+/t). It is noted that the sampling was not undertaken in accordance with best practice guidelines.

Further testing and analysis of unsaturated sand more than 2 metres below the natural ground surface is required to characterise these sands.

3.0 ASS RISKS ASSOCIATED WITH FINES

A number of potential risks are associated with the handling and management of ASS fines during dredging and sand processing activities. These risks, and the corresponding proposed mitigation measures, are described below.

There is a risk of incorrect management of sands located between 5 m AHD and the groundwater table. Preliminary investigations by Geoterra (2022) indicated that the unsaturated sand in this zone contains low levels of acidity; however, to confirm this, additional sampling and analysis will need to be undertaken in accordance with the *National Acid Sulfate Soils Sampling and Identification Methods Manual* (Sullivan et al., 2018). If the sand does not contain ASS, the sand can be managed as per the current operations/approvals. If the sand does contain ASS, the sand will need to be treated in a treatment area or the fines will need to be separated from the saleable sand and placed in the temporary settlement pond.

During sand processing, there is potential for sulfidic fines to oxidise if they are exposed to atmospheric oxygen or oxygenated process water. Oxidation of these fines could lead to the generation of acid mobilisation of metals due to the resulting low pH conditions. The extraction, separation, and fines return process occurs rapidly (within two to three minutes) and fines remain in continuous contact with water throughout, thereby significantly reducing the risk of oxidation and subsequent acid generation. To further mitigate this risk during early works, fines will be directed to a temporary lined settlement pond, where they will be placed under water to limit exposure to oxygen and minimise the potential for acidification. As operations progress, the fines will be returned directly to the dredge pond to a depth of greater than 4 m below the water level. To refine the ASS management strategy for reinterment of fines in the dredge pond, additional testing will be undertaken during early works on *in situ* ASS to assess the mobility of metals and metalloids in the dredged sediments under site-specific conditions. This includes further analysis of Heavy metals, ASLP (metals) and Elutriate (metals).

In addition to oxygen, sulfidic fines can also be oxidised by ferric iron (Fe^{3+}). Aqueous Fe^{3+} is produced from the oxidation of Fe^{2+} or from the dissolution of primary ferric minerals and is stable in solution in low pH conditions. At pH values above 4.5, the concentration of soluble Fe^{3+} decreases greatly due to its precipitation as ferric hydroxide. Given that the groundwater pH at the site is above 4.5, Fe^{3+} predominantly exists as ferric hydroxide and is therefore unavailable to oxidise sulfides. To minimise the potential for Fe^{3+} dissolution and its role as an oxidant during sand processing, neutral pH conditions will need to be maintained. As the fines will remain saturated throughout the process and in-line lime dosing will be implemented, the water and fines are expected to remain at neutral pH, thereby limiting the availability of Fe^{3+} for oxidation reactions.

The wash plant will be fitted with in-line lime dosing at multiple locations to neutralise acidity that may be generated by the fines during processing and maintain a neutral pH within the process waters. The lime dosing will assist in neutralising any existing actual or retained acidity in the sand. Validation of the process will take place in the early stages to ensure that sufficient a neutral pH is maintained (as metals can become mobile in acidic and alkaline conditions) and that sufficient alkalinity is maintained within the washed sands to mitigate generation of acidic leachate from washed sand stockpiles.

Another identified risk is the potential oxidation and acidification of residual fines that may remain entrained within the washed saleable sand. This is typically around 10% by volume. If unmanaged, this may result in the generation of acidic drainage water (also known as leachate) in sand stockpiling areas. To address this, the in-line lime dosing will contribute to neutralising the entrained fines. Initially, whilst the in-line lime dosing process is being validated, lime guard layers will be established beneath washed sand placement areas to intercept and neutralise acidic leachate. Once the in-line lime dosing process is validated, and sand stockpiles generate neutral pH leachate, the guard layers may be removed. Leachate collection systems will be implemented to capture any drainage from the washed sand stockpiles. Additionally, all washed construction sand will be tested to ensure compliance with end-user specifications. Any sand not intended for construction use will be treated and verified in accordance with the Soil Management Guidelines V5.1 (Dear et al., 2024).

The sulfidic fines stored in the temporary settlement pond may oxidise over time. To manage this, the stored fines will be sampled and analysed in accordance with the GWMP (ENV 2025) to determine the suitability for placement into the dredge pond. If oxidation has occurred, or if the fines are deemed likely to pose a risk to groundwater, the material will either be removed and treated with aglime in a designated treatment area or cement-stabilised before being placed in the dredge pond, subject to further assessment.

The placement of fines from the temporary settlement pond into the dredge pond, or the direct reinternment of the fines into the dredge pond following the early stages may result in metals being leached from the soil into solution. Currently, there is limited reliable leach data that would estimate metal leachability under site specific conditions. Further testing (e.g. elutriate) is required to better understand risks to the Site and receptors.

3.1 Historic Regional Issues

Heavy mineral dredge mining by Rutile & Zircon Mines (RZM) between 1972 and 1999 resulted in impacts to groundwater quality with the Tomago Sandbeds, a major unconfined aquifer supplying Newcastle's water. In 1996, a review and assessment of the hydrogeological and hydrochemical impacts of heavy mineral mining on the Tomago Sandbed aquifer was conducted by Coffey Partners International Pty Ltd (1996) for the NSW Department of Planning, Housing and Infrastructure.

The mining activities redistributed and exposed pyrite-rich sands to oxygenated conditions, leading to the oxidation of sulfides and subsequent generation of elevated dissolved Fe and SO_4 concentrations in groundwater.

The report documented that different mining stages (shallow mining, re-mining, and deep mining) led to increases in dissolved Fe concentrations. The greatest increase in dissolved Fe concentrations occurred following deep mining, where Fe concentrations up to 200 mg/L were reported, with these elevated levels persisting for several years post-mining before declining as the system equilibrated. Sulfate concentrations also increased in response to sulfide oxidation

The key differences between the assessment and management by RZM compared to the assessment and proposed management by Holcim at Salt Ash is provided in **Table 5**

Table 5. Key Differences Between Assessment and Management at RZM and Salt Ash.

Assessment and Management Practices by RZM (based on report authored by the Steering Committee 1996)	Key Differences for Proposed Dredging at Salt Ash
Dredging at the Rutile & Zircon Mines (Newcastle) Limited (RZM) occurred between 1972 and 1999 prior to the release of guidelines for the assessment and management of ASS. (i.e., *Assessing and Managing Acid Sulfate Soils: Guidelines for Land Management in NSW Coastal Areas was released by NSW EPA in 1995,* and the Qld *Sampling and Analysis Procedure for Lowland Acid Sulfate Soils in Queensland was released by QASSIT in 1996).* As such, there is no evidence that characterisation of the ore body occurred with respect to ASS prior to the commencement of dredging.	Since 1999, a large number of guidance documents have been released, firstly by individual states and then nationally (in 2018) with clear advice on sampling density, sampling analysis, sample handling, assessment of results and ASS management. Some of the guidelines have been revised to amend or refine advice/guidance based on problems that have occurred on ASS sites. The latest guidance advice with respect to sampling and analysis was released nationally in 2018. Geosyntec (2025) referenced these guidelines when developing a sampling approach for the proposed dredge sand, with sampling and analysis completed in accordance with the guidelines. The Geosyntec (2025) analytical approach went beyond that required by the guidelines by including additional assessments including Scanning Electron Microscopy (SEM), Xray Diffraction (XRD), X-ray fluorescence (XRF), ALSP and LEAF testing. Kinetic leach testing was also undertaken, although limited reliance can be placed on these results. The latest guideline pertaining to management, the *Queensland Acid Sulfate Soil Technical Manual - Soil Management Guidelines V5.1,* was released in May 2024. It is considered the best practice guideline for management in Australia. The ASS EMP and the GWMP (ENV 2025) both reference *Soil Management Guidelines V5.1* and incorporate the guidance provided by these guideless in the management of the ASS. In summary: The Site has been assessed in accordance with the current national guidelines. The acidity regime of the ASS on the Site is well understood and the findings of the analysis has been used to develop

Assessment and Management Practices by RZM (based on report authored by the Steering Committee 1996)	Key Differences for Proposed Dredging at Salt Ash
	management measures included in this ASS EMP and to assess additional areas for investigation to refine the management approach. Additional proposed sampling and testing described in this ASS EMP will fill in the data gaps and be used to refine the process.
The reports states that the tailings were '*ejected from a pipe at the rear of the concentrator to a point near the back edge of the dredge pond. A cone of tailings builds underneath the outlet pipe until it reaches about 4m above the dredge pond level. The outlet pipe is then moved and the process repeats…. Cones of tailings build from individual or mixed bench heights. A bulldozer flattens these cones to create the* post-mining land profile for revegetation.' The report states that the '*mining process discharges and redistributes the pyrite throughout the tailings and into an oxygen rich environment*' Therefore, the mining practices resulted in a percentage of fines, containing pyrite, within the tailings that resulted in the exposure of the fines to atmospheric oxygen. As a result of oxidation, the fines generated acid and leached acid, Fe, sulfate and other trace elements into the groundwater. Iron contamination was the key metal of concern at the Site. The report states that progressive mine rehabilitation involved reshaping the tailings topography. As reshaping is often an iterative process to maintain appropriate slope, drainage, or to prepare for final landform design, it is possible that previously buried oxidised fines were brought to the surface during these activities, generating additional acidity.	Under the proposed management strategy at Salt Ash, the fines will be in contact with water during processing and, after separation from the coarse sand, will be placed underwater. As a result, they will not be stockpiled above ground where oxidation could occur as per the RMZ site. Minimising exposure to atmospheric oxygen will limit the ability of the sulfidic fines to leach acid, Fe, sulfate and other elements into the water. In-line lime dosing will be incorporated into the wash plant. Acidity generated during the process will therefore be neutralised prior to subaqueous discharge into the temporary settling pond or dredge pond. The overall aim of the project is to reinter the fines at a depth of 4 m below the dredge pond water level thus maintaining the fines in a saturated state so that they will not oxidise. As such the fines will not be placed on land where they can oxidise and generated dissolved Fe. Reinternment would only be considered if results of testing of the fines in the temporary settlement pond indicate that impacts to the groundwater are unlikely, or can be mitigated through management.

Assessment and Management Practices by RZM (based on report authored by the Steering Committee 1996)	Key Differences for Proposed Dredging at Salt Ash
During early shallow mining (up until 1986), fines were separated in the wash plant and pumped to dedicated settlement ponds at Fullerton Cove (approximately 7km from the Salt Ash site subject of this report)). Post 1986, when re-mining and deeper mining occurred, the tailings were incorporated into the tailings waste stream and allowed to dry. The report indicates that trials were conducted whereby dried slimes were mixed with tailings. Sampling at the time showed that this was environmentally acceptable (although it is unclear what criteria were adopted), however is noted that the focus of any studies referred to in the report related primarily to the hydraulic conductivity / infiltration properties of the soils, rather than soil chemistry (indicating there is potential that the sampling did not consider soil chemistry in great detail, if at all). The process of removing the fines from the dredge pond and mixing it with the back pond tailings would have resulted in oxidation of the fines and generation and mobilisation of acid, Fe, sulfate and other elements into the groundwater.	Under the proposed management strategy at Salt Ash, the fines will be placed underwater at all times and will not be stockpiled on land at any time

4.0 PROPOSED OPERATIONS

In accordance with the Site's Environmental Impact Statement (EIS), vegetation will be cleared and grubbed, and topsoil/organic material will be stripped. Stockpiling of topsoil/organic material will occur where feasible.

During the initial stage of the project, until dredging operations are established, sand extracted by front-end loader or excavator will be transported by front-end loader and/or dump trucks to the in-feed plant for processing as per existing operations. As groundwater is encountered, a pond would be created immediately south of the processing area and will be made large enough to float a dredge. The Project involves progressive extraction of sand over seven operational stages commencing in the centre of the Site (**Plate 1** and **Plate 2**).

Following the dry-excavation, the dredge pond will be established to a suitable size to float the dredge. The initial dredge-pond is anticipated to extend to between 1-3 m AHD. Dredging is proposed to be carried out to a maximum depth of -28 metres Australian Height Datum (AHD).

The dredge will move backwards and forwards across the dredge pond, vacuuming (dredging) the underwater sand resource using a Jaden Cutter Suction Dredge. The rotating cutting head will be fitted to the end of the dredge extraction line to loosen materials and generate a suitable slurry mix. The slurry containing a mixture of sand and water will be pumped from the dredge via a floated pipeline to a receiving washplant. The dredge will manoeuvre around the pond by anchor wires/ropes and will be secured to the pond banks by wires. The benefit of using a Jaden Cutter Suction Dredge is that it directs the cut material towards the suction chute thereby reducing the amount of disturbed fines resettling within the pond during the dredging process.

The project will utilise hydraulic separation to manage the sulfidic fines during the sand extraction process. Hydraulic separation has been identified in the *Soil Management Guidelines V5.1* (Dear et al 2024) as an established method for managing sulfidic fines, where combined with neutralisation of the fine fraction and sand product, as required, and/or strategic reburial of fine fractions.

The extracted slurry from the sand dredge will be conveyed within a closed pipework system to one or more hydrocyclones (within the receiving washplant) depending on the grading requirements of the sand product. The centrifugal forces within the hydrocyclone direct larger particles to the outside wall of the hydrocyclone and are discharged from a spigot at the bottom of the hydrocyclone while finer particles (<75 µm) move towards the centre of the hydrocyclone and discharge through the top of the hydrocyclone. As pyrite crystals in the sand at Salt Ash were found to typically measure between 5 -20 µm diameter, they will be predominantly associated with the fine fraction. Therefore, an appropriately calibrated hydrocyclone setup can effectively separate sulfidic fines from the sand component. Hydrocyclone separation will not separate 100% of the sulfidic fines from the target flow. As a result, the separated product and any associated drainage from sand stockpiles will be monitored for acid generating potential.

For the early stages of the project, strategic burial of fines into the dredge pond is not possible as there is insufficient pond void volume to accommodate the discharge of returned fines greater than 4 m below the permanent water table, as per the guidance in the *Soil Management Guidelines V5.1* (Dear et al 2024). Consequently, the fines will be placed within a temporary settlement pond. The early fines are likely to be derived predominantly from unit D1/D2, with a lesser contribution from units D1 and D2. Given the higher risk associated with the D1/D2 layers, the temporary settlement pond will be lined. During the early stage of the project, testing of the fines will be undertaken (refer ENV 2025) to further assess the potential for metal leaching under site-specific conditions. The results will inform whether any refinement in the management measures will be required before transitioning to the use of the dredge pond for strategic reburial.

4.1 Dredge and Wash Plant Process at Salt Ash – Early Stage

A process flow diagram for the 300 t/h plant in the project early stages is presented in **Appendix A** and summarised below:

1. **Dredging and Initial Slurry Transport**

   The extracted slurry from the sand dredge (the “feed”) will be pumped within a closed pipework system to the wash plant. The sand and fines will be contained in a water suspension which limits the initiation of and rate of oxidation reactions.

2. **Screening and Sizing**

   The slurry passes through a wet screen which is used to separate oversize material (typically > 1mm) from the sand product. The sand product is directed to a collection sump.

3. **Cyclone Separation**

   From the collection sump, material is pumped via the primary feed pump to the primary cyclones. These use centrifugal force to separate coarse saleable sand from suspended fines and water.

   - Coarse sand exits through the cyclone underflow and is sent to a dewatering screen, producing up to ~300 t/h of coarse washed sand. The stockpiled coarse sand is left in place for 2 to 3 weeks allowing it to drain and air dry. This helps reduce the moisture content of the sand from approx. 10% to approx. 5% for selling.
   - Fine sand, including, silts and clays, are routed to a secondary sump for further processing.

4. **Fines Management**

   The fine sand slurry is pumped from the secondary sump by a secondary feed pump into a secondary cyclone. The fine sand fraction then pass to a dewatering screen, producing up to ~24 t/h of fine washed sand, which typically will be blended through the plant with the coarse sand producing a saleable sand product.

   Excess water and fines not captured (generally <75 µm) are directed to a temporary settlement pond for clarification and water recovery.

5. **Water Use and Management**

   Spray water is used at various stages to aid in screening and material transport.

6. **De-Aeration**

   De-air tanks are included in the process streams to stabilise flow and reduce entrained air, ensuring more effective pumping and separation.

7. **Environmental Controls**

   - A lime dosing unit is incorporated into the circuit with optional dosing points to allow for pH adjustment of the process water and product.
   - A flocculant will be injected instream to help settle the suspended 5-20 µm fraction. The flocculent would be injected at the last step of the washplant outflow. The flocculant addition would be removed if early operations show it is not required.
   - A silt curtain will be installed in the temporary settlement pond to help to manage turbidity.

4.2 Post Early Stage Fines Management

Following the early stage, it is proposed to reinter the process fines directly into the dredge pond from the process plant outflow, provided the results of proposed testing (leachable metals, testing of the fines and monitoring of the temporary settlement pond) indicates that impacts to the groundwater are unlikely, or can be mitigated through management.

In the event that fines cannot be placed within the dredge pond without posing a risk to groundwater quality, an assessment of alternate options for process fines management shall be undertaken, such as:

- dewatering of fines from the process plant in geotextile dewatering tubes
- concentrating fines using deep cone thickener (and high-pressure plate filter) to form stackable clay cakes
- cement stabilising of fines.

These management measures are described below.

4.2.1 Geotextile Dewatering Tubes

Geotextile dewatering tubes are passive, geosynthetic-based system designed to separate and contain fine sediments from slurry or process water (Koerner et al 2016). They are widely used across the mining, construction, industrial, and environmental sectors as a cost-effective alternative to mechanical dewatering systems such as centrifuges, belt presses, and filter presses.

The system works through three main stages: filling, dewatering, and consolidation. In the filling stage, slurry containing suspended solids is pumped directly into high-strength, permeable geotextile tubes. During pumping, polymers (typically cationic or anionic flocculants) are dosed into the slurry to induce flocculation of fine particles, enabling rapid separation of solids from water. This polymer addition typically occurs through an inline static mixer prior to entry into the tube.

Once inside the tubes, gravity-driven drainage allows water to filter out through the pores of the geotextile, while retaining the solid material. The clear water can be recirculated or treated and returned to the dredge pond.

Over time, the solids within the geotextile dewatering tubes consolidate as water continues to drain. This consolidation significantly reduces the total volume of retained solids. The consolidated material can be left in situ for drying or further handled depending on its physical characteristics and potential reuse options. Once dewatering is complete, the contents can be aglime treated and verified and either reused on site if geotechnically suitable, or removed offsite, either to a licensed landfill for disposal or as a saleable product subject to obtaining relevant NSW Environmental Protection Agency (EPA) permits.

4.2.2 Deep Cone Thickeners

Fines can be managed through a staged approach, depending on site requirements and the desired level of dewatering.

Stage 1: Deep Cone Thickener (DCT) Only

A deep cone thickener acts as a vertical static decanter with a conical base that facilitates the gravitational settling of suspended solids. Clarified water is decanted from the top and can be returned to the dredge dam. The thickened underflow is discharged from the base and may be contained and treated on site, or stabilised as per the approach described in Section 4.2.3. (Note that Section 4.2.3. relates to concrete stabilisation).

Stage 2: DCT with Additional Dewatering via Filter Press

Where further dewatering is required, the thickened slurry from the DCT can be directed to a high-pressure filter press. This system consists of a series of filter plates forming sealed chambers under hydraulic pressure. The slurry is pumped into these chambers using a high-pressure diaphragm pump. Water passes through the filter cloths and exits through filtrate ports, while the solids are retained as low-moisture, stackable clay cakes.

The filter cakes could then be aglime treated aglime treated and verified and either reused on site if geotechnically suitable, or removed offsite, either to a licensed landfill for disposal or as a saleable product subject to obtaining relevant NSW EPA permits.

4.2.3 Cement Stabilisation

An alternative to lime amendment of the returned fines slurry would be cement stabilisation of the fines, in the form of a thickened paste. Paste technology has been increasingly applied over the past 20 years for management of sulfidic fines in the metals mining industry, as amendment of the thickened paste with Portland cement (a common paste amendment) has been shown to be very effective in reducing metals mobility, and acid generation in the fines can be markedly reduced by mixing with alkaline materials (Verburg 2001; Mudd 2011).

Management of the fines as a cement stabilised paste would have the benefit of encapsulating the sulfidic fines in a cement matrix, which would significantly reduce the surface area available for exposure to oxygen. The paste could then be disposed underwater at a depth of greater than 4 m, as per the *Soil Management Guidelines V5.1* (Dear et al 2024).

5.0 MANAGEMENT STRATEGIES

Management strategies for implementation have been developed for each key aspect of the site operations and ASS risk. These include:

- Dry Extraction (Extraction Prior to Dredging)
- Pre-Extraction Preparation
- Sand Processing – Hydraulic Separation Fines Management
- Washed Sand Product

Prescribed treatment and management methods have been determined based on the ASS Investigation completed by Geosyntec (2025).

The management strategies for each of the above has been prepared specifically to address ASS management. Other environmental issues not relating to ASS and associated controls will be required to be managed in accordance with other site documentation.

5.1 Dry Extraction

Following the removal of topsoil, a layer of sand resource between 5m AHD and the groundwater table will be extracted via excavation. Prior to the extraction of this material, the unsaturated sand is to be sampled in accordance with the *National acid sulfate soils sampling and identification methods manual* (Sullivan et al 2018). Samples are to be analysed using the CRS Suite to assess the presence of ASS. Elutriate analysis should also be undertaken on select unsaturated sand samples.

If the dry sand contains ASS, it will need to be treated within a treatment area or processed through the wash plant with fines separated and placed in the temporary settlement pond. An ASS EMP would need to be prepared, or this plan updated, to include management measures for the dry extraction.

5.2 Preparation Pre Wet Extraction

Prior to commencement of wet extraction, site preparation and controls are to be implemented to ensure readiness for future ASS management. These actions are summarised below in **Table 6**Error! Reference source not found.**.**

Table 6: Pre-Extraction Preparation/Management

Element	Details
Purpose	Prior to the commencement of wet extraction, appropriate controls are to be installed to ensure the effective management of environmental impacts associated with ASS that may arise from the dredging of the Salt Ash Sand Resource.
Performance Targets	• Ensuring all appropriate controls are installed prior to the commencement of the activity.
Strategies/Mitigation Measures	• Environmental controls specified in the site environmental documentation are established. **<u>In-line Lime Dosing System (ENV 2025)</u>** • Ensuring that in-line lime dosing systems are in place in the wash plant. The lime dosing system shall be employed with multiple inlet points to the wash plant to allow for process control. An additional outlet should be included with capacity to dose to the main dredge pond, if needed. • The optimal dosing point will require testing during the commissioning phase of the wash plant and may vary during operation, depending on the depth of extraction and slurry composition. • 'Tune' the lime dosing system during operation to achieve the appropriate dose rate and dosing point. **<u>Temporary Settling Pond</u>** • Ensuring a temporary settling pond, sufficient in size to retain the fines in the early stages of the project, is constructed prior to works commencing. • The temporary settling pond will be constructed above the water line (ENV 2025) and therefore, any soil disturbed will need to be sampled and analysed for ASS and treated at the required liming rate at a designated treatment area, if required.

Element	Details
Strategies/Mitigation Measures (Cont.)	• Ensuring that the temporary settling pond is constructed with an impermeable base (e.g., liner) to minimise movement of surface water into groundwater and in accordance with the GWMP (ENV 2025). **<u>Stockpiling of Sand</u>** • Areas for stockpiling processed coarse sand and construction sand are developed. Drainage infrastructure is installed around all stockpiling areas to ensure drainage waters (also commonly referred to as leachate) are captured and treated if required (such as by directing back to the wash plant). • A treatment area for the aglime treatment of sand sold for purposes other than concrete batching and asphalt mixing and fines are to be constructed, if required (refer **Section 6.2).** • Material tracking system is established. • Sufficient quantity and quality of aglime shall be retained on site. Once the required environmental controls are implemented, wet extraction may commence.
Monitoring	No additional specific environmental monitoring associated with ASS is required during the pre-extraction preparation.

5.3 Sand Processing – Hydraulic Separation and Fines Management

Once a dredge pond is formed, sand will be extracted via dredging and directed to the processing plant. Initially, the process fines will be placed in a temporary settlement pond where they will remain saturated. Once the dredge pond is of sufficient size, the aim is to reinter the process fines into the dredge pond, subject to the results of future testing.

Hydrocycloning will not remove 100% of the sulfides. It is common for concrete batching and asphalt plants to receive materials of low acidity and / or detectable levels of sulfide. Holcim have advised that most sand specifications have a tolerance level for sulfides. This is largely dealt with at the receiving point when the sand is mixed with the additives required to create the product (regarding concrete this may include fly ash, hydrated lime, cement etc.). Concrete batching plants result in a highly alkaline product, typically pH 10 to pH 12, which can effectively manage the washed sand product that may have residual sulfides. The sand is to be tested in line with the Inspection and Test Plan (ITP) process. Acceptance of materials of low acidity and /or detectable levels of sulfides must be confirmed by the end user prior to transport of material off site.

The specific management actions are summarised below in **Table 7.**

Table 7. Sand Processing - Hydraulic Separation and Fines Management

Element	Details
Relevance	The sand resource below the water table contains sulfides. The resource will be processed at an on-Site processing plant, which will enable the management of sulfidic fines. The method of processing at the Site will result in two (2) outputs, the sand product and the separated fines / process water. Storage of separated sulfidic fines under anoxic conditions in an underwater environment is considered an acceptable strategy. The fines are to remain saturated during the extraction process and placed as rapidly as possible in the temporary settlement pond before oxidation of sulfides can occur. Following the early stage, the process fines will be returned to the dredge pond provided the results of testing (as described in the GWMP [ENV 2025]) indicate that impacts to the groundwater are unlikely or can be mitigated through management.
Purpose	Ensure that the sand resource is processed into saleable product, whilst the fines are managed to prevent environmental impacts.
Performance Targets	• Sulfidic fines contained in the dredged materials must continue to be separated out during the ‘washing’ process, kept saturated and placed into the temporary settling pond. • Separated sulfidic fines must be returned IMMEDIATELY to below the water line in the temporary settlement pond in a controlled manner. A minimum water depth of greater than 1 metre (>1m) will be maintained over the settled fines at all times, in accordance with the GWMP (ENV 2025). • Lime dosing of the process water to achieve the performance targets specified in the GWMP (ENV 2025) if required. • Treatment of water in the temporary settlement pond to achieve required performance targets (refer to the GWMP [ENV 2025]).

<table>
<tr><th>Element</th><th>Details</th></tr>
<tr><td>Performance Targets (Cont.)</td><td>

If the fines in the temporary settlement pond are deemed to be unsuitable for placement in the dredge pond, and are treated with aglime, the following performance limits are set:

The Verification Net Acidity of the treated fines is less than zero.
Post-neutralisation, the soil pH (pH_{KCl}) is to be greater than 6.5.

</td></tr>
<tr><td>Strategies/Mitigation Measures</td><td>
Processing of these sands will occur via hydrocycloning which will remove the fine (sulfidic) fraction (<75µm) from the coarse sand fraction (≥ 75 µm) although some residual fines will remain within the coarse sand fraction.

Fines generated through these processes are to be immediately placed in a temporary settlement pond, with a minimum water column cover of 1m (ENV 2025).

The following controls and mitigation measures are proposed:

Fines contained in the sand resource are to be separated out by hydraulic separation and placed in the temporary settlement pond via the wash water slurry return stream.
Separated fines are to be returned below the water line in the temporary settlement pond.
Fines are to be deposited into the temporary settlement pond in a controlled manner to maintain minimum water cover.

At the end of the early stage, the fines in the settlement pond will be sampled and analysed in accordance with the GWMP (ENV 2025) to determine if they are suitable for placement in the dredge pond.

Sampling is to be undertaken by a suitably qualified person.
If the fines are suitable for placement in the dredge pond:

movement of unoxidised fines to the dredge pond must be undertaken in stages.
fines must not oxidise during the transfer process.

If the fines are not suitable for placement in the dredge pond, the fines may be:

removed from the settlement pond and taken to the designated treatment area (refer Section 6.2) for aglime treatment.

aglime treatment rates are to be determined by sampling and analysing the fines at a rate of 1 sample per 250 m^3.

aglime treated and verified fines can then be removed from the treatment area and either be reused on Site if geotechnically suitable, or removed offsite, either to a licensed landfill for disposal or as a saleable product subject to obtaining relevant NSW EPA permits.
Cement stabilised and placed in a dredge pond. This would require further assessment (refer Section 4.2.3).

</td></tr>
</table>

Element	Details
Monitoring and Records	• Where verification testing is required of oxidised and treated fines, verification testing is to be undertaken at a rate of 1 sample per 250 m^3. • Inspections and monitoring of the temporary settlement pond as per the GWMP (ENV 2025). • Daily inspections of the aglime treatment area. • Inspection of Fe staining etc. • Spatial tracking records are to be maintained of the volumes and locations of sand excavated. • Verification testing (as described above) is to be conducted by an experienced and suitably qualified professional. • At the conclusion of the early stage, the temporary settlement pond is to be decommissioned. Water in the pond is to meet the specified Performance criteria (ENV 2025) prior to release into the dredge pond.
Corrective Actions	Should results of any verification testing of aglimed ASS indicate results outside the allowable performance limits, the affected material shall remain within the treatment area and be re-treated with sufficient aglime to achieve the ‘Verification Performance Limits’. Verification is to be repeated until the limits are met. Corrective measures for surface water quality in the temporary settlement pond are provided in the GWMP (ENV 2025).

5.4 Washed Sand Product

Material that will result from the sand extraction operation is regarded as a quarry product, with its primary destination being concrete batching. Any material not taken to the concrete batching plant (which is not expected to take place on a routine basis) will be sold as washed sand.

The processing plant includes inline lime dosing and therefore lime will be introduced into the washed sand product. Inline lime dosing will neutralise acidity in the water stream and will also neutralise acidity generated by residual fines in the washed sand product, given that hydrocycloning will not remove 100% of the residual fines. The inline lime dosing rates will be validated initially to achieve the required performance criteria specified in the GWMP (ENV 2025).

As mentioned in **Section 5.3**, it is common for concrete batching plants to receive materials of low acidity and / or detectable levels of sulfide. The sand is to be tested in line with the Inspection and Test Plan (ITP) process. Acceptance of materials of low acidity and /or detectable levels of sulfides must be confirmed by the end user prior to transport of material off site.

In the event that sand is not sold for the purpose of concrete batching and asphalt manufacturing, and is sold for another purpose, **Table 8** includes the methodology for sampling and verification testing of the sand.

The specific management actions are summarised below in **Table 8**.

Table 8. Washed Sand Product

Element	Details
Relevance	The sand product will be stockpiled on-site following processing before being loaded and transported offsite to a concrete batching or asphalt plant where it will undergo mixing and treatment as part of the concrete batching and asphalt mixing process. Following washing, the sand is expected to contain low levels of sulfides. Some lime will have been incorporated into the washed sand due to the in-line lime dosing process. It is anticipated that testing of washed sand will principally be for ITP purposes.
Purpose	The washed sand may contain low concentrations of sulfides. If approved by the end user, sand with residual sulfidic fines may be acceptable and this is to be confirmed prior to movement of the material offsite. Nevertheless, some measures are to be adopted to provide safeguards to any residual risk that may be present.
Performance Targets	**<u>Sand Sold for Concrete Batching and Asphalt Manufacturing</u>** Given that the sand resource can contain concentrations of sulfides within the relevant product specification for the manufacture of concrete, no performance limits for sulfide has been set. However, ITPs are to be provided to the buyer (if requested) of the product to inform them of the sulfide content. **<u>Sand Sold for Other Purposes</u>** The target performance criteria for hydrocycloned washed sand that is to be used for purposes <u>other than</u> concrete batching and asphalt manufacturing, and requires testing, is as follows (Dear et al 2024):

Element	Details
Performance Targets (Cont.)	• Net Acidity ≤0.03%S (18 moles H^+/tonne) To account for the fact that there may be some residual level in the washed sand, the following also applies: • No sample is to exceed 0.04%S (25 moles H^+/tonne) • If any single sample exceeds 0.03%S (18 moles H+/tonne) then the average of any 6 consecutive samples (including the exceeding sample) shall have an average not exceeding 0.03%S (18 moles H^+/tonne).
Strategies/Mitigation Measures	• Any 'washed sands' retained on site are to be stockpiled in the designated stockpile area. A compacted aglime 'guard layer' is to be applied to the surface of the stockpiling area at a rate of 5 kg/m^2. The guard layer may be removed if results of onsite testing (e.g. ITP testing) indicates that acidic leachate is not being generated. • Ensure appropriate testing, treatment and verification testing is undertaken for sand designated for uses other than concrete and asphalt.
Monitoring and Records	**<u>Sand Sold for Concrete Batching and Asphalt Manufacturing</u>** Washed sand for concrete batching is to be tested in line with the product testing requirements. **<u>Sand Sold for Other Purposes</u>** Sand to be sold for purposes other than concrete batching and asphalt manufacturing is to be moved to the designated treatment area (refer **Section 6.2**) and tested to determine liming rates. • Testing of the sand to determine liming rate is to be undertaken at a sampling rate consistent with Table 6.1 of Sullivan et al (2018), i.e., 1 sample per 500 m^3. Following treatment with Aglime (if required), the sand is to be verified. • Verification testing is to be undertaken at a rate of 1 test per 500 m^3. Refer to **Section 6.3.** **<u>General</u>** The following monitoring will be required: • Spatial tracking records are to be maintained of the volumes and locations of soil excavated. • Records of aglime used in guard layers and to treat spoil quantities should match records of bulk lime bought on to site and used for that purpose. A general photographic record of the aglime mixing procedures should be made and maintained for reference. • Aglime guard layers shall be inspected weekly and following rainfall events greater than 25 mm/24 hours and replenished as necessary.

Element	Details
Corrective Actions	**<u>Sand Sold for Concrete Batching and Asphalt Manufacturing</u>** Should the washed sand not meet the concrete product requirements with respect to sulfide content, the hydrocycloning process is to be reviewed/investigated by the site operational team. **<u>Sand Sold for Other Purposes</u>** Should results of any verification testing fall outside the allowable performance limits, the affected material shall remain within the treatment area and be re-treated with sufficient aglime to achieve the 'Verification Performance Limits'. Verification is to be repeated until the limits are met.

6.0 ASS NEUTRALISATION

This section describes the ASS neutralisation (if required) for the following:

- sand sold for the purposes other than concrete batching or asphalt manufacturing, and
- fines from the settling pond that cannot be placed in the dredge pond.

The following protocols apply.

6.1 Neutralising Agent

Fine high-quality aglime with a minimum effective neutralising value of 95% is to be used.

Other alternative neutralising agents such as dolomite may be used but these must be approved by an appropriately qualified person. If lower quality aglime is used, the quantity must be increased accordingly, based on purity analysis data for the aglime source.

The application of neutralising agents, such as aglime (and hydrated lime), will be conducted in line with work health & safety (WHS) guidelines relevant to the use of such materials.

The WHS recommendations for the application of lime products at the site are as follows:

- machinery operators are to have all windows closed during operation
- persons present in the treatment area are to be attired with suitable gloves, safety glasses and long sleeved and trousered clothing
- persons present in the immediate vicinity of the lime stockpile and/or application area are to be wearing appropriate dust masks and have immediate access to breathing respirators and a first aid kit, and
- a temporary enclosure constructed of shade-cloth, or other materials suitable for dust suppressing, will need to be established around the aglime stockpile/ application area to prevent nuisance aglime dust being generated and migrating across the site or offsite.

6.2 ASS Treatment Area

The treatment area must be located on stable ground, away from overland flow paths to avoid instances of accidental release of acidic drainage water.

The treatment area must comprise a layer of compacted non-ASS clayey material (0.3 m thick) on the surface to reduce the infiltration of leachate to the soil and groundwater. The treatment area shall have a guard layer of aglime applied at a minimal rate of 5 kg/m^2 per vertical metre of ASS beneath any stockpiles of sand requiring treatment and 10 kg aglime/m^2 shall be used beneath any stockpiles of fines requiring treatment. The guard layer is to be replenished if the guard layer is removed with the treated soil.

The treatment area is to be surrounded by compacted earth bunds, constructed from low permeability aglime treated and verified spoil, or non-ASS fill. A surface water collection system shall be incorporated into the design of the pads so that drainage/runoff water from the pad can be captured and treated (if required).

The purpose-built treatment area is to be divided into 'cells' to enable aglime treatment of spoil requiring different rates, and to facilitate tracking of treated spoil.

ASS spoil shall be placed on top of the 'guard layer' in up to 300 mm thick layers (or windrows) to allow drying. Once a layer of ASS is sufficiently dry (the length of drying time will depend on the texture of the soil), apply aglime to the spoil using physical or mechanical means, such as a rotary hoe, at the required liming treatment rate and mix well.

The treated spoil will be sampled for verification testing at the rates indicated in **Section 6.3** and held in the bunded treatment area until verification testing is completed, and results meet the verification performance criteria.

If the soil fails verification testing, additional aglime is to be incorporated into the soil at the rate required and the verification process repeated.

6.3 Verification Testing of Neutralised ASS Soil

Verification testing of the aglime treated ASS is to be undertaken to ensure that the soil has been adequately neutralised. Verification testing must be undertaken using the Chromium Suite, with Net Acid Soluble Sulfur (S_{NAS}) analyses undertaken regardless of pH_{KCl} value, as per Dear et al (2024).

Verification sampling and analysis is to be undertaken within 72 hours of treatment. Each verification sample should comprise 6-8 random subsamples (as per Dear et al., [2024]) to reduce the likelihood of accidentally sampling a small patch of under- or over-treated soil. Verification sampling is to be undertaken at the rates described in the Tables in **Section 5.0**. Samples are to be sent to a National Association of Testing Authorities (NATA) certified laboratory for analysis. The verification testing must be conducted by an experienced and suitably qualified professional.

The soil must remain in the treatment area until the results are available. The treated soil must meet the performance criteria before it can be removed from the treatment area.

6.3.1 Performance Criteria

The following performance criteria applies to the treated ASS, based on the results of the Chromium Suite testing (Dear et al. 2024):

For Washed Sand:

- The verification net acidity is ≤0.03%S (18 moles H^+/tonne)

To account for the fact that there may be some residual level in the washed sand, the following also applies:

- No sample is to exceed a net acidity 0.04%S (25 moles H^+/tonne)

If any single sample exceeds 0.03%S (18 moles H+/tonne) then the average of any 6 consecutive samples (including the exceeding sample) shall have an average not exceeding 0.03%S (18 moles H^+/tonne).

For Fines

- The verification net acidity of the treated soil is less than zero.
- Post-neutralisation, the soil pH (pH_{KCl}) is to be greater than 6.5.

Where treated ASS does not meet the performance criteria, the material will require re-treatment and verification.

7.0 REPORTING

The following will be recorded on a weekly basis:

- Estimates of sand production quantities.
- Daily estimates of fines placed in the temporary settlement pond.
- The location and depth of daily excavations and material movements and storage.
- Location(s) of any aglime treated material awaiting sampling and/or verification.

- All sampling and receipt of analytical test results for ASS testing.
- All sampling and receipt of analytical test results for aglime verification testing to support that treated ASS materials have been adequately neutralised.
- Copies of truck weigh bills or other proof of quantities of lime brought on-site and used in treatment.

Records of the following activities must be kept on-site:

- Spatial tracking of stockpiling operations and quantities of 'washed' sand product taken off-site.
- Quantities of aglime added during operation, whether in treatment of soils or guard layers.
- Quantities of lime used instream dosing and in the temporary settlement pond.
- All monitoring data in accordance with requirements of **Section 8.4.**
- Results and dates of verification tests undertaken.
- Any changes to operational or management procedures.
- A photographic record of the lime mixing procedure is to be made and retained for reference.
- An assay test (per source) confirming purity of aglime used
- Maintenance, calibration or repairs to any monitoring or lime mixing equipment.

8.0 ASS EMP IMPLEMENTATION PROTOCOLS

8.1 Responsibility

This section outlines the framework that will be used by Holcim to manage, document, and report on environmental issues for the Site. Holcim shall nominate a responsible person, who shall be responsible for the implementation of the ASS EMP. The responsible person may be the Quarry Operator, an employee, or an independent contractor or consultant (as required to support the implementation of the ASS EMP).

8.2 Contractor Management

The Responsible Person (Holcim) and sub-contractors are required to comply with the provisions of this EMP at all times and all site personnel shall complete an Environmental Site Induction. This is to be documented through the site induction process. Environmental performance obligations shall be incorporated into the Responsible Person's (and sub-contractors) conditions of work for the project.

8.3 Training

All site staff and specific contractors will be required to undergo a site induction relating to the Environmental Procedures and Management framework outlined in the EMP. The induction will aim to develop and instil a high level of environmental awareness in all project personnel.

The induction program is to be endorsed by Holcim.

8.4 Monitoring and Inspection

Environmental monitoring and inspection of the Site will be carried out by means of a routine monitoring program and a weekly meeting of responsible personnel and a site inspection. These measures will be used to identify any areas of non-conformance or opportunities for improvement. Any non-conformances will be reviewed at the weekly meeting. Monitoring shall be documented as outlined in **Section 8.7.**

8.5 Government Authority Requirements

The responsible person shall liaise with the relevant regulatory authorities (e.g. NSW EPA) and shall comply with their requirements where applicable. All necessary approvals, permits and licences must be obtained prior to extraction activities in the extension area commencing. These approvals, permits and licences must be maintained and complied with during the life of the quarry.

8.6 Review

Reviewing of the site's performance against the requirements of this ASS EMP is to be carried out by Holcim's Environmental Officer or a suitably experienced Environmental Consultant annually.

Reviews may be conducted concurrently with other site reviews that are required (e.g. Occupational Health & Safety [OH&S] and 'Quality' reviews) and monitoring may be included with any other regular monitoring conducted at the Site.

The review is to comprise:

- Checking that all requirements of the ASS EMP have been met.
- Documenting why requirements may not have been met.
- Reviewing the results of all monitoring undertaken during the previous 12 months.
- Assessing whether the objectives, actions, standards and responsible persons listed in the ASS EMP are still relevant, and recommending changes where necessary.
- Identify any other activities that have, or may, cause an adverse impact to the environment, or non-conformance to regulation.
- Provide recommendations to Holcim regarding any practical measures that can be made to continuously improve the effectiveness of environmental management of the Site.

Reviewing requirements must demonstrate implementation of agreed operation and management strategies and compliance with the specified Performance Criteria.

8.7 Record Keeping

All documents produced under this ASS EMP relating to monitoring and reporting shall be stored for a minimum period of five years. Records shall be made available for review of authorised persons upon request.

9.0 INCIDENT RESPONSE PROCEDURE

9.1 Incident Awareness

When an employee becomes aware of an event resulting in the breach of a DA condition, or an incident with actual or potential environmental harm implications, the employee must report the incident to the Quarry Manager or delegate immediately after becoming aware of the incident.

To demonstrate regard for the general environmental duty, all possible breaches of the DA should be reported to the administering authority as soon becoming aware of the matter, even if there is uncertainty as to whether a condition of the DA has been breached.

9.2 Notification

If the matter is an emergency, call 000.

Under Part 5.7 of the Protection of the Environment Operations Act 1997 No 156, persons have a duty to notify the administering authority immediately after becoming aware of any incidents or activities following a pollution event.

All records of the incident or breach are to be stored at the site and made available to the administering authority upon request.

All incidents are to be investigated.

10.0 STUDY LIMITATIONS

Your attention is drawn to the document – Limitations, attached at **Appendix B**.

The statements presented in this document are intended to advise you of what your realistic expectations of this report should be, and to present you with recommendations on how to minimise the risks associated with the services provided for this project. The document is not intended to reduce the level of responsibility accepted by PSK, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing.

11.0 REFERENCES

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FIGURE

LEGEND

Site Boundary

PSK Environmental

Client:

Holcim (Australia) Pty Ltd

Project:

Preliminary Draft Acid Sulfate Management Plan - Dredge Fines, Salt Ash Sand Operations, New Sotuh Wales

Notes:
- Imagery sourced from QGIS 2024

Drawn:	Date:
RO	11/06/2025
Review:	Date:
SLS	11/06/2025

Title:

Site Location Map

Scale 1:
0 2.5 5 km

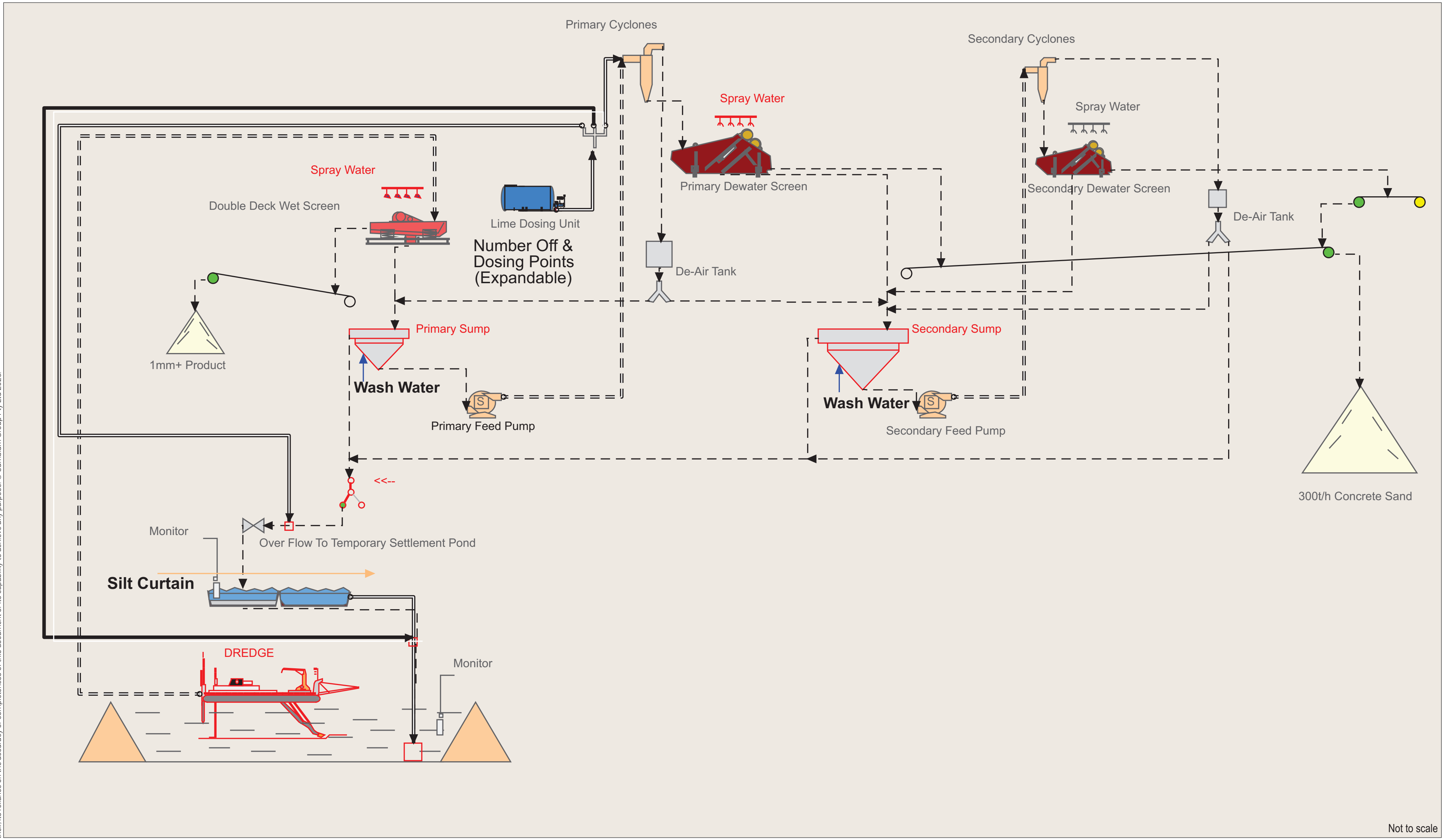
Job No.:	Fig.:	Rev.:	
J0724-014-005	1	0	A4

APPENDIX A

WASH PLANT FLOW DIAGRAM

Figure 3.2
Dredge processing plant concept flow diagram

HOLCIM SALT ASH SAND OPERATIONS
RESPONSE TO SUBMISSIONS



Source: Holcim (2025), Cambium Group (2025).

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APPENDIX B

Limitations

LIMITATIONS

This Document has been provided by PSK Environmental Pty Ltd ("PSK") subject to the following limitations:

This Document has been prepared for the particular purpose outlined in our proposal and no responsibility is accepted for the use of this Document, in whole or in part, in any other contexts or for any other purpose. The scope and the period of PSK's Services are as described in PSK's proposal, and are subject to restrictions and limitations. PSK did not perform a complete assessment of all possible conditions or circumstances that may exist at the site referenced in the Document. If a service is not expressly indicated, do not assume it has been provided. If a matter is not addressed, do not assume that any determination has been made by PSK in regards to it.

Conditions may exist which were undetectable given the limited nature of the enquiry PSK was retained to undertake with respect to the site. Variations in conditions may occur between investigatory locations, and there may be special conditions pertaining to the site which have not been revealed by the investigation and which have not therefore been taken into account in the Document. Accordingly, additional studies and actions may be required.

In addition, it is recognised that the passage of time and changes to Government regulations may affect the information and assessment provided in this Document. PSK's opinions are based upon information that existed at the time of the production of the Document. It is understood that the services provided allowed PSK to form no more than an opinion of the actual conditions of the site at the time the site was visited and cannot be used to assess the effect of any subsequent changes in the quality of the site, or its surroundings, or any laws or regulations.

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