

## DEWATERING MANAGEMENT PLAN (DMP)

Shell Suffolk Park  
207-209 Broken Head Road, Suffolk Park NSW

For:  
Horizon Retail Pty Ltd

By:  
ENV Solutions Pty Ltd

Date:  
11/06/2020

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## Document Control:

<b>Filename:</b>	21140 – Horizon_Shell_SuffolkPark_DMP_20210611		
<b>Job No:</b>	ENV 21140		
<b>Client:</b>	Horizon Retail Pty Ltd		
<b>File/Pathname:</b>	C:\Users\GusHilliard\Dropbox (ENV Solutions)\ENV Solutions Team Folder\01. jobs\21140 - Horizon_Shell Suffolk Park_DMP and Approvals\Reports\21140 - Horizon_Shell_SuffolkPark_DMP_202105XX GH.docx		
<b>Revision No:</b>	<b>Author:</b>	<b>Date:</b>	<b>Signed:</b>
0	Gus Hilliard	11/06/2021	GH
	<b>Reviewed By:</b>		
	Robert Mitchell	11/06/2021	

## Scope of Engagement and Limitations:

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## 1 Introduction

ENV Solutions Pty Ltd (ENV) were engaged by Horizon Retail Pty Ltd to prepare a Dewatering Management Plan (DMP). The purpose of the DMP is to successfully identify, determine & describe dewatering and water treatment methodologies required to successfully remove and install Underground Petroleum Storage Systems (UPSS) infrastructure at the existing service station located at 207-209 Broken Head Road, Suffolk Park (**Figure 1, Attachment 1**).

Furthermore, this DMP has been authored to be attached as part of the integrated approval process for upgrading the service station, providing remedial works to both soils and groundwater onsite & support the Water Supply Works Application required by WaterNSW under section 91 (Aquifer interference approval) of the Water Management Act (2000).

### 1.1 Proposed Development

Following conversations with Horizon Retail and review of relevant design drawings, it is understood that the proposed development involves the raise & rebuild of the existing service station located at 207-209 Broken Head Road, Suffolk Park.

In addition to the demolition and rebuild of several structures onsite, it is ENV's understanding that four (4) existing Underground Storage Tanks (USTs) and their associated infrastructure will be removed and replaced with three (3) 70 kL split compartment USTs & supporting UPSS infrastructure and a SPEL unit (**Figure 2, Attachment 1**).

To install the new USTs successfully & safely, a tank pit measuring approximately 20m x 11m x 4.5m (length x width x depth) will be excavated in the northeast corner of the site (ENV 2021).

Referencing the both the Civil Consult Geotech Report (May 2021), a support system will need to be engineered and installed to support the excavation prior to commencement of the new tank pit dig.

Awaiting design detail at the time of DMP publication, preliminary discussions favour a sheet piling solution where sheets will be driven into the dense indurated sand layer in the proposed tank pit area and supported with several braces.

Creating a confined excavation, a dewatering process would be required to initially drop the standing water level (SWL) to approximately 1.0 m below the base of excavation (drawdown phase).

Once drawn down, dewatering process will then control seepage into the excavation (steady state phase). This will be done to ensure SWL is adequately maintained to allow the removal of dry tank pit spoil, provide safe access into the excavation and allow for compliant installation & backfill of USTs to meet manufacturers requirements.

Furthermore, in addition the proposed tank pit, it is ENV's understanding that a new sewer pump will be installed along the northern boundary of the site. At the time of publication, pump station excavation dimensions were estimated to be 3m x 3m x 3m (length x width x depth).

Shoring methodologies are unknown and awaiting detailed design. However, a shoring box (or slide rail system) and sheet piled system are both being considered and are discussed below.

In addition, following review of the both the ASSMP and RAP (ENV 2021 and ENV 2020), dewatering and water treatment methodologies outlined in detail below are mindful of the Actual Acid Sulfate Soils (AASS) soil profiles found onsite & the contamination risk as a result of historic phase separate hydrocarbons (PSH) identified in historic site investigations. A copy of both the ASSMP and RAP are included as **Attachment 2** and **Attachment 3**.

## 1.2 Stakeholder Identification

Table 1 outlines immediate direct (internal) and indirect (external) stakeholders with an interest or concern in construction works associated with the proposed works outlined in section 1.1.

**Table 1: Stakeholder Identification**

Stakeholder	Role or Position	Internal/ External
Horizon Retail Pty Ltd	Client	Internal
ENV Solutions Pty Ltd	Principle Contractor / Consultant	Internal
Byron Shire Council	Local Authority	External
WaterNSW	State Authority	External

## 1.3 Previous Environmental & Geotechnical Investigations

The following DMP has been developed following review of the following environmental and geotechnical investigations:

- ENV (2020). Shell Suffolk Park RAP. Document Reference 20770\_Shell\_Suffolk\_Park\_RAP, dated November 2020.
- ENV (2021). Shell Suffolk Park ASSMP. Document Reference 21121\_Shell\_Suffolk\_Park\_ASSMP, dated March 2021
- Civil Consult (2021). Geotechnical Investigation Shell Suffolk Park. Document Reference 21033 Geotechnical Investigation – Shell, Suffolk Park.pdf, dated May 2021
- ENV (2018). BP Suffolk Park Due Diligence. Document Reference 18064\_BP\_Suffolk\_Park\_Due\_Diligence\_Assessment, dated April 2018.
- Cavanba (2012a). Groundwater Investigation, Suffolk Park Service Station, 207-209 Broken Head Road, Suffolk Park, NSW, 2481. Report reference 11098 R02, dated January 2012.
- Cavanba (2012b). Groundwater Monitoring Event, May 2012; Suffolk Park Service Station, 207-209 Broken Head Road, Suffolk Park, NSW, 2481. Report reference 11098 R03, dated August 2012.
- Cavanba (2013). Groundwater Monitoring Event, April 2013; Suffolk Park Service Station, 207-209 Broken Head Road, Suffolk Park, NSW, 2481. Report reference 11098 R04, dated May 2013.

## 1.4 Relevant Standards, Guidelines & Literature

This DMP has been developed referencing the following Standards & Guidelines.

- ANZECC/ARMCANZ. 2000. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.
- ANZG. 2018. Australian and New Zealand Guideline for Fresh and Marine Water Quality 2018. Australian and New Zealand state and territory governments, Canberra ACT, Australia.

- National Environment Protection (Assessment of Site Contamination) Measure 1999 (as amended 2013) ('NEPM') (NEPC, 2013).
- Cachman, M. & Preene, M. 2013. Groundwater Lowering in Construction: A Practical Guide to Dewatering, 2nd Edition, CRC Press, New York.
- Tchobanoglous, G. et al, 2003, Wastewater Engineering Treatment and Reuse: Metcalf & Eddy, 4th edn, McGraw-Hill, New York.

## **1.5 General Environmental Duty**

This DMP (and its treatment measures) have been developed to mitigate risks that cause or are likely to cause, environmental harm in accordance with the precautionary principles outlined in the National strategy for Ecologically Sustainable Development (1992), described by the National Water Quality Management Strategy (2018) (NWQMS).

## **1.6 Dewatering Management Plan Objectives**

The objectives of the DMP are to describe dewatering methodology, outline groundwater treatment requirement/ methodology and define monitoring/ reporting procedures to be implemented during temporary dewatering & dewatering water treatment works. In addition, this DMP outlines effective management procedures to prevent environmental harm resulting from the discharge of extracted groundwater from the site.

## 2 Site Characteristics

### 2.1 Site Description

The site is located at 207-209 Broken Head Road, Suffolk Park (**Figure 1, Attachment 1**). The legal description of the site is Lot 1 DP701391 within the Local Government Authority (LGA) of the Byron Shire Council (Council) and has an approximate area of 3,322 m<sup>2</sup>. The site is currently under operation as a service station with two (2) entrances, both accessed via Broken Head Road.

### 2.2 Surrounding Environment

The Councils Land Environment Plan (LEP) (2014) presents the site as located in an area zone R2 – Low Density Residential. Surrounding land use is described in Table 2.

**Table 2: Surrounding Land Use**

Direction	Environment
North	Residential adjacent to the site, then residential and holiday accommodation. Byron Bay Nursing home is located approximately 60 m north-west of the site, across Broken Head Road. A cattle tick dip was formerly located to the north-west of the site (across Broken Head Road) but has since been remediated.
East	Tallow Creek, then residential R2
South	Tallow creek, then “The Park” Motel and Hotel, including carpark and the Suffolk Park shopping village, then residential R2.
West	Broken Head Road, Tallow Creek and wetlands (south-west) Zoned E2 and E3 (Environmental Conservation and Management areas, then residential R2.

### 2.3 Topography & Drainage

The site has an elevation of less than 10 m AHD (Google Earth imagery 2021). The site is generally flat, apart from the entrance and exit driveways from Broken Head Road, which have slope at approximately 10% from Broken Head Road to the main service station area. The site also slopes towards Tallow Creek along the southern and eastern boundaries in the immediate area of the creek, comprising the embankment.

The topography of the surrounding land is generally flat, low-lying land. Infiltration is expected to be low in the immediate vicinity of the site given the surface is predominantly covered in hardstand. However, based Geotech reports the presence of granular soils below the typical water table depth mean soil permeability would be high.

### 2.4 Geology & Soils

The geology at the site is mapped at 1:250,000 as “Beach and dune sand” (Geological Survey of NSW, 1972). The soil landscape at the site is mapped at 1:100,000 as Black Rock (bra) Aeolian landscape (Morand, 1994). This is described as “extensive sand sheet (possible Holocene) supporting low heath and shrubland”.

The site appears to be on a low barrier dune system, and soils are therefore expected to be podzols, i.e., acid sandy soils with strongly differentiated horizons including a bleached horizon

above a coffee-coloured pan and coloured subsoil. The coffee-coloured pan is evident along the beach dunes nearby at Tallow Beach. Soil limitations include: non-cohesive, highly permeable, highly acidic soils of very low fertility (Morand, 1994).

Referencing most recent geotechnical investigations conducted by Civil Consult (2021), a total 3 (3) boreholes were drilled to depths between 5 m and 10 m. A copy of this referenced geotechnical investigation is presented as **Attachment 4** where a summary of logged material descriptions and depths are summarised in Table 3.

**Table 3: Subsurface Condition Summary**

Borehole Number	Fill/Pavement	ALLUVIUM			
	UNIT 1: Pavement/FILL	UNIT 2: Sandy CLAY (CH)/ Clayey Sandy SILT (MH) (m)	UNIT 3: Loose Clayey SAND (SC)/ SAND (SP) (m)	UNIT 4: Medium Dense SAND (SW) (m)	UNIT 5: Dense SAND (SW) (Coffee Rock) (m)
BH1	0.0 – 0.1	0.1 – 1.2	1.2 – 2.3	2.3 – 5.0	5.0 – 5.12*
BH2	0.0 – 0.3	0.5 – 1.5	0.3 – 0.5 1.5 – 3.8	NE	3.8 – 5.92*
BH3	0.0 – 0.3	NE	0.3 – 2.5	2.5 – 4.0 8.2 – 10.0	4.0 – 8.2 10.0 – 10.13*
<b>Notes:</b> NE: Not Encountered * Borehole termination depth					

## 2.5 Acid Sulfate Soils

The Byron Shire Council Local Environment Plan (LEP) (2014) maps the site as Class 3 Acid sulfate soils (ASS) risk. ENV a field program for ASS assessment in March 2021. Results are summarised as follows where a copy of the ASSMP is presented as **Attachment 2**:

- ASS occur in soil profiles between 1.0 – 5.5 mBGL in boreholes BH1, BH3 and BH4 and from 4.0 – 5.5 mBGL in BH2. Results indicate predominantly actual acid sulfate soil (AASS) and to a lesser extent potential acid sulfate soil (PASS).
- Net acidity results for profiles depth within each borehole outlined above are reported as being greater than the action criteria threshold of 18 mol H<sup>+</sup>/t for ASS material disturbance greater than 1000 tonnes; such as the case is with this investigation. The action criteria threshold of 18 mol H<sup>+</sup>/t has also been adopted due to
- the consistent occurrence of sands within localised on-site soils noted whilst drilling. While laboratory interpretation of the soil texture from the samples provided to the laboratory were outlined as a mix of fine (light medium to heavy clays) medium (clayey sand to light clays) and coarse (sands to loamy sands), evidence obtained from drilling in the field indicted a predominant volume of sand within all profile of soils encountered.

Furthermore, section 1.5 of the ASSMP discusses the need to dewater the excavation to allow safe access & installation of USTs. In doing so, the ASSMP recommends dewatering extent (i.e. zone of influence) should be managed to minimise potential oxidation outside the tank pit excavation.

## 2.6 Saturated Hydraulic Conductivity

Saturated hydraulic conductivity ( $k_{sat}$ ) is used to determine inground permeability (m/s) utilising data obtained from the sites underlain geology (section 2.4). Cross referencing data collected from the most recent sub surface investigations (Civil Consult 2021), Medium and Dense Sands are expected to be most predominantly encountered onsite to the required depth of excavation.

Utilising values recommended by Engineers Australia (2006) and Cachman & Preene's: Practical Guidelines Towards Lowering Groundwater in Construction (2013), this DMP adopts a hydraulic conductivity medium to coarse sands where  $k_{sat}$  is estimated to be within the range of  $5 \times 10^{-5}$  and  $1 \times 10^{-4}$  meters per second.

Due to the limitations associated with the homogenous nature of inground conditions, and other assumptions regarding inground geology, changes in permeability ( $k_{sat}$ ) are highly volatile. Any changes in underlain geology may result in changes in saturated hydraulic conductivity and therefore groundwater extraction flow rate. On this basis, calculations (discussed in following sections) have been used as an approximation of steady state dewatering rates for planning purposes only.

## 2.7 Groundwater

Review of cumulative Groundwater Monitoring Event (GME) data indicates that groundwater (GW) levels have remained relatively consistent and similar, across several well locations.

Minor fluctuations in SWL can be noted between sampling events where these fluctuations are considered to be attribute to seasonal variances and rainfall patterns. On average, stabilised SWL remains at its highest point 1.0m below ground level (mbgl).

Furthermore, following review of most recent geotechnical investigations conducted by Civil Consult in May 2021, SWL was recorded at approximately 1.2 mBGL in Bore Hole 3 (BH3) – situated in the centre of the proposed tank pit excavation.

Referencing topographical observations outlined in section 2.3 of this report, groundwater would be expected to move in an easterly direction towards Tallow Creek. This was inferred in the Due Diligence Report undertaken by ENV in 2018 with the inferred groundwater flow direction being East South-Easterly (ESE) direction towards the creek.

In addition to the above, a search of groundwater bore licences via WaterNSW real time data platform (<https://realtimedata.watersnsw.com.au/water.stm>), showed four (4) licensed bores located within 250 m of the site; one approximately 130 m to the north-west, one approximately 100 m to the south-east; one approximately 175 m to the north-east and one approximately 250 m to the east. The information presented on the mapping shows that the two bores situated in a down-hydraulic gradient direction (east or south-east) from the site have been installed using a spear, with no other information available for the bores. These licences may be associated with construction activities such as dewatering. The bore situated 175 m to the north-east of the site was installed to a depth of 6.4 m in 2010 for domestic purposes.

## 2.8 Baseline Groundwater Quality

The historic monitoring well network onsite is comprised of seven (7) onsite groundwater monitoring wells identified as MW05 to MW07 and MW09 to MW012. **Figure 3 Attachment 1** provides detail existing monitoring well locations with reference to current UPSS infrastructure.

Outlined in ENV RAP (2020), a groundwater investigation was conducted concurrently with the soil borehole investigation, to update groundwater conditions beneath the site.

Four wells (MW5, MW6, MW9 and MW10) were sampled, with the remaining monitoring wells either lost (MW11 and MW12) or containing LNAPL (MW7 only which was not sampled).

The results of the groundwater sampling indicate concentrations of the chemicals of potential concern (COPC) were present in low concentrations. Benzene detections are likely a result of ongoing use as a services station where low metal concentration (Arsenic, Copper & Zinc) are naturally occurring, and likely present due to the reducing conditions of the shallow aquifer.

A copy of the Soil and Groundwater results from this most recent sampling event have been made available for viewing in **Attachment 5**.

## 2.9 Baseline Receiving Environment Water Quality

The construction works proposed for this site as mentioned above will require dewatering and water treatment using a suitable designed Water Treatment Plant (WTP) before being discharged to the environment.

The receiving environment for treated discharge water has been identified as the Lowland River catchment of Tallow Creek. As a result, a receiving environment sample was collected directly from the Tallow creek for analysis on the 13<sup>th</sup> of May 2021 (see **Attachment 6**).

In summary, as follows, receiving environment water quality can be described as;

- Fresh with a salinity reading of 0.296 mS/cm
- Slightly below neutral pH = 6.52.
- Of reasonable clarity 12.6 NTU.

Furthermore, it is worth noting that tannin staining may be encountered in both the receiving waters and groundwaters because of the coffee-coloured subsoils. This is believed to be naturally occurring.

**Table 4: Receiving Environment Sample**

Parameter	Receiving Environment Water Quality (Baseline)
pH	6.52
Turbidity (NTU)	12.6
Salinity (mS/cm)	0.296

Treated water quality objectives (WQO's) can be established following thorough assessment of the receiving environment.

Guided by the ANZG (2018) with references to its origin the ANZECC/ ARMCANS (2000), the receiving environment for this site has been recognized as the slightly to moderately disturbed Lowland River system of Tallow Creek as defined in section 3.1.3.1. of the ANZECC/ ARMCANZ (2000).

On this basis, for slightly disturbed ecosystems, as 95th percentile (%) level of protection on toxicant Default Guideline Values (DGVs) is recommended.



### 3 Water Quality Objectives (WQO)

Following review of both baseline groundwater and receiving environment water quality, the following WQO's have been determined. Table 5 contains details for analytes and chemical of potential concern with footnotes referencing relevant standards and guidelines consulted for the values stipulated.

Note that all extracted groundwater will need to be treated to meet WQOs prior to discharge into the Tallow creek catchment area.

**Table 5: Water Quality Objectives (WQO's)**

Parameter	Water Quality Objective (WQO)
<b>Physicochemical</b>	
pH	6.5 – 8.0 <sup>1</sup>
Total Suspended Solids (TSS)	< 50
Turbidity (NTU)	< 50 <sup>2</sup>
Dissolved Oxygen (% Saturation)	85 – 110 <sup>1</sup>
<b>BETEXN</b>	
Benzene (µg/L)	950 <sup>3</sup>
Toluene (µg/L)	180 <sup>3</sup>
Ethylbenzene (µg/L)	80 <sup>3</sup>
Xylene (m)	75 <sup>3</sup>
Xylene (p)	200 <sup>3</sup>
Xylene (o)	350 <sup>3</sup>
Naphthalene (µg/L)	16 <sup>3</sup>
<b>Dissolved Metals</b>	
Dissolved Aluminium (ug/L)	55 <sup>3</sup>
Dissolved Iron (ug/L)	300 <sup>4</sup>

Table notes:

1. Derived from ANZECC/ ARMCANZ (2000) Lowland River – (Table 3.3.2)
2. Derived from ANZECC/ ARMCANZ (2000) Lowland River – (Table 3.3.3)
3. Derived from ANZG (2018) – Freshwater 95th Percentile DVG
4. Derived from ANZECC/ ARMCANZ Volume 2 – Low Reliability (Iron)

## 4 Dewatering Management Plan

### 4.1 Site Characteristics & Desktop Summary

Following desktop review of the proposed development, sub-surface geology, historic & current groundwater condition and receiving environment water quality – the following has been established:

- For the UPSS pit, an internal spear point dewatering process will be required to temporarily drop (drawdown) and maintain (steady state) SWL within the tank pit excavation to allow the safe installation of three (3) new 70 kL split compartment USTs as well as a SPEL tank.
- Dewatering will be required to be continuous for the duration of the works est. 2-3 weeks.
- A tank pit measuring approximately 20m x 11m x 4.5m (length x width x depth) will be constructed to the northeast of the site (ENV 2020) as presented in **Figure 2, Attachment 1**. Here, SWL will need to be maintained approximately 1.0 meter below the base of excavation (i.e., drawn down from 1.2 mBGL to 6.0 mBGL).
- The proposed dewatering process will need to be an internal dewatering process (i.e., internal well points only) to meet ASSMP recommendation to reduce the extent of PASS oxidation by unnecessarily extending the zone of influence. Consequently, the support/shoring system will need to be designed to suit.
- Outlined in section 2.4 and 2.6, dewatering installers are likely to encounter a pavement/sandy gravel fill from 0.00 mBGL – 0.30 mBGL. Below this, a soft to firm sandy clay and clayey sand silt (0.30 mBGL – 1.50 mBGL) unit overlain medium to dense sands (Table 3).
- ASS occur in soil profiles between 1.0 – 5.5 mBGL in boreholes BH1, BH3 and BH4 and from 4.0 – 5.5 mBGL in BH2. Results indicate predominantly actual acid sulfate soil (AASS) and to a lesser extent potential acid sulfate soil (PASS).
- Historical investigations, cross reference with Engineers Australia (2006) and Cachman & Preene's: Practical Guidelines Towards Lowering Groundwater in Construction (2013), show saturated hydraulic conductivity for medium to coarse grained sands to be within the range of  $5 \times 10^{-5}$  and  $1 \times 10^{-4}$  meters per second.
- Furthermore, in addition the proposed tank pit, it is ENVs understanding that a new sewer pump will be installed along the northern boundary of the site. At the time of publication, pump station excavation dimensions were estimated to be 3m x 3m x 3m (length x width x depth). Shoring methodologies are unknown and awaiting detailed design. However, a shoring box (or slide rail system) and sheet piled system are both being considered where external dewatering may be required for short durations (Figure 4, Attachment 1).
- A groundwater investigation was conducted to verify historical GW monitoring observations where results of the groundwater sampling indicate concentrations of the chemicals of potential concern (COPC) were present in low concentrations.
- Receiving environment water quality can be described as; fresh with salinity 0.296 mS/cm, slightly below neutral pH = 6.52, of reasonable clarity 12.6 NTU.
- Guided by both the ANZG (2018) and ANZECC/ ARMCANS (2000), the receiving environment ecosystem would be recognised as being 'slightly to moderately disturbed' as defined in section 3.1.3.1. of the ANZECC/ ARMCANZ (2000). On this basis, for slightly

to moderately disturbed ecosystems, as 95th percentile (%) level of protection on toxicant Default Guideline Values (DGVs) is recommended.

- Table 5 outlines discharge water quality objectives (WQOs) developed in consultation with the ANZG (2018), ANZECC/ ARMCANZ (2000). Note that all extracted groundwater will need to be treated to meet WQOs prior to discharge into the Tallow Creek Catchment.

## **4.2 Dewatering Process**

### **4.2.1 Underground Storage Tanks**

The UST excavation will be dewatered using a spear point (well point) dewatering system. Here, following sheet pile installation, six (6) meter spears will be installed internally at 1.5 m centres. Referencing most recent geotechnical investigations, pre-drilling will likely be required within the proposed area.

As part of the well point installation process, all spears should be screened (using filter sock) and backfilled with washed 7 – 10 mm gravels (or coarse grained sand) to the top of the excavation. This will allow the effective removal of any surface waters collected in the base of the pit as a result of seepage.

Continuous 24-hour pumping will be required to temporarily lower the groundwater table during excavation UST installation. The dewatering contractor will need to select a suitably sized vacuum pump (i.e. BBA PT150E or equivalent) capable of extracting both air and water. Given several dwellings existing with close proximity to the site, a 'super silenced' pump housing is recommended to reduce noise.

### **4.2.2 Sewer Pump Tank**

The new sewer pump station will include an excavation of 3m x 3m by 3m deep. At the time of publication shoring methodologies are unknown (subject to detailed design by engineers) which will dictate the specific dewatering process.

It is assumed that the two main shoring methodologies that may be imposed are; the use of a shoring box which will require external spearpoint dewatering of the excavation area, due to both the small excavation size and length of dewatering required this is deemed to be the most practical approach. The second method being sheet piling and internal spearpoint dewatering.

## **4.3 Flow Rates & Totalised Volumes**

Mentioned in earlier section of the DMP, it is ENV's understanding that the project stakeholders favour a sheet pile support system for the UPSS install. Awaiting design detail at the time of DMP publication, sheets are expected to be driven into deeper alluvial material (i.e. 10 mBGL). Supported with suitable braces, the sheets will need to be 'tightly' installed to prevent seepage to the greatest possible extent.

With the sheets creating somewhat of a confined excavation, a dewatering process would be required to initially drop the SWL to approximately 1.0 m below the base of excavation (drawdown phase).

As the shoring methodology of the smaller sewer pump station pit is still awaiting design by engineers at the time of this report flow rates and totalised volumes of the two main shoring methods; shoring box and sheet piling have been explored.

### 4.3.1 Tank Pit

#### Drawdown Phase

The tank pit measuring approximately 20m x 11m x 4.5m (Length x Width x Depth), a baseline SWL of approximately 1.2 mBGL, dewatering installation to 5.5 mBGL and a voids ratio of 0.35 (COARSE SANDS), estimated static volume within the tank pit is 353.7 m<sup>3</sup> (Table 6).

**Table 6: Drawdown Calculations (Underground Storage Tanks)**

Description	Units	Quantity
Standing Water Level Depth	mBGL	1.2
Depth of Excavation	mBGL	4.5
Groundwater Depth (required reduction to 1m bellow base of excavation)	meters	4.3
Length of Excavation (m)	meters (m)	20
Width of Excavation (m)	meters (m)	11
Voids Ratio	n	0.35
Groundwater Volume	cubic meters (m <sup>3</sup> )	353.7

#### Steady State Phase

Dependent sheet pile installation (i.e., sheets installed and clutched at joins and corners), it is likely seepage will enter the excavation during dig out at depths below 1.2 mBGL (Civil Consult 2021). On this basis, as an estimate, the DMP assumes maximum seepage volumes of 3 m<sup>3</sup> per hour.

#### Totalised Volume

Working to a three-week (3) program dewatering duration, referencing sections above, totalised volume is estimated to be in the order of 1,866 m<sup>3</sup> (1.866 ML).

#### Zone of Influence

Given that dewatering activities are internal only, zone of influence is expected to remain within the sheet pile extent.

### 4.3.2 Sewer Pump Station (Shoring Box Option)

#### Drawdown Phase

See steady state phase (below).

#### Steady State Phase

As aforementioned, due to the nature of this shoring method, the small pit size and the short duration of the required dewatering works, steady state will be assumed for the duration of these dewatering works. The estimated flow rates for the duration of these works is between 59 m<sup>3</sup> - 84 m<sup>3</sup> per day, please refer to **Attachment 7**.

### **Totalised Volume**

Working to a 5-day program dewatering duration, referencing the section above, totalised flow rate is estimated to be in the order of 300 m<sup>3</sup> - 420 m<sup>3</sup> (0.3-0.42 ML).

### **Zone of Influence**

The estimated zone of influence of the external spearpoint wells is estimated to range between 34.6 metres and 49 metres from the centre of each well point, please refer to **Attachment 7**.

## **4.3.3 Sewer Pump Station (Sheet Piled Option)**

### **Drawdown Phase**

If sheet piling is designed the tank pit measuring approximately 3m x 3m x 3m (Length x Width x Depth), a baseline SWL of approximately 1.2 mBGL, dewatering installation to 4 mBGL and a voids ratio of 0.35 (COARSE SANDS), estimated static volume within the tank pit is 8.82 m<sup>3</sup> (Table 7).

**Table 7: Drawdown Calculations (Sewer Pump Station)**

Description	Units	Quantity
Standing Water Level Depth	mBGL	1.2
Depth of Excavation	mBGL	3
Groundwater Depth (required reduction to 1m bellow base of excavation)	meters	2.8
Length of Excavation (m)	meters (m)	3
Width of Excavation (m)	meters (m)	3
Voids Ratio	n	0.35
Groundwater Volume	cubic meters (m <sup>3</sup> )	8.82

### **Steady State Phase**

Dependent sheet pile installation (i.e., sheets installed and clutched at joins and corners), it is likely seepage will enter the excavation during dig out at depths below 1.2 mBGL (Civil Consult 2021). On this basis, as an estimate, the DMP assumes maximum seepage volumes of this pit to be 0.3 m<sup>3</sup> per hour.

### **Totalised Volume**

Working to a 5-day program dewatering duration, referencing the above sections, totalised flow rate is estimated to be in the order of 44.82m<sup>3</sup> (0.045 ML).

### **Zone of Influence**

Given that dewatering activities are internal only, zone of influence is expected to remain within the sheet pile extent.

## 4.4 Groundwater Treatment Process

Discussed in earlier sections of this DMP, extracted groundwater will require treatment prior to release into the receiving environment. Treated groundwater will need to meet WQO's presented in Table 5.

To achieve this, a Dewatering Water Treatment Plant (WTP) will need to be established onsite & commissioned by suitably qualified engineer or scientist. To meet WQO's noted in Table 5, minimum plant requirements include (but are not limited to);

- Primary Process - coalescing plate oil/ water separator to remove light hydrocarbon liquids and gross hydrocarbon contamination (LNAPL).
- Secondary Process – Gravity assisted tilt separation unit to remove suspended solids, & collect precipitated solids, pH correction tank & secondary hydrocarbon removal;
- Volatiles Removal – A counter-current air stripper arrangement is recommended; and
- Polishing Skid – Granular activated carbon (GAC) filters.

Each step of the treatment process is discussed in more detail below. A process flow diagram (PFD) of each anticipated process is presented in **Attachment 8**. Furthermore, it is noted that additional treatment units or processes may be required. As a contingency, all dewatering water treatment plant should be sized to suit a minimum 5 litres per second.

## 4.5 Hydrocarbon Removal

As identified in section 3, BETEXN (benzene, toluene, ethylbenzene, xylene (m + p), xylene (o) and naphthalene) & Total Recoverable Hydrocarbon (TRH) treatment capabilities are required onsite. Hydrocarbon WTP requirements are presented in sub-sections below.

### 4.5.1 Primary Treatment Process

Relying on the density differential between groundwater and PSH, gravity separation processes promotes the density separation of LNAPL (lower density) and groundwater (higher density). Here, LNAPL is encourage to 'float' to the surface of the 'treatment chamber' where groundwater (excluding LNAPL) moves onto the next process step. As LNAPL accumulates, within the treatment chamber, free hydrocarbons are then removed by a 'skimmer process' (i.e. collected in a tank and disposed of offsite by a licenced contractor).

### 4.5.2 Secondary Treatment

Assisted utilising an appropriately selected flocculant, coagulant and/or polymer, the tilt separation process primarily works to removed suspended solids prior to the volatiles and GAC processes. Although primarily designed for sediment removal, secondary treatment options do have 'under-overflow' components that aid in 'secondary' free phase hydrocarbon removal.

Although sediment loads should be managed upfront (i.e. 'socking' or backfilling spears), the system should be suitably sized to handle flow rates specified in the earlier sections of this report.

As recommended by the NSW Blue Book - flocculant, coagulant and/or polymer dose rates should be determined & managed by an appropriately qualified person (i.e. chemical engineer/ industrial chemist or equivalent). A material safety data sheet (MSDS) for a typical aluminium based coagulant is presented in **Attachment 9**.

### **4.5.3 Counter-Current Air Stripper**

Post sediment removal (via the secondary process), a counter-current air stripper should be implemented to volatilise dissolved phase hydrocarbons utilising counter-current air stripping processes (i.e. volatilisation). Here, water droplets are directed 'downward' through a series of plates where high velocity air is directed upward (i.e. via blower arrangement). In promoting the volatilisation process, dissolved phase hydrocarbons will generally reduce from inlet to outlet.

### **4.5.4 Granular Activated Carbon Polishing**

The final process prior to stormwater discharge, the GAC processes uses adsorption to 'polish' groundwater prior to discharge. Here, any hydrocarbons present following gravity separation or counter-current air stripping (absorbate) will be accumulated on the GAC interface (absorbent).

A contact time of at least three minutes should be considered in GAC selection. As the absorbent fouls over time, it is recommended the dewatering contractor have additional GAC onsite for 'vessel change out'.

## **4.6 pH Correction & Metals Removal**

Given the site contains actual acid Sulfate soils, it is anticipated extracted groundwater will need to be aerated and pH corrected (using Caustic Soda (46%)) to meet pH, dissolved metals and dissolved WQO's specified in Table 5.

An automated pH dosing system is recommended where operational setpoints should be refined to meet pH WQO thresholds. As part of the commissioning process, proportional bands will need to be refined to ensure the likelihood of pH over/ under shoot risk is mitigated for the entire dewatering duration. Dose rates should be determined by an appropriately qualified person. A MSDS for Caustic Soda (46%) is available for viewing in **Attachment 10**.

## **4.7 Environmental Risk**

Referencing section 2.7 (Groundwater), section 4.4.1 (dewatering flow rate, zone of influence and total volume estimates) and section 4.6 (Groundwater treatment) the following assessment of environmental risk can be determined.

### **4.7.1 Groundwater Users**

A total of four (4) private groundwater bores are located within 500m of the proposed dewatering activities, the closest being approximately 100 m to the south east. Impacts to these neighbouring groundwater users is considered negligible given dewatering will only be undertaken internally of the sheet piling.

### **4.7.2 Groundwater Dependant Ecosystems**

Tallow Creek is classified as an ICOLL (Intermittently Closed and Open Coastal Lake or Lagoon), where the proposed dewatering and water treatment methodology works minimise any impact extracted water volumes and quality pose to the greatest possible & practicable extent (i.e. increased water quality, reduced flow rates & zone of influence).

### **4.7.3 Subsidence**

It is understood that the proposed shoring & dewatering design work to minimise the zone of influence. Therefore mitigating (to the greatest possible extent) dilapidation & subsidence of any adjacent structures & infrastructure.

It is recommended that dilapidation survey should be conducted where geotechnical sign-off will be provided following installation of the pilling solution.



## 5 Validation & Monitoring

The purpose of the validation and monitoring process is to provide a framework for dewatering contractors to collect, interpret, act and report on the performance of the dewatering process. Ultimately to ensure treatment measures are satisfactory and meet WQOs outlined in Table 5. the DMP promotes a combination of collection techniques including analytical field sampling and telemetric data collection (i.e. real time).

### 5.1 Analytical Field Sampling Frequency

Prior to discharge, a sample will need to be collected from the outlet of the WTP and validated (utilising NATA certified laboratory) against WQO's presented in Table 5.

Once discharge has commenced, an additional sample will be collected and validated every seven (7) days (or as required under the guidance of a suitably qualified person) for the duration of dewatering works onsite as part of the continual discharge monitoring program. Standard turn-around-time (TAT) for sample analysis should be a maximum three (3) days for all sample analytes.

#### 5.1.1 Analytical Sampling Methodology

At the frequency outlined above, laboratory samples will be collected from the discharge point. The samples will:

- Represent a waste or element of the environment from which it is taken;
- Not be contaminated during collection, where analyte concentrations will not change between the time of collection and analysis;
- Be collected by an appropriately qualified person;
- Include sampling utilising correct sampling methodologies;
- Include representative sample(s); and,
- Be labelled, preserved, stored, and transported appropriately for analysis.

Samples will be analysed by a National Association of Testing Authority (NATA) laboratory and will be inclusive of analytes outlined in Table 5.

#### 5.1.2 Daily Field Monitoring (Daily)

To ensure management of the treatment processes, daily field monitoring will be included as part of the ongoing monitoring process. Daily monitoring will cover aspects of all treatment steps, these include but are not limited to:

- Visual inspection of treatment process;
- Hydrocarbon (odour and visual) inspection;
- pH assessment;
- Turbidity (NTU) assessment; and,
- Flow (m/s OR m<sup>3</sup>/ hour) assessment.

Daily observations will be recorded and stored onsite where a 'daily report' will be provided and presented to the principal contractor outlining physiochemical changes across the process, high level plant function/ performance summary and flow (rate & totalised volume).

### **5.1.3 Telemetric Data Collection**

In addition to daily monitoring, data will be collected using an online PLC system (such as HOBOLink™). As part of this system, physiochemical and physical parameters such as; pH, turbidity and flow rate will be measured in real time where analysis will be provided to a dewatering treatment expert.

Should physiochemical or physical parameters fall 'out of spec', the dewatering subcontractor will be notified via SMS or an alternative method (i.e. Email) where action will be required as outlined in the following section.

## 6 Action & Analysis

The following section aims to provide dewatering water treatment operators with the ability to effectively assess treatment performance following receipt of monitoring data and make accurate decisions to ensure risk treatment processes are upheld. Analysis and action processes are detailed in the sections below.

### 6.1 Hydrocarbons

Daily Check:

- Visual sheen or hydrocarbon odour detected in dewatering discharge.

Action:

- Shut down WTP process or put into recycle.
- If necessary deployed booms and the hydrocarbon source addressed.
- Notify relevant stakeholders (internal & external)
- Dewatering Manager to note in daily dewatering management plan report.
- Inspect and review dewatering process and hydrocarbon processing units (if fowled remove affected media or liquid utilising licenced methodologies).
- Conduct revised analysis (below).

Analytical Check:

- BTEXN, TRH analysis exceed thresholds presented in Table 5.

Action:

- Shutdown or put into recycle.
- Notify relevant stakeholders (internal & external).
- Dewatering Manager to note in daily dewatering management plan report.
- Assess secondary unit for sheet and if so, remove via licenced methodologies (i.e. sucker truck).
- Re assess risk and treatment methodology.
- Implement revised solution and validate methodology.
- Additional treatment units or methodologies may need to be employed.

### 6.2 pH Correction/ Metals Precipitation

Daily Check:

- Telemetric OR physiochemical check (pH1 OR pH2) out of specification.

Action:

- Check and re calibrate pH1 OR pH2 probe.
- Check chemical (NaOH) dosing pump to ensure its functionality.
- Check chemical drum to ensure chemical volume is sufficient.

IF pH1 OR pH2 still out of specified range;

- Replace pH2 probe with critical spare.
- Notify relevant stakeholders of change.
- Dewatering Manager to note in daily dewatering management plan report.

Analytical Check:

- Analytical pH results outside of specified WQO's .

Action:

- Shut down or put into recycle.
- Re-calibrate pH probes.
- Check proportional bands (or equivalent pH control process).
- Implement changes and monitor.
- Notify relevant stakeholders (internal & external).
- Dewatering Manager to note in daily dewatering management plan report.
- Re-sample and validated once pH corrections have occurred.
- Re assess risk and treatment methodology (if pH challenges persist).
- Additional treatment units or methodologies may need to be employed.

### 6.3 Dissolved Oxygen (DO) – Physiochemical Only

Daily Check:

- Dissolved Oxygen (DO) physiochemical check outside of specified limit.

Action:

- Check Dissolved Oxygen probe on Horiba U-52 meter.
- Re measure DO in fresh sample collected from discharge of treatment train (post Air-Stripper and Post GAC Polishing Unit).
- Assess result.
- IF DO still out of specified range;
- Review DO treatment methodology.
- Implement DO treatment methodology change.
- Dewatering Manager to note in daily dewatering management plan report.
- Re – evaluated the following day, and if required.
- Re assess risk and treatment methodology.
- Implement revised solution and validate methodology.

### 6.4 Turbidity (NTU) & Total Suspended Solids (TSS)

Daily Check & Analytical Check:

- Turbidity (NTU) physiochemical check outside of specified limits.
- Turbidity (NTU) analytical check out of specification.
- Turbidity (NTU) telemetric result out of specification.

Action:

- Check and Turbidity probe (PLC Unit and Horiba U-52 meter).
- Re measure Turbidity in fresh sample collected from discharge of treatment train.
- Assess result.
- Check chemical dosing pump(s) to ensure its functionality.
- Check chemical drum to ensure chemical volume is sufficient.
- Check sediment level in treatment tank.

IF NTU still out of specified range;

- Review NTU treatment methodology.
- Conduct assisted flocculation checks (i.e. Jar Test) to re define and optimise dose rates.
- Implement NTU treatment methodology change.
- Dewatering Manager to note in daily dewatering management plan report.
- Additional treatment units or methodologies may need to be employed.

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## **7 Reporting & Record Keeping**

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A dewatering summary report will be supplied, summarising the results of monitoring within two weeks of cessation of discharges.

During the dewatering process, a daily report will need to be completed by the onsite Dewatering Management. The report will note any exceedance in discharge criteria, as well as any other comments relating to the dewatering process.

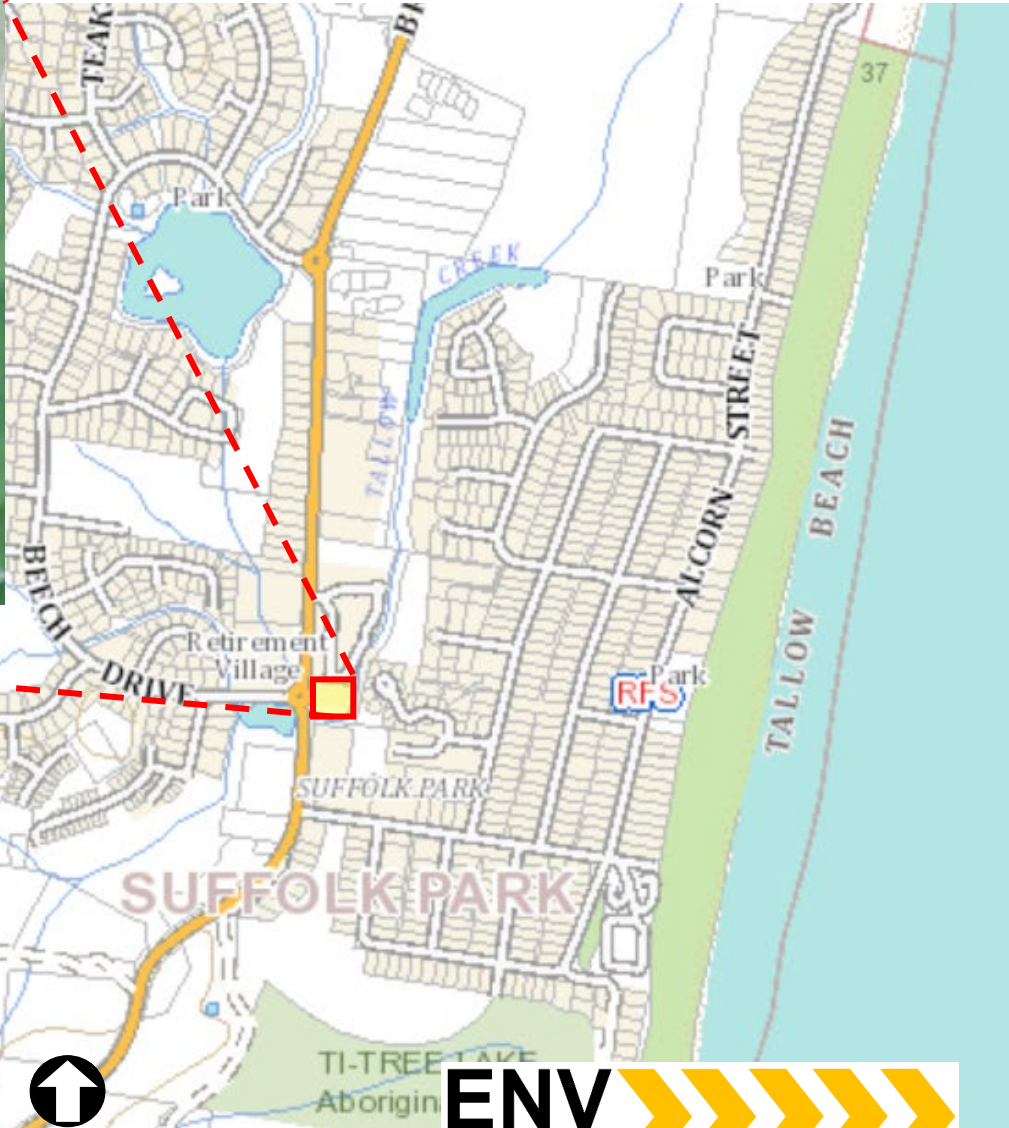
Any complaints shall be noted in the site logbook and corrective action taken (where appropriate and practicable) to prevent recurrence. Complaints and complaints management are the responsibility of the principal contractor where their policy will be adopted as best practice.

## 8 Attachments

Attachment Reference	Attachment Title
Attachment 1	Figure 1: Site Location Figure 2: Proposed UPSS Infrastructure Figure 3: Sewer Pump Proposed Location Figure 4: Existing well locations
Attachment 2	Acid Sulfate Soils Management Plan (ASSMP)
Attachment 3	Remediation Action Plan (RAP)
Attachment 4	Geotechnical Investigation
Attachment 5	Groundwater Monitoring Event (GME)
Attachment 6	Receiving Environment Water Quality Analysis
Attachment 7	Sewer pump pit Zone of Influence, Flow Rate Calculation
Attachment 8	WTP Process Flow Diagram (PFD)
Attachment 9	Alum MSDS
Attachment 10	Caustic MSDS







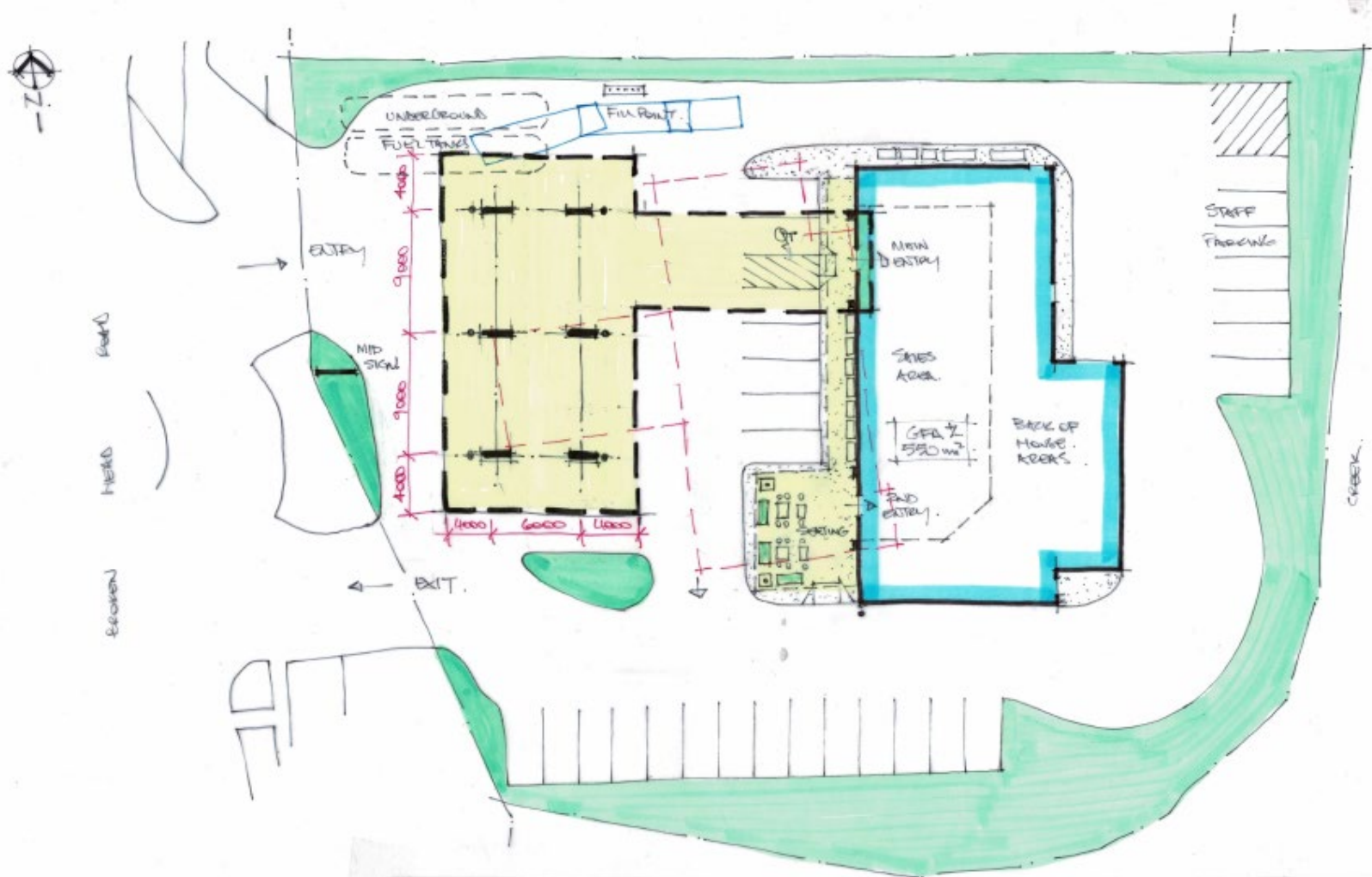
Site area (approximate)



**Attachment 1, Figure 1 – Site Location Plan**  
207-209 Broken Head Road, Suffolk Park, NSW

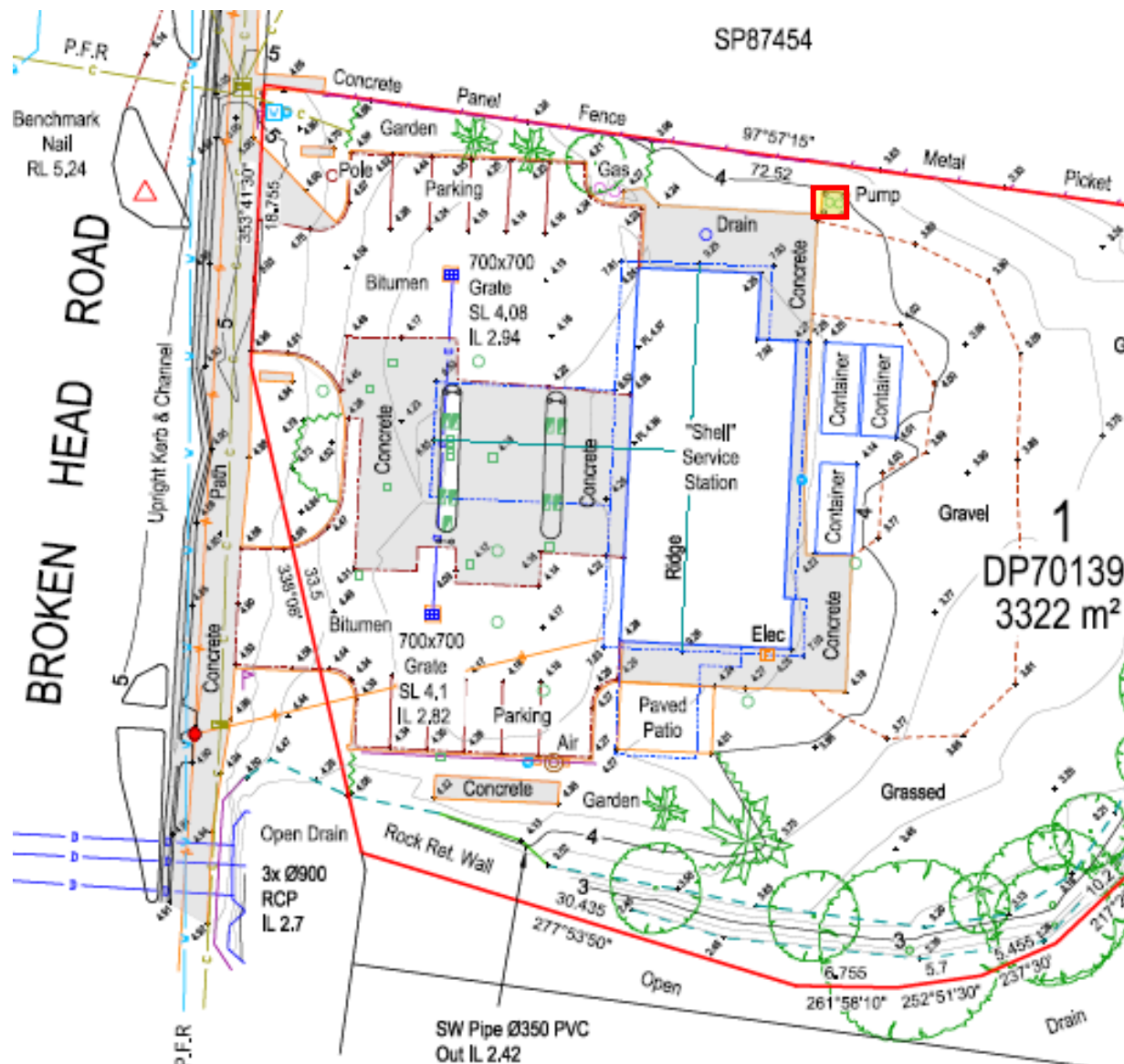
**Client:** Horizon Retail Pty Ltd  
**Project:** Dewatering Management Plan  
**Job No:** 21140





**Attachment 1, Figure 2 – Proposed UPSS Infrastructure**  
207-209 Broken Head Road, Suffolk Park, NSW

**Client:** Horizon Retail Pty Ltd  
**Project:** Dewatering Management Plan  
**Job No:** 21140



SP87454

1  
DP70139  
3322 m<sup>2</sup>



Site area (approximate)

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**Attachment 1, Figure 3 – Sewer Pump Proposed Location**  
207-209 Broken Head Road, Suffolk Park, NSW

**Client: Horizon Retail Pty Ltd**  
**Project: Dewatering Management Plan**  
**Job No: 21140**





**Attachment 1, Figure 4 – Existing Well Locations**  
207-209 Broken Head Road, Suffolk Park, NSW

**Client:** Horizon Retail Pty Ltd  
**Project:** Dewatering Management Plan  
**Job No:** 21140



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# ACID SULFATE SOIL MANAGEMENT PLAN

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Shell Service Station

207-209 Broken Head Road, Suffolk Park NSW

(Lot 1, DP701391)

For:

Horizon Retail Pty Ltd

Author:

ENV Solutions

Date:

June 2021

**ENV Solutions Pty Ltd**

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<b>Filename:</b>	21121_Shell Suffolk Park ASSMP_20210611		
<b>Job No:</b>	21121		
<b>Client:</b>	Horizon Retail Pty Ltd		
<b>File/Pathname:</b>	C:\Users\BenPieterse\Dropbox (ENV Solutions)\ENV Solutions Team Folder\01. jobs\21121 - Horizon_Shell Suffolk Park_ASS\Reports		
<b>Revision No:</b>	<b>Author:</b>	<b>Date:</b>	<b>Signed:</b>
V1	Craig Helbig	11/06/2021	
<b>Reviewed By:</b>			
V1	Tony Coyle	11/06/2021	

### **Scope of Engagement and Limitations:**

This report has been prepared by ENV Solutions PTY LTD (ENV) at the request of Horizon Retail Pty Ltd for the purpose of an Acid Sulfate Soil Management Plan. No other parties may rely on the contents of this report for any purposes except those stated.

This report has been prepared based on the information provided to us and from other information obtained as a result of enquiries made by us. ENV accepts no responsibility for any loss or damage suffered howsoever arising to any person or corporation who may use or rely on this document for a purpose other than that described above.

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ENV declares that it does not have, nor expects to have, a beneficial interest in the subject project.

To avoid this advice being used inappropriately, it is recommended that you consult with ENV before conveying the information to another who may not fully understand the objectives of the report. This report is meant only for the subject site/project and should not be applied to any other.

**List of Acronyms:**

Below is a list of commonly used acronyms in this report:

AASS – Actual Acid Sulfate Soils

ASS – Acid Sulfate Soils

ASSMAC – Acid Sulfate Soils Management Advisory Committee (NSW)

COC – Chain of Custody

CRS – Chromium Reducible Sulfur

ENV – ENV Solutions PTY LTD

ha – Hectare

mBGL – Metres Below Ground Level

NASSIMM – National Acid Sulfate Soils Sampling and Identification Methods Manual

NEPC – National Environment Protection Council

NEPM – National Environment Protection (Assessment of Site Contamination) Measure 1999 (as amended 2013)

NSW EPA – New South Wales Environment Protection Authority

PASS – Potential Acid Sulfate Soils

QA/QC – Quality Assurance and Quality Control

TAA – Titratable Actual Acidity

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## Executive Summary

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ENV Solutions Pty Ltd (ENV) was engaged by Horizon Retail Pty Ltd (Horizon) (the client) to complete an Acid Sulfate Soils Assessment and Management Plan (ASSMP) to support redevelopment of property situated at 207-209 Broken Head Road, Suffolk Park NSW.

The property operates as a Shell branded service station, which will shortly undergo redevelopment. The ASSMP has been developed as part of the planning process for the redevelopment works.

The Byron Shire Council Local Environment Plan (LEP) (2014) maps the site as Class 3 Acid sulfate soils (ASS) risk. An ASS assessment is required for works 1 m below the ground surface or works which may lower the water table by more than 1 m below the natural ground surface for an area mapped as having a Class 3 ASS risk. Both of these conditions may be met by the proposed redevelopment.

### Proposal Description

The proposed redevelopment works include removal of the existing underground petroleum storage system (UPSS), installation of a new UPSS and reconfiguration of the site; including demolition and redevelopment of the existing sales building and alfresco seating area.

ENV understands the following excavation dimensions are likely to apply to the earth works component of the program:

#### Installation of the new tank farm area:

- 20 m wide x 11 m long x 5 m deep

#### Removal of the old tank farm area

- 10 m wide x 15 m long x 3 m deep, noting that the tanks may be ‘floated out’ of the excavations, in which case excavation would be limited vertically and potentially horizontally.

#### Excavation of the new sewer pump area:

- 3 m wide x 3 m long x 3 m deep.

Each of these excavation components have the potential to disturb in situ ASS.

The most recent historical environmental site investigation undertaken at site comprises of a Due Diligence Environmental Assessment, undertaken by ENV in April of 2018. The investigation was undertaken to determine the contamination status of the site, which included the drilling of ten (10) boreholes to a maximum depth of 3.8 m below ground level (mBGL) across strategic locations, as well as sampling of the four (4) existing groundwater monitoring wells. A fifth well was observed to contain a small amount of weathered light non-aqueous phase liquid (LNAPL) and was not sampled. Two (2) additional wells could not be located and were not sampled. This investigation concluded that soil results were less than the adopted commercial/industrial land use assessment criteria, while groundwater results were also below the adopted site-specific assessment criteria, with the exception of various metals (noted to be representative of background levels) and benzene. It was determined that the benzene concentrations

were reducing from those reported in previous investigations and that natural attenuation was occurring.

The results of the contamination assessment are documented separately (ENV, 2018).

Groundwater gauging information last collected in September 2020 indicates the standing water levels in 4 wells ranged between 1.25 and 1.69 m below top of PVC well casing (mBTC). A more recent geotechnical investigation (Civil Consult, 2021) recorded similar groundwater conditions during drilling activities. On this basis, groundwater extraction via the process of dewatering will be required for excavation greater than 1.2 mBGL. The following are likely to comprise the methodology for dewatering:

- Installation of sheet piling to a depth of at least 5 mBGL (expected depth of excavation for tank installation).
- Installation of sheet piling or a shoring box for installation of a new sewer pump (expected depth of 3 mBGL).
- Implementation of dewatering infrastructure likely comprising a spear battery on the inside of the sheet piling and/or outside of the shoring box to provide a dry workspace to the maximum depth of excavation.
- Extracted groundwater will be treated to remove all contaminants (if present) (e.g. hydrocarbons, iron and aluminium) prior to discharge.

### **Investigation Results**

A site investigation and ASS sampling program was carried out on 8 March 2021. The investigation program comprised the drilling of 4 boreholes to a maximum depth of 6.0 mBGL with sample collection every 0.5m intervals for ASS analysis. Samples for ASS analysis (using the chromium suite) were collected from BH1 (3 m total depth), BH3 (6 m total depth), BH4 (6 m total depth) and BH7 (3 m total depth).

The reported ASS laboratory results indicate the following:

- ASS occur in soil profiles between 1.0 and 5.5 mBGL in boreholes BH1, BH3 and BH4; and from 4.0 to 5.5 mBGL in BH2. Results indicate predominantly actual acid sulfate soil (AASS) and to a lesser extent, potential acid sulfate soil (PASS).
- Net acidity results for several profile depths within each borehole outlined above are reported as being greater than the action criteria threshold of 18 mol H<sup>+</sup>/t for ASS material disturbance greater than (or less than) 1,000 tonnes.
- The action criterion of 18 mol H<sup>+</sup>/t has also been adopted due to the consistent occurrence of sands in the investigation areas. While laboratory interpretation of the soil texture from the samples provided to the laboratory were outlined as a mix of fine (light medium to heavy clays) medium (clayey sand to light clays) and coarse (sands to loamy sands), adoption of the action criterion for sand is conservative, as it is the lowest of the criteria based on soil texture.

## Management Measures

### *Excavated Soil*

With reference to the tank pit dimensions and considering the laboratory results, the following volumes of soil impacted with ASS from each earthworks component have been calculated:

#### **Installation of the new tank farm area (BH2 and BH3):**

20 m wide x 11 m long x 5 m deep:

- BH2: ASS noted to be between 4.0 – 5.0 mBGL (1.0 m range).
- BH3: ASS noted to be between 1.0 – 5.0 mBGL (4.0 m range).
- Excavated ASS volume = 880 m<sup>3</sup> (based on ASS profile within BH3), or 1,320 t (with a 1.5 t/m<sup>3</sup> bulk density conversion rate for sands).

#### **Removal of the old tank farm area (BH4):**

10 m wide x 15 m long x 3 m deep:

- BH4: ASS noted to be between 1.0 – 3.0 mBGL (2 m range).
- Significant ASS volumes are not anticipated if USTs are 'floated out' and excavation occurs to groundwater level only (just below 1.0 mBGL).

#### **Excavation of the new sewer pump area (BH1):**

3 m wide x 3 m long x 3 m deep:

- BH1: ASS noted to be between 1.5 – 3.0 mBGL (1.5 m range) = 14 m<sup>3</sup>, or 21 t (with a 1.5 t/m<sup>3</sup> bulk density conversion rate for sands).

Based on the above excavation information, it is assumed that the total volume of ASS soil to be excavated from site will be approximately 900 m<sup>3</sup> or 1,350 tonnes. This material will require treatment with aglime upon excavation to neutralise the acid generating potential of the ASS material.

When determining a suitable liming rate for such a large volume of soil (i.e. approximately 1,350 t) consideration needs to be given to the low-lying nature of the site and the subsequent proximity of acid-tolerant vegetation in the general locality. The highest prescribed liming rate (i.e. from the laboratory) for the new UST pit and the sewer pump station is 12 kg/tonne, however the liming rate for the majority of samples analysed was in the range of 2-7 kg/tonne.

**Consequently, a liming rate of 10 kg CaCO<sub>3</sub>/t soil (DW) is considered appropriate for any ASS excavated during the proposed works.**

Aglime is to comprise >98% calcium carbonate by weight with a particle size <0.5 mm. Based on an assumed ~1,350 t of excavated ASS material, approximately 13.5 t of aglime will be required.

Options for treatment of excavated ASS soil comprise the following:

### **Option 1**

**In-situ mixing during excavation:** Aglime would be progressively added into the pit when the excavations exceed 1.0 mBGL. The aglime would be mixed into the upper portion (approximately 0.3 m) of the soil to be removed, via the excavator, prior to excavation and removal from the pit. The soil would be stockpiled on an engineered pad that drains back into the excavation pit, prior to neutralisation validation and re-use on site, or disposal off-site.

### **Option 2**

**On-pad treatment:** Untreated soil would be excavated and placed directly onto a suitably engineered treatment pad where aglime would be added and neutralisation validation would occur.

#### *In-situ Soils*

Soils at the base of excavations should have a guard layer of aglime applied prior to the installation of any temporary work surface (i.e. concrete or road base).

On the basis that the reported Net Acidity in PASS below the maximum depth of excavation (i.e. 5 mBGL) in the new UST pit is up to 47 mol H<sup>+</sup>/t (<1.0%S), a guard layer of aglime should be applied at a rate of 10 kg/m<sup>2</sup> (aglime application rate based on s. 8.4.2 of Dear *et al*, 2014).

Dusting of other exposed surfaces of excavations >1.0 mBGL should be carried out at a rate of not less than 1 kg of fine aglime per m<sup>2</sup> of exposed soil surface.

#### *Dewatering*

Mitigation measures to be implemented include the following:

- The extent of dewatering should be minimised where possible to minimise the oxidation of PASS that is known to occur in the soil profiles deeper than 1.0 mBGL across site.
- A suitably qualified Environmental Engineer/Scientist should be engaged to prepare a Dewatering Management Plan (DMP) which addresses potential environmental risks posed by the dewatering activities and provides environmental management measures to mitigate these risks. ENV has prepared a DMP which is provided under separate cover.

#### *Management of Treated Soils*

It is understood that the excavated and treated soil will be reused on site where possible. If this is not possible, the soil will be transported off-site to a suitably licensed facility in either NSW or QLD.

If soil is transferred to QLD, it may be either transported directly to a facility where burial beneath water occurs. In this case, the material may not require liming treatment on site, prior to transport. Alternatively, the ASS may be treated on site and disposed to a suitably licensed landfill facility.

If soil is transferred to a waste facility in NSW, the material will require further classification in accordance with the NSW Waste Classification Guidelines (2014), prior to disposal.

## 1 Introduction

### 1.1 Introduction

ENV Solutions Pty Ltd (ENV) was engaged by Horizon Retail Pty Ltd (Horizon) to complete an Acid Sulfate Soils Assessment and Management Plan (ASSMP) for the property situated at 207-209 Broken Head Road, Suffolk Park NSW (the 'site'). The relative site location is presented in Figure 1, Appendix A.

The property operates as a Shell branded service station, which is set to undergo redevelopment. The ASSMP has been requested by Horizon in order to characterise in situ soils from an acid sulfate soil (ASS) perspective and subsequently identify management options for excavation spoil generated as part of redevelopment works. The proposed development plans are provided in Appendix B.

The Byron Local Environment Plan (2014) maps the site as Class 3 ASS risk. An ASS assessment is required for works 1 m below the ground surface or works which may lower the water table by more than 1 m below the natural ground surface. Reference to the ASS risk map can be found in Figure 3, Appendix A. Both of these conditions will be met by the development proposal.

This ASSMP presents the treatment works and management procedures to be adopted during the proposed earthworks associated with the development.

### 1.2 Relevant Objectives

The objectives that are relevant to ASS management include:

- To minimise the potential for inappropriate material handling through accurate identification of ASS;
- To manage ASS material so that the potential for environmental harm is minimised;
- To minimise lowering of the groundwater, due to dewatering, in areas containing ASS;
- To minimise the potential for adverse environmental impact due to handling, storage and application of hazardous materials related to the treatment of ASS; and,
- To ensure awareness of all personnel involved in the works at the proposed development of the requirements of this ASSMP and its objectives and management, particularly those aspects relevant to individual workers.

### 1.3 Targets & Performance Indicators

The targets that are relevant to management of ASS include:

- ASS material has been identified;
- Excavation and/or filling to occur only in those areas where disturbance is necessary;
- No residual sulfidic acidity is present in treated excavated material, to be confirmed by collection and analysis of neutralisation verification samples;
- Confirmation that any containment measures (i.e. bunds) are intact and impermeable and that records be kept of effectiveness and augmentation of these facilities;
- Groundwater level is maintained above ASS during and after works, where possible;

- Confirmation that any collected groundwater or surface water meets relevant approved release criteria and/or existing characteristics prior to discharge to a receiving environment;
- Confirmation that handling and storage of hazardous materials is undertaken in accordance with relevant legislation and that records are kept of said handling and storage; and,
- All personnel involved in the works have undertaken appropriate training for their role in the project with regards to management of ASS.

## 1.4 Acid Sulfate Soils (ASS)

Acid Sulfate Soil (ASS) is the common name given to soils containing iron sulfides. When exposed to oxygen through lowering of surrounding groundwater or excavation, air drawn into the soils can cause oxidation of the iron sulfides, producing sulfuric acid.

ASS typically occurs in low-lying coastal areas with historically high organic matter. Runoff from exposed ASS areas may find its way to stormwater, groundwater and eventually into natural aquatic environments. The acidic runoff may lower the pH of receiving waters, increase the concentration of metals and reduce the natural buffering capacity of the receiving waters.

There are two fundamental types of ASS: Actual Acid Sulfate Soils (AASS) and Potential Acid Sulfate Soils (PASS). AASS are soils in which some sulfides have already been oxidised. Hence AASS environments may already be acidic and an ongoing source of acid generation. PASS are soils in which the sulfides have not yet been oxidized (i.e. they contain oxidisable sulfur). AASS and PASS can coexist.

In anaerobic conditions (such as below the water table), PASS do not pose an environmental threat, however if conditions change (such as during dewatering or excavation), the sulfides can oxidise and form sulfuric acid (and release metals such as aluminium at toxic concentrations) which can then enter groundwater and/or surface water. Developments involving excavation and/or dewatering must establish the presence and extent of ASS down the soil profile, as works may intercept ASS horizons and pose risks to both human and ecological health.

Exposure of PASS to oxygen, even for a short period of time, can result in the continued oxidation of pyrite ( $\text{FeS}_2$ ) through the exchange of electrons between  $\text{Fe}^{2+}$  and  $\text{Fe}^{3+}$ . This reaction, which can produce sulfuric acid ( $\text{H}_2\text{SO}_4$ ), can continue in the absence of oxygen (re-saturated sediments) resulting in the same environmental impact as could be expected should excavated materials be exposed to the atmosphere.

## 1.5 Proposed Development

### 1.5.1 Summary

The proposed redevelopment works include removal of the existing underground petroleum storage system (UPSS), installation of a new UPSS, installation of a new sewer pump and reconfiguration of the site; including demolition of the existing sales building and construction of a new building.



### 1.5.2 Excavation

Works with potential to impact ASS largely comprise the excavation for the tank pit to accommodate the new UPSS, the excavation and removal of the existing UPSS and the excavation of the new sewer pump area. ENV understand these developments will likely comprise excavation with the following approximate dimensions:

#### **Installation of the new tank farm area:**

- 20 m wide x 11 m long x 5 m deep.

#### **Removal of the old tank farm area**

- 10 m wide x 15 m long x 3 m deep, noting that the existing tanks are likely to be 'floated' out of the excavation, given the shallow groundwater depth. In this case, there may be only a small volume of soil removed from this excavation; and all soil would be located above groundwater level.

#### **Excavation of the new sewer pump area:**

- 3 m wide x 3 m long x 3 m deep.

### 1.5.3 Dewatering

The site is low-lying and historical gauging events undertaken periodically by ENV (last undertaken in September 2020) indicate the standing water levels in 4 wells ranged between 1.25 and 1.7 m mBTC. A more recent geotechnical investigation (Civil Consult, 2021) encountered groundwater at a similar depth. Consequently, groundwater is expected to be intercepted during excavation, resulting in the need for dewatering.

It is assumed that dewatering will only occur for excavation of the new tank farm (approximately 5 mBGL) and new sewer pump (approximately 3 mBGL). The existing UPSS will likely be removed without dewatering, by floating out the USTs and removing hydrocarbon impacts, where present, to groundwater level.

ENV understands that the preferred method for dewatering will likely involve the following:

- Installation of sheet piling to a depth of at least 5 mBGL (new UST pit).
- Installation of sheet piling or a shoring box to a depth of at least 3 mBGL (new sewer pump).
- Implementation of dewatering infrastructure comprising a spear battery on the inside of the sheet piling and/or outside of the shoring box, to provide a dry workspace to the maximum excavation depth.
- Treatment of extracted groundwater to remove all contaminants (if present) (e.g. hydrocarbons, iron and aluminium) prior to discharge.

## 2 Investigation Methodology

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A site investigation was undertaken by ENV Environmental Scientist Ben Pieterse on 9 March 2021. The site investigation included drilling four boreholes (BH1 to BH4) using a trailer mounted drill rig and solid flights augers to a maximum depth of 6.0 m (1.0 m beyond the expected maximum soil disturbance depth) at the following locations:

- BH1: near the location where a new sewer pump station will be constructed – 4.0 mBGL.
- BH2 and BH3: within the footprint of the new UST pit – 6.0 mBGL.
- BH4: near the location of the existing UPSS area, and where footings for the new canopy are located to be constructed – 4.0 mBGL.

The borehole locations are shown on Figure 2, Appendix A.

Soil samples were collected at 0.5 m intervals to the maximum investigation depth at each location. The samples were placed on ice in an insulated container pending dispatch to a laboratory accredited by the National Association Testing Authorities (NATA) for ASS analysis. Every sample was analysed using the field peroxide test and at least 25% of the samples were analysed for ASS using the chromium reducible sulfur (CRS) suite. The soils encountered were logged in general accordance with the Unified Soil Classification System (USCS).

## 3 Investigation Results

### 3.1 Geological Profile

Borehole logs from the drilling program are included in Appendix C.

The generalised soil profile beneath the site can be summarised as follows:

- Surface cover: Asphalt (Grass at BH1).
- 0.0 – 1.5: Variable SAND/CLAY mixtures
- 1.5 – 6.0 m: SAND with trace levels of silt and clay.

Groundwater was encountered on site during the drilling of all 4 boreholes, at depths ranging between approximately 1.0 and 2.3 mBGL.

Sulfidic odours were noted in material recovered from all boreholes, below a depth of 1.0 mBGL.

### 3.2 Laboratory Results

ENV understands that the proposal may involve the excavation of ~1,350 tonnes of ASS. In addition, the majority of soils collected from deeper than 1.0 mBGL were noted to be predominantly of a coarse (sand) texture. Although the laboratory reported differing textures in the samples analysed from deeper than 1.0 mBGL (sand, silt and clay), adoption of sand as the predominant soil profile is conservative – as it has the lowest action criteria presented in the ASSMAC (1998). As such, the ‘net acidity action criteria’ adopted for the investigation (as per Table 4.4 of the ASSMAC Guidelines) are as follows:

- **≥ 0.03% S; or**
- **18 mol H<sup>+</sup>/t.**

The reported laboratory results are presented in Appendix D (tabulated results) and indicate the following:

- ASS occur in soil profiles between 1.0 and 5.5 mBGL in boreholes BH1, BH3 and BH4; and from 4.0 to 5.5 mBGL in BH2.
- Results indicate the presence of predominantly actual acid sulfate soil (AASS) in the upper soil profile, and potential acid sulfate soil (PASS) in the lower soil profile (primarily below groundwater).
- Net acidity results for each depth interval sampled within the boreholes, as outlined above, were reported as being greater than the action criterion of 18 mol H<sup>+</sup>/t.

## 4 Discussion

The majority of soil to be excavated will be from the new UST pit and the sewer pump station. A much smaller amount will be generated from the location of the existing USTs (refer s.1.5.2). In this regard, the reported results from the boreholes undertaken in the former two locations (i.e. BH1 – BH3) are more applicable to the management of excavated soil.

Based on the excavation information provided in Section 1.5.2, it is assumed that the total volume of ASS soil to be excavated from site will be approximately 900 m<sup>3</sup>, or 1,350 tonnes. This material will require treatment with aglime upon excavation to neutralise the acid generating potential of the ASS material.

The laboratory analysis has determined a liming application rate (with a safety factor of 1.5) based on the results of the chromium reducible sulfur (CRS) analysis.

When determining a suitable liming rate for such a large volume of soil (i.e. approximately 1,350 t) consideration needs to be given to the low-lying nature of the site and the subsequent proximity of acid-tolerant vegetation in the general locality. The highest prescribed liming rate (i.e. from the laboratory) for new UST pit and the sewer pump station is 12 kg/tonne, however the liming rate for the majority of samples analysed was in the range of 2-7 kg/tonne.

**Consequently, a liming rate of 10 kg CaCO<sub>3</sub>/t soil (DW) is considered appropriate for any ASS excavated during the proposed works.**

Aglime is to comprise >98% calcium carbonate by weight with a particle size <0.5 mm. Based on an assumed ~1,350 t of excavated material, approximately 13.5 t of aglime will be required.

Additional details are provided in Section 6.

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## **5 Environmental Responsibilities and Roles**

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### **5.1 Overview**

The principal contractor for the development will be responsible for implementing the management requirements of this ASSMP. This contractor will have responsibility for ensuring that all employees, subcontractors and persons involved with the proposed works are familiar with the requirements of the ASSMP.

Determining and implementing management for other environmental aspects associated with the works at the proposed development site; including but not limited to erosion and sediment control, and stormwater management; will also be the responsibility of the principal contractor. ENV has prepared a Remediation Action Plan (RAP) which sets out environmental management measures to be adopted to mitigate potential risks to human and environmental receptors from the proposed redevelopment and remediation works. As such, this ASSMP does not address environmental impact and mitigation measures associated with environmental aspects of the project other than those which are specific to ASS.

A copy of this ASSMP must be kept by the principal contractor onsite at all times during the excavation works program, which is accessible to all site personnel.

Successful implementation of this ASSMP relies upon support from and compliance by all involved parties. Such responsibilities are detailed below.

### **5.2 Appointed Project Manager**

- Review and monitor environmental performance at regular worksite meetings.
- Required to be notified of any major environmental incidents and review the management procedures in place to deal with such occurrences.
- Monitor non-compliance and review management procedures if problem persists.
- Ensure that appropriate and adequate resources are allocated to allow for effective implementation and maintenance of the ASSMP, in particular the excavation, treatment and validation of excavated PASS.

### **5.3 Principal Contractor's Site Supervisor/Foreman**

- Facilitate the reporting of incidents that may impact on the surrounding environment.
- Manage remediation actions to correct incidents of environmental non-compliance.
- Ensure that all staff are aware of, and understand their responsibilities under the ASSMP.
- Identify any environmental training requirements.

### **5.4 Principal Contractor's Environment Officer**

- May be the same person as the Site Supervisor/Foreman.
- Provide guidance and advice to staff regarding ASS management requirements.

- Monitor statutory requirements and ensure compliance.
- Where necessary, coordinate and/or assist in the response to environmental incidents.
- Maintain records of treatment, including verification testing of treated soils.
- Report all incidents with the potential to cause serious environmental harm to the Project Manager and where necessary, to the NSW EPA.

## 6 Neutralisation Treatment of Excavated Soil

### 6.1 Application Rates for Neutralising Agent

**A liming rate of 10 kg CaCO<sub>3</sub>/t soil (DW) is considered appropriate for any ASS excavated during the proposed works.**

All material excavated from a depth of 1.0 mBGL or greater should be treated using the specified liming rate. If a variation from the liming rate is proposed, further field investigations will be required. If sub-surface conditions vary significantly from those observed during this investigation (refer Section 3.1), excavation should cease and appropriately qualified personnel engaged to assess the site conditions, including laboratory testing to confirm the concentrations of any contaminants observed.

**Aglime is to comprise >98% calcium carbonate by weight with a particle size <0.5 mm. This material typically has a neutralising value (NV) of 98%. If there is any variation in the NV of the aglime used, the application rate may require recalculation.**

### 6.2 Option 1 – *In-situ* Mixing of Excavated Soil

#### 6.2.1 Overview

Works with potential to impact ASS include the following:

**Installation of the new tank farm area (BH2 and BH3):** 20 m wide x 11 m long x 5 m deep:

- Approximately 880 m<sup>3</sup>, or 1,320 t of ASS may be excavated and require treatment.

**Removal of the old tank farm area (BH4):** 10 m wide x 15 m long x 3 m deep:

- It is likely that the existing USTs will be ‘floated out’, with minimal excavation of soils below 1 mBGL.

**Excavation of the new sewer pump area (BH1):** 3 m wide x 3 m long x 3 m deep:

- Approximately 14 m<sup>3</sup>, or 21 t of ASS may be excavated and require treatment.

Based on the above excavation information, it is assumed that the total volume of ASS soil to be excavated from site will be approximately 900 m<sup>3</sup>, or 1,350 tonnes. This material will require treatment with aglime upon excavation to neutralise the acid generating potential of the ASS material.

#### 6.2.2 Method

Aglime is to be progressively added into the excavation when the excavation exceeds 1.0 mBGL. The aglime is to be mixed into the upper portion of the soil (approximately 0.3 m) to be removed (via the excavator), prior to excavation.

The soil is to be stockpiled on a pad constructed as follows:

- adequate sediment and erosion measures in place to prevent surface water flow entering the pad stockpile area.

- surface water drainage from the pad is directed back to the open excavation only.

Validation of treated material is to occur in accordance with Section 6.

### 6.3 Option 2 – *Ex-situ* Treatment

**If excavated soil is to be treated on a treatment pad, the treatment pad should be constructed prior to commencement of excavation.**

Material should be moved to the nominated treatment area(s) within 24 hours of exposure.

Prior to commencement of excavation, the treatment area must be appropriately constructed to intercept any material that may cause environmental harm to the surrounding environments (e.g. acid leachate collection systems and sediment traps around the treatment pad). Multiple treatment areas may be required for different portions of the excavation to allow for effective onsite treatment and validation before removal.

#### 6.3.1 Leachate Capture

The entire liming pad (treatment area) is to be constructed with a perimeter bund wall, no less than 400 mm high and no less than 500 mm wide. The bund wall should be constructed using fine-grained and non-dispersive material (clay) and should be compacted to be as impermeable as possible. The leachate collection point should be constructed as a sump that is of sufficient size to store a Q<sub>10</sub> storm event (1:10 year ARI). Additional construction details are provided in Section 6.3.3.

It may be more efficient and effective to have a sump of limited size that is fitted with a pump with a float trigger. Water would then be pumped from the smaller (concrete pit style) sump to a portable plastic water tank. This tank could then be emptied by a wastewater contractor or the water treated and released following approval from relevant authorities.

#### 6.3.2 Leachate Treatment

Water and leachate collected in the sump should be monitored using a calibrated pH meter prior to the commencement of work, and following the completion of work, each day for 14-21 days after the completion of works. All pH measurements should be recorded.

Should water in the sump have a pH falling outside applicable trigger values appropriate for the receiving watercourse, the water should be buffered using an accepted chemical neutralisation agent, (commonly superfine agricultural aglime). Additional treatment may be required where other parameters such as turbidity (high iron “floc”) exceed the trigger values.

Standard application rates for the treatment of water and leachate are presented in Table 1. The table indicates the amount of neutralising agent required to raise the pH of the water to neutral (7.0 pH units). For example, if the leachate has low salinity and a pH of 3.5, 16 kg of aglime would be required to neutralise 1ML of water. Table 1 has been provided as a guide only. Depending on the chemistry of the water, additional



neutralising agent may be required to obtain a pH of 7.0. Regular pH testing of the water should also be undertaken to monitor changes in pH during any dosing operations.

**Table 1: Neutralisation Rates for Leachate**

Water pH	H+ (mol/L)	H+ (mol/ML)	Aglime to Neutralise 1 ML	Hydrated Aglime to Neutralise 1 ML	Sodium Bicarbonate to Neutralise 1 ML
			Kilograms Required		
0.5	0.316	316228	15824	11716	26574
1.0	0.1	100000	5004	3705	8403
1.5	0.032	31623	1582	1172	2657
2.0	0.01	10000	500	371	840
2.5	0.0032	3162	158	117	266
3.0	0.001	1000	50	37	84
3.5	0.00032	316	16	12	27
4.0	0.0001	100	5	4	8.4
4.5	0.000032	32	1.6	1.17	2.66
5.0	0.00001	10	0.5	0.37	0.84
5.5	0.0000032	3.2	0.16	0.12	0.27
6.0	0.000001	1.0	0.05	0.037	0.08
6.5	0.0000003 2	0.3	0.016	0.012	0.027

Source: State Planning Policy 2/02 Guideline: Acid Sulfate Soils, Department of Natural Resources and Mines, Brisbane, 2004.

### 6.3.3 Liming Pad Design

If excavated soil is to be treated on a treatment pad, the treatment pad should be constructed prior to commencement of excavation.

The liming pad (treatment area) should be constructed in an area that is not to be disturbed during the excavation and filling processes. If this is not possible, the

treatment area may need to be relocated as excavation works progress. A graphical representation of a treatment pad is provided as Figure 1.

### **Basic Design**

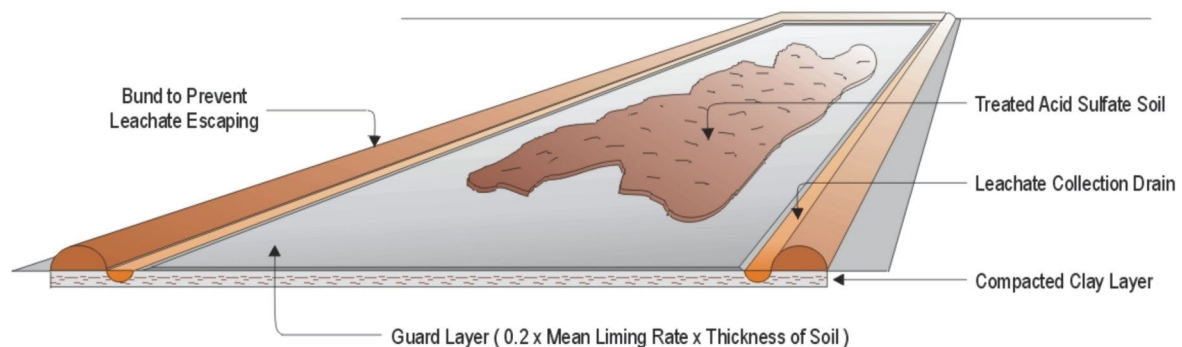
The liming pad should be constructed so the base of the pad is composed of compacted fine-grained material, so as to produce as impermeable foundation as possible. Ideally a clay liner, no less than 300 mm thick, should be placed on the base of the pad. The base of the pad should slope gently (2 – 5%) so as to allow water/leachate to drain to a designated collection point. A leachate collection system, as described above, should be constructed.

### **Guard Layer**

The base of the liming pad should be dusted with aglime at a rate determined using the following equation:

Guard layer ( $\text{kg/m}^2$ ) =  $0.2 \times \text{thickness of layer to be treated (m)} \times \text{average liming rate (kg/tonne)}$ .

The aglime for the guard layer should be spread using an aglime/fertilizer spreader (tractor-towed) to ensure the base of the pad is evenly covered, prior to the placement of the material requiring treatment.



**Figure 1: Treatment Pad Design**

### **6.3.4 Mixing of Neutralising Agent on Treatment Pad**

The following section describes the techniques that can be implemented if mixing of aglime is to occur on a treatment pad.

The material excavated should be placed on the liming pad in a layer no greater than 300 mm in thickness.

Ideally, the soils/sediments should be allowed to partially dry prior to attempting to mix the neutralising agent. If the soils are too moist, the neutralising agent will not be evenly distributed throughout the soils and pockets of aglime and untreated PASS will form within the stockpile.

There are several ways to mix the neutralising agent into the materials to be treated, all of which have positive and negative aspects. Common mixing methods are described in Table 2.

Although it is recognised that the most likely method that will be used on this particular site is an excavator, the most efficient and effective method of mixing neutralising

agents, from those listed in Table 2, is the tractor-towed disc-plough. Provided the soils are dry to moist, the disc plough is ideal, however should water be present, and the soils comprise of cohesive material (clays), the excavator is likely to be more efficient (however not as effective) in mixing the neutralising agent through the soils.

No less than three (3) passes will be required to mix the neutralising agent through the soil. The effectiveness of the mixing process is contingent on the methodology of mixing.

**Table 2: Common Mixing Methods (Liming Agent)**

Method	Positive Factors	Negative Factors
Tractor-towed disc plough	<ul style="list-style-type: none"> <li>Allows thorough mixing of aglime and constant turning of soil to ensure aglime distribution is even.</li> <li>Works well on dry soils.</li> </ul>	<ul style="list-style-type: none"> <li>Requires a tractor, which may have no other use on site.</li> <li>Can require relatively large areas to enable treatment, as tractor will require turning space.</li> </ul>
Rubber tyred vehicles	<ul style="list-style-type: none"> <li>Able to utilise any idle machinery to drive over the aglime/soil mixture to mix materials together.</li> </ul>	<ul style="list-style-type: none"> <li>Often results in pockets of aglime forming in the soils.</li> </ul>
Excavator	<ul style="list-style-type: none"> <li>Can utilise idle excavators to mix aglime with soils.</li> <li>Works well on moist/wet soils.</li> </ul>	<ul style="list-style-type: none"> <li>Requires specialised (longer) teeth to allow soils to be ripped deeply, allowing aglime to be mixed more thoroughly.</li> <li>Can result in the formation of aglime pockets in the soils.</li> </ul>
Grader	<ul style="list-style-type: none"> <li>Can utilise idle machinery on site.</li> <li>Allows some churning of soil/aglime mix by inclining blade and using tines.</li> </ul>	<ul style="list-style-type: none"> <li>Can result in pockets of aglime developing.</li> <li>Can result in damage to low permeability liner beneath the liming pad.</li> </ul>
Pug Mill	<ul style="list-style-type: none"> <li>Allows high aglime dosage rates.</li> <li>Guaranteed thorough mixing of neutralising material and soil.</li> </ul>	<ul style="list-style-type: none"> <li>Additional plant required at high mobilisation cost.</li> </ul>

## 6.4 In-situ Soils

### 6.4.1 Base of Excavations

Soils at the base of excavations should have a guard layer of aglime applied prior to the installation of any temporary work surface (i.e. concrete or road base).

**On the basis that the reported Net Acidity in PASS below the maximum depth of excavation (i.e. 5 mBGL) in the new UST pit is up to 47 mol H<sup>+</sup>/t (<1.0%S), a guard layer**

of aglime should be applied at a rate of 10 kg/m<sup>2</sup> (aglime application rate based on s. 8.4.2 of Dear *et al*, 2014).

#### 6.4.2 Dusting of Exposed Excavation Surfaces

If left untreated after excavation, the exposed ASS in excavation faces may oxidise over time, causing an acidic environment. In addition, any acid produced during exposure may corrode concrete and other structures constructed within the excavations. It is therefore critically important to neutralise the exposed surfaces (base and walls) of excavations into ASS, to minimise drying out and reduce the potential for ASS and/or PASS to produce acid leachate.

**Dusting of exposed surfaces of excavations >1.0 mBGL should be carried out at a rate of not less than 1 kg of fine aglime per m<sup>2</sup> of exposed soil surface.**

### 6.5 Short Term Stockpiling and Exposure

Table 3 presents information regarding the short-term stockpiling of soils within the treatment area (refer Section 5.3) without liming for neutralisation.

**Table 3: Indicative Maximum Periods for Short-Term Stockpiling of Untreated ASS**

Type of Material		Duration of stockpiling		
Texture range	Approx clay content (%)	Days		Hours
Coarse texture: Sands to loamy sands	≤ 5	Overnight	or	18 hours
Medium texture: Sandy loams to light clays	5-40	2½ days	or	70 hours
Fine texture: Medium to heavy clays and silty clays	≥ 40	2½ days	or	70 hours

Source: Queensland Acid Sulfate Soil Technical Manual: Soil Management Guidelines, Department of Natural Resources and Mines, Brisbane, 2014.

Additional measures to minimise any impacts of stockpiled untreated material include the following:

- Covering the stockpiled material with impervious material such as black plastic to prevent ingress of rainfall;
- Ensure surface water run-off does not enter the stockpiled material.

### 6.6 Waste Tracking

Waste tracking must be undertaken by the principal contractor and provided in a final report, as per the requirements outlined in Section 7.

## **7 Validation of Treated Soils**

### **7.1 Environmental Testing of Treated Soils**

The principal contractor will be responsible for ensuring that any validation sampling and analysis of aglime treated soil undertaken is conducted by a suitably qualified person, and in a manner that will demonstrate, with acceptable confidence, that sufficient Aglime has been mixed into the ASS, to provide an adequate buffer, such that the material meets the criteria set out in Table 4.

Validation sampling locations will be selected such that a representative distribution for sample locations is achieved for the treated soil.

Validation sampling and analysis will be undertaken at a frequency that will demonstrate that satisfactory neutralisation has taken place. The frequency of soil validation sampling and analysis will be:

- 1 sample per 100 m<sup>3</sup> of remediated (lime treated) soil.

#### **7.1.1 Sampling Technique**

A suitably qualified Engineer/Scientist shall collect ten representative sub-samples to produce one (1) representative (composite) sample from each 100 m<sup>3</sup> of treated soil, in accordance with the following requirements:

- approximately 250 g of soil must be collected from 10 representative locations, evenly distributed through the 100 m<sup>3</sup> lot of treated spoil; and
- where the soil is cohesive, the sample must be homogenised in a large stainless bowl or similar, and a representative sample taken from the homogenised material.

#### **7.1.2 Laboratory Analysis**

Acid sulfate soil net acidity testing for treatment verification must be undertaken by a third-party laboratory accredited by the National Association of Testing Authorities (NATA) for the required testing, on all material that has been treated. Southern Cross University's Environmental Analysis Laboratory (EAL) can perform the required testing.

### **7.2 Validation Reporting**

The principal contractor is responsible for ensuring that a suitably qualified Engineer/Scientist prepares two (2) copies of an ASS Neutralisation Certification Report ('ASSNCR') suitable for submission to Byron Shire Council and the NSW EPA. The report will demonstrate that the excavated and treated soil has been sufficiently neutralised and meets the criteria presented in Table 4.

The ASSNCR will include, but not be limited to, the following information:

- Summary table of analytical results for each soil lot tested and the results of validation analysis;
- Plan of earthworks stockpile locations, showing:
  - Sample identification numbers (if relevant)

- Location of validation samples.

By submitting the ASSNCR to the Superintendent for review, the principal contractor is deemed to be stating to the Superintendent that all information presented in the ASSNCR is true and accurate and that the remediation and validation of the ASS soils is of sufficient quality that the contractor is certifying that remediation, as defined under the contract, has been satisfactorily completed.

If the Superintendent considers that the ASSNCR does not provide sufficient evidence to demonstrate that satisfactory remediation has been achieved, or is of unsatisfactory quality, the Superintendent shall notify the principal contractor in writing, outlining the deficiencies in the ASSNCR and any corrective actions to be undertaken before approval by the Superintendent will be further considered. The principal contractor must immediately undertake such corrective action to the ASSNCR. The cost of such corrective action will be borne by the principal contractor.

### 7.3 Neutralisation Criteria

The criteria presented in Table 4 will be used to ensure that the excavated material has been sufficiently neutralised. The criteria have been drawn from the ASSMAC (1998) Guidelines (refer Table 5), with further detail provided from Dear *et al* (2014).

Verification testing is deemed to have been successful, for coarse-grained material, when the following is achieved:

- No single sample shall exceed a net acidity of 18 mol H<sup>+</sup>/tonne.
- If any single sample is between 0 and 18 mol H<sup>+</sup>/tonne, then the average of any four spatially adjacent samples (including the exceeding sample) shall have an average net acidity of zero or less.

**Table 4: Action Limits for Treatment**

ASS Soil Texture	Clay Content %	< 1,000 Tonnes Disturbed		> 1,000 Tonnes Disturbed	
		Sulfur Content % w/w	Acid Trail mol H <sup>+</sup> /tonne	Sulfur Content % w/w	Acid Trail mol H <sup>+</sup> /tonne
<b>Coarse</b> (sand & gravel)	< 5	0.03	18	0.03	18
<b>Medium</b> (sandy loam - light clay)	5 - 40	0.06	36		
<b>Fine</b> (medium to heavy clays, silty clays)	> 40	0.10	62		

## 8 Waste Traceability

All work under the Contract will be subdivided into distinct work lots or work items. Work lots or work items shall be chosen by the principal contractor, consistent with any specified requirements, but will be subject to approval by the Superintendent.

Each work lot or work item will be assigned a unique identification number, and the principal contractor will maintain a register of all allocated work lot or work item numbers. This register will contain as a minimum, the following information:

- Brief description of the work lot or work item;
- Location reference (3 dimensional, where applicable); and
- Lot or item status (ASS conforming or non-conforming).

The principal contractor will ensure that traceability is maintained throughout all documented records under this Contract. All test results, where applicable under this Contract, will be positively identified with their respective work lot or work item number. The principal contractor will notify the Superintendent in writing 24 hours prior to commencing a new work lot or work item.

The principal contractor will be responsible for implementing a traceability programme for neutralisation and off-site transport of the material. The documentation will contain, but not be limited to, the following information:

- Truck registration;
- Truck driver;
- Date and time of departure from site;
- Date and time of arrival at the disposal or beneficial re-use site;
- Source of material (stockpile identification); and,
- Estimated volume of material transported.

Clear records of movements of excavated material to the treatment pads (source and destination), *in-situ* treatment details (aglime volumes and application times) and disposal/reuse destinations are to be kept. Table 5 provides an example of how the records could be tabulated.

Details of dewatering volumes, water quality, and disposal/reinjection destinations and volumes are also to be kept.



**Table 5: Example of a Record of Movement**

Label	Date	Volume (m <sup>3</sup> )	Location	Disposal Location A	Treatment Date	Volume of Agaglime required	pH field testing	Testing Date	Result <sup>1</sup>	Disposal Location B	Disposal Location B
Vol A	5-6-06	150	Channel Ch 0-40	Treatment Pad	7-6-06	160 kg/tonne = 45,600 kg	pH <sub>r</sub> = 6.5 pH <sub>rox</sub> = 6.0	7-6-06	12-6-06 Acceptable (refer lab results)	12-6-04	Existing Drain Ch 0 to Ch 50, 3 m below surface level.
Vol B	6-6-06	330	Channel Ch 40-80	Treatment Pad	8-6-06	220 kg/tonne = 139,940 kg	pH <sub>r</sub> = 5.5 pH <sub>rox</sub> = 5.0	8-6-05	13-6-06 Failed	-	-
					14-6-06	120 kg/tonne = 45,240 kg	pH <sub>r</sub> = 6.5 pH <sub>rox</sub> = 6.0	14-6-06	19-6-06 Acceptable (refer lab results)	19-6-06	Existing Drain Ch 50 to Ch 120, 3 m below surface level.
Vol C	7-6-05	120	Table Drain	Lemura Quarry	NA	NA	NA	25-5-06	27-5-06 Sent to Lemura	NA	NA
Vol D	9-6-05	NA	Existing Drain Ch 20 - Ch 60	<i>In-situ</i> guard layer	9-6-06	80 kg/m <sup>3</sup> = 4,800 kg	NA	NA	NA	NA	NA

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## 9 Management of Treated Excavated Materials

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All management of treated ASS materials must be undertaken in accordance with the NSW EPA Waste Classification Guidelines, Part 4: Acid Sulfate Soils (refer Appendix E), and other applicable EPA guidance documents.

Once the excavated material is treated, and the validation testing results are shown to meet the neutralisation criteria (Table 5), the treated material can be re-used on site if required (pending suitability from a chemical perspective).

It is not possible to beneficially re-use AASS or PASS as virgin excavated natural material (VENM) or excavated natural material (ENM) off-site. This means that any treated excavated material that is surplus to the construction works will need to be disposed of as waste to a nominated landfill, or beneficially re-used as fill material off-site under a specific exemption granted by EPA in accordance with the NSW Resource Recovery framework. ENV can prepare an application for this exemption if required. If the application is approved by EPA, the treated excavated material can be transported to the approved receiving site and used as engineered fill. Movement of the treated excavated material to another site is not permissible unless the application for a specific exemption for beneficial reuse is granted by the EPA.

If the application to EPA is not approved, or it is considered more cost-effective to dispose of the material to landfill, it can be disposed to a suitably licensed landfill facility.

If soil is transferred to a waste facility in NSW, the material will be further classified in accordance with the NSW Waste Classification Guidelines (2014), prior to disposal.

If soil is transferred to QLD, there are two options for managing the ASS. It may be possible to transport untreated ASS directly to a facility in QLD for interment beneath groundwater. Alternatively, the ASS may be treated and then disposed to landfill.

These management options should be reviewed to ascertain the most cost-effective treatment and/or disposal method for the soils.

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## 10 References

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Ahern, C.R, Stone, Y., Blunden, B. (1998) Acid Sulfate Soils Assessment Guidelines, Acid Sulfate Soils Management Advisory Committee, Wollongbar, NSW.

ANZECC and ARMCANZ (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality.

Civil Consult (2021). Service Station Upgrade: 207-209 Broken Head Road, Suffolk Park, Geotechnical Investigation Report. Report reference 21033-00-REP-0001, Rev0, dated 5 May 2021.

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ENV Solutions (2018). Due Diligence Environmental Assessment, BP Suffolk Park Service Station, 207-209 Broken Head Road, Suffolk Park, NSW. Document reference 18064 Stage 1 PSI\_Rev1, dated 20 April 2018.

NSW EPA (2014) Waste Classification Guidelines - Part 4: Acid Sulfate Soils, NSW Environmental Protection Authority (EPA).

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.

## 11 Appendices

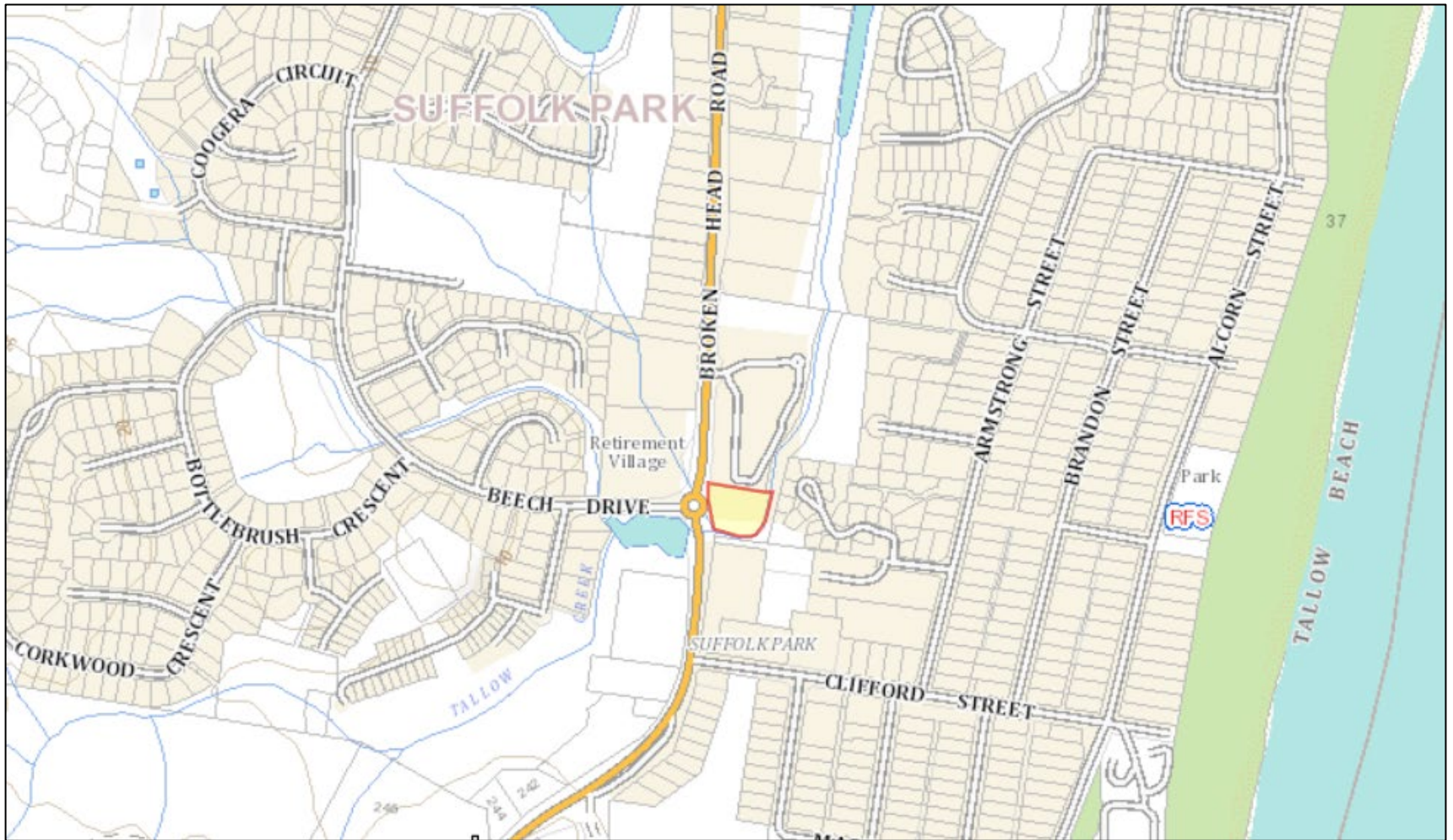
Appendix A	Figures
Appendix B	Proposed Site Plans
Appendix C	Bore Logs
Appendix D	Laboratory Results
Appendix E	NSW Waste Classification Guidelines Part 4: Acid Sulfate Soils (ASS)

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## APPENDIX A

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### Figures



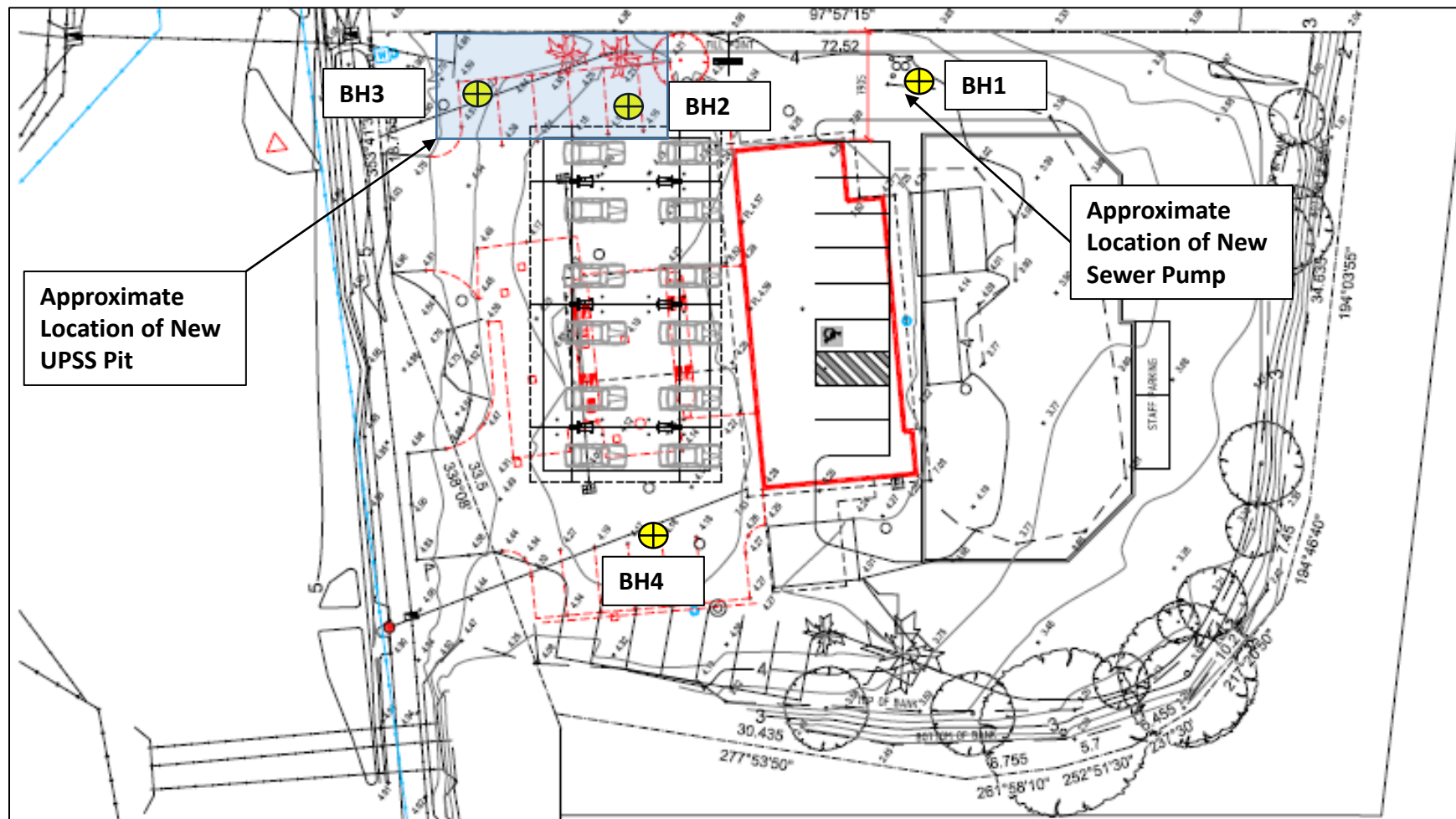
Site Location



0 50 100 m



**Figure 1 – Site Locality Plan**  
207-209 Broken Head Road, Suffolk Park, NSW



Sample Location (approximate)

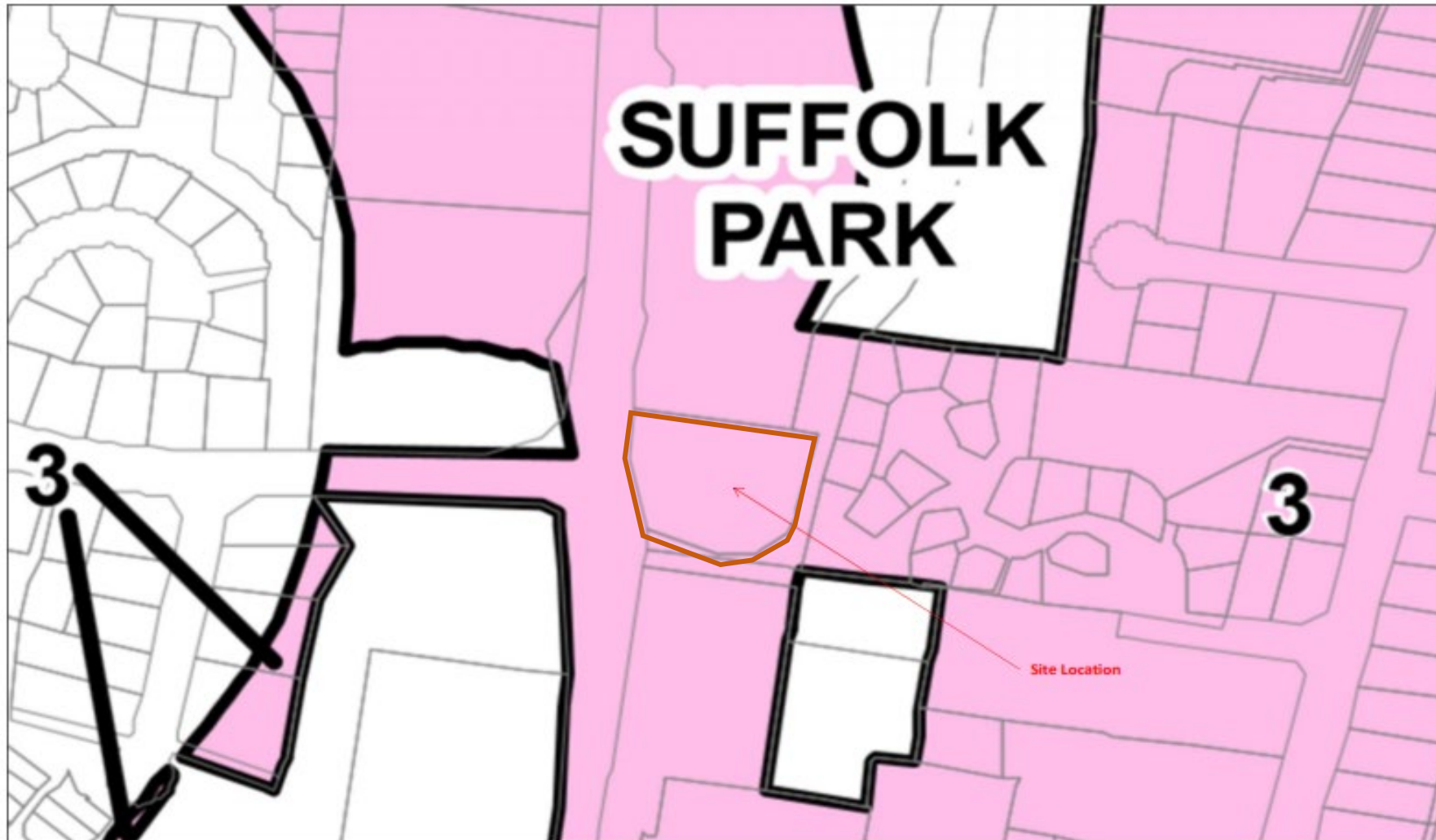


0 10 20 m

**ENV**  
Solutions  
ENVIRONMENTAL | ASBESTOS | REMEDIATION | RESOURCE RECOVERY

**Figure 2 – Site Layout and Sample Location Plan**  
207-209 Broken Head Road, Suffolk Park, NSW





Site Location



0 60m



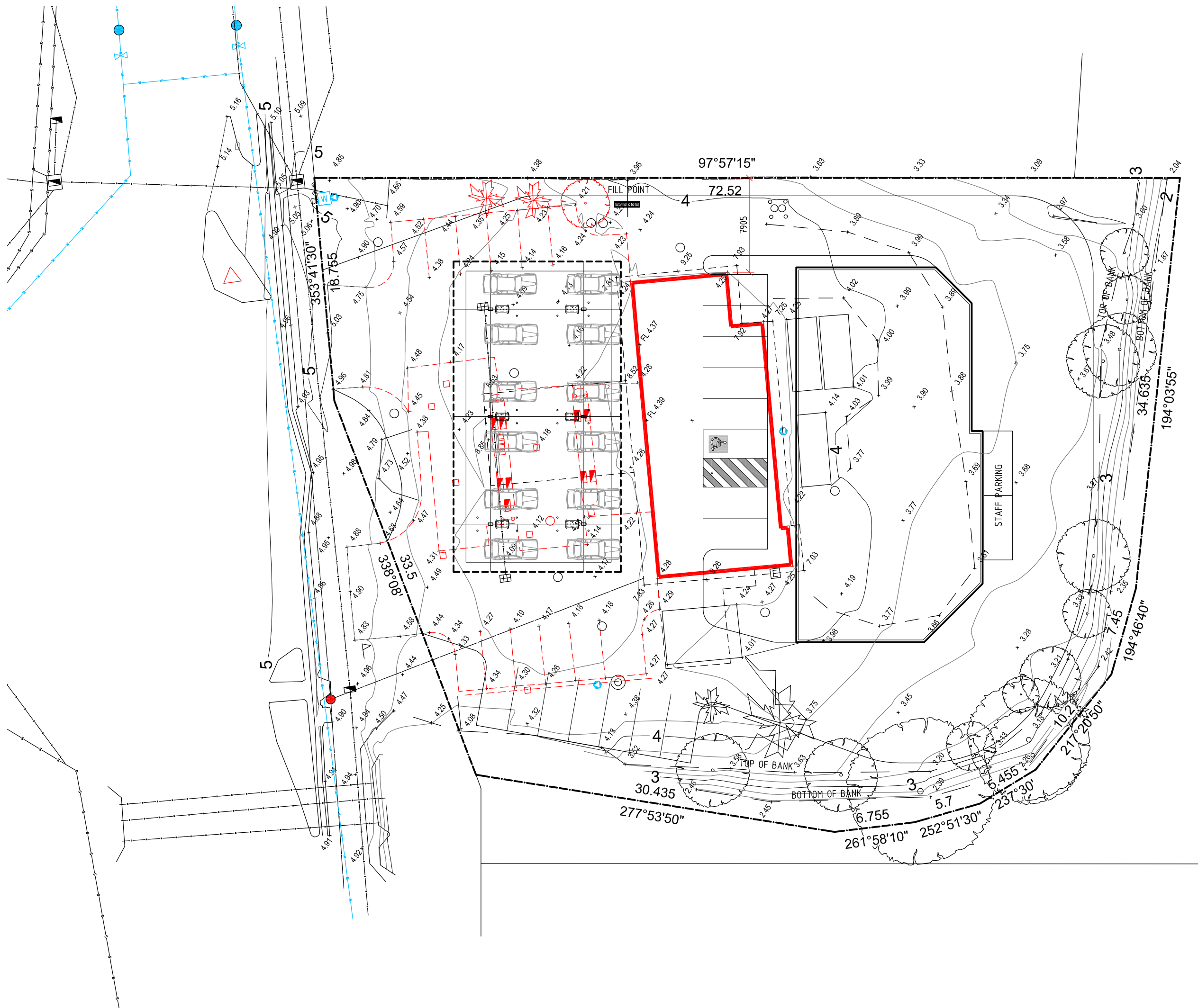
**Figure 3 – Acid Sulfate Soil (ASS) Risk**  
207-209 Broken Head Road, Suffolk Park, NSW

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**APPENDIX B**

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**Proposed Site Plans**




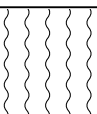
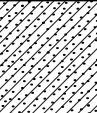
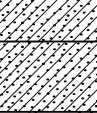


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**APPENDIX C**


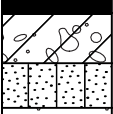
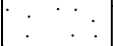
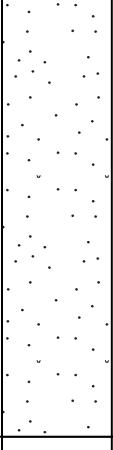
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**Bore Logs**



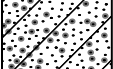
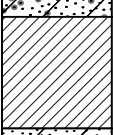
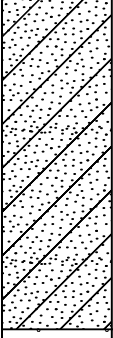
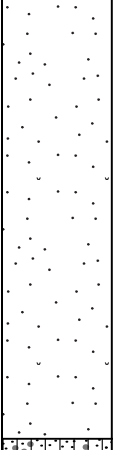
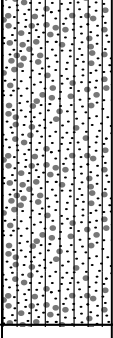
## Acid Sulfate Assessment Borehole Log BH1

<b>PROJECT NUMBER</b> 21121 <b>PROJECT NAME</b> Suffolk Park ASS Assessment <b>CLIENT</b> Horizon Retail Pty Ltd <b>ADDRESS</b> 207-209 Broken Head Rd <b>DRILLING DATE</b> 08/03/2021		<b>DRILLING COMPANY</b> ENV Solutions <b>DRILLER</b> B. Peiterse <b>TOTAL DEPTH</b> 4 m		<b>SURFACE ELEVATION</b> ~9 mAHD <b>LOGGED BY</b> W. Reynolds <b>CHECKED BY</b> B. Peiterse	
<b>COMPLETION</b>		<b>08/03/2021</b>			
<b>COMMENTS</b> Next to sewer pump (NE)					
Depth (m)	Samples	Standing Water	Graphics Log	Material Description	Additional Observations
0.5	BH1 0.1			LOAM, Brown, dry loose, fine/medium density gravel to 10 mm diameter.	
	BH1 0.5			Sandy CLAY, moist dark brown, dense, soft, fine, low to medium plasticity.	
1	BH1 1.0			Sandy CLAY, grey brown, wet, soft, fine and dense, low plasticity.	Becomes Saturated
1.5	BH1 1.5			Clayey SAND, saturated, coarse white sands with grey clay, loose.	Sulfur odour
2	BH1 2.0			Clayey SAND: dark grey, saturated, soft, non - plastic fines.	Sulfur odour
2.5	BH1 2.5				
3	BH1 3.0				
3.5	BH1 3.5				
	BH1 4.0				
4				EOH at 3.8 m hard object encountered, possible indurated sand.	
4.5					
5					
5.5					


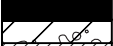
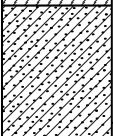
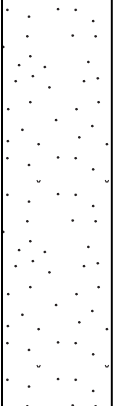
## Acid Sulfate Assessment Borehole Log BH2

<b>PROJECT NUMBER</b> 21121 <b>PROJECT NAME</b> Suffolk Park ASS Assessment <b>CLIENT</b> Horizon Retail Pty Ltd <b>ADDRESS</b> 207-209 Broken Head Rd <b>DRILLING DATE</b> 08/03/2021		<b>DRILLING COMPANY</b> ENV Solutions <b>DRILLER</b> B. Peiterse <b>TOTAL DEPTH</b> 6 m		<b>SURFACE ELEVATION</b> ~9 mAHD <b>LOGGED BY</b> W. Reynolds <b>CHECKED BY</b> B. Peiterse		
<b>COMPLETION</b>		<b>08/03/2021</b>				
<b>COMMENTS</b> Park Bay next to footpath (NW corner)						
Depth (m)	Samples	Standing Water	Graphics Log	Material Description	Additional Observations	
0.5	BH2 0.1			Asphalt		
	Sandy CLAY, orange, dry, loose, coarse 50% gravel up to 30mm diameter.					
1.0	BH2 0.5			Silty SAND: dark grey, moist, fine to medium, loose.	Slight sulfur odour	
	BH2 1.0			SAND light grey, fine, loose, dry to moist to wet.		
1.5	BH2 1.5					Becomes wet
2.0	BH2 2.0					
2.5	BH2 2.5					
3.0	BH2 3.0					
3.5	BH2 3.5					
4.0	BH2 4.0					
4.5	BH2 4.5			SAND brown, fine, loose, wet.	Very strong sulfur odour	
5.0	BH2 5.0					
5.5	BH2 5.5					
6.0	BH2 6.0			EOH at 6 m		

## Acid Sulfate Assessment Borehole Log BH3

<b>PROJECT NUMBER</b> 21121 <b>PROJECT NAME</b> Suffolk Park ASS Assessment <b>CLIENT</b> Horizon Retail Pty Ltd <b>ADDRESS</b> 207-209 Broken Head Rd <b>DRILLING DATE</b> 08/03/2021			<b>DRILLING COMPANY</b> ENV Solutions <b>DRILLER</b> B. Peitersse <b>TOTAL DEPTH</b> 6 m		<b>SURFACE ELEVATION</b> ~9 mAHD <b>LOGGED BY</b> W. Reynolds <b>CHECKED BY</b> B. Peitersse		
<b>COMPLETION</b>			08/03/2021				
<b>COMMENTS</b> Park Bay, NW corner							
Depth (m)	Samples	Water	Graphics Log	Material Description	Additional Observations		
0.5  1  1.5  2  2.5  3  3.5  4  4.5  5  5.5  6	BH3 0.1			Asphalt			
	BH3 0.5			Clayey SAND, brown with slight orange mottles, moist, coarse, gravel up to 5mm diameter.			
	BH3 1.0			CLAY, dark brown, medium plasticity, moist, soft.	Slight hydrocarbon odour		
	BH3 1.5			Clayey SAND, brown, saturated.			
	BH3 2.0				Slight sulfur odour		
	BH3 2.5						
	BH3 3.0				SAND, grey brown, saturated.		
	BH3 3.5						
	BH3 4.0						
	BH3 4.5						
	BH3 5.0				SAND, brown, saturated, loose, fine pieces of shell present.	Strong sulfur odour	
	BH3 5.5						
	BH3 6.0						
						EOH at 6 m	

## Acid Sulfate Assessment Borehole Log BH4

<b>PROJECT NUMBER</b> 21121 <b>PROJECT NAME</b> Suffolk Park ASS Assessment <b>CLIENT</b> Horizon Retail Pty Ltd <b>ADDRESS</b> 207-209 Broken Head Rd <b>DRILLING DATE</b> 08/03/2021		<b>DRILLING COMPANY</b> ENV Solutions <b>DRILLER</b> B. Peiterse <b>TOTAL DEPTH</b> 4 m		<b>SURFACE ELEVATION</b> ~9 mAHD <b>LOGGED BY</b> W. Reynolds <b>CHECKED BY</b> B. Peiterse		
<b>COMPLETION</b>		<b>08/03/2021</b>				
<b>COMMENTS</b> Park Bay, southern portion						
Depth (m)	Samples	Water	Graphics Log	Material Description	Additional Observations	
0.5	BH4 0.1			Asphalt		
	BH4 0.5			Clayey GRAVEL, brown, inferred road base material, dry to moist. Sandy CLAY, grey, slightly moist, fine, medium plasticity.	Slight hydrocarbon odour Strong hydrocarbon odour	
1	BH4 1.0				Slight hydrocarbon and sulfur odour	
1.5	BH4 1.5			Sandy CLAY, grey, moist, medium plasticity.		
2	BH4 2.0					
2.5	BH4 2.5			SAND, grey, saturated, coarse.		
3	BH4 3.0					
3.5	BH4 3.5					
4	BH4 4.0				EOH at 4 m	
4.5						
5						
5.5						



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**APPENDIX D**

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**Tabulated Laboratory Results**

## RESULTS OF ACID SULFATE SOIL ANALYSIS

44 samples supplied by Env Solutions Pty Ltd on 9/03/2021. Lab Job No. K4689.

Analysis requested by Will Reynolds. Your Job: 21121.

PO Box 368 SALLINA NSW 2478

SAS 248 BALUBA NEW 2478														Non-treated soil		Non-treated soil		
Sample Identification	EAL Lab Code	Texture	Moisture Content		pH <sub>i</sub> and pH <sub>ox</sub>				Potential Sulfidic Acidity		Actual Acidity		Retained Acidity		Acid Neutralising Capacity		Net Acidity	Lime Calculation
			(% moisture of total wet weight)	(g moisture / g of oven dry soil)	pH <sub>i</sub>	pH <sub>ox</sub>	pH change	Reaction	(% S <sub>2</sub> )	(mol H <sup>+</sup> /t)	pH <sub>ox</sub>	(mol H <sup>+</sup> /t)	(% S <sub>acid</sub> )	(mol H <sup>+</sup> /t)	(% CaCO <sub>3</sub> )	(mol H <sup>+</sup> /t)	(mol H <sup>+</sup> /t)	(kg CaCO <sub>3</sub> /t DW)
Method title					(In-house method S21)				(In-house method S20)		(In-house method 188)		(In-house method S14)					
BH1 - 0.1	K4689/1	Medium	7.4	0.08	4.86	3.09	-1.77	Medium	--	--	--	--	--	--	--	--	--	--
BH1 - 0.5	K4689/2	Medium	24.2	0.32	5.37	3.58	-1.79	Medium	--	--	--	--	--	--	--	--	--	--
BH1 - 1.0	K4689/3	Medium	25.6	0.34	5.24	3.00	-2.24	Medium	--	--	--	--	--	--	--	--	--	--
BH1 - 1.5	K4689/4	Medium	32.0	0.47	5.35	3.00	-2.35	Medium	0.016	10	5.12	33	--	--	--	--	44	3
BH1 - 2.0	K4689/5	Medium	23.7	0.31	5.95	1.80	-4.15	Medium	--	--	--	--	--	--	--	--	--	--
BH1 - 2.5	K4689/6	Fine	19.2	0.24	6.15	1.41	-4.74	High	0.134	84	5.98	7	--	--	--	--	91	7
BH1 - 3.0	K4689/7	Fine	20.0	0.25	5.96	1.25	-4.71	Medium	--	--	--	--	--	--	--	--	--	--
BH1 - 3.5	K4689/8	Medium	23.9	0.31	5.64	1.23	-4.41	High	0.104	65	5.61	15	--	--	--	--	79	6
BH1 - 4.0	K4689/9	Fine	31.2	0.45	5.09	2.01	-3.08	Medium	--	--	--	--	--	--	--	--	--	--
BH2 - 0.1	K4689/10	Medium	11.4	0.13	5.31	3.54	-1.77	Medium	--	--	--	--	--	--	--	--	--	--
BH2 - 0.5	K4689/11	Medium	5.1	0.05	5.76	2.23	-3.53	Medium	--	--	--	--	--	--	--	--	--	--
BH2 - 1.0	K4689/12	Coarse	4.9	0.05	6.23	2.88	-3.35	Medium	<0.005	0	6.52	0	--	--	0.00	0	0	0
BH2 - 1.5	K4689/13	Coarse	18.7	0.23	6.15	3.06	-3.09	Medium	--	--	--	--	--	--	--	--	--	--
BH2 - 2.0	K4689/14	Coarse	19.7	0.25	6.68	4.04	-2.64	Low	--	--	--	--	--	--	--	--	--	--
BH2 - 2.5	K4689/15	Coarse	17.4	0.21	5.81	2.91	-2.90	Medium	<0.005	0	6.52	0	--	--	0.00	0	0	0
BH2 - 3.0	K4689/16	Coarse	19.7	0.24	6.09	2.35	-3.74	Medium	--	--	--	--	--	--	--	--	--	--
BH2 - 3.5	K4689/17	Coarse	19.4	0.24	6.21	2.40	-3.81	Extreme	--	--	--	--	--	--	--	--	--	--
BH2 - 4.0	K4689/18	Medium	17.3	0.21	6.12	2.21	-3.91	Extreme	0.100	63	6.58	0	--	--	0.00	0	63	5
BH2 - 4.5	K4689/19	Medium	19.6	0.24	5.84	2.08	-3.76	Medium	--	--	--	--	--	--	--	--	--	--
BH2 - 5.0	K4689/20	Medium	19.9	0.25	5.88	2.11	-3.77	Medium	--	--	--	--	--	--	--	--	--	--
BH2 - 5.5	K4689/21	Medium	19.7	0.25	6.14	2.25	-3.89	Medium	0.024	15	5.95	5	--	--	--	--	20	2
BH2 - 6.0	K4689/22	Medium	20.4	0.26	5.83	1.48	-4.35	Medium	--	--	--	--	--	--	--	--	--	--
BH3 - 0.1	K4689/23	Medium	8.1	0.09	5.61	3.25	-2.36	Medium	--	--	--	--	--	--	--	--	--	--
BH3 - 0.5	K4689/24	Medium	7.1	0.08	6.01	3.11	-2.90	Medium	--	--	--	--	--	--	--	--	--	--
BH3 - 1.0	K4689/25	Medium	29.3	0.41	6.21	1.98	-4.23	High	0.007	5	5.31	26	--	--	--	--	31	2
BH3 - 1.5	K4689/26	Fine	30.8	0.44	5.58	3.27	-2.31	High	--	--	--	--	--	--	--	--	--	--
BH3 - 2.0	K4689/27	Medium	26.4	0.36	5.81	1.32	-4.49	High	0.086	54	5.42	18	--	--	--	--	72	5
BH3 - 2.5	K4689/28	Coarse	22.4	0.29	6.62	1.40	-5.22	Extreme	--	--	--	--	--	--	--	--	--	--
BH3 - 3.0	K4689/29	Coarse	18.5	0.23	6.44	1.74	-4.70	Medium	--	--	--	--	--	--	--	--	--	--
BH3 - 3.5	K4689/30	Coarse	19.1	0.24	6.06	2.07	-3.99	Medium	0.261	163	6.45	2	--	--	--	--	164	12
BH3 - 4.0	K4689/31	Medium	20.7	0.26	5.74	1.51	-4.23	Medium	--	--	--	--	--	--	--	--	--	--
BH3 - 4.5	K4689/32	Medium	19.1	0.24	5.80	1.45	-4.35	Medium	0.040	25	6.02	8	--	--	--	--	33	2
BH3 - 5.0	K4689/33	Medium	21.1	0.27	5.58	1.29	-4.29	Medium	--	--	--	--	--	--	--	--	--	--
BH3 - 5.5	K4689/34	Medium	20.9	0.26	5.69	1.26	-4.43	Medium	0.054	33	5.78	14	--	--	--	--	47	4
BH3 - 6.0	K4689/35	Medium	20.7	0.26	6.08	1.33	-4.75	Medium	--	--	--	--	--	--	--	--	--	--
BH4 - 0.1	K4689/36	Medium	6.2	0.07	5.75	3.29	-2.47	Low	--	--	--	--	--	--	--	--	--	--
BH4 - 0.5	K4689/37	Medium	7.9	0.09	5.63	2.80	-2.83	Low	--	--	--	--	--	--	--	--	--	--
BH4 - 1.0	K4689/38	Fine	28.6	0.40	5.30	3.19	-2.11	Volcanic	0.010	6	4.74	65	--	--	--	--	71	5
BH4 - 1.5	K4689/39	Fine	23.8	0.31	5.05	3.39	-1.66	Extreme	--	--	--	--	--	--	--	--	--	--
BH4 - 2.0	K4689/40	Fine	24.8	0.33	4.83	2.16	-2.67	Volcanic	0.256	160	4.80	48	--	--	--	--	207	16
BH4 - 2.5	K4689/41	Fine	24.7	0.33	6.02	2.19	-3.83	Extreme	--	--	--	--	--	--	--	--	--	--
BH4 - 3.0	K4689/42	Medium	19.8	0.25	6.20	2.24	-3.96	Extreme	0.158	99	5.97	5	--	--	--	--	103	8
BH4 - 3.5	K4689/43	Medium	19.5	0.24	6.11	2.25	-3.86	Volcanic	--	--	--	--	--	--	--	--	--	--
BH4 - 4.0	K4689/44	Medium	19.7	0.24	5.38	2.55	-2.83	Volcanic	0.091	57	5.50	17	--	--	--	--	73	6

## NOTES:

- All analysis is reported on a dry weight (DW) basis, unless wet weight (WW) is specified.
- Samples are dried and ground immediately upon arrival (unless supplied dried and ground).
- Analytical procedures are sourced from 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.
- The Acid Base Accounting Equation, where Acid Neutralising Capacity has not been corroborated by other data, is **Net Acidity = Potential Acidity + Actual Acidity + Retained Acidity** (Eq. 3.2; Sullivan et al. 2018 - full reference above).
- The Acid Base Accounting Equation for post-limed soil materials is **Net Acidity = Potential Acidity + Actual Acidity + Retained Acidity - (post treatment Acid Neutralising Capacity - Initial Acid Neutralising Capacity)** (Eq. 3.3; Sullivan et al. 2018 - full reference above).
- While the Acid Neutralising Capacity of a soil material may not be included in the Net Acidity calculation (Note 4), it must be measured to give an Initial Acid Neutralising Capacity if verification testing is planned post-liming.
- The Initial Acid Neutralising Capacity must be provided by the client to enable EAL to produce Verification Net Acidity and Liming calculations for post-limed soil materials.**
- The Acid Base Accounting Equation, where Acid Neutralising Capacity has been corroborated by other data, is **Net Acidity = Potential Acidity + Actual Acidity + Retained Acidity - Acid Neutralising Capacity** (Eq. 3.1; Sullivan et al. 2018 - full reference above).
- The time calculation includes a Safety Factor of 1.5 as a safety margin for acid neutralisation (Sullivan et al. 2018). This is only applied to positive values. An increased Safety Factor may be required in some cases.
- Retained Acidity is required when the pH<sub>ox</sub> < 4.5 or where jarosite has been visually observed.
- A negative Net Acidity result indicates an excess acid neutralising capacity.
- If insufficient mixing occurs during initial sampling, or during post-liming, or both: the Potential Sulfidic Acidity may be greater in the post-limed sample than in the initial sample; the post-liming Acid Neutralising Capacity may be lower in the post-limed sample than in the initial sample.
- An acid sulfate soil management plan is triggered by Net Acidity results greater than the texture dependent criterion: coarse texture ≥ 0.03% S or 18 mol H<sup>+</sup>/t; medium texture ≥ 0.06% S or 36 mol H<sup>+</sup>/t; fine texture ≥ 0.1% S or 62 mol H<sup>+</sup>/t** (Table 1.1; Sullivan et al. 2018 - full reference above).
- For projects that disturb > 1000 t of soil material, the coarse trigger of ≥ 0.03% S or ≥ 18 mol H<sup>+</sup>/t must be applied in accordance with Sullivan et al. (2018) (full reference above).
- Acid sulfate soil texture triggers can be related to NCST (2009) textures: coarse and peats = sands to loamy sands; medium = clayey sand to light clays; fine = light medium to heavy clays (Sullivan et al. 2018 - full reference above).
- Bulk density is required to convert liming rates to soil volume based results. Field bulk density mgs can be submitted to EAL for bulk density determination.
- A negative Net Acidity result indicates an excess acid neutralising capacity.
- '-' is reported where a test is either not requested or not required. Where pH<sub>ox</sub> is < 4.5 or > 6.5, zero is reported for S<sub>acid</sub> and ANC in Net Acidity calculations, respectively.
- Results refer to samples as received at the laboratory. This report is not to be reproduced except in full.
- NATA accreditation does not cover the performance of this service.
- Analysis conducted between sample arrival date and reporting date.
- All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions (refer scu.edu.au/eal or on request).
- Results relate to the samples tested.
- This report was issued on 12/03/2021.



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**APPENDIX E**

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**NSW EPA Waste Classification Guidelines (Part 4: Acid Sulfate Soils)**

# **Waste classification guidelines**

## **Part 4: Acid sulfate soils**

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**Published by:**

NSW Environment Protection Authority (EPA)  
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ISBN 978 1 74359 808 5

EPA 2014/0798

November 2014

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Classifying wastes into groups that pose similar risks to the environment and human health facilitates their management and appropriate disposal. It is the responsibility of those who generate waste to classify that waste. To assist waste generators classify the wastes they produce, the EPA has developed the *Waste Classification Guidelines* ('the Guidelines') which are a step-by-step process for classifying waste.

Generators and waste facilities must carefully follow the procedures in these Guidelines to ensure they comply with applicable laws in classifying their waste and safeguard protection of the environment and human health.

The Guidelines are comprised of the following sections, of which this document is Part 4:

Overview of the Guidelines

Part 1: Classifying waste

Part 2: Immobilisation of waste

Part 3: Waste containing radioactive material

Part 4: Acid sulfate soils

All sections of the Guidelines are available for download from the EPA website at [www.epa.nsw.gov.au/waste/classification.htm](http://www.epa.nsw.gov.au/waste/classification.htm).



## Introduction

Acid sulfate soils (ASS) are those naturally occurring sediments and soils which contain sulfides, mainly iron sulfide and iron disulfide or their precursors. Exposure of these sulfides in the soil to oxygen – often as a result of drainage or excavation – can produce sulfuric acid, which may have a significant impact on the environment. Leaching of sulfuric acid into waterways can cause serious water quality problems, resulting in fish kills and damage to infrastructure, such as floodgates and bridges.

ASS are most commonly found in NSW along the coast and they need to be managed appropriately to avoid major environmental damage.

The NSW *Acid Sulfate Soils Manual*<sup>1</sup> (the ASS Manual) provides ‘best practice’ guidance for planning, assessing and managing activities in areas prone to developing ASS. The manual is available from the NSW Department of Planning: phone 1300 305 695.

## Using this part of the Guidelines

This part of the EPA Waste Classification Guidelines (the Guidelines) applies to acid sulfate soils which are unable to be managed on-site. In these cases, off-site disposal to landfill is often the most appropriate management option.

Waste generators need to assess the status of ASS at their point of generation, using the techniques outlined in the ASS Manual. The ASS Manual also provides guidance for on-site management, while this part of the Waste Classification Guidelines details disposal requirements for ASS that need to be transported and managed off-site.

This document has advice on dealing with both ‘potential’ ASS and ‘actual’ ASS. The two types are often found together in the same soil profile, with actual ASS generally overlying potential ASS horizons.

## Potential acid sulfate soils

Potential ASS are soils that contain iron sulfides or sulfidic materials that have not been exposed to air and thus are not oxidised. The pH of these soils in their undisturbed state is 5.5 or more, making them neutral or slightly alkaline. If not managed appropriately, potential ASS pose a considerable environmental risk: disturbance and exposure to air may render them severely acidic.

## Handling potential acid sulfate soils prior to disposal

Potential ASS must be kept wet at all times during excavation and subsequent handling, transport and storage, until they can be disposed of safely. They must be received at the proposed disposal point within 16 hours of being dug up.

---

<sup>1</sup> Stone Y, Ahem, CR and Blunden, B 1998. *Acid Sulphate Soils Manual 1998*. Acid Sulphate Soils Management Advisory Committee (ASSMAC), Wollongbar, NSW.



## Disposal of potential acid sulfate soils *below* the water table

Potential ASS may be disposed of in water below the permanent water table, provided:

- this occurs before they have had a chance to oxidise, i.e. within 24 hours of excavation and
- they meet the definition of ‘virgin excavated natural material’ (VENM) under the *Protection of the Environment Operations Act 1997*, even though they contain sulfidic ores or soils.

Landfills must be licensed by the EPA to dispose of potential ASS below the water table. EPA’s Environment Line has details on facilities able to accept this waste: phone 131 555.

Potential ASS must be disposed of within 8 hours of their receipt at a landfill and kept wet at all times until their burial at least two metres below the lowest historical level of the water table at the disposal site.

Documentation must be provided to the occupier of the landfill for each truckload of potential ASS received, indicating that the soil’s excavation, transport and handling have been in accordance with the ASS Manual, thus preventing the generation of acid.

The occupier of the disposal site must also test the pH of each load of soil received immediately prior to its placement under water using the test method(s) in the ASS Manual (Methods 21A and/or 21Af). These details, together with the pH of the soil recorded at the time of its extraction, must be retained by the occupier of the landfill site.

The disposal site’s licence will outline what documentation needs to be kept and for how long.

Soil that has dried out, undergone any oxidation of its sulfidic minerals, or which has a pH of less than 5.5 must be treated by neutralisation and disposed of at a landfill that can lawfully accept it (see **Disposal of actual acid sulfate soils** below).

The pH of the water at the landfill into which the potential ASS is placed must not be less than 6.0 at any time. Landfill licence conditions require the occupiers of potential ASS disposal sites to regularly monitor the pH of ground and surface waters at their premises.

## Disposal of potential acid sulfate soils *above* the water table

Where potential ASS cannot be classified as VENM or a suitable underwater disposal site at a landfill is not available, the soil must be treated in accordance with the neutralising techniques in the ASS Manual. After treatment the soil should be chemically assessed in accordance with Step 5 in Part 1 of the Waste Classification Guidelines, available at [www.epa.nsw.gov.au/waste/classification.htm](http://www.epa.nsw.gov.au/waste/classification.htm). This will determine whether any other contaminants are present in the material. When the classification has been established, the soil should be disposed of to a landfill that can lawfully accept that class of waste.

## Actual acid sulfate soils

Actual ASS contain highly acidic soil horizons or layers resulting from the aeration of soil materials that are rich in sulfides, primarily iron sulfide. This oxidation produces more hydrogen ions than the sediment is able to neutralise, resulting in soils with a pH of 5.5 or less when measured in dry season conditions. These soils can usually be identified by the presence of pale yellow mottles and coatings of jarosite.

## Treatment of actual acid sulfate soils prior to disposal

Actual ASS must be treated by the generator of the waste before they can be considered for disposal. Treatment should be in accordance with the neutralising techniques outlined in the ASS Manual.

## **Disposal of actual acid sulfate soils**

Following neutralisation, the generator of the waste must chemically assess the soil in accordance with Step 5 of Part 1 of the Waste Classification Guidelines. This will determine whether there are any other contaminants that may affect how the waste is classified for disposal.

Once classified, the waste must be taken to a landfill licensed to accept that class of waste.

Prior arrangements should be made with the occupier of the landfill to ensure that it is licensed to accept the waste. The landfill should be informed that the actual ASS has been treated in accordance with the neutralising techniques outlined in the ASS Manual and that the waste has also been classified in accordance with Part 1 of the Waste Classification Guidelines.



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## REMEDIATION ACTION PLAN

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Shell Service Station  
207-209 Broken Head Road, Suffolk Park NSW  
(Lot 1, DP701391)

For:  
Horizon Retail Pty Ltd

Author:  
ENV Solutions

Date:  
June 2021

### **Document Control:**

<b>Filename:</b>	20770_RAP_20210611		
<b>Job No:</b>	20770		
<b>Client:</b>	Horizon Retail Pty Ltd		
<b>File/Pathname:</b>	C:\Users\BenPieterse\Dropbox (ENV Solutions)\ENV Solutions Team Folder\01. jobs\21121 - Horizon_Shell Suffolk Park_ASS\Reports		
<b>Revision No:</b>	<b>Author and Approver:</b>	<b>Date:</b>	<b>Signed:</b>
V1	Craig Helbig	11/06/2021	

### **Scope of Engagement and Limitations:**

This report has been prepared by ENV Solutions PTY LTD (ENV) at the request of Horizon Retail Pty Ltd for the purpose of a Remediation Action Plan. No other parties may rely on the contents of this report for any purposes except those stated.

This report has been prepared based on the information provided to us and from other information obtained as a result of enquiries made by us. ENV accepts no responsibility for any loss or damage suffered howsoever arising to any person or corporation who may use or rely on this document for a purpose other than that described above.

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To avoid this advice being used inappropriately, it is recommended that you consult with ENV before conveying the information to another who may not fully understand the objectives of the report. This report is meant only for the subject site/project and should not be applied to any other.

**List of Acronyms:**

Below is a list of commonly used acronyms in this report:

COC – Chain of Custody

BSC – Byron Shire Council

EILs – Ecological Investigation Levels

ESLs – Ecological Screening Levels

ENV – ENV Solutions PTY LTD

HILs – Health Investigation Levels

HSLs – Health Screening Levels

NEPC – National Environment Protection Council

NEPM – National Environment Protection (Assessment of Site Contamination) Measure 1999 (as amended 2013)

NSW EPA – New South Wales Environment Protection Authority

PID – Photo Ionisation Detector

ppm<sub>v</sub> – Parts Per Million (by volume)

QA/QC – Quality Assurance and Quality Control

RC – Remediation Consultant

RWC – Remediation Works Contractor

UST – Underground Storage Tank

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## 1 Introduction

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### 1.1 Background

ENV Solutions Pty Ltd (ENV) has been engaged by Horizon Retail Pty Ltd (Horizon) to prepare a Remediation Action Plan (RAP) for removal of an underground petroleum storage system (UPSS) from the property situated at 207-209 Broken Head Road, Suffolk Park, NSW. The service station is hereafter referred to as the 'site'. The relative site location is presented on Figure 1, Attachment 1.

The property operates as a Shell branded service station, which is set to undergo redevelopment. The proposed redevelopment works include removal of the existing UPSS, installation of a new UPSS comprising 3 x new multi-compartment 70kL capacity underground storage tanks (USTs) and associated pipework and dispensing bowsers, installation of a new sewer pump and reconfiguration of the site; including demolition of the existing sales building and construction of a new building. A SPEL unit will also be installed within the new UST area.

This RAP has been prepared on the basis of previous environmental investigations conducted at the site; and the known site conditions.

The focus of this RAP is the removal of the existing UPSS, which comprises four underground storage tanks (USTs) and associated dispensing bowsers and pipework. The approximate extent of this area is indicated on Figure 2, Attachment 1.

### 1.2 Scope of RAP

The NSW Environment Protection Authority (EPA) has prepared a document entitled "Consultants Reporting on Contaminated Land (Contaminated Land Guidelines)" (2020), which provides a framework for reporting on contaminated land assessments, including preparation of a RAP. The Guidelines require that the following is presented by the RAP:

- Summarise the findings of the preliminary and detailed site investigations and risk assessment (where applicable), and present the refined conceptual site model (CSM).
- Document the identified contamination risks to human health and/or the environment.
- Set remediation objectives that ensure the remediated site will be suitable for its current and/or proposed use and which will result in no unacceptable risk to human health or to the environment and state remediation criteria.
- Define the extent of remediation required across the site.
- Assess options and remedial technologies to achieve the remediation objectives and select and justify a preferred approach, which must include the consideration of the principles of ecologically sustainable development.
- Document in detail all procedures and plans to reduce risks posed by contamination to acceptable levels for the proposed site use.
- Identify the need for and reporting requirements of remedial technology pilot trials (if applicable).

- Establish the environmental safeguards required to complete the remediation in an environmentally acceptable manner, including consideration of the potential for off-site impacts (such as air quality, odour and aesthetics).
- Address contingencies and unexpected finds protocols.
- Identify the necessary approvals and licences required by regulatory authorities including any items contained in development consent conditions.
- Clearly outline waste classification, handling and tracking requirements in accordance with the Guidelines for the NSW Site Auditor Scheme and Waste Classification Guidelines (EPA, 2014).
- Ensure remediation is consistent with relevant laws, policies (including planning instruments and policies) and guidelines and reference these in the remedial action plan.
- Identify how successful implementation of the remedial action plan will be demonstrated, for example the validation requirements by documentation of site works and sampling and analysis etc (when sampling and analysis is required, a validation sampling and analysis quality plan must be included, with clearly defined acceptance validation criteria indicating what statistics will be used and any trend analysis following remediation, i.e. Mann-Kendall test).
- Identify the need for, and nature of, any long-term management and/or monitoring following the completion of remediation and, if required, provide an outline of an environmental management plan and include this in the remedial action plan.

This RAP has been prepared to address each of these items (where applicable).

### **1.3 Summary of Anticipated Remedial Activities**

The activities covered by this document can be categorized as follows:

- Preliminaries, including site establishment, identification of underground and above ground utilities which may be affected by the works and implementation of environmental controls such as sediment and erosion control mechanisms.
- Removal of residual liquids from the four USTs to be removed.
- Excavation of soils around the USTs and assisting the Remediation Consultant (RC) with soil validation sampling.
- Removal of each of the USTs and associated infrastructure, including but not limited to vent pipes, suction pipes, remote filling points and dispensing bowers. It is likely that the existing USTs will be 'floated out', given the shallow nature of groundwater beneath the site.
- Piling and dewatering of the new tank pit excavation. A Dewatering Management Plan (DMP) is provided under separate cover.
- Piling and dewatering of the area where a new sewer pump will be installed.
- Excavation of soils from within the piled areas.

- Stockpiling of excavated soils within a bunded stockpiling area at the rear (east portion) of the site.
- Treatment of excavated soils from below 1 m depth in accordance with the requirements of the Acid Sulfate Soil Management Plan (ASSMP), provided under separate cover.
- Re-use of excavated soils on-site (if suitable), or disposal off-site to an appropriately licensed landfill.
- Backfill of the final excavation extents with appropriate clean fill material which meets the site-specific remediation criteria. ENV understands this may include site-won fill which has been treated to neutralise ASS, if it is shown to be suitable for re-use on site.

Further details regarding each of these tasks is included in later sections of the document.

Groundwater assessment and/or remediation is not included in this document, as previous assessments (ENV, 2018) have indicated that the existing groundwater conditions do not pose a risk to site users or the environment. Groundwater monitoring will continue at the site in accordance with the requirements of the *Protection of the Environment Operations (Underground Petroleum Storage Systems) Regulation 2019* once the new service station facility has been constructed and is operational.

## 1.4 Objectives

The primary objective of the remedial works is to remove the existing UPSS from the site; and ensure that COPC concentrations in the remaining site soils meet the adopted remediation criteria for future commercial/industrial land use (ongoing service station land use).

## 1.5 Regulatory Framework

The following regulatory framework has been considered in preparing this document, and should be understood by the Remediation Works Contractor (RWC) and/or RC (as required) prior to commencing the remedial program:

### Acts, Policies and Regulations

- Byron Shire Council: Management of Contaminated Land Policy (2008).
- Contaminated Land Management Act (1997) ('CLM Act').
- Protection of the Environment Operations Act (1997) ('POEO Act').
- Protection of the Environment Operations (Underground Petroleum Storage Systems) Regulation (2019).
- Protection of the Environment Operations (Waste) Regulation (2014).
- State Environment Protection Policy 55 – Remediation of Land (SEPP 55) under the Environmental Planning and Assessment Act (1997) ('SEPP 55').
- Work Health and Safety Act (2011).
- Work Health and Safety Regulations (2011).

## **Guidelines and Standards**

- DECCW (2009) Guidelines for Implementing the Protection of the Environment Operations (Underground Petroleum Storage Systems) Regulation 2008 (now 2019) ('UPSS Guidelines').
- NSW EPA (1995) Sampling Design Guidelines.
- NSW EPA (2014) Technical Note: Investigation of Service Station Sites.
- NSW EPA (2014) Waste Classification Guidelines.
- NSW EPA (2014) The Excavated Natural Material Order.
- NSW EPA (2020) Consultants Reporting on Contaminated Land (Contaminated Land Guidelines).
- NEPC (2013) Schedule B(1) Guideline on Investigation Levels for Soil and Groundwater.
- NEPC (2013) Schedule B(2) Guideline on Site Characterisation.
- NEPC (2013) Schedule B(3) Guideline on Laboratory Analysis of Potentially Contaminated Soils.
- Standards Australia (2008). AS4976-2008: The removal and disposal of underground petroleum storage tanks.

## 2 Site Identification Details

Table 1 provides identification details of the subject land relevant to this RAP.

**Table 1: Site Identification Details**

<b>Site Address</b>	207 – 209 Broken Head Road, Suffolk Park, NSW
<b>Site Area</b>	Total site – approximately 3,322 m <sup>2</sup>
<b>Real Property Description</b>	Lot 1, DP701391
<b>Local Government Area</b>	Byron Shire Council (BSC)
<b>Current Zoning</b>	R2 – Low Density Residential – Byron Shire Council Local Environmental Plan (LEP) 2014. The objectives of this zone are: <ul style="list-style-type: none"> <li>- To provide for the housing needs of the community within a low density residential environment.</li> <li>- To enable other land uses that provide facilities or services to meet the day to day needs of residents.</li> </ul>
<b>Existing Land Use</b>	Service Station
<b>Proposed Land Use</b>	Service Station

### 3 Site and Surrounding Area Characteristics

A desktop study was undertaken to establish the physical characteristics of the site and surrounding environment. A summary of the relevant details is provided in the following sub-sections. Some details were collated from previous reports prepared for the site (ENV, 2018).

#### 3.1 Site Description

The site comprises a service station with an attached mechanical workshop, which are situated in the western portion of the site.

The eastern portion of the site consists of grassed open space, used as a car parking area and for trailer storage. An outdoor seating area is located in the southern site portion. The western portion of the site is predominantly covered with bitumen in a fair condition. Some concrete covering was present beneath the sales canopy.

Minor surface staining was noted around the fuel dispensing pumps. No stressed vegetation was observed in the landscaped areas (ENV, 2018).

There are six (6) fuel dispensing bowsers below the canopy; and four vent pipes on the western edge of the site and on the northern wall of the workshop building. There is also a 6.5 kL LPG tank which was installed in 1998.

There are currently four (4) USTs. A fifth UST is understood to have been decommissioned and removed in 2006. The details of the USTs are summarised in Table 2 below (refer to Figure 2, Attachment 1 for approximate UST locations).

**Table 2: Summary of Known Underground Storage Tank (UST) Details**

Tank ID	Contents	Capacity (kL)	Location	Current Usage
1	Diesel	43	Below Canopy	In Use
2	Premium Unleaded Petrol (PULP) – 98 octane	11	South of canopy	In Use
3	Premium Unleaded Petrol (PULP) – 95 octane	11	West of canopy	In Use
4	ULP	36	West of canopy	In Use
5	ULP	5	-	Decommissioned and Removed

### **3.2 Primary Activities on the Land**

The site is currently used for service station activities, including storing and dispensing fuel. A mechanical workshop also operates on the northern side of the existing sales building.

### **3.3 Local Topography and Drainage**

The has an elevation of less than 10 m AHD, according to Google Earth imagery. The topography of the site is generally flat, apart from the entrance and exit driveways from Broken Head Road, which have an approximate 10% slope from Broken Head Road to the main service station area. The site also slopes towards Tallow Creek along the southern and eastern boundaries in the immediate area of the creek, comprising the embankment.

The topography of the surrounding land is generally flat, low-lying land. Infiltration is expected to be low in the immediate vicinity of the site given the surface is predominantly covered in hardstand. However, based on the adjacent open-space areas, it is possible that there are localised groundwater recharge areas given the flat topography and low elevation, and likely sandy soils.

### **3.4 Flooding Risk**

A 2015 floodplain management study conducted by Sinclair Knight Mertz (SKM, 2015) indicates that the site lies within a flood risk area associated with Tallow Creek (refer to Figure 3, Attachment 1). Mapping associated with the study shows that the majority of the site lies within an area defined within the study as having a low risk of flooding in a 1 in 100 year ARI event. Parts of the site close to Tallow Creek lie within a high risk area of flooding. The area of the site on which the sales building and workshop are located appears to be free of flooding risk.

### **3.5 Surface Coverings and Vegetation**

The operational area of the service station is surfaced with bitumen and concrete. There is a large grassed vacant area behind the service station building, extending to the site's eastern boundary.

### **3.6 Local Geology and Hydrogeology**

The geology at the site is mapped at 1:250,000 as "Beach and dune sand" (Geological Survey of NSW, 1972). The soil landscape at the site is mapped at 1:100,000 as Black Rock (bra) Aeolian landscape (Morand, 1994). This is described as "extensive sand sheet (possible Holocene) supporting low heath and shrubland".

The site appears to be on a low barrier dune system, and soils are therefore expected to be podzols, i.e. acid sandy soils with strongly differentiated horizons including a bleached horizon above a coffee coloured pan and coloured subsoil. The coffee coloured pan is evident along the beach dunes nearby at Tallow Beach. Soil limitations include: non-cohesive, highly permeable, highly acidic soils of very low fertility (Morand, 1994).



The groundwater below the site is between approximately 1 m and 2 m below ground level, with the direction of groundwater flow being to the south-east towards Tallow Creek.

### **3.7 Surrounding Environment and Adjacent Land Uses**

#### **3.7.1 Overview**

The properties adjoining the site include:

*North:* Residential adjacent to the site, then residential and holiday accommodation. Byron Bay Nursing home is located approximately 60 m north-west of the site, across Broken Head Road. A cattle tick dip was formerly located to the north-west of the site (across Broken Head Road), but has since been remediated.

*South:* Tallow creek, then “The Park” Motel and Hotel, including carpark and the Suffolk Park shopping village, then residential.

*East:* Tallow Creek, then residential

*West:* Broken Head Road, Tallow Creek and wetlands (south-west), then residential.

#### **3.7.2 Potential Off-Site Sources of Contaminants**

The chemicals of potential concern (COPC) associated with the UPSS removal program are petroleum hydrocarbons stored and dispensed by the UPSS.

None of the adjacent or nearby properties are considered a plausible off-site source of these COPC.

#### **3.7.3 Regional Watercourses**

Tallow Creek is located adjacent to the southern and eastern boundaries of the site and flows east around the site, then in a northerly direction and discharges into Tallow Beach, approximately 2.5 km to the north. Tallow Beach is also located approximately 600 m to the direct east of the site.

Tallow Creek flows into areas of land that are zoned 7(a) Wetlands Zone, which is covered by State Environmental Planning Policy (Coastal Management) 2018, approximately 10 m south-west and 75 m north-east of the site. Tallow Creek flows into land zoned 7(b) Coastal Habitat Zone approximately 60 m north-east of the site.

#### **3.7.4 Groundwater Resources**

A search of the WaterNSW Groundwater Bores online mapping shows four (4) licensed bores located within 250 m of the site; one approximately 130 m to the north-west, one approximately 100 m to the south-east; one approximately 175 m to the north-east and one approximately 250 m to the east (refer to Figure 4, Attachment 1). The information presented on the mapping shows that the two bores situated in a down-hydraulic gradient direction (east or south-east) from the site have been installed using a spear, with no other information available for the bores. These licences may be associated

with construction activities such as dewatering. The bore situated 175 m to the north-east of the site was installed to a depth of 6.4 m in 2010 for domestic purposes.

### **3.7.5 Acid Sulfate Soils (ASS)**

The Byron Shire Council Local Environmental Plan (LEP) (2014) indicates the site is situated within a Class 3 area (refer to Figure 5, Attachment 1). This means that Development Consent is required for any works 1 m below the existing ground surface, or for works which may lower the groundwater table more than 1 m below the natural ground surface.

Given that the site works will disturb soils below 1 m, an ASSMP has been prepared (ENV, 2021) and is provided under separate cover. The ASSMP contains management measures applicable to the treatment of soils during the remediation program.

## **4 Site History and Regulatory Information**

The site history information presented in this section is drawn from desktop searches made by ENV on April 2018; and on information provided by Horizon relating to previous environmental investigations.

### **4.1 Previous Investigations**

Several environmental investigations have been conducted previously at the site. Reports provided to ENV for review for the desktop study included the following:

- Cavvanba (2012a). Groundwater Investigation, Suffolk Park Service Station, 207-209 Broken Head Road, Suffolk Park, NSW, 2481. Report reference 11098 R02, dated January 2012.
- Cavvanba (2012b). Groundwater Monitoring Event, May 2012; Suffolk Park Service Station, 207-209 Broken Head Road, Suffolk Park, NSW, 2481. Report reference 11098 R03, dated August 2012.
- Cavvanba (2013). Groundwater Monitoring Event, April 2013; Suffolk Park Service Station, 207-209 Broken Head Road, Suffolk Park, NSW, 2481. Report reference 11098 R04, dated May 2013.

The Cavvanba reports also reference the following reports, which were not available for review by ENV (although a summary of the report findings is provided in Cavvanba, 2012a and 2013):

- Golder Associates Pty Ltd (Golder Associates; April 2008) Phase I and Phase II Environmental Site Assessment, Lot 1 DP701391, Suffolk Park Service Centre, 209 Broken Head Road, Suffolk Park NSW, (Ref. 004-077633082-R-Rev0).
- Golder Associates (June 2009) Groundwater Assessment, Suffolk Park Service Centre, Broken Head Road, Suffolk Park NSW, (Ref. 097633023 001 Rev0).
- Cavvanba (2011a). Suffolk Park Service Station – Progress Report, 207 – 209 Broken Head Road, Suffolk Park NSW, RE: Response to Direction to Take Preventative Action – No. 75.2010.79.1, (Ref. 11098L01-BSC01) letter report.
- Cavvanba (2011b). Data Quality Objectives and Sampling, Analysis and Quality Plan, Shell Service Station, 207 – 209 Broken Head Road, Suffolk Park, NSW, 2481, (Ref. 11098 R01).

ENV has also undertaken several rounds of groundwater monitoring at the site in accordance with the UPSS (2014) Regulation requirements. During each of the monitoring events, ENV measured depth to groundwater and LNAPL in the wells, as well as undertaking visual and olfactory observations of the groundwater. A separate due diligence assessment was completed by ENV in 2018, and a more recent Acid Sulfate Soil (ASS) investigation was undertaken in March 2021 for preparation of the ASSMP (ENV, 2021).

These reports are summarised in the following sub-sections.

#### **4.1.1 Golder Associates Pty Ltd (2008 and 2009)**

Previous groundwater investigations were conducted by Golder Associates Pty Ltd (Golder) in 2008 and 2009, and the investigations identified petroleum hydrocarbon impacts to groundwater on the site. The investigations involved the installation, sampling and analysis of groundwater wells and petroleum hydrocarbon impacts were identified on the site. The concentrations were indicative of diesel fuel, and it was described that the likely source of contamination was from spillage during bulk fuel refilling of diesel.

In response to the Golder findings, Byron Shire Council (BSC) notified the NSW EPA as the regulatory authority under the Underground Petroleum Storage System (UPSS) Regulation 2008 (now 2014). EPA responded by requesting that Council take action to investigate the groundwater impacts.

#### **4.1.2 Cavvanba (2012a)**

In response to the above, a groundwater investigation was conducted by Cavvanba in November 2011, and included the installation of four additional groundwater wells, and sampling and analysis of the four newly installed wells and three existing wells (installed by Golder). The investigation found that groundwater underlying the area of investigation had been impacted with petroleum hydrocarbons, including the presence of light non-aqueous phase liquid (LNAPL) in one well, MW7. Cavvanba's conclusions included the recommendation to conduct further groundwater monitoring.

#### **4.1.3 Cavvanba (2012b)**

Further groundwater investigations were subsequently conducted by Cavvanba in April and May 2012. The investigations found that petroleum hydrocarbon impacts were present in the groundwater beneath the site and the dissolved-phase plume showed a clear decreasing trend with distance from the source area to the down-hydraulic gradient boundary adjacent to Tallow Creek. LNAPL was again detected in MW7 in April 2012, and a hydrocarbon sheen observed, but no LNAPL was detected in May 2012. Cavvanba concluded that the fluctuating presence of LNAPL at MW7 may be the result of environmental factors such as fluctuating groundwater elevations, influencing the immobile, residual LNAPL within the soil across the capillary zone.

Ongoing groundwater investigations were recommended to monitor any changes in groundwater concentrations and the potential movement of the hydrocarbon plume towards Tallow Creek. These were to be conducted as part of ongoing monitoring requirements in accordance with the UPSS Regulation 2008 (now 2014).

#### **4.1.4 Cavvanba (2013)**

In April 2013, Cavvanba conducted a further round of groundwater sampling of the existing monitoring network.

The data collected as part of the investigation were considered by Cavvanba to confirm that a dissolved-phase plume was present in groundwater beneath the site. However, Cavvanba considered that no further regulation was required and that the

contamination could be managed under the current UPSS Regulation for the following reasons:

- The hydrocarbon contamination source was controlled (diesel spill) and no new sources of hydrocarbon contamination had been detected.
- The current land use and continued use was as an operational service station.
- The current monitoring program was appropriate and met the UPSS Regulation requirements.
- The trends in concentration data indicated that natural attenuation may be occurring.

There was a favourable subsurface environment for soil/water oxygen exchange and degradation.

#### **4.1.5 ENV Solutions (April 2018)**

A borehole and soil and groundwater sampling program was conducted to meet the objectives of the assessment. Ten (10) boreholes were drilled across the site, including five at the rear and five in the operational (western) site portion. Soil samples were collected from discrete depth intervals and laboratory analysed for the chemicals of potential concern (petroleum hydrocarbons and metals). Concentrations of each of the analytes tested in the soil samples analysed met the adopted assessment criteria.

A groundwater investigation was conducted concurrently with the borehole investigation, to update groundwater conditions beneath the site from previous investigations conducted by Golder and Cavvanba between 2008 and 2013. Four wells (MW5, MW6, MW9 and MW10) were sampled, with the remaining monitoring wells either lost (MW11 and MW12) or containing LNAPL (MW7 only which was not sampled).

The results of the groundwater sampling indicate that concentrations of the chemicals of potential concern met the adopted assessment criteria for the protection of on-site workers and ecological systems.

The summary table of the laboratory results for soils and groundwater are presented in Attachment 2.

#### **4.1.6 ENV Solutions (March 2021)**

An ASS field investigation was undertaken by ENV on 9 March 2021. The investigation included drilling four boreholes (BH1 to BH4) using a trailer mounted drill rig and solid flights augers to a maximum depth of 6.0 m (1.0 m beyond the expected maximum soil disturbance depth for the proposed remediation program) at the following locations:

- BH1: near the location where a new sewer pump station will be constructed – 4.0 mBGL.
- BH2 and BH3: within the footprint of the new UST pit – 6.0 mBGL.
- BH4: near the location of the existing UPSS area, and where footings for the new canopy are located to be constructed – 4.0 mBGL.

The borehole locations are shown on Figure 2, Appendix A of the ASSMP (ENV, 2021).

Soil samples were collected at 0.5 m intervals to the maximum investigation depth at each location. The samples were placed on ice in an insulated container pending dispatch to a laboratory accredited by the National Association Testing Authorities (NATA) for ASS analysis. Every sample was analysed using the field peroxide test and at least 25% of the samples were analysed for ASS using the chromium reducible sulfur (CRS) suite. The soils encountered were logged in general accordance with the Unified Soil Classification System (USCS).

The investigation reported that ASS were presented in most site soils below a depth of 1 mBGL and will require liming treatment if disturbed during the proposed remediation program.

## **4.2 Product Loss and Spill History**

According to information provided in Golder (2009), as summarized in Cavvanba (2012a), the site has been used as a service station and motor vehicle workshop since the 1970s and has been used for activities typical of these businesses, including the storage of equipment, vehicles and various fuels, oils, chemicals, etc. Individual remote fill points were previously used at the site, and it was reported by Golder (2009) that “the likely source of contamination to groundwater is from spillage during bulk fuel refillings”.

According to Cavvanba (2012a), maintenance works were conducted at the site by the site owner in early 2010, and included the following:

- decommissioning of the existing remote fill points and addition of a new spill box;
- encompassing the fill points for all of the USTs at the site in one spill box; and
- repair of the driveway area.

## **4.3 Contaminated Land Record Search**

The OEH’s Contaminated Land – Record of Notices was searched for the Suffolk Park area on 17 November 2020. One site was listed – the former dip site to the north-west of the site. Two notices were issued to Laughton Pty Ltd in May and December 1991 relating to the dip. It is understood that the dip has since been decommissioned.

The subject site was not listed on OEH’s Record of Notices database.

## **4.4 Record of Notices**

The NSW EPA Record of Notices provides information regarding land that has been notified to the EPA; and the EPA has subsequently issued a formal Notice under the CLM Act to the occupying business or land owner. The information on the Record of Notices includes only documents which are required to be placed on the register under s58 of the CLM Act (and which may be publicly accessible).

The site is listed on the record of Notices. However, regulation of the site by EPA is not required.

#### **4.5 POEO Act Public Register Search**

The NSW EPA POEO Act Public Register contains information about environment protection licences, licence applications, notices issued under the POEO Act and pollution studies and reduction programs.

The EPA's POEO Act Public Register was searched for the Suffolk Park area on 16 November 2020. Fifteen licences were located, for the Broken Head Quarry approximately 1 km to the south of the site. All 15 licences relate to this Quarry. Given the quarry's distance from the site, there is unlikely to be any impact associated with the quarry on soils at the site.

## 5 Conceptual Site Model (CSM)

From the results of previous investigations, a Conceptual Site Model (CSM) was developed to identify potential sources, exposure pathways and receptors of contamination associated with the service station operations and mechanical workshop at the subject site. This information is summarised in the following sub-sections.

### 5.1 Contamination Sources

Based on the current and historical use of the site for service station purposes, the contamination sources are considered to include the following:

- Leaks from former USTs which have now been decommissioned or removed.
- Leaks from the existing USTs and associated fill pipes.
- Leaks from the existing fuel dispensing bowsers and associated suction pipework.
- Leaks from the former filling points and spills during refuelling operations.
- Spills on the forecourt area. The forecourt is noted to be covered with concrete and bitumen, which were in a fair to good condition at the time of the investigation.
- Leaks from the storage of waste oil drums and minor quantities of chemicals such as lubricants within the workshop area.

### 5.2 Chemicals of Potential Concern

Based on the contamination sources described above, the COPC in potentially affected environmental media at the site have been summarised in Table 3.

**Table 3: Summary of Chemicals of Potential Concern (COPC)**

Chemical	Potentially Affected Media	Comments
Total recoverable hydrocarbons (TRH): <ul style="list-style-type: none"> <li>- F1: C<sub>6</sub>-C<sub>10</sub> minus BTEX</li> <li>- F2: &gt;C<sub>10</sub>-C<sub>16</sub> minus naphthalene</li> <li>- F3: &gt;C<sub>16</sub>-C<sub>34</sub></li> <li>- F4: &gt;C<sub>34</sub>-C<sub>40</sub></li> </ul>	Soil, groundwater and soil vapour (<C <sub>16</sub> only)	Health risk-based fractions presented in the NEPM (2013)*. Associated with all forms of petroleum products.
Benzene, toluene, ethylbenzene, xylenes, naphthalene (BTEXN)	Soil, groundwater and soil vapour	Associated primarily with unleaded petrol
Polycyclic aromatic hydrocarbons (PAH)	Soil, groundwater and soil vapour (naphthalene only)	Associated primarily with diesel
Lead	Soil and groundwater	Associated with former leaded (super) petrol

National Environment Protection (Assessment of Site Contamination) Measure 1999 (as amended 2013) (the 'NEPM').



### **5.3 Potentially Affected Media**

Petroleum hydrocarbons from fuel related infrastructure may affect the quality of soil, groundwater and soil vapour within the unsaturated (vadose) zone.

### **5.4 Potential Exposure Pathways and Receptors of Contamination**

Potential exposure pathways and receptors of contamination in soils at the subject site are summarised in Table 4.

**Table 4: Summary of Potential Exposure Pathways and Receptors of Contamination**

Potential Exposure Pathway	Potential Receptor(s)	Potentially Complete Pathway?	Potential Risk?	Comments
<b>On-Site</b>				
Direct contact with contaminated soil	Current and future site workers	Unlikely	Unlikely	The UPSS area, where soil impacts are likely, is currently almost entirely sealed with concrete or bitumen, and will remain sealed following redevelopment. As such, soils in this area are unlikely to be accessible to future site workers.
	Future sub-surface workers	Yes	Unlikely	<p>Future sub-surface workers may be exposed to contaminated soils during excavation works associated with remediation/removal of the UPSS and/or maintenance of other underground utilities, excavations for building footings, etc.</p> <p>However, potential risks to onsite utility/intrusive maintenance workers are typically managed using procedures that provide strict health and safety requirements for sub-surface workers. This restricts the potential for oral and dermal contact during ground disturbing activities. Exposure periods of maintenance workers are also acute, and would not meet the assumptions which underpin derivation of the chronic assessment criteria provided in the NEPM (adopted as remediation criteria).</p>
	Terrestrial ecological receptors	Yes	Unlikely	<p>Contaminated soils on-site are accessible to terrestrial fauna which may reside in, or otherwise use, the top 2 m of the soil profile.</p> <p>However, where hydrocarbons have been reported, the entire site is sealed, or will be sealed on completion of the redevelopment works.</p>

Potential Exposure Pathway	Potential Receptor(s)	Potentially Complete Pathway?	Potential Risk?	Comments
<b>On-Site</b>				
Direct contact with contaminated groundwater, including LNAPL	Current and future site workers	Unlikely	Unlikely	Depth to groundwater beneath the site is shallow (generally between 1.3 and 1.92 m bgl). However, it is unlikely that site workers would conduct excavations themselves or otherwise have the opportunity to make contact with groundwater beneath the site.
	Future sub-surface workers	Yes	Unlikely	<p>Future sub-surface workers may be exposed to contaminated groundwater and/or LNAPL during excavation works associated with remediation/removal of the UPSS and/or maintenance of other underground utilities, excavations for building footings, etc.</p> <p>However, potential risks to onsite utility/intrusive maintenance workers are typically managed using procedures that provide strict health and safety requirements for sub-surface workers at the site. This restricts the potential for oral and dermal contact during ground disturbing activities. Exposure periods of maintenance workers are also acute, and would not meet the assumptions which underpin derivation of the chronic assessment criteria provided in the NEPM (adopted as remediation criteria).</p>

Potential Exposure Pathway	Potential Receptor(s)	Potentially Complete Pathway?	Potential Risk?	Comments
<b>On-Site</b>				
Inhalation of vapours from contaminated soil, groundwater and/or LNAPL	Current and future site workers	Unlikely	Unlikely	<p>Site workers may be exposed to hydrocarbon vapours migrating upwards from groundwater and/or soil impacts, if they enter the on-site building or future building, and accumulate over time. Vapour movement may be more rapid if preferential pathways, such as utility trenches or services, exist.</p> <p>However at active service stations, ambient air emissions from filling activities are the predominant source of hydrocarbon vapours. The proposed location of the sales building in the current vacant grassed area in the east of the site, where future site workers will be located, will be up to 10 m. This lateral separation distance is typically sufficient to reduce vapour concentrations to acceptable levels, before they enter indoor air spaces.</p>
	Future sub-surface workers, including utility pit workers (where vapours may accumulate)	Yes	Unlikely	<p>Future sub-surface workers may be exposed to vapours migrating into trenches and utility pits.</p> <p>However, potential risks to onsite utility/intrusive maintenance workers are managed using procedures that provide strict health and safety requirements for sub-surface workers on Shell sites. This restricts the potential for worker exposure during ground disturbing activities. Exposure periods of maintenance workers are also acute, and would not meet the assumptions which underpin derivation of the chronic assessment criteria provided in the NEPM (adopted as remediation criteria).</p>

Potential Exposure Pathway	Potential Receptor(s)	Potentially Complete Pathway?	Potential Risk?	Comments
<b>Off-Site</b>				
Direct contact with contaminated soil	Off-site workers, including sub-surface workers	Possible	Unlikely	<p>Future off-site sub-surface workers may be exposed to contaminated soils during excavation works associated with installation and/or maintenance of other underground utilities (including the sewer system), excavations for building footings, etc. Exposure would be more likely closer to the site boundaries (e.g. along Broken Head Road).</p> <p>However, exposure periods would be short (acute), and would not meet the assumptions which underpin derivation of the chronic assessment criteria presented in the NEPM (adopted as remediation criteria).</p>
	Off-site residents	Unlikely	Unlikely	<p>Based on the previous soil results, residents in off-site areas are unlikely to be exposed to contaminated soils if undertaking excavations within their properties. Additionally, the reported soil results of the most recent ENV assessment (April 2018) have not exceeded assessment criteria close to any neighbouring residential properties.</p>

Potential Exposure Pathway	Potential Receptor(s)	Potentially Complete Pathway?	Potential Risk?	Comments
<b>Off-Site</b>				
Direct contact with contaminated groundwater, including LNAPL	Off-site workers, including sub-surface workers	Possible (sub-surface workers only)	Unlikely	<p>Sub-surface workers may be exposed to contaminated groundwater and/or LNAPL during excavation works associated with installation and/or maintenance of underground utilities (including the sewer system), excavations for building footings, etc.</p> <p>However, exposure periods would be short (acute), and would not meet the assumptions which underpin derivation of the chronic assessment criteria presented in the NEPM.</p> <p>Off-site, above-ground workers are unlikely to come into contact with groundwater.</p>
	Off-site residents, including users of bore water	Unlikely	Unlikely	<p>The closest licensed bore is situated 100 m to the south east of the site in the direction of groundwater flow. However, there are monitoring wells not impacted by hydrocarbons between the UPSS and this bore. As such, impact from site activities is not likely to impact on water quality in this bore.</p> <p>Off-site residents are unlikely to come into contact with contaminated groundwater, given its depth (1 to 2 m below ground level).</p>
	Ecological receptors in aquatic (terrestrial) receiving environments	Possible	Unlikely	<p>Terrestrial aquatic flora and fauna may be exposed to hydrocarbons if impacted groundwater extends to the surface water body of Tallow Creek located along the site southern and eastern boundaries.</p> <p>However, there delineation wells MW9 and MW10 have been reported to contain COPC concentrations below assessment criteria, between Tallow Creek and the UPSS.</p>

Potential Exposure Pathway	Potential Receptor(s)	Potentially Complete Pathway?	Potential Risk?	Comments
<b>Off-Site</b>				
Inhalation of vapours from soil and/or groundwater and/or LNAPL	Off-site workers, including sub-surface workers	Yes (sub-surface workers only)	Unlikely	<p>Future off-site sub-surface workers may be exposed to vapours migrating into trenches and utility pits.</p> <p>However, exposure periods would be short (acute), and would not meet the assumptions which underpin derivation of the chronic assessment criteria presented in the NEPM.</p>
	Off-site residents	Unlikely	Unlikely	<p>Off-site residents may be exposed to vapours migrating from contaminated soil and/or groundwater/LNAPL into their homes, or along preferential movement pathways associated with underground services (including sewer pipelines).</p> <p>However, the reported results do not indicate plausibly complete exposure pathways between the identified volatile compounds in soil (UST area, central site portion) and nearby residential properties to the north and east.</p>

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## 6 Data Quality Objectives (DQOs)

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### 6.1 Step 1: Problem Identification

The existing UPSS requires removal and replacement with a new UPSS. This RAP is required to provide a framework and detailed measures for ensuring that the works do not pose unacceptable risks to human health or the surrounding environment, and to ensure the site is suitable for ongoing service station use on completion of the program.

### 6.2 Step 2: Identify the Decisions

The principal decisions (questions) are:

- Is there residual contamination in soil at the site, associated with the UPSS being removed, and do the COPC concentrations exceed the adopted remediation criteria for the protection of potential receptors?
- Subsequently, what are the identified receptors; and are the contamination pathways to those receptors complete? If so, what risks are potentially posed by the site conditions to these receptors?

### 6.3 Step 3: Inputs to the Decision

To address the decisions in Step 2, the following activities are required:

- Validation of in-situ soils will be required during the course of the remediation works and the results assessed relative to the adopted remediation criteria.
- If soil validation results exceed adopted remediation criteria, and practical limits of excavation have been met, further investigations may be required to determine if contaminant-receptor pathways are active (e.g. soil vapour and/or indoor air sampling).
- Excavation of contaminated soil will need to be undertaken under the supervision of a suitably qualified Environmental Scientist (RC) to ensure that excavated contaminated soil is managed in accordance with the correct Waste Classification.

### 6.4 Step 4: Define the Study Boundaries

For the purposes of this RAP, the study area is limited to land immediately surrounding the existing UPSS (refer to Figure 2, Attachment 1), and where the new UPSS will be installed. The study area does not extend to other areas of the site, or to any off-site areas.

Temporally, the study will be limited to the timeframe required for removal of the UPSS. That is, all field observations and soil validation sampling will be conducted across a period of 1 – 7 days.

If soils are stockpiled and/or remediated on site, the temporal boundaries may extend beyond this timeframe.



## 6.5 Step 5: Develop a Decision Rule

Data from the soil investigation will be compared with the adopted remediation criteria. These criteria were derived from generic (Tier 1) investigation and screening levels presented in the NEPM.

Both the maximum observed contaminant concentrations and 95% upper confidence limit (UCL) of the arithmetic mean contaminant concentrations (if statistical analysis is required) will be compared to these criteria. The UCLs will be calculated and applied in consideration of the geographical location, depth and soil type of the validation sample(s).

Given the objectives of the soil assessment, and the nature of hydrocarbon contamination typically associated with UPSS, an approach which allows targeted sampling will be adopted. Soil samples will be collected in locations which are consistent with the requirements of the *NSW EPA Technical Note: Investigation of Service Station Sites* (2014a). These include the walls and base of the final excavation extents, beneath underground pipework and beneath dispensing bowser locations.

The precision (reproducibility), accuracy, representativeness and overall reliability of the data sets will be assessed using the information presented in Table 5. This includes the collection of appropriate quality assurance (QA) samples during sampling, and internal QA testing conducted by the analytical laboratories. The QA sampling regime will be adopted from the NEPM and from *AS4482.1 Guide to the Investigation and Sampling of Sites with Potentially Contaminated Soil – Part 1: Non-volatile and semi-volatile compounds* (2005); and *Part 2: Volatile compounds* (1999).

**Table 5: Summary of QA Sample Parameters for Assessing Data Reliability**

QA Sample Type	Media	Frequency	Acceptable Range of Results
<b>Precision (Reproducibility)</b>			
<b>Field Sampling</b>			
Intra-lab duplicate	Soil	1 per 20 primary samples, or part thereof	Relative percent difference (RPD) ≤50%
Inter-lab duplicate	Soil	1 per 20 primary samples, or part thereof	RPD ≤50%
<b>Laboratory Analysis</b>			
Internal duplicate	Soil	1 per 10 primary samples	Laboratory specified, concentration dependent;  Envirolab: (RPD of any % for concentrations < 5 x LOR; RPD of 0-50% for concentrations > 5 x LOR)
<b>Accuracy</b>			
<b>Laboratory Analysis</b>			
Matrix Spikes	Soil	1 per sampling batch (20 samples per batch)	Laboratory specified;  Envirolab: 70-130% (inorganics); 60-140% (organics)
Surrogate Spikes	Soil	1 per sampling batch (20 samples per batch)	Laboratory specified;  Envirolab: 70-130% (inorganics); 60-140% (organics)
Laboratory Control Samples	Soil	1 per sampling batch (20 samples per batch)	Laboratory specified;  Envirolab: 70-130% (inorganics); 60-140% (organics)

Representativeness			
Laboratory Analysis			
Laboratory Blank	Soil	1 per sampling batch (20 samples per batch)	Results <LOR

## 6.6 Step 6: Specify the Performance or Acceptance Criteria

### 6.6.1 In Situ Soils

The remediation criteria adopted for the RAP are drawn from Tier 1 investigation and screening levels presented in the NEPM and other relevant documents, as follows:

- National Environment Protection Council (NEPC, 2013a). The NEPM - Schedule B(1) Investigation and Screening Levels.
- Friebe, E. and Nadebaum, P. (2011). Health screening levels for petroleum hydrocarbons in soil and groundwater. Summary, CRC CARE Technical Report No. 10. CRC for Contamination Assessment and Remediation of the Environment, Adelaide, Australia.

Based on the information presented above, the following investigation and screening levels were adopted as remediation criteria:

- NEPM Health Investigation Levels (HILs) and Health Screening Levels (HSLs): exposure setting D (HIL/HSL D); for continued (future) commercial land use as a service station facility; for coarse grained soil (sand). This exposure setting reflects the proposed ongoing service station use and known shallow soil conditions in the area.
- NEPM Ecological Investigation Levels (EILs) and Ecological Screening Levels (ESLs) for commercial land use (coarse grained soil, sand).

Olfactory and visual indicators of contamination, such as staining and odours, will also be used to identify the potential presence of petroleum hydrocarbons in the soils. A PID will be used to screen the headspace of discrete sub-samples and provide 'real-time' guidance for the extent of excavation works on site, as well as the selection of samples for laboratory analysis.

Remediation criteria are tabulated in Attachment 3.

### 6.6.2 Excavated and Stockpiled Soil

Soils removed from the existing UPSS area will be stockpiled temporarily in a designated remediation area (refer to Section 7.7.1 for further details). Soils which exhibit field indicators of potential contamination will be segregated from soils which are not visibly contaminated.

If the stockpiled soils are to be re-used on site, final validation sampling concentrations will be compared with the adopted remediation criteria presented in Section 6.6.1.

If the soils are to be disposed off-site in NSW, they will be classified in accordance with the NSW EPA Waste Classification Guidelines (2014). If the soils are disposed off-site in QLD, further classification testing may also need to occur, with respect to individual landfill licence requirements in QLD.

### **6.6.3 Application of the Remediation Criteria**

Where comparison of the soil validation sample results indicates that either a maximum COPC concentration in one or more locations exceeds the remediation criteria, or the 95% UCL of the arithmetic mean COPC concentration exceeds the remediation criteria, the results will first be evaluated in the context of the CSM. That is, the potential source-pathway-receptor (SPR) linkage associated with the result(s) will be assessed, with particular reference to whether the SPR linkage is complete.

If the SPR linkage is not considered to be complete, no further action will be taken (the soil represented by the exceedence will be left in situ).

If the SPR linkage is complete, further excavation will occur until such time as the COPC concentrations in soils remaining in situ are less than the Remediation Criteria.

## **6.7 Step 7: Optimise the Design for Obtaining Data**

The sampling regime has been designed to collect data from soils which are representative of in situ conditions following removal of the UPSS, in consideration of the fact the site will continue to be used as a service station.

The design incorporates guidance presented in AS4482.1 (1999 and 2005), the NEPM and other current industry standards relating to the objectives of the assessment. To optimise the design of the investigation, the sampling and analytical program was devised to specifically target information required to meet the project objectives.

## 7 Remediation Works Program

### 7.1 Preamble

This section provides a description of the expected remedial works required to remove the existing UPSS and ensure soils at the site are suitable for future commercial land use (service station) upon completion of the program.

The scope of the remedial works is based on the known UPSS composition, reasonably anticipated ground conditions and sampling and other requirements specified in the NSW EPA (2014) Technical Note: Investigation of Service Station Sites.

It is possible that unexpected conditions will be encountered during excavation works. If this is the case, the RAP may be revised to incorporate any changes required to the remedial program. Contingency measures for the remedial works are also presented in Table 9.

### 7.2 Responsibilities and Contacts

The overall responsibilities and contacts for the remedial works are summarised in Table 6.

**Table 6: Responsibilities and Contacts**

Responsible Party	Contact	Responsibilities
<b>Property Owner</b>	Horizon Retail Pty Ltd	<ul style="list-style-type: none"> <li>- Engage the RWC and RC to undertake all activities required by this RAP.</li> </ul>
<b>Remediation Works Contractor (RWC)</b>	TBA	<ul style="list-style-type: none"> <li>- Ensure that all remediation activities are undertaken in accordance with this RAP and any other management plans required and approved by regulatory bodies for the works (e.g. Council).</li> <li>- Induct all employees, subcontractors and authorised visitors to the site, with respect to work procedures, the requirements of this RAP and other approved management plans (if any).</li> <li>- Report any environmental issues to the Property Owner.</li> <li>- Maintain site induction, site visitor and complaint registers, as required.</li> </ul>
<b>Remediation Consultant (RC)</b>	ENV Solutions Pty Ltd (ENV)	<ul style="list-style-type: none"> <li>- Ensure that all soil validation and reporting activities are carried out in accordance with this RAP.</li> </ul>

### 7.3 Preliminary Works

Preliminary works will be required at the site prior to the remediation program commencing. The preliminary works will include, but may not be limited to, the following:

- Erection of appropriate fencing, shade cloth or other appropriate screening material and associated signage around the works area, to warn of the nature of works being conducted.
- Erection of appropriate sediment barriers (e.g. silt fence or hay bales) around the works areas and around the site perimeter.
- Implementation of appropriate OH&S and administrative protocols, including induction procedures, site inspection requirements, training registers, etc; as required.
- Removal of concrete and/or bitumen hardstand covering the UPSS area.
- Removal of residual liquids from the component USTs and attached pipework.

### 7.4 UPSS Exhumation and Removal

Four USTs, dispensing bowsers and associated pipework comprise the existing UPSS. The UPSS will be exhumed, removed and disposed off-site by the RWC in accordance with the provisions of *AS4976-2008: The removal and disposal of underground petroleum storage tanks*.

The following works will be conducted as part of this program:

- The overburden fill above the USTs will be excavated by the RWC to expose the UST tops.
- The USTs and associated pipework will be exhumed by the RWC and removed from the excavations, degassed and transported off-site for disposal. If the USTs are not degassed on site, they will be removed from site by a contractor licensed to transport dangerous goods.
- Potentially contaminated soil within the excavation(s) will be removed by the RWC to the extent practicable, in consideration of the remediation criteria. It is noted that if the USTs are 'floated out', in consideration of the site's shallow groundwater (1-2 mBGL), the extent of excavation around and beneath the USTs will be limited. Any soil removal will be based on visual and olfactory observations, together with photo-ionisation detector (PID) measurements to assess the concentration of volatile organic compounds (VOCs) that may be indicative of petroleum hydrocarbon concentrations within the soil. The relative location of the contamination, with respect to current and future building locations and potential human receptors of soil vapour migration, will also be considered in deciding the final extents of excavation required.
- Soil validation samples will be collected by the RC from the final excavation extents and spoil (refer below), and visual and olfactory observations made of the overburden soils that have been removed, as well as the exposed excavation extents.

- Spoil from the excavations will be stockpiled on site by the RWC in the designated stockpiling area, pending visual observation and field testing by the RC. Should field observations indicate that chemical concentrations within the spoil are likely to meet the adopted remediation criteria, it may be set aside for placement back into the excavation(s) and nominally compacted. If field observations indicate the potential presence of petroleum hydrocarbons in the soil (staining, odours or elevated PID readings), it will be remediated on-site, or disposed off-site to a suitably licensed landfill facility following sampling and laboratory testing. If this is the case, the spoil will be placed into a bunded and lined area, situated away from the site boundaries – nominally, as close to the central portion of the site as possible and out of flood prone areas.
- Haybales and low-density polyethylene (LDPE) plastic will be used to form the bunded stockpiling area in a manner which reduces the potential for stormwater run-off to leach soil and associated hydrocarbons away from the bunded area. The soil will remain in the bunded area until the laboratory results are received, after which time the soil will either be bioremediated on-site (refer to Section 7.7), or disposed to landfill. The decision regarding on-site treatment or landfill disposal may depend on factors including the volume of contaminated soil and available timeframe for remediation.
- Groundwater wells are located within or close to the UPSS area. The RWC must exercise all due care to ensure that these wells are not damaged by the remediation works. If the wells are damaged, they will require replacement such that the site can continue to meet its obligations under the POEO (UPSS) Regulation (2019). Some wells may also require decommissioning in consideration of the new site configuration.
- It is not proposed to conduct dewatering during removal of the existing UPSS. Rather, it is likely the USTs will be ‘floated out’, with surrounding soils excavated to the extent practicable in consideration of the shallow groundwater (1-2 m BGL).
- If a vacuum truck is used to remove groundwater from the excavation(s), the water will be disposed to a facility which is licensed to accept the water.

## 7.5 Soil Validation Sampling

The resulting excavation extents will be inspected and validated by the RC, and the RWC will assist the RC with soil validation sampling by providing the use of on-site plant (excavator) for this purpose. If further excavation is required, the RC will direct the RWC in this regard.

Sampling will be conducted by the RC in a manner which is compliant with the requirements of the NSW EPA (2014) Technical Note: Investigation of Service Station Sites. Nominally, this will include at least one (1) sample collected from the base of each UST, one (1) sample collated from each wall of the excavation adjacent to the USTs, one (1) sample per each linear 5 m of pipework and one (1) sample from beneath each dispensing bowser. A sub-sample will be collected at each location and screened for the potential presence of volatile organic compounds (VOCs) using a

calibrated photo-ionisation detector (PID). Should any field indicators of contamination be detected, additional soil samples may be required.

Further details regarding validation sampling are presented in Section 12.

## **7.6 Backfilling**

Once all excavation and validation sampling is complete, the excavations may be either backfilled with imported fill material from a virgin quarry source (i.e. VENM); or backfilled with bioremediated soil (if this is practicable). It should be noted that backfilling with bioremediated soil will cause delays in the overall program, and would require the long-term management of open, or partially open excavations. Further information regarding bioremediation and validation sampling is presented in Section 7.7.

Appropriate chemical testing will be conducted by the RC prior to placement of the fill, in accordance with current NSW EPA requirements. Testing will not be required if certifying documentation for the VENM can be provided by the source quarry.

The backfill may be compacted by the RWC to provide geotechnical conditions which are appropriate for future development; and the ground surface above all excavated and stockpiling areas will be left level with the surrounding ground surfaces, or at design level.

Appropriate certification for the backfill material, which confirms that it meets the remediation criteria, will be provided by the RWC to the RC for the purposes of the final Validation Report.

## **7.7 Bioremediation**

Some of the hydrocarbon impacted soils may be bioremediated on-site to reduce project costs. The bioremediation process is described in the following sub-sections.

If bioremediation is not conducted, any hydrocarbon impacted spoil will require appropriate waste classification by the RC in accordance with the NSW EPA Waste Classification Guidelines (2014) and off-site disposal by the RWC at a facility which is licensed to accept the category of waste assigned to the spoil.

### **7.7.1 Establishment of Treatment Area**

Prior to commencing any remediation excavations, a treatment area would be established by the RWC in an area of the site where excavations are not proposed. The location will provide appropriate buffer distances to the nearest sensitive receptors and be situated beyond the limits of known flood prone areas. These are understood to be limited to the central and western site portions.

The treatment area would be constructed on a relatively flat section of ground. A layer of low density polyethylene (LDPE) would then be placed on the ground surface, onto which the hydrocarbon contaminated soil can be placed. Prior to placement of the impacted soils, weights may be used to keep the layer in place, although the LDPE lining would be placed immediately prior to excavation of the contaminated soils.



### **7.7.2 Construction of Biopile(s)**

Once excavation of the contaminated soils commences, the soils would be trucked by the RWC to the treatment area and deposited onto the LDPE lining. Deposition would occur in a manner which maximises the potential for volatilisation of volatile contaminants and allows oxygenation of the soils.

Once all hydrocarbon impacted soils have been excavated and placed in the treatment area, the soils would be augmented with nutrients by way of the addition of a natural or synthetic fertiliser and the soils mixed thoroughly. To achieve a suitable level of mixing, the fertiliser may be added in increments as the impacted soils are placed in layers into the treatment area.

The biopile(s) will require aeration by thoroughly turning the soils with an excavator or similar on a weekly basis, as a minimum.

The entire treatment area will be appropriately bunded to prevent the discharge of stormwater run-off from the biopile(s).

Dust and odour controls will also be implemented. If complaints are received from project stakeholders, including neighbouring property occupiers, additional controls may be required to address the complaints.

### **7.7.3 Periodic Monitoring and Testing**

Check samples will be collected from the biopile(s) by the RC and laboratory analysed periodically during the bioremediation treatment works. The frequency of this sampling may be dictated by the COPC concentrations in the initial (characterisation) samples collected from the spoil. Sub-samples may also be collected more frequently from the biopile(s) and screened using a PID to evaluate progress of the bioremediation works.

During the periodic testing, the LDPE lining will be inspected for integrity and indications of odour emissions outside of the treatment area and/or at the site boundaries evaluated. Should the inspection indicate that the integrity of the system is compromised or inadequate, corrective actions will be implemented by the RWC. These may include, but not be limited to, replacing the LDPE liner, placing odour suppressing misters at the site boundaries or at the edges of the treatment area.

Once the periodic testing indicates that the adopted remediation criteria are likely to have been achieved, final validation samples will be collected by the RC from the biopile(s).

### **7.7.4 Decommissioning of Treatment Area**

Once the final validation sampling results indicate that the treated soil is suitable for on-site re-use as backfill, the soil will be progressively removed from the treatment area and the LDPE basal liner removed.

If the treated soil is surplus to the program, it may be either tested for beneficial re-use as Excavated Natural Material (ENM), in accordance with the requirements of the ENM Order (2014), or disposed off-site to landfill in NSW or QLD. Disposal in QLD may

be subject to the provision of a Soil Disposal Permit (SDP), issued by the QLD Department of Environment and Science (DES).

## 8 Indicative Remediation Schedule

An indicative schedule for the proposed remedial works program is presented below in Table 7.

**Table 7: Indicative Remediation Schedule**

Action	Timeframe <sup>1</sup>
<b>UPSS REMOVAL PROGRAM</b>	
On Site Preparation and Setup (RWC)	1-2 days
UST Removal and Excavation Program (RWC)	2 days to 1 week
Validation Sampling and Laboratory Analysis (RC)	1-2 weeks
Backfill of Excavations and Site Cleanup (RWC)	2 days
Validation Reporting (RC)	2 weeks from receipt of final laboratory results and all documentation from the RWC
<b>BIOREMEDIATION (if conducted)</b>	
Establish Bioremediation Treatment Area (RWC)	1 day
Construct Biopile(s) (RWC)	1-2 days
Bioremediation Treatment (RWC, or other designated person)	Approximately 12 weeks. <b>NOTE:</b> The treatment process will require weekly turning of the soil as a minimum, for aeration purposes.
Final Validation Testing of Treated Soils (RC)	1 day
Laboratory Testing (Final Validation Samples) (RC)	1 – 2 weeks
Decommissioning of Treatment Area (RWC)	1 day – 1 week
Backfilling On-Site with Treated Soils or Disposal Off-Site (RWC)	1-2 days

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## **9 Site Environmental Management – Remediation Works**

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All remediation works will be undertaken by the RWC with due regard to the minimisation of adverse environmental effects, and to meet all statutory environmental and safety requirements.

Site environmental management measures which will apply to the remedial works are presented in Table 8.

**Table 8: Site Environmental Management Measures**

Item	Description/Requirements
<b>Stormwater Management</b>	<ul style="list-style-type: none"> <li>- Measures will be adopted by the RWC to ensure that potentially contaminated water does not leave the site.</li> <li>- As a minimum, the following controls will be considered and implemented by the RWC: diversion and isolation of any stormwater from any contaminated areas; provision of sediment traps; discharge of any water to drains and water bodies must meet the appropriate effluent discharge consent condition under the <i>Protection of the Environment Operations Act (1997)</i>.</li> </ul>
<b>Soil Management</b>	<ul style="list-style-type: none"> <li>- The RWC will ensure that soils are excavated, transported and placed (backfill) using methodologies that will ensure nuisance dust and odours are not generated, and that no discernible (visible) dust crosses the property boundaries (refer also below – ‘Dust’ and ‘Odour’).</li> <li>- The RWC will ensure that different soil types, where practicable, are not mixed, and that potentially contaminated soils are segregated from those that are considered unlikely by the RC to be contaminated.</li> <li>- During periods of heavy rain, site works will cease to prevent sediment run-off from the works area(s).</li> <li>- Contaminated soil will be bioremediated on-site in a controlled manner consistent with this RAP; or disposed to an appropriately licensed landfill facility by the RWC, in accordance with all legislative requirements and directions from the RC.</li> <li>- Wheel washes, or other methods which effectively remove soil from vehicle wheels, will be used to prevent the tracking of contaminated soil onto adjacent roadways. If soil is tracked onto adjacent roadways, the RWC will be responsible for cleaning the affected roadways.</li> </ul>
<b>Dust</b>	<ul style="list-style-type: none"> <li>- The RWC will implement measures to ensure that no nuisance dust is generated during the remedial works. These may include: the use of a water cart to wet soils; and the use of sprinklers or spray to wet stockpiled soils (before they can be appropriately covered or transported off-site).</li> <li>- Excessively windy days should be avoided, and the scheduling of works should consider the weather forecast.</li> <li>- All heavy equipment used for the works will be appropriately serviced and maintained to minimise the generation of excessive diesel exhaust emissions.</li> </ul>
<b>Odour</b>	<ul style="list-style-type: none"> <li>- The RWC will implement measures to ensure that no nuisance odour is generated during the remedial works. These may include the use of odour suppressing agents to control strong odours. Any odour suppressing agents used will contain only degradable and otherwise environmentally friendly constituents, and will not affect the contamination status of site soils, or alter the waste classification assigned to the soils by the RC (if required).</li> <li>- Excessively windy days should be avoided, and the scheduling of works should consider the weather forecast.</li> </ul>

	<ul style="list-style-type: none"> <li>- All heavy equipment used for the works will be appropriately serviced and maintained to minimise the generation of excessive diesel exhaust emissions.</li> </ul>
<b>Noise and Vibration</b>	<ul style="list-style-type: none"> <li>- Noise and vibration will be restricted to reasonable levels. All plant and equipment used on site will have mufflers fitted (where practicable) to reduce noise generation.</li> <li>- Vibration levels from backfill compaction activities (if used) will be monitored by the RWC, and appropriate measures implemented to ensure that adjacent infrastructure, including off-site structures, are not damaged by the activities.</li> </ul>
<b>Hours of Operation</b>	<ul style="list-style-type: none"> <li>- Site works will be limited to the following hours: <ul style="list-style-type: none"> <li>- Monday to Friday: 7 am to 6 pm</li> <li>- Saturday: 8 am to 1 pm</li> <li>- Sunday: No operation.</li> </ul> </li> </ul> <p>Any work outside of these hours will require prior authorisation from BSC.</p>
<b>Incident Management and Community Relations</b>	<ul style="list-style-type: none"> <li>- While this RAP includes management measures to reduce the risk of potential human health and environmental impacts from the site activities, it is possible that unforeseen circumstances may occur which lead to a perceived risk by stakeholders such as nearby residents, commercial workers and the general public. To mitigate impacts from such events, the RWC will include in its safety documentation details of responsible persons and the actions to be taken by them in such cases.</li> </ul>

## 10 Contingency Management

During the remediation works, there is the potential for unexpected environmental conditions, or conditions for which management measures have not been provided in this RAP, to be encountered. This section provides a summary of conditions which have been reasonably anticipated based on previous experience with similar works programs, and the known site conditions. Contingency management measures to be adopted during the remediation works are summarised in Table 9.

**Table 9: Contingency Management Requirements**

Anticipated Issue	Required Action(s)
<b>Chemical/Fuel Leak or Spill from Machinery</b>	<ul style="list-style-type: none"> <li>- Stop work immediately or as soon as practicable.</li> <li>- Use accessible soil or other appropriate absorbent material to absorb the spill (if practicable), remove the material and place it temporarily on LDPE or similar impervious plastic close to the work area. If free liquid is associated with the material(s), use additional soil or other suitable material to bund the area of stockpiled soil. The RC will conduct observation/testing of the material as soon as possible and define management options.</li> </ul>
<b>Excessive Dust</b>	<ul style="list-style-type: none"> <li>- Use water sprays to suppress the dust, or stop activities which are generating the dust as soon as practicable such that alternative methodologies can be discussed and agreed with the RC and Site Owner.</li> <li>- If the dust problem is caused by excessively windy conditions, consider the possibility of rescheduling works to a calmer day.</li> </ul>
<b>Excessive Noise</b>	<ul style="list-style-type: none"> <li>- Identify the source of noise, isolate the source if possible, and modify the actions of the source or replace it.</li> </ul>
<b>Excessive Odours/Vapours</b>	<ul style="list-style-type: none"> <li>- The RC will monitor the work area with a PID and lower explosive limit (LEL) meter at all times during excavation. If the PID measurement exceeds 50 ppm<sub>v</sub> and/or the LEL measurement exceeds 5%, stop work and assess the source of the vapours. Do not re-commence work until the PID measurement is less than 50 ppm<sub>v</sub> and the LEL measurement is less than 5%. If the PID measurement exceeds 100 ppm<sub>v</sub> and/or the LEL measurement exceeds 10%, stop work and evacuate the work area. Do not re-enter the work area for a period of at least 10 minutes, and do not re-commence work until the PID measurement has fallen below 50 ppm<sub>v</sub> and the LEL measurement below 5%.</li> <li>- If excessive odours are noted, stop work and assess the source of the odours. Change work methods, if practicable, to reduce odours. If the odours persist, consider the use of an odour suppressant which has characteristics consistent with the requirements of Table 8 ('Odour').</li> </ul>
<b>Excessive Rainfall</b>	<ul style="list-style-type: none"> <li>- Stop work immediately or as soon as practicable.</li> <li>- Ensure sediment and surface water controls are operating correctly.</li> <li>- If practicable, divert surface water away from open excavations, particularly if contaminated soils are still present within the excavation.</li> </ul>

Anticipated Issue	Required Action(s)
<b>Water in Excavation(s)</b>	<ul style="list-style-type: none"> <li>- Shallow groundwater may enter the remedial excavations.</li> <li>- The RC may take water quality measurements and/or use visual and olfactory indicators of contamination to assess whether sampling is required.</li> </ul>
<b>Contaminated Groundwater (including LNAPL) is Encountered</b>	<ul style="list-style-type: none"> <li>- The RC may review groundwater conditions on site by collecting samples of the potentially contaminated water, and/or by sampling the existing groundwater wells. The need for LNAPL characterisation and removal will be discussed by the RC with the RWC and the site owner prior to any LNAPL testing or removal occurring.</li> </ul>
<b>Failure of Erosion or Sedimentation Control Measures</b>	<ul style="list-style-type: none"> <li>- Stop work and repair failed control measure.</li> </ul>
<b>Unearthing Unexpected Materials, Fill or Waste (including highly contaminated soils, asbestos, etc)</b>	<ul style="list-style-type: none"> <li>- Stop work.</li> <li>- The RC will direct the excavation and segregation of the materials on site for possible testing and observation.</li> </ul>
<b>Identification of Potential Cultural Heritage Items</b>	<ul style="list-style-type: none"> <li>- If potential cultural heritage items are encountered, stop work immediately.</li> <li>- The RWC will discuss the find with the Site Owner, who will contact the Office of Environment and Heritage (OEH) for direction.</li> <li>- The RWC will barricade the immediate area of the find to prevent access and/or potential damage.</li> </ul>
<b>Complaints</b>	<ul style="list-style-type: none"> <li>- The RWC will notify the site owner as soon as practicable.</li> <li>- The site owner will discuss with the RC and RWC possible changes to the works program to address the complaint(s). The complainant will be contacted by the site owner or the RWC following implementation of the changes, to ensure that the complaint has been adequately addressed.</li> </ul>



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## **11 Work Health and Safety Requirements**

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The NSW Work Health and Safety Act and associated Regulation (2017) require the preparation of documentation that addresses project-specific risks when undertaking construction related work.

In accordance with these requirements, the RWC will have available on site a Work Health and Safety Manual, or similar documentation, which:

- contains a description of commonly completed activities (remedial works);
- identifies potential risks associated with the activities; and
- presents appropriate risk mitigation measures and responsibilities for these risks.

Project-specific Safe Work Method Statements (SWMS) for the works will also be prepared by both the RC and RWC, prior to the remedial program commencing. Copies of these documents will be available on site at all times during the remedial works program.

## 12 Validation Sampling and Analysis Quality Plan (SAQP) – Remedial Works

### 12.1 Validation Methodology

Soil validation samples will be collected by the RC from within the excavations made for removal of the UPSS.

The objective of the sampling is to ensure that:

- soil remaining *in situ* at the site following UPSS removal meets the adopted remediation criteria; and
- any surplus soils that are transported off-site for landfill disposal are classified in accordance with the accepting landfill licence conditions.

Table 10 provides a summary of the soil validation sampling, handling, transport and laboratory analysis activities that are anticipated for the program. Changes to these activities may be required where unexpected contamination is encountered and/or where greater volumes of contaminated soils are removed from the site. Any changes will be discussed with the site owner and RWC prior to implementation; and will conform to current statutory requirements and NSW EPA guidance, as required.

**Table 10: Summary of Soil Validation Activities – Remediation Program**

Activity	Details
<b>Sample Collection Methods</b>	<ul style="list-style-type: none"> <li>- All <i>in situ</i> soil samples will be collected directly from the face of excavation surfaces, or where this is not safe, from material brought to the surface by an excavator bucket.</li> <li>- All stockpiled soils will be sampled with consideration of the representativeness of different material types and total volumes.</li> <li>- A sub-sample of each sample will be screened using a PID to provide an indication of the potential for VOCs to be present in the samples.</li> <li>- A fresh pair of nitrile or other suitable disposable gloves will be worn to collect each sample and minimise the potential for cross-contamination.</li> <li>- Any reusable equipment such as trowels will be decontaminated between sample locations with potable water and Decon-90 or equivalent. A rinsate sample will also be collected from any reusable equipment at a rate of 1 rinsate per piece of reusable equipment.</li> <li>- Samples for laboratory analysis will be placed into new glass jars with no headspace and kept chilled and secure in a cool box from sample collection to laboratory dispatch. All jars will be labelled with unique identifying information. Chain of Custody (COC) documentation will be prepared in accordance with NEPM (2013) requirements.</li> </ul>

Activity	Details
<b>Sampling Location and Frequency</b>	<ul style="list-style-type: none"> <li>- Soil samples will be collected from the UPSS area at the following rates, which are consistent with the requirements of the NSW EPA Technical Note: Investigation of Service Station Sites (2014): <ul style="list-style-type: none"> <li>- <b>Base (within UST area(s)):</b> 1 per UST (length <math>\leq 4</math>m); 2 per UST (length 4 - <math>\leq 10</math> m) and 3 per UST (length <math>&gt; 10</math> m).</li> <li>- <b>Walls (within UST area(s)):</b> 1 per wall (UST length <math>\leq 4</math>m); 2 per wall (UST length 4 - <math>\leq 10</math> m) and 3 per wall (UST length <math>&gt; 10</math> m).</li> <li>- <b>Pipework:</b> 1 per 5 linear metres.</li> <li>- <b>Dispensing Bowsers:</b> 1 per bowser.</li> <li>- <b>Stockpiled Material (including biopiles):</b> 1 sample per 25 m<sup>3</sup> up to 200 m<sup>3</sup>. For volumes over 200 m<sup>3</sup>, an appropriate rate will be decided in consideration of the overall volume, consistency and contamination status of the material.</li> </ul> </li> <li>- Additional validation samples may be collected where visual and/or olfactory indicators suggest contamination may be present and/or additional soils are excavated (as per the above sampling rates).</li> </ul>
<b>Laboratory Analysis</b>	<ul style="list-style-type: none"> <li>- All soil validation samples: TPH/TRH, BTEXN, PAH and heavy metals (8).</li> <li>- All stockpile characterisation samples: same COPC as above, plus TCLP leachability testing for some compounds.</li> </ul>
<b>Field QA/QC Sampling</b>	<ul style="list-style-type: none"> <li>- Field QA/QC samples will be collected and analysed in general accordance with the requirements of NEPM (2013). These will include: <ul style="list-style-type: none"> <li>- Duplicate and triplicate soil samples at a rate of 1 duplicate per 10 primary samples (1 set of duplicates per 20 primary samples).</li> <li>- An equipment rinsate blank (if reusable equipment such as a trowel is required to collect the soil samples) at a rate of 1 per piece of reusable equipment.</li> </ul> </li> </ul>
<b>Laboratory QA/QC Analysis</b>	<ul style="list-style-type: none"> <li>- The analytical laboratories will be required to conduct a minimum level of QA/QC analysis, in accordance with Schedule B(3) of the NEPM (2013). These analyses will include, but may not be limited to: reagent blanks, spike recoveries, laboratory duplicates, calibration standards and method blanks. The laboratories will perform their own statistical analyses on the QA/QC results, and report whether the results were within acceptable limits. Comments will be provided in the Validation Report on the validity of the laboratory results, with reference to the QA/QC data and statistical analyses.</li> </ul>

## 12.2 Reporting

Following completion of the UPSS removal program and laboratory analysis (including bioremediated soils, if this is conducted), the RC will prepare a validation report which presents the following information:

- Details of the methodology used for all elements of the remedial program.
- Details of the validation sampling conducted by the RC.
- The results of the laboratory analyses, with comment on their reliability in consideration of the QA/QC data.
- Conclusions regarding the suitability of the site for future commercial/industrial land use.

The report will be prepared to meet the requirements of the NSW EPA (2020) Consultants Reporting on Contaminated Land (Contaminated Land Guidelines).

In accordance with the requirements of SEPP 55, a copy of the Validation Report will be provided to Byron Shire Council for its records no later than 60 days after completion of the remedial program (including bioremediation treatment).

## 13 References

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## 14 Appendices

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Appendix A	Figures
Appendix B	Laboratory Results (ENV, 2018)
Appendix C	Remediation Criteria

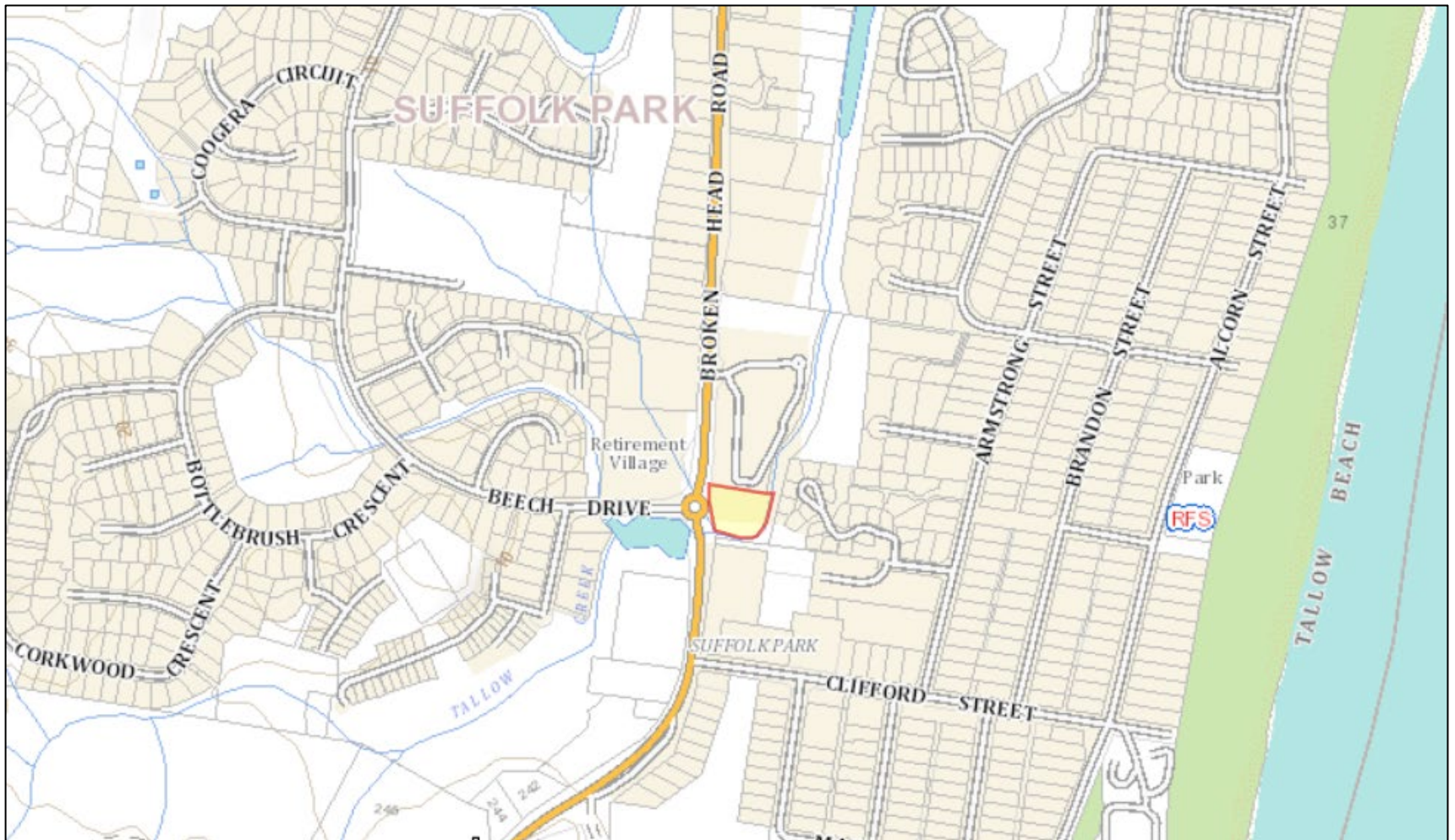
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## APPENDIX A

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### Figures





Site Location



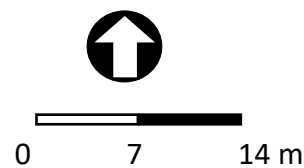
0 50 100 m

**ENV**  
Solutions  
ENVIRONMENTAL | ASBESTOS | REMEDIATION | RESOURCE RECOVERY

**Figure 1 – Site Locality Plan**  
207-209 Broken Head Road, Suffolk Park, NSW

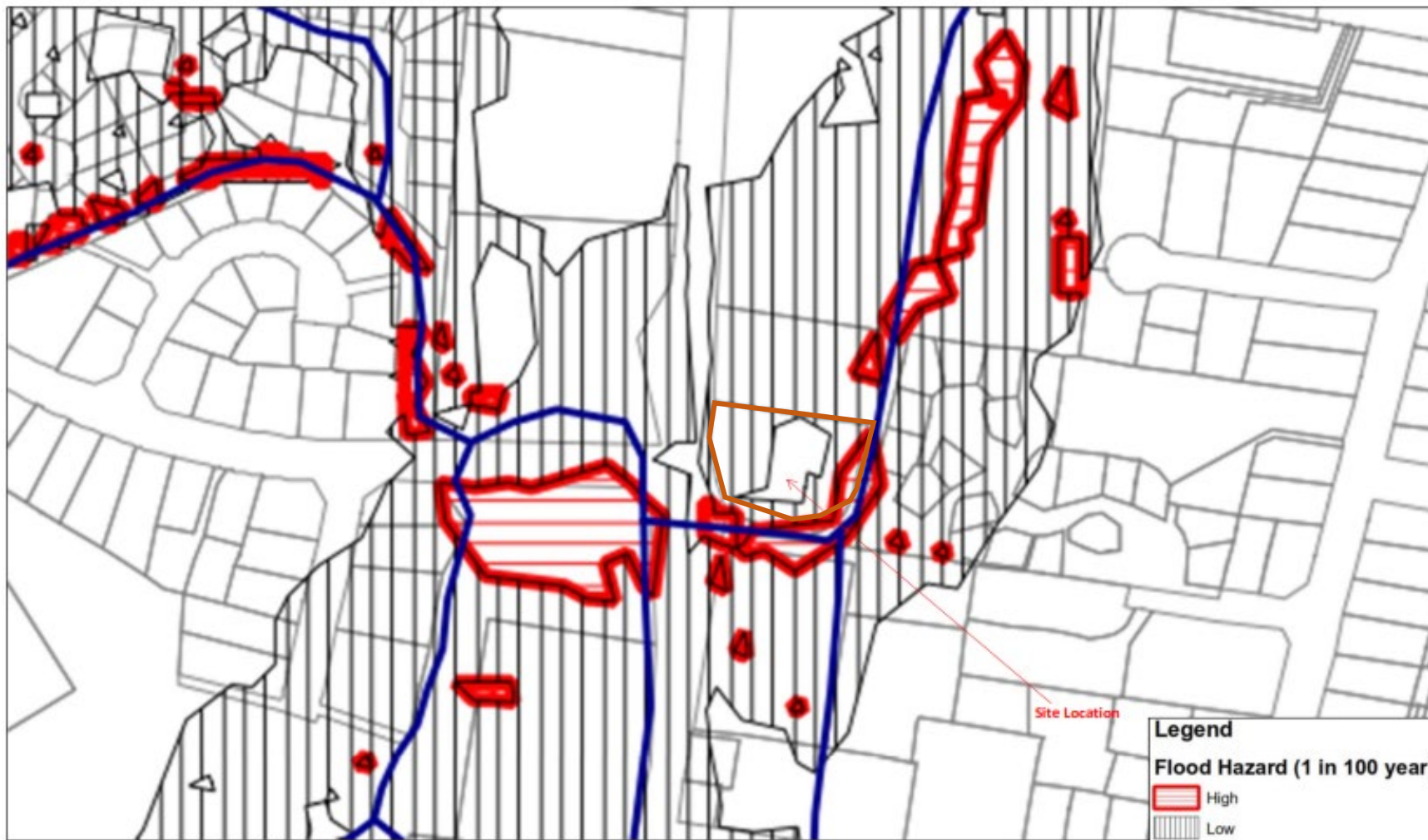


- Potential Stockpiling Location (pre-demolition)
- Potential Stockpiling Location (post-demolition)



**Figure 2 – Site Layout**  
 207 – 209 Broken Head Road,  
 Suffolk Park, NSW





Site Location (Approximate)



Not to Scale



**Figure 3 – Flooding Risk**  
207-209 Broken Head Road, Suffolk Park, NSW



Site Location (Approximate)



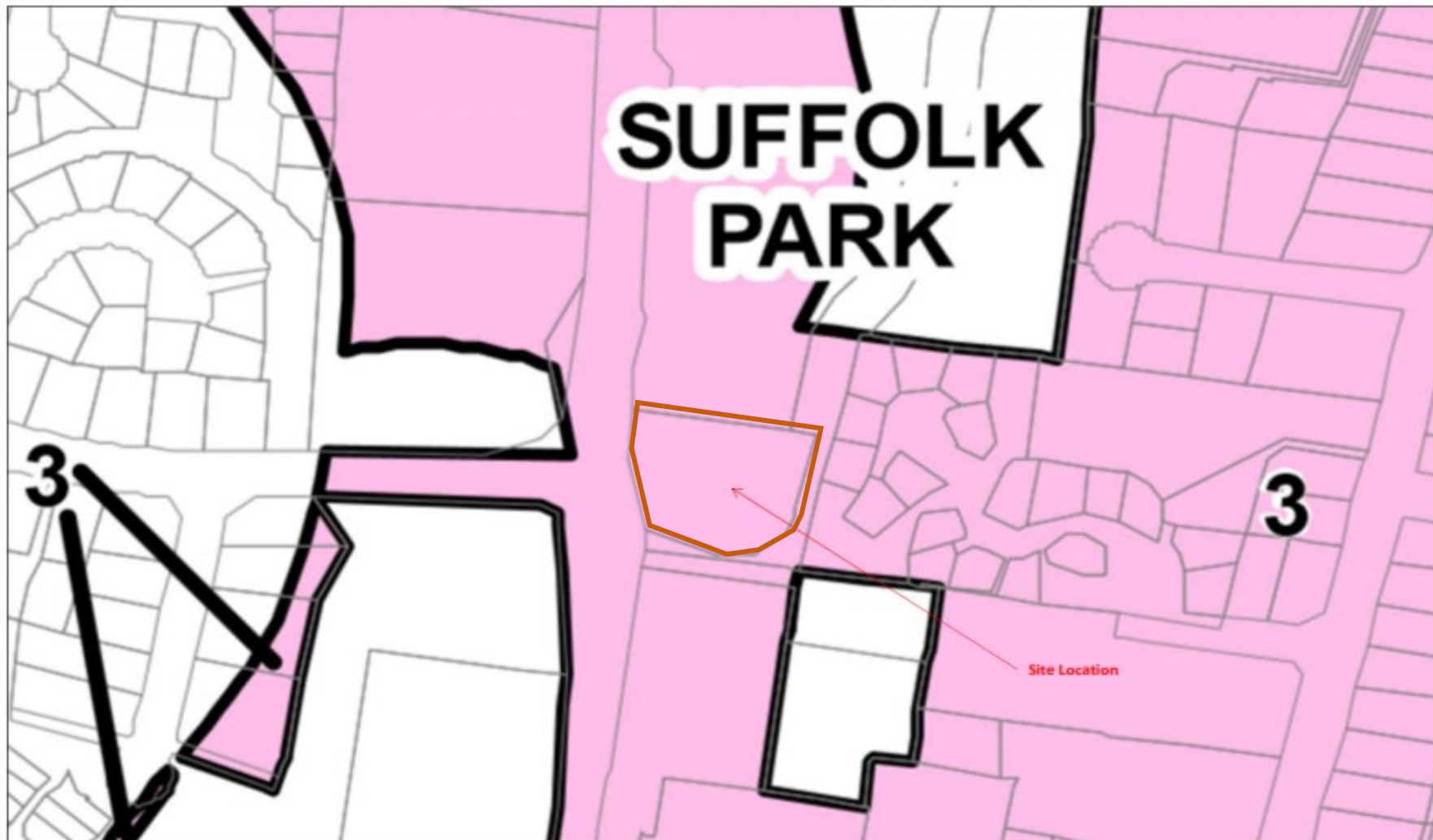
0 60m



**Figure 4 – Groundwater Bore Locations**  
207-209 Broken Head Road, Suffolk Park, NSW

**Project: Remediation Action Plan (RAP)**  
**Client: Horizon Retail Pty Ltd**





Site Location



0 60m



**Figure 5 – Acid Sulfate Soil (ASS) Risk**  
207-209 Broken Head Road, Suffolk Park, NSW

**Project: Remediation Action Plan (RAP)**  
**Client: Horizon Retail Pty Ltd**

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**APPENDIX B**

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**Laboratory Results (ENV, 2018)**

TABULATED SOIL RESULTS

	NA	Benzene, Toluene, Ethylbenzene and Xylenes (BTEx)						Inorganics	Lead	Metals				
	Benzo(b+j+k)fluoranthene	Benzene	Toluene	Ethylbenzene	Xylene (m & p)	Xylene (o)	Xylene Total	Moisture	Lead	Arsenic	Cadmium	Chromium (III+VI)	Copper	Mercury
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL	0.2	0.2	0.5	1	2	1	1	0.1	1	4	0.4	1	1	0.1
CRC Care HSL-D Commercial / Industrial		430	99,000	27,000			81,000							
NEPM 2013 Table 1B(7) Management Limits Comm / Ind, Coarse Soil														
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand														
0-1m		3					230							
1-2m		3												
2-4m		3												
>4m		3												
NEPM 2013 Table 1B(5) Generic EIL - Comm/Ind										160				
NEPM 2013 Table 1B(6) ESLs for Comm/Ind, Coarse Soil														
0-2m		75	135	165			180							
NEPM 2013 Table 1A(1) HILs Comm/Ind D Soil									1,500	3,000	900		240,000	730

Field ID	Date	Depth (m)														
BH1	09-03-18	0 - 0.1	<0.2	<0.2	<0.5	<1	<2	<1	<1	11	3	<4	<0.4	4	3	<0.1
BH2	09-03-18	0 - 0.1	<0.2	<0.2	<0.5	<1	<2	<1	<1	15	4	<4	<0.4	5	14	<0.1
BH3	09-03-18	0.3 - 0.4	<0.2	<0.2	<0.5	<1	<2	<1	<1	19	3	<4	<0.4	5	3	<0.1
BH4	09-03-18	0 - 0.1	<0.2	<0.2	<0.5	<1	<2	<1	<1	7.8	3	<4	<0.4	4	4	<0.1
BH5	09-03-18	0.4 - 0.5	<0.2	<0.2	<0.5	<1	<2	<1	<1	25	6	<4	<0.4	8	6	0.1
BH6	09-03-18	0 - 0.1	<0.2	<0.2	<0.5	<1	<2	<1	<1	6.7	2	<4	<0.4	5	1	0.4
BH6	09-03-18	1.9 - 2	<0.2	<0.2	<0.5	<1	<2	<1	<1	24	2	<4	<0.4	4	3	<0.1
BH7	09-03-18	0 - 0.1	<0.2	<0.2	<0.5	<1	<2	<1	<1	9.7	4	7	<0.4	10	18	0.2
BH7	09-03-18	1.9 - 2	<0.2	<0.2	<0.5	<1	<2	<1	<1	18	<1	<4	<0.4	<1	2	<0.1
BH8	09-03-18	0.4 - 0.5	<0.2	<0.2	<0.5	<1	<2	<1	<1	6.9	2	<4	<0.4	3	<1	<0.1
BH8	09-03-18	3.7 - 3.8	<0.2	<0.2	<0.5	<1	<2	<1	<1	27	<1	4	<0.4	1	1	<0.1
BH9	09-03-18	0.2 - 0.4	<0.2	<0.2	<0.5	<1	<2	<1	<1	7.8	2	<4	<0.4	4	<1	<0.1
BH9	09-03-18	1.9 - 2	<0.2	<0.2	<0.5	<1	<2	<1	<1	24	3	<4	<0.4	5	5	<0.1
BH10	09-03-18	0.4 - 0.5	<0.2	<0.2	<0.5	<1	<2	<1	<1	9.9	<1	<4	<0.4	<1	<1	<0.1
BH10	09-03-18	1.9 - 2	<0.2	<0.2	<0.5	<1	<2	<1	<1	20	3	<4	<0.4	6	5	<0.1

**Notes:**  
NEPM - National Environment Protection (Assessment of Site Contamination) Measure 1999 (as amended 2013)  
HSL - Health Screening Level  
EIL - Ecological Investigation Level  
HIL - Health Investigation Level  
ESL - Ecological Screening Level

TABULATED SOIL RESULTS

	Metals		Polycyclic Aromatic Hydrocarbons (PAH)											
	Nickel	Zinc	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a) pyrene	Benzo(g,h,i)perylene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL	1	1	0.1	0.1	0.1	0.1	0.05	0.1	0.1	0.1	0.1	0.1	0.1	0.1
CRC Care HSL-D Commercial / Industrial														11,000
NEPM 2013 Table 1B(7) Management Limits Comm / Ind, Coarse Soil														
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand														
0-1m														
1-2m														
2-4m														
>4m														
NEPM 2013 Table 1B(5) Generic EIL - Comm/Ind														370
NEPM 2013 Table 1B(6) ESLs for Comm/Ind, Coarse Soil														
0-2m							1.4							
NEPM 2013 Table 1A(1) HILs Comm/Ind D Soil	6,000	400,000												

Field ID	Date	Depth (m)														
BH1	09-03-18	0 - 0.1	3	8	<0.1	<0.1	<0.1	<0.1	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
BH2	09-03-18	0 - 0.1	3	8	<0.1	<0.1	<0.1	<0.1	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
BH3	09-03-18	0.3 - 0.4	4	10	<0.1	<0.1	<0.1	<0.1	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
BH4	09-03-18	0 - 0.1	2	8	<0.1	<0.1	<0.1	<0.1	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
BH5	09-03-18	0.4 - 0.5	8	20	<0.1	<0.1	<0.1	<0.1	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
BH6	09-03-18	0 - 0.1	<1	4	<0.1	<0.1	<0.1	<0.1	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
BH6	09-03-18	1.9 - 2	3	7	<0.1	<0.1	<0.1	<0.1	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
BH7	09-03-18	0 - 0.1	4	16	<0.1	<0.1	<0.1	<0.1	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
BH7	09-03-18	1.9 - 2	<1	2	<0.1	<0.1	<0.1	<0.1	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
BH8	09-03-18	0.4 - 0.5	<1	3	<0.1	<0.1	<0.1	<0.1	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
BH8	09-03-18	3.7 - 3.8	2	7	<0.1	<0.1	<0.1	<0.1	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
BH9	09-03-18	0.2 - 0.4	<1	3	<0.1	<0.1	<0.1	<0.1	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
BH9	09-03-18	1.9 - 2	6	17	<0.1	<0.1	<0.1	<0.1	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
BH10	09-03-18	0.4 - 0.5	<1	2	<0.1	<0.1	<0.1	<0.1	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
BH10	09-03-18	1.9 - 2	6	14	<0.1	<0.1	<0.1	<0.1	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

**Notes:**  
NEPM - National Environment Protection (Assessment of Site Contamination)  
Measure 1999 (as amended 2013)  
HSL - Health Screening Level  
EIL - Ecological Investigation Level  
HIL - Health Investigation Level  
ESL - Ecological Screening Level



TABULATED SOIL RESULTS

	PAH			Total Petroleum Hydrocarbons (TPH) / Total Recoverable Hydrocarbons (TRH)										
	Phenanthrene	Pyrene	PAHs (Sum of positives)											
	mg/kg	mg/kg	mg/kg	C6-C9	C10-C14	C15-C28	C29-C36	C6-C10	C10-C16	C16-C34	C10-C40 (Sum of total)	C34-C40	F1 (TRH C6-C10 minus BTEX)	F2 (TRH C10-C16 minus naphthalene)
EQL	0.1	0.1	0.05	25	50	100	100	25	50	100	50	100	25	50
CRC Care HSL-D Commercial / Industrial								26,000	20,000	27,000		38,000		
NEPM 2013 Table 1B(7) Management Limits Comm / Ind, Coarse Soil								700	1,000	3,500		10,000		
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand														
0-1m													260	
1-2m													370	
2-4m													630	
>4m														
NEPM 2013 Table 1B(5) Generic EIL - Comm/Ind														
NEPM 2013 Table 1B(6) ESLs for Comm/Ind, Coarse Soil														
0-2m										1,700		3,300	215	170
NEPM 2013 Table 1A(1) HILs Comm/Ind D Soil														

Field ID	Date	Depth (m)														
BH1	09-03-18	0 - 0.1	<0.1	<0.1	<0.05	<25	<50	<100	<100	<25	<50	<100	<50	<100	<25	<50
BH2	09-03-18	0 - 0.1	<0.1	<0.1	<0.05	<25	<50	<100	<100	<25	<50	<100	<50	<100	<25	<50
BH3	09-03-18	0.3 - 0.4	<0.1	<0.1	<0.05	<25	<50	<100	<100	<25	<50	<100	<50	<100	<25	<50
BH4	09-03-18	0 - 0.1	<0.1	<0.1	<0.05	<25	<50	<100	<100	<25	<50	<100	<50	<100	<25	<50
BH5	09-03-18	0.4 - 0.5	<0.1	<0.1	<0.05	<25	<50	<100	<100	<25	<50	<100	<50	<100	<25	<50
BH6	09-03-18	0 - 0.1	<0.1	<0.1	<0.05	<25	<50	<100	<100	<25	<50	<100	<50	<100	<25	<50
BH6	09-03-18	1.9 - 2	<0.1	<0.1	<0.05	<25	<50	<100	520	<25	<50	510	670	160	<25	<50
BH7	09-03-18	0 - 0.1	<0.1	<0.1	<0.05	<25	<50	<100	<100	<25	<50	<100	<50	<100	<25	<50
BH7	09-03-18	1.9 - 2	<0.1	<0.1	<0.05	<25	<50	<100	<100	<25	<50	<100	<50	<100	<25	<50
BH8	09-03-18	0.4 - 0.5	<0.1	<0.1	<0.05	<25	<50	<100	<100	<25	<50	<100	<50	<100	<25	<50
BH8	09-03-18	3.7 - 3.8	<0.1	<0.1	<0.05	<25	<50	<100	<100	<25	<50	<100	<50	<100	<25	<50
BH9	09-03-18	0.2 - 0.4	<0.1	<0.1	<0.05	<25	<50	<100	<100	<25	<50	<100	<50	<100	<25	<50
BH9	09-03-18	1.9 - 2	<0.1	<0.1	<0.05	<25	<50	<100	<100	<25	<50	<100	<50	<100	<25	<50
BH10	09-03-18	0.4 - 0.5	<0.1	<0.1	<0.05	<25	<50	<100	<100	<25	<50	<100	<50	<100	<25	<50
BH10	09-03-18	1.9 - 2	<0.1	<0.1	<0.05	<25	<50	<100	<100	<25	<50	<100	<50	<100	<25	<50

**Notes:**  
NEPM - National Environment Protection (Assessment of Site Contamination)  
Measure 1999 (as amended 2013)  
HSL - Health Screening Level  
EIL - Ecological Investigation Level  
HIL - Health Investigation Level  
ESL - Ecological Screening Level

TABULATED GROUNDWATER RESULTS

		NA	Benzene, Toluene, Ethylbenzene and Xylenes (BTEX)					Lead	Metals							PAH	
		Benzo(b+j+k)fluoranthene	Benzene	Toluene	Ethylbenzene	Xylene (m & p)	Xylene (o)	Lead (filtered)	Arsenic (filtered)	Cadmium (filtered)	Chromium (III+VI) (filtered)	Copper (filtered)	Mercury (filtered)	Nickel (filtered)	Zinc (filtered)	Acenaphthene	Acenaphthylene
		mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L
EQL		0.002	1	1	1	2	1	0.001	0.001	0.0001	0.001	0.001	0.00005	0.001	0.001	1	1
NEPM 2013 Table 1C GILs, Drinking Water NEPM 2013 Table 1C GILs, Fresh Waters NEPM 2013 Table 1C GILs, Marine Waters NHMRC 2008 Recreational Use			1	800	300			0.01	0.01	0.002		2	0.001	0.02			
			950				350	0.0034		0.0002		0.0014	0.00006	0.011	0.008		
			500					0.0044		0.0007		0.0013	0.0001	0.007	0.015		
			10	250	30	200		0.1	0.07	0.02	0.5	10	0.01	0.2	30		
NEPM 2013 Table 1A(4) Comm/Ind HSL D GW for Vapour Intrusion, Sand 2-4m 4-8m >8m																	
			5,000														
			5,000														
			5,000														
Field ID		Date															
MW5	09-03-18	<0.002	<1	<1	<1	<2	<1	<0.001	0.088	<0.0001	<0.001	<0.001	<0.00005	<0.001	0.002	<1	<1
MW6	09-03-18	<0.002	6	<1	<1	<2	<1	<0.001	0.028	<0.0001	<0.001	<0.001	<0.00005	<0.001	0.008	<1	<1
MW9	09-03-18	<0.002	1	<1	5	11	1	<0.001	0.033	<0.0001	<0.001	0.009	<0.00005	0.002	0.08	<1	<1
MW10	09-03-18	<0.002	2	<1	22	11	<1	<0.001	0.007	<0.0001	<0.001	0.002	<0.00005	0.002	0.006	<1	<1

**Notes:**  
NEPM - National Environment Protection (Assessment of Site Contamination) Measure 1999 (as amended 2013)  
HSL - Health Screening Level  
GIL - Groundwater Investigation Level  
NHMRC - National Health and Medical Research Council

TABULATED GROUNDWATER RESULTS

		Polycyclic Aromatic Hydrocarbons (PAH)														TPH	
		Anthracene	Benz(a)anthracene	Benzo(a) pyrene	Benzo(g,h,i)perylene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene	Benzo(a)pyrene TEQ	PAHs (Sum of positives)	C6-C9	C10-C14
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	µg/L	µg/L
EQL		1	1	1	1	1	1	1	1	1	1	1	0.005	0.001		10	50
NEPM 2013 Table 1C GILs, Drinking Water NEPM 2013 Table 1C GILs, Fresh Waters NEPM 2013 Table 1C GILs, Marine Waters NHMRC 2008 Recreational Use NEPM 2013 Table 1A(4) Comm/Ind HSL D GW for Vapour Intrusion, Sand 2-4m 4-8m >8m				0.01													
											16						
											50						
				0.01													
Field ID		Date															
MW5	09-03-18	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.005	0	<10	<50
MW6	09-03-18	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.005	0	42	<50
MW9	09-03-18	<1	<1	<1	<1	<1	<1	<1	<1	<1	3	<1	<1	<0.005	0.0030	120	130
MW10	09-03-18	<1	<1	<1	<1	<1	<1	<1	<1	<1	2	<1	<1	<0.005	0.0015	110	97

**Notes:**  
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HSL - Health Screening Level  
GIL - Groundwater Investigation Level  
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## TABULATED GROUNDWATER RESULTS

		Total Petroleum Hydrocarbons (TPH) / Total Recoverable Hydrocarbons (TRH)																																																									
		C15-C28	C29-C36	C6-C10	C10-C16	C16-C34	C34-C40	F1 (TRH C6-C10 minus BTEX)	F2 (TRH C10-C16 minus naphthalene)																																																		
		µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L																																																		
EQL		100	100	0.01	0.05	0.1	0.1	0.01	0.05																																																		
NEPM 2013 Table 1C GILs, Drinking Water																																																											
NEPM 2013 Table 1C GILs, Fresh Waters																																																											
NEPM 2013 Table 1C GILs, Marine Waters																																																											
NHMRC 2008 Recreational Use																																																											
NEPM 2013 Table 1A(4) Comm/Ind HSL D GW for Vapour Intrusion, Sand																																																											
2-4m								6																																																			
4-8m								6																																																			
>8m								7																																																			
<table border="1"> <thead> <tr> <th>Field ID</th> <th>Date</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> </tr> </thead> <tbody> <tr> <td>MW5</td> <td>09-03-18</td> <td>&lt;100</td> <td>&lt;100</td> <td>&lt;0.01</td> <td>&lt;0.05</td> <td>&lt;0.1</td> <td>&lt;0.1</td> <td>&lt;0.01</td> <td>&lt;0.05</td> </tr> <tr> <td>MW6</td> <td>09-03-18</td> <td>&lt;100</td> <td>&lt;100</td> <td>0.048</td> <td>&lt;0.05</td> <td>&lt;0.1</td> <td>&lt;0.1</td> <td>0.042</td> <td>&lt;0.05</td> </tr> <tr> <td>MW9</td> <td>09-03-18</td> <td>&lt;100</td> <td>&lt;100</td> <td>0.17</td> <td>0.096</td> <td>&lt;0.1</td> <td>&lt;0.1</td> <td>0.16</td> <td>0.091</td> </tr> <tr> <td>MW10</td> <td>09-03-18</td> <td>&lt;100</td> <td>&lt;100</td> <td>0.15</td> <td>0.06</td> <td>&lt;0.1</td> <td>&lt;0.1</td> <td>0.11</td> <td>0.057</td> </tr> </tbody> </table>										Field ID	Date									MW5	09-03-18	<100	<100	<0.01	<0.05	<0.1	<0.1	<0.01	<0.05	MW6	09-03-18	<100	<100	0.048	<0.05	<0.1	<0.1	0.042	<0.05	MW9	09-03-18	<100	<100	0.17	0.096	<0.1	<0.1	0.16	0.091	MW10	09-03-18	<100	<100	0.15	0.06	<0.1	<0.1	0.11	0.057
Field ID	Date																																																										
MW5	09-03-18	<100	<100	<0.01	<0.05	<0.1	<0.1	<0.01	<0.05																																																		
MW6	09-03-18	<100	<100	0.048	<0.05	<0.1	<0.1	0.042	<0.05																																																		
MW9	09-03-18	<100	<100	0.17	0.096	<0.1	<0.1	0.16	0.091																																																		
MW10	09-03-18	<100	<100	0.15	0.06	<0.1	<0.1	0.11	0.057																																																		

Notes:

NEPM - National Environment Protection (Assessment of Site Contamination) Measure 1999 (as amended 2013)

HSL - Health Screening Level

GIL - Groundwater Investigation Level

NHMRC - National Health and Medical Research

Council

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**APPENDIX C**

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**Remediation Criteria**

**Table 1A(1) Health investigation levels for soil contaminants**

Chemical	Health-based investigation levels (mg/kg)			
	Residential <sup>1</sup> A	Residential <sup>1</sup> B	Recreational <sup>1</sup> C	Commercial/ industrial <sup>1</sup> D
<b>Metals and Inorganics</b>				
Arsenic <sup>2</sup>	100	500	300	3 000
Beryllium	60	90	90	500
Boron	4500	40 000	20 000	300 000
Cadmium	20	150	90	900
Chromium (VI)	100	500	300	3600
Cobalt	100	600	300	4000
Copper	6000	30 000	17 000	240 000
Lead <sup>3</sup>	300	1200	600	1 500
Manganese	3800	14 000	19 000	60 000
Mercury (inorganic) <sup>5</sup>	40	120	80	730
Methyl mercury <sup>4</sup>	10	30	13	180
Nickel	400	1200	1200	6 000
Selenium	200	1400	700	10 000
Zinc	7400	60 000	30 000	400 000
Cyanide (free)	250	300	240	1 500
<b>Polycyclic Aromatic Hydrocarbons (PAHs)</b>				
Carcinogenic PAHs (as BaP TEQ) <sup>6</sup>	3	4	3	40
Total PAHs <sup>7</sup>	300	400	300	4000
<b>Phenols</b>				
Phenol	3000	45 000	40 000	240 000
Pentachlorophenol	100	130	120	660
Cresols	400	4 700	4 000	25 000
<b>Organochlorine Pesticides</b>				
DDT+DDE+DDD	240	600	400	3600
Aldrin and dieldrin	6	10	10	45
Chlordane	50	90	70	530
Endosulfan	270	400	340	2000
Endrin	10	20	20	100
Heptachlor	6	10	10	50
HCB	10	15	10	80
Methoxychlor	300	500	400	2500
Mirex	10	20	20	100
Toxaphene	20	30	30	160
<b>Herbicides</b>				
2,4,5-T	600	900	800	5000

Chemical	Health-based investigation levels (mg/kg)			
	Residential <sup>1</sup> A	Residential <sup>1</sup> B	Recreational <sup>1</sup> C	Commercial/ industrial <sup>1</sup> D
2,4-D	900	1600	1300	9000
MCPA	600	900	800	5000
MCPB	600	900	800	5000
Mecoprop	600	900	800	5000
Picloram	4500	6600	5700	35000
<b>Other Pesticides</b>				
Atrazine	320	470	400	2500
Chlorpyrifos	160	340	250	2000
Bifenthrin	600	840	730	4500
<b>Other Organics</b>				
PCBs <sup>s</sup>	1	1	1	7
PBDE Flame Retardants (Br1–Br9)	1	2	2	10

**Notes:**

- (1) Generic land uses are described in detail in Schedule B7 Section 3

HIL A – Residential with garden/accessible soil (home grown produce <10% fruit and vegetable intake (no poultry), also includes childcare centres, preschools and primary schools.

HIL B – Residential with minimal opportunities for soil access; includes dwellings with fully and permanently paved yard space such as high-rise buildings and apartments.

HIL C – Public open space such as parks, playgrounds, playing fields (e.g. ovals), secondary schools and footpaths. This does not include undeveloped public open space where the potential for exposure is lower and where a site-specific assessment may be more appropriate.

HIL D – Commercial/industrial, includes premises such as shops, offices, factories and industrial sites.

- (2) Arsenic: HIL assumes 70% oral bioavailability. Site-specific bioavailability may be important and should be considered where appropriate (refer Schedule B7).
- (3) Lead: HIL is based on blood lead models (IEUBK for HILs A, B and C and adult lead model for HIL D where 50% oral bioavailability has been considered. Site-specific bioavailability may be important and should be considered where appropriate.
- (4) Methyl mercury: assessment of methyl mercury should only occur where there is evidence of its potential source. It may be associated with inorganic mercury and anaerobic microorganism activity in aquatic environments. In addition the reliability and quality of sampling/analysis should be considered.
- (5) Elemental mercury: HIL does not address elemental mercury. A site-specific assessment should be considered if elemental mercury is present, or suspected to be present,
- (6) Carcinogenic PAHs: HIL is based on the 8 carcinogenic PAHs and their TEFs (potency relative to B(a)P) adopted by CCME 2008 (refer Schedule B7). The B(a)P TEQ is calculated by multiplying the concentration of each carcinogenic PAH in the sample by its B(a)P TEF, given below, and summing these products.

PAH species	TEF	PAH species	TEF
Benzo(a)anthracene	0.1	Benzo(g,h,i)perylene	0.01
Benzo(a)pyrene	1	Chrysene	0.01
Benzo(b+j)fluoranthene	0.1	Dibenz(a,h)anthracene	1
Benzo(k)fluoranthene	0.1	Indeno(1,2,3-c,d)pyrene	0.1

Where the B(a)P occurs in bitumen fragments it is relatively immobile and does not represent a significant health risk.

- (7) Total PAHs: HIL is based on the sum of the 16 PAHs most commonly reported for contaminated sites (WHO 1998). The application of the total PAH HIL should consider the presence of carcinogenic PAHs and naphthalene (the most volatile PAH). Carcinogenic PAHs reported in the total PAHs should meet the B(a)P TEQ HIL. Naphthalene reported in the total PAHs should meet the relevant HSL.
- (8) PCBs: HIL relates to non-dioxin-like PCBs only. Where a PCB source is known, or suspected, to be present at a site, a site-specific assessment of exposure to all PCBs (including dioxin-like PCBs) should be undertaken.



Table 1A(3) Soil HSLs for vapour intrusion (mg/kg)

	HSL A & HSL B Low – high density residential				HSL C recreational / open space				HSL D Commercial / Industrial				
CHEMICAL	0 m to <1 m	1 m to <2 m	2 m to <4 m	4 m+	0 m to <1 m	1 m to <2 m	2 m to <4 m	4 m+	0 m to <1 m	1 m to <2 m	2 m to <4 m	4 m+	Soil saturat ion concent ration (Csat)
SAND													
Toluene	160	220	310	540	NL	NL	NL	NL	NL	NL	NL	NL	560
Ethylbenzene	55	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	64
Xylenes	40	60	95	170	NL	NL	NL	NL	230	NL	NL	NL	300
Naphthalene	3	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	9
Benzene	0.5	0.5	0.5	0.5	NL	NL	NL	NL	3	3	3	3	360
F1 <sup>(9)</sup>	45	70	110	200	NL	NL	NL	NL	260	370	630	NL	950
F2 <sup>(10)</sup>	110	240	440	NL	NL	NL	NL	NL	NL	NL	NL	NL	560
SILT													
Toluene	390	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	640
Ethylbenzene	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	69
Xylenes	95	210	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	330
Naphthalene	4	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	10
Benzene	0.6	0.7	1	2	NL	NL	NL	NL	4	4	6	10	440
F1 <sup>(9)</sup>	40	65	100	190	NL	NL	NL	NL	250	360	590	NL	910

	HSL A & HSL B Low – high density residential				HSL C recreational / open space				HSL D Commercial / Industrial				
<b>F2<sup>(10)</sup></b>	230	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	570
<b>CLAY</b>													
<b>Toluene</b>	480	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	630
<b>Ethylbenzene</b>	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	68
<b>Xylenes</b>	110	310	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	330
<b>Naphthalene</b>	5	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	10
<b>Benzene</b>	0.7	1	2	3	NL	NL	NL	NL	4	6	9	20	430
<b>F1<sup>(9)</sup></b>	50	90	150	290	NL	NL	NL	NL	310	480	NL	NL	850
<b>F2<sup>(10)</sup></b>	280	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	560

**Notes:**

- (1) Land use settings are equivalent to those described in Table 1A(1) Footnote 1 and Schedule B7. HSLs for vapour intrusion for high density residential assume residential occupation of the ground floor. If communal car parks or commercial properties occupy the ground floor, HSL D should be used,
- (2) The key limitations of the HSLs should be referred to prior to application and are presented in Friebel and Nadebaum (2011b and 2011d).
- (3) Detailed assumptions in the derivation of the HSLs and information on how to apply the HSLs are presented in Friebel and Nadebaum (2011a and 2011b).
- (4) Soil HSLs for vapour inhalation incorporate an adjustment factor of 10 applied to the vapour phase partitioning to reflect the differences observed between theoretical estimates of soil vapour partitioning and field measurements. Refer Friebel & Nadebaum (2011a) for further information.
- (5) The soil saturation concentration (C<sub>sat</sub>) is defined as the soil concentration at which the porewater phase cannot dissolve any more of an individual chemical. The soil vapour that is in equilibrium with the porewater will be at its maximum. If the derived soil HSL exceeds C<sub>sat</sub>, a soil vapour source concentration for a petroleum mixture could not exceed a level that would result in the maximum allowable vapour risk for the given scenario. For these scenarios, no HSL is presented for these chemicals and the HSL is shown as 'not limiting' or 'NL'.
- (6) The HSLs for TPH C<sub>6</sub>-C<sub>10</sub> in sandy soil are based on a finite source that depletes in less than seven years, and therefore consideration has been given to use of sub-chronic toxicity values. The >C<sub>8</sub>-C<sub>10</sub> aliphatic toxicity has been adjusted to represent sub-chronic exposure, resulting in higher HSLs than if based on chronic toxicity. For further information refer to Section 8.2 and Appendix J in Friebel and Nadebaum (2011a).
- (7) The figures in the above table may be multiplied by a factor to account for biodegradation of vapour. A factor of 10 may apply for source depths from 2 m to <4 m or a factor of 100 for source depths of 4 m and deeper. To apply the attenuation factor for vapour degradation, a number of conditions must be satisfied. Firstly the maximum length of the shorter side of the concrete slab and surrounding pavement cannot exceed 15 m, as this would prevent oxygen penetrating to the centre of the slab. Secondly, measurement of oxygen in the subsurface is required to determine the potential for biodegradation. Oxygen must be confirmed to be present at >5% to use these factors.

- (8) For soil texture classification undertaken in accord with AS 1726, the classifications of sand, silt and clay may be applied as coarse, fine with liquid limit <50% and fine with liquid limit >50% respectively, as the underlying properties to develop the HSLs may reasonably be selected to be similar. Where there is uncertainty, either a conservative approach may be adopted or laboratory analysis should be carried out.
- (9) To obtain F1 subtract the sum of BTEX concentrations from the C<sub>6</sub>-C<sub>10</sub> fraction.
- (10) To obtain F2 subtract naphthalene from the >C<sub>10</sub>-C<sub>16</sub> fraction.

**Table 1B(1) Soil-specific added contaminant limits for aged zinc in soil**

<b>Zn added contaminant limits (ACL, mg added contaminant/kg)</b>						
<b>Areas of ecological significance</b>						
<i>pH<sup>a</sup></i>	<i>CEC<sup>b</sup> (cmol/kg)</i>					
	<i>5</i>	<i>10</i>	<i>20</i>	<i>30</i>	<i>40</i>	<i>60</i>
<b>4.0</b>	15	20	20	20	20	20
<b>4.5</b>	20	25	25	25	25	25
<b>5.0</b>	30	40	40	40	40	40
<b>5.5</b>	40	60	60	60	60	60
<b>6.0</b>	50	90	90	90	90	90
<b>6.5</b>	50	90	130	130	130	130
<b>7.0</b>	50	90	150	190	190	190
<b>7.5</b>	50	90	150	210	260	280
<b>Urban residential/public open space<sup>1</sup></b>						
<i>pH<sup>a</sup></i>	<i>CEC<sup>b</sup> (cmol/kg)</i>					
	<i>5</i>	<i>10</i>	<i>20</i>	<i>30</i>	<i>40</i>	<i>60</i>
<b>4.0</b>	70	85	85	85	85	85
<b>4.5</b>	100	120	120	120	120	120
<b>5.0</b>	130	180	180	180	180	180
<b>5.5</b>	180	270	270	270	270	270
<b>6.0</b>	230	400	400	400	400	400
<b>6.5</b>	230	400	590	590	590	590
<b>7.0</b>	230	400	700	880	880	880
<b>7.5</b>	230	400	700	960	1200	1300

Commercial/industrial						
<i>pH<sup>a</sup></i>	<i>CEC<sup>b</sup> (cmol/kg)</i>					
	<i>5</i>	<i>10</i>	<i>20</i>	<i>30</i>	<i>40</i>	<i>60</i>
<i>4.0</i>	110	130	130	130	130	130
<i>4.5</i>	150	190	190	190	190	190
<i>5.0</i>	210	290	290	290	290	290
<i>5.5</i>	280	420	420	420	420	420
<i>6.0</i>	360	620	620	620	620	620
<i>6.5</i>	360	620	920	920	920	920
<i>7.0</i>	360	620	1100	1400	1400	1400
<i>7.5</i>	360	620	1100	1500	1900	2000

1. Urban residential/public open space is broadly equivalent to the HIL A, HIL B and HIL C land use scenarios in Table 1A(1) Footnote 1 and as described in Schedule B7.
2. Aged values apply to contamination present in soil for at least two years. For fresh contamination refer to Schedule B5c.
3. The EIL is calculated from summing the ACL and the ABC.

a = pH measured using the CaCl<sub>2</sub> method (Rayment & Higginson 1992).

b = CEC measured using the silver thiourea method (Chabra et al. 1972).

**Table 1B(2) Soil-specific added contaminant limits for aged copper in soils**

Cu added contaminant limits (ACL, mg added contaminant/kg)					
Areas of ecological significance					
<i>CEC (cmol/kg)<sup>a</sup> based</i>					
<i>5</i>	<i>10</i>	<i>20</i>	<i>30</i>	<i>40</i>	<i>60</i>
30	65	70	70	75	80
<i>pH<sup>b</sup> based</i>					
<i>4.5</i>	<i>5.5</i>	<i>6</i>	<i>6.5</i>	<i>7.5</i>	<i>8.0</i>
20	45	65	90	190	270
Urban residential/public open space <sup>1</sup>					
<i>CEC (cmol/kg)<sup>a</sup> based</i>					
<i>5</i>	<i>10</i>	<i>20</i>	<i>30</i>	<i>40</i>	<i>60</i>
95	190	210	220	220	230
<i>pH<sup>b</sup> based</i>					
<i>4.5</i>	<i>5.5</i>	<i>6</i>	<i>6.5</i>	<i>7.5</i>	<i>8.0</i>
60	130	190	280	560	800

Commercial/industrial					
CEC (cmol/kg) <sup>a</sup> based					
5	10	20	30	40	60
140	280	300	320	330	340
pH <sup>b</sup> based					
4.5	5.5	6	6.5	7.5	8.0
85	190	280	400	830	1200

**Notes:**

1. Urban residential/public open space is broadly equivalent to the HIL A, HIL B and HIL C land use scenarios in Table 1A(1) Footnote 1 and as described in Schedule B7.
2. The lower of the CEC or the pH-based ACLs for the land use and soil conditions is the ACL to be used.
3. Aged values apply to contamination present in soil for at least two years. For fresh contamination refer to Schedule B5c.
4. The EIL is calculated from summing the ACL and the ABC.

a = CEC measured using the silver thiourea method (Chabra et al. 1972).

b = pH measured using the CaCl<sub>2</sub> method (Rayment & Higginson 1992).

**Table 1B(3) Soil-specific added contaminant limits for aged chromium III and nickel in soil**

CHEMICAL	Clay content (% clay)	Added contaminant limits (mg added contaminant/kg) for various land uses		
		Areas of ecological significance	Urban residential and public open space	Commercial and industrial
Chromium III	1	60	190	310
	2.5	80	250	420
	5	100	320	530
	≥10	130	400	660
Nickel	CEC <sup>a</sup> (cmol/kg)	Areas of ecological significance	Urban residential and public open space <sup>1</sup>	Commercial and industrial
	5	5	30	55
	10	30	170	290
	20	45	270	460
	30	60	350	600
	40	70	420	730
	60	95	560	960

**Notes:**

1. Urban residential/public open space is broadly equivalent to the HIL A, HIL B and HIL C land use scenarios in Table 1A(1) Footnote 1 and as described in Schedule B7.

2. Aged values apply to contamination present in soil for at least two years. For fresh contamination refer to Schedule B5c.
  3. The EIL is calculated from summing the ACL and the ABC.
- a = CEC measured using the silver thiourea method (Chabra et al. 1972).

**Table 1B(4) Generic added contaminant limits for lead in soils irrespective of their physicochemical properties**

	<b>Pb added contaminant limit (ACL, mg added contaminant/kg) for various land uses</b>		
<b>CHEMICAL</b>	<b>Areas of ecological significance</b>	<b>Urban residential and public open space<sup>1</sup></b>	<b>Commercial and industrial</b>
<b>Lead</b>	470	1100	1800

**Notes:**

1. Urban residential/public open space is broadly equivalent to the HIL A, HIL B and HIL C land use scenarios in Table 1A(1) Footnote 1 and as described in Schedule B7.
2. Aged values are applicable to lead contamination present in soil for at least two years. For fresh contamination refer to Schedule B5c.
3. The EIL is calculated from summing the ACL and the ABC.

**Table 1B(5) Generic EILs for aged As, fresh DDT and fresh naphthalene in soils irrespective of their physicochemical properties**

	<b>Ecological Investigation Levels (mg total contaminant/kg)</b>		
<b>CHEMICAL</b>	<b>Areas of ecological significance</b>	<b>Urban residential and public open space<sup>1</sup></b>	<b>Commercial and industrial</b>
<b>Arsenic<sup>2</sup></b>	40	100	160
<b>DDT<sup>3</sup></b>	3	180	640
<b>Naphthalene<sup>3</sup></b>	10	170	370

**Notes:**

1. Urban residential/public open space is broadly equivalent to the HIL-A, HIL-B and HIL-C land use scenarios in Table 1A(1) Footnote 1 and as described in Schedule B7.
2. Aged values are applicable to arsenic contamination present in soil for at least two years. For fresh contamination refer to Schedule B5c.
3. Insufficient data was available to calculate aged values for DDT and naphthalene, consequently the values for fresh contamination should be used.
4. Insufficient data was available to calculate ACLs for As, DDT and naphthalene. The EIL should be taken directly from Table 1B(5).

**Table 1B(6) ESLs for TPH fractions F1 - F4, BTEX and benzo(a)pyrene in soil**

CHEMICAL	Soil texture	ESLs (mg/kg dry soil)		
		Areas of ecological significance	Urban residential and public open space	Commercial and industrial
<b>F1</b> C <sub>6</sub> -C <sub>10</sub>	<i>Coarse/ Fine</i>	125*	180*	215*
<b>F2</b> >C <sub>10</sub> -C <sub>16</sub>		25*	120*	170*
<b>F3</b> >C <sub>16</sub> -C <sub>34</sub>	<i>Coarse</i>	-	300	1700
	<i>Fine</i>	-	1300	2500
<b>F4</b> >C <sub>34</sub> -C <sub>40</sub>	<i>Coarse</i>	-	2800	3300
	<i>Fine</i>	-	5600	6600
<b>Benzene</b>	<i>Coarse</i>	10	50	75
	<i>Fine</i>	10	65	95
<b>Toluene</b>	<i>Coarse</i>	10	85	135
	<i>Fine</i>	65	105	135
<b>Ethylbenzene</b>	<i>Coarse</i>	1.5	70	165
	<i>Fine</i>	40	125	185
<b>Xylenes</b>	<i>Coarse</i>	10	105	180
	<i>Fine</i>	1.6	45	95
<b>Benzo(a)pyrene</b>	<i>Coarse</i>	0.7	0.7	0.7
	<i>Fine</i>	0.7	0.7	0.7

**Notes:**

- (1) ESLs are of low reliability except where indicated by \* which indicates that the ESL is of moderate reliability.
- (2) '-' indicates that insufficient data was available to derive a value.
- (3) To obtain F1, subtract the sum of BTEX concentrations from C<sub>6</sub>-C<sub>10</sub> fraction and subtract naphthalene from >C<sub>10</sub>-C<sub>16</sub> to obtain F2.



**Table 1 B(7) Management Limits for TPH fractions F1>F4 in soil**

TPH fraction	Soil texture	Management Limits <sup>1</sup> (mg/kg dry soil)	
		Residential, parkland and public open space	Commercial and industrial
<b>F1<sup>2</sup> C<sub>6</sub>-C<sub>10</sub></b>	<i>Coarse</i>	700	700
	<i>Fine</i>	800	800
<b>F2<sup>2</sup> &gt;C<sub>10</sub>-C<sub>16</sub></b>	<i>Coarse</i>	1000	1000
	<i>Fine</i>	1000	1000
<b>F3 &gt;C<sub>16</sub>-C<sub>34</sub></b>	<i>Coarse</i>	2500	3500
	<i>Fine</i>	3500	5000
<b>F4 &gt;C<sub>34</sub>-C<sub>40</sub></b>	<i>Coarse</i>	10 000	10 000
	<i>Fine</i>	10 000	10 000

<sup>1</sup> Management limits are applied after consideration of relevant ESLs and HSLs

<sup>2</sup> Separate management limits for BTEX and naphthalene are not available hence these should not be subtracted from the relevant fractions to obtain F1 and F2.





ENV Solutions

## Service Station Upgrade - 207 – 209 Broken Head Road, Suffolk Park

### Geotechnical Investigation Report

Issue Date: 05-May-2021

Document Number: 21033-00-REP-0001

Rev 0

This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

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## Document Control

### Document Description

Project:	Service Station Upgrade – 207 – 209 Broken Head Road, Suffolk Park	
Document Title:	Geotechnical Investigation Report	Document Number: 21033-00-REP-0001

### Document Development

Revision		Prepared by	Reviewed by	Approved by
	Rev 0	James Greentree	Greg Saenger	Greg Saenger
Date	05/05/2020			

Revision		Prepared by	Reviewed by	Approved by
Date				

Revision		Prepared by	Reviewed by	Approved by
Date				

Revision		Prepared by	Reviewed by	Approved by
Date				

Revision		Prepared by	Reviewed by	Approved by
Date				

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## 1 Introduction

ENV Solutions (the Client) engaged Civil Consult to undertake a geotechnical investigation, analysis and reporting for the proposed upgrades at the Shell Service Station, 207 – 209 Broken Head Road, Suffolk Park.

Based on the information provided by the Client for the proposed development, it is understood that the development will comprise demolition and construction of a new service station including a new service station building, new canopy over fuel bowsers and installation of inground fuel tanks. Design loads have not been provided to Civil Consult but are expected to be typical of these types of structures.

Civil Consult undertook a geotechnical site investigation in accordance with AS1726-2016 [1] on 19/04/2021 including drilling of three boreholes to depths between 5.12 m and 10.13 m below the existing ground level at various locations. A site plan for the proposed development is presented in Appendix A.

### 1.1 Scope

This report presents the results of a geotechnical investigation and provides engineering analysis and recommendations on the following elements:

- Geotechnical investigation and report in accordance with AS 1726 [1]
- Factual findings of the investigation
- Summary of the subsurface profile
- Excavation conditions and methodology
- Site Classification as per AS2870 Residential Slabs and Footings
- Suitable foundation options for the proposed structures
- Excavation support methodology, design parameters and lateral earth pressure coefficients
- Groundwater observations
- Engineering assessment and recommendations

## 2 Site Conditions

### 2.1 Site Description

The site is located adjacent to the roundabout at the intersection of Beech Drive and Broken Head Road, Suffolk Park. The total site covers approximately 3,275 m<sup>2</sup> of generally flat lying ground on the northern bank of Tallow Creek. The creek runs in a general easterly direction along the southern boundary of the site and bends to the north to run in a generally northerly direction along the eastern boundary. Broken Head Road lies adjacent to the western boundary a residential unit complex makes up the northern boundary of the site.

A service station building, including a retail space and mechanic workshop, lies generally at the centre of the site with a canopy extending from the front of the building covering four fuel bowzers. Most of the area lying in front of the building is paved, with the exception of gardens at the front and sides. The area at the rear of the building is clear with a partial covering of gravel and is used for parking and storage.

### 2.2 Site Geological Setting

Reference to the Tweed Coast Area 1:25 000 scale geological map [2] indicates the site is underlain by Holocene interbarrier creek deposits (sand silt, clay, organic mud, peat) overlying Pleistocene coastal barrier deposits (marine sand and indurated sand). The map shows the boundary between these units close to the western boundary of the site.

## 3 Geotechnical Investigation

### 3.1 Field Work

The site geotechnical investigation included the drilling of three boreholes to depths ranging between 5.12 m and 10.13 m below the existing ground surface using a truck mounted drill rig. One borehole was drilled at the rear of the existing building, another on the southern side of the proposed canopy, and another at the northwestern corner of the site at the location of proposed new fuel tanks. The upper 2.5 m of the boreholes were drilled using a 100 mm diameter solid flight auger, washbore techniques were used to drill to depth greater than 2.5 m.



Standard Penetration Tests (SPTs) were undertaken at 1.5 m intervals throughout the depth range of the boreholes. A Dynamic Cone Penetrometer (DCP) test was undertaken adjacent to one borehole, DCP testing was not possible adjacent to other boreholes due to pavement at these locations. The material encountered in the boreholes was logged and visually classified by an engineering geologist from Civil Consult in accordance with AS1726-2017. An undisturbed soil sample was collected for Shrink Swell Index testing at an external laboratory.

A site plan showing the approximate borehole locations is presented in Appendix A, geotechnical borehole logs are presented in Appendix B.

## 4 Subsurface Profile and Geotechnical Model

The subsurface conditions encountered throughout the site have been characterised into four general geotechnical units. The geotechnical units are summarised in Table 1 and Section 4.1 to Section 4.5.

**Table 1 - Summary of Geotechnical Units**

Geotechnical UNIT	Origin and Material	Material Description
UNIT 1	PAVEMENT/FILL	Bitumen and gravel bases
UNIT 2	ALLUVIUM - Sandy CLAY (CH)/ Clayey Sandy SILT (MH)	Soft to firm, high plasticity, dark grey, fine to medium grained sand, dry or moist
UNIT 3	ALLUVIUM – Loose Clayey SAND (SC)/ SAND (SP)	Loose, fine to coarse grained, dark grey or light brown, high plasticity clay fines, trace of fine to coarse sized gravel, wet
UNIT 4	ALLUVIUM – Medium Dense SAND (SP)	Medium dense, fine to coarse grained, light grey brown, sometimes a trace of fine to coarse sized gravel, wet
UNIT 5	ALLUVIUM – Dense SAND (SP) (Coffee Rock)	Dense, fine to coarse grained, red brown, sometimes trace of fine to coarse sized gravel, moist

Detailed logs of the subsurface conditions encountered are presented in Appendix B. The subsurface profile encountered in the boreholes is summarised Table 2.

**Table 2 - Summary of Materials Encountered in the boreholes**

Borehole Number	Fill/Pavement	ALLUVIUM			
	UNIT 1: Pavement/FILL	UNIT 2: Sandy CLAY (CH)/ Clayey Sandy SILT (MH) (m)	UNIT 3: Loose Clayey SAND (SC)/ SAND (SP) (m)	UNIT 4: Medium Dense SAND (SW) (m)	UNIT 5: Dense SAND (SW) (Coffee Rock) (m)
BH1	0.0 – 0.1	0.1 – 1.2	1.2 – 2.3	2.3 – 5.0	5.0 – 5.12*
BH2	0.0 – 0.3	0.5 – 1.5	0.3 – 0.5 1.5 – 3.8	NE	3.8 – 5.92*
BH3	0.0 – 0.3	NE	0.3 – 2.5	2.5 – 4.0 8.2 – 10.0	4.0 – 8.2 10.0 – 10.13*
Notes: NE: Not Encountered * Borehole termination depth					

#### 4.1 Unit 1 (Pavement/Fill)

A 300 mm thick pavement layer was encountered in BH02 and BH03, and a 100 mm layer of sandy gravel used as a road surface material was encountered in BH01.

#### 4.2 Unit 2 (Soft to firm Sandy CLAY and Clayey Sandy SILT ALLUVIUM)

Unit 2 comprises high plasticity alluvial clay and silt of soft to firm consistency and was encountered in BH01 and BH02 underlying pavement or fill material, it was not encountered in BH03. The unit likely represents interbarrier creek deposits which overly the coastal barrier sand deposits and may subsequently thicken across the site towards the south and east. It is typically dark grey and dry to moist at shallow levels and moistens with depth. The dry upper section of the unit forms a harder crust which is underlain by soft clay.

#### 4.3 Unit 3 (Loose SAND ALLUVIUM)

Unit 3 comprises loose alluvial clayey sand (SC), sand (SW) and silty sand (SM) and was encountered in all boreholes underlying alluvial clay and/or pavement. It is typically dark grey at shallower depths turning to light grey brown with depth and extended to depths between 2.3 m and 3.8 m. The unit was typically wet except for a moist section the upper section of BH03.

#### 4.4 Unit 4 (Medium Dense SAND ALLUVIUM)

Unit 4 was encountered in all BH01 and BH02 at depths ranging between 2.3 m and 5.0 m overlying dense sand and typically comprised medium dense sand and traces of gravel. Some gravelly sand and sandy gravel layers were also encountered within the unit. In BH03 a layer of medium dense sand was also encountered from 8.2 m to 10.0 m between dense sand layers. The unit is most commonly light grey brown in colour and wet.

#### 4.5 Unit 5 (Dense Indurated SAND)

Unit 5 typically comprises dense indurated alluvial sand with very dense layers 4.0 m and 10.13 m below the ground surface. The unit typically comprises well graded fine to coarse grained sand and traces of fine to medium sized gravel.

#### 4.6 Groundwater

The groundwater surface was encountered at depths between 1.2 m and 1.5 m below the in the existing ground surface. Ground water level variations may occur due to climatic effects, heavy rainfall, the water level in the nearby Tallow Creek, and the permeability of the soil strata.

Based on the subsurface profile, groundwater observations, the underlying regional geology and geomorphology at the site, a shallow groundwater table is likely to extend across the site. The presence of granular soils below the typical water table depth mean soil permeability would be high.

## 5 Laboratory Testing

Laboratory testing was carried out on an undisturbed soil sample recovered from BH01 determine the shrink swell index of cohesive soil at the site. Laboratory testing was conducted by an approved NATA

facility, in accordance with the relevant Australian Standards. The laboratory testing certificate is attached in Appendix C.

### 5.1 Shrink Swell Index Testing

One undisturbed “U50” tube sample was selected for Shrink Swell Index testing at an external laboratory to assess the characteristic ground surface movement at the site. The results of the test are presented in Table 3 and the laboratory test certificate is presented Appendix C.

**Table 3. Shrink Swell Index Test Result**

Borehole Number	Depth (m)	Natural Soil Description	Shrink-Swell Index, Iss (%)
BH01	1.0 – 1.24	Sandy Clay (CH)	3.9

## 6 Geotechnical Parameters and Recommendations

### 6.1 Lateral Earth Pressure Design Parameters

This section provides shear strength parameters and lateral earth pressure coefficients for the materials encountered at the site. These values may be used during design of sheet pile walls for the fuel tank excavation.

Where lateral movements are tolerable, retaining walls should be designed for ‘active’ ( $K_a$ ) lateral earth pressure conditions. Where movements are to be limited, design for the ‘at rest’ ( $K_o$ ) condition is required. Where adjacent structures and/or underground services are present, design using the ‘at rest’ ( $K_o$ ) lateral earth pressure is required. Table 4 presents the design parameters which can be used for the design of retaining walls.

**Table 4. Geotechnical Parameters and Lateral earth Pressure Coefficients**

Geotechnical Unit	Total Unit Weight $\gamma_t$	Drained Friction Angle $\phi'$ (°)	Drained Cohesion $C'$ (kPa)	Undrained Shear Strength $C_u$ (kPa)	Youngs Modulus $E$ (MPa)	Rankine Earth Pressure Coefficients	
						Active $K_a$	At Rest
UNIT 1 – Pavement/Fill	20	38	0	-	10	0.24	0.38
UNIT 2 – Soft to Firm Clay	16	23	1	25	3	0.44	0.61
UNIT 3 – Loose Sand	17	30	0	-	3	0.33	0.50
UNIT 4 – Medium Dense	18	34	0	-	20	0.28	0.44
UNIT 5 – Dense Indurated	19	35	5	-	120	0.27	0.43
Notes: 1) These values of earth pressure coefficient ignore the effect of wall friction. 2) These values do not account for a backslope. 3) The active earth pressure coefficient, $K_a$ , should be used for free headed walls which can rotate while the “at rest” earth pressure coefficient, $K_o$ , should be used for stiff or propped walls which cannot rotate or accept movement.							

The following requirements and recommendations must be followed and implemented for design and construction of temporary or permanent retaining structures at the site.

- Where adjacent footings apply line or point loads behind temporary or permanent retaining structures, further advice must be sought.

## 6.2 Excavation Conditions and Excavation Support

### 6.2.1 Excavation Conditions

Based on information provided by the Client, installation of the fuel tanks would involve a 5.0 m excavation beneath the existing ground level. An excavation at the proposed fuel tank location to a depth of 5.0 m will encounter pavement at the surface overlying alluvial sand soil to approximately 4.0 m deep overlying indurated sand. Excavations to a depth of up to 4 m and encountering these materials will be possible using a medium to small to medium sized excavator in the order of 4 tonne to 12 tonne in weight/size fitted with a general purpose bucket (a ripper may be required for indurated sand at the base of the excavation). Advice regarding deep excavation methodology is provided in Section 6.2.3 of this Report.

### **6.2.2     *Groundwater Conditions***

Groundwater was encountered in all boreholes from 1.2 m to 1.5 m deep during the site investigation in alluvial granular soils. On this basis, high rates of groundwater ingress are expected in any excavation at the site and dewatering would be required throughout the duration of temporary works.

### **6.2.3     *Temporary Excavation Support***

The sides of excavations are likely to be unstable below the surface of the water table in Unit 2, Unit 3, and Unit 4 meaning excavation supports would be required. Unit 5 is likely to be more stable than the overlying units. Sheet pile walls are recommended to be used to support the sides of the fuel tank excavation. Typical sheet pile installation techniques are likely to be appropriate in Unit 2, Unit 3, and Unit 4. Sheet pile refusal is likely in Unit 5.

Sheet pile design may be undertaken using the parameters presented in Table 4 and must account for surcharges imposed by construction plant. Best practice excavation techniques involve using a small (4 t to 5 t) excavator operating within the sheet pile walls. Doing so would remove plant loads from the zone of influence of the excavation support. Excavated material is typically removed by a crane at greater depths when this technique is used.

A masonry wall is located on the northern boundary of the site, near to the location of the proposed fuel tank excavation. Any load applied by the wall should be considered in sheet pile wall design.

### **6.2.4     *Potential Surface Settlement***

Dewatering of loose granular soils is likely to cause surface settlement adjacent to an excavation. The total surface settlement would depend on the depth of dewatering and proximity to the excavation. If structures sensitive to surface settlements lie adjacent to a dewatered excavation, settlement analysis must be undertaken.

It is recommended that dewatering be undertaken within the excavation to reduce the settlement effects in the surrounding areas.

### 6.3 Deep Piled Foundations

No design loads have been provided by the Client for the purpose of foundation design recommendations. Based on typical loads for the proposed structures, deep piled foundations may be used at the site. Displacement (driven) piles would be most appropriate based on the subsurface profile encountered during the investigation.

When assessing a pile capacity, ultimate geotechnical capacities ( $R_{d,ug}$ ) obtained from the derivation of material parameters, must be multiplied by the appropriate Geotechnical Strength Reduction Factor ( $\phi_g$ ) in accordance with AS2159, Section 4, Table 4.3.2, to calculate the Design Geotechnical Strength ( $R_{d,g}$ ).

An assessment of the appropriate ( $\phi_g$ ) has been made based on the following project specific assumptions:

- Full geotechnical supervision will be carried out during installation of piles.
- Design will be carried out by a designer of at least moderate experience, within similar pile types and geotechnical conditions;
- No performance monitoring will be carried out on the installed pile;
- Well established and soundly based design methods will be adopted for the design;
- The design will utilise the ultimate pile design parameters presented in this report.

In accordance with AS2159 and based on the above assumptions, the overall design average risk rating (ARR) is 2.58.

Adopting this value for ARR and reference to Table 4.3.2(C), of AS2159, for a low redundancy system the Geotechnical Strength Reduction Factor of ( $\phi_g$ ) =0.52 would be considered an appropriate factor for the site if no load testing is undertaken.

The design of displacement pile foundations may be based on the ultimate end bearing capacity ( $f_b$ ) and ultimate skin friction ( $f_s$ ) values presented in Table 5.

**Table 5. Ultimate End Bearing and Shaft Adhesion for Displacement Piles**

Geotechnical Unit	Soil Consistency/Density	$f_b$ (kPa)	$f_s$ (kPa)
UNIT 1 – PAVEMENT/FILL	Medium dense	NR	NR
UNIT 2 – CLAY ALLUVIUM	Soft to Firm	NR	NR
UNIT 3 – SAND ALLUVIUM	Loose	NR	15
UNIT 4 – SAND ALLUVIUM	Medium Dense	4,000	50
UNIT 5 – SAND ALLUVIUM	Dense	10,000	100
Notes: 1) NR – Not Recommended $f_b$ – Ultimate end bearing pressure $f_s$ – Ultimate shaft adhesion			

#### 6.4 Soil Reactivity and Characteristic Ground Surface Movements

The site has been classified in accordance with the methods suggested and set out in Section 2 of the AS2870-2011: Residential Slabs and Footings. The site is classified as **Class P** due to the presence of uncontrolled fill. Characteristic surface movement ( $y_s$ ) has been calculated for the site using methods suggested and set out in AS2870-2011: Residential Slabs and Footings, and the following input parameters have been adopted for the analysis:

- Depth of soil suction change ( $H_s$ ) – 1.2m
- Design surface suction change ( $\Delta u$ ) - 1.5pF – based on Suffolk Park Climate Zone 1 (Vitharana & Colman, 1999).
- Crack depth factor for non-filled profiles - 0.5 $H_s$
- Shrink-swell index ( $I_{ss}$ ) – Based on the results of Shrink Swell Index Testing (Appendix C).

On undertaking this calculation for a site which is subject to normal moisture conditions,  $y_s$  values could be expected to be between 40 mm and 60 mm, which is considered '**Class H1**' (highly reactive site with high ground movement with moisture change).



## 7 Recommendations and Geotechnical Constraints

The following geotechnical site constraints and recommendations should be considered and followed for the service station upgrade project;

- Design and construction of structural elements should be carried out according to the recommendations and parameters presented in Section 5 and Section 6 of this report;
- Uncontrolled fill and pavement materials were encountered on the site and areas of uncontrolled fill are considered unsuitable to support any type of structural element;
- Soft to firm clay soil and loose sand was encountered at the site and is not suitable for use as a foundation material for any structural element.
- Highly reactive (Class H1) fine grained soils were encountered to depths of up to 1.2 m at the site. Structures and pavements will need to be designed with consideration of highly reactive soils.
- Temporary excavation support would be required for deep excavations. Temporary support may be designed using the parameters presented in Table 4 and the comments and recommendations presented in Section 6.2 of this report.
- The effects of surface settlements on nearby sensitive structures should be assessed prior to commencement of dewatering.
- Based on the subsurface profile encountered at the site, driven pile foundations would be appropriate as a foundation option at the site. Pile design may be based on ultimate end bearing and shaft adhesion values presented in Table 5 and the recommendations presented in Section 6.1 of this report.
- Sheet pile retaining structures must be designed by a suitably qualified geotechnical/structural engineer with at least 10 years experience.

Should any further information be required, please contact this office.

Prepared by:

A handwritten signature in black ink, appearing to read 'J. Greentree'.

**James Greentree – Engineering Geologist**

Reviewed by:

A handwritten signature in black ink, appearing to read 'G. Saenger'.

**Greg Saenger – Senior Geotechnical Engineer**

CPEng, MIEAust, NPER, RPEQ  
0490 419 541

Civil Consult Pty Ltd

The logo for Civil Consult, featuring a stylized blue 'C' icon followed by the text 'civil consult' in a sans-serif font.

**Consulting Engineers**

CPEng, MIEAust, NPER, RPEQ  
0490 419 541

## Limits of Geotechnical Investigation & Design

The results, analysis and design presented in this report are indicative of the specific investigation test locations and sample locations undertaken by Civil Consult.

The data provided in this report relates only to the structures described within this report and should not be used or modified for any other purpose. Civil Consult accepts no liability for any use of the data by others.

The results and design work (where presented) in this report are based specifically on test and sample locations, and are only valid at these precise locations. At all other locations across the site differences will occur to varying degrees. The subsurface profile will vary between test locations and also between individual samples taken within a test location. Conditions in the subsurface profile including groundwater can change over short periods of time and this should be considered when reviewing data presented in this report.

The data presented in the report should be reviewed by a suitably qualified engineer when footings, excavations, and subsurface structures are installed to confirm assumed conditions presented in this report. If they do not agree, further advice should be sought immediately.

Due to inherent uncertainties when interpreting subsurface conditions, there are often cost variations during projects or during the execution of projects as a result of unanticipated subsurface conditions. Civil Consult accepts no responsibility for variation of the subsurface profile and the consequences of these variations on the project or execution of the project.

Civil Consult accepts no responsibility for the use or modification of the data presented within this report by others.

## 8 References

- [1] Standards Australia 2016, Geotechnical site investigations, AS 1726-2016, Standards Australia, Sydney
- [2] Tweed Heads 1:250000 Geological Series Sheet SH-56-3. 1972. Geological Survey of New South Wales.
- [3] Standards Australia 2011, Residential Slabs and Footings, AS 2870-2011, Standards Australia, Sydney
- [4] Standards Australia 2009, Piling Design and Installation, AS2159-2009, Standards Australia, Sydney
- [5] Standards Australia 2007, Guidelines on earthworks for commercial and residential developments, AS 3798-2007, Standards Australia, Sydney

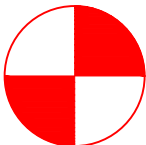
## Appendix A - Site Plan

File Name: C:\Users\CIVIL CONSULT\04\Dropbox (Civil Consult)\Civil Consult Team Folder\01 Projects\21033 - ENV Solutions - Shell Suffolk Park\CADD\21033 - Geotech.dwg



0			
D1			
ISSUE	DESCRIPTION	DATE	APPROVAL

LEGEND

 Approximate borehole location



21 CLARK STREET, BALLINA, NSW,  
2478  
ABN:12591694943  
PH: (02) 6686 9036  
E: info@civilconsult.com.au

FINAL			
ORIGINAL SIZE	A3	DRAWN	E.F
COORDINATE SYSTEM	MGA ZONE 56	DESIGNED	/
HEIGHT DATUM	AHD	DATE PRINTED	22 - April - 2021 9:30
FILE: 21033 - Geotech.dwg		ALIGNMENT MODEL No:	

--

SITE PLAN AND BOREHOLE LOCATIONS SHELL SUFFOLK PARK PROPOSED SERVICE STATION UPGRADE				
CLEINT: ENV Solutions				
ZONE	LOT CODE	DOC TYPE	SHEET No	ISSUE
-	-	21033	S-01	0

## Appendix B Borehole Logs








## GEOTECHNICAL LOG - SUBSURFACE PROFILE

JOB NUMBER: 21033

CLIENT: ENV Solutions  
PROJECT: Geotechnical Investigation  
POSITION: Shell Suffolk Park  
METHOD: 0m - 2.5m 100mm Solid Flight Auger, >2.5m Washbore  
DATE: 4/19/2021

TEST HOLE ID: BH01

SURFACE RL:  
HOLE SIZE: 100mm  
LOGGED BY: J Greentree

Depth	Groundwater	USC Symbol	Graphical Log	MATERIAL DESCRIPTION	Consistency / Density	DCP (Blows / 100mm)	Comments, Observations, Samples
0		GM		FILL - SILTY TO SANDY GRAVEL (GM): Medium dense, fine to medium sized, pale brown, fine to coarse grained sand, dry	MD	16	
		MH		ALLUVIAL - SANDY SILT (MH): Medium dense, firm, medium to high plasticity, grey dark, fine grained sand, inorganic, dry	MD	6	
0.5		MH		ALLUVIAL - SANDY SILT (MH): Soft, medium to high plasticity, dark grey, fine grained sand, inorganic, dry	S	6	
		CH		ALLUVIAL - SILTY TO SANDY CLAY (CH): Soft, high plasticity, grey dark, fine to medium grained sand, moist	S	5	
1		SC		ALLUVIAL - CLAYEY SAND (SC): Loose, medium to coarse grained, brown dark, high plasticity clay, wet (sandy clay layers thruought. hole collapse at 2.0m.)	L	4	
1.5						2	SPT N=4
2						2	
		SP		ALLUVIAL - SAND (SP): Medium dense, medium grained, grey, wet (some fine to medium sized gravel layers)	MD	2	
2.5						3	
						5	
						8	
						5	
						7	
						6	
						7	
						8	
						11	SPT N=11
						15	
						18	
						19	
						20	
3.5							
4							
							SPT N=26
4.5							
5		SP		ALLUVIAL - SAND (SP): Dense, medium grained, grey, wet (some fine to medium sized gravel layers. indurated sand (coffee rock))	D		SPT N=30/120
5.5				Borehole Terminated @ 5.12m			
6							



**GEOTECHNICAL LOG - SUBSURFACE PROFILE**
**JOB NUMBER: 21033**

CLIENT: ENV Solutions  
PROJECT: Geotechnical Investigation  
POSITION: Shell Suffolk Park  
METHOD: 0m - 2.5m 100mm Solid Flight Auger, >2.5m Washbore  
DATE: 4/19/2021

**TEST HOLE ID: BH02**

SURFACE RL:  
HOLE SIZE: 100mm  
LOGGED BY: J Greentree









Depth	Groundwater	USC Symbol	Graphical Log	MATERIAL DESCRIPTION	Consistency / Density	DCP (Blows /100mm)	Comments, Observations, Samples
0		PA		Pavement - BITUMEN (PAV)			
		V					
		GM		FILL - SILTY TO SANDY GRAVEL (GM): Medium dense to dense, fine to medium sized, brown, fine grained sand, moist to dry	MD		
		SW			L		
0.5		CH		ALLUVIAL - SAND (SW): Loose to medium dense, fine to medium grained, brown, moist	S		
				ALLUVIAL - SILTY CLAY (CH): Soft to firm, high plasticity, dark grey, moist			
1							SPT N=2
1.5	▼	SC		ALLUVIAL - CLAYEY SAND (SC): Loose, medium to coarse grained, brown, high plasticity clay, trace fine sized gravel, wet (some sandy clay layers)	L		
2							
2.5							SPT N=5
3							
3.5							
4		SW		ALLUVIAL - SAND (SW): Very dense, fine to medium grained, red brown, trace fine sized gravel, moist (indurated sand (coffee rock))	D		
		SM		ALLUVIAL - SILTY SAND (SM): Dense to very dense, medium to coarse grained, red brown, trace fine to medium sized gravel, moist (indurated sand (coffee rock))	D		SPT N=30,30/60
4.5							
5							
5.5							SPT 30/120
6				Borehole Terminated @ 5.92m			

**GEOTECHNICAL LOG - SUBSURFACE PROFILE**
**JOB NUMBER: 21033**

CLIENT: ENV Solutions  
PROJECT: Geotechnical Investigation  
POSITION: Shell Suffolk Park  
METHOD: 0m - 2.5m 100mm Solid Flight Auger, >2.5m Washbore  
DATE: 4/19/2021

**TEST HOLE ID: BH03**

SURFACE RL:  
HOLE SIZE: 100mm  
LOGGED BY: J Greentree

Depth	Groundwater	USC Symbol	Graphical Log	MATERIAL DESCRIPTION	Consistency / Density	DCP (Blows / 100mm)	Comments, Observations, Samples
0		PA		Pavement - BITUMEN (PAV)			
		V		FILL - SILTY TO SANDY GRAVEL (GM): Medium dense to dense, fine to coarse sized, brown, fine to coarse grained sand, dry	MD		
		GM			L		
0.5		SM		ALLUVIAL - SILTY SAND (SM): Loose, fine to medium grained, dark grey, moist			
		SM		ALLUVIAL - SILTY SAND (SM): Loose, fine to medium grained, pale brown, moist	L		
1		SW		ALLUVIAL - SAND (SW): Loose, medium to coarse grained, pale grey brown, wet	L		SPT N=2
1.5							
2							
2.5		SW		ALLUVIAL - SAND (SW): Medium dense, medium to coarse grained, pale grey brown, trace fine sized gravel, wet	MD		SPT N=22
3							
3.5							
4		SP		ALLUVIAL - SAND (SP): Dense to very dense, medium grained, red brown, trace fine sized gravel, moist (indurated sand (coffee rock))	D		SPT N=13,30/120
4.5							
5							
5.5							SPT 30/145
6							

**GEOTECHNICAL LOG - SUBSURFACE PROFILE**
**JOB NUMBER:** 21033

**CLIENT:** ENV Solutions  
**PROJECT:** Geotechnical Investigation  
**POSITION:** Shell Suffolk Park  
**METHOD:** 0m - 2.5m 100mm Solid Flight Auger, >2.5m Washbore  
**DATE:** 4/19/2021

**TEST HOLE ID:** BH03

**SURFACE RL:**  
**HOLE SIZE:** 100mm  
**LOGGED BY:** J Greentree

Depth	Groundwater	USC Symbol	Graphical Log	MATERIAL DESCRIPTION	Consistency / Density	DCP (Blows / 100mm)	Comments, Observations, Samples
6							
6.5							
7							
7.5							
8							
8.5		SW		ALLUVIAL - GRAVELLY SAND (SW): Medium dense, medium to coarse grained, red brown, fine to coarse sized gravel, wet	MD		SPT 30/140
9							
9.5							
10		SP		ALLUVIAL - GRAVELLY SAND (SP): Dense to very dense, coarse grained, red brown, fine to medium sized gravel, wet	D		SPT N=18
10.5				Borehole Terminated @ 10.135m			SPT 30/135
11							
11.5							
12							

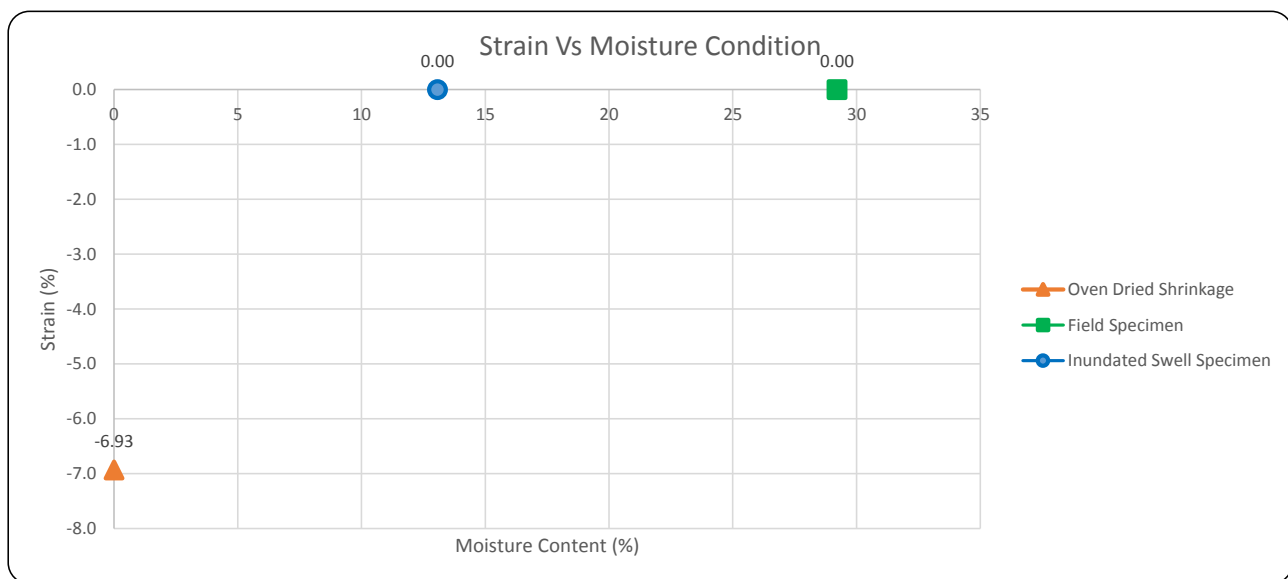
## Appendix C Laboratory Test Results


### Report on Shrink / Swell Index of a Soil

Client:	Civil Consult	Report No:	1
Client Address:	21 Clark St, Ballina NSW 2478	Report Date:	3/05/2021
Project:	Suffolk Park BP	Report Page:	Page 1 of 1
Works Component:	Shrink-Swell Index	Project No:	2259
Material Used:	Natural	Test Request/Order:	NA
Material Description:	Silty Clay	Lot Number:	NA
Lab Test Date/s:	Testing commenced 20/04/2021 and was completed 30/04/2021.	ITP/PCP Number:	-
Lot Comments:	-	Control Line:	NA

Sample Number	Sample Date	Chainage/Location	Offset	Level of Test	Test Depth
14126	Client	BH01	BH01	Subgrade	1.0m-1.2m

Parameters	Units	Test Results	Soil Description
Shrinkage - Field Moisture Content	%	31.4	Silty Clay
Swell - Field Moisture Content	%	27.1	
Swell - Inundated Moisture Content	%	13.1	
Inert Inclusions in the soil	%	5	
Extent of Soil Crumbling	-	None	
Extent of Soil Cracking	-	Minor	
<b>Shrink-Swell Index</b>	%	<b>3.9</b>	



Sampling & Test Methods (Results relate only to the items sampled/tested)	Report Remarks & Endorsement
AS 1289.7.1.1, Cl 4: Shrink Swell Index - Thin wall sampler (U50) AS 1289.7.1.1: Shrink Swell Index of a Soil	<div>  <p><b>AUSTRALIAN SOIL AND CONCRETE TESTING</b></p> <p>Always Test With The Best.</p> </div> <div> <p>Issued By: _____</p> <p>J.Fitzgibbon Approved Signatory</p> </div>



TABULATED GROUNDWATER RESULTS

		NA	Benzene, Toluene, Ethylbenzene and Xylenes (BTEX)					Lead	Metals							PAH	
		Benzo(b+j+k)fluoranthene	Benzene	Toluene	Ethylbenzene	Xylene (m & p)	Xylene (o)	Lead (filtered)	Arsenic (filtered)	Cadmium (filtered)	Chromium (III+VI) (filtered)	Copper (filtered)	Mercury (filtered)	Nickel (filtered)	Zinc (filtered)	Acenaphthene	Acenaphthylene
		mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L
EQL		0.002	1	1	1	2	1	0.001	0.001	0.0001	0.001	0.001	0.00005	0.001	0.001	1	1
NEPM 2013 Table 1C GILs, Drinking Water NEPM 2013 Table 1C GILs, Fresh Waters NEPM 2013 Table 1C GILs, Marine Waters NHMRC 2008 Recreational Use			1	800	300			0.01	0.01	0.002		2	0.001	0.02			
			950				350	0.0034		0.0002		0.0014	0.00006	0.011	0.008		
			500					0.0044		0.0007		0.0013	0.0001	0.007	0.015		
			10	250	30	200		0.1	0.07	0.02	0.5	10	0.01	0.2	30		
NEPM 2013 Table 1A(4) Comm/Ind HSL D GW for Vapour Intrusion, Sand 2-4m 4-8m >8m																	
			5,000														
			5,000														
			5,000														
Field ID	Date																
MW5	09-03-18	<0.002	<1	<1	<1	<2	<1	<0.001	0.088	<0.0001	<0.001	<0.001	<0.00005	<0.001	0.002	<1	<1
MW6	09-03-18	<0.002	6	<1	<1	<2	<1	<0.001	0.028	<0.0001	<0.001	<0.001	<0.00005	<0.001	0.008	<1	<1
MW9	09-03-18	<0.002	1	<1	5	11	1	<0.001	0.033	<0.0001	<0.001	0.009	<0.00005	0.002	0.08	<1	<1
MW10	09-03-18	<0.002	2	<1	22	11	<1	<0.001	0.007	<0.0001	<0.001	0.002	<0.00005	0.002	0.006	<1	<1

**Notes:**  
NEPM - National Environment Protection (Assessment of Site Contamination) Measure 1999 (as amended 2013)  
HSL - Health Screening Level  
GIL - Groundwater Investigation Level  
NHMRC - National Health and Medical Research Council

TABULATED GROUNDWATER RESULTS

Polycyclic Aromatic Hydrocarbons (PAH)															TPH	
Anthracene	Benz(a)anthracene	Benzo(a) pyrene	Benzo(g,h,i)perylene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene	Benzo(a)pyrene TEQ	PAHs (Sum of positives)		C6-C9	C10-C14
µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L		µg/L	µg/L
EQL	1	1	1	1	1	1	1	1	1	1	1	0.005	0.001		10	50
NEPM 2013 Table 1C GILs, Drinking Water NEPM 2013 Table 1C GILs, Fresh Waters NEPM 2013 Table 1C GILs, Marine Waters NHMRC 2008 Recreational Use NEPM 2013 Table 1A(4) Comm/Ind HSL D GW for Vapour Intrusion, Sand 2-4m 4-8m >8m		0.01														
									16							
									50							
		0.01														
Field IDDate																
MW5	09-03-18	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.005	0	<10
MW6	09-03-18	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.005	0	42
MW9	09-03-18	<1	<1	<1	<1	<1	<1	<1	<1	<1	3	<1	<1	<0.005	0.0030	120
MW10	09-03-18	<1	<1	<1	<1	<1	<1	<1	<1	<1	2	<1	<1	<0.005	0.0015	110

**Notes:**  
NEPM - National Environment Protection (Assessment of Site Contamination) Measure 1999 (as amended 2013)  
HSL - Health Screening Level  
GIL - Groundwater Investigation Level  
NHMRC - National Health and Medical Research Council



## TABULATED GROUNDWATER RESULTS

		Total Petroleum Hydrocarbons (TPH) / Total Recoverable Hydrocarbons (TRH)																																																									
		C15-C28	C29-C36	C6-C10	C10-C16	C16-C34	C34-C40	F1 (TRH C6-C10 minus BTEX)	F2 (TRH C10-C16 minus naphthalene)																																																		
		µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L																																																		
EQL		100	100	0.01	0.05	0.1	0.1	0.01	0.05																																																		
NEPM 2013 Table 1C GILs, Drinking Water																																																											
NEPM 2013 Table 1C GILs, Fresh Waters																																																											
NEPM 2013 Table 1C GILs, Marine Waters																																																											
NHMRC 2008 Recreational Use																																																											
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2-4m								6																																																			
4-8m								6																																																			
>8m								7																																																			
<table border="1"> <thead> <tr> <th>Field ID</th> <th>Date</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> </tr> </thead> <tbody> <tr> <td>MW5</td> <td>09-03-18</td> <td>&lt;100</td> <td>&lt;100</td> <td>&lt;0.01</td> <td>&lt;0.05</td> <td>&lt;0.1</td> <td>&lt;0.1</td> <td>&lt;0.01</td> <td>&lt;0.05</td> </tr> <tr> <td>MW6</td> <td>09-03-18</td> <td>&lt;100</td> <td>&lt;100</td> <td>0.048</td> <td>&lt;0.05</td> <td>&lt;0.1</td> <td>&lt;0.1</td> <td>0.042</td> <td>&lt;0.05</td> </tr> <tr> <td>MW9</td> <td>09-03-18</td> <td>&lt;100</td> <td>&lt;100</td> <td>0.17</td> <td>0.096</td> <td>&lt;0.1</td> <td>&lt;0.1</td> <td>0.16</td> <td>0.091</td> </tr> <tr> <td>MW10</td> <td>09-03-18</td> <td>&lt;100</td> <td>&lt;100</td> <td>0.15</td> <td>0.06</td> <td>&lt;0.1</td> <td>&lt;0.1</td> <td>0.11</td> <td>0.057</td> </tr> </tbody> </table>										Field ID	Date									MW5	09-03-18	<100	<100	<0.01	<0.05	<0.1	<0.1	<0.01	<0.05	MW6	09-03-18	<100	<100	0.048	<0.05	<0.1	<0.1	0.042	<0.05	MW9	09-03-18	<100	<100	0.17	0.096	<0.1	<0.1	0.16	0.091	MW10	09-03-18	<100	<100	0.15	0.06	<0.1	<0.1	0.11	0.057
Field ID	Date																																																										
MW5	09-03-18	<100	<100	<0.01	<0.05	<0.1	<0.1	<0.01	<0.05																																																		
MW6	09-03-18	<100	<100	0.048	<0.05	<0.1	<0.1	0.042	<0.05																																																		
MW9	09-03-18	<100	<100	0.17	0.096	<0.1	<0.1	0.16	0.091																																																		
MW10	09-03-18	<100	<100	0.15	0.06	<0.1	<0.1	0.11	0.057																																																		

Notes:

NEPM - National Environment Protection (Assessment of Site Contamination) Measure 1999 (as amended 2013)

HSL - Health Screening Level

GIL - Groundwater Investigation Level

NHMRC - National Health and Medical Research

Council



**HORIBA**

SINGLE MEASUREMENT

SITE:

23.61 °C

6.99 mg/L DO

6.52 pH

82.5 % DO

12 pHmV

0.193 g/L TDS

93 ORPmV

0.14 ppt

0.296 mS/cm

0.0 ct

12.6 NTU

Press MEAS to collect data.

WATER QUALITY MONITOR

MEAS



LIGHT



ENTER



a) Excavation Dimensions, Standing Water Level (SWL) and Dewatering Duration				
Input Description	Input Information		Units	Symbol
Length of Excavation	3		meters	L
Width of Excavation	3		meters	W
Depth to 'Natural' Standing Water Level	1.2		meters	SWL <sub>01</sub>
Depth to 'Required' Standing Water Level	4		meters	SWL <sub>02</sub>
Dewatering Duration Required	5		days	t

b) Soil Type	
Soil 'Type' (Drop Down Select)	Sand

c) Outputs				
Disturbance of Influence, Flow Rate and Total Discharge Volume				
Output Description	Min Output	Max Output	Units	Symbol
Distance of Influence	34.6	49.0	meters	Lo
Flow Rate	59	84	kilolitres/ day	Q
Estimate Total Discharge Volume	0.30	0.42	megalitres	V

d) Does Estimate Total Discharge (Max Output) Exceed 3 megalitres?	
NO	

**Disclaimer**

Calculations have been developed utilising the Dupuit Forcheimer Formula.

ksat for 'soil types' generated utilising Engineers Australia (2006) and Cashman & Preene 2013).

In all cases, a confining layer has been fixed at 20 meters below ground level.

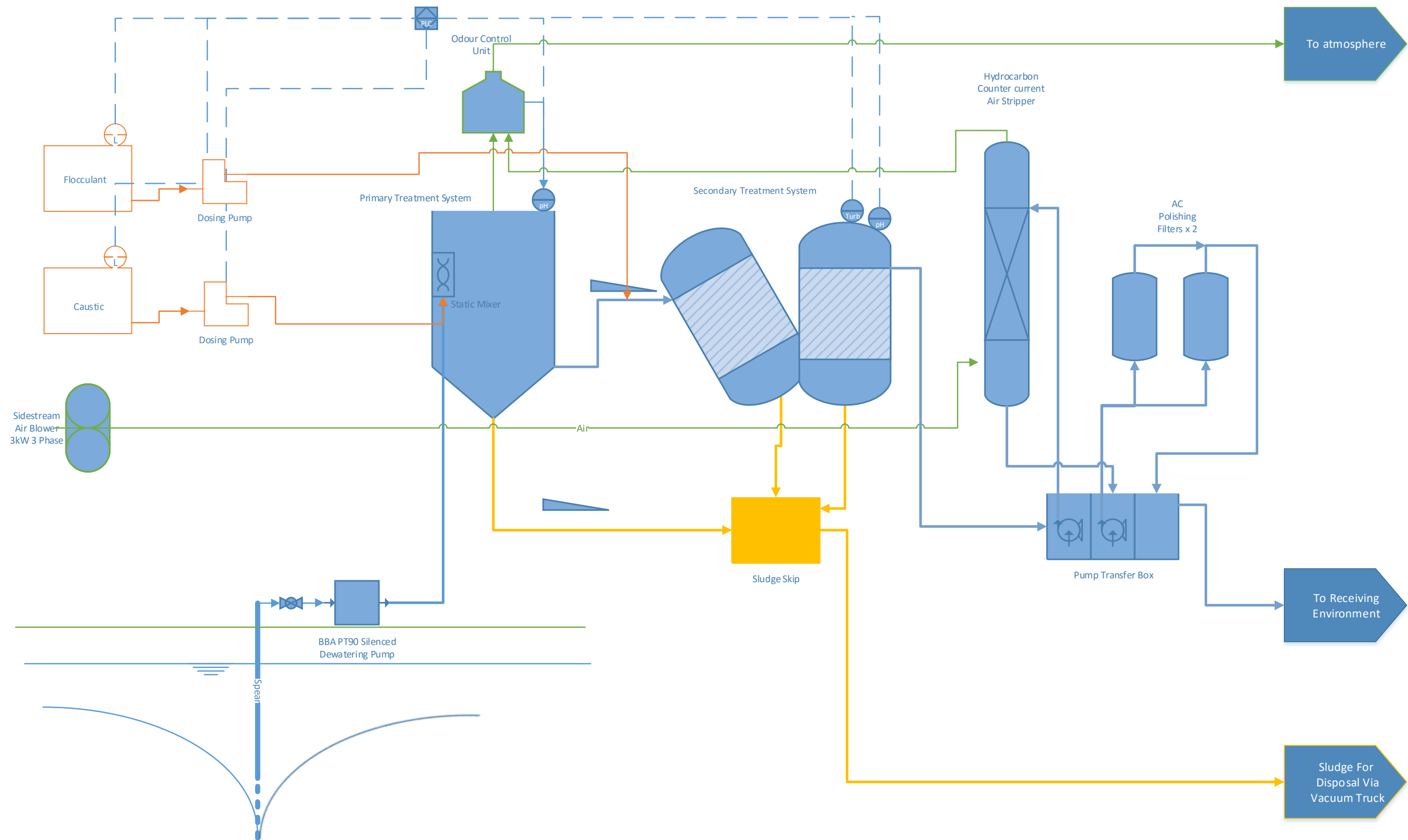
All outputs are Calculated Estimates Only and based combined modelling and practical approach.



**Attachment 7 – Sewer Pump Station Shoring Box Calculations**  
207-209 Broken Head Road, Suffolk Park, NSW

**Client: Horizon Retail Pty Ltd**  
**Project: Dewatering Management Plan**  
**Job No: 21140**





REV	DESCRIPTION	DATE	DRAWN	DESIGN	CHECK	APP.	Client:	<div>ENV Solutions</div> <div>ENV Solutions Pty Ltd PO BOX 248 Ballina NSW 2478 admin@envsolutions.com.au</div>	Project: Dewatering System Overview	Drawing Title: Process Flow Diagram	Size: A3    Job No: ENV    Drawing No: 0001    Revision: A
A	ISSUED FOR INFORMATION	16/06/16	JKF	JKF	RM	RM					







Liquid Aluminium Chlorohydrate

Issued: 19 January 2017

Version: 3

Page 1 of 9

## SAFETY DATA SHEET

### 1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

<b>Product Name:</b>	<b>LIQUID ALUMINIUM CHLOROHYDRATE</b>
<b>Other Names:</b>	Aluminium Chloride Hydroxide, Aluminium Chlorohydrate, Aluminium Hydroxychloride, Aluminium Chlorohydroxide.
<b>Manufacturers Product Code:</b>	MegaPac 23™.
<b>Recommended use of the chemical and restrictions on use:</b>	Flocculent for the treatment of municipal water supplies, waste water and industrial effluents; removal of phosphate in sewage treatment; paper manufacture; chemical manufacture.
<b>Supplier:</b>	Omega Chemicals
<b>ABN:</b>	32 982 143 022 / A.C.N 005 032 744 T/A
<b>Street Address:</b>	55 FITZGERALD ROAD, LAVERTON NORTH VIC 3026
<b>Telephone Number:</b>	+61 3 8368 8000
<b>Facsimile:</b>	+61 3 8368 8020
<b>Emergency Telephone:</b>	1300 131 001 (24 Hours) Poisons Information Centre Australia: 131 126

### 2. HAZARD IDENTIFICATION

<b>Hazard Classification:</b>	Not classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for transport by Road and Rail; NON-DANGEROUS GOODS. Classified as hazardous according to Safe Work Australia; HAZARDOUS SUBSTANCE.
<b>GHS Classification:</b>	No available data
<b>Signal Word (s):</b>	No available data
<b>Hazard Statement(s):</b>	H320 Causes eye irritation H316 Causes mild skin irritation
<b>Precautionary Statement(s):</b>	
<b>Prevention Statement(s):</b>	P102 Keep out of reach of children P103 Read Label before use P104 Read Safety Data Sheet before use P234 Keep only in original container P264 Wash hand thoroughly after handling. P280 Wear protective gloves/protective clothing/eye protection/face protection

**Response Statement(s):** P305+P351+P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do. Continue rinsing.  
 P337+P313 If eye irritation persists: Get medical advice/attention.  
 P302+P352 IF ON SKIN: Wash with plenty of soap and water.  
 P362 Take off contaminated clothing and wash before use.  
 P332+P313 If skin irritation occurs: Get medical advice/attention.  
 P301+P330+P331 IF SWALLOWED: Rinse mouth. Do not induce vomiting.  
 P313 Get medical advice/attention  
 P304+P340 IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.  
 P262 Do not get in eyes, skin or on clothing.

**Storage Statement(s):** P405 Store locked up.  
 P406 Store in corrosive resistant/compatible container.  
 P403+P235 Store in well-ventilated place. Keep cool.

**Disposal Statement(s):** Dispose of contents/container according to jurisdictional regulations.

**Poison Schedule (SUSMP):** None Allocated

### 3. COMPOSITION/INFORMATION ON INGREDIENTS

Ingredients:	CAS Number	Proportion:	Hazard Codes
Aluminium Chlorohydrate	12042-91-0	50%	H320, H316
Water	7732-18-5	Balance to 100%	

### 4. FIRST - AID MEASURES

For advice, contact Poisons Information Centre on 131 126 or a Doctor.

**Ingestion:** Immediately rinse mouth with water. Give plenty of water to drink. **DO NOT** induce vomiting. If vomiting occurs give further water. Never give anything by mouth if victim is rapidly losing consciousness. **Seek immediate medical attention.**

**Eyes:** Immediately irrigate with copious quantities of water for at least 15 minutes. Eyelids to be held open. Remove clothing if contaminated and wash skin. **Seek medical assistance.**

**Skin:** Remove all contaminated clothing without delay. Wash skin gently and thoroughly with copious amounts of water. If irritation occurs, seek medical attention.

**Inhalation:** Remove the source of contamination or move the victim to fresh air; avoid becoming a casualty. Remove contaminated clothing and loosen remaining clothing. Allow patient to assume most comfortable position and keep warm. Keep at rest until fully recovered. Seek medical attention.

**Advice to Doctor:** Treat symptomatically.

#### Additional Information

**Aggravated medical conditions caused by exposure:** No information available on medical conditions which are aggravated by exposure to this product. Repeated skin exposure may lead to dermatitis. Repeated ingestion of this product may cause phosphate deficiency which can weaken bones.

## 5. FIRE FIGHTING MEASURES

**Extinguishing Media:** In case of fire, use an appropriate extinguishing media (water fog or if unavailable fine water spray, foam, carbon dioxide, dry chemical powder) that is the most suitable for surrounding fire conditions. Keep containers cool with water spray. If safe to do so, remove containers from path of fire. Suppress (knock-down) gases, vapours and mists with a water spray jet.

**Hazchem Code:** N/A.

**Specific Hazards arising from the substance or mixture:**

**Hazards from Combustion:** Product is non-flammable and stable under normal conditions of use and storage. Under fire conditions this product may emit toxic and/or irritating vapours and gases including hydrogen chloride gas.

**Flammability Conditions:** Product is a non-flammable liquid.

**Special Protective Precautions and Equipment for Fire Fighters:** Fire fighters should wear a self-contained breathing apparatus and full protective clothing along with protective equipment. Prevent fire extinguishing water from contaminating surface water or the ground water system.

## 6. ACCIDENTAL RELEASE MEASURES

**Emergency Procedures/Protective Equipment/Personal Precautions:** Evacuate all unnecessary personnel. Work upwind. Increase ventilation. Use water spray to disperse vapours. Personnel involved in the clean-up should wear full protective clothing; self-contained breathing apparatus may be needed for prolonged periods of exposure. Avoid walking through spilled product as it may be slippery. Cover drains. Collect, bind and pump off spills.

<b>Environmental Precautions:</b>	Do not allow product to enter drains, sewers, waterways or soil. If contamination of drains has occurred, advise the local emergency services.
<b>Methods and Materials for Containment and Clean Up:</b>	Contain spilled product using absorbent (soil or sand). Prevent run off into drains, sewers waterways or soil. Collect and seal in properly labelled drums ready for appropriate disposal. Dilute remaining product with water, then carefully neutralize with lime. For large spills notify local emergency services.

## 7. HANDLING AND STORAGE

<b>Precautions for Safe Handling:</b>	Irritant liquid. Ensure an eye bath and safety shower are available and ready for use. Use only in a well-ventilated area. Prevent the build-up of mists in the work atmosphere. Avoid inhalation of mists, and skin or eye contact. Wear appropriate protective equipment to prevent inhalation, skin and eye contact when mixing and using. Ensure a high level of personal hygiene is maintained when using this product, that is, always wash hands before eating, drinking, smoking or using the toilet. Keep containers sealed when not in use.
<b>Container Type:</b>	Packaging must comply with requirements of Hazardous Substances (Packaging) Regulations 2001. Store in original packaging as approved by manufacturer. Store and transport in corrosion resistant containers such as stainless steel, rubber lined steel, PVC, fibreglass or polyethylene.
<b>Conditions for Safe Storage, including any Incompatibles:</b>	Store in a cool, dry, well-ventilated area out of direct sunlight. Do not store with incompatible products such as chlorite, hypochlorite, sulphite, oxidizing agents and cyanides; Avoid contact with unalloyed steels, galvanized or aluminium surfaces. Do not store with any foodstuffs.

## 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

<b>Control Parameters:</b>	
National Exposure Standards:	Aluminium Chlorohydrate: No specific exposure standard. Aluminium soluble salts (as Aluminium): AU OEL: 2 mg/m <sup>3</sup> .
Biological Limit Values:	No data available
<b>Appropriate Engineering Controls:</b>	Select suitable materials for the construction of storage tanks, containers, pipe valves and fittings. Ensure adequate ventilation. Natural ventilation should be adequate under normal use conditions. Keep containers closed when not in use in a well-ventilated area.

**Individual Protection Measures, such as Personal Protective Equipment (PPE):****Respirator:** If engineering controls are not effective in controlling airborne exposure then an approved respirator with a replaceable mist filter should be used.**Eyes:** Chemical splash goggles or safety glasses with side shields and a full-face shield as appropriate should be used.**Hands:** Wear elbow-length gloves of impervious material, PVC or rubber should be suitable.**Clothing:** Protective overalls, splash apron and rubber boots.

After using this product always wash hands before smoking, eating, drinking or using the toilet. Wash contaminated clothing and other protective equipment before storage or re-use.

**9. PHYSICAL AND CHEMICAL PROPERTIES****Core Information****Appearance:** Colourless to slightly cloudy liquid.**Formula:**  $\text{Al}_2(\text{OH})_5\text{Cl}$ .**Odour:** Odourless.**pH:** 2.5 – 3.5.**Vapour Pressure:** No data available.**Vapour Density:** No data available.**Boiling Point:** >100°C.**Freezing Point:** ca. -5°C.**Solubility (in Water):** Miscible.**Specific Gravity:** 1.33 – 1.34 (at 20°C).**Flash Point:** N/A.**Flammability Limits (as Percent Volume in Air):**  
**Lower Explosive Limit** N/A.  
**Upper Explosive Limit** N/A.**Ignition Temperature:** No data available.

**Additional Information**

<b>Specific Heat Value:</b>	No data available.
<b>Particle Size:</b>	No data available.
<b>Volatile Organic Compounds Content (VOC):</b>	No data available.
<b>Viscosity:</b>	No data available.
<b>Percent Volatile:</b>	No data available.
<b>Octanol/Water Partition Coefficient:</b>	No data available.
<b>Saturated Vapour Concentration:</b>	No data available.
<b>Additional Characteristics:</b>	Insoluble in alcohol.
<b>Flame Propagation/Burning Rate of Solid Materials:</b>	No data available.
<b>Properties that may Initiate or Contribute to the Intensity of a Fire:</b>	No data available.
<b>Potential for Dust Explosion:</b>	N/A.
<b>Reactions that Release Flammable Gases or Vapours:</b>	Thermal decomposition will produce hydrogen chloride gas.
<b>Fast or Intensely Burning Characteristics:</b>	No data available.
<b>Non-Flammables that Could Contribute Unusual Hazards to a Fire:</b>	No data available.
<b>Release of Invisible Flammable Vapours and Gases:</b>	No data available.
<b>Decomposition Temperature:</b>	No data available.
<b>Evaporation Rate:</b>	No data available.

**10. STABILITY AND REACTIVITY****Reactivity:****Chemical Stability:**

Stable under normal conditions of storage and handling.  
This product can hydrolyse and form a precipitate of aluminium hydroxide in very dilute aqueous solutions. The solubility is dependent on the pH.

<b>Possibility of hazardous Reactions:</b>	Strong aqueous solutions of the product will readily react with sodium hydroxide and other alkali to form a thick slippery paste or gel. When involved in a fire, the product will undergo thermal decomposition to produce hydrogen chloride gas.
<b>Conditions to Avoid:</b>	Heat-sensitive, avoid exposure to extreme heat and high temperatures. Avoid sources of ignition.
<b>Incompatible Materials:</b>	Avoid contact with unalloyed steels, galvanized or aluminium surfaces. Do not expose to chlorite, hypochlorite, sulphite, sodium hydroxide, alkalis, oxidizing agents and cyanides. Keep away from all foodstuffs.
<b>Hazardous Decomposition Products:</b>	Hydrogen chloride gas.

## 11. TOXICOLOGICAL INFORMATION

### Toxicity Data

**LD50:** 13000 mg/kg (rat, oral).

### Acute (short term)

<b>Ingestion:</b>	May be harmful if swallowed. May cause abdominal pain, nausea, vomiting, bleeding stomach, incoordination, muscle spasm and kidney damage.
<b>Eye:</b>	Can cause moderate to severe irritation and inflammation to the eyes.
<b>Skin:</b>	Can cause irritation and stinging to open cuts and wounds.
<b>Inhalation:</b>	This product has a very low vapour pressure at ambient temperature and therefore cannot normally be inhaled. Inhalation of mists from the product can cause sore throat, coughing and irritation of nose. High concentration of mists may cause congestion and restriction of airways.

### Chronic (long term)

<b>Skin:</b>	Repeated or prolonged exposure may cause dermatitis.
<b>Ingestion:</b>	Repeated ingestion of this product may cause phosphate deficiency which can weaken bones.

## 12. ECOLOGICAL INFORMATION

<b>Ecotoxicity:</b>	No data available.
<b>Persistence and Degradability:</b>	No data available.

**Mobility:** No data available.

#### Additional Information

**Environmental Fate (Exposure):** No data available.

**Bio accumulative Potential:** No data available.

**Other Adverse Effects:** Discharge into the environment must be avoided. Avoid contaminating waterways, drains and sewers. This product is an inorganic compound. A metal hydroxide precipitate is formed during hydrolyses in the pH range 5 to 7; due to this reaction the pH of the water decreases. If phosphates are present then metal phosphate complexes may form.

### 13. DISPOSAL CONSIDERATIONS

**Disposal Methods:** Dispose of in accordance with all local, state and federal regulations. Refer to appropriate State Waste Disposal Authority. Observe local regulations. After dilution and careful neutralisation, approved liquid waste land fill site may be suitable.

**Special Precautions for Landfill or Incineration:** No data available.

### 14. TRANSPORT INFORMATION

**UN Number:** None allocated.

**UN Proper Shipping Name:** Aluminium Chloride Hydroxide.

**Dangerous Goods Class:** None allocated.

**Subsidiary Risk:** None allocated.

**Packaging Group:** None allocated.

**Special Precautions for User:** Irritant.

**Hazchem Code:** N/A.

**APPROVED FOR AIR CARGO by IATA.**

### 15. REGULATORY INFORMATION

**Poisons Schedule:** N/A.

**EPG:** N/A.

**AICS Name:** Aluminium Chloride Hydroxide.

**Additional information:** No data available.



**16. OTHER INFORMATION****Revision Details****Reason for Revision:**

Version 1	5 year review. Updated to a new format. Additional information added.
Version 2	Alignment to GHS requirements.
Version 3	Reclassified as Hazardous.

**Literature References**

<b>Chemical Rubber Company:</b>	Handbook of Chemistry and Physics, 85 <sup>th</sup> Edition.
<b>Safe Work Australia:</b>	Hazardous Chemicals Information System (HCIS) Exposure Standards and GHS Classifications Data-Base, 25 June 2016.
<b>National Transport Commission:</b>	Australian Code for the Transport of Dangerous Goods by Road and Rail, Volume 7.

**Abbreviations**

<b>CAS Number:</b>	Chemical Abstract Service Registry Number.
<b>GHS</b>	Globally Harmonized System of Classification and Labelling of Chemicals.
<b>EPG:</b>	Emergency Procedure Guide.
<b>LD50:</b>	Lethal Dose 50%: The lowest concentration at which approximately 50% of test animals will die when given the specified dose by mouth.
<b>ADG Code:</b>	Australian Code for the Transport of Dangerous Goods by Road and Rail, Volume 7.
<b>AICS Name:</b>	Australian Inventory of Chemical Substances Name.
<b>OEL:</b>	Occupational Exposure Level.
<b>N/A:</b>	Not Applicable.

**Disclaimer**

This Safety Data Sheet is offered solely for information, consideration and investigation to determine the suitability of various health and safety precautions as may be required under the user's specific conditions and processes. All such conditions and processes are beyond the control of Omega Chemicals.

The information contained herein is based on data available to Omega Chemicals from both our own technical sources and recognised published references and is believed to be both accurate and reliable. Omega Chemicals however provides no warranties, either expressed or implied, and assumes no responsibility for the accuracy or completeness of this information.

Omega Chemicals reserves the right to revise this Safety Data Sheet as information becomes available. The user has the responsibility, by making contact with this company or otherwise to make certain the Safety Data Sheet is the latest issue.

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**DOCUMENT END**



# OMEGA CHEMICALS

Manufacturers of Aluminium Sulphate – Suppliers of Industrial Chemicals

"THE ALUM PEOPLE"

Liquid Caustic Soda 46 - 50%


Issued: 20 May 2016 Version: 2 Page 1 of 11

## SAFETY DATA SHEET

### 1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

<b>Product Name:</b>	<b>LIQUID CAUSTIC SODA 46 - 50%.</b>
<b>Other Names:</b>	Sodium hydroxide - liquid (46 - 50%), Soda lye solution (46 - 50%), Caustic soda solution (46 - 50%), Sodium hydroxide solution (46 - 50%), Liquid caustic soda (46 - 50%).
<b>Manufacturers Product Code:</b>	Liquid Caustic Soda 46 - 50%.
<b>Recommended use of the chemical and restrictions on use:</b>	Neutralising acids; making sodium salts (e.g. removing sulphuric and organic acids during petroleum refining); treating cellulose for production of viscose rayon and cellophane; reclaiming rubber by dissolving out the fabric; dissolving casein for plastics production; hydrolysing fats to manufacture soaps; precipitating alkaloids (bases) and most metals (hydroxides) from aqueous solutions of their salts; laboratory reagent; alkalizer in pharmaceutical production. Veterinary therapeutic category – dehorning of cows.
<b>Supplier:</b>	Omega Chemicals
<b>ABN:</b>	32 982 143 022 / A.C.N 005 032 744 T/A
<b>Address:</b>	55 Fitzgerald Road, Laverton North, Victoria 3026.
<b>Telephone Number:</b>	+61 3 8368 8000
<b>Facsimile:</b>	+61 3 8368 8020
<b>Emergency Telephone:</b>	1300 131 001 (24 Hours) Poisons Information Centre Australia: 131 126

### 2. HAZARD IDENTIFICATION

<b>Hazard Classification:</b>	Classified as Hazardous according to the criteria of Safe Work Australia. Classified as Dangerous according to the ADG Code.
<b>GHS Classification:</b>	Skin corrosion/irritation – Category 1A Eye damage/irritation – Category 1 Corrosive to metals – Category 1
<b>Signal Word (s):</b>	DANGER 
<b>Hazard Statement(s):</b>	H314 Causes severe skin burns and eye damage. H290 Maybe corrosive to metals H302 Harmful if swallowed

**Precautionary Statement(s):**

**Prevention Statement(s):** P102 Keep out of reach of children.  
 P103 Read label before use.  
 P234 Keep only in original container.  
 P260 Do not breathe fume/vapours/spray.  
 P264 Wash hand thoroughly after handling  
 P270 Do not eat, drink smoke when using this product.  
 P280 Wear protective gloves/protective clothing/eye protection/face protection.

**Response Statement(s):** P301+P330+P331 IF SWALLOWED: Rinse mouth. Do not induce vomiting.  
 P303+P361+P353 IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower.  
 P363 Wash contaminated clothing before reuse.  
 P304+P340 IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.  
 P310 Immediately call a POISON CENTER or doctor/physician.  
 P305+P351+P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.  
 P321 Specific treatment (see First Aid Measures on Safety Data Sheet).  
 P390 Absorb spillage to prevent material damage.

**Storage Statement(s):** P405 Store locked up.  
 P406 Store in corrosive resistant container with resistant inner liner.

**Disposal Statement(s):** P501 Dispose of contents/container in accordance with local/regional regulations.

**Poisons Schedule (SUSMP):** 6: POISON

**3. COMPOSITION/INFORMATION ON INGREDIENTS**

Ingredients:	CAS Number	Proportion	Hazard Codes
Sodium Hydroxide	1310-73-2	46 - 50%	H314, H290, H302, H318
Water	7732-18-5	Balance to 100%	

**4. FIRST - AID MEASURES**

For advice, contact Poisons Information Centre on 131 126 or a Doctor.

**Ingestion:** Immediately rinse mouth with water. Give water to drink. DO NOT induce vomiting. If vomiting occurs, place victim's face downwards, head lower than hips to prevent vomit entering lungs. **Seek immediate medical attention.**

**Eyes:** Immediately irrigate with copious quantities of water for at least 15 minutes. Eyelids to be held open. Remove clothing if contaminated and wash skin. Risk of blindness. **Urgently seek medical assistance. Transport to hospital or medical centre.**

**Skin:** Remove all contaminated clothing without delay. Immediately wash contaminated skin gently and thoroughly with copious amounts of water or

swab with polyethylene glycol 400. For gross contamination, immediately drench with water and remove clothing. If swelling, redness, blistering or irritation occurs immediate seek medical advice. For skin burns, immediately flood burnt area with plenty of water and cover with a clean, dry dressing. Seek medical advice. Ensure contaminated clothing is washed before re-use or discarded.

**Inhalation:** Remove the source of contamination or move the victim to fresh air; avoid becoming a casualty. Remove contaminated clothing and loosen remaining clothing. Allow patient to assume most comfortable position and keep warm. Keep at rest until fully recovered. **For all but the most minor symptoms arrange for patient to be seen by a doctor as soon as possible, either on site or at the nearest hospital.**

**Advice to Doctor:** Treat symptomatically and for exposure to strongly alkaline substances and corrosive material. **Can cause corneal burns.**

## 5. FIRE FIGHTING MEASURES

**Extinguishing Media:** Not combustible, however reaction with metals will produce flammable hydrogen gas, which will burn if ignited. Use water fog (or if unavailable then fine water spray), foam or dry agent (carbon dioxide or dry chemical powder).

**Hazchem Code:** 2R

**Specific Hazards arising from the substance or mixture:**

**Hazards from Combustion:** Product is non-flammable and stable under normal conditions of use and storage. Reacts violently with acids. Reacts with ammonium salts liberating ammonia gas. Corrosive to aluminium, zinc and tin liberating flammable hydrogen gas. Absorbs carbon dioxide from air. Reacts exothermically (produces heat) on dilution with water.

**Flammability Conditions:** Product is a non-flammable liquid; however, flammable hydrogen gas may be formed in contact with aluminium, zinc and tin.

**Special Protective Precautions and Equipment for Fire Fighters:** Fire fighters should wear a self-contained breathing apparatus operated in positive pressure mode and full protective clothing along with protective equipment. Water spray may be used to keep fire exposed containers cool. Prevent fire extinguishing water from contaminating surface water or the ground water system.

## 6. ACCIDENTAL RELEASE MEASURES

**Emergency Procedures/Protective Equipment/Personal Precautions:** Evacuate all unnecessary personnel. Work upwind. Increase ventilation. Personnel involved in the clean-up should wear full protective clothing including respiratory protection. Stop leak if safe to do so. Avoid walking through spilled product as it will be slippery. Cover drains. Collect, bind and pump off spills.

<b>Environmental Precautions:</b>	Do not allow product to enter drains, waterways, sewers or soil. If contamination of drains has occurred, advise the local emergency services.
<b>Methods and Materials for Containment and Clean Up:</b>	Slippery when spilt. Avoid accidents, clean up immediately. Wear protective equipment to prevent skin and eye contact and breathing in vapours. Self-contained breathing apparatus may be needed for prolonged periods of exposure. Work up wind or increase ventilation. Contain spilled product using absorbent (sand or kitty litter). Prevent run off into drains, waterways, sewers or soil. Collect and seal in properly labelled containers or drums ready for appropriate disposal. Caution - heat may be evolved on contact with water. For large spills notify local emergency services.

## 7. HANDLING AND STORAGE

<b>Precautions for Safe Handling:</b>	Ensure an eye bath and safety shower are available and ready for use. Avoid skin and eye contact and breathing in vapour, mists and aerosols. Wear appropriate protective equipment to prevent inhalation, skin and eye contact. Ensure a high level of personal hygiene is maintained when using this product, that is, always wash hands before eating, drinking, smoking or using the toilet.
<b>Container Type:</b>	Packaging must comply with requirements of Hazardous Substances (Packaging) Regulations 2001. Store in original packaging as approved by manufacturer. Do not store in aluminium or galvanised containers or use die-cast zinc or aluminium bungs. Plastic bungs should be used.
<b>Conditions for Safe Storage, including any Incompatibles:</b>	<p>Store in a cool, dry, well-ventilated area out of direct sunlight. Do not store with incompatible products such as acids and ammonium salts. Keep containers securely sealed at all times and protected against physical damage. Reacts exothermically (produces heat) with water. Heat evolved may cause boiling and spattering. Do not store with any foodstuffs</p> <p>At temperatures greater than 40°C, tanks must be stress relieved. Check regularly for spills and leaks. Over a period of time, sludge may develop in the base of storage tanks. The sludge may contain mercury in a finely divided form, spread throughout the particulate matter in the sludge.</p>

## 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

### Control Parameters:

National Exposure Standards: Sodium hydroxide: AU OEL Peak Limitation: 2 mg/m<sup>3</sup>.

Biological Limit Values: No data available.

**Appropriate Engineering Controls:** Ensure ventilation is adequate to maintain air concentrations below exposure standards. Use with local exhaust ventilation or while wearing mist respirator. Keep containers closed when not in use in a well-ventilated area.

**Individual Protection Measures, such as Personal Protective Equipment (PPE):**

**Respirator:** If there is a risk of inhalation of mists, wear an approved canister-type respirator suitable for particulates and alkaline gases.

**Eyes:** Splash-proof chemical goggles or full-face shield.

**Hands:** Elbow-length impervious nitrile gloves.

**Clothing:** Protective overalls, splash apron and rubber boots. Launder frequently. Change clothing if required.

After using this product always wash hands before smoking, eating, drinking or using the toilet. Wash contaminated clothing and other protective equipment before storage or re-use.

## 9. PHYSICAL AND CHEMICAL PROPERTIES

### Core Information

**Appearance:** Colourless to slightly coloured clear liquid.

**Formula:** NaOH.

**Molecular Weight:** 40.00.

**Odour:** Odourless.

**pH:** >14.

**Vapour Pressure:** No data available.

**Vapour Density:** >1 (where air = 1).

**Boiling Point:** ca. 140°C.

**Freezing Point:** ca. 12°C.

**Solubility (in Water):** 100% g/L (at 25°C).

**Specific Gravity:** 1.48 – 1.52 (at 20°C).

**Flash Point:** N/A.

**Flammability Limits** **Lower Explosive Limit** N/A.

**(as Percent Volume in Air):** **Upper Explosive Limit** N/A.

**Ignition Temperature:** No data available.

**Additional Information**

<b>Specific Heat Value:</b>	No data available.
<b>Particle Size:</b>	No data available.
<b>Volatile Organic Compounds Content (VOC):</b>	No data available.
<b>Viscosity:</b>	ca. 180 centipoise (at 25°C).
<b>Percent Volatile:</b>	No data available.
<b>Octanol/Water Partition Coefficient:</b>	No data available.
<b>Saturated Vapour Concentration:</b>	No data available.
<b>Additional Characteristics:</b>	No data available.
<b>Flame Propagation/Burning Rate of Solid Materials:</b>	No data available.
<b>Properties that may Initiate or Contribute to the Intensity of a Fire:</b>	Reacts violently with acids. Reacts with ammonium salts liberating ammonia gas. Corrosive to aluminium, zinc and tin liberating flammable hydrogen gas.
<b>Potential for Dust Explosion:</b>	No data available.
<b>Reactions that Release Flammable Gases or Vapours:</b>	Corrosive to aluminium, zinc and tin liberating flammable hydrogen gas. Reacts with ammonium salts liberating ammonia gas.
<b>Fast or Intensely Burning Characteristics:</b>	No data available.
<b>Non-Flammables that Could Contribute Unusual Hazards to a Fire:</b>	No data available.
<b>Release of Invisible Flammable Vapours and Gases:</b>	No data available.
<b>Decomposition Temperature:</b>	No data available.
<b>Evaporation Rate:</b>	<1.0 (where n-butyl acetate = 1).



**10. STABILITY AND REACTIVITY**

<b>Reactivity:</b>	Reacts violently with acids. Reacts exothermically on dilution with water.
<b>Chemical Stability:</b>	Stable under normal ambient and anticipated storage and handling conditions of temperature and pressure.
<b>Possibility of hazardous Reactions:</b>	Reacts violently with acids. Reacts exothermically (produces heat) on dilution with water. Corrosive to aluminium, zinc, lead and tin liberating flammable hydrogen gas. Reacts with ammonium salts liberating ammonia gas. Results in explosion when heated in the presence of zirconium. Reacts vigorously with chloroform/methanol mixtures.
<b>Conditions to Avoid:</b>	Contact with aluminium, zinc, tin, lead, acids, ammonium salts. Reacts exothermically (produces heat) on dilution with water.
<b>Incompatible Materials:</b>	Reacts violently with acids. Reacts exothermically (produces heat) on dilution with water. Corrosive to aluminium, zinc, lead and tin liberating flammable hydrogen gas. Keep away from all foodstuffs.
<b>Hazardous Decomposition Products:</b>	No data available.

**11. TOXICOLOGICAL INFORMATION****Toxicity Data**

<b>LD50:</b>	40 mg/kg (mouse, intraperitoneal, solid).
<b>LD50:</b>	500 mg/kg (rabbit, oral, 10% solution).
<b>LD50:</b>	500 mg/kg (mouse, 10% solution).
<b>Skin (severe irritation):</b>	500 mg/24 hours (rabbit, solid).
<b>Eyes (severe irritation):</b>	1 mg/30 seconds rinse (rabbit, solid).

Concentrated solutions are irritant and corrosive to all tissues with which they come into contact; producing burns, deep ulceration and gelatinous necrotic areas at the site of contact; it will cause severe burns to the eyes and skin. Solutions as low as 5% (w/v) can damage eyes severely. Ingestion of this product will cause severe internal irritation and damage. Inhalation of the mist will cause irritation and damage to the respiratory tract. Low systemic toxicity.

**Acute (short term)**

- Ingestion:** May be harmful if swallowed. Ingestion of this product may cause nausea, vomiting, diarrhoea, abdominal pain and chemical burns to the mouth, throat and stomach, perforation of the gastrointestinal tract, cardiovascular collapse and coma.
- Eye:** Causes serious eye damage. Corrosive to eyes, contact can cause corneal burns.  
**Can result in permanent injury. Risk of blindness.**
- Skin:** Corrosive to skin. May cause skin burns. Contact with skin will result in severe irritation. Repeated or prolonged skin contact may lead to irritant contact dermatitis.
- Inhalation:** Inhalation of mists will result in severe respiratory irritation and possible harmful corrosive effects including lesions of the nasal septum, pulmonary oedema, pneumonitis and emphysema. Inhalation of mists at elevated temperatures will increase these symptoms.

**Chronic (long term)**

- Ingestion:** Repeated or prolonged exposure can cause erosion of teeth and ulceration of the nose and gums.
- Skin:** Repeated or prolonged exposure may lead to dermatitis in some individuals.
- Inhalation:** Repeated or prolonged exposure can lead to respiratory disorders, or it may aggravate existing respiratory disorders such as emphysema and chronic bronchitis.

**12. ECOLOGICAL INFORMATION**

- Ecotoxicity:** Harmful effect due to pH shift.
- Persistence and Degradability:** No data available.
- Mobility:** No data available.

**Additional Information**

- Environmental Fate (Exposure):** No data available.
- Bio accumulative Potential:** No data available.
- Other Adverse Effects:** Discharge into the environment must be avoided. Avoid contaminating waterways.
- Aquatic toxicity:** 125 ppm/96 hours (mosquito fish, TL<sub>m</sub>, fresh water).  
180 ppm/23 hours (oysters, lethal, salt water).

**13. DISPOSAL CONSIDERATIONS**

**Disposal Methods:** Dispose of in accordance with all local, state and federal regulations. Refer to appropriate State Waste Disposal Authority. Observe local regulations. After dilution and careful neutralisation, approved liquid waste land fill site may be suitable. Empty containers must be decontaminated.

**Special Precautions for Landfill or Incineration:** No data available.

**14. TRANSPORT INFORMATION**

**UN Number:** 1824.

**UN Proper Shipping Name:** Sodium Hydroxide Solution.

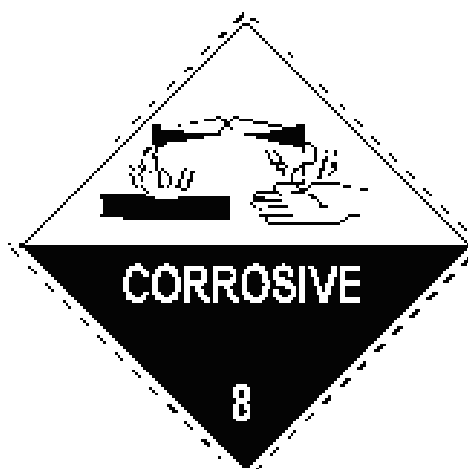
**Dangerous Goods Class:** 8.

**Subsidiary Risk:** None allocated.

**Packaging Group:** II.

**Special Precautions for User:** CORROSIVE.

**Hazchem Code:** 2R.

**Incompatible Classes**

This product is incompatible in a placard load with any of the following:

- Class 1 – Explosives.
- Class 4.3 - Dangerous when Wet Substances.
- Class 5.1 - Oxidising Agents.
- Class 5.2 - Organic Peroxides.
- Class 7 - Radioactive Substances.
- All food and food packaging in any quantity.

**15. REGULATORY INFORMATION**

**Poisons Schedule:** 6.

**EPG:** 37.

**AICS Name:** Sodium Hydroxide.

**Additional information:** No data available.

**16. OTHER INFORMATION****Revision Details****Reason for Revision:****Version 1**

5 year review. Updated to a new format. Additional information added.

**Version 2**

Alignment to GHS requirements.

**Literature References****Chemical Rubber Company:** Handbook of Chemistry and Physics, 85<sup>th</sup> Edition.**Merck:** The Merck Index, 14<sup>th</sup> Edition.**Weiss, G.:** Hazardous Chemicals Data Book, 2<sup>nd</sup> Edition.**Luxon, S. G.:** Hazards in the Chemical Laboratory, 5<sup>th</sup> Edition.**Sax, N. Irving:** Dangerous Properties of Industrial Materials, 3<sup>rd</sup> Edition.**Safe Work Australia:** Hazardous Chemicals Information System (HCIS) Exposure Standards and GHS Classifications Data-Base, 25 June 2016.**National Transport Commission:** Australian Code for the Transport of Dangerous Goods by Road and Rail, Volume 7.**Abbreviations****CAS Number:** Chemical Abstract Service Registry Number.**GHS:** Globally Harmonized System of Classification and Labelling of Chemicals.**EPG:** Emergency Procedure Guide.**LD50:** Lethal Dose 50%: The lowest concentration at which approximately 50% of test animals will die when given the specified dose by mouth.**TL<sub>m</sub>:** Medium Tolerance Limit, approximately 50% of fish will show abnormal behaviour including death under the given concentration and time.**ADG:** Australian Code for the Transport of Dangerous Goods by Road and Rail, Volume 7.**AICS Name:** Australian Inventory of Chemical Substances Name.**OEL:** Occupational Exposure Level.**N/A:** Not Applicable.

**Disclaimer**

This Safety Data Sheet is offered solely for information, consideration and investigation to determine the suitability of various health and safety precautions as may be required under the user's specific conditions and processes. All such conditions and processes are beyond the control of Omega Chemicals.

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**DOCUMENT END**