STATE TRANSIT AUTHORITY

REMEDIATION ACTION PLAN (REVISED 2020)

STATE TRANSIT BUS DEPOT, 58 DARLEY STREET MONA VALE, NEW SOUTH WALES

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Remediation Action Plan (Revised 2020)
State Transit Bus Depot, 58 Darley Street Mona Vale, New South Wales

State Transit Authority

WSP
Level 27, 680 George Street
Sydney NSW 2000
GPO Box 5394
Sydney NSW 2001

Tel: +61 2 9272 5100
Fax: +61 2 9272 5101
wsp.com

REV	DATE	DETAILS
A	20/07/2018	DRAFT for Client comment
B	7/08/2018	For Issue
C	29/07/2019	Reissue following Auditor Comments (IAA06)
D	06/12/2019	Reissue following Auditor Comments (IAA08) and to align with the updated VMP
E	18/05/2020	Reissue following Auditor Comments (IAA09)

	NAME	DATE	SIGNATURE
Prepared by:	Sarah Klocke	18/05/2020	
Reviewed by:	Colin McKay	18/05/2020	
Approved by:	Colin McKay	18/05/2020	

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ABBREVIATIONS

ANZECC	Australian and New Zealand Environment and Conservation Council
BTEX	Benzene, toluene, ethyl benzene and xylene
COC	Chain of custody
DO	Dissolved oxygen
DQI	Data quality indicators
DQO	Data quality objectives
EC	Electrical conductivity
EOH	End of hole
LDL	Laboratory detection limit
mg	Milligrams
mbgl	Metres below ground level
mbtoc	Metres below top of casing
MNA	Monitored natural attenuation
MW	Monitoring well
NA	Natural attenuation
NATA	National Association of Testing Authorities
NEPM	National Environment Protection (Assessment of Site Contamination) Measure (prepared by the NEPC, 2013)
NSW EPA	Over the past few years the environmental regulatory body has undergone a number of name changes, including: Department of Environment and Conservation (DEC); Department of Environment and Climate Change (DECC); Department of Environment, Climate Change and Water (DECCW); and, Office of Environment and Heritage (OEH). For the purpose of currency, the organisation is referred to as NSW EPA in this report.
ORP	Oxidation/reduction potential
PAH	Polycyclic aromatic hydrocarbons
PACM	Potential asbestos containing material
PB	Parsons Brinkerhoff Pty Limited
pH	Unit of measurement for acidity and alkalinity
PSH	Phase separated hydrocarbons
QA/QC	Quality assurance / quality control
RL	Relative level
SAC	Site assessment criteria
ToC	Top of case (of monitoring well)
TOC	Total organic carbon
TRH	Total recoverable hydrocarbons (C_{10} to C_{40})
UST	Underground storage tank
vTRH	Volatile total recoverable hydrocarbons (C_6 to C_{10})
WSP	WSP Australia Pty Limited
µg	Microgram

1 INTRODUCTION

1.1 BACKGROUND

WSP Australia Pty Limited (WSP) was commissioned by the State Transit Authority (STA) to update the Remediation Action Plan (RAP) for the Mona Vale Bus Depot located at 58 Darley Street, Mona Vale NSW (the Site). The Site location is presented in Figure 1, **Appendix A**.

WSP completed a Contaminated Site Assessment (CSA) for the site in 2012, which identified soil and groundwater impacted with Total Recoverable Hydrocarbons (TRH [formerly TPH]) and Polycyclic Aromatic Hydrocarbons (PAH) above adopted site criteria for commercial/industrial land-use. WSP concluded that the findings were indicative of the presence of phase separated hydrocarbons (PSH) potentially sourced from a diesel spill sump pit within the sites refuelling area. WSP also recommended that STA prepare and submit a Contaminated Land Notification Form in accordance with NSW EPA, 2009 *Contaminated Sites: Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997*. This notification was submitted to the NSW EPA on 7 February 2012.

Based on the findings of the CSA, WSP was then engaged by STA to conduct further on and off-site delineation of soil and groundwater impact at the site (two separate investigations). WSP concluded that hydrocarbon impact was located within the vicinity of the site's refuelling area, and in a northerly and westerly direction from this location, corresponding with the determined groundwater flow direction. In addition, WSP confirmed that identified impact was restricted to groundwater and sandy soils immediately above the groundwater table (1 to 2 m bgl), which indicates that soil impact is likely to be associated with a groundwater plume rather than spot sources of contamination across the Site (WSP, 2012).

A RAP, was prepared for the Site by WSP in May 2013, to address on-going liability and risk associated with the identified hazards and to render the site suitable for on-going commercial/industrial use.

Following preparation of the original RAP in 2013, STA engaged Australian Environmental Services (AES) to carry out targeted remedial works recommended in that document including removal of the Site's diesel spill sump pit, removal of the underground petroleum storage system (UPSS) and installation of an active onsite groundwater skimmer system at the site boundary. STA also engaged Environment and Natural Resource Solutions (ENRS) to implement an on-going groundwater monitoring program that has included eight rounds of testing to April 2018. Since then WSP have conducted a further two rounds of monitoring in October 2018 and May 2019.

The NSW EPA declared the site as significantly contaminated land on 11 November 2014. A Voluntary Management Proposal (VMP) and a VMP Communications Plan were prepared by STA and issued to the NSW EPA in January 2015. Since that time the site has been managed under the VMP, which under various revisions has consistently had the objective of assessment of the extent of impacts, assessment of the risk of the contamination and removal of the hydrocarbon impact to the extent practicable.

A revision to the first version of the RAP was prepared in 2015 (WSP, 2015), which updated the criteria to align with the NEPC, 2013 *National Environment Protection (Assessment of Site Contamination) Measure* 1999, summarised various remedial works carried out since 2013, and recommended trialling of various groundwater and PSH remedial technologies, along with ongoing monitoring works. As much of this investigation work has now been carried out, and STA have implemented a more permanent phase separated hydrocarbon (PSH) skimming system on the site and surrounds, this RAP has been prepared as an update to the previous RAPs.

The most recent version of the VMP is dated 8 May 2015, with amendments issued on 20 May 2016, 26 June 2017 and 16 January 2020 These documents are included in **Appendix F** for reference. This RAP is written to align with the current version of the VMP (December 2019).

1.2 OBJECTIVE OF THE AMENDED RAP

The overarching objectives of the remediation program, under the current VMP are to:

- Assess and monitor the extent of soil and groundwater contamination;
- Assess the risks posed by the identified contamination; and
- Remove phase separated hydrocarbon (PSH) from groundwater to the extent practicable.

This updated Remediation Action Plan (RAP) has been developed such that the remediation program complies, where practicable, with relevant guidelines, including:

- CRC Care, 2010 *Technical Report No 18 Selecting and assessing strategies for remediating LNAPL in soils and aquifers*
- CRC Care, 2013 Technical Report No 23 Petroleum hydrocarbon vapour intrusion assessment: Australian guidance.
- NEPC, 2013 *National Environmental Protection (Assessment of Site Contamination) Measure 1999*;
- NSW EPA 2004, *Technical Note: Investigation of Service Station Sites*;
- NSW EPA 2007, Contaminated Sites: *Guidelines for the Assessment and Management of Groundwater Contamination*
- NSW EPA 2011, *Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites*
- NSW EPA 2015, *Technical Note: Light Non-Aqueous Phase Liquid Assessment and Remediation*.
- NSW EPA 2017, *Contaminated Land Management: Guidelines for the NSW Site Auditor Scheme, 3rd Edition*;
- State Environmental Planning Policy No. 55 – *Remediation of Land (SEPP 55 - 1998)*.

2 SITE CHARACTERISTICS

2.1 SITE LOCATION AND DESCRIPTION

The subject site is located at 58 Darley Street, Mona Vale, NSW. The site is currently an active bus depot and comprises Lot 2 of DP 542640. Refer to Figure 1 and Figure 2, **Appendix A** for site location plans. A summary of site details are presented in Table 2.1 below.

Table 2.1 Site Identification Details

PARAMETER	SITE DETAILS
Street Address	58 Darley Street, Mona Vale, NSW
Lot / DP	Lot 2 DP 542640
Local Government Area	Pittwater Council
Land Zoning	4(b1) Light Industrial B1
Current Landuse	Bus Depot
Site Area	17,100 m^2 (approximately)
Geographical Coordinates Lat/Long	33°40'28.02"S 151°18'25.70"E

2.1.1 OPERATIONAL HISTORY

KMH Environmental, (16 March 2002) prepared an Environmental Compliance Audit for the site. The report indicated the site was developed as a bus depot in 1970, prior to which it was reported to be vacant swamp land.

2.1.2 CURRENT SITE LAYOUT

The Site is accessed via an entry and exit driveway located on Darley Street and is used for bus maintenance, refuelling and parking. The north-western corner of the Site is used as a staff car parking area. The site comprises a depot facility centre, a garage/workshop area, a refuelling area, two bus chassis wash facilities, bus hardstand parking and staff car park.

Fuel is stored in a self-bunded diesel AST (88,560L), located adjacent to the refuelling area, south of the garage / workshop (refer Figure 3, **Appendix A**). The above ground tank and associated delivery system are understood to have been commissioned in July 2013.

A waste oil UST is located adjacent to the refuelling area and waste water treatment pits are located adjacent to each of the bus chassis wash facilities.

The general site layout is shown in Figure 3 with groundwater monitoring well locations shown in Figure 4 **Appendix A**. A survey of current site infrastructure is provided in **Appendix C**.

2.1.3 HISTORICAL INFRASTRUCTURE

A 35,000 litre diesel underground storage tank (UST) and one 35,000 L above ground diesel storage tank (AST) were previously located within and adjacent to the car park in the north-western corner of the site. Fuel lines are understood to have previously run along the north western boundary. In addition, a diesel spill sump was located adjacent to the refuelling area.

WSP understands that STA has decommissioned all underground storage tanks (UST) and associated underground fuel distribution infrastructure. These systems have been replaced with the above ground diesel storage tank adjacent to the site entrance in the south west of the site.

Various surveys of historical site layouts and infrastructure design are provided in **Appendix C**. Pertinent details have been transferred onto Figure 3, **Appendix A**.

2.2 SURROUNDING LANDUSE

2.2.1 NEIGHBOURING SITES

The Site and immediate surrounds are shown in Figure 2, **Appendix A**. The site is positioned in a commercial and industrial precinct of Mona Vale. It is accessed via a driveway on Darley Street, to the south west and opens to a battle axe layout surrounded on all sides by other commercial enterprises.

The north eastern boundary at the rear of the site adjoins properties that front Perak Street and appear to be engineering workshops. The south eastern boundary is topographically up gradient of the site. Properties adjoining that boundary have frontage to By The Sea Road and Polo Road. These include a number of vehicle maintenance and smash repairers.

Neighbouring sites on Darley Street in the south west include general commercial shops including pet supplies, hardware store and café.

The north west is downgradient of the site and includes commercial outlets and warehousing on Taronga Place. The adjoining sites include Pittwater Joinery and Reece Plumbing. Beyond Taronga Place further mixed commercial and warehousing enterprises are located.

The nearest residential properties to the site are located approximately 250 m to the west of the site and 70 m to the south of the site, beyond Darley Street.

2.2.2 NEARBY NOTIFIED AND REGULATED SITES

The NSW EPA's list of notified sites for the Mona Vale suburb are presented in Table 2.2. Of these only the first three (STA Bus Depot, and Caltex Mona Vale and surrounds) are shown on the NSW EPA's register of contaminated sites.

Table 2.2 Sites Notified to the NSW EPA

SITE	ADDRESS	USE	STATUS
Mona Vale Bus Depot	58 Darley Street	Other Petroleum	Contamination currently regulated under CLM Act
Former Caltex service station and adjacent properties	79 Barrenjoey Road, 2 Polo Avenue, 6 Polo Avenue, 45 Bassett Street	Service Station	Contamination formerly regulated under the CLM Act
Caltex Investigation Area	Polo Ave, Perak Street	Service Station	Regulation being finalised
7-Eleven (former Mobil) Service Station	24 Barrenjoey Road	Service Station	Regulation under CLM Act not required
BP Peninsula Express Service Station	Corner Barrenjoey Road and Darley Street East Street	Service Station	Regulation under CLM Act not required
BP Service Station Mona Vale	1721 Pittwater Road	Service Station	Regulation under CLM Act not required

The former service station located at 79 Barrenjoey Road (and surrounds) was subject to a voluntary remediation notice (initially issued September 2000 and reissued September 2003). At its closest point the former service station is located approximately 125 m north-east of the Site, however, the plume appears to be migrating to the west as indicated by the other surrounding properties included on the notice (2 Polo Avenue, 6 Polo Avenue, 45 Bassett Street).

In 2012 the NSW EPA stated that it had reviewed the results of the remediation of the site at 79 Barrenjoey Road and was satisfied that the contamination was no longer significant enough to warrant regulation under the Contaminated Land Management Act 1997. On this basis, it is considered unlikely that the contamination from 79 Barrenjoey Road would be affecting the Bus Depot.

2.2.3 SERVICES SURROUNDING THE SITE

Appendix C presents the results of a dial before you dig search and a drainage search. These have been collated, along with information provided in the historical site maps, to show the key service easements downgradient of the site.

Two services have the potential to be of particular interest to contaminant migration from the site. These include:

- A sewer line located along the eastern side of Taronga Place, which passes across the road and between the boundary of numbers 4 and 5 Taronga Place to the rear of those properties before connecting with another sewer line running towards the north. The approximate location is shown on Figure 8, **Appendix A.** This service is described in the marked up diagram in **Appendix C** (from ENRS, 2016) as having it's invert at 1.9 to 3.1 m (presumably below grade).
- A culverted stormwater easement the bisects the site and then flows to the north west discharging to an open culvert 300 m to the north west of the site. The inverts of the stormwater culverts was not provided in the most recent site survey (**Appendix C**), however by comparing RLs for various site features with the historical survey from 1984 (**Appendix C**), the invert appears to be between 1.51 m AHD at a manhole in the centre of the site dipping to 1.38 m AHD at a manhole near the north western boundary.

2.2.4 SENSITIVE ENVIRONMENTS

The nearest sensitive environments are as follows:

- The nearest residential premises are located approximately 250 m to the west of the site (possibly downgradient) and 70 m to the south of the site, beyond Darley Street (likely cross gradient);
- The closest downgradient water body is an open stormwater channel located approximately 300 m north-west of the site (down hydraulic gradient). The channel flows into the estuarine environment of Cahill Creek and then Winnererremy Bay (part of Pittwater) approximately 1 km northwest of the site; and
- Bongin Bongin Bay is located approximately 750 m to the east of the site, but groundwater and surface water do not appear to migrate in this direction.

2.3 ENVIRONMENTAL SETTING

2.3.1 TOPOGRAPHY

Based on the site survey and a review of available topographical maps for the region, the site is relatively flat with the ground surface sloping gently in a general north westerly direction. The site has an elevations of less than 10 mAHD.

2.3.2 SOIL & GEOLOGY

Soils information was obtained from the 1:100,000 Sydney Soil Landscape Series Sheet 9130. The site is situated within the Warriewood Grouping. The Warriewood Grouping is described as level to gently undulating swales, depressions and in-filled lagoons on Quaternary sands. Deep soils (>150 cm) of well sorted sandy Humus Podzols and dark mottled

Siliceous Sands overlie buried Acid Peats in depressions. Deep Podzols (>200 cm) and pail Siliceous Sands are typically found on sandy rises.

According to the 1:100,000 Sydney Geological Series Sheet 9130 (Edition 1), the area is underlain by Quaternary silty to peaty quartz sand, silt and clay. The lithology includes ferruginous and humic cementations in places and common shell layers. The Quaternary sediments are underlain by shale, sandstone and claystone of the Newport Formation.

WSP (2012) reported that observed subsurface conditions were in general accordance with regional soil and geology maps. Fill material was encountered to 1.4 m and was underlain by sand with variable quantities of clay and gravel. Available borelogs are provided in **Appendix D**.

2.3.3 HYDROGEOLOGY

To better understand the potential for local groundwater users to be impacted by the site, WSP have recently completed a groundwater bore search (Australian Government, Bureau of Meterology *Australian Groundwater Explorer* (accessed on 23/7/2019). The search results are presented in **Appendix E** with a summary provided in Table 2.3. In summary 24 licensed bores are located within 1 km radius of the site. Of these only one is located downgradient, on parkland at the mouth of Cahill Creek where it discharges to Winnererremy Bay, approximately 975 m from the site. This bores purpose is listed as "other" indicating it is unlikely for potable supply.

Most bores are located east of Barrenjoey Road, which occupies a low ridge to the east of the site. These bores are likely to be up gradient of the site, or beyond a groundwater divide expected between the site and the Tasman Sea to the east, or otherwise are intercepting regional groundwater within underlying sandstone.

The shallow groundwater that is the subject of this assessment is unlikely to flow towards the east, or south east, based on groundwater contours presented in Figure 5, **Attachment A**. The bores to the east and south east include a number of supply bores, most of which are installed to depth of greater than 50 m, likely in underlying sandstone. The nearest bore to the site is located approximately 60 m to the south south west of the Site entrance, and is listed as being 93 m deep. Its purpose is shown as "Supply". The groundwater flow direction of the regional aquifer in the sandstone is unknown as none of these wells are included in the monitoring program. It would be expected, based on regional topography that the regional groundwater flow system recharges west of the site and discharges to the Tasman Sea.

Table 2.3 Registered Groundwater Bores within 1 km

BORE ID	DATE DRILLED	APPROX DISTANCE	DEPTH (m)	PURPOSE	HYDRAULIC DIRECTION FROM SITE WELLS
GW113213	22/05/2012	275 m (E)	2.5	Monitoring	Up-gradient or separate groundwater catchment
GW018770	1/08/1960	280 m (SE)	40.2	Water Supply	Separate aquifer
GW108579	9/03/2007	690 m (ESE)	6.6	Water Supply	Up-gradient or separate groundwater catchment
GW108158	7/05/2006	500 m (ESE)	6.3	Water Supply	Up-gradient or separate groundwater catchment
GW111104	15/06/2010	180 m (SE)	4	Monitoring	Up-gradient or separate groundwater catchment
GW111427	25/02/2008	610 m (SSW)	103	Other	Separate aquifer
GW111444	25/02/2008	390 m (SSW)	103	Other	Separate aquifer
GW108682	23/03/2007	490 m (E)	3.5	Water Supply	Up-gradient or separate groundwater catchment
GW111105	15/06/2010	220 m (SE)	5	Monitoring	Up-gradient or separate groundwater catchment
GW108558	5/02/2007	500 m (E)	4.3	Water Supply	Up-gradient or separate groundwater catchment
GW018778	1/10/1960	400 m (SW)	124.9	Water Supply	Separate aquifer
GW035791	1/12/1960	470 m (SE)	59.4	Water Supply	Separate aquifer
GW105936	19/05/2005	510 m (ESE)	-	Unknown	Up-gradient or separate groundwater catchment

BORE ID	DATE DRILLED	APPROX DISTANCE	DEPTH (m)	PURPOSE	HYDRAULIC DIRECTION FROM SITE WELLS
GW113211	22/05/2012	280 m (E)	3	Monitoring	Up-gradient or separate groundwater catchment
GW113212	22/05/2012	280 m (E)	2.5	Monitoring	Up-gradient or separate groundwater catchment
GW108500	10/11/2006	515 m (ESE)	4	Water Supply	Up-gradient or separate groundwater catchment
GW026581	1/01/1967	60 m (SSW)	92.9	Water Supply	Cross-gradient, separate aquifer
GW018808	1/12/1960	550 m (E)	91.4	Water Supply	Separate aquifer
GW026026	1/11/1966	160 m (S)	51.8	Water Supply	Separate aquifer
GW026027	1/12/1966	190 m (S)	61.5	Water Supply	Separate aquifer
GW018771	1/11/1960	475 m (SE)	100.5	Water Supply	Separate aquifer
GW019104	1/02/1961	190 m (SE)	47.2	Water Supply	Separate aquifer
GW108853	6/10/2007	975 m (NW)	5	Other	Down-gradient
GW108888	2/06/2008	570 m (SSE)	73	Other	Separate aquifer

Based on information provided in the site Detailed Site Investigation (WSP, 2012) and ongoing groundwater monitoring reports (ENRS, 2018), the uppermost aquifer at the site is located within the underlying sand and is unconfined. Groundwater is generally encountered at approximately 1.6 mbgl and reported to flow generally west with a potential north-westerly flow component.

Hydraulic conductivity (K) testing (documented in ENRS, 2016a) indicated a K value of 2.9 m/day. In addition to this work WSP conducted hydraulic conductivity testing on three additional locations (MW07, MW12 and MW26) in November 2019. The AQTESOLV Pro outputs are provided in Appendix G. The K values ranged between wells from an average of 0.75 m/day to 6.1 m/day, with an overall average of 3.7 m/day, which is comparable to the ENRS results.

Based on the groundwater contour diagram in Figure 7, **Appendix A**, the groundwater gradient is approximately 0.003. If the porosity of the sand was assumed to be 0.3 the groundwater seepage velocity would therefore be between 0.029 m/day (10.6 m/year) using ENRS values and 0.037 m/day (13.6 m/year) if using the recent WSP data.

2.3.4 HYDROLOGY

Storm-water runoff generated on-site and shallow groundwater are anticipated to follow local topography and flow towards the open storm-water channel located approximately 300 m north-west of the site, which discharges to Winnererremy Bay (part of Pittwater).

3 SUMMARY OF INVESTIGATION AND REMEDAITION TO DATE

3.1 OVERVIEW

This chapter provides an overview of the investigation and remediation efforts to date.

A summary of chronology of activities is provided below with more detail in following subsections, arranged into broader categories of the works. These include the initial assessments, various RAP iterations, remediation and infrastructure works, overview of groundwater monitoring events, risk assessment works, groundwater remediation trials, and preparation of the environmental management plan.

The site's environmental assessment and remediation chronology, largely taken from ENRS, 2018 includes:

- 2012, February – Stage 2 soil and groundwater investigation conducted by WSP. Soil bores SB01 to SB08 and groundwater wells MW01 to MW04 drilled and sampled. Soil and groundwater impacts discovered near the refuelling area.
- 2012, September – Onsite soil and groundwater delineation works by WSP. Soil bores SB08 to SB14 and groundwater wells MW05 to MW07 drilled and sampled. Soil and groundwater impacts near the refuelling area assumed to extend beyond the boundary.
- 2013, May – offsite soil and groundwater delineation works by WSP. Groundwater wells MW08 to MW12 installed and sampled. Soil and groundwater impacts exist offsite to the west. Without remedial works possible risk to receptors flagged recommendation to develop a remedial strategy.
- 2013, June – Remediation action plan developed for the site. Focus of risk assessment, installation of skimming system on site boundary and removal of legacy infrastructure pits and tanks in the refuelling area, along with implementation of a monitoring program.
- 2013, October – a 2,000 litre spill sump was pumped out of residual product and then backfilled with 25 mPa concrete. 6.74 tonnes of contaminated soils excavated adjacent the backfilled abandoned spill sump (AES)
- 2013, October – Installation by ENSR of three additional groundwater wells; MW15 down-gradient of MW8; MW16 down-gradient of MW11; and MW17 downgradient from MW10 (on other side of buildings). This information was required to delineate Phase Separate Hydrocarbon (PSH) down-gradient of MW10 and delineate the dissolved phase plume down-gradient of MW8 and MW11. Onsite skimmer system installed in MW05, MW13 and MW14.
- 2013, November – MW15, MW16 and MW17 – installed for to assess extent of PSH. Aquifer tests by ENRS (falling head slug tests) to determine the hydraulic properties of the underlying aquifer and product thickness;
- 2013, November – Re-sampling by ENRS of groundwater in new and selected existing monitoring wells for contaminants of concern and MNA parameters
- 2014, January – 1st Round GME for offsite MNA by ENRS;
- 2014, April – Decommissioning by excavation and offsite removal of 1x 35 kL AST and 1x 35 kL UST (both diesel) located in the pump house area;
- 2014, June – 2nd Round GME for offsite MNA by ENRS;
- 2014, October – 3rd Round GME for offsite MNA by ENRS;

- 2014, June – Comparison by ENSR of laboratory results against standard chromatograph charts to confirm the primary form of hydrocarbon contamination at the site is associated with diesel product;
- 2014, June – Two monitoring wells (MW08 and MW12) were re-drilled by AES under ENRS (new wells MW08-B and MW12-B) after the original bores became blocked and were not accessible for sampling. The replacement wells were sampled during the June and October 2014 groundwater monitoring events (GME);
- 2014, October – Door knock and field survey of nearby properties to assess the potential for offsite sources of contamination, conducted by STA and ENRS;
- 2015, February – 4th Round GME for offsite MNA by ENRS;
- 2015, April – 1st Round of Multi-Phase Vacuum Extraction (MPVE) using trailer mounted unit to remove product from accessible offsite wells by ENRS;
- 2015, April –Revised Remediation Action Plan (WSP) to acknowledge and capture the findings of works that had been completed and review the approach. The RAP recommended risk assessment and trialling of active PSH recovery technologies, along with ongoing monitoring.
- 2015, September – Installation by AES under ENRS of two additional groundwater wells. MW19 was constructed between MW09 and MW10, whilst MW18 was positioned between MW10 and MW11. The aim of these wells (MW18 and MW19) was to further delineate the lateral extent of the plume downgradient of MW09 and provide additional points for PSH extraction from large diameter wells.
- 2015, November – 2nd Round of MPVE event for product recovery from offsite wells by ENRS;
- 2015, December – 5th Round GME for offsite MNA including newly installed MW18 and MW19 by ENRS;
- 2015, December – 3rd Round of MPE event for product recovery from offsite wells by ENRS;
- 2016, June – Installation by AES under ENRS of five additional groundwater wells. MW20 and MW21 were installed within the road reserve adjacent private property where MW11 and MW18 were no longer accessible. MW22, MW25 and MW26 were installed down hydraulic gradient of the existing bore network;
- 2016, July – Preliminary Risk Assessment report (ENRS) issued based on existing groundwater data with general findings the plume was relatively stable and modelled vapour intrusion rates did not exceed the threshold criteria for human health and ecological receptors. Recommendations were to continue monitoring and update the risk assessment with site specific soil vapour data;
- 2016, September – 6th Round GME for offsite MNA by ENRS;
- 2016, September – GME to validate onsite UPSS decommission;
- 2016, October – 4th Round of MPVE event for product recovery from offsite wells by ENRS;
- 2017, January – Passive skimmer trial commenced by WSP.
- 2017, February – Passive skimmer trial completed and soil vapour assessment conducted (WSP). The sub-slab vapour study found that vapour risks to commercial industrial users of the site and surrounds were acceptably low;
- 2017, February – 7th Round GME for offsite MNA by ENRS;
- 2017, June – Additional soil vapour monitoring event (WSP). The study corroborated the findings of the initial sub-slab vapour monitoring indicating acceptable risk to commercial/industrial users on the site and surrounds.
- 2017, August – 1st MPVE event for product recovery from offsite wells by WSP;
- 2017, August – 8th Round GME for offsite MNA by ENRS;
- 2017, November – 2nd MPVE event for product recovery from offsite wells by WSP;
- 2018, January – 3rd MPVE event for product recovery from offsite wells by WSP;

- 2018, April – 9th Round GME for offsite MNA by ENRS;
- 2018, April – Commission semi-permanent PSH recovery system in selected monitoring wells adjoining Taronga Place.
- 2018, October – 10th Round GME for offsite MNA by WSP;
- 2019, May – 11th Round GME for offsite MNA by WSP
- 2019, Nov – 12th Round GME for offsite MNA by WSP
- 2019, Dec – Installation of additional groundwater monitoring wells to address data gaps listed within the VMP
- 2020, Feb – Limited groundwater sampling of newly installed monitoring wells. Surface water sampling to address data gap within the VMP. Completion of a vapour assessment of two commercial buildings (Pittwater Joinery and Reece Plumbing) located directly west of the STA bus depot at 9 and 10 Taronga Place, Mona Vale, NSW, respectively, to address data gap within the VMP.

3.2 INITIAL SOIL AND GROUNDWATER INVESTIGATIONS

Investigation of the site commenced in 2012 with two phases of soil and groundwater assessment. These are documented in the following reports:

- WSP 2012a, *Stage 2 Contaminated Site Investigation, Mona Vale Bus Depot, 58 Darley Street, Mona Vale NSW*
- WSP 2012b, *Soil and Groundwater Delineation Report, Mona Vale Bus Depot, 58 Darley Street, Mona Vale, NSW*

In summary, these investigations commenced with assessment of the Bus Depot with a total of 14 soil bores (SB01 to SB14) and 7 groundwater wells (MW01 to MW07). The groundwater well locations are presented on Figure 4, **Appendix A**. The sampling locations targeted potential contamination sources of hydrocarbons, including the former diesel tanks (1 x 35,000L UST and 1 x 35,000L AST), the refuelling area, fuel line, chassis wash, underground waste oil storage tank and a bus maintenance workshop. The investigation was also designed to establish a groundwater monitoring well network at the site to comply with the requirements of the *Protection of the Environment Operations (Underground Petroleum Storage Systems) (UPSS) Regulation (2008)*.

Groundwater flow was determined to be in a general westerly direction with a potential north-westerly or south-westerly flow component. WSP reported TRH and PAH contamination impacts in soils close to and above the water table (0.5m – 1.5 m bgl) in the vicinity of the site's refuelling area and fuel line. TRH and PAH impacts were also identified in the sand aquifer within the monitoring well (MW01) located south-west of the refuelling area. No soil or groundwater impact was identified in monitoring wells located close to the (former) diesel AST and UST located in the north west of the site, indicating these tanks were unlikely to be the source of the identified contamination.

A summary of soil results is reproduced in Table 1 **Appendix B**. At the time these were compared with criteria in the now rescinded NSW EPA, 1994 *Contaminated Sites Guidelines for Assessing Service Station Sites*. Table 1 in **Appendix B** compares the results to those provided in the NEPC, 2013 *National Environment Protection (Assessment of Site Contamination) Measure 1999*.

Groundwater results from these early investigations are summarised in Table 2a and 2b, **Appendix B**. At the time of the reports mentioned above the groundwater criteria were based on NSW EPA, 1994, which has since been superseded by criteria listed in NEPM 2013. Table 1 compares results (where possible) with criteria provided in NEPC 2013.

WSP concluded that hydrocarbon impact identified in soils were indicative of the presence of phase separated hydrocarbons (PSH) potentially sourced from a leaking fuel line and/or spills within and/or in close proximity to the refuelling area. This was confirmed by the presence of PSH in MW05 (0.26 m). WSP concluded that, based on the inferred direction of groundwater flow (generally west), that there was a potential for off-site migration of contamination.

In order to understand the risk of offsite impact WSP was engaged to conduct a limited assessment of soil and groundwater offsite to the west of the site. The findings were documented in:

- WSP 2013a, Offsite *Soil and Groundwater Delineation Report, Mona Vale Bus Depot, 58 Darley Street, Mona Vale, NSW*

In summary, the assessment included soil sampling from five offsite boreholes, all of which were converted to groundwater monitoring wells (MW08, MW09, MW10, MW11 and MW12). These are shown on Figure 4, **Appendix A**. Borelogs are presented in **Appendix D**. Sampling locations were targeted to delineate the lateral and vertical extent of any offsite hydrocarbon contamination attributable to the STA Bus Depot.

Soil results from that assessment are available in Table 1, **Appendix B** and groundwater results are in Table 2b, **Appendix B**. In both cases the criteria adopted in the assessment have since been updated in NEPC, 2013.

PSH was reported within monitoring wells MW09 and MW10 with thicknesses of 0.30 m and 0.02 m, respectively. Based on these observations and the results of soil and groundwater testing in non PSH affected locations, WSP concluded that soil and groundwater impact attributable to the STA bus depot had migrated offsite. The lateral extent was estimated to at between 60 – 80 m north west from the sites refuelling area. Soil impacts in offsite bores was only detected at the water table depth, no shallow sources were found.

The results of the investigation surmised that the source of identified on and off-site contamination was likely to be the diesel spill sump pit and/or associated drainage located within the sites refuelling area. Note: current thinking (given the volume of PSH present on and offsite) is that the most likely source was a line or bowser where the product was released under some pressure rather than simply seepage from a sub surface drains – notwithstanding that these may have contributed to the hydrocarbons.

Based on the nature of the shallow groundwater system and identified offsite PSH, WSP considered that without implementation of appropriate mitigation measures, the migration of the groundwater plume could potentially impact on nearby sensitive environmental receptors. In addition, WSP recommended that excavations to the groundwater table in the vicinity of identified contamination be appropriately managed (e.g. EMP) to protect the health of workers from associated hydrocarbon exposure risks.

3.3 REMEDIATION ACTION PLANS

Based on the findings of on and offsite soil and groundwater investigations pertinent to the Site (refer Sections 3.1 – 3.3), WSP was engaged by STA to develop a Remediation Action Plan (RAP) for the site to enable the site to be suitable for continued commercial / industrial landuse and mitigate potential risks to human health and/or the environment posed by the identified hydrocarbon impact. The initial RAP was prepared in 2013 as:

- WSP 2013b, *Remedial Action Plan, STA Mona Vale Bus Depot – 58 Darley St, Mona Vale NSW*

The RAP was prepared based on the investigation findings and included a review of feasible remediation / management options, WSP recommended the following preferred remediation approach:

- Risk assessment to quantify human health and environmental risks posed by identified offsite hydrocarbon impact. The risk assessment was also required to determine the suitability of monitored natural attenuation (MNA) as a management strategy for offsite hydrocarbon impact
- Installation of active skimmers in existing (two additional monitoring wells are required to be drilled) onsite monitoring wells to remove onsite PSH within the refuelling area at the site and prevent any further offsite migration of contaminants;
- Excavation and removal of the diesel spill sump pit (source) within the refuelling area, including excavation and disposal of surrounding shallow (above the groundwater table) hydrocarbon impacted soils; and

- An on-going groundwater monitoring program to evaluate the effectiveness of remediation works and progress on MNA.

To complete the risk assessment for the site the following works were required to be undertaken:

- Installation of three additional groundwater wells – one down-gradient of MW8, one down-gradient of MW11 and one down-gradient from MW10. This information was required to provide further understanding of the PSH down-gradient of MW10 and associated dissolved phase plume. Analysis for organic carbon in soil and pertinent fate and transport calibration data is also required;
- Slug and bail down tests to determine the hydraulic properties of the underlying aquifer and true product thickness; and
- Resampling of groundwater in new and selected existing monitoring wells for contaminants of concern and MNA parameters.

By 2015 several of the items noted in the original RAP had been actioned including removal of the site's diesel spill sump pit (possible source), removal of the underground petroleum storage system (UPSS), installation of an active onsite groundwater skimmer system and implementation of an on-going groundwater monitoring program. It was concluded that an update to the remediation strategy was required to meet State Transit's obligations under a Voluntary Management Proposal (VMP) for the site. The updated RAP was updated was entitled:

- WSP, 2015 *Remedial Action Plan (Revised 2015) State Transit Mona Vale Bus Depot – 58 Darley St, Mona Vale NSW*

The updated RAP revised remediation strategy for the Site included:

- Expansion of the monitoring networks – particularly offsite to the west and north west, but also including one location onsite in an up gradient (background) location. A total of three additional offsite groundwater wells and one onsite well was recommended;
- Risk assessment to quantify the human health and ecological risks associated with on- and off-site hydrocarbon contamination. The assessment would include contaminant fate and transport modelling, which would provide for a better appreciation of the potential migration of the groundwater plume, and assessment of human health risks by vapour intrusion modelling and assessment of risk to workers involved in future excavation works on the site and surrounds;
- Continued operation of the onsite free phase recovery system;
- Implementation of a pilot trial for the targeted in-situ remediation of PSH in offsite monitoring wells MW09 and MW10 using mechanical methods such as multi-phase extraction.

3.4 REMEDIATION AND INFRASTRUCTURE WORKS

The following table provides a summary of capital works and remediation strategies (excluding groundwater monitoring described in Section 3.5) implemented at the Site to date. The works were primarily based on the findings of the original RAP (WSP, 2013b). These works have been completed by others and as such, WSP has relied on information provided in the VMP and by STA's Environmental Manager David Gosling regarding the completion of these works.

Table 3.1 Remediation Works Summary

WORKS	STATUS	WORKS DETAIL	CONTRACTOR
Source abandonment (diesel spill sump pit), soil excavation and offsite disposal	Completed October, 2013	The 2,000 litre spill sump was pumped out of residual product and then backfilled with 25 mPa concrete. 6.74 tonnes of heaviest contaminated soils, in a 2m x 3m footprint, were excavated adjacent the backfilled abandoned spill sump, between sump and the western boundary of the Site. The excavation was backfilled with suitable certified soils and the concrete slab in the fuel area driveway was reinstated	Australian Environmental Services (AES) Worth Recycling (soil disposal)
Installation of two additional monitoring wells for enhanced free phase recovery within groundwater impacted zone	Completed October 2013	Additional wells (MW13 and MW14) were installed on the western boundary of the Site, adjacent to MW05. Refer Figure 4, **Appendix A** for well locations	AES subcontracted to ENRS
Operation of an onsite active free phase recovery system. The skimmer system utilised monitoring wells MW05, MW13 and MW14 between 2013 and 2017. In 2018 STA extended the scope of skimming works to also include offsite wells MW09, MW19 and MW21	Commenced in October 2013 – continued till March 2018 Program extended to offsite in April 2018	Field observations indicate that approximately 1,600 – 1,700 litres of product have been recovered in the period since commissioning. Preliminary result pending.	AES
Decommissioning by excavation and offsite removal of 1x 35 kL AST and 1x 35 kL UST (both diesel) and the pump house area.	Completed April 2014 by Petrolink	UST and AST soil validation samples were reported below the validation criteria. Pump House area was only excavated to a depth of 0.5 m with validation samples showing elevated levels of TRH and PAHs remaining.	Petrolink

WORKS	STATUS	WORKS DETAIL	CONTRACTOR
Installation of additional wells to existing network of 5 wells for the purpose of delineation and monitoring of natural attenuation. Various mobilisation.	November 2013 June 2014 September 2015 June 2016	MW15, MW16 and MW17 – installed for to assess extent of PSH. MW08-B and MW12-B – installed after the original bores became blocked and were not accessible for sampling MW18 and MW19 - further assess lateral extent of plume and provide additional points for PSH extraction from large diameter wells. MW20 and MW21 - within road reserve adjacent private property as MW11 and MW18 no longer accessible. MW22, MW25 and MW26 - down gradient of existing bore network to further assess offsite migration. Refer Figure 4, **Appendix A** for well locations	ENRS
Passive skimmer trial	Commenced January 2017 completed February 2017	Three fortnightly rounds of skimmer maintenance targeting offsite wells. Approximately 18 L recovered. Further details in Section 3.7.1.	WSP
Multi-Phase Vacuum Extraction (MPVE) trial works	Phase 1 Commenced April 2015, completed October 2016 Phase 2 commenced August 2017 completed January 2018	Three rounds of MPVE targeting offsite wells. Approximately 70 L recovered. Further details in Section 3.7.2. Three rounds of MPVE targeting offsite wells. Approximately 360 L recovered. Further details in Section 3.7.2.	AES subcontracted to ENRS EPS subcontracted to WSP

3.5 GROUNDWATER MONITORING

Based on the outcomes of the original RAP (WSP, 2013), Environment and Natural Resource Solutions (ENRS) was commissioned by STA to undertake quarterly groundwater monitoring of conditions particularly down-gradient of the site, in the vicinity of the PSH and associated dissolved phase plume. In total 11 monitoring events have been undertaken to date. The monitoring was undertaken by ENRS from January 2014 until April 2018, with WSP continuing the program for October 2018 and May 2019.

3.5.1 SUMMARY OF FINDINGS BY ENRS 2014-2018

Though the primary objective of the monitoring has been to assess PSH presence, the concentrations of hydrocarbons in the dissolved phase and natural attenuation parameters, various associated works were conducted during the program including:

- Installation of 12 additional groundwater wells over the period of monitoring as described in Table 3.1.
- Analysis for organic carbon in soil to inform future fate and transport calibration as recommended in the RAP (WSP, 2013. The results were presented in ENRS, October 2013 (not provided to WSP);
- Aquifer slug tests to determine the hydraulic properties of the underlying aquifer. Falling head tests were carried out and analysed by ENRS in November 2013. In summary, hydraulic conductivity ranged from 1.5 to 4.7 m/day with an average of 2.9 m/day (ENRS, 2016a); and
- Comparison of laboratory results against standard chromatograph charts to confirm the primary form of hydrocarbon contamination at the site is associated with diesel product (ENRS, 2014).

With respect to the groundwater monitoring program itself, ENRS has, in various reports, concluded that:

- Groundwater flow direction is in a general north-westerly direction with a gradient of approximately 0.002.
- PSH had been measured in monitoring wells MW09, MW10, MW18, MW19, MW20, MW21 ranging from 0.05 m thick to 0.7 m thick (Average of 0.37 m thick), with a film being also recorded in MW25 by April 2018. Further analysis is provided in Section 4.1.
- In general, the results of the last GME conducted by ENRS (ENRS, 2018b) identified site conditions similar to previous monitoring events with a moderate increase in PSH. In ENRS's opinion the data indicated that whilst the plume had been relatively stable since 2013, it had reached MW10 on the west side of Taronga Place;
- The primary indicators for natural attenuation continue to suggest the potential for MNA is limited. ENRS concluded that the extent of PSH remains too great for MNA alone to provide a successful remediation outcome. PSH recovery should continue to be supported by active recovery methods to manage the risk of further plume migration and liability from cumulative offsite impacts;

At ENRSs most recent GME (ENRS, 2018b) they recommended that:

- Monitoring be reduced to annual sampling supplemented by quarterly field gauging (or in accordance with the VMP) and comprise low flow sampling with analysis at NATA accredited laboratories (though this is not supported by the Auditor (Enviroview, 2018b and Enviroview 2019);
- Monitoring be supported by quarterly or monthly field inspections to record VOC levels in well heads using a PID meter, measure the thickness of any PSH, and the depth to water within accessible wells;
- A regular program of product recovery to removed PSH at the site continue;
- Groundwater monitoring continues until concentrations of hydrocarbons fall below the relevant water quality assessment criteria;
- ENRS to proceed with previous commission to undertake a review of plume migration potential and volume utilising the latest GME data and previous aquifer test results, to be issued in a standalone report;
- Consider an investigation program to further assess the potential for migration of contaminants through preferential pathways, namely underground services intersecting Taronga Place and a former Sydney Water easement trending northwest from the Site;
- Continue site management and monitoring in accordance with the EPA approved VMP and RAP.

3.5.2 SUMMARY OF WSP'S FINDINGS 2018-2019

Based on the findings of WSP 2019a and WSP 2019b WSP have made the following conclusions and recommendations:

- PSH is present in five offsite wells north west of the bus refuelling bay (MW10, MW18, MW19, MW20, MW21 and MW25), ranging in thickness from 145 mm to 468 mm. It is likely that PSH is also present in the inaccessible skimmer wells (MW05, MW09, MW13, MW14). Overall the PSH thickness in recent events remains within historical ranges. The exception is the result from MW25 that appears to be on an increasing trend. These findings

indicate that the ongoing skimming operation is currently having minimal impact on the PSH and it continues to be slowly spreading to the northwest. Recovery of product in the IBC on STAs land appeared minimal.

- The dissolved phase hydrocarbon plume surrounding the PSH impacted area appears relatively stable and, while not delineated, the concentrations appear to attenuate significantly with distance from the PSH affected area.
- There is clear evidence of biodegradation of hydrocarbons occurring within dissolved hydrocarbon plume. The range of redox conditions suggest a dynamic system but in places the redox conditions appear quite reducing and may indicate that the rate of degradation is limited by availability of electron acceptors.
- An arsenic plume is present beneath the site and surrounds. The source of the plume is uncertain but the distribution and concentrations appears relatively stable.
- The site is considered suitable for its continued use as an operational bus depot. Surrounding sites are also suitable for ongoing commercial/industrial use. Based on the current site orientation and activities, the risk posed by the identified contamination to human or ecological receptors is considered low. In the event of excavation or earthworks which expose impacted soils or groundwater, there is an increased risk to human health via ingestion and dermal contact with contaminated material which would require management through occupational exposure controls in accordance with health and safety legislation.

WSP recommended that:

- Maintenance of the on- and off-site skimmer system should be carried out to optimise its function.
- MW20 should be added to the skimming system.
- Groundwater monitoring should continue along with a program to close data gaps including installation of additional delineation bores (see Section 5.4).

3.6 HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT

3.6.1 HERA DEVELOPMENT

ENRS was engaged to prepare a health and ecological risk assessment. The report was entitled:

- ENRS, 2016 *Human Health & Ecological Risk Assessment (HHERA) STA Bus Depot Monavale*

The objectives of the risk assessment were to

- undertake a risk assessment methodology consistent with current industry guidelines for appraising and recording public health risks at contaminated sites;
- establish the baseline risks and determine appropriate site management actions for ongoing remediation and monitoring;
- determine tolerable levels of contaminants in soil and groundwater that are protective of public health and ecosystems; and
- enable the comparison of potential health benefits and impacts (where relevant) of various remedial technologies.

The risk assessment included tier 1 assessment of groundwater results against available generic criteria, supplemented by some site specific vapour intrusion modelling to assess risk via inhalation pathways. The risk assessment concluded that based on groundwater monitoring results available to the date of the report, and modelled vapour intrusion results, the risk to human health and ecological receptors was acceptably low.

The report provided recommendations regarding the need for ongoing monitoring including:

- Maintaining quarterly gauging events for PSH thickness;

- Reducing frequency of analytical monitoring to 6 monthly events, but maintaining the analytical suite adopted for these events;
- Consideration of obtaining sub slab vapour monitoring data over the PSH plume.
- Continue assessing the MNA conditions of the plume and surrounds

With respect to the remedial efforts the report recommended:

- Recommencing passive skimming and consideration of extending the onsite automated skimming network to include offsite wells.
- Six monthly review of PSH recovery and MNA conditions in conjunction with groundwater monitoring events.

3.6.2 VAPOUR ASSESSMENTS

WSP was commissioned by STA to undertake a soil vapour assessment on the Site to quantify the vapour intrusion risk for commercial workers on the site and, by inference, on the neighbouring properties occupied by Pittwater Joinery (Lot 2 DP701913) and Reece Plumbing (Lot 34 DP708050). Two rounds of vapour assessment have been undertaken to date.

The initial vapour risk assessment was prepared in February 2017 and entitled:

- WSP, 2017a *Soil Vapour Assessment- Mona Vale Bus Depot 58 Darley Street, Mona Vale NSW*

The scope of works comprised:

- Review of previous environmental investigations to assess the extent of the hydrocarbon plume and inform selection of appropriate locations to evaluate vapour intrusion risk;
- Installation of sub-slab vapour pins and measurement of sub-slab soil vapour concentrations of hydrocarbons, BTEXN and other volatile organic compounds (VOCs) along the site boundary; and
- Evaluation of vapour intrusion risk on site and likely risk on adjoining Pittwater Joinery and Reece Plumbing sites.

Sample locations were placed in close proximity to the western boundary and within the area where PSH had previously been identified in monitoring wells (MW05, MW13 and MW14). Four sub slab vapour pins were installed and then sampled and analysed in accordance with the US EPA TO-15 method.

The results indicate that sub-slab vapour concentrations were below health screening levels, therefore the risk to commercial workers occupying buildings onsite through vapour intrusion was low and acceptable. No soil vapour measurements were taken on adjoining properties due to access restrictions, however it is likely that the sub slab conditions captured in this investigation are similar to the sub-slab conditions in the adjoining properties. Therefore, the risk to commercial site workers in adjacent properties, currently occupied by Pittwater Joinery and Reece Plumbing was also considered likely to be acceptably low.

A second round of soil vapour sampling was commissioned by STA in June 2017:

- WSP, 2017d *Soil Vapour Assessment - STA Bus Depot 58 Darley Street, Mona Vale NSW*

The objective was to provide further soil vapour concentration data that could be used to assess whether there was any potential health risk to on-site and off-site commercial workers in buildings.

The scope replicated the initial testing and included retesting of sub-slab hydrocarbon vapour concentrations at the four existing test points on the western side of the bus depot, using the summa canister sampling technique (TO-15 technique)

Sub-slab vapour concentrations were low for all VOCs. No compound exceeded its screening criterion and all concentrations were well below the criterion. This result is consistent with the groundwater sampling data which indicate clearly that the predominant hydrocarbon impact is of diesel origin.

Benzene, toluene, ethylbenzene and xylene (BTEX), and trimethylbenzene were present at very low concentrations at all four sub-slab sampling locations on the bus depot. These results are not significant from a vapour intrusion risk perspective.

The two rounds of sub-slab vapour sampling showed substantial agreement. All results from both rounds fell into the very low to trace levels category. The second round of sampling confirmed the results of the first round, that being that concentrations of volatile hydrocarbons were at trace to very low levels and thus there was no indication from the vapour data of an unacceptable vapour intrusion risk for the buildings over the plume.

The second round showed essentially the same pattern of vapour impacts, and temporal and seasonal differences were small and considered to be insignificant.

A summary of vapour results from both rounds is provided as Table 3 in **Appendix B**.

3.7 GROUNDWATER REMEDIATION TRIAL WORKS

3.7.1 PASSIVE SKIMMER TRIAL

WSP was commissioned by STA to undertake a passive skimmer installation and maintenance trial as part of STA's commitments to an EPA approved voluntary management plan (VMP) and to assess the feasibility of a passive skimmer program as a remediation strategy for offsite groundwater contamination. The trial works were carried out in January to February 2017 and were documented in:

- WSP, 2017b *Passive Skimmer Trial- Mona Vale Bus Depot, 58 Darley Street, Mona Vale NSW*

Three STA provided skimmers were installed into selected wells within the PSH plume. These included MW19, MW20 and MW21. The locations of these wells are shown of Figure 5, **Appendix A**. The program included three fortnightly maintenance events to inspect the integrity of the skimmers, recover and dispose of product and record volumes of product recovered.

The PSH recovery at MW19 and MW21 was generally high and appeared to correspond with a slight reduction in PSH thickness, suggesting that the skimmers in these wells were effectively removing some product. Recovery was minimal at MW20, however the plume thickness was less significant at this location. The trial found that removal of 3 to 4 L of product from 100 mm wells was achievable when the skimmer installation was optimised. In total 18 L was recovered from three wells over three events during the 6 week trial.

The results of this skimmer trial suggested that the PSH recovery was high in the majority of the wells (2 of the 3 wells included in the trial), and particularly where the plume thickness is greater. It was concluded that passive skimmers may be a viable, low-impact remediation strategy, however, due to the area and thickness of the plume, the remediation timeframe is likely to be very long. WSP recommended that a passive skimmer program should only be considered as a remediation strategy if employed in conjunction with other more active remedial options.

Considering the significant area and thickness of the offsite PSH plume, WSP suggested that multi-phase vacuum extraction (MPVE) on selected wells in the centre of the PSH plume may be a more effective remediation strategy.

If MPVE was not a feasible option, WSP recommended the extension of the active skimming system, operating along the site boundary at MW05, MW13 and MW14, to accessible offsite PSH impacted wells

3.7.2 MPVE TRIAL

ENRS was engaged by STA to conduct three rounds of multi-phase vacuum extraction (MPVE) on four PSH affected offsite wells. The program included events in April 2015, November 2015, December 2015 and October 2016. These findings of these events are summarised in:

- ENRS, 2016 *Summary of Multi-Phase Extraction (MPE) Results – 12th October 2016 STA Bus Depot, 58 Darley Street Mona Vale, NSW, 2103*

AES was contracted to carry out the works using a mobile MPVE unit. The program was somewhat effective with recoveries of between 25 L and 13 L of product recovered each round. It was found that larger diameter wells resulted in a greater recovery (as expected).

ENRS recommended continuation of the program, where practicable, to expedite the remediation program.

In 2017, following the passive skimmer trial works (See section 3.7.1), WSP was engaged to supervise three additional rounds of multi-phase vacuum extraction (MPVE) on PSH affected offsite wells. The works were contracted to Enviropacific and occurred in August 2017, November 2017 and January 2018. Summary reports were provided following each event and included:

- WSP, 2017e *Multiphase Vapour Extraction (MPVE) State Transit Authority Bus Depot, Mona Vale August 2017*
- WSP, 2017f *Multiphase Vapour Extraction (MPVE) State Transit Authority Bus depot, Mona Vale November 2017 (Second event)*
- WSP, 2018 *Multiphase Vapour Extraction (MPVE) State Transit Authority Bus Depot, Mona Vale January 2018 (Third Event)*

The primary objectives of the MPVE trial program was to quantify the effectiveness of MPVE in removing hydrocarbon mass from the defined plume, and to continue removal of PSH. Hydrocarbon extraction rates – in vapour, liquid product and dissolve product forms were all to be quantified. These rates would be used as measures of the suitability and cost effectiveness of MPVE as a method of meeting the objective contained in the Voluntary Remediation Proposal (VMP) number 20164409.

The first of the MPVE events (August 2017) showed very effective recovery of PSH in liquid form with 197 L of PSH extracted over 6 hours of operation. The subsequent two events (November 2017 and January 2018) were less effective in terms of PSH extraction volume, but still relatively productive, with 90 L and 70 L extracted respectively. All three events showed essentially the same profile conditions in terms of average air flow rates from the profile, water volume extracted and vacuum at well heads. Given the similar conditions during each event, and the continued presence of considerable thicknesses of PSH, it was not obvious why the extracted volume of PSH has fallen over the three events.

The low level of volatiles recovered was noted to be further evidence of the low vapour content above the PSH, typical of diesel impacted groundwater.

The thicknesses of PSH remained substantial at completion of the trial and it was assumed that the volume of PSH (diesel) within the plume (impacted groundwater) remains considerable.

3.8 ENVIRONMENTAL MANAGEMENT PLAN

Based on the predominantly non-volatile nature of the identified PSH, vapours derived from concentrations in groundwater are unlikely to pose a significant risk to current site users. The soil vapour assessment (SVA) conducted by WSP in 2017 (see Section 3.6.2) found that sub slab vapour conditions within the PSH footprint in the refuelling area were acceptable for a commercial / industrial land use. Based on the current extent of identified petroleum hydrocarbon plumes, no unacceptable risks have been identified for onsite and offsite receptors considering the current commercial / industrial land use of the site and nearby properties.

However, hydrocarbon contamination in shallow soils and groundwater beneath the site could pose a potential risk to maintenance or construction workers undertaking excavation works within the plume footprint, and to manage this risk an environmental management plan (EMP) was developed for the site and immediate surrounds that are affected by PSH. This EMP is documented in:

- WSP 2017c *Environmental Management Plan - Mona Vale Bus Depot, 58 Darley Street, Mona Vale NSW*

The EMP provides:

- The regulatory framework in which this EMP has been prepared, the roles and responsibilities relating to environmental management on the site and surrounds and reporting, training and emergency response procedures relating to the residual impact;
- Analysis of the nature and extent of contamination at the site and surrounds, the likely risks this residual contamination poses to future site users, and key implementation strategies to control those risks; and
- A recommended program for auditing of compliance, corrective actions and routine EMP review so that the EMP remains relevant and up to date.

3.9 FURTHER ASSESSMENTS UNDER THE CURRENT VMP

The most recent revision of the VMP was approved by the EPA on 16 January 2020.

Within Part 3 of the VMP, there were four data gap areas (items T10 – T13) listed which included:

— Item T10: Preferential Pathways Investigations;

— Item T11: Surface Water Sampling;

— Item T12: Additional Monitoring wells; and

— Item T13: Indoor Air Vapour Risk.

WSP has completed additional site works between December 2019 to February 2020 in attempt to address these data gaps to the extent practicable. Separate factual letters have been prepared for each of the fieldworks associated with the above data gaps:

- *WSP, 2020a Groundwater Monitoring Event – Oct 2019 and Feb 2020, STA Mona Vale Bus Depot 58 Darley Street, Mona Vale NSW dated March 2020.*
- *WSP, 2020b Factual Record of Well Installation Works, Mona Vale Bus Depot, 58 Darley Street, Mona Vale, NSW dated March 2020*
- *WSP, 2020c Offsite Vapour Intrusion Assessment, STA Mona Vale dated March 2020*
- *WSP, 2020d, Data Gap Assessment, STA Mona Vale Bus Depot, 58 Darley Street, Mona Vale NSW dated April 2020*

In December 2019, WSP installed two shallow wells (MW36 and MW37) installed into the bedding sands surrounding adjacent the stormwater drainage culvert. Both wells were gauged on 7 February 2020 and determined to be dry. This provided a line of evidence that despite the nearby presence of phase separated hydrocarbons (PSH) to the south of the stormwater easement, bedding sands surrounding the stormwater culvert are not in connection with groundwater and are therefore not a preferential pathway for PSH to migrate laterally.

In February 2020, WSP collected three surface water samples; one from upstream, at the site's downgradient boundary, and downstream of the site along the stormwater channel. The results indicated that no detectable hydrocarbons were present in the stormwater upstream, at the site boundary or downstream of the site. This provides a further line of evidence that despite the proximity of the PSH to the stormwater easement, it is unlikely that the contamination is leaking into the system putting the ecology of the creek or downstream receptors at risk.

In December 2019, additional monitoring wells (MW28 – MW33 and MW35) were installed to further characterise the extent of the PSH plume. WSP are of the opinion that the well network now effectively defines the southern, eastern and northern extents of the PSH with a reasonable degree of confidence. The extent of the dissolved phase plume remains generally uncertain as low levels of hydrocarbons are detected in most wells that do not have PSH present. WSP is of the opinion that the additional well network has assisted in delineation of the PSH and dissolved phase plume, but that there remains some uncertainty in the extent of the PSH and dissolved phase plume, particularly west of the site. However, in our opinion, while a data gap remains, we do not consider the lack of information affects the remediation approach, nor

do we consider that the plume is likely to represent a significant health or ecological risk despite the lack of full delineation.

The 2020 vapour assessment was completed to assess whether contaminants in groundwater or PSH originating from the bus depot, and migrating beneath adjacent properties, were leading to the intrusion of contaminant vapours into the buildings on those adjacent properties; and if so, whether the vapours present a possible health risk to occupants of those buildings. Results indicated that that the diesel plume is not causing a vapour intrusion risk to the occupants of the two commercial buildings included in the assessment. The result corroborates the findings of the two rounds of sub slab vapour assessment conducted on the STA site (discussed in Section 3.6.2) which showed that all diesel constituents from both rounds were at very low to trace levels and that there was no indication from the soil vapour data of an unacceptable vapour intrusion risk for the buildings over the plume.

A more comprehensive summary of the results of the above assessments is provided in Section 4.3.

4 SITE CHARACTERISATION

4.1 EXTENT OF CONTAMINATION

4.1.1 SOIL AND SOIL VAPOUR CONTAMINATION

Concentrations of soil contaminants were assessed in WSP's investigations carried out in 2012 and 2013. Since that time the guidelines have changed with the introduction of the NEPC, 2013 *National Environment Protection (Assessment of Site Contamination) Measure 1999*. The data collected at that the time of the original site investigation work has been reproduced and compared (where possible) with the updated criteria in Table 1 of **Appendix B**.

In summary PAHs and heavy metal concentrations were all below health based investigation levels (HILs) for commercial/industrial sites. Similarly, the concentrations of BTEXN were all less than heath screening levels (HSLs) for vapour intrusion under commercial/industrial landuse scenarios. In general, BTEX was non-detect but on occasion naphthalene was present, consistent with the presence of phase separated diesel.

Total recoverable hydrocarbons were generally below the HSLs, except for samples in SB02, SB04 and SB12 which were inferred to marginally exceed the F1 criteria. These locations were all in close proximity to the now abandoned former waste oil UST. These, and other locations, particularly around refuelling bay and along the former fuel line on the western boundary, also exhibited elevated hydrocarbons across the C_{10} to C_{28} range.

It is noted that across all locations tested the most elevated TRHs were detected at a depth of around 1.8 to 2.0 m consistent with the water table level. On only a few occasions (SB01, SB02 and MW05 – in proximity to the refuelling bay) were elevated hydrocarbons found at depths of less than or equal to 1 m depth. This finding indicates that the hydrocarbons in soils are predominantly associated with the PSH plume beneath the site and not with widespread surface spillage.

In order to understand the actual risk posed to site (and offsite) personnel by the presence of residual hydrocarbons in the soil and groundwater two rounds of sub-slab vapour analysis have been conducted along the western boundary. The findings are outlined in Section 3.6.2 and the data has been reproduced in Table 3, **Appendix B**. In summary, the assessments showed that all results for BTEXN and F1 were less than HSLs for commercial industrial use. This result is consistent with diesel contamination.

4.1.2 PHASE SEPARATED HYDROCARBON PRESENCE AND TRENDS.

Phase separated hydrocarbons (PSH) have been detected beneath the site and surrounds since the investigation phases were undertaken in 2012 and 2013. The PSH exists as a light non-aqueous phase liquid (LNAPL) above the ground water. The groundwater monitoring program has assisted in understanding the extent and in assessing the stability of PSH.

Data on the PSH thickness is presented in Table 2a, **Appendix B.** The inferred areal extent of PSH is depicted on Figure 6 in **Appendix A**. Wells containing PSH include:

- Onsite wells MW05, MW13 and MW14 located downgradient of the refuelling bay, on the western site boundary;
- Offsite wells MW09, MW10, MW18, MW19, MW20, MW21, MW25, MW31, MW32 and MW33 located west (downgradient) of the site.
- The most downgradient point in which PSH has been detected in MW33 which was installed in December 2019 and gauged in February 2020 with approximately 0.123 m.
- The total inferred area of the PSH impact is approximately 4,500 m^2.

The temporal gauging data is presented in Figure 4.1 and generally shows that the PSH fluctuates between 0.1 m and 0.7 m thickness. Within this range there appears to be a relatively high degree of variability. In general, the PSH thicknesses

recorded follow parallel lines indicating the degree of partitioning of PSH may be affected by environmental conditions such as rainfall. In wetter seasons the PSH appears to generally be thicker compared to levels recorded after dryer periods.

A rudimentary estimate of the PSH volume, based on the inferred area multiplied by the average thickness over the monitoring period of 0.38 m, and assuming 15% effective porosity approximates to 256,500 L of product. WSP has assumed an effective porosity of 15% as the PSH is likely to be present in the large pore spaces as the PSHs spread is not under pressure and unlikely to flow into the smaller pore spaces. The PSH affected zone is likely to be a mix of PSH, water and air filling the total porosity (likely to be in to be order of 30% of the soil bulk volume).

Given the extent of PSH, the hydrocarbons clearly have migrated with the groundwater, however, the PSH does not appear at this time to have passed beyond MW22 on the north western side of Taronga Place. The PSH has been detected in MW33, indicating the lateral extent of the plume to the west is not yet known, though the absence of PSH in MW16 and MW22 indicate the extent to the north in defined.

It is assumed that the decommissioning of primary sources, including replacement of the fuel line on the boundary and abandonment of the spill sump (with surrounding soil removal), have successfully removed the primary source of fuel discharges. STA have also committed to implementing a much more aggressive method of PSH removal and this should reduce the head of PSH that is the primary driver for PSH migration. Thus, it is expected that the potential for PSH plume expansion will be reduced once the system has been installed.

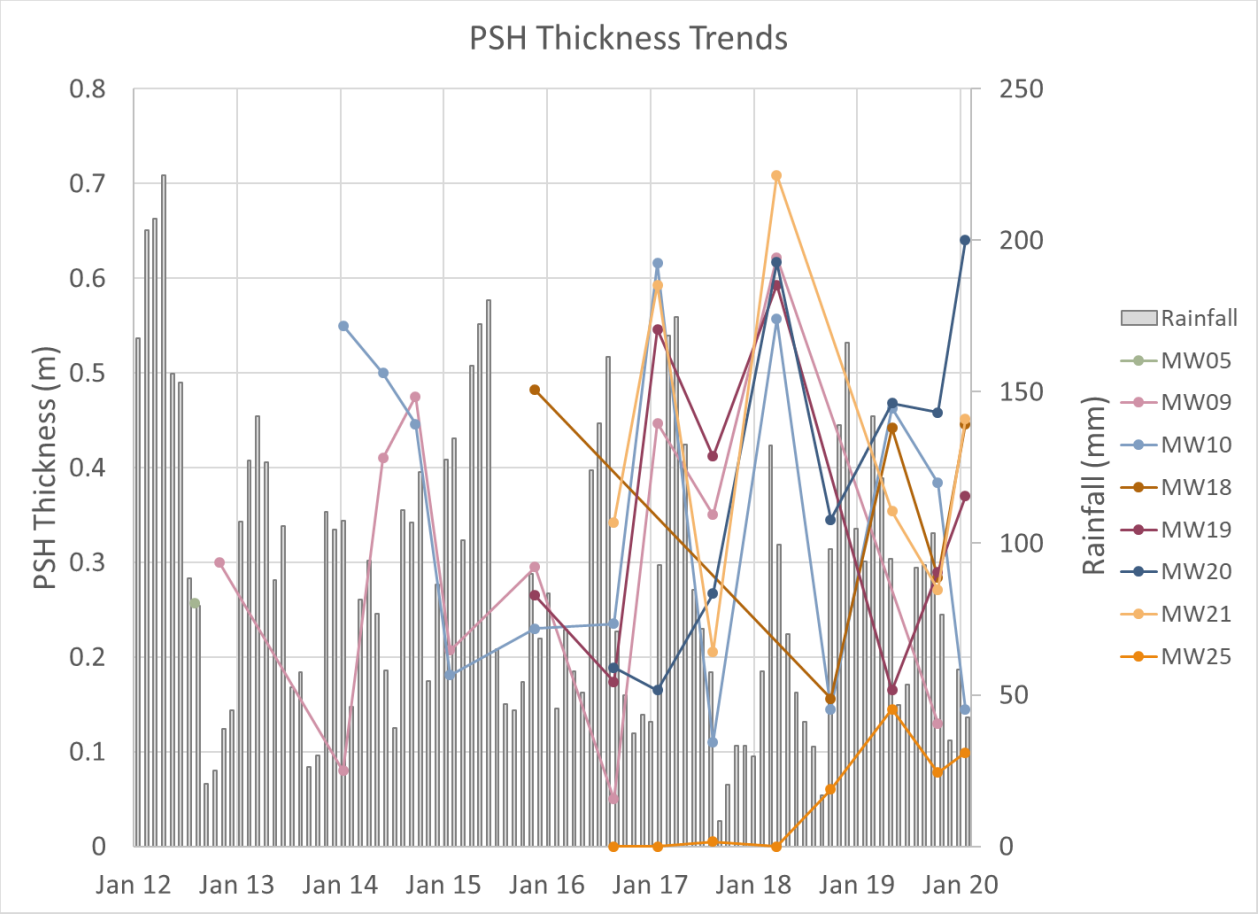

Figure 4.1 PSH thickness over time and rainfall (3 month moving average).

4.1.3 PRESENCE OF DISSOLVED CONTAMINANTS

The laboratory results for the monitoring events conducted to date are provided in Table 2b, **Appendix B**.

These results have been compared with NEPC, 2013 criteria including HSLs for vapour intrusion risk and GILs for the protection of marine ecosystems.

A dissolved phase hydrocarbon plume is present in association with the PSH plume. In general, the hydrocarbon plume exhibits very low BTEX and low naphthalene. The F1 component of the hydrocarbons generally comprises less than 2% of the total TRH. The dominant fractions are the F2 and F3 fractions consistent with diesel impact.

No results exceeded the HSL criteria indicating the vapour intrusion risk is acceptably low. This result is consistent with the findings of the risk assessment (ENRS, 2016) and the sub slab vapour assessments (WSP, 2017a and WSP 2017d).

GILs for protection of marine ecosystems were exceeded on a number of occasions. While no BTEX results exceeded these criteria, the naphthalene concentrations in MW09, MW10, MW19, MW20 and MW21 all exceeded the criteria. However, these locations are all PSH affected and so the results may be subject to cross contamination from the product that the sampling equipment must pass through to obtain a water sample. Typically, groundwater samples are not collected from PSH impacted wells.

Results from downgradient locations with no measurable PSH, including MW22, and MW26, whilst on occasions having detectable naphthalene have not exceeded the criteria to date. This indicates that while the PSH may be extensive, and contains naphthalene at levels that would exceed the ecological criteria, the dissolved plume surrounding the PSH is likely to be relatively short with concentrations unlikely to exceed the site criteria.

These wells do also exhibit dissolved TRH for which there are no GILs. TRH trends have been presented in Figure 4.2. While concentrations of TRH in MW22 and MW26 appear relatively stable the concentrations in MW25 were observed between 2017 to 2018 to rise steeply and this well has since begun to exhibit PSH, also on a rising thickness trend as discussed in Section 4.1.2.

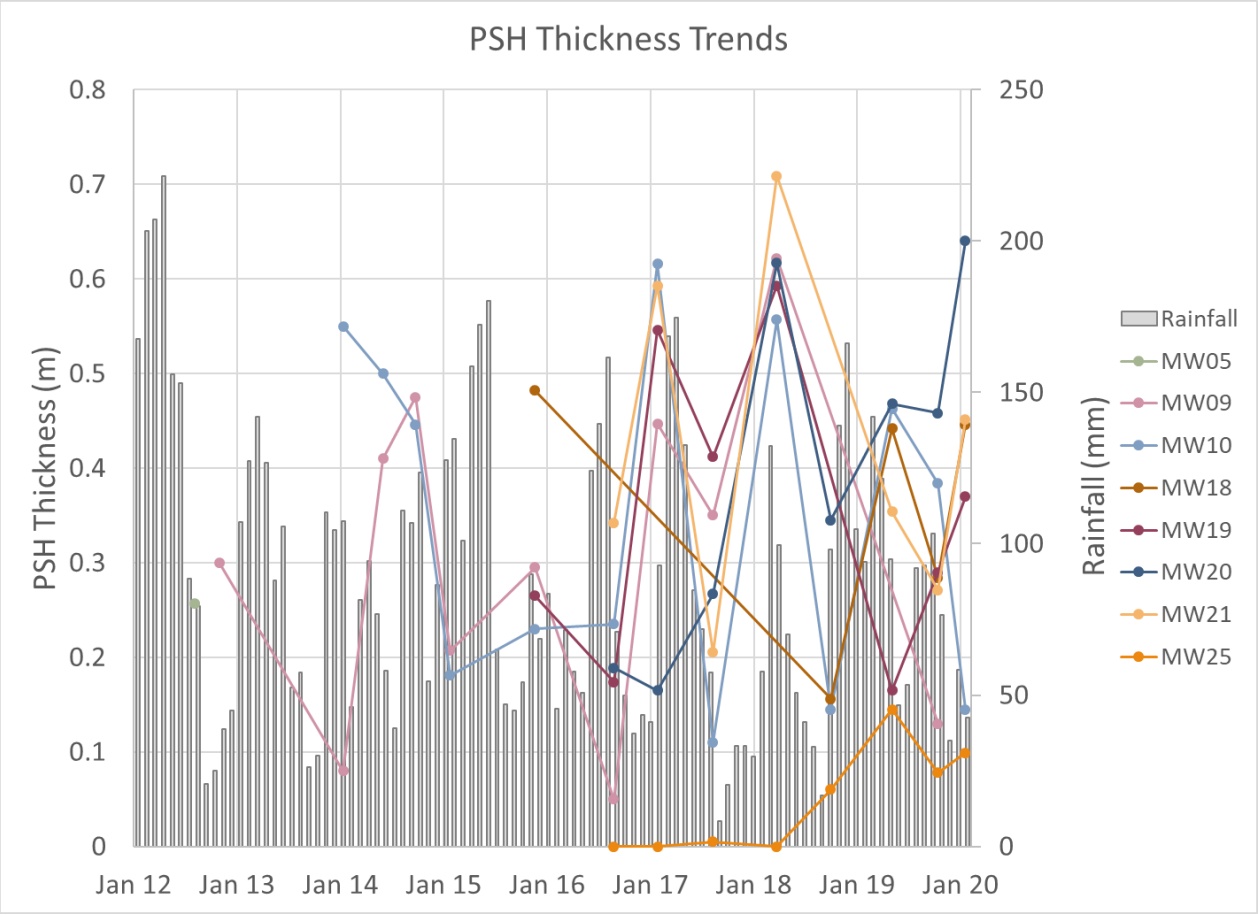

Figure 4.2 Dissolved TRH concentration over time, and rainfall (3 month moving average)

With respect to inorganic contaminants (see Tables 2b and 2c, **Appendix B**), nitrate is frequently detectable in the groundwater and in MW15 and MW17. The source is unlikely to relate to the site use as a bus depot. Within the dissolved plume, the lower redox conditions mean that the dominant nitrogen species is ammonium, which exceeds site criteria in MW07, MW12, MW16, MW22, MW23, MW24 and MW26.

Copper, nickel and zinc have been observed to fluctuate in wells MW15, MW16 and MW17 exceeding marine GILs on occasions. These compounds are also unlikely to relate to site activities and may be either of natural origin or result from dissolution from overlying fill into percolating water.

Arsenic has been observed to be unusually elevated across a number of wells, at levels exceeding GILs for marine ecosystems and also GILs for drinking water in MW02, MW09, MW10, MW11, MW16, MW18, MW19, MW20, MW21, MW22 and MW26. The historically most concentrated results were from the offsite (and now abandoned) MW11, approximately one order of magnitude higher than the criteria. The concentrations of arsenic appear relatively stable over time. The source of the arsenic is unknown, possibly dating from pre 1960s when the site and surrounds were vacant or agricultural land, possibly comprising turf farms. It is considered unlikely to directly relate to the bus depot operations.

Nevertheless, there does appear to be a spatial relationship between the arsenic and the hydrocarbon plume. It is possible that the redox conditions generated by the plume are resulting in greater dissolution of arsenic from the solid phase.

4.1.4 EVIDENCE OF NATURAL ATTENUATION

A common natural attenuation process involves petroleum hydrocarbons acting as electron donors in oxidation-reduction reactions resulting in biodegradation of hydrocarbon molecules. Monitoring the concentrations of certain electron acceptors, or by-products of respiration in the groundwater can indicate whether natural attenuation processes are taking place on a hydrocarbon plume (DEP, 2004).

Important chemical parameters which may indicate natural attenuation processes are occurring include:

- Decline in field redox potential as oxygen sources (electron acceptors) are depleted. This results in:
  - Decrease in dissolved oxygen – the most readily available electron acceptor in the aquifer;
  - Nitrate reduction: decrease in nitrate concentrations and corresponding increase in ammonia (a reduced form of nitrogen);
  - Iron reduction: reduction of oxidised (ferric) iron off the solid phase minerals resulting in increase in dissolved (ferrous) iron.
  - Sulfate reduction: decrease in sulphate and corresponding increase in H_2S odours; and
  - Methanogenesis: If redox declines further, then consumption (decrease) in bicarbonate and increase in dissolved methane and a by-product.
- With the exception of methanogenesis, alkalinity (as bicarbonate) is expected to increase within the plume resulting from an increase in production of CO_2 (a by-product of microbial respiration);

Some of these indicators have been included in the monitoring program to date, including field measurements of redox and dissolved oxygen, and laboratory tests for nitrate, ferrous iron, sulfate and methane. The results are available in Tables 2a and 2c, **Appendix B**.

The following conclusions were presented in WSP 2019b with respect to the geochemistry at the site;

- Recorded redox results were lower within and downgradient of the hydrocarbon plume (MW12, MW16, MW22) compared with background locations (MW03, MW17, and MW23 and MW24). This indicates microbial degradation processes are acting on the plume;

- Nitrogen species are relatively ubiquitous on the site and surrounds. Within and downgradient of the dissolved plume the dominant species is ammonium reflecting reducing conditions in the dissolved plume. Nitrate is detected well above ammonium concentrations on the plume periphery and downgradient (MW15 and MW17). This finding suggests active microbial degradation is occurring in the dissolved plume utilizing the nitrate as an electron acceptor.
- Sulfate was generally present across the site and surrounds at varying concentrations. The lowest sulfate results were within the dissolved plume, directly downgradient of the PSH (MW16 and MW22). In the dissolved phase plume periphery (MW01, MW02, MW07 and MW26 the sulfate remained relatively low compared with background wells (MW03, MW17, and MW23 and MW24). These results are further evidence for microbial degradation occurring, but given that the sulfate is low downgradient of the plume it may indicate that electron acceptors may be limited.
- Ferrous iron concentrations were reported within all sampled wells in proximity to the site with the highest concentrations within the dissolved phase plume and immediately downgradient of the PSH (MW07, MW16, MW22 and MW26). The only location where this analyte was non detect was MW17 located a block to the west, where no hydrocarbons are present. This location is considered a background location (albeit downgradient of the site). Ferrous iron is the by-product of iron reduction and is an indication of reducing conditions;
- Alkalinity (bicarbonate) concentrations continue to be most prevalent in groundwater from wells with dissolved hydrocarbons making up between 80% and 100% of the anions in that groundwater compared with approximately 75% of the anions in MW17, MW23 and MW24, where hydrocarbons were not detected. The results are a further line of evidence that microbial respiration is occurring.
- Dissolved methane was present in all wells within the dissolved plume but most elevated in MW01 and MW07 (up gradient of the PSH) and MW16, MW22 and MW26 (downgradient of the PSH). Methane was absent or very low in all background locations MW03, MW17, MW23 and MW24).

Overall, there is strong correlations between natural attenuation indicators and the plume footprint. The range of natural attenuation parameter concentrations indicates that the system is in a dynamic state. The natural groundwater provides various sources of electron acceptors as nitrate and sulfate, however, these are clearly insufficient to maintain optimised conditions for aerobic degradation as they are generally non-detect or at very low concentrations within and downgradient of the plume. It is likely that the rate of degradation is limited by the availability of electron acceptors.

4.2 CONCEPTUAL SITE MODEL

A Conceptual Site Model was prepared as an appendix to the Environmental Management Plan (WSP 2017c). This chapter reiterates and updates the findings of that model.

A key component of understanding the risks posed by potentially contaminated sites is the development of a contaminant Conceptual Site Model (CSM). For a risk to exist there must be a source of contamination, a potential receptor (e.g. a human or ecological community) and a plausible pathway that links the two. This is known as a source-pathway-receptor analysis. If any one of these components is absent there is no unacceptable risk.

Figure 10 in **Appendix A** has been included to assist in visualising the various identified potential relationships with discussion on the plausibility and qualitative risk of each of these provided in Section 4.2.4 and Table 4.1.

4.2.1 SOURCES

Based on review of available information, relevant identified sources of contamination include:

- Former diesel refuelling infrastructure, sump pit, and waste oil tank understood to have all been decommissioned;
- Likely localised residual soil impacts beyond the extent of remedial works;
- Phase separated hydrocarbons on the site's western boundary and extending to the north west.

- Associated dissolved phase hydrocarbons surrounding the PSH impacted area.
- Inorganic groundwater contamination including arsenic, copper, nickel and zinc unrelated to fuel storage on the site.

4.2.2 POTENTIAL RECEPTORS

Potential receptors on the site and surrounds include:

- STA site personnel;
- Construction workers and future site maintenance personnel working onsite or offsite within the contamination plume footprint;
- Future site occupants (under a commercial/industrial land use scenario);
- Down gradient residential occupants (approximately 250 m west of the site);
- Nearby ecological receptors including but not limited to onsite and offsite vegetation, trees and landscaped areas;
- An open stormwater channel located approximately 300 m northwest of the site which drains into Cahill Creek 950 m north west of the site, and ultimately Winnererremy Bay approximately 1 km northwest of the site. The drain itself is unlikely to represent a significant ecological receptor, the most relevant downgrading ecological receiving environment would he the estuarine environment of Cahill Creek and Winnererremy Bay.

4.2.3 POTENTIAL PATHWAYS

The following contaminant pathways applicable to the site and adjacent properties given the site's current and proposed future land use as an operational bus depot with surrounding light industrial land use:

- Ingestion or dermal contact with contaminated groundwater extracted via domestic bores or the use of downgradient surface water bodies for recreation (considered unlikely);
- Ingestion or dermal contact with contaminated water encountered during excavation / trenching;
- Inhalation or ingestion of dust or air borne contaminants during regular site operations or during excavations / trenching;
- Migration of contaminants with shallow groundwater in a sandy aquifer with an estimated water seepage velocity of approximately 10 m per year;
- Migration of contaminants through underlying soils or preferential pathways such as underground service trenches or former fuel lines; and
- Inhalation of hydrocarbon vapours derived from soil and groundwater contamination through soil pore spaces and intrusion into building spaces.

4.2.4 SUMMARY OF RISK

A summary of plausible pathways, and a qualitative assessment of the risk of those pathways resulting in an unacceptable exposure to a receptor is summarised in Table 4.1. In the site's present condition, the identified contaminants present a low risk to human receptors. In the event of excavation or earthworks which expose impacted soils or groundwater, there is a moderate risk to human health via ingestion or dermal contact with contaminated soils or groundwater which would require management under a Construction Environmental Management Plan (CEMP) and site specific safe work method statements (SWMS). An EMP has been prepared for the site and surrounds to assist in management of these risks.

For the off-site neighbouring buildings, vapour risk has been shown via vapour flux through building floor slabs and via direct indoor air measurements to be acceptably low. The contaminants present a low to moderate risk to on-site and offsite ecological receptors. Given the industrial nature of the site setting and using of surrounding properties the local

ecology is not considered to be of high value. Nevertheless, the plume may result in stunting of vegetation where dissolved oxygen is low due to the microbial activity.

Risks to more distant downgradient human and ecological receptors are unlikely given the low toxicity of the PSH constituents and the evidence for microbial degradation occurring, which, coupled with PSH removal, will limit the dissolved phase plume spread. It is possible that the hydrocarbons may migrate more rapidly via preferential pathways provided by local services however based on the discussion provided in the Data Gaps Assessment report (WSP, 2020d) the pathway to the stormwater system at present is incomplete, but the risk warrants ongoing monitoring. Inorganic contamination of the groundwater, primarily an arsenic plume, is present beneath the site and surrounds. This is unlikely to relate the Bus Depot activities and may be a more regional issue possibly related to historical agricultural or turf production, or possibly a geochemical effect releasing arsenic from the mineral phase due to redox conditions resulting from the plume.

Risks presented by the arsenic plume are unlikely to be significant to general commercial and industrial use of the site and surrounds but would be of concern during excavations works. However, the precautions required under the EMP (WSP, 2017c) for minimising dermal and ingestion risks presented by the hydrocarbons during construction works would assist in managing this risk as well.

Ecological risk associated with the arsenic is unknown as the extent of the plume is uncertain. Risk to residents some distance from the site is also uncertain, however, given the groundwater is unlikely to be used for potable supply the risk is likely to be of a recreational exposure scenario. Results from the groundwater in the vicinity of the site have generally been lower than health-based recreational criteria.

Table 4.1 Source Pathway Receptor Analysis.

IDENTIFIED SOURCES	PLAUSIBLE PATHWAY	POTENTIAL RECEPTOR	QUALITATIVE RISK	COMMENTS / RATIONALE
Hydrocarbon impacts to the site and surrounds including: — Localised diesel impacts in soil onsite — PSH located above the water table (~2 mbgl) on the western boundary and extending offsite, to the far side of Taronga Place, to the west. — Dissolved phase hydrocarbons in association with the PSH impacts.	Ingestion or dermal contact with known contaminated water or soils	Site and neighboring site workers and future occupants	Negligible	The onsite soil contamination is located beneath pavements, with the majority of known impacts at a depth of approximately 2 m bgl. Offsite soil impacts relate to the PSH that has spread from the site at the soil/water interface and is present at depths of approximately 2 mbgl. Therefore, directed contact with impacted soil or groundwater during typical onsite or offsite activities will not occur.
		Construction or maintenance workers	Low	Given the location of the contamination the only plausible linkage for direct contact is associated with excavation activities. The risk of encountering hydrocarbon contamination has been notified to Dial Before You Dig and notification is provided on various utility plans accessed by that service. Measures to minimize risk during excavation works are provided in the site EMP (WSP, 2017c). Control measures should be developed in project specific Safe Work Method Statements.
	Migration of contaminants with groundwater resulting in potential exposure to more distant receptors	Down gradient residential occupants extracting groundwater from domestic bores	Low to Negligible	A search of the Bureau of Meteorology (BOM) Groundwater Explorer database revealed 14 groundwater bores for water supply use within a 1 km radius of the site. All these, however, were either located hydraulically up gradient of the site, or based on their construction depth are likely to be intercepting regional groundwater aquifers within the underlying sandstone. The nearest of these bores is GW026581, located 60 m to the south south west of the site installed to a depth of 93 m. One well (GW018803) is located in an hydraulically downgradient position, and is installed within the alluvium. However, this well is 975 m from the site, and has its purpose stated as "Other". As the dissolved phase plume is not known to have migrated further than 80 m offsite, it is unlikely that contamination derived from the identified hydrocarbon plume would reach this well. Furthermore it's location in parkland and stated purpose mean that it is unlikely this water would be used for potable supply.
		Recreational users and ecological receptors of Cahill Creek 950 m north west and Winnererremy Bay 1 km from the site.	Low to Negligible	Given the extent of the plume and evidence for active biodegradation, it is unlikely that the contamination could migrate through sediments to these receiving waters. Moreover, the hydrocarbons present in the PSH, which forms the source of dissolved phase impacts, contain negligible BTEX which is the most toxic component of fuel. Naphthalene exceeds ecological criteria only in bores that have PSH. Therefore, it is unlikely this contaminant would migrate in groundwater to the receptors.

IDENTIFIED SOURCES	PLAUSIBLE PATHWAY	POTENTIAL RECEPTOR	QUALITATIVE RISK	COMMENTS / RATIONALE
Hydrocarbon impacts to the site and surrounds including: — Localised diesel impacts in soil onsite — PSH located above the water table (~2 mbgl) on the western boundary and extending offsite, to the far side of Taronga Place, to the west. — Dissolved phase hydrocarbons in association with the PSH impacts.				Surface water samples were collected from upstream, at the site boundary or downstream along the stormwater channel. The results indicated that no detectable hydrocarbons were present in the stormwater drain upstream, at the site boundary or downstream of the site. Therefore, it is unlikely that the contamination is leaking into the system putting the ecology of the creek or downstream receptors at risk.
		Vegetation onsite and offsite within and downgradient of the contaminant plume	Moderate	There is minimal vegetation present on the site, the majority of which is located up gradient or cross gradient of the hydrocarbon plume. Most of the vegetation on the adjacent properties (Pittwater Joinery and Reece Plumbing) are mature trees which have been present since 2003 and have most likely adapted to any contamination that is present in the soil or groundwater. The low DO conditions may result in stunted growth of trees within and downgradient of the plume.
	Accelerator migration of contaminants through preferential pathways.	Underlying groundwater and surface water receptors	Low to Negligible	The PSH plume has migrated west of the site across areas where municipal services exist in Taronga Place. Whilst the majority of these services are likely to be well above the impact, two potential deeper services have been identified including the stormwater easement to the north west of the plume and a sewer line that crosses Taronga Place and follows the northern boundary of No. 4 Taronga Place (Lot 7, DP701913), it was considered possible that the sewer line could intercept the groundwater level. Two shallow wells (MW36 and MW37) installed adjacent the stormwater drainage culvert were gauged on 7 February 2020 and determined to be dry. Therefore, the backfill sands adjacent to the stormwater drain do not appear to be a complete pathway for PSH migration at this time. Moreover, surface water testing of the stormwater has corroborated this finding with no detectable hydrocarbons measured in the February 2020 GME (WSP, 2020a)..
	Inhalation of vapours or ingestion of air borne contaminants during site operations or excavation / trenching	Site workers Occupants of adjacent properties General public accessing Taronga Place	Negligible	The sources of contamination are mainly diesel products which are inherently less volatile than petroleum-based products. The soil vapour assessments conducted by WSP in 2017 indicated that sub slab vapour concentrations were unlikely to pose a risk to site workers or occupants of the adjacent Reece Plumbing and Pittwater Joinery properties. In February 2020, a vapour assessment was completed using flux, indoor and ambient air testing methodologies on the two commercial properties adjacent to the site (9 Taronga Place [Lot 2 DP701913] and 10 Taronga Place [Lot 34 DP708050]) which overly the main PSH impact. Results indicated that that the diesel plume is not causing a vapour intrusion risk to the occupants of the two commercial buildings tested in this evaluation. Furthermore, there was no

IDENTIFIED SOURCES	PLAUSIBLE PATHWAY	POTENTIAL RECEPTOR	QUALITATIVE RISK	COMMENTS / RATIONALE
				evidence of any other compound that was presenting a significant vapour flux into either building. As the contamination is limited to shallow soils and groundwater that is predominantly covered by concrete slab, the risk of generating airborne contaminants such as dust are minimal unless the concrete slab is compromised and/or if unsealed landscaped areas are disturbed due to trenching or excavation works. The EMP (WSP, 2017c) provides measures to minimizing generation of dust during future works and these should be adopted in project specific work method statements.
Inorganic contaminants in groundwater (arsenic, lead, nickel and zinc) beneath the site and surrounds Inorganic contaminants in groundwater (arsenic, lead, nickel and zinc) beneath the site and surrounds	Ingestion or dermal contact with known contaminated water	Site and neighboring site workers and future occupants	Negligible	The contamination has been identified in groundwater which is present at approximately 2 mbgl. Therefore, direct contact with impacted soil or groundwater during typical onsite or offsite activities will not occur.
		Construction or maintenance workers	Low	Given the location of the contamination the only plausible linkage for direct contact is associated with excavation activities. Measures to minimize risk via dermal contact for hydrocarbons during excavation works are provided in the site EMP (WSP, 2017c), these should also be effective at mitigating risks associated with the inorganic contamination. Control measures should be developed in project specific Safe Work Method Statements. Of the contaminants identified the arsenic is of most concern.
	Migration of contaminants with groundwater resulting in potential exposure to more distant receptors	Down gradient residential occupants extracting groundwater from domestic bores Recreational users and ecological receptors of the storm water channel Cahill Creek and Winnererremy Bay.	Low to Moderate	The source of the arsenic plume, and its extent are unknown and it could potentially represent a regional issue. It is unlikely to relate to the Bus Depot operations. It is unlikely that local residents would use the groundwater for potable supply. It is possibly they use the groundwater for swimming pools or watering lawns. The results to date generally fall beneath recreational criteria (applying 10 × multiplier to convert drinking water guidelines to recreational criteria as per NHMRC, 2008 Guidelines for Managing Risks in Recreational water). If groundwater was to migrate to open waters the risk to recreational users would be similarly low. Risk to ecological receptors could be moderate given the concentrations in the groundwater are up to an order of magnitude above the criteria. It would, however, be expected that significant dilution would occur at the discharge point.
		Vegetation onsite and offsite within the contaminant plume	Moderate	There is minimal vegetation present on the site. Most of the vegetation on the adjacent properties (Pittwater Joinery and Reece Plumbing) are mature trees which have been present since 2003. The trees appear healthy and actively growing.

4.3 RISK CHARACTERISATION AND DATAGAP REVIEW

Contamination on the site and surrounds comprises:

- Hydrocarbons, and in particular a PSH plume on the western boundary in the vicinity of the refuelling bay and associated infrastructure, which extends to the far side of Taronga Place west of the site.
  - The PSH is consistent with diesel and as such is predominantly F2 and F3, with minor F1, and virtually no F4. BTEX is low to non-detect, though naphthalene is elevated within the PSH affected areas. The elevated concentrations of naphthalene are likely to be an artefact of droplets of PSH in the analysed samples taken from beneath the PSH. As such, the analysed concentrations should not be compared to HSLs as they do not represent true dissolved phase concentrations to which the HSLs apply.
  - A dissolved phase plume surrounds the PSH. Concentrations in the dissolved phase plume do not exceed available health or ecological criteria.
  - There is strong evidence for active biodegradation occurring with the plume and beneath the PSH. The rate of degradation is likely limited by availability of electron acceptors.
  - Primary sources are understood to have been removed or decommissioned.
- Inorganic dissolved heavy metals, and in particular arsenic as a widespread impact on the site and surrounds. The source is uncertain and unlikely to relate to the bus depot activities. There is an apparent spatial relationship between the locations with elevated arsenic and the presence of the hydrocarbon plume. It is possible the plume's influence on the groundwater redox may be mobilising more arsenic from the solid phase, primarily as the low redox results in dissolution of iron minerals, that in the sandy environment provide the bulk of exchange sites for arsenic sorption. This phenomenon is described by Nriagu *et al*, 2007 as follows:

  > *The mobility of As is mainly determined by the adsorption capacity on the mineral surfaces, which is controlled by geochemical parameters such as pH, Eh, ionic composition, and mineral type. However, redox processes in the aquifers trigger the mobility through dissolution of the Fe oxides that transfer substantial amounts of As into the aqueous phases*.

Identified risks relating to the contamination sources outlined above are generally acceptably low and manageable:

- The PSH is present at a depth that will not be intercepted during typical activities on the site and surrounds and there are no known nearby groundwater abstraction activities
- Direct contact could occur during construction works or maintenance, however these activities should be carried out in accordance with the EMP (WSP, 2017c) and in accordance with site specific SWMS. The presence of the hydrocarbons has been notified to Dial Before you Dig and is shown of various utility plans for the local area.
- Vapour risk is acceptably low in the context of the commercial/ industrial land use of the site and surrounds.
- The plume is unlikely to migrate through sediments to more distant sensitive receptors including residential dwellings, recreational users of Cahill Creek or Winnererremy Bay, and ecosystems of these surface waters.
- The risks related to the arsenic plume are uncertain as the extent of the plume is unknown. If the arsenic is present as a result of dissolution of iron minerals in the low redox groundwater associated with the dissolved hydrocarbon plume, it is likely that beyond the plume where redox conditions are more oxidised, the geochemistry of the water will be more favourable to iron precipitation providing additional arsenic absorption sites and controlling the extent of the arsenic plume. As the arsenic is likely to be unrelated to the site activities, and at most may be a secondary effect of the geochemistry within the hydrocarbon plume, it is not the subject of this RAP and will not be considered further, beyond the recommendation to continue monitoring it along with primary chemicals of concern and natural attenuation indicators.

Identified data gaps in the current VMP include:

- Potential for preferential migration through deep services on Taronga Place including the sewer line and the stormwater easement as discussed in Section 2.2.3. This data gap has since been partially addressed.
  - WSP installed two shallow wells (MW36 and MW37) into the bedding sands surrounding the stormwater culvert. Both wells were determined to be dry. Thus, providing a line of evidence that despite the proximity of the phase separated hydrocarbons (PSH) to the stormwater easement, bedding sands surrounding the stormwater culvert have not acted as a preferential pathway for PSH to migrate laterally.
  - Two locations were also proposed to be installed along an identified sewer line that runs along the northern boundary of 4 Taronga Place (Lot 7, DP701913). However, the two proposed locations adjacent to the sewer line were unable to be installed as access was not provided. There is uncertainty remaining as to the possibility that the sewer line identified west of the site could represent a preferential pathway. However, in WSPs opinion, the risk is relatively minor as the hydraulic conductivity of the bedding sands is likely to be similar to the aquifer sediments and therefore the rate of migration of contamination in the bedding sands in unlikely to be significantly greater than is observed elsewhere on the site.
- Potential for leakage of hydrocarbons into the stormwater channel that bisects the site, allowing it to discharge to the open stormwater drain west of the site. This data gap has been addressed and will continue to be monitored.
  - In February 2020, WSP collected three surface water samples; one from upstream, at the site's downgradient boundary, and downstream of the site along the stormwater channel. The results indicated that no detectable hydrocarbons were present in the stormwater drain upstream, at the site boundary or downstream of the site. This provides a line of evidence that despite the proximity of the PSH to the stormwater easement, it is unlikely that the contamination is leaking into the system putting the ecology of the creek or downstream receptors at risk. Surface water testing is now included in the bi-annual monitoring program.
- The PSH extent is not well defined to the south or south east (between MW08 and MW19, and onsite between MW01 and MW13, and within the workshop. This data gap has been partially addressed.
  - In December 2019, seven additional groundwater monitoring wells (MW28 – MW33 and MW35) and two shallow wells (MW36 and MW37) were installed along Taronga Place, and on the STA site to further characterise the extents of the PSH plume. Three proposed wells (MW34, MW38, MW39) could not be installed due to permission constraints by the landowner/body corporate of the neighbouring land. WSP are of the opinion that the well network now effectively defines the southern, eastern and northern extents of the PSH with a reasonable degree of confidence. There remains uncertainty as to the extent of PSH directly west of the site, between MW32 and MW16. To be able to define the plume extent to the west, permission from owners of land on the western side of Taronga Place would be needed
  - The extent of the dissolved phase plume remains generally uncertain as low levels of hydrocarbons are detected in most wells that do not have PSH present, with the exception on MW2 and MW3 to the east and north east (likely upgradient or cross gradient), MW12 to the north (downgradient) and MW17, a considerable distance to the northwest (likely downgradient or cross gradient). WSP is of the opinion that the additional well network has assisted in delineation of the PSH and dissolved phase plume, but that there remains some uncertainty in the extent of the PSH and dissolved phase plume, particularly west of the site. However, in our opinion, while a data gap remains, we do not consider the lack of information affects the remediation approach, nor do we consider that the plume is likely to represent a significant health or ecological risk despite the lack of full delineation.
- Various bores have become lost or abandoned. This includes MW04, MW06, MW11 and MW27 as shown on Figure 4 **Appendix A**.
  - Groundwater in the vicinity of MW04 and MW27 has historically been shown to be free of hydrocarbons and can continue to be assessed by other wells in proximity to these (MW03, MW23 and MW24).

- MW06 was on the plume periphery in an up gradient position. Nearby well MW01 is likely to continue to be reasonably representative of water from this portion of the site. At this time it is not considered necessary to replace MW06.
- MW11 was abandoned at the neighbours request, however it was an important monitoring point between the PSH plume and the stormwater channel to the north. MW 35 was installed in December 2019 to provide a monitoring point in close proximity to MW11.

5 REMEDIATION STRATEGY

5.1 REMEDIATION OBJECTIVES

The main objectives of the remediation program, as described in the VMP, are to:

- Assess the extent of soil and groundwater contamination;
- Assess the risks posed by the contamination; and
- Remove phase separated hydrocarbon (PSH) from groundwater to the extent practicable.

5.2 SOIL REMEDIATION OPTIONS

Based on the identified source of onsite hydrocarbon impact and the nature and extent of soil contamination within the refuelling area, WSP recommended that the diesel spill sump pit and surrounding impacted soils be remediated (RAP, 2013).

Since that time there has been limited soil remediation activities carried out on the site as discussed in Section 3.4.

In the absence of any other known primary sources on the site, and given the site is an active bus depot, further soil remediation works are not considered practicable, nor necessary, at present.

During any future development works on the site, any soil excavation activities should be seen as an opportunity to assess the soil for hydrocarbons and if identified, targeted removal should occur. Hydrocarbon impacted soil could be either disposed of to landfill or bioremediated onsite in accordance with NSW EPA, 2014 Best *Practice Note: Landfarming*. Any waste removed from the site will need to be classified in accordance with the NSW EPA, 2014 *Waste Classification Guidelines – Part 1: Classifying waste*.

During the installation of the proposed remediation system, it is expected that a limited amount of soil will be excavated to account for the system infrastructure. The excavated soils will be assessed for hydrocarbons, heavy metals and polyaromatic hydrocarbons and classified in accordance with the NSW EPA, 2014 *Waste Classification Guidelines – Part 1: Classifying waste* to facilitate disposal of excess material to an appropriately licensed facility.

5.3 GROUNDWATER REMEDIATION OPTIONS

Based on the known extent and nature of identified hydrocarbon impact at the site, and based on the findings of the quarterly offsite groundwater monitoring program (ENRS, 2018), direct remediation and/or management of offsite groundwater impact (in particular identified PSH) is required.

Various available technologies are described and discussed in the following sections. The list is not comprehensive but focuses on those that are most applicable to the site in the context of its ongoing use as a bus depot.

A summary of the key aspects of each reviewed technology is also summarised in Table 5.1.

5.3.1 DO NOTHING

No remedial action is taken using this approach. The option has some merit in that there are no identified actual risks to users of the site or surrounds and microbial activity is clearly occurring in the dissolved plume which will limit its spread. Monitoring data indicate that the plume has reached it maximum extent. The advantages of this option are that no remedial costs are incurred.

However, the PSH has clearly migrated a significant distance from the site and, whilst biodegradation is occurring on the dissolved phase, it is unlikely be able to remove the contamination, and improve the environmental conditions in the foreseeable future without intervention to remove the PSH.

Moreover while the PSH remains it represents a liability to STA and may affect neighbouring property development options or value. Some form of PSH removal would assist in reducing the longevity of the hydrocarbon impacts to the site and surrounds.

Therefore this is an unacceptable option for STA and is not consistent with the VMP.

5.3.2 RISK ASSESSMENT FOR ON AND OFFSITE HYDROCARBON IMPACT

A detailed risk assessment would involve contaminant fate and transport modelling, providing STA and the EPA an appreciation of the potential migration extent of the groundwater plume. The risk assessment would also quantify of human health and environmental risks posed by identified on- and off-site hydrocarbon impact, which will enable targeted remediation efforts in the future.

Some risk assessment work has been carried out to date (ENRS, 2016) and has assisted in understanding that health and ecological risks presented by the plume are generally low. However, the presence of the PSH is an ongoing liability to STA and physical remedial efforts are recommended to reduce this risk and shorten the timeframe for the plume to be degraded.

5.3.3 MONITORED NATURAL ATTENUATION (MNA)

Monitored natural attenuation is the monitoring of naturally occurring physical, chemical and biological processes to demonstrate via multiple lines of evidence that one or a combination of these processes reduce the mass, concentration or toxicity of identified hydrocarbon impact in offsite groundwater; to an acceptable level within an acceptable timeframe.

The advantages of MNA are that it has very low energy and natural resource requirements. In terms of data assessment and on-going monitoring, the cost of MNA can be significant, particularly as the timeframe is generally relatively long.

Given the volume of PSH the approach would require monitoring for the foreseeable future.

Based on a review of results for the quarterly groundwater monitoring program (ENRS, 2018) against the primary indicators for natural attenuation it was concluded that natural attenuation of offsite hydrocarbons is occurring, however the extent of PSH is too great for MNA alone to provide a successful remediation outcome within a suitable timeframe.

5.3.4 ENHANCED MNA

Natural attenuation at the site is known to be occurring but it's rate is likely limited by the availability of electron acceptors.

This technology would involve injection of chemicals with slow release oxidant to stimulate the microbial degradation. The effective breakdown will be in the dissolved phase, however, as PSH presence is a result of partitioning due to the solubility in the dissolve phase being exceeded, as dissolved contamination is removed more of the PSH will dissolve into the groundwater thus resulting (with time) in a reduction in the PSH on the site.

Given the volume of PSH present on the site, this technology alone is unlikely to meet meaningful timeframes for the remediation, but it could be a very effective adjunct to more active PSH removal methods and will become more effective as the PSH thickness declines.

5.3.5 MULTI-PHASE VACUUM EXTRACTION (MPVE)

This approach involves in-situ removal of PSH and treatment of contaminated groundwater using mechanical methods such as Multi Phase Vacuum Extraction (MPE). MPE allows for the recovery of free phase, dissolved phase and vapour phase hydrocarbon contaminants by an applied vacuum and down-well pumping system, which utilises the existing

monitoring well network at the site. Under appropriate sub-surface conditions, MPE can also provide hydraulic control of the contaminant plume, aiding in the prevention of further contaminant migration.

The advantages of this option are that it is an effective short term response for the removal of PSH, utilising the existing monitoring well network. The technique is flexible for different sub-surface conditions and potentially suitable for removal of PSH and dissolved phase groundwater from both on and off-site monitoring wells.

The disadvantages of this option are that it is expensive, energy intensive and requires significant human resources and attention to maximise remediation effectiveness. Based on the underlying geology (high permeability sands and shallow groundwater), this strategy is also likely to generate and require significant disposal of hydrocarbon impacted groundwater from the site, which is expensive.

Two stages of MPVE trial work have been completed on the site today as described in Section 3.7.2. There has been mixed success. AES were able to extract between 13 L and 25 L of product each round while EPS were able to extract between 70 and 200 L per round.

Given the likely volume of PSH (estimated in Section 4.1.2 at approximately 264,000L) this extraction, while physically effective, will be cost prohibitive.

5.3.6 PSH REMOVAL BY PASSIVE SKIMMER SYSTEM

Passive skimming relies on physical gravity flow of PSH, through a hydrophobic barrier, into a passive skimming sump. The sump needs to be manually emptied and maintained on a regular basis to optimise the PSH collection.

A limited passive skimming trial was conducted at the site as discussed in Section 3.7.1. The trial found that removal of 3 to 4 L of product from 100 mm wells was achievable when the skimmer installation was optimised. In total 18 L was recovered from three wells over three events during the 6 week trial.

Given the volume of PSH on the site and surrounds, and the high labour costs of this method, the technology is not considered feasible for this site at this time.

5.3.7 PSH REMOVAL BY ACTIVE SKIMMER SYSTEM

This approach involves removal of PSH from existing PSH impacted wells both onsite and offsite using an active skinner system. A skimming system has been in operation on the western boundary of the site in MW05, MW13 and MW14 since 2013 resulting in removal of approximately 2,000 L of product as described in Section 3.4. The technique allows for removal of PSH only (hydrophobic skimmers), and the product is pumped and stored on site prior to appropriate disposal.

It is understood that since April 2018 the system has been extended to include skimming from three offsite wells (MW09, MW19, MW21).

The advantage of this option is that it can utilise the existing monitoring well network at the site, and existing infrastructure. The system requires a level of maintenance of the skimmer screens to ensure ongoing optimisation of the PSH removal.

This remediation strategy has been implemented at the Site, but to date has removed less product than expected. It is intended that this system be decommissioned and replaced by a total fluids removal system as described in Section 5.3.8.

5.3.8 TOTAL FLUIDS REMOVAL BY ACTIVE PNEUMATIC PUMPS (PREFERRED OPTION)

This approach is similar to the skimmer option above but is more aggressive as it involves removal of PSH and some groundwater using a series of pneumatically operated total fluids pumps. To optimise the recovery, it is intended to install new large diameter wells, with wide screen slots and an appropriately sized gravel pack in four arrays, three across the plume and one longitudinally within the plume.

The proposed setup is presented in Figure 11 and includes a total of 25 new groundwater extraction locations. The existing wells located in the PSH affected area will be retained as observation wells. A total fluids pump is to be manually installed in each new groundwater extraction well to a depth that marginally penetrates the underlying groundwater so that it extracts both water and all overlying product. A pipework system (air and returns fluids) from each pump will be installed and run to the water treatment plant which is proposed to be located on the STA depot.

Extracted fluids will be transferred to a water treatment plant on the STA depot where a process of separation and removal of PSH and treatment of dissolved hydrocarbon loads in the water, to allow the treated water to be discharged to trade waste (pending approval from Sydney Water) or disposed off-site to a licensed waste facility. The skimmed PSH product will be either disposed of as liquid waste or will be recycled.

The advantage of this option is that by removal of total fluids a slight hydraulic gradient will be maintained towards the extraction wells promoting PSH flow towards the wells and also reducing the further spread of the PSH in the wider environment. The system is also understood to be less prone to fouling and blockages than the previously used skimming system. Moreover, the expanded extraction network will provide a much larger coverage of the plume resulting in a larger volume of potential product removal.

Table 5.1 Evaluation of Remediation Options for Impacted Groundwater

REMEDIAL OPTION	BENEFITS	LIMITATIONS	ACCEPTABILITY	TIMELINESS	COST	ON-GOING LIABILITY
Do nothing	Nil cost	Liability for the PSH will remain for the foreseeable future.	Does not meet EPA requirements and does not meet the remedial objectives for the property	Decades	Nil cost outlay	Yes for foreseeable future
Risk assessment	Quantifies the human health and ecological risk associated with offsite hydrocarbon contamination. Provides a better understanding of the potential migration of the groundwater plume away from the site and the influence of tidal culverts on groundwater movements in the area. .	Does not address the actual presence of PSH or associated liability.	Required to be completed in conjunction with active remediation of identified offsite PSH	< 3 month	Low	NA
Natural attenuation	Low cost Minimal disturbance to future development	Slow process PSH not removed in the short term. On-going groundwater monitoring program required.	Natural attenuation of hydrocarbons is occurring; however, the extent of PSH is too great for MNA alone to provide a successful remediation outcome within a suitable timeframe. May be an appropriate strategy in conjunction with more active methods.	Decades	Low - Medium	Yes for foreseeable future
Enhanced MNA.	Minimal disturbance to the site or surrounds. Low labour input Stimulates and seeks to optimise natural breakdown processes.	Effective on the dissolved phase so will take time for the PSH to dissolve and then be treated. On-going groundwater monitoring program required.	Would assist in increasing the rate of natural attenuation. Infrastructure already in place. May be best used in conjunction with PSH removal technologies and certainly once the practical limit of PSH skimming has been reached.	Years to Decades	Medium	Yes – declining as the plume reduces in area and thickness.

REMEDIAL OPTION	BENEFITS	LIMITATIONS	ACCEPTABILITY	TIMELINESS	COST	ON-GOING LIABILITY
Multi-Phase Vacuum Extraction	Removes contamination Can be used to treat both on- and off-site PSH impact.	High Cost. Requires on-going remediation program involving the physical presence of mechanical MPVE operators. Will have diminishing effectiveness as the PSH thickness declines. On-going groundwater monitoring program required.	Meets EPA requirements for groundwater remediation. Ideal for the sandy geology beneath the site. While proven to be physically effective the number of events required to have a meaningful reduction in the PSH renders the technology cost prohibitive.	Years	Very High	Yes – declining as the plume reduces in area and thickness.
Passive skimmers.	Removes contamination. Prevents further migration of contaminants off-site.	High labour cost. Slow, limited by the number of accessible wells with skimmers installed. On-going groundwater monitoring program required.	Acceptable approach for shallow groundwater contamination. Acceptable approach for groundwater in medium – high permeability soils. Given the volume of PSH the technology will not meet the project objectives in a timely manner.	Decades	High	Yes – declining as the plume reduces in area and thickness.
Active skimmers.	Removes contamination. Reduces further migration of contaminants off-site.	On-going remediation program requiring access during and post development. On-going groundwater monitoring program required.	Acceptable approach for shallow groundwater contamination. Acceptable approach for groundwater in medium – high permeability soils. Infrastructure already in place. Limited success to date and current network is relatively minor.	Decades	High	Yes – declining as the plume reduces in area and thickness.

REMEDIAL OPTION	BENEFITS	LIMITATIONS	ACCEPTABILITY	TIMELINESS	COST	ON-GOING LIABILITY
Active total fluids removal	Removes contamination. Reduces further migration of contaminants off-site.	On-going remediation program requiring access during and post development. On-going groundwater monitoring program required.	Acceptable approach for shallow groundwater contamination. Acceptable approach for groundwater in medium – high permeability soils. Infrastructure already in place, however it is intended to install new arrays of purpose build wells. More aggressive than skimming alone and should result in improvements over a shorter timeframe. Preferred option.	Years	High	Yes – declining as the plume reduces in area and thickness.

5.4 REVISED REMEDIATION STRATEGY

Since the 2015 revision of the RAP (WSP, 2015) several recommended actions have been carried out including:

- Limited risk assessment to identify whether the plume represents a human health or ecological risks on- and off-site.
- Installation of additional offsite wells to further characterise the extent of the PSH and dissolved phase plume;
- Continued operation of the onsite free phase recovery system;
- Implementation of pilot trials for the targeted *in-situ* remediation of PSH using mechanical methods such as multi-phase extraction and passive skimming.

Following the review of the investigations, site characterisation and updated conceptual site model Sections 3 and 4 WSP is of the opinion that the primary focus of the remediation works should be installation and operation of a total fluids recovery system to optimise PSH recovery, with limited monitoring to support ongoing understanding of the plume extent and thickness. In order to maximise the recovery of PSH, we recommend:

  - STA to conduct stakeholder engagement with the neighbouring community (Taronga Place) advising them of the proposed installation of the systems;
  - All necessary approvals to be sought and obtained (see section 7);
  - Installation of a total fluids recovery system as detailed in Section 5.3.8;
  - Monthly records of PSH removal should be collected by the technician and be provided to WSP for inclusion in routine groundwater monitoring reports. The monthly reporting by the contractor should include at a minimum:
    - Date of inspection, volume of recovered PSH, volume of treated water discharged under the trade waste agreement, results of any treatment testing, confirmation that all pumps and lines are operational, and summary of any maintenance works carried out.
- Records of any waste oil disposal including date of removal, volume removed and waste tracking documentation including details of the liquid waste removal contractor and the waste disposal location should be provided to WSP.
- Quarterly gauging of the monitoring wells should be conducted with results collated for inclusion in the six-monthly reports; and
- Ongoing six-monthly groundwater monitoring events to gauge and undertake chemical testing of the dissolved phase for 2 years (2020-2021).

WSP notes that the current system should be decommissioned post-successful installation and operations of the Total Fluids recovery system. Wells associated with the existing system will be retained for PSH monitoring purposes.

A number of data gaps remain as summarised in Section 4.3 and were addressed as part of additional assessment works which occurred in December 2019. Figure 8, **Appendix A** provides a summary of recommended additional testing points. Principally we recommend:

- Inclusion of surface water samples as part of the monitoring program including one location at the discharge point of the culverts, to the west of the site (downgradient). One location from an accessible point up gradient of the site, and one location from within the culverts assuming an access point can be provided on the site. These points will be added to the scope to assess if hydrocarbon loads in the stormwater are due to the site or other background sources. Recommended surface water testing locations are shown on Figure 9 **Appendix A**.
- Installation of shallow wells into the backfill sands of the sewer line along Taronga Place and the stormwater infrastructure to the north of the plume (recommended locations MW36 to MW39 are shown on Figure 8, **Appendix A**). Monitoring wells, MW36 and MW37, were installed into the bedding sand surrounding the stormwater culvert in

December 2019. Monitoring wells, MW38 and MW39, which were to assess the soil adjacent to the sewer line, were unable to be installed as access to the privately owned land was not provided.

- Installation of additional monitoring wells between MW08 and MW19, and MW15 and MW10 on Taronga Place, and onsite to the south of MW13 and to the east of MW14, within the workshop, to better define the extent of PSH and the up gradient extent of the plume. Monitoring wells MW28 to MW32 were installed in December 2019 and are shown on Figure 8, **Appendix A**.
- MW25 has recently become impacted by PSH. This indicates the lateral spread of the PSH to the west continues to grow and therefore additional monitoring wells should be installed to the north west, however this will require permission from the owners of that land. Recommended locations are shown as MW33 and MW34 on Figure 8 **Appendix A**. These wells could not be installed during the December 2019 assessment works due to permission constraints by the owners of the neighbouring land.
- MW11 and MW12 are important locations for verifying that the risk of migration to the stormwater system is low. They should be reintroduced to the monitoring program. It is understood that MW11 has been abandoned. A replacement well (MW35 on Figure 8, **Appendix A**) has been installed in December 2019.

5.5 CONTINGENCY

Based on the findings of the quarterly groundwater monitoring program there is limited potential for the natural attenuation to reduce the extent of PSH in the foreseeable future and thus MNA alone is unlikely to be a sufficient remediation strategy.

However, MNA is an appropriate strategy for further polishing of the water quality once more active PSH removal has occurred. It is likely that the rate of natural attenuation is being constrained in the plume by reducing redox conditions and so STA may investigate the use of Oxygen Releasing Compounds to promote and accelerate the natural attenuation process.

STA have committed to implementing a much more aggressive method of PSH removal, and at the time of this report are in contract negotiations with the preferred contractor. Therefore, a more effective PSH removal method will soon be implemented and this should reduce the head of PSH that is the primary driver for PSH migration. Thus, it is expected that the potential for PSH plume expansion will be reduced once the system has been installed.

If the system as designed fails to extract sufficient quantities of contaminated groundwater and LNAPL product over a two year period to reduce LNAPL mass to an extent as reasonably practicable, then a contingency plan would be implemented.

The contingency plan should include a re-evaluation of the available remediation technologies by a nominated panel of stakeholders (i.e. STA, WSP, remediation contractor, auditor and EPA) to assess if a more suitable method of remediation may be available to achieve the remedial objectives. The re-evaluation should also take into account additional factors including but not limited to practical constraints due to infrastructure present both on- and off-site and the potential impacts to neighbouring properties.

6 GROUNDWATER MONITORING PLAN

6.1 DATA QUALITY OBJECTIVES (DQOS)

The data quality objectives (DQO) process is a systematic planning tool based on the scientific method for establishing criteria for data quality and for developing data collection designs. The data quality objectives define the experimental process required to test a hypothesis. The DQO process was developed to ensure that efforts relating to data collection are cost effective, by eliminating unnecessary, duplicative or overly precise data whilst at the same time, ensuring the data collected is of sufficient quality and quantity to support defensible decision making.

It is recognised that the most efficient way to accomplish these goals is to establish criteria for defensible decision making before the data collection begins, and then develop a data collection design based on these criteria. By using the DQO process to plan the investigation, the relevant parties can improve the effectiveness, efficiency and defensibility of a decision in a resource and cost effective manner.

The DQO process consists of seven steps, which are designed to clarify the study objectives, define the appropriate type of data and specify tolerable levels of potential decision errors. The seven-step DQO process that will be adopted for the soil remedial works will be as follows:

- Step 1 – Defining the Problem. The first step in the DQO process is to 'define the problem' that has initiated remedial works;
- Step 2 – Identify the Decision. The second step in the process is to define the decision statement that the works will attempt to resolve;
- Step 3 – Identify Inputs to the Decision. In this step, the different types of information needed to resolve the decision statement are identified.
- Step 4 – Define the Study Boundaries;
- Step 5 – Develop a Decision Rule;
- Step 6 – Specify Limits on Decision Errors; and
- Step 7 – Optimise the Design for Obtaining the Data.

6.1.1 STEP 1 – DEFINING THE PROBLEM

The problem under consideration is that the site and surrounds contain PSH and TRH in groundwater. Though the concentrations in the dissolved plume surrounding the PSH do not exceed available health or ecological criteria, the extent of the plume, and the thickness and extent of the PSH should continue to be monitored to assess the efficacy of the active skimming and whether conditions on the site and surrounds are improving with time.

6.1.2 STEP 2 – IDENTIFY THE DECISION

The principle decision is 'is the condition of the site and surrounds improving with time and with implementation of the active skimming system'?

6.1.3 STEP 3 – IDENTIFICATION OF INPUTS INTO THE DECISION

The inputs to the decision are as follows:

- Ongoing assessment of PSH thickness and areal extent;
- Additional onsite and offsite test locations will further refine the understanding of the plume extent, the conceptual site model, and provide for monitoring data into the future;

- Records of the volumes of PSH extracted using the active skimming system;
- Ongoing information on the dissolved phase chemistry including primary contaminant concentrations, and natural attenuation parameters.

6.1.4 STEP 4 – DEFINING THE STUDY BOUNDARIES

The extent of the revised RAP includes both identified on and off-site impact. Previous soil and groundwater investigations delineated the extent of soil impact between 60 – 80 m north from the refuelling facility and approximately 50 m south-west, south, south-east and east from the refuelling area.

The investigations confirmed that soil impact is vertically confined to the soil profile immediately surrounding the groundwater table (1m – 2m bgl) and that soil impact is predominantly associated with a groundwater plume rather than widespread surface contamination across the Site.

Based on the outcomes of quarterly groundwater monitoring program undertaken by ENRS, the extent of offsite groundwater impact is reasonably well defined though some data gaps remain. As such, the installation of additional monitoring wells is recommended to further delineate the extent of offsite contamination (as discussed in Section 5.4).

Therefore, the study boundaries are the site boundaries and the surrounds to the west of the site.

6.1.5 STEP 5 – DEVELOPING DECISION RULES

Based on the available site assessment information, elements of the decision rule should be related to the remediation objectives and include:

- Has the program adequately delineated the extent of soil and groundwater contamination?
- Has the program adequately assessed the risk posed by the contamination? and
- Has the program removed PSH from the groundwater to the extent practicable?

Further practical decisions to be made during the works are as follows:

- Can the remedial works be conducted such that further contamination issues in the form of on or off-site impacts do not occur during remediation?
- Can the remediation be carried out in a safe and financially viable manner?
- Will the remedial works adequately reduce the overall risk of the site?
- Will the site remain suitable for the proposed use during the works and into the future?

Given that the PSH plume has not yet stabilised it is recommended that 6-monthly groundwater monitoring continues. This also aligns with the current VMP requirements. Sampling and analysis is required for BTEXN, TRH and key natural attenuation parameters.

The most relevant information on the spread of the plume is the extent and thickness of the PSH. As such quarterly gauging of wells within the PSH impacted areas, and those immediately surrounding these wells is recommended, in accordance with the VMP. The 6-monthly events, which include analytical testing, should also require gauging of all available wells on and offsite so that groundwater contour plots can be updated.

Where PSH is encountered, the thickness will be confirmed with a disposable bailer. No further sampling is required where PSH is identified.

For groundwater, there are no EPA endorsed criteria for TRH. The PSH is required to be removed to the extent practicable. It would be expected that prior to this being achieved the PSH would at least need to be demonstrated to be stable or declining both in extent and thickness.

The monitoring program should be reviewed annually and once the PSH is demonstrated to have stabilised or be found to be decreasing, then the frequently of monitoring could potentially be reduced in consultation with the Auditor and the NSW EPA.

6.1.6 STEP 6 – SPECIFY LIMITS ON DECISION ERRORS

Quality Assurance and Quality Control (QA/QC) protocols in accordance with NEPM 2013 (amended) guidelines will be applied to the groundwater monitoring works.

The acceptable limits for data QA will be the following:

- Accuracy is measured by percent recovery '%R'. Accuracy data is expected to vary within the range of 70-130 %R;
- Precision is measured using the standard deviation 'SD' or Relative Percent Difference '%RPD'. Replicate data is expected to be as follows:
  - RPD criteria of 30% or less, for concentrations > or = 10 times EQL;
  - RPD criteria of 75% or less, for concentrations between 5 and 10 times the EQL; and
  - RPD criteria of 100% or less, for concentrations < 5 times EQL.

6.1.7 STEP 7 – OPTIMISE DESIGN

The purpose of this step is to identify a resource-effective data collection design for generating data to meet the project objectives. This will be achieved by the proposed Sampling and Analysis program for groundwater monitoring; including the number of sample locations, media to be sampled, number of samples retained for analysis, analytical suite and method of sample collection.

6.2 GROUNDWATER MONITORING

6.2.1 GROUNDWATER SAMPLING NETWORK AND PROGRAM

Groundwater monitoring of the existing on and offsite monitoring well network should be undertaken on a 6-monthly basis for a period of 2 years and then reviewed. The program will include gauging and sampling of a variety of wells as summarised below:

Table 6.1 Summary of proposed monitoring program

MONITORING EVENT	WELLS INCLUDED	FIELD PARAMETERS	ANALYTICAL SCHEDULE
Quarterly Events			
PSH impacted locations and immediate surrounding bores.	MW01, MW05, MW07, MW09, MW10, MW12, MW13, MW14, MW16, MW18, MW19, MW20, MW21, MW22, MW25, MW26, MW28, MW29, MW30, MW31, MW32, MW33, MW35, MW36 and MW37	Gauge only. Where PSH present confirm with bailer. Note access to MW05, MW09, MW13 and MW14 may be restricted due to skimmer infrastructure.	Nil
6 Monthly Events			
PSH affected wells	MW05, MW06, MW09, MW10, MW12, MW13, MW14, MW18, MW19, MW20, MW21, MW25. (See Figure 8)	Gauge only. Where PSH present confirm with bailer. Note access to MW05, MW09, MW13 and MW14, may be restricted due to skimmer infrastructure.	Nil

MONITORING EVENT	WELLS INCLUDED	FIELD PARAMETERS	ANALYTICAL SCHEDULE
Dissolved phase wells	MW01, MW02, MW07, MW08, MW12, MW15, MW16, MW22, MW26, MW28, MW29, MW30, MW31, MW32, MW33, and MW35. (See Figure 8)	Standing Water Level, pH, Redox, Temperature, Electrical Conductivity, note odour colour and flow characteristics	TRH, BEXN, Ionic Balance (Ca, Mg, Na, K, NH_4, Cl, SO4, HCO_3, F, PO_4, NO_3, NO_2) dissolved Fe, Mn, As, Methane
Backfill Sands wells	MW36, MW37 (See Figure 8)	Standing Water Level, pH, Redox, Temperature, Electrical Conductivity, note odour colour and flow characteristics	TRH, BEXN
Surface water samples	SW1, SW2, SW3 (See Figure 9)	pH, Redox, Temperature, Electrical Conductivity, note odour colour and flow characteristics	TRH, BEXN

Note: if any wells scheduled for analysis show PSH then these should be placed into the "PSH affected wells" program.

6.3 SAMPLING AND ANALYSIS

6.3.1 GROUNDWATER SAMPLING

Prior to sampling, all wells will be gauged with an interface water level meter, where PSH is identified, the thickness will be confirmed with a bailer and no further sampling will be undertaken. Where no PSH is identified, monitoring wells will be purged. Wells will be purged until groundwater parameters stabilise to within individually specified limits of previous readings.

Water quality parameters including pH, redox potential (Eh), electrical conductivity, dissolved oxygen and temperature will be recorded. Purging equipment will be thoroughly decontaminated between purge events with a phosphate free detergent (Decon 90) and rinsed with potable water and de-ionised water.

Samples from monitoring wells will be collected using a low flow pump or HydraSleeve ™, with samples placed directly into water sampling containers.

6.3.2 SURFACE WATER SAMPLING

Surface water samples are to be collected from three locations along the stormwater channel; one from upstream (S01), at the site's downgradient boundary (S02), and downstream of the site (S03). Samples from S01 and S03 are collected as a grab sample from the flowing water in the drainage line directly into the laboratory provided sample bottles, with the exception of the samples for metals which are field filtered prior to placing into the nitric acid preserved bottle. Sample S02 to be collected by bailer through an access port in the top of the stormwater culvert.

Field parameters (pH, dissolved oxygen, reduction/oxidation (redox), electrical conductivity and temperature) were monitored using a water quality meter placed directly into the drainage line (S01 and S03) or culvert (S02).

6.3.3 SAMPLE STORAGE AND HANDLING

Groundwater samples will be immediately placed in a chilled cooler to assist with sample preservation. A chain of custody (COC) form will be filled out with the sample ID and required analyses, and dispatched to the laboratory for analysis

6.3.4 LABORATORY ANALYSIS AND METHODS

Sample analysis will be conducted by Envirolab Services (NATA No. 2901). Secondary quality assurance analysis (inter-laboratory duplicate analysis) will be conducted by ALS Group Services Pty Ltd (NATA No. 825). All analysis will be undertaken will be conducted accordance with NATA approved methods.

6.3.5 GROUNDWATER REMEDIATION CRITERIA

WSP has applied guidance from Schedule B1 of NEPM 2013 in selection of site criteria for health (via vapour intrusion and drinking water pathways) and ecological receptors. Guideline values are listed in Table 6.2. The NEPM ecological criteria are based on ANZECC 2000 criteria that have been updated in the ANZG, 2018 guidance.

It is noted that HSLs are only relevant to dissolved phase hydrocarbons. Where PSH is present HSLs should not be used. It must be assumed that HSLs for some contaminants, if present, may be exceeded. The only component of diesel likely to represent risk a vapour risk is the F2 fraction. Sub-slab vapour monitoring is helpful in assessing the actual risks presented by PSH.

Application of NEPM ecological criteria as "groundwater" investigation criteria is a conservative approach as the guidelines were derived for receiving waters. The closest downgradient ecological receptor is an open storm water channel located approximately 300 m north-west of the site (down hydraulic gradient). The channel flows into Cahill Creek and then Winnererremy Bay (part of Pittwater) approximately 1 km northwest of the site. As Cahill Creek and Winnererremy Bay are tidal, criteria for marine ecosystems have been adopted.

Table 6.2 Summary of proposed criteria (µg/L)

CONTAMINANT	NEPM, 2013 HSLS FOR VAPOUR INTRUSION COMERCIAL / INDUSTRIAL	NEPM, 2013 HILS FOR DRINKING WATER	NHMRC, 2008 RECREATIONAL CRITERIA (10 × HILS)	NEPM, 2013 GILS FOR MARINE WATER	ANZG, 2018 95% TRIGGER VALUES FOR MARINE WATER
TRH					
F1 (C_6-C_{10} less BTEX)	6,000	-	-	-	-
F2 (C_{10}-C_{16} less naphthalene)	Non Limiting	-	-	-	-
F3 (>C_{16}-C_{34})	-	-	-	-	-
F4 (>C_{34}-C_{40})	-	-	-	-	-
BTEX					
Benzene	5,000	1	10	500	700
Ethylbenzene	Non Limiting	300	3,000	-	5
Toluene	Non Limiting	800	8,000	-	180
Xylene (o-xylene)	-	-	-	-	350
Xylene (m-xylene)	-	-	-	-	75
Xylene (p-xylene)	-	-	-	-	200
Total Xylene	Non Limiting	600	6,000	-	-
PAHs					
Naphthalene	Non Limiting	-	-	16	16

CONTAMINANT	NEPM, 2013 HSLS FOR VAPOUR INTRUSION COMERCIAL / INDUSTRIAL	NEPM, 2013 HILS FOR DRINKING WATER	NHMRC, 2008 RECREATIONAL CRITERIA (10 × HILS)	NEPM, 2013 GILS FOR MARINE WATER	ANZG, 2018 95% TRIGGER VALUES FOR MARINE WATER
Heavy Metals					
Arsenic	-	10	100	-	-
Cadmium	-	2	20	0.7	5.5
Chromium	-	50	500	4.4	4.4
Copper	-	2,000	20,000	1.3	1.3
Lead	-	10	100	4.4	4.4
Mercury	-	1	10	0.1	0.4
Nickel	-	20	200	7	70
Zinc	-	-	-	15	15

Notes:

1. HSLs based on Sand texture and groundwater present between 2 and 4 m bgl.

Evaluation of the effectiveness of the remediation system, and whether PSH has been removed to the extent practicable is subjective. Metrics that will be considered for this evaluation include:

- That the thickness of PSH in both extraction wells and observation wells has reduced from current levels.
- The extent of wells affected by PSH is reducing (ideally – recognising this may not be achievable due to residual PSH in the profiles around affected bores).
- That the recovery of PSH by the system has declined to a point where, in mass removal terms, it is no longer considered to be providing meaningful/practical volumes (cost/benefit).
- That the dissolved phase is ideally declining (recognising that this also may not be achievable due to residual PSH in the profile providing an ongoing source for dissolved phase).

6.4 QUALITY ASSURANCE / QUALITY CONTROL

The pre-determined Data Quality Indicators (DQIs) established for the project in relation to precision, accuracy, representativeness, comparability and completeness are presented in Table 6.3.

Table 6.3 Proposed QA/QC

DATA QUALITY OBJECTIVE	FREQUENCY CONDUCTED	DATA QUALITY INDICATOR
Precision and Accuracy		
Blind duplicates (Concentrations > or = 10 times EQL)	1/20 samples	< 30% RPD[1]
Blind duplicates (Concentrations between 5 and 10 times EQL)	1/20 samples	< 75% RPD
Blind duplicates (Concentrations < 5 times EQL)	1/20 samples	< 100% RPD
Rinsate samples	If non-dedicated equipment used	≤ rinse water blank

DATA QUALITY OBJECTIVE	FREQUENCY CONDUCTED	DATA QUALITY INDICATOR
Trip Blank	1 per GME	<LOR
Trip Spike	1 per GME	70% -110%
Representativeness		
Sampling appropriate for media and analytes	All Samples	-
Samples extracted and analysed within holding times	All Samples	Hold Time: 6 months
Comparability		
Standard operating procedures adopted	All Samples	-
NATA accredited analytical methods used for all analyses	All Samples	-
Consistent field conditions, sampling staff and laboratory analysis	All Samples	-
Limits of reporting appropriate and consistent	All Samples	-
Completeness		
Soil description and COCs completed and appropriate	All Samples	-
Appropriate documentation	All Samples	-
Satisfactory frequency and result for QC samples	All Samples	-

Notes: [1] If the RPD between duplicates is greater than the pre-determined data quality indicator, a judgment will be made as to whether the excess is critical in relation to the validation of the data set or unacceptable sampling error is occurring in the field.

6.5 REPORTING

At the completion of each bi-annual groundwater monitoring event, results will be documented in a Groundwater Monitoring Event (GME) report. GME reports will include analytical results for on and offsite groundwater monitoring wells reported in accordance NSW EPA, 2011 *Guidelines for Consultants Reporting of Contaminated Sites*. At the completion of the 2 year monitoring program, an assessment of all results will be conducted to determine the effectiveness of the remedial strategy and make recommendations for on-going monitoring and/or future remediation.

In addition, reporting of the effectiveness of the total fluids removal system will be required, including presentation of the volume of PSH recovered and treated water disposed, and trends in PSH extent and thickness over time.

7 REGULATORY APPROVALS / LICENSING

The remedial program will be undertaken with due regard to legislative requirements and any relevant environment planning instruments that apply to the site.

7.1 VOLUNTARY MANAGEMENT PROPOSAL

The site and surrounds were declared as "significantly contaminated land" (Declaration Number 20141101) by the Environment Protection Authority (EPA), and is the subject of an EPA-approved voluntary management proposal (Notice No. 20141707, and as amended through Notice Number 20164409 and 20174407). It is noted that the VMP is currently under review.

The current VMP states the following objectives, and these are expected to be reinforced in the new VMP:

- Assess the extent of soil and groundwater contamination;
- Assess the risks posed by the contamination; and
- Remove PSH from groundwater to the extent practicable.

The VMP and its amendments set out STAs commitments with respect to conducting targeted remediation, continuing to remove PSH, implementation of monitoring, conducting assessments to better define the extent of impact and associated risks and development and maintenance of an EMP.

The VMP amendment (20174407) also requires engagement of a NSW EPA accredited site auditor to review the works and, upon completion of the remediation, provide a site audit statement and site audit report as to the suitability of on and offsite lands for continued commercial/industrial land use and the enforceability of the EMPs.

The strategy of this RAP focuses on the requirements for optimising the ongoing PSH removal, and the ongoing monitoring of the plume.

7.2 APPROVALS REQURIED TO FACILITATE REMEDIATION

The following aspects will need to be discussed with the remediation contractor, and in cases where triggers for approvals are met, approvals will need to be sought prior to works commencing.

7.2.1 PLANNING APPROVALS

SEPP 55 provides the planning framework for the remediation of contaminated land within NSW.

A review of Clause 9 of SEPP 55 indicates that the proposed remediation works fall under Category 2 of SEPP 55. However, this is subject to review of Council Policy in relation to contaminated sites.

In accordance with the requirements of SEPP55 for Category 2 Remediation Works:

- Council will be notified in writing not less than 30 days prior to commencement of any site remediation works.
- Council will be notified of works completion within one month of completion of work.

The Environmental Planning and Assessment Act 1979 (the EP&A Act) provides for the environmental impact assessment of development in NSW. Part 5, Division 5.1 of the EP&A Act generally specifies the environmental impact assessment requirements for activities undertaken by public authorities, such as STA, which do not require development

consent under the EP&A Act. Even if Council do not require planning consent, it is likely that the works will still require STA to prepare a review of environmental factors (REF) under Part 5, Division 5.1 of the EP&A Act.

7.2.2 COUNCIL ROAD OPENING AND TRAFFIC MANAGEMENT APPROVALS

Prior to installation of the extraction wells and pipework Council (Northern Beaches Council) approvals must be obtained for construction works in roadways and nature reserves. This will include road opening permits and road closure requirements during the works;

7.2.3 WATER ACCESS LICENCE (WATER MANAGENT ACT 2000)

As STA is a government entity, the regulator for groundwater access licencing is the Natural Resources Access Regulator (NRAR). It is possible that the volumes of water to be extracted, and the location of the works, may mean the activity can be exempt, though an application would still be required.

A water access licence application will need to be made and the licence or exemption documentation provided prior to water being extracted for treatment.

7.2.4 TRADE WASTE AGREEMENT

A trade waste agreement must be obtained with Sydney Water which will allow the discharge of the treated water to sewer. The remediation contractor is expected to negotiate this approval in consultation with STA.

7.2.5 WASTE MANAGEMENT OF RECOVERED OIL

Groundwater to be removed from site will require classification in accordance with NSW EPA (2014) *Waste Classification Guidelines* prior to disposal.

Part 6 of the Regulations specify that if waste is transported from a premises the waste generator must ensure that the waste is transported:

- To a waste facility that is licensed under the Act; or
- To a person carrying on mobile waste processing that is licensed under the Act; or
- To a place that can otherwise lawfully be used as a waste facility for that waste.

All waste transported from the Site that is required by the POEO (Waste) Regulation, 2005 to be tracked, must be tracked using EPA's on-line tracking system or an alternative tracking system approved in writing by the EPA.

Diesel / oily water, which is recovered through the groundwater remediation system is required to be appropriately disposed of offsite at a licensed waste receiving facility. The waste is pre-classified as waste oil/water, hydrocarbons/water mixtures or emulsions waste (waste code J120) and will be required to be tracked in accordance with the Protection of the Environment Operations (Waste) Regulation 2005.

7.2.6 ENVIRONMENT PROTECTION LICENCE UNDER THE POEO ACT 1997

It is considered unlikely that the trade waste agreement negotiated with Sydney Water will allow for more than 100 ML per year to be discharged. Treatment of 100 ML per annum is the trigger for contaminated groundwater treatment becoming a scheduled activity under the Act. Therefore, it is unlikely that an EPL will be needed for this work.

However, the wording of the Act states that a system with the *capacity* to treat 100 ML per year must be licenced. Therefore, this should be considered in consultation with the remediation contractor and either the system be designed so that its capacity is less than this trigger, or an EPL be negotiated with the NSW EPA.

8 ENVIRONMENTAL MANAGEMENT PLAN

Any future excavation of soil (e.g. during maintenance or development works) will be undertaken with due regard to legislative requirements and any relevant environment planning instruments that apply to the site, including the following:

- Protection of the Environment Operations Act (1997);
- Contaminated Land Management Act (1997); and
- NSW State Environmental Planning Policy 55.

Works will also be subject to the recommendations of the site Environmental Management Plan (WSP, 2017c)

8.1 HOURS OF OPERATION

Remediation works shall only be permitted during the following hours:

- Monday to Friday: 7:00 am to 5:00 pm
- Saturday: Within Council permitted times
- Sunday and Public Holidays: No work permitted.

Emergency work is permitted to be completed outside of these hours.

8.2 SITE ACCESS

The site is currently operated by the STA as Bus Depot. The site currently operates with restricted access. All site access will be subject to STA approval and relevant site specific inductions. The timing of works will be conducted in consultation with STA site managers to minimise impact on site operations. The work area for drilling and excavations must be barricaded and appropriately signed to manage potential occupational health and safety hazards.

Access and permission from adjoining landholders for offsite works will be facilitated by STA.

8.3 UNDERGROUND SERVICES

The remediation contractor shall be responsible for the location and protection of underground services which have the potential to be impacted by the remedial works.

8.4 NOISE

The remediation works shall comply with AS2436-1981 Guide to Noise Control on Construction, Maintenance Demolition Sites and the NSW EPA (2009) *Interim Construction Noise Guideline* for the control of noise from construction sites.

Mechanical equipment used on site will be in good working order and will be fitted with appropriate silencers when necessary.

8.5 SOIL WASTE CLASSIFICAITON AND DISPOSAL

Soil arisings generated during future groundwater well installation works will be collected in sealable drums. Waste classification will be based on the chemical results from the soil tests collected during the drilling works, or if no soil tests are made, then a composite sample for every three drums will be collected from the drum contents for analysis of the chemicals of concern. A waste classification report should be prepared with reference to the NSW EPA, 2014 *Waste Classification Guidelines – Part 1: Classifying waste* and the soil disposed of by an appropriately licenced contractor to a facility lawfully able to receive the class of waste.

8.6 GROUNDWATER DISCHARGES

Contaminated groundwater removed as part of the groundwater monitoring program will be stored onsite prior to disposal at a facility licensed to receive the liquid waste. Alternatively, the small quantities of contaminated groundwater extracted during monitoring events could be disposed of to the workshops waste oil system. This would be disposed of by liquid waste disposal contractor.

Contaminated groundwater removed as part of the ongoing skimming program will be disposed of by liquid waste contractors to a facility licensed to receive the liquid waste. This will be in accordance with all applicable legislative requirements and will be the responsibility of the remediation contractor

9 WORK HEALTH AND SAFETY

A Site Specific Occupational Health & Safety Plan will be developed by the remediation contractor prior to the commencement of remedial works in order to protect the health and safety of contractor staff and the site occupants.

The plan will include:

- Emergency phone numbers;
- Definition of Roles and Responsibilities for remediation personnel;
- Hazard identification and control;
- Material Safety Data Sheets for known contaminants at the site;
- Handling procedures for contaminated material;
- Use of Personal Protective Equipment;
- Decontamination procedures; and
- Incident reporting.

All staff will be made aware of the Site Specific Occupational Health & Safety Plan and an on-site briefing will be carried out prior to the commencement of remediation activities.

Site specific hazards which require identification and control are likely to include:

- Slips, trips and falls;
- Contact with contaminated media (soil and/or groundwater);
- Noise
- Manual handling hazards; and
- Below ground services.

10 LIMITATIONS

The findings of this report are based on the scope of work outlined in this report. WSP performed the services in a manner consistent with the normal level of care and expertise exercised by members of the environmental assessment profession. No warranties, express or implied, are made.

Subject to the scope of work, WSP assessment was limited strictly to identifying environmental conditions within groundwater at the Site and does not include evaluation of any other issues. This report does not comment on any regulatory obligations based on the findings. This report relates only to the objectives stated and does not relate to any other work undertaken for the Client or site owner. It is a report based on the conditions and concentrations observed in groundwater at the time of the sample collection. These conditions may change with time and space.

All conclusions regarding the Site are the professional opinions of the WSP personnel involved with the project, subject to the qualifications made above. While normal assessments of data reliability have been made, WSP assumes no responsibility or liability for errors in any data obtained from regulatory agencies, statements from sources outside of WSP, or developments resulting from situations outside the scope of this project.

WSP is not engaged in environmental assessment and reporting for the purpose of advertising, sales promoting, or endorsement of any Client interests, including raising investment capital, recommending investment decisions, or other publicity purposes.

SCOPE OF SERVICES

This environmental site assessment report (the report) has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between the client and WSP (scope of services). In some circumstances the scope of services may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints.

RELIANCE ON DATA

In preparing the report, WSP has relied upon data, surveys, analyses, designs, plans and other information provided by the client and other individuals and organisations, most of which are referred to in the report (the data). Except as otherwise stated in the report, WSP has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report (conclusions) are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. WSP will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to WSP.

ENVIRONMENTAL CONCLUSIONS

In accordance with the scope of services, WSP has relied upon the data and has conducted environmental field monitoring and/or testing in the preparation of the report. The nature and extent of monitoring and/or testing conducted is described in the report.

On all sites, varying degrees of non-uniformity of the vertical and horizontal soil or groundwater conditions are encountered. Hence no monitoring, common testing or sampling technique can eliminate the possibility that monitoring or testing results/samples are not totally representative of soil and/or groundwater conditions encountered. The conclusions are based upon the data and the environmental field monitoring and/or testing and are therefore merely indicative of the environmental condition of the site at the time of preparing the report, including the presence or otherwise of contaminants or emissions.

Also, it should be recognised that site conditions, including the extent and concentration of contaminants, can change with time.

Within the limitations imposed by the scope of services, the monitoring, testing, sampling and preparation of this report have been undertaken and performed in a professional manner, in accordance with generally accepted practices and using

a degree of skill and care ordinarily exercised by reputable environmental consultants under similar circumstances. No other warranty, expressed or implied, is made.

REPORT FOR BENEFIT OF CLIENT

The report has been prepared for the benefit of the client and no other party. WSP assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of WSP or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report). Other parties should not rely upon the report or the accuracy or completeness of any conclusions and should make their own enquiries and obtain independent advice in relation to such matters.

OTHER LIMITATIONS

WSP will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report.

The scope of services did not include any assessment of the title to or ownership of the properties, buildings and structures referred to in the report nor the application or interpretation of laws in the jurisdiction in which those properties, buildings and structures are located.

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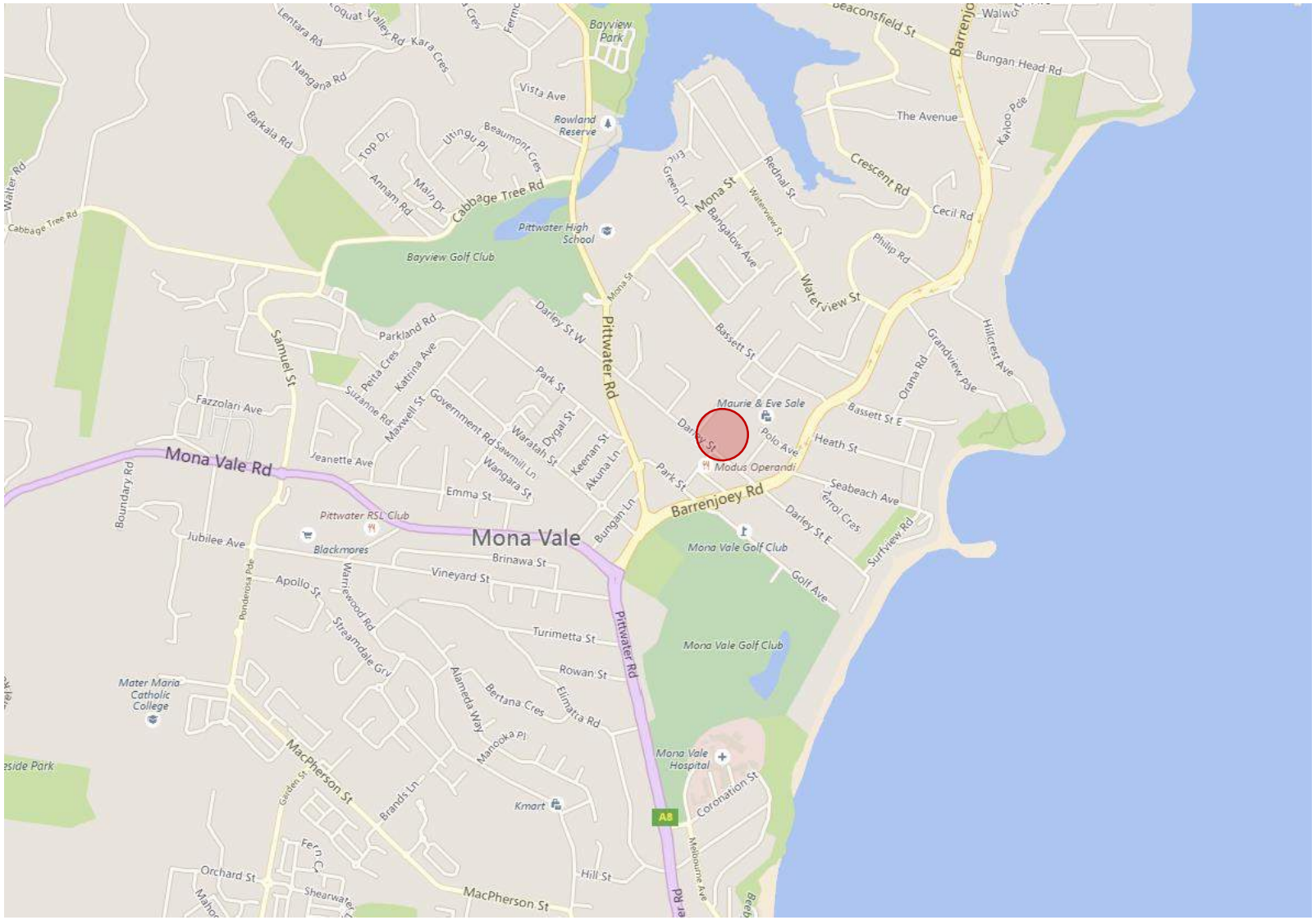
- *WSP, 2020d, Data Gap Assessment, STA Mona Vale Bus Depot, 58 Darley Street, Mona Vale NSW dated April 2020*

APPENDIX A

FIGURES

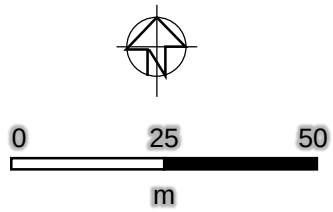


Source: Bing Maps

Figure 1 Site Location
PS111744 GME – Oct 2019 & Feb 2020
STA Bus Depot, 58 Darley Street Mona Vale

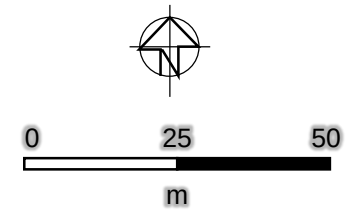
Basemap Source: NSW Government – Six Maps

Figure 2 Site and Surrounds
PS111744 GME – Oct 2019 & Feb 2020
STA Bus Depot, 58 Darley Street Mona Vale



Basemao Source: NSW Government – Six Maps

Figure 3 Site Current and Historical Features
PS111744 GME – Oct 2019 & Feb 2020
STA Bus Depot, 58 Darley Street Mona Vale



Site Boundary

Groundwater Well

Soil Borehole

Lost or Abandoned well

Basemap Source: NSW Government – Six Maps

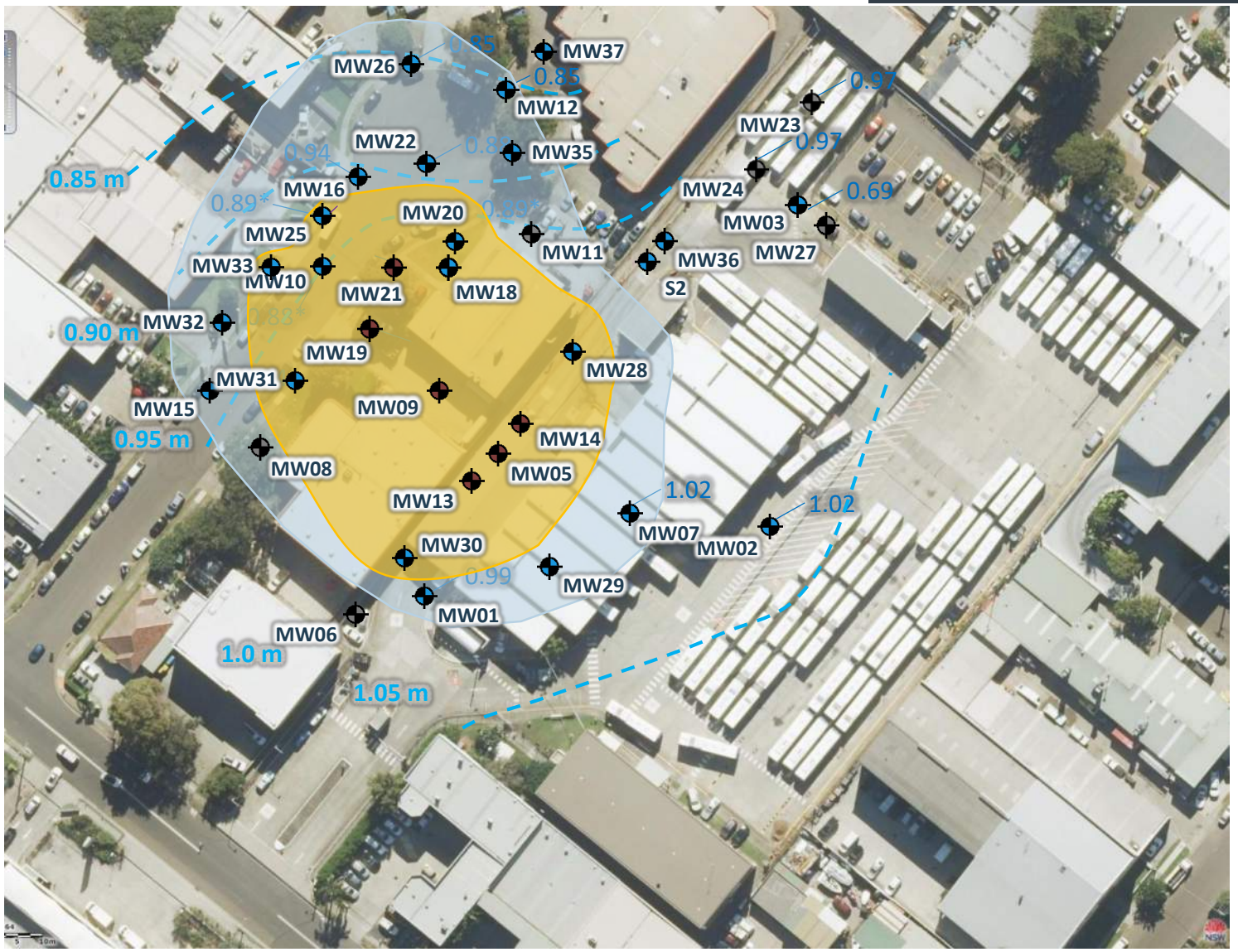
Figure 4 Soil Boreholes and Groundwater Wells
PS111744 - Remediation Action Plan
STA Bus Depot, 58 Darley Street Mona Vale

Basemap Source: Google Earth

Figure 5 Sub-slab Vapour Ports
PS111744 - Remediation Action Plan
STA Bus Depot, 58 Darley Street Mona Vale

Basemap Source: NSW Government – Six Maps

Figure 6 Hydrocarbon Results
PS111744 GME – Oct 2019 & Feb 2020
STA Bus Depot, 58 Darley Street Mona Vale



Basemap Source: NSW Government – Six Maps

Figure 7 Inferred Groundwater Flow
PS111744 GME – Oct 2019 & Feb 2020
STA Bus Depot, 58 Darley Street Mona Vale

Basemap Source: NSW Government – Six Maps

Figure 8 Surface Water Monitoring + Location of MW17
PS111744 GME – Oct 2019 & Feb 2020
STA Bus Depot, 58 Darley Street Mona Vale

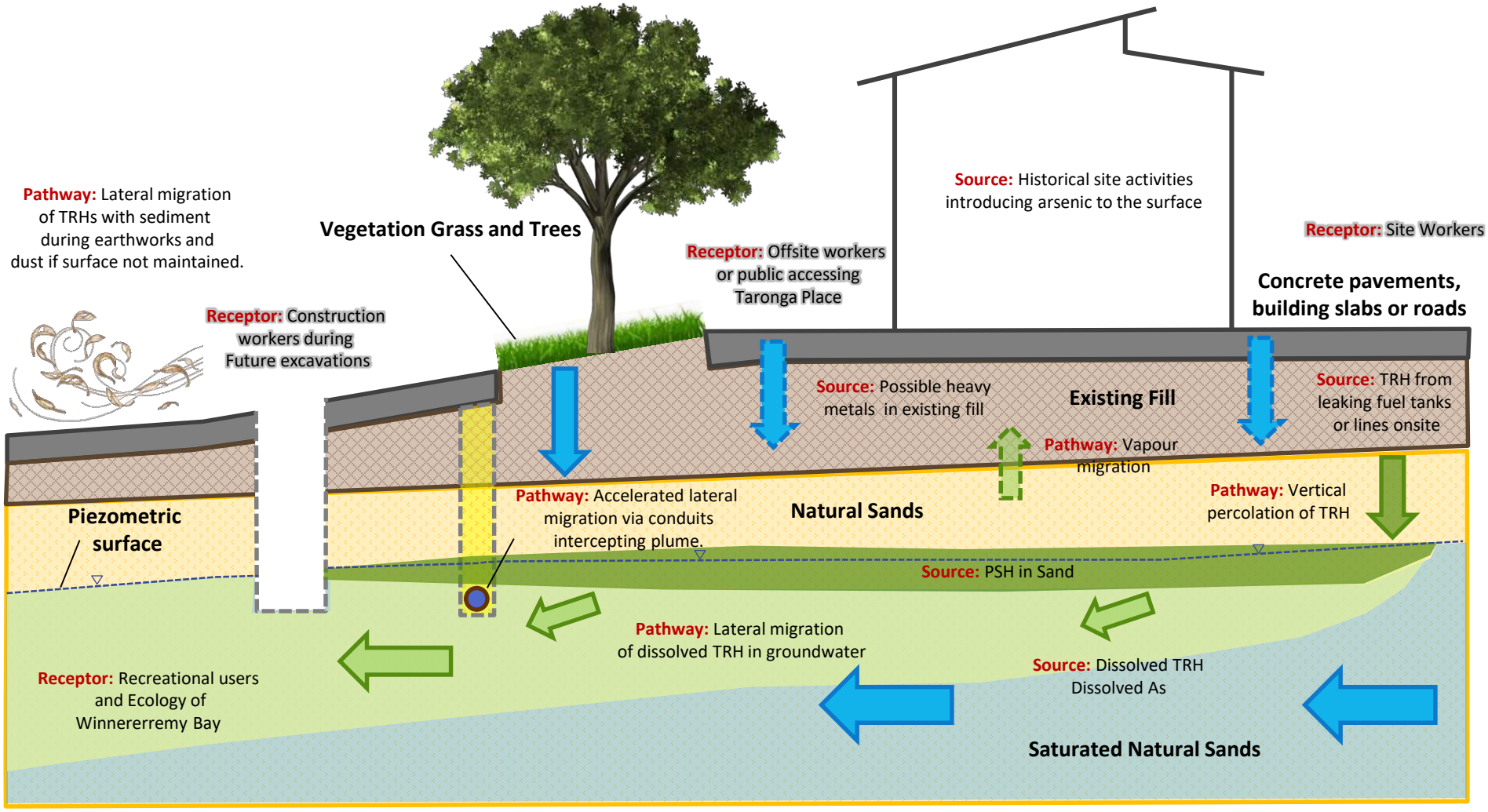


Figure 9 Conceptual Site Model
PS111744 GME Jan 20
STA Bus Depot, 58 Darley Street Mona Vale

Basemap Source: NearMaps

Figure 10 Conceptual Infrastructure (schematic only)
PS111744 - Remediation Action Plan
STA Bus Depot, 58 Darley Street Mona Vale

APPENDIX B

SUMMARY RESULTS

Appendix B - Table 1
Soil Summary Results

State Transit Authority
RAP Update
58 Darley Street, Mona Vale NSW

				BTEX				PAH																TPH					Heavy Metals								
				Benzene	Ethylbenzene	Toluene	Xylene Total (Sum of Detects)	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a) pyrene	Benzo(b)&(k)fluoranthene	Benzo(g,h,i)perylene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene	Total PAH (Sum of Detects)	TPH C6 - C9	TPH C10 - C14	TPH C15 - C28	TPH C29-C36	TPH+C10 - C36 (Sum of Detects	Arsenic	Cadmium	Chromium (III+VI)	Copper	Lead	Mercury	Nickel	Zinc
				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	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	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL				0.2	0.5	0.5	0.5	0.1	0.1	0.1	0.1	0.05	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	10	50	100	100	50	4	0.5	1	1	1	0.1	1	1
NEPC, 2013 - HSLs and HILs Industrial, Sand, <1m				3	NL	NL	230					40								NL			4000	260*	NL*				3000	900	3600	240,000	1500	730	6000	400,000
Field ID	**Depth**	**Date**	**Matrix**																																	
WSP, 2012a (Onsite)																																				
MW01	0.5	19/12/2011	soil	<0.2	<1	<0.5	ND	<0.1	<0.1	<0.1	<0.1	<0.05	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND	<25	<50	<100	<100	ND	10	<0.5	6	9	11	<0.1	2	15
MW01	2	19/12/2011	soil	<0.2	<1	<0.5	ND	1.9	0.8	0.5	<0.1	<0.05	<0.2	<0.1	<0.1	<0.1	0.2	4.5	<0.1	2.5	7.4	1	18.8	51	2200	5300	<100	7551	8	<0.5	9	5	3	<0.1	2	10
MW01	2.7	19/12/2011	soil	<0.2	<1	<0.5	ND	<0.1	<0.1	<0.1	<0.1	<0.05	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND	<25	<50	<100	<100	ND	7	<0.5	12	7	4	<0.1	4	14
MW03	0.5	19/12/2011	soil	<0.2	<1	<0.5	ND	<0.1	<0.1	<0.1	<0.1	<0.05	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND	<25	<50	<100	<100	ND	27	<0.5	11	6	28	<0.1	3	12
MW03	1.5	19/12/2011	soil	<0.2	<1	<0.5	ND	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<25	<50	<100	<100	ND	15	<0.5	11	6	6	<0.1	4	10
MW04	0.5	19/12/2011	soil	<0.2	<1	<0.5	ND	<0.1	<0.1	<0.1	<0.1	<0.05	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND	<25	<50	<100	<100	ND	27	<0.5	16	50	72	<0.1	4	57
MW04	2.3	19/12/2011	soil	<0.2	<1	<0.5	ND	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<25	<50	<100	<100	ND	31	<0.5	13	12	7	<0.1	6	15
SB01	0.5	19/12/2011	soil	0.3	<1	<0.5	5.3	6.1	<1	1	<1	1.2	<2	<1	1.6	<1	2	11	<1	11	9.3	5	48.2	110	7100	17000	<100	24210	5	<0.5	4	1	2	<0.1	1	4
SB01	2	19/12/2011	soil	0.4	<1	<0.5	4.4	21	4.1	5	<1	1.2	<2	<1	1.9	<1	4	35	<1	52	55	8.6	187.8	250	9400	27000	<100	36650	<4	<0.5	6	3	2	<0.1	1	6
SB01	2.7	19/12/2011	soil	<0.2	<1	<0.5	ND	<0.1	<0.1	<0.1	<0.1	<0.05	<0.2	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	0.3	<0.1	0.4	<25	<50	<100	<100	ND	26	<0.5	18	20	7	<0.1	6	27
SB02	1	19/12/2011	soil	0.2	<1	<0.5	0.2	2.2	<1	<1	<1	<0.5	<2	<1	<1	<1	<1	3.5	<1	6.2	6.3	<1	18.2	260	7500	23000	<100	30760	10	<0.5	8	3	3	<0.1	3	7
SB02	1.4	19/12/2011	soil	<0.2	<1	<0.5	ND	17	3.5	4.2	<1	1	<2	<1	1.9	<1	3.5	27	<1	46	45	6.5	155.6	200	5200	18000	<100	23400	13	<0.5	7	3	5	<0.1	2	7
SB03	1	19/12/2011	soil	<0.2	<1	<0.5	ND	0.6	0.3	0.2	<0.1	<0.05	<0.2	<0.1	<0.1	<0.1	0.2	2	<0.1	0.3	4.2	0.7	8.5	<25	300	1700	<100	2000	51	<0.5	14	5	11	<0.1	5	18
SB03	1.5	19/12/2011	soil	<0.2	<1	<0.5	ND	<0.1	<0.1	<0.1	<0.1	<0.05	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.1	<25	<50	<100	<100	ND	10	<0.5	14	11	6	<0.1	5	18
SB04	0.6	19/12/2011	soil	<0.2	<1	<0.5	ND	<0.1	<0.1	<0.1	<0.1	<0.05	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	1.2	<0.1	<0.1	1.2	<25	<50	<100	<100	ND	49	<0.5	13	21	89	<0.1	3	40
SB04	2	19/12/2011	soil	<0.2	<1	<0.5	ND	31	6.8	10	<1	1.3	<1	<1	2.8	<1	5.3	48	<1	98	83	10	296.2	280	11000	32000	<100	43280	5	<0.5	6	3	2	<0.1	2	6
SB04	2.7	19/12/2011	soil	<0.2	<1	<0.5	ND	<0.1	<0.1	<0.1	<0.1	<0.05	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	<25	<50	<100	<100	ND	<4	<0.5	<1	<1	<1	<0.1	<1	3
SB05	2	19/12/2011	soil	<0.2	<1	<0.5	ND	0.3	0.1	0.1	<0.1	<0.05	<0.2	<0.1	<0.1	<0.1	<0.1	0.6	<0.1	1	1.2	0.1	3.4	<25	140	430	<100	570	14	<0.5	11	4	3	<0.1	3	12
SB05	2.7	19/12/2011	soil	<0.2	<1	<0.5	ND	<0.1	<0.1	<0.1	<0.1	<0.05	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND	<25	<50	<100	<100	ND	8	<0.5	6	2	2	<0.1	1	6
SB06	0.3	19/12/2011	soil	<0.2	<1	<0.5	ND	<0.1	<0.1	<0.1	<0.1	<0.05	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND	<25	<50	<100	<100	ND	4	<0.5	3	<1	1	<0.1	<1	3
SB06	1	19/12/2011	soil	<0.2	<1	<0.5	ND	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<25	<50	<100	<100	ND	5	<0.5	3	2	2	<0.1	1	4
SB07	0.3	20/12/2011	soil	<0.2	<1	<0.5	ND	<0.1	<0.1	<0.1	<0.1	<0.05	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.1	<25	<50	<100	<100	ND	11	<0.5	48	25	16	<0.1	45	38
SB07	1	20/12/2011	soil	<0.2	<1	<0.5	ND	<0.1	<0.1	<0.1	<0.1	<0.05	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND	<25	<50	<100	<100	ND	<4	<0.5	6	2	5	<0.1	<1	3
SB08	0.3	20/12/2011	soil	<0.2	<1	<0.5	ND	<0.1	<0.1	<0.1	<0.1	<0.05	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND	<25	<50	<100	<100	ND	6	<0.5	4	2	3	<0.1	2	8
SB08	0.6	20/12/2011	soil	<0.2	<1	<0.5	ND	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<25	<50	<100	<100	ND	12	<0.5	14	9	19	<0.1	3	44
WSP, 2012b (Onsite)																																				
MW05	1	13/08/2012	Soil	<0.2	<1	<0.5	ND	1.5	<1	<1	<1	<0.5	<2	<1	<1	<1	<1	5.8	<1	8.4	11	<1	26.7	<25	1700	6000	<100	7750	-	-	-	-	-	-	-	-
MW05	2	13/08/2012	Soil	0.7	<1	<0.5	ND	6.5	4.1	4.3	<1	<0.5	<2	<1	<1	<1	1.2	25	<1	38	53	5.1	137.2	210	7100	28,000	<100	35,150	-	-	-	-	-	-	-	-
MW06	1.5	13/08/2012	Soil	<0.2	<1	<0.5	ND	<0.1	<0.1	<0.1	<0.1	<0.05	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND	<25	<50	<100	<100	ND	-	-	-	-	-	-	-	-
MW06	2	13/08/2012	Soil	<0.2	<1	<0.5	ND	0.1	<0.1	0.2	<0.1	<0.05	<0.2	<0.1	<0.1	<0.1	<0.1	0.6	<0.1	<0.1	1.6	0.2	2.5	<25	500	1900	<100	2450	-	-	-	-	-	-	-	-
MW07	1.5	13/08/2012	Soil	<0.2	<1	<0.5	ND	<0.1	<0.1	<0.1	<0.1	<0.05	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND	<25	<50	<100	<100	ND	-	-	-	-	-	-	-	-
MW07	2	13/08/2012	Soil	<0.2	<1	<0.5	ND	1.4	<1	<1	<1	<0.5	<2	<1	<1	<1	<1	4.2	<1	10	8.7	<1	24.3	34	1800	4300	<100	6150	-	-	-	-	-	-	-	-
SB09	0.5	13/08/2012	Soil	<0.2	<1	<0.5	ND	<0.1	<0.1	<0.1	<0.1	<0.05	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND	<25	<50	<100	<100	ND	-	-	-	-	-	-	-	-
SB09	1.5	13/08/2012	Soil	0.3	<1	<0.5	ND	5.1	2.8	3.4	<1	<0.5	<2	<1	<1	<1	<1	17	<1	36	36	3	103.3	190	5500	19,000	<100	24,550	-	-	-	-	-	-	-	-
SB10	1	13/08/2012	Soil	<0.2	<1	<0.5	ND	<0.1	<0.1	<0.1	<0.1	<0.05	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND	<25	<50	<100	<100	ND	-	-	-	-	-	-	-	-
SB10	2	13/08/2012	Soil	<0.2	<1	<0.5	5	1.7	1	1.3	<1	<0.5	<2	<1	<1	<1	<1	5.9	<1	6.7	13	1	30.6	33	2300	6300	<100	8650	-	-	-	-	-	-	-	-
SB11	1	13/08/2012	Soil	<0.2	<1	<0.5	ND	<0.1	<0.1	<0.1	<0.1	<0.05	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	1.6	<0.1	<0.1	ND	<25	93	<100	150	93	-	-	-	-	-	-	-	-
SB11	1.9	13/08/2012	Soil	<0.2	2	<0.5	ND	6.1	2.7	4	<1	<0.5	<2	<1	<1	<1	<1	15	<1	29	30	2.5	89.3	140	4800	16,000	<100	20,850	-	-	-	-	-	-	-	-
SB12	0.5	13/08/2012	Soil	<0.2	<1	<0.5	ND	<0.1	<0.1	<0.1	<0.1	<0.05	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND	<25	<50	<100	<100	ND	-	-	-	-	-	-	-	-
SB12	1.8	13/08/2012	Soil	0.2	<1	<0.5	ND	12	6.5	7.9	<1	<0.5	<2	<1	<1	<1	1.3	39	<1	100	85	6.7	258.1	330	16,000	43,000	110	59,110	-	-	-	-	-	-	-	-
SB13	1.5	13/08/2012	Soil	<0.2	<1	<0.5	ND	<0.1	<0.1	<0.1	<0.1	<0.05	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND	<25	<50	<100	<100	ND	-	-	-	-	-	-	-	-
SB13	1.8	13/08/2012	Soil	<0.2	<1	<0.5	ND	0.9	0.6	0.9	<0.1	<0.05	<0.2	<0.1	<0.1	<0.1	0.2	3.6	<0.1	4.2	7.9	0.7	19	<25	1300	3800	<100	5150	-	-	-	-	-	-	-	-
SB14	1	13/08/2012	Soil	<0.2	<1	<0.5	ND	<0.1	<0.1	<0.1	<0.1	<0.05	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND	<25	<50	<100	<100	ND	-	-	-	-	-	-	-	-
SB14	1.5	13/08/2012	Soil	<0.2	<1	<0.5	ND	<0.1	<0.1	<0.1	<0.1	<0.05	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.3	<0.1	ND	<25	<50	<100	<100	ND	-	-	-	-	-	-	-	-
WSP, 2013 (Offsite)																																				
MW08	1	12/11/2012	Soil	<0.2	<1	<0.5	ND	<0.1	<0.1	<0.1	<0.1	<0.05	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND	<25	<50	<100	<100	ND	-	-	-	-	-	-	-	-
MW08	2	12/11/2012	Soil	<0.2	<1	<0.5	ND	<1	<1	<1	<1	<0.5	<2	<1	<1	<1	<1	<1	<1	<1	<1	<1	ND	<25	230	6300	<100	6580	-	-	-	-	-	-	-	-
MW09	0.5	12/11/2012	Soil	<0.2	<1	<0.5	ND	<0.1	<0.1	<0.1	<0.1	<0.05	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.5	<0.1	<0.1	0.5	<25	<50	<100	<100	ND	-	-	-	-	-	-	-	-
MW09	2	12/11/2012	Soil	<0.2	<1	<0.5	ND	8.9	7.7	12	0.4	<0.05	<0.2	<0.1	0.4	<0.1	2.8	35	<0.1	61	79	8.5	215.7	180	9100	38,000	<100	47,150	-	-	-	-	-	-	-	-
MW10	0.2	22/03/2013	Soil	<0.2	<1	<0.5	ND	<0.1	<0.1	<0.1	<0.1	<0.5	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND	<25	<50	<100	<100	ND	-	-	-	-	-	-	-	-
MW10	0.7	22/03/2013	Soil	<0.2	<1	<0.5	ND	<0.1	<0.1	<0.1	<0.1	<0.5	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.7	<0.1	<0.1	ND	<25	<50	<100	<100	ND	-	-	-	-	-	-	-	-
MW10	1.2	22/03/2013	Soil	<0.2	<1	<0.5	ND	<0.1	<0.1	<0.1	<0.1	<0.5	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.1	<25	<50	<100	<100	ND	-	-	-	-	-	-	-	-
MW10	2	22/03/2013	Soil	<0.2	<1	<0.5	ND	16	3.8	4.1	<1	<0.5	<2	<1	<1	<1	2.1	26	<1	41	42	3.7	97.7	120	9200	27,000	<100	36,250	-	-	-	-	-	-	-	-
MW10	4	22/03/2013	Soil	<0.2	<1	<0.5	ND	1.3	0.3	0.2	<0.1	<0.5	<0.2	<0.1	<0.1	<0.1	0.2	2	<0.1	2.8	3.4	0.4	7.8	<25	480	1500	<100	2030	-	-	-	-	-	-	-	-
MW11	0.7	12/11/2012	Soil	<0.2	<1	<0.5	ND	<0.1	<0.1	<0.1	<0.1	<0.05	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND	<25	<50	<100	<100	ND	-	-	-	-	-	-	-	-
MW11	1.5	12/11/2012	Soil	<0.2	<1	<0.5	ND	<0.1	<0.1	<0.1	<0.1	<0.05	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND	<25	<50	<100	<100	ND	-	-	-	-	-	-	-	-
MW12	1.5	12/11/2012	Soil	<0.2	<1	<0.5	ND	<0.1	<0.1	<0.1	<0.1	<0.05	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND	<25	<50	<100	<100	ND	-	-	-	-	-	-	-	-
MW12	2	12/11/2012	Soil	<0.2	<1	<0.5	ND	<0.1	<0.1	<0.1	<0.1	<0.05	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND	<25	<50	<100	<100	ND	-	-	-	-	-	-	-	-
Statistical Summary																																				
Number of Results				56	56	56	56	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	56	56	56	56	56	56	25	25	25	25	25	25	25	25
Number of Detects				6	1	0	4	20	15	17	1	4	0	0	5	0	12	21	0	24	25	17	31	14	22	21	2	22	22	0	24	23	24	0	22	25
Minimum Concentration				<0.2	<1	<0.5	0	<0.1	<0.1	<0.1	<0.1	<0.05	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	<25	<50	<100	<100	0	<4	<0.5	<1	<1	<1	<0.1	<1	3
Maximum Concentration				0.7	2	<0.5	5.3	31	7.7	12	<1	1.3	<2	<1	2.8	<1	5.3	48	<1	100	85	10	296.2	330	16,000	43,000	150	59,110	51	<0.5	48	50	89	<0.1	45	57
Average Concentration				0.13	0.53	0.25	0.27	2.8	0.95	1.2	0.18	0.17	0.33	0.17	0.3	0.17	0.54	6	0.17	11	11	1.3	34	52	1853	5844	53	7685	14	0.25	11	8.5	12	0.05	4.4	15
Median Concentration				0.1	0.5	0.25	0	0.05	0.05	0.05	0.05	0.025	0.1	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.075	0.05	0.05	12.5	25	50	50	0	10	0.25	9	5	5	0.05	3	10
Standard Deviation				0.096	0.2	0	1.1	6.2	1.9	2.6	0.2	0.31	0.39	0.2	0.56	0.2	1.1	12	0.2	23	23	2.5	71	83	3558	10,947	15	14,527	14	0	9	11	22	0	8.6	15

* The criteria applied to these anlytes are taken from the NEPC, 2013 and adopted for indicative purposes - the actual fractions the guidelines apply to are F1 (C6-C10 less Benzene) and F2 (>C10 - C16 less Naphthalene), however these were not reported in 2012 and 2013 when the analysis took place.

Appendix B - Table 1 Summary of Field Data

State Transit Authority
Groundwater Monitoring
58 Darley Street, Mona Vale NSW

							Guaging Data			Field Parameters						
							Standing Water Level (mBTOC)	PSH thickness (m)	Adjusted Standing Water Level (mAHD)	pH (Field)	Redox (Field)	Electrical Conductivity (Field)	Temperature (Field)	Dissolved Oxyven (Field)	Well headspace PID	Comments
Units										pH units	mV	µS/cm	°C	ppm	ppm	
Laboratory PQL										0.01	0.01	1	0.1	0.01	0.1	
Well ID	Easting	Northing	Ground (mAHD)	TOC (mBGL)	TOC (mAHD)	Date										
MW01	-	-	2.85	0.063	2.787	10-01-12	-	0	-	7.21	29.8	911	25.7	0.07	-	-
MW01	-	-	2.85	0.063	2.787	24-08-12	-	0	-	7.06	-28.3	640	17.2	0.1	-	-
MW01	-	-	2.85	0.063	2.787	19-10-18	1.70	0	1.08	6.8	-127.7	846	20.1	3.1	-	clear, no odour
MW01	-	-	2.85	0.058	2.792	23-05-19	1.81	0	0.99	6.11	-81.4	824	23.2	0	35.6	Clear, colourless, slight HC odour
MW01	-	-	2.85	0.058	2.792	31-10-19	1.75	0	1.05	6.91	-127.8	839	23.2	0	-	Clear, colourless, odourless
MW01	-	-	2.85	0.058	2.792	06-02-20	1.81	0	0.99	-	-	-	-	-	-	Gauge only
MW02			2.73	0.071	2.659	10-01-12	-	0	-	7.03	367.7	909	25.7	0.16	-	-
MW02	-	-	2.73	0.071	2.659	24-08-12	-	0	-	6.96	-24	737	18.9	0.12	-	-
MW02	-	-	2.73	0.071	2.659	19-10-18	1.58	0	1.08	-	-	-	-	-	-	Guage only
MW02	-	-	2.73	0.051	2.679	23-05-19	1.66	0	1.02	7.15	-141.6	600	24.4	0	1.2	Clear, colourless, odourless
MW02	-	-	2.73	0.051	2.679	31-10-19	1.60	0	1.08	7.29	-156.9	546	24	0.3	-	Clear, colourless, odourless
MW02	-	-	2.73	0.051	2.679	06-02-20	1.66	0	1.02	-	-	-	-	-	-	Gauge only
MW03			2.51	0.04	2.47	10-01-12	-	0	-	6.99	173.6	1413	25.4	-	-	-
MW03	-	-	2.51	0.04	2.47	24-08-12	-	0	-	6.94	-22.6	1349	19.2	0.32	-	-
MW03	-	-	2.51	0.04	2.47	19-10-18	1.68	0	0.80	7.04	-75.4	924	21.2	0.25	-	clear, no odour
MW03	-	-	2.51	0.051	2.459	23-05-19	1.77	0	0.69	5.33	37.8	899	23.4	0	0.2	Clear, colourless, odourless
MW03	-	-	2.51	0.051	2.459	06-02-20			2.46	-	-	-	-	-	-	Inaccessible - Under new bus port
MW04			2.78	-	-	10-01-12	-	0	-	7.33	55.2	55.2	22.7	0.16	-	-
MW04	-	-	2.78	-	-	24-08-12	-	0	-	7.07	-28.9	784	17.4	0.15	-	-
MW04	-	-	2.78	-	-	06-02-20	-		-							-
MW05			2.57	-	-	24-08-12	-	0.257	-	-	-	-	-	-	-	
MW05	-	-	2.57	-	-	06-02-20	-	-	-							-
MW06	-	-	2.92	-	-	24-08-12	-	0	-	7.44	-50.1	456	16.8	1.67	-	-
MW07	-	-	3	0.142	2.858	24-08-12		0	2.86	6.81	-15.8	738	18.5	0.19	-	-
MW07	-	-	3	0.142	2.858	19-10-18	1.853	0	1.01	6.97	-158.1	757	18.9	0.11	-	clear, slight HC odour
MW07	-	-	3.13	0.142	2.988	23-05-19	1.964	0	1.02	6.72	-127.3	852	21.7	0	1.1	Clear, colourless, slight HC odour
MW07	-	-	3.13	0.142	2.988	31-10-19	1.902	0	1.09	6.88	-115.8	762	20.0	0.29	-	-
MW07	-	-	3.13	0.142	2.988	06-02-20	1.873	0	1.12	-	-	-	-	-	-	Gauge only
MW08	-	-	3.04	-	-	19-11-12	-	0	-	6.89	-129.6	113	21.2	0.67	-	-
MW08	342996	62772656	3.04	-	-	30-01-14	-	0	-	-	-	-	-	-	-	Dry
MW08-B	342996.15	6272656.64	3.22	-	-	21-06-14	-	0	-	7.14	-88	1000	20.8	0.01	-	-
MW08-B	342996.15	6272656.64	3.22	-	-	13-10-14	-	0	-	7.21	-114	915	18.4	0.38	-	-
MW08-B	342996.15	6272656.64	3.22	-	-	11-02-15	-	0	-	7.08	-187	1087	21.2	0.18	-	-
MW08-B	342996.15	6272656.64	3.22	-	-	09-12-15	-	0	-	7.19	-182	903	20.8	1.49	-	-
MW08-B	342996.15	6272656.64	3.22	0.08	3.14	19-10-18	2.07	0	1.07	-	-	-	-	-	-	Insufficient water for all samples
MW08-B	342996.15	6272656.64	3.22	-	-	23-05-19	-	-	-	-	-	-	-	-	1.1	Insufficient water for all samples
MW08	342996.15	6272656.64	3.22	0.08	3.14	31-10-19	-	-	-	-	-	-	-	-	-	Dry at 2.04 m
MW08	342996.15	6272656.64	3.22	0.08	3.14	06-02-20	2.05	0	1.09	-	-	-	-	-	-	Gauge only, Dry
MW09	-	-	2.89	-	-	19-11-12	-	0.3	-	-	-	-	-	-	-	
MW09	343030.91	6272672.59	3.01	-	-	30-01-14	-	0.08	-	6.3	-81	953	23.2	-	-	
MW09	343030.91	6272672.59	3.01	-	-	21-06-14	-	0.41	-	7.05	-127	715	20	0.15	-	
MW09	343030.91	6272672.59	3.01	-	-	13-10-14	-	0.475	-	6.73	-128	708	16.9	0.83	-	
MW09	343030.91	6272672.59	3.01	-	-	11-02-15	-	0.207	-	7.1	-160	563	23	0.25	-	
MW09	343030.91	6272672.59	3.01	-	-	09-12-15	-	0.295	-	7.17	-251	702	21.2	0.3	-	
MW09	343030.91	6272672.59	3.01	-	-	12-09-16	-	0.05	-	7.81	-237	483	17 .8	0.93	-	
MW09	343030.91	6272672.59	3.01	-	-	14-02-17	-	0.447	-	7.14	-136.5	750.63	24.1	0.37	-	
MW09	343030.91	6272672.59	3.01	-	-	29-08-17	-	0.35	-	6.96	-283	745	19.4	-	-	
MW09	343030.91	6272672.59	3.01	-	-	10-04-18	-	0.622	-	7.09	-251	728	24.1	-	-	
MW09	343030.91	6272672.59	3.01	-	-	19-10-18	-	-	-	-	-	-	-	-	-	Inacessible
MW09	343030.91	6272672.59	3.01	-	-	23-05-19	-	-	-	-	-	-	-	-	-	Inacessible
MW09	343030.91	6272672.59	3.01	-	-	31-10-19	2.00	0.13	-	-	-	-	-	-	-	PSH present so not sampled
MW09	343030.91	6272672.59	3.01	-	-	06-02-20	-	-	-	-	-	-	-	-	-	Inacessible
MW10	-	-	-	-	-	02-04-13	-	0.02	-	6.97	-146	761	26.8	1.25	-	
MW10	343009.73	6272696.86	2.81	-	-	30-01-14	-	0.55	-	6.66	-85	890	26.2	-	-	
MW10	343009.73	6272696.86	2.81	-	-	21-06-14	-	0.5	-	7.02	-135	717	22.1	0.07	-	
MW10	343009.73	6272696.86	2.81	-	-	13-10-14	-	0.446	-	7.37	-148	747	20	0.38	-	
MW10	343009.73	6272696.86	2.81	-	-	11-02-15	-	0.181	-	6.98	-171	846	26.1	0.11	-	
MW10	343009.73	6272696.86	2.81	-	-	09-12-15	-	0.23	-	6.96	-223	740	24.4	0.41	-	
MW10	343009.73	6272696.86	2.81	-	-	12-09-16	-	0.235	-	7.41	-232	605	20.8	0.62	-	
MW10	343009.73	6272696.86	2.81	-	-	14-02-17	-	0.616	-	7.02	-187.3	294.24	26	0.03	-	
MW10	343009.73	6272696.86	2.81	-	-	29-08-17	-	0.11	-	6.7	-289	833	21.3	-	-	
MW10	343009.73	6272696.86	2.81	-	-	10-04-18	-	0.557	-	7.2	-172	927	21.7	-	-	
MW10	343009.73	6272696.86	2.81	0.08	2.73	18-10-18	1.71	0.145	1.14	-	-	-	-	-	-	IP malfunction, PSH measured with bailer
MW10	343009.73	6272696.86	2.81	0.08	2.73	23-05-19	2.23	0.463	0.88	-	-	-	-	-	76.7	PSH present so not sampled
MW10	343009.73	6272696.86	2.81	0.08	2.73	31-10-19	2.13	0.384	0.92	-	-	-	-	-	-	PSH present so not sampled
MW10	343009.73	6272696.86	2.81	0.08	2.73	06-02-20	2.01	0.145	0.84	-	-	-	-	-	-	Gauge only
MW11	-	-	2.67	-	-	19-11-12	-	0	-	7.6	-170.3	793	21.5	0.57	-	-
MW11	343048.97	6272701.3	2.77	-	-	30-01-14	-	0	-	6.8	-96	848	25.2	-	-	-
MW11	343048.97	6272701.3	2.77	-	-	21-06-14	-	0	-	6.94	-120	730	20.5	0.23	-	-
MW11	343048.97	6272701.3	2.77	-	-	13-10-14	-	0	-	6.79	-157	668	18.9	0.14	-	-
MW11	343048.97	6272701.3	2.77	-	-	11-02-15	-	0	-	6.9	-157	774	24.9	0.14	-	-
MW11	343048.97	6272701.3	2.77	-	-	09-12-15	-	0	-	6.98	-214	637	23.3	0.32	-	Abandoned after this date
MW12	-	-	2.6	-	-	19-11-12	-	0	-	7.2	169.3	115	19.6	0.01	-	-
MW12	3403044	6272732	2.71	-	-	30-01-14	-	0	-	-	-	-	-	-	-	-
MW12-B	343044.64	6272731.85	2.68	-	-	21-06-14	-	0	-	7.55	-76	1066	18.8	1.08	-	-
MW12-B	343044.64	6272731.85	2.68	-	-	13-10-14	-	0	-	7.16	-195	2300	17.6	0.17	-	-
MW12-B	343044.64	6272731.85	2.68	-	-	11-02-15	-	0	-	7.14	-194	1247	22.6	0.07	-	-
MW12-B	343044.64	6272731.85	2.68	-	-	09-12-15	-	0	-	7.11	-201	1300	21.5	0.33	-	-
MW12-B	3403044	6272732	2.68	0.085	2.595	18-10-18	1.54	0	1.06	7.1	-165.3	3687	18.3	2.37	-	Clear, faint H2S odour, free flowing
MW12-B	3403044	6272732	2.68	0.085	2.595	23-05-19	1.74	0	0.85	7.17	-155.4	2688	20.9	0.13	1.4	Clear, colourless, odourless
MW12-B	3403044	6272732	2.68	0.085	2.595	31-10-19	1.67	0	0.93	7.06	-117	1688	19.9	0.1	-	-
MW12-B	3403044	6272732	2.68	0.085	2.595	06-02-20	1.74	0	0.86	-	-	-	-	-	-	Gauge only
MW15	342984.96	6272667.61	3.01	-	-	30-01-14	-	0	-	7.09	69	909	28.2	-	-	-
MW15	342984.96	6272667.61	3.01	-	-	21-06-14	-	0	-	6	-19	1025	22.2	0.2	-	-
MW15	342984.96	6272667.61	3.01	-	-	13-10-14	-	0	-	6.96	6	1012	20.6	0.2	-	-
MW15	342984.96	6272667.61	3.01	-	-	11-02-15	-	0	-	6.84	-12	962	27.5	0.13	-	-
MW15	342984.96	6272667.61	3.01	-	-	09-12-15	-	0	-	6.96	47	768	25	0.55	-	-
MW15	342984.96	6272667.61	3.01	0.154	2.856	18-10-18	1.836	0	1.02	-	-	-	-	-	-	Guage only
MW15	342984.96	6272667.61	3.01	0.135	2.875	23-05-19	1.938	0	0.94	6.56	33.5	1261	24.8	1.1	2.8	Clear, colourless, odourless
MW15	342984.96	6272667.61	3.01	0.135	2.875	31-10-19	1.89	0	0.99	6.81	19.1	1302	23.7	0	-	-
MW15	342984.96	6272667.61	3.01	0.135	2.875	06-02-20	1.94	0	0.94	-	-	-	-	-	-	Gauge only
MW16	343014.6	6272713.36	2.62	-	-	02-11-13	-	0	-	-	-	-	-	-	-	-
MW16	343014.6	6272713.36	2.62	-	-	30-01-14	-	0	-	6.7	-101	835	28.8	-	-	-
MW16	343014.6	6272713.36	2.62	-	-	21-06-14	-	0	-	6.82	-95	822	21.9	1.6	-	-
MW16	343014.6	6272713.36	2.62	-	-	13-10-14	-	0	-	6.28	-105	938	21.5	0.32	-	-
MW16	343014.6	6272713.36	2.62	-	-	11-02-15	-	0	-	6.94	-149	850	28.3	0.23	-	-
MW16	343014.6	6272713.36	2.62	-	-	09-12-15	-	0	-	6.87	-139	801	26.2	1.14	-	-
MW16	343014.6	6272713.36	2.62	0.139	2.481	18-10-18	1.512	0	0.97	6.89	-149.1	759	22.8	0.11	-	clear, faint sweet odour, free flowing
MW16	343014.6	6272713.36	2.62	0.08	2.54	23-05-19	1.603	0	0.94	6.51	-108.3	784	25	0	0.8	Clear, colourless, odourless
MW16	343014.6	6272713.36	-	-	-	31-10-19	1.56	0	-	6.99	-169.4	724	23.5	0.11	-	-
MW16	343014.6	6272713.36	2.62	0.139	2.481	06-02-20	1.602	0	-	-	-	-	-	-	-	Gauge only

Appendix B - Table 1 Summary of Field Data

State Transit Authority
Groundwater Monitoring
58 Darley Street, Mona Vale NSW

							Guaging Data			Field Parameters						
							Standing Water Level (mBTOC)	PSH thickness (m)	Adjusted Standing Water Level (mAHD)	pH (Field)	Redox (Field)	Electrical Conductivity (Field)	Temperature (Field)	Dissolved Oxyven (Field)	Well headspace PID	Comments
Units										pH units	mV	µS/cm	°C	ppm	ppm	
Laboratory PQL										0.01	0.01	1	0.1	0.01	0.1	
Well ID	Easting	Northing	Ground (mAHD)	TOC (mBGL)	TOC (mAHD)	Date										
MW17	342916.14	6272773.34	2.656	-	-	02-11-13	-	0	-	-	-	-	-	-	-	-
MW17	342916.14	6272773.34	2.656	-	-	30-01-14	-	0	-	6.69	88	787	25.5	-	-	-
MW17	342916.14	6272773.34	2.656	-	-	21-06-14	-	0	-	6.29	54	792	20.4	0.23	-	-
MW17	342916.14	6272773.34	2.656	-	-	13-10-14	-	0	-	6.77	42	691	20.2	0.33	-	-
MW17	342916.14	6272773.34	2.656	-	-	11-02-15	-	0	-	6.14	30	674	25.1	0.17	-	-
MW17	342916.14	6272773.34	2.656	-	-	09-12-15	-	0	-	7.37	23	656	23.6	1.09	-	-
MW17	342916.14	6272773.34	2.656	0.102	2.554	19-10-18	1.803	0	0.75	7.42	88.6	743	21.9	2.28	-	-
MW17	342916.14	6272773.34	2.656	0.102	2.554	23-05-19	1.884	0	0.67	7.25	27.6	788	23.1	0.09	1.1	Clear, colourless, odourless
MW17	342916.14	6272773.34	2.656	0.102	2.554	31-10-19	1.848	0	0.71	7.2	23.8	940	21.7	0.08	-	-
MW17	342916.14	6272773.34	2.656	0.102	2.554	06-02-20	-	-	-	-	-	-	-	-	-	-
MW18	343033.19	6272695.48	-	-	-	09-12-15	-	0.482	-	7.01	-220	785	22.1	0.56	-	-
MW18	343033.19	6272695.48	-	0.074	-	19-10-18	1.738	0.156	-	-	-	-	-	-	-	IP malfunction, PSH measured with bailer
MW18	343033.19	6272695.48	-	0.06	-	23-05-19	2.248	0.442	-	-	-	-	-	-	68	PSH present so not sampled
MW18	343033.19	6272695.48	-	0.06	-	31-10-19	2.054	0.284	-	-	-	-	-	-	-	PSH present so not sampled
MW18	343033.19	6272695.48	-	0.06	-	06-02-20	2.251	0.446	-	-	-	-	-	-	-	Gauge only
MW19	343017.09	6272682.25	3.08	-	-	09-12-15	-	0.265	-	7.12	-246	693	20.9	0.37	-	-
MW19	343017.09	6272682.25	3.08	-	-	12-09-16	-	0.174	-	7.9	-286	674	19.1	1.23	-	-
MW19	343017.09	6272682.25	3.08	-	-	14-02-17	-	0.546	-	7.66	-145	707.84	23.44	2.13	-	-
MW19	343017.09	6272682.25	3.08	-	-	29-08-17	-	0.412	-	6.94	-184	750	20.8	-	-	-
MW19	343017.09	6272682.25	3.08	-	-	10-04-18	-	0.593	-	7	-200	698	20.1	-	-	-
MW19	343017.09	6272682.25	3.08	0.088	2.992	19-10-18	-	-	-	-	-	-	-	-	-	Remediation system prevents sampling
MW19	343017.09	6272682.25	3.08	0.08	3	23-05-19	2.23	0.165	0.91	-	-	-	-	-	49.2	PSH present so not sampled
MW19	343017.09	6272682.25	3.08	0.08	3	31-10-19	2.07	0.29	1.17	-	-	-	-	-	-	PSH present so not sampled
MW19	343017.09	6272682.25	3.08	0.08	3	06-02-20	2.39	0.37	0.92	-	-	-	-	-	-	Gauge only
MW20	342034.94	6272702.51	2.69	-	-	12-09-16	-	0.189	-	6.99	-252	671	19.7	0.53	-	-
MW20	342034.94	6272702.51	2.69	-	-	14-02-17	-	0.165	-	6.94	-127.8	909.1	24	0.22	-	-
MW20	342034.94	6272702.51	2.69	-	-	29-08-17	-	0.267	-	6.86	-267	776	20.5	-	-	-
MW20	342034.94	6272702.51	2.69	-	-	10-04-18	-	0.617	-	7.25	-257	794	24.6	-	-	-
MW20	342034.94	6272702.51	2.69	0.08	2.61	19-10-18	1.548	0.345	1.35	-	-	-	-	-	-	IP malfunction, PSH measured with bailer
MW20	342034.94	6272702.51	2.69	0.07	2.62	23-05-19	2.122	0.468	0.89	-	-	-	-	-	80.5	PSH present so not sampled
MW20	342034.94	6272702.51	2.69	0.07	2.62	31-10-19	2.053	0.458	0.95	-	-	-	-	-	-	PSH present so not sampled
MW20	342034.94	6272702.51	2.69	0.07	2.62	06-02-20	2.245	0.64	0.91	-	-	-	-	-	-	Gauge only
MW21	343029.12	6272699.84	2.79	-	-	12-09-16	-	0.342	-	7.13	-227	705	20.9	0.79	-	-
MW21	343029.12	6272699.84	2.79	-	-	14-02-17	-	0.593	-	7.12	-139.5	887.49	24.8	0.2	-	-
MW21	343029.12	6272699.84	2.79	-	-	29-08-17	-	0.205	-	6.91	-187	796	21.7	-	-	-
MW21	343029.12	6272699.84	2.79	-	-	10-04-18	-	0.709	-	7.11	-164	712	25.6	-	-	-
MW21	343029.12	6272699.84	2.79	0.092	2.698	19-10-18	1.68	-	-	-	-	-	-	-	-	Remediation system prevents sampling
MW21	343029.12	6272699.84	2.79	0.08	2.71	23-05-19	1.774	0.354	1.23	-	-	-	-	-	51	PSH present so not sampled
MW21	343029.12	6272699.84	2.79	0.08	2.71	31-10-19	1.986	0.271	0.95	-	-	-	-	-	-	PSH present so not sampled
MW21	343029.12	6272699.84	2.79	0.08	2.71	06-02-20	2.12	0.415	0.93	-	-	-	-	-	-	Gauge only
MW22	343028.28	6272731.99	2.67	-	-	12-09-16	-	0	-	7.03	-170	748	20.7	0.82	-	-
MW22	343028.28	6272731.99	2.67	-	-	14-02-17	-	0	-	6.89	-154.4	901.83	27.7	0.1	-	-
MW22	343028.28	6272731.99	2.67	-	-	29-08-17	-	0	-	7.01	-208	794	21.1	-	-	-
MW22	343028.28	6272731.99	2.67	-	-	10-04-18	-	0	-	7.08	-185	902	27.3	-	-	-
MW22	343028.28	6272731.99	2.67	0.091	2.579	18-10-18	1.61	0	0.97	7.09	-132.4	920	22.6	0.75	-	Sweet odour. Sampled by hydrasleeve
MW22	343028.28	6272731.99	2.67	0.085	2.585	23-05-19	1.70	0	0.88	6.88	-78	950	23.3	0.98	3	Faint HC, slightly turbid
MW22	343028.28	6272731.99	2.67	0.085	2.585	01-11-19	1.66	0	0.92	6.95	-141.4	920	22.6	0.06	-	Nil Turbidity, colourless, odourless
MW22	343028.28	6272731.99	2.67	0.085	2.585	06-02-20	1.72	0	0.86	-	-	-	-	-	-	Gauge only
MW23	343105.75	6272731.99	2.5	-	-	29-08-17		0	-	7	-223	817	19.4	-	-	-
MW23	343105.75	6272731.99	2.5	-	-	10-04-18		0	-	6.99	-177	976	15.1	-	-	-
MW23	343105.75	6272731.99	2.5	0.073	2.427	19-10-18	1.339	0	1.09	-	-	-	-	-	-	Guage only
MW23	343105.75	6272731.99	2.5	0.088	2.412	24-05-19	1.44	0	0.97	6.93	-73.3	911	21.1	0	0.3	Clear, colourless, odourless
MW23	343105.75	6272731.99	2.5	0.088	2.412	06-02-20	-	-	-	-	-	-	-	-	-	Inaccessible - Under new bus port
MW24	343094.78	6272718.13	2.54	-	-	29-08-17	-	0	-	7.28	-191	887	20.6	-	-	-
MW24	343094.78	6272718.13	2.54	-	-	10-04-18	-	0	-	7.07	-102	765	25.3	-	-	-
MW24	343094.78	6272718.13	2.54	0.085	2.455	19-10-18	1.37	0	1.09	7.19	-101.1	829	20.5	0.11	-	clear, no odour
MW24	343094.78	6272718.13	2.54	0.089	2.451	24-05-19	1.48	0	0.97	6.48	-51.3	818	23.1	0	0.2	Clear, colourless, odourless
MW24	343094.78	6272718.13	2.54	0.089	2.451	06-02-20	-	-	-	-	-	-	-	-	-	Inaccessible - Under new bus port
MW25	343007.79	6272705.16	2.75	-	-	12-09-16	-	0	-	7.3	-196	692	21	0.53	-	-
MW25	343007.79	6272705.16	2.75	-	-	14-02-17	-	0	-	7.16	-131.9	812.02	25.2	0.09	-	-
MW25	343007.79	6272705.16	2.75	-	-	29-08-17	-	0.005	-	7.13	-198	804	21.5	-	-	-
MW25	343007.79	6272705.16	2.75	-	-	10-04-18	-	0	-	7.24	-197	786	26	-	-	thin film
MW25	343007.79	6272705.16	2.75	0.116	2.634	19-10-18	1.654	0.06	1.03	-	-	-	-	-	-	IP malfunction, PSH measured with bailer
MW25	343007.79	6272705.16	2.75	0.08	2.67	23-05-19	1.905	0.145	0.89	-	-	-	-	-	52.2	PSH present so not sampled
MW25	343007.79	6272705.16	2.75	0.08	2.67	31-10-19	1.78	0.058	0.94	-	-	-	-	-	-	PSH present so not sampled
MW25	343007.79	6272705.16	2.75	0.08	2.67	06-02-20	1.904	0.099	0.85	-	-	-	-	-	-	Gauge only
MW26	343025.25	6272733.38	2.58	-	-	12-09-16	-	0	-	7.05	-192	711	19.7	0.75	-	-
MW26	343025.25	6272733.38	2.58	-	-	14-02-17	-	0	-	6.94	-139.2	868.81	26.5	0.07	-	-
MW26	343025.25	6272733.38	2.58	-	-	29-08-17	-	0	-	7.02	-207	825	20.5	-	-	-
MW26	343025.25	6272733.38	2.58	-	-	10-04-18	-	0	-	7.01	-110	895	26.8	-	-	-
MW26	343025.25	6272733.38	2.58	0.088	2.492	19-10-18	1.564	0	0.93	7.04	-139.3	908	21	0.1	-	clear, slight H2S odour
MW26	343025.25	6272733.38	2.58	0.078	2.502	23-05-19	1.654	0	0.85	6.98	-142.2	965	24.5	0	1.1	light brown, slightly turbid, odourless
MW26	343025.25	6272733.38	2.58	0.078	2.502	31-10-19	1.623	0	0.88	6.97	-133.3	876	21.1	0.16	-	Clear, colourless, odourless
MW26	343025.25	6272733.38	2.58	0.078	2.502	06-02-20	1.671	0	0.83	-	-	-	-	-	-	Gauge only
MW27	-	-	-	-	-	06-02-20	-	-	-	-	-	-	-	-	-	Inaccessible - Under new bus port
MW28	-	-	-	-	-	07-02-20	2.085	0.431	-	7.14	126.8	722	20.2	0.04	-	strong odour, turbid, brown
MW29	-	-	-	-	-	07-02-20	1.804	0	-	6.94	76.4	926	21.4	0	-	very strong odour
MW30	-	-	-	-	-	07-02-20	1.995	0.291	-	6.19	-92.1	855	19.9	0	-	strong odour, turbid, brown
MW31	-	-	-	-	-	07-02-20	2.486	0.797	-	6.65	-132.1	839	20.9	0	-	strong odour, highly turbid, brown, sheen
MW32	-	-	-	-	-	07-02-20	2.302	0.497	-	7.17	-173.9	2665	20.2	0	-	odour, highly turbid, brown
MW33	-	-	-	-	-	07-02-20	1.908	0.123	-	6.92	38.1	921	20.4	0.01	-	strong odour, highly turbid, brown
MW35	-	-	-	-	-	07-02-20	1.785	0	-	7.53	-151.8	658	20.9	0.02	-	-
MW36 [1]	-	-	-	-	-	07-02-20	-	-	-	-	-	-	-	-	-	Dry
MW37 [1]	-	-	-	-	-	07-02-20	-	-	-	-	-	-	-	-	-	Dry
S01	-	-	-	-	-	07-02-20	-	-	-	7.81	124.9	2769	18.0	3.22	-	Surface water samples - upstream of site
S02	-	-	-	-	-	07-02-20	-	-	-	7.81	138.2	2941	17.9	3.50	-	Surface water samples - onsite
S03	-	-	-	-	-	07-02-20	-	-	-	7.97	137.1	2731	17.3	3.70	-	Surface water sample - downstream of site

TOC = Top of Casing
mAHD = metres above the Australian Height Datum
mTOC = metres below Top of Casing
mBGL = metres below ground level
1. Wells installed adjacent to underground service trench

			Heavy Metals								TPH		TRH				BTEX						PAHs		
			Arsenic - Dissolved	Cadmium - Dissloved	Chromium - Dissolved	Copper - Dissolved	Lead - Dissolved	Mercury - Dissolved	Nickel - Dissolved	Zinc - Dissolved	TRH C6-C9	TRH C10-C36	F1 TRH C6-C10	F2 TRH >C10-C16	F3 TRH >C16-C34	F4 TRH >C34-C40	Benzene	Toluene	Ethylbenzene	m+p-xylene	o-xylene	Total xylene	Naphthalene	Benzo(a)pyrene	Total PAH
Units			µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Laboratory PQL			1	0.1	1	1	1	0.1	1	1	10	125	10	50	100	100	1	1	1	2	1	3	1	1	0.1
NEPM Groundwater HSLs for Vapour Intrusion (Sand - 2m - <4m)													6000	NL			5000	NL	NL	NL	NL	NL	NL		
NEPM GIL Drinking Water			10	2	50	2000	10	1	20								1	800	300			600			
NEPM GIL Marine Waters			13*	0.7	4.4	1.3	4.4	0.1	7	15							500			200*	350*		50		
ANZECC 2018 - Marine (95% species protection)			13*	5.5	4.4	1.3	4.4	0.4	70	15							700	180	5	200*	350*		70		
Lab Report.	Well ID	Date																							
67411	MW01	10-01-12	11	<0.1	<1	<1	<1	<0.05	<1	<1	<10	4900	-	-	-	-	<1	<1	<1	<2	<1	<3	33	<1	68
77958	MW01	24-08-12	-	-	-	-	-	-	-	-	<10	1280	-	-	-	-	<1	<1	<1	<2	<1	<3	3	<1	13
203543	MW01	19-10-18	44	<0.1	<1	<1	<1	<0.05	<1	5	<10	3600	29	1900	1600	<100	<1	<1	<1	<2	<1	-	16		
218279	MW01	23/05/2019	11	<0.1	<1	<1	<1	<0.05	<1	4	<10	680	25	440	220	<100	<1	<1	<1	<2	<1	<3	3		
229899	MW01	31-10-19	23	<0.1	<1	<1	<1	<0.05	<1	4	<10	510	<10	310	190	<100	<1	<1	<1	<2	<1	<3	<1	-	-
67411	MW02	10-01-12	41	<0.1	<1	<1	<1	<0.05	2	<1	<10	<250	-	-	-	-	<1	<1	<1	<2	<1	<3	<1	<1	ND
77958	MW02	24-08-12	-	-	-	-	-	-	-	-	<10	<250	-	-	-	-	<1	<1	<1	<2	<1	<3	<1	<1	ND
218279	MW02	23/05/2019	18	<0.1	<1	<1	<1	<0.05	<1	3	<10	<250	<10	<50	<100	<100	<1	<1	<1	<2	<1	<3	<1		
229899	MW02	31-10-19	11	<0.1	<1	<1	<1	<0.05	<1	3	<10	<250	<10	<50	<100	<100	<1	<1	<1	<2	<1	<3	<1	-	-
67411	MW03	10-01-12	5	<0.1	<1	<1	<1	<0.05	2	<1	<10	<250	-	-	-	-	<1	<1	<1	<2	<1	<3	<1	<1	ND
77958	MW03	24-08-12	-	-	-	-	-	-	-	-	<10	<250	-	-	-	-	<1	<1	<1	<2	<1	<3	<1	<1	ND
203543	MW03	19-10-18	4	<0.1	<1	<1	<1	<0.05	1	7	<10	<250	<10	<50	<100	<100	<1	<1	<1	<2	<1	-	<1		
218279	MW03	23/05/2019	3	<0.1	<1	<1	<1	<0.05	1	4	<10	<250	<10	<50	<100	<100	<1	<1	<1	<2	<1	<3	<1		
67411	MW04	10-01-12	4	<0.1	<1	<1	<1	<0.05	<1	<1	<10	<250	-	-	-	-	<1	<1	<1	<2	<1	<3	<1	<1	ND
77958	MW04	24-08-12	-	-	-	-	-	-	-	-	<10	<250	-	-	-	-	<1	<1	<1	<2	<1	<3	<1	<1	ND
-	MW05	24-08-12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
77958	MW06	24-08-12	-	-	-	-	-	-	-	-	<10	<250	-	-	-	-	<1	<1	<1	<2	<1	<3	<1	<1	ND
77958	MW07	24-08-12	-	-	-	-	-	-	-	-	41	2110	-	-	-	-	4	<1	<1	<2	<1	<3	140	<1	156
203543	MW07	19-10-18	74	<0.1	<1	<1	<1	<0.05	<1	5	16	4800	38	2700	2100	<100	<1	<1	<1	<2	<1	-	44	-	-
218279	MW07	23/05/2019	98	<0.1	<1	<1	<1	<0.05	<1	3	<10	1220	33	720	450	<100	<1	<1	<1	<2	<1	<3	45		
229899	MW07	31-10-19	65	<0.1	<1	<1	<1	<0.05	<1	3	<10	1310	<10	700	570	<100	<1	<1	<1	<2	<1	<3	<1	-	-
81841	MW08	19-11-12	-	-	-	-	-	-	-	-	<10	1070	-	-	-	-	<1	<1	<1	<2	<1	<3	8	<1	16
112083	MW08-B	21-06-14	5	<0.1	2	5	3	<0.05	4	16	<10	570	12	290	220	<100	<1	<1	<1	<2	<1	<3	1	-	-
117589	MW08-B	13-10-14	2	<0.1	<1	<1	<1	<0.05	2	3	<10	<125	<10	<50	<100	<100	<1	<1	<1	<2	<1	<3	<1	-	-
123376	MW08-B	11-02-15	5	<0.1	<1	<1	<1	<0.05	1	2	<10	495	<10	<50	410	<100	<1	5	<1	<2	<1	<3	<1	-	-
138949	MW08-B	09-12-15	5	<0.1	<1	<1	<1	<0.05	<1	<1	<10	290	<10	150	200	<100	<1	<1	<1	<2	<1	<3	<1	-	-
104302	MW09	30-01-14	6	<0.1	<1	<1	<1	<0.05	13	3	27	44600	88	22000	21000	<100	<1	<1	<1	<2	<1	<3	600	-	-
112083	MW09	21-06-14	42	<0.1	<1	<1	<1	<0.05	5	5	38	19150	64	9500	9000	<100	<1	<1	<1	<2	<1	<3	78	-	-
117589	MW09	13-10-14	64	<0.1	<1	<1	<1	<0.05	4	7	27	48850	51	24000	24000	<100	1	<1	<1	<2	<1	<3	89	-	-
123376	MW09	11-02-15	53	<0.1	<1	<1	<1	<0.05	4	1	38	174340	80	85000	81000	<100	<1	<1	<1	<2	<1	<3	180	-	-
138949	MW09	09-12-15	67	<0.1	<1	<1	<1	<0.05	1	<1	22	6600	55	4100	2600	<100	<1	<1	<1	<2	<1	<3	150	-	-
153522	MW09	12-09-16	57	<0.1	<1	<1	<1	<0.05	<1	<1	19	13400	66	6100	7200	<100	<1	<1	<1	<2	<1	<3	190	-	-
161939	MW09	14-02-17	54	<0.1	<1	<1	<1	<0.05	<1	3	25	56100	68	30000	26000	<100	<1	<1	<1	<2	<1	<3	120	-	-
174472	MW09	29-08-17	26	<0.1	<1	<1	<1	<0.05	1	1	16	9200	39	4600	4600	<100	<1	<1	<1	<2	<1	<3	86	-	-
189182	MW09	10-04-18	36	<0.1	<1	<1	<1	<0.05	3	<1	33	29400	100	17000	13000	<100	<1	<1	<1	<2	<1	<3	120	-	-
81841	MW10	02-04-13	-	-	-	-	-	-	-	-	<10	5650	-	-	-	-	1	<1	<1	<2	<1	<3	46	<1	92
104302	MW10	30-01-14	4	<0.1	<1	<1	<1	<0.05	6	4	22	17980	65	8000	9500	<100	2	<1	<1	<2	<1	<3	190	-	-
112083	MW10	21-06-14	25	<0.1	<1	<1	<1	<0.05	1	5	23	36620	41	19000	17000	<100	<1	<1	<1	<2	<1	<3	86	-	-
117589	MW10	13-10-14	30	<0.1	<1	<1	<1	<0.05	2	2	21	36550	43	19000	17000	<100	1	<1	<1	<2	<1	<3	83	-	-
123376	MW10	11-02-15	38	<0.1	<1	<1	<1	<0.05	1	2	15	18950	46	8900	9500	<100	1	<1	<1	<2	<1	<3	120	-	-
138949	MW10	09-12-15	35	<0.1	<1	<1	<1	<0.05	1	2	11	12400	37	6900	5900	<100	<1	<1	<1	<2	<1	<3	68	-	-
153522	MW10	12-09-16	31	<0.1	<1	<1	<1	<0.05	1	<1	15	8500	47	3800	4800	<100	<1	<1	<1	<2	<1	<3	120	-	-
161939	MW10	14-02-17	51	<0.1	<1	<1	<1	<0.05	<1	1	<10	28900	<10	14000	13000	<100	<1	<1	<1	<2	<1	<3	140	-	-
174472	MW10	29-08-17	39	<0.1	<1	<1	<1	<0.05	1	1	28	9300	67	4600	4600	<100	<1	<1	<1	<2	<1	<3	140	-	-
189182	MW10	10-04-18	50	<0.1	<1	<1	<1	<0.05	1	1	10	76000	53	44000	35000	<100	<1	<1	<1	<2	<1	<3	94	-	-
229899	MW10	31-10-19	32	<0.1	<1	<1	<1	<0.05	2	3	<10	690	<10	360	300	<100	<1	<1	<1	<2	<1	<3	<1	-	-
81841	MW11	19-11-12	-	-	-	-	-	-	-	-	<10	490	-	-	-	-	<1	<1	<1	<2	<1	<3	18	<1	22
104302	MW11	30-01-14	10	<0.1	<1	<1	<1	<0.05	5	4	<10	1080	27	720	400	<100	<1	<1	<1	<2	<1	<3	<1	-	-
112083	MW11	21-06-14	100	<0.1	<1	<1	<1	<0.05	1	7	10	1280	28	770	380	<100	<1	<1	<1	<2	<1	<3	13	-	-
117589	MW11	13-10-14	120	<0.1	<1	<1	<1	<0.05	5	5	29	408	78	150	200	<100	<1	<1	<1	<2	<1	<3	18	-	-
123376	MW11	11-02-15	220	<0.1	<1	<1	<1	<0.05	2	2	<10	1310	42	810	450	<100	<1	<1	<1	<2	<1	<3	<1	-	-
138949	MW11	09-12-15	140	<0.1	<1	<1	<1	<0.05	1	<1	<10	1210	41	960	280	<100	<1	<1	<1	<2	<1	<3	5	-	-
81841	MW12	19-11-12	-	-	-	-	-	-	-	-	<10	<250	-	-	-	-	<1	<1	<1	<2	<1	<3	<1	<1	ND
104302	MW12	30-01-14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
112083	MW12	21-06-14	11	<0.1	1	1	2	<0.05	1	11	22	<125	25	<50	<100	<100	<1	2	<1	<2	<1	<3	<1	-	-
117589	MW12	13-10-14	6	<0.1	<1	<1	<1	<0.05	<1	<1	<10	<125	<10	<50	<100	<100	<1	<1	<1	<2	<1	<3	<1	-	-
123376	MW12	11-02-15	6	<0.1	<1	<1	<1	<0.05	2	2	<10	<125	<10	<50	<100	<100	<1	<1	<1	<2	<1	<3	<1	-	-
138949	MW12	09-12-15	5	<0.1	<1	<1	<1	<0.05	1	1	<10	<100	<10	<50	<100	<100	<1	<1	<1	<2	<1	<3	<1	-	-
203543	MW12	18-10-18	3	<0.1	<1	<1	<1	<0.05	<1	4	<10	<250	<10	<50	<100	<100	<1	<1	<1	<2	<1	<3	<1	-	-
218279	MW12	23/05/2019	2	<0.1	<1	<1	<1	<0.05	<1	5	<10	<250	<10	<50	<100	<100	<1	<1	<1	<2	<1	<3	<1	-	-
229899	MW12	31-10-19	3	<0.1	<1	<1	<1	<0.05	<1	6	<10	<250	<10	<50	<100	<100	<1	<1	<1	<2	<1	<3	<1	-	-
100305	MW15	02-11-13	<1	0.1	2	8	2	<0.05	2	110	<10	680	<10	290	380	<100	<1	<1	<1	<2	<1	<3	<1	<1	2.3
104302	MW15	30-01-14	<1	<0.1	<1	1	<1	<0.05	14	11	<10	470	<10	290	200	<100	<1	<1	<1	<2	<1	<3	16	-	-
112083	MW15	21-06-14	<1	<0.1	<1	1	<1	<0.05	3	7	<10	245	<10	58	130	<100	<1	<1	<1	<2	<1	<3	<1	-	-
117589	MW15	13-10-14	<1	<0.1	<1	<1	<1	<0.05	3	2	<10	<125	<10	<50	<100	<100	<1	<1	<1	<2	<1	<3	<1	-	-
123376	MW15	11-02-15	<1	<0.1	<1	1	<1	<0.05	1	3	<10	<125	<10	<50	120	<100	<1	<1	<1	<2	<1	<3	<1	-	-
138949	MW15	09-12-15	<1	<0.1	<1	1	<1	<0.05	<1	<1	<10	<100	<10	<50	<100	<100	<1	<1	<1	<2	<1	<3	<1	-	-
218279	MW15	23/05/2019	<1	<0.1	<1	<1	<1	<0.05	<1	3	<10	1558	<10	170	1400	<100	<1	<1	<1	<2	<1	<3	<1	-	-

			Heavy Metals								TPH		TRH				BTEX						PAHs		
			Arsenic - Dissolved	Cadmium - Dissloved	Chromium - Dissolved	Copper - Dissolved	Lead - Dissolved	Mercury - Dissolved	Nickel - Dissolved	Zinc - Dissolved	TRH C6-C9	TRH C10-C36	F1 TRH C6-C10	F2 TRH >C10-C16	F3 TRH >C16-C34	F4 TRH >C34-C40	Benzene	Toluene	Ethylbenzene	m+p-xylene	o-xylene	Total xylene	Naphthalene	Benzo(a)pyrene	Total PAH
Units			µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Laboratory PQL			1	0.1	1	1	1	0.1	1	1	10	125	10	50	100	100	1	1	1	2	1	3	1	1	0.1
NEPM Groundwater HSLs for Vapour Intrusion (Sand - 2m - <4m)													6000	NL			5000	NL	NL	NL	NL	NL	NL		
NEPM GIL Drinking Water			10	2	50	2000	10	1	20								1	800	300			600			
NEPM GIL Marine Waters			13*	0.7	4.4	1.3	4.4	0.1	7	15							500			200*	350*		50		
ANZECC 2018 - Marine (95% species protection)			13*	5.5	4.4	1.3	4.4	0.4	70	15							700	180	5	200*	350*		70		
Lab Report.	Well ID	Date																							
229899	MW15	31-10-19	<1	<0.1	<1	<1	<1	<0.05	<1	4	<10	2400	<10	140	2,300	<100	<1	<1	<1	<2	<1	<3	<1	-	-
100305	MW16	02-11-13	17	<0.1	<1	<1	1	<0.05	15	25	15	3890	17	1500	2300	<100	1	<1	<1	<2	<1	<3	<1	<1	1.4
104302	MW16	30-01-14	8	<0.1	<1	<1	<1	<0.05	21	8	15	4640	33	1700	2900	<100	<1	<1	<1	<2	<1	<3	34	-	-
112083	MW16	21-06-14	37	<0.1	<1	<1	<1	<0.05	10	5	27	3300	37	1300	1900	<100	<1	<1	<1	<2	<1	<3	4	-	-
117589	MW16	13-10-14	33	<0.1	<1	<1	<1	<0.05	11	22	22	2740	39	810	1900	<100	<1	<1	<1	<2	<1	<3	3	-	-
123376	MW16	11-02-15	46	<0.1	<1	<1	<1	<0.05	14	2	19	2010	34	890	990	<100	<1	<1	<1	<2	<1	<3	1	-	-
138949	MW16	09-12-15	42	<0.1	2	<1	<1	<0.05	9	1	12	2470	19	1200	1300	<100	<1	<1	<1	<2	<1	<3	2	-	-
203543	MW16	18-10-18	41	<0.1	<1	<1	<1	<0.05	8	4	27	1340	41	570	870	<100	<1	<1	<1	<2	<1	<3	<1	-	-
218279	MW16	23/05/2019	60	<0.1	<1	<1	<1	<0.05	7	3	<10	2030	<10	950	1100	<100	<1	<1	<1	<2	<1	<3	<1	-	-
229899	MW16	31-10-19	71	<0.1	<1	<1	<1	<0.05	6	4	23	2350	34	990	1,300	<100	<1	<1	<1	<2	<1	<3	<1	-	-
100305	MW17	02-11-13	3	<0.1	1	2	<1	<0.05	3	9	<10	<125	<10	<50	<100	<100	<1	<1	<1	<2	<1	<3	<1	<1	-
104302	MW17	30-01-14	2	<0.1	<1	2	<1	<0.05	9	8	<10	<125	<10	<50	<100	<100	<1	<1	<1	<2	<1	<3	<1	-	-
112083	MW17	21-06-14	2	<0.1	<1	3	1	<0.05	7	43	<10	2540	<10	1200	1300	<100	<1	<1	<1	<2	<1	<3	5	-	-
117589	MW17	13-10-14	2	<0.1	<1	3	<1	<0.05	2	16	<10	<125	<10	<50	<100	<100	<1	<1	<1	<2	<1	<3	<1	-	-
123376	MW17	11-02-15	2	<0.1	<1	3	<1	<0.05	9	27	<10	<125	<10	<50	100	<100	<1	<1	<1	<2	<1	<3	<1	-	-
138949	MW17	09-12-15	2	<0.1	<1	2	<1	<0.05	<1	3	<10	<100	<10	<50	<100	<100	<1	<1	<1	<2	<1	<3	1	-	-
203543	MW17	19-10-18	2	<0.1	<1	1	<1	<0.05	<1	4	<10	<250	<10	<50	<100	<100	<1	<1	<1	<2	<1	<3	>1	-	-
218279	MW17	23/05/2019	2	<0.1	<1	<1	<1	<0.05	<1	3	<10	<250	<10	<50	<100	<100	<1	<1	<1	<2	<1	<3	<1	-	-
229899	MW17	31-10-19	2	<0.1	<1	1	<1	<0.05	<1	4	<10	<250	<10	<50	<100	<100	<1	<1	<1	<2	<1	<3	<1	-	-
138949	MW18	09-12-15	27	<0.1	<1	<1	<1	<0.05	3	2	<10	9000	<10	5400	3900	<100	<1	<1	<1	<2	<1	<3	16	-	-
138949	MW19	09-12-15	36	<0.1	<1	<1	<1	<0.05	<1	2	<10	4100	18	2700	1600	<100	<1	1	1	<2	1	<3	53	-	-
153522	MW19	12-09-16	37	<0.1	<1	<1	<1	<0.05	<1	<1	<10	1680	27	500	1200	<100	<1	<1	<1	<2	<1	<3	44	-	-
161939	MW19	14-02-17	28	<0.1	<1	<1	<1	<0.05	<1	2	20	65000	63	35000	30000	<100	<1	<1	1	<2	<1	<3	100	-	-
174472	MW19	29-08-17	25	<0.1	<1	<1	<1	0.2	<1	1	18	10700	50	5300	5400	<100	<1	<1	<1	<2	<1	<3	74	-	-
189182	MW19	10-04-18	26	<0.1	<1	<1	<1	<0.05	<1	2	23	11800	64	6900	5200	<100	<1	<1	<1	<2	<1	<3	89	-	-
153522	MW20	12-09-16	36	<0.1	<1	<1	<1	<0.05	3	<1	10	43720	40	22000	22000	<100	<1	<1	<1	<2	<1	<3	140	-	-
161939	MW20	14-02-17	59	<0.1	<1	<1	<1	<0.05	3	1	23	7600	49	4100	3400	<100	<1	<1	<1	<2	<1	<3	82	-	-
174472	MW20	29-08-17	35	<0.1	<1	<1	<1	<0.05	2	1	37	21400	78	12000	9800	<100	<1	<1	<1	<2	<1	<3	130	-	-
189182	MW20	10-04-18	45	<0.1	<1	<1	<1	<0.05	2	<1	27	46000	87	27000	20000	<100	<1	<1	<1	<2	<1	<3	200	-	-
153522	MW21	12-09-16	17	<0.1	<1	<1	<1	<0.05	3	<1	<10	3440	25	1500	1900	<100	<1	<1	<1	<2	<1	<3	94	-	-
161939	MW21	14-02-17	14	<0.1	<1	<1	<1	<0.05	3	3	<10	426840	22	230000	200000	280	<1	<1	<1	<2	<1	<3	130	-	-
174472	MW21	29-08-17	17	<0.1	<1	<1	<1	<0.05	3	1	16	12800	33	6300	6500	<100	<1	<1	<1	<2	<1	<3	47	-	-
189182	MW21	10-04-18	22	<0.1	<1	<1	<1	<0.05	2	1	<10	43000	50	25000	20000	<100	<1	<1	<1	<2	<1	<3	94	-	-
153522	MW22	12-09-16	40	<0.1	<1	<1	<1	<0.05	3	2	<10	680	<10	250	430	<100	<1	<1	<1	<2	<1	<3	<1	-	-
161939	MW22	14-02-17	66	<0.1	<1	<1	<1	<0.05	2	3	11	690	20	390	270	<100	<1	<1	<1	<2	<1	<3	8	-	-
174472	MW22	29-08-17	60	<0.1	<1	<1	<1	<0.05	2	2	16	690	35	390	280	<100	<1	<1	<1	<2	<1	<3	12	-	-
189182	MW22	10-04-18	37	<0.1	<1	<1	<1	<0.05	2	1	<10	300	<10	220	<100	<100	<1	<1	<1	<2	<1	<3	2	-	-
203543	MW22	18-10-18	57	<0.1	<1	<1	<1	<0.05	3	16	11	1230	28	470	710	<100	<1	<1	<1	<2	<1	<3	7	-	-
218279	MW22	23/05/2019	49	<0.1	<1	<1	<1	<0.05	3	5	<10	870	26	510	360	<100	<1	<1	<1	<2	<1	<3	2	-	-
174472	MW23	29-08-17	4	<0.1	<1	<1	<1	<0.05	<1	2	<10	100	<10	<50	<100	<100	<1	<1	<1	<2	<1	<3	<1	-	-
189182	MW23	10-04-18	3	<0.1	<1	<1	<1	<0.05	<1	2	<10	<100	<10	<50	<100	<100	<1	<1	<1	<2	<1	<3	<1	-	-
218279	MW23	23/05/2019	2	<0.1	<1	<1	<1	<0.05	<1	5	<10	<250	<10	<50	<100	<100	<1	<1	<1	<2	<1	<3	<1	-	-
174472	MW24	29-08-17	6	<0.1	<1	<1	<1	<0.05	<1	1	<10	100	<10	<50	<100	<100	<1	<1	<1	<2	<1	<3	<1	-	-
189182	MW24	10-04-18	6	<0.1	<1	<1	<1	<0.05	<1	<1	<10	<100	<10	<50	<100	<100	<1	<1	<1	<2	<1	<3	<1	-	-
203543	MW24	19-10-18	4	<0.1	<1	<1	<1	<0.05	<1	7	<10	<250	<10	<50	<100	<100	<1	<1	<1	<2	<1	<3	<1	-	-
218279	MW24	23/05/2019	4	<0.1	<1	<1	<1	<0.05	<1	4	<10	<250	<10	<50	<100	<100	<1	<1	<1	<2	<1	<3	<1		
153522	MW25	12-09-16	8	<0.1	<1	<1	<1	<0.05	<1	<1	<10	380	<10	97	320	<100	<1	<1	<1	<2	<1	<3	1	-	-
161939	MW25	14-02-17	8	<0.1	<1	<1	<1	<0.05	<1	1	<10	450	<10	150	290	<100	<1	<1	<1	<2	<1	<3	<1	-	-
174472	MW25	29-08-17	8	<0.1	<1	<1	<1	<0.05	<1	2	<10	1390	<10	690	710	<100	<1	<1	<1	<2	<1	<3	6	-	-
189182	MW25	10-04-18	11	<0.1	<1	<1	<1	<0.05	1	1	12	4700	20	2700	2100	<100	<1	<1	<1	<2	<1	<3	30	-	-
153522	MW26	12-09-16	47	<0.1	<1	<1	<1	<0.05	2	2	<10	407	<10	150	270	<100	<1	<1	<1	<2	<1	<3	<1	-	-
161939	MW26	14-02-17	41	<0.1	<1	<1	<1	<0.05	1	1	<10	297	<10	170	110	<100	<1	<1	<1	<2	<1	<3	<1	-	-
174472	MW26	29-08-17	48	<0.1	<1	<1	<1	<0.05	2	2	12	500	23	290	210	<100	<1	<1	<1	<2	<1	<3	<1	-	-
189182	MW26	10-04-18	46	<0.1	<1	<1	<1	<0.05	1	<1	10	300	15	220	<100	<100	<1	<1	<1	<2	<1	<3	1	-	-
203543	MW26	19-10-18	40	<0.1	<1	<1	<1	<0.05	2	3	12	560	28	260	260	240	<1	<1	<1	<2	<1	<3	<1	-	-
218279	MW26	23/05/2019	46	<0.1	<1	<1	<1	<0.05	2	3	<10	460	<10	280	180	<100	<1	<1	<1	<2	<1	<3	<1	-	-
229899	MW26	31-10-19	42	<0.1	<1	<1	<1	<0.05	2	2	<10	370	<10	290	250	<100	<1	<1	<1	<2	<1	<3	<1	-	-
236498	MW28	07-02-20	28	<0.1	<1	<1	<1	<0.05	2	3	<10	1830	<10	830	970	<100	<1	<1	<1	<2	<1	<3	<1	-	-
236498	MW29	07-02-20	8	<0.1	<1	<1	<1	<0.05	2	1	<10	8100000	<10	4000000	3000000	20000	<1	<1	<1	<2	<1	<3	<1	-	-
236498	MW30	07-02-20	7	<0.1	<1	<1	<1	<0.05	<1	<1	20	51110	67	28000	22000	110	<1	<1	<1	<2	1	1	4	-	-
236498	MW31	07-02-20	4	<0.1	<1	<1	<1	<0.05	<1	<1	<10	2600000	26	2000000	1000000	<10,000	<1	<1	<1	<2	<1	<3	210	-	-
236498	MW32	07-02-20	1	<0.1	<1	2	<1	<0.05	<1	1	<10	11420	<10	5100	6200	<100	<1	<1	<1	<2	<1	<3	<1	-	-
236498	MW33	07-02-20	2	<0.1	<1	1	<1	<0.05	<1	2	<10	101110	<10	52000	47000	<100	<1	<1	<1	<2	<1	<3	<1	-	-
236498	MW35	07-02-20	<1	<0.1	<1	9	<1	<0.05	<1	29	48	263	59	53	240	150	<1	2	<1	<2	<1	<3	<1	-	-

			Heavy Metals								TPH		TRH				BTEX						PAHs		
			Arsenic - Dissolved	Cadmium - Dissloved	Chromium - Dissolved	Copper - Dissolved	Lead - Dissolved	Mercury - Dissolved	Nickel - Dissolved	Zinc - Dissolved	TRH C6-C9	TRH C10-C36	F1 TRH C6-C10	F2 TRH >C10-C16	F3 TRH >C16-C34	F4 TRH >C34-C40	Benzene	Toluene	Ethylbenzene	m+p-xylene	o-xylene	Total xylene	Naphthalene	Benzo(a)pyrene	Total PAH
Units			µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Laboratory PQL			1	0.1	1	1	1	0.1	1	1	10	125	10	50	100	100	1	1	1	2	1	3	1	1	0.1
NEPM Groundwater HSLs for Vapour Intrusion (Sand - 2m - <4m)													6000	NL	100		5000	NL	NL	NL	NL	NL	NL		
NEPM GIL Drinking Water			10	2	50	2000	10	1	20								1	800	300			600			
NEPM GIL Marine Waters			13*	0.7	4.4	1.3	4.4	0.1	7	15							500			200*	350*		50		
ANZECC 2018 - Marine (95% species protection)			13*	5.5	4.4	1.3	4.4	0.4	70	15							700	180	5	200*	350*		70		
Lab Report.	Well ID	Date																							
236498	**S01**	**07-02-20**	3	<0.1	2	10	1	<0.5	<1	42	<10	<250	<10	<50	<100	<100	<1	<1	<1	<2	<1	<3	<1	-	-
236489	**S02**	**07-02-20**	3	<0.1	2	11	1	<0.5	<1	40	<10	<250	<10	<50	<100	<100	<1	<1	<1	<2	<1	<3	<1	-	-
236498	**S03**	**07-02-20**	2	<0.1	1	10	<1	<0.05	<1	40	<10	<250	<10	<50	<100	<100	<1	<1	<1	<2	<1	<3	<1	-	-

			Miscellaneous											MNA Indicators (mg/L)														
			Electrical Conductivity (Lab)	Electrical Conductivity (field)	Electrical Conductivity (lab : field) ratio	pH (Lab)	pH (Field)	pH (lab : field) ratio	Total Dissolved Solids	EC:TDS Ratio	Dissolved Iron	Disolved Manganese	Biochemical Oxygen Demand	Methane	Calcium (Filtered)	Magnesium (Filtered)	Potassium (Filtered)	Sodium (Filtered)	Ammonia	Bicarbonate Alkalinity as CaCO3	Carbonate alkalinity as CaCO3	Hydroxide	Chloride	Fluoride	Sulfate	Nitrate (as N)	Nitrite (as N)	Phosphate (as P)	Alkalinity (total)
Units			µS/cm	µS/cm	µS/cm	pH Units	pH Units	%	mg/L		mg/L	mg/L	mg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Laboratory PQL			2	0.1		0.1	0.01	0.1	2		0.05	0.05	5	5	0.1	0.1	0.2	0.1	0.01	5	1	5	1	0.02	1	0.005	0.005	0.005	5
NEPM Groundwater HILs for Drinking Water			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.5	500	11.3	0.91	-	-
ANZG 2018 - Marine (95% species protection)			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.91	-	-	-	-	-	-	0.158	-	-	-
NEPM GIL Marine Waters			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.91	-	-	-	-	-	-	-	-	-	-
Lab Report.	Well ID	Date																											
229899	MW01	31-10-19	830	839	0.989273	7	6.87	1.018923	370	0.445783	9	110	<5	2200	120	7.5	5.4	41	0.55	360	<5	<5	46	0.2	13	0.04	0.015	<0.005	360
229899	MW02	31-10-19	630	546	1.153846	7.3	7.3	1	370	0.587302	3.3	17	7	98	79	4.7	3.6	15	1.6	310	<5	<5	20	0.5	9	<0.005	<0.005	<0.005	310
229899	MW07	31-10-19	810	762	1.062992	7	6.88	1.017442	400	0.493827	16	28	7	2000	140	6.9	3.9	20	1.9	410	<5	<5	21	0.3	16	<0.005	<0.005	<0.005	410
229899	MW10	31-10-19	930	-	-	6.9	-	-	470	0.505376	14	47	6	1800	140	14	5	35	3.7	430	<5	<5	31	0.3	37	<0.005	<0.005	<0.005	430
229899	MW12	31-10-19	1,900	1688	1.125592	7.3	7.06	1.033994	950	0.5	4.8	82	<5	56	150	40	10	180	1.1	460	<5	<5	270	0.5	42	<0.005	<0.005	<0.005	460
229899	MW15	31-10-19	1,300	1302	0.998464	7.1	6.81	1.042584	750	0.576923	<0.01	260	<5	21	160	24	6.1	82	0.29	440	<5	<5	120	<0.1	69	0.17	<0.005	0.006	440
229899	MW16	31-10-19	710	724	0.980663	7.2	6.99	1.030043	400	0.56338	11	20	34	2700	110	12	3.7	19	6.6	360	<5	<5	20	0.3	<1	<0.005	<0.005	<0.005	360
229899	MW17	31-10-19	980	940	1.042553	7.4	7.2	1.027778	600	0.612245	<0.01	190	<5	<5	140	13	3.4	47	0.035	350	<5	<5	73	0.1	42	0.91	0.034	0.1	350
229899	MW26	31-10-19	910	876	1.038813	7.2	6.97	1.032999	490	0.538462	11	27	33	690	140	15	4.5	36	2.6	460	<5	<5	31	0.4	6	<0.005	<0.005	<0.005	460
236498	MW28	07-02-20	830	722	1.149584	7.5	7.14	1.05042	490	0.590361	4400	43	9	29	130	12	3.5	21	0.89	420	<5	<5	34	2.2	20	<0.005	<0.005	0.012	420
236498	MW29	07-02-20	770	926	0.831533	7.3	6.95	1.05036	490	0.636364	400	81	810	2100	140	6.6	3.5	19	0.71	480	<5	<5	25	2	6	<0.005	<0.005	<0.050	480
236498	MW30	07-02-20	850	855	0.994152	7.5	6.19	1.211632	470	0.552941	97	55	6	<5	110	16	5.1	47	<0.005	360	<5	<5	82	3.1	36	<0.005	<0.005	0.011	360
236498	MW31	07-02-20	810	839	0.965435	7.1	6.63	1.07089	450	0.555556	150	99	1,800	160	130	13	3.5	12	4	400	<5	<5	27	2.5	9	<0.005	<0.005	<0.005	400
236498	MW32	07-02-20	960	2665	0.360225	7.4	7.17	1.032078	700	0.729167	31	190	28	21	150	18	2.8	42	0.47	450	<5	<5	70	2	50	0.02	0.015	<0.005	450
236498	MW33	07-02-20	660	921	0.716612	7.4	6.92	1.069364	410	0.621212	17	140	31	960	110	11	1.9	15	2.7	340	<5	<5	24	1.7	2	<0.005	<0.005	<0.005	340
236498	MW35	07-02-20	250	658	0.379939	7.1	7.53	0.942895	190	0.76	28	12	20	<5	22	4.1	5.8	12	<0.005	28	<5	<5	22	<0.1	23	6.6	0.013	0.071	28

			Cations (milliequivalents)					Anions (milliequivalents)									Ionic Balance and Ratios							
			Calcium	Magnesium	Potassium	Sodium	Ammonia	Bicarbonate	Carbonate	Hydroxide	Chloride	Fluoride	Sulfate	Nitrate	Nitrite	Phosphate	Sum Cations	Sum Anions	Ionic Balance	Alkalinity:Sum of Anions	NO3:Sum of Anions	NH4:Sum of Cations	SO4:Sum Anions	Leachate:Native cations (L:N)
Units			meq	meq	meq	meq	meq	meq	meq	meq	meq	meq	meq	meq	meq	meq	meq	meq	%	%	%	%	%	%
Laboratory PQL																								
NEPM Groundwater HILs for Drinking Water			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ANZG 2018 - Marine (95% species protection)			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPM GIL Marine Waters			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lab Report.	Well ID	Date																						
229899	MW01	31-10-19	5.988	0.617	0.138	1.783	0.039	7.194	0.000	0.000	1.297	0.011	0.271	0.003	0.001	0.000	8.56625959	8.77635937	-1.2%	82.0%	0.0%	0.5%	3.1%	2.2%
229899	MW02	31-10-19	3.942	0.387	0.092	0.652	0.114	6.195	0.000	0.000	0.564	0.026	0.187	0.000	0.000	0.000	5.18783386	6.97244548	-14.7%	88.8%	0.0%	2.2%	2.7%	4.1%
229899	MW07	31-10-19	6.986	0.568	0.100	0.870	0.136	8.193	0.000	0.000	0.592	0.016	0.333	0.000	0.000	0.000	8.65950964	9.13413016	-2.7%	89.7%	0.0%	1.6%	3.6%	2.8%
229899	MW10	31-10-19	6.986	1.152	0.128	1.522	0.264	8.593	0.000	0.000	0.874	0.016	0.770	0.000	0.000	0.000	10.0528587	10.2530732	-1.0%	83.8%	0.0%	2.6%	7.5%	4.1%
229899	MW12	31-10-19	7.485	3.292	0.256	7.830	0.079	9.192	0.000	0.000	7.616	0.026	0.874	0.000	0.000	0.000	18.9407657	17.7085008	3.4%	51.9%	0.0%	0.4%	4.9%	1.8%
229899	MW15	31-10-19	7.984	1.975	0.156	3.567	0.021	8.792	0.000	0.000	3.385	0.000	1.437	0.012	0.000	0.001	13.7028532	13.6271466	0.3%	64.5%	0.1%	0.2%	10.5%	1.4%
229899	MW16	31-10-19	5.489	0.987	0.095	0.826	0.471	7.194	0.000	0.000	0.564	0.016	0.000	0.000	0.000	0.000	7.86903578	7.77366692	0.6%	92.5%	0.0%	6.0%	0.0%	7.7%
229899	MW17	31-10-19	6.986	1.070	0.087	2.044	0.002	6.994	0.000	0.000	2.059	0.005	0.874	0.065	0.002	0.021	10.1899593	10.0215182	0.8%	69.8%	0.6%	0.0%	8.7%	1.8%
229899	MW26	31-10-19	6.986	1.234	0.115	1.566	0.186	9.192	0.000	0.000	0.874	0.021	0.125	0.000	0.000	0.000	10.0873219	10.212386	-0.6%	90.0%	0.0%	1.8%	1.2%	3.1%
236498	MW28	07-02-20	6.487	0.987	0.090	0.913	0.064	8.393	0.000	0.000	0.959	0.116	0.416	0.000	0.000	0.003	8.54130822	9.88650117	-7.3%	84.9%	0.0%	0.7%	4.2%	1.9%
236498	MW29	07-02-20	6.986	0.543	0.090	0.826	0.051	9.592	0.000	0.000	0.705	0.105	0.125	0.000	0.000	0.000	8.49613604	10.5270199	-10.7%	91.1%	0.0%	0.6%	1.2%	1.7%
236498	MW30	07-02-20	5.489	1.317	0.130	2.044	0.000	7.194	0.000	0.000	2.313	0.163	0.750	0.000	0.000	0.002	8.98072275	10.4217326	-7.4%	69.0%	0.0%	0.0%	7.2%	1.5%
236498	MW31	07-02-20	6.487	1.070	0.090	0.522	0.286	7.993	0.000	0.000	0.762	0.132	0.187	0.000	0.000	0.000	8.45415396	9.07360138	-3.5%	88.1%	0.0%	3.4%	2.1%	4.6%
236498	MW32	07-02-20	7.485	1.481	0.072	1.827	0.034	8.992	0.000	0.000	1.974	0.105	1.041	0.001	0.001	0.000	10.898647	12.1154199	-5.3%	74.2%	0.0%	0.3%	8.6%	1.0%
236498	MW33	07-02-20	5.489	0.905	0.049	0.652	0.193	6.794	0.000	0.000	0.677	0.089	0.042	0.000	0.000	0.000	7.28828261	7.60217226	-2.1%	89.4%	0.0%	2.6%	0.5%	3.4%
236498	MW35	07-02-20	1.098	0.337	0.148	0.522	0.000	0.560	0.000	0.000	0.621	0.000	0.479	0.471	0.001	0.015	2.10555297	2.14625923	-1.0%	26.1%	22.0%	0.0%	22.3%	32.5%

	Total Recoverable Hydrocarbons				BTEX				PAHs
	C6-C10	F1 C6-C10 less BTEX	>C10-C12	>C10-C12 (less Naphthalene)	Benzene	Ethylbenzene	Toluene	Xylenes (Total)	Naphthalene
	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3
CRC CARE IMW(Shallow Trench), 0m to <2m, Sand		180000000			760000				880000
NEPM HSL-D, 0m to <1m, Sand, Vapour		680000		500000*	4000	1300000	4800000	840000	3000

Field_ID	Sampled Date	Report No.								
VP1	25/11/2016	M162253	760	740	2200	2200	3.8	<2.8	4.9	13	<10
VP1	28/06/2017	M170597	6000	5876	0.48	0.48	11	9	61	43	<9.7
VP2	25/11/2016	M162253	4000	4000	2500	2500	3.5	3.4	<2.8	25	<10
VP2	29/06/2017	M170597	950	940.4	370	370	<2.3	<2.8	9.6	ND	<9.8
VP3	25/11/2016	M162253	2400	2400	4400	4400	4.3	3.9	11	28.1	<10
VP3	30/06/2017	M170597	980	923.4	660	660	<2.1	4.5	30	22.1	<8.9
VP4	25/11/2016	M162253	2700	2600	5400	5400	10	4.9	18	31	<11
VP4	1/07/2017	M170597	8500	8490.9	350	350	<2.3	<2.7	9.1	ND	<9.6

* = NEPM HSL-D F2 criteria which comprises TRH >C10-C16 minus Naphthalene

Table A1 Ambient Indoor & Outdoor Air Concentrations
Taronga Place, Mona Vale. February 2020
Radiello SD 130 tubes. Units µg/m^3

ANALYTE	Units	AA1 Joinery Lunchroom	AA1A Joinery Lunchroom	AA2 Joinery workshop	AA3 Joinery outdoor	AA1 Reece entrance	AA1 Reece entrance dup	AA2 Reece Warehouse	AA3 Reece Outdoor
1,1,1,2-tetrachloroethane	µg/m^3	nd	nd	nd	nd	nd	nd	nd	nd
1,1,1-Trichloroethane	µg/m^3	nd	nd	nd	nd	nd	nd	nd	nd
1,1,2,2-tetrachloroethane	µg/m^3	nd	nd	nd	nd	nd	nd	nd	nd
1,1,2-Trichloroethane	µg/m^3	nd	nd	nd	nd	nd	nd	nd	nd
1,1-Dichloroethane	µg/m^3	3.9	3.1	5.3	1.1	1.9	2.1	1.3	1.4
1,1-dichloroethene	µg/m^3	nd	nd	nd	nd	nd	nd	nd	nd
1,1-dichloropropene	µg/m^3	nd	nd	nd	nd	nd	nd	nd	nd
1,2,4-trimethyl benzene	µg/m^3	7.8	15.7	8.6	0.5	0.1	0.1	0.1	0.2
1,2-Dibromoethane	µg/m^3	nd	nd	nd	nd	nd	nd	nd	nd
1,2-dichlorobenzene	µg/m^3	nd	nd	nd	nd	nd	nd	nd	nd
1,2-dichloroethene (cis)	µg/m^3	nd	nd	nd	nd	nd	nd	nd	nd
1,2-Dichloroethene (trans)	µg/m^3	nd	nd	nd	nd	nd	nd	nd	nd
1,2-dichloropropane	µg/m^3	nd	nd	nd	nd	nd	nd	nd	nd
1,3,5-trimethyl benzene	µg/m^3	nd	nd	nd	nd	nd	nd	nd	nd
1,3-dichlorobenzene	µg/m^3	nd	nd	nd	nd	nd	nd	nd	nd
1,3-dichloropropane	µg/m^3	nd	nd	nd	nd	nd	nd	nd	nd
1,4 dichloro benzene	µg/m^3	nd	nd	nd	nd	nd	nd	nd	nd
1-methyl naphthalene	µg/m^3	nd	nd	nd	nd	nd	nd	nd	nd
2,2,4-trimethyl pentane	µg/m^3	4.7	3.9	3.5	0.3	0.4	0.4	0.2	0.3
2,2-dimethyl butane	µg/m^3	nd	nd	nd	nd	nd	nd	nd	nd
2,4-Dimethylpentane	µg/m^3	10.4	9.4	4.2	nd	0.2	0.3	nd	nd
2-chloro-1,3-butadiene	µg/m^3	nd	nd	nd	nd	nd	nd	nd	nd
2-Methyl naphthalene	µg/m^3	nd	nd	nd	nd	nd	nd	nd	nd
2-Methylbutane	µg/m^3	nd	nd	nd	nd	nd	nd	nd	nd
3-Methylhexane	µg/m^3	62.5	51.3	27.1	0.9	0.7	0.8	0.5	0.5
3-Methylpentane	µg/m^3	1.7	1.7	2.5	nd	0.6	0.6	0.5	nd
Benzene	µg/m^3	0.8	0.7	1.1	0.2	0.2	0.3	0.2	0.2
Carbon tetrachloride	µg/m^3	0.3	0.3	0.4	0.3	0.4	0.4	0.3	0.3
Chlorobenzene	µg/m^3	nd	nd	nd	nd	nd	0.0	nd	nd
Chloroform	µg/m^3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cyclohexane	µg/m^3	4.1	4.0	4.9	0.6	1.2	1.2	0.9	0.8
dimethyl cyclohexane	µg/m^3	nd	nd	nd	nd	nd	nd	nd	nd
Dimethylhexane	µg/m^3	nd	nd	nd	nd	nd	nd	nd	nd
Ethylbenzene	µg/m^3	40.4	32.6	65.3	0.6	0.8	0.8	0.5	0.4
Ethylcyclohexane	µg/m^3	0.4	0.3	0.6	0.0	0.0	0.0	0.0	0.0
Ethylcyclopentane	µg/m^3	nd	nd	nd	nd	nd	nd	nd	nd
Hexachlorobutadiene	µg/m^3	nd	nd	nd	nd	nd	nd	nd	nd
Isopropyl benzene	µg/m^3	0.9	0.7	1.5	nd	0.0	0.0	0.0	nd
m&p-Xylene	µg/m^3	157.1	132.3	248.0	2.1	3.1	3.1	1.9	1.4
MEK	µg/m^3	57.1	73.3	102.6	nd	73.7	80.8	44.2	nd
Methylcyclohexane	µg/m^3	6.7	5.5	6.4	0.5	0.8	0.9	0.5	0.6
Napthalene	µg/m^3	nd	nd	nd	nd	nd	nd	nd	nd
n-Decane	µg/m^3	2.3	2.7	3.4	nd	1.2	1.3	0.9	nd
n-Dodecane	µg/m^3	9.7	7.5	7.3	4.2	7.4	8.0	5.8	4.2
n-Heptane	µg/m^3	8.3	6.7	7.9	0.5	0.8	0.8	0.5	0.5
n-hexane	µg/m^3	3.9	3.1	5.3	1.1	1.9	2.1	1.3	1.4
n-Nonane	µg/m^3	1.6	1.3	2.1	0.1	0.2	0.2	0.1	0.2
n-Octane	µg/m^3	2.4	2.0	3.5	0.1	0.5	0.5	0.3	0.1
n-Tetradecane	µg/m^3	4.3	3.7	10.4	5.2	4.4	5.1	4.6	3.2
n-Tridecane	µg/m^3	2.3	1.4	3.2	1.8	1.6	1.9	1.4	1.3
n-Undecane	µg/m^3	3.5	2.9	3.1	0.3	0.4	0.5	0.4	0.3
o-Xylene	µg/m^3	36.6	29.3	55.8	0.5	1.0	0.9	0.6	0.4
p-cymene	µg/m^3	0.1	0.2	0.2	0.0	0.1	0.1	0.1	0.0
n-pentane	µg/m^3	nd	nd	nd	nd	nd	nd	nd	nd
Propyl benzene	µg/m^3	1.7	1.3	2.6	0.0	0.0	0.0	0.0	0.0
Propyl cyclohexane	µg/m^3	nd	nd	nd	nd	nd	nd	nd	nd
sec butyl benzene	µg/m^3	nd	nd	nd	nd	nd	nd	nd	nd
Styrene	µg/m^3	3.2	2.1	3.1	nd	0.1	0.1	0.1	nd
Tetrachloroethylene	µg/m^3	0.0	0.0	0.0	nd	0.0	0.0	0.0	0.0
Toluene	µg/m^3	328.5	281.5	469.2	4.0	3.2	3.2	2.5	2.1
Trichloroethylene	µg/m^3	0.1	0.1	0.2	nd	nd	nd	nd	nd
Trimethyl benzene isomer	µg/m^3	nd	nd	nd	nd	nd	nd	nd	nd
C6-C10	µg/tube	720	580	1000	15	31	31	20	12
>C10-C14	µg/tube	7	8	24	nd	15	11	10	13

Table A2 Surface vapour flux in two commercial buildings
Taronga Place, Mona Vale. February 2020
Passive flux chamber method - Radiello SD 130 tubes. 12 day deployment

ANALYTE	Units	detection limit	Flux 1 Joinery Lunchroom	Flux 2 Joinery workshop	Flux 2 dup joinery workshop	Flux 1 Reece entrance	Flux 2 Reece Wearhouse
1,1,1,2-tetrachloroethane	µg/tube	0.02	nd	nd	nd	nd	nd
1,1,1-Trichloroethane	µg/tube	0.02	nd	nd	nd	nd	nd
1,1,2-Trichloroethane	µg/tube	0.02	nd	nd	nd	nd	nd
1,1-dichloroethene	µg/tube	0.02	nd	nd	nd	nd	nd
1,1,2,2-tetrachloroethane	µg/tube	0.02	nd	nd	nd	nd	nd
1,1-Dichloroethane	µg/tube	0.02	2.0	1.3	1.2	0.74	1.2
1,2-Dichloroethene (trans)	µg/tube	0.02	nd	nd	nd	nd	nd
1,1-Dichloropropene	µg/tube	0.02	nd	nd	nd	nd	nd
1,2-Dibromoethane	µg/tube	0.02	nd	nd	nd	nd	nd
1,2,4-trimethyl benzene	µg/tube	0.02	22	13	39	0.15	0.30
1,2-dichloroethene (cis)	µg/tube	0.02	nd	nd	nd	nd	nd
1,2-dichloropropane	µg/tube	0.02	nd	nd	nd	nd	nd
1,3-dichloropropane	µg/tube	0.02	nd	nd	nd	nd	nd
1,3,5-trimethyl benzene	µg/tube	0.02	nd	nd	nd	nd	nd
1,4 dichlorobenzene	µg/tube	0.02	nd	nd	nd	nd	nd
1,3-dichlorobenzene	µg/tube	0.02	nd	nd	nd	nd	nd
1,2-dichlorobenzene	µg/tube	0.02	nd	nd	nd	nd	nd
1-methyl naphthalene	µg/tube	0.02	nd	nd	nd	nd	nd
2,2,4-trimethyl pentane	µg/tube	0.02	0.92	0.31	0.28	0.05	0.11
2,2-dimethyl butane	µg/tube	0.02	nd	nd	nd	nd	nd
2,4-Dimethylpentane	µg/tube	0.02	1.3	0.22	0.21	nd	nd
2-Methyl naphthalene	µg/tube	0.02	nd	nd	nd	nd	nd
2-Methylbutane	µg/tube	0.02	nd	nd	nd	nd	nd
2-chloro-1,3-butadiene	µg/tube	0.02	nd	nd	nd	nd	nd
3-Methylhexane	µg/tube	0.02	12.3	1.2	1.1	0.07	0.09
3-Methylpentane	µg/tube	0.02	nd	nd	nd	nd	nd
Benzene	µg/tube	0.02	0.45	0.15	0.19	0.06	0.08
Carbon tetrachloride	µg/tube	0.02	0.05	nd	nd	nd	nd
Chlorobenzene	µg/tube	0.02	nd	nd	nd	nd	nd
Chloroform	µg/tube	0.02	0.04	nd	nd	nd	nd
Cyclohexane	µg/tube	0.02	0.50	0.42	0.34	0.03	nd
dimethyl cyclohexane	µg/tube	0.02	nd	nd	nd	nd	nd
Dimethylhexane	µg/tube	0.02	nd	nd	nd	nd	nd
Ethylbenzene	µg/tube	0.02	7.8	5.5	7.7	3.8	14
Ethylcyclohexane	µg/tube	0.02	0.35	0.13	0.53	nd	nd
Ethylcyclopentane	µg/tube	0.02	nd	nd	nd	nd	nd
Hexachlorobutadiene	µg/tube	0.02	nd	nd	nd	nd	nd
Isopropyl benzene	µg/tube	0.02	2.4	1.3	4.5	0.05	0.15
m&p-Xylene	µg/tube	0.02	39	24	35	18	67
MEK	µg/tube	0.02	nd	nd	nd	nd	nd
Methylcyclohexane	µg/tube	0.02	60	nd	nd	110	nd
Napthalene	µg/tube	0.02	0.6	0.4	0.5	nd	nd
n-Decane	µg/tube	0.02	55	47	115	1.3	1.6
n-Dodecane	µg/tube	0.02	170	25	35	1.8	2.8
n-Heptane	µg/tube	0.02	2.3	1.2	1.5	0.12	0.20
n-hexane	µg/tube	0.02	2.0	1.3	1.2	0.74	1.2
n-Nonane	µg/tube	0.02	8.0	6.3	31.3	0.10	0.14
n-Octane	µg/tube	0.02	2.4	1.3	3.4	0.18	0.28
n-Tetradecane	µg/tube	0.02	27	2.9	3.8	1.8	1.8
n-Tridecane	µg/tube	0.02	220	7.8	11	1.7	1.9
n-Undecane	µg/tube	0.02	180	90	180	2.9	3.1
o-Xylene	µg/tube	0.02	20	8.5	18	5.8	19
p-cymene	µg/tube	0.02	3.6	2.1	3.2	nd	nd
n-pentane	µg/tube	0.02	nd	nd	nd	nd	nd
Propyl benzene	µg/tube	0.02	4.8	2.6	6.7	0.05	0.13
Propyl cyclohexane	µg/tube	0.02	nd	nd	nd	nd	nd
sec butyl benzene	µg/tube	0.02	6.5	2.2	6.2	nd	nd
Styrene	µg/tube	0.02	0.90	0.39	0.90	nd	nd
Tetrachloroethylene	µg/tube	0.02	nd	nd	0.0	nd	nd
Toluene	µg/tube	0.02	52	32	35	1.1	1.8
Trichloroethylene	µg/tube	0.02	0.02	nd	nd	nd	nd
Trimethyl benzene isomer	µg/tube	0.02	nd	nd	nd	nd	nd
C6-C10	µg/tube	5	620	340	810	36	83
>C10-C14	µg/tube	5	27000	nd	48	nd	14

Table A3 Ambient Indoor & Outdoor Air Concentrations
Relative Percent Differences (RPDs)
Taronga Place, Mona Vale. February 2020
Radiello SD 130 tubes. Units µg/m3

ANALYTE	Units	AA1 Joinery Lunchroom	AA1A Joinery Lunchroom	RPD
1,1,1,2-tetrachloroethane	µg/m^3	nd	nd	-
1,1,1-Trichloroethane	µg/m^3	nd	nd	-
1,1,2,2-tetrachloroethane	µg/m^3	nd	nd	-
1,1,2-Trichloroethane	µg/m^3	nd	nd	-
1,1-Dichloroethane	µg/m^3	3.9	3.1	24%
1,1-dichloroethene	µg/m^3	nd	nd	-
1,1-dichloropropene	µg/m^3	nd	nd	-
1,2,4-trimethyl benzene	µg/m^3	7.8	15.7	67%
1,2-Dibromoethane	µg/m^3	nd	nd	-
1,2-dichlorobenzene	µg/m^3	nd	nd	-
1,2-dichloroethene (cis)	µg/m^3	nd	nd	-
1,2-Dichloroethene (trans)	µg/m^3	nd	nd	-
1,2-dichloropropane	µg/m^3	nd	nd	-
1,3,5-trimethyl benzene	µg/m^3	nd	nd	-
1,3-dichlorobenzene	µg/m^3	nd	nd	-
1,3-dichloropropane	µg/m^3	nd	nd	-
1,4 dichloro benzene	µg/m^3	nd	nd	-
1-methyl naphthalene	µg/m^3	nd	nd	-
2,2,4-trimethyl pentane	µg/m^3	4.7	3.9	20%
2,2-dimethyl butane	µg/m^3	nd	nd	-
2,4-Dimethylpentane	µg/m^3	10.4	9.4	10%
2-chloro-1,3-butadiene	µg/m^3	nd	nd	-
2-Methyl naphthalene	µg/m^3	nd	nd	-
2-Methylbutane	µg/m^3	nd	nd	-
3-Methylhexane	µg/m^3	62.5	51.3	20%
3-Methylpentane	µg/m^3	1.7	1.7	0%
Benzene	µg/m^3	0.8	0.7	23%
Carbon tetrachloride	µg/m^3	0.3	0.3	12%
Chlorobenzene	µg/m^3	nd	nd	-
Chloroform	µg/m^3	0.0	0.0	0%
Cyclohexane	µg/m^3	4.1	4.0	2%
dimethyl cyclohexane	µg/m^3	nd	nd	-
Dimethylhexane	µg/m^3	nd	nd	-
Ethylbenzene	µg/m^3	40.4	32.6	21%
Ethylcyclohexane	µg/m^3	0.4	0.3	24%
Ethylcyclopentane	µg/m^3	nd	nd	-
Hexachlorobutadiene	µg/m^3	nd	nd	-
Isopropyl benzene	µg/m^3	0.9	0.7	23%
m&p-Xylene	µg/m^3	157.1	132.3	17%
MEK	µg/m^3	57.1	73.3	25%
Methylcyclohexane	µg/m^3	6.7	5.5	21%
Napthalene	µg/m^3	nd	nd	-
n-Decane	µg/m^3	2.3	2.7	13%
n-Dodecane	µg/m^3	9.7	7.5	26%
n-Heptane	µg/m^3	8.3	6.7	22%
n-hexane	µg/m^3	3.9	3.1	24%
n-Nonane	µg/m^3	1.6	1.3	25%
n-Octane	µg/m^3	2.4	2.0	20%
n-Tetradecane	µg/m^3	4.3	3.7	14%
n-Tridecane	µg/m^3	2.3	1.4	48%
n-Undecane	µg/m^3	3.5	2.9	19%
o-Xylene	µg/m^3	36.6	29.3	22%
p-cymene	µg/m^3	0.1	0.2	42%
n-pentane	µg/m^3	nd	nd	-
Propyl benzene	µg/m^3	1.7	1.3	22%
Propyl cyclohexane	µg/m^3	nd	nd	-
sec butyl benzene	µg/m^3	nd	nd	-
Styrene	µg/m^3	3.2	2.1	39%
Tetrachloroethylene	µg/m^3	0.04	0.03	44%
Toluene	µg/m^3	328.5	281.5	15%
Trichloroethylene	µg/m^3	0.1	0.1	28%
Trimethyl benzene isomer	µg/m^3	nd	nd	-
C6-C10	µg/tube	720	580	22%
>C10-C14	µg/tube	7	8	13%

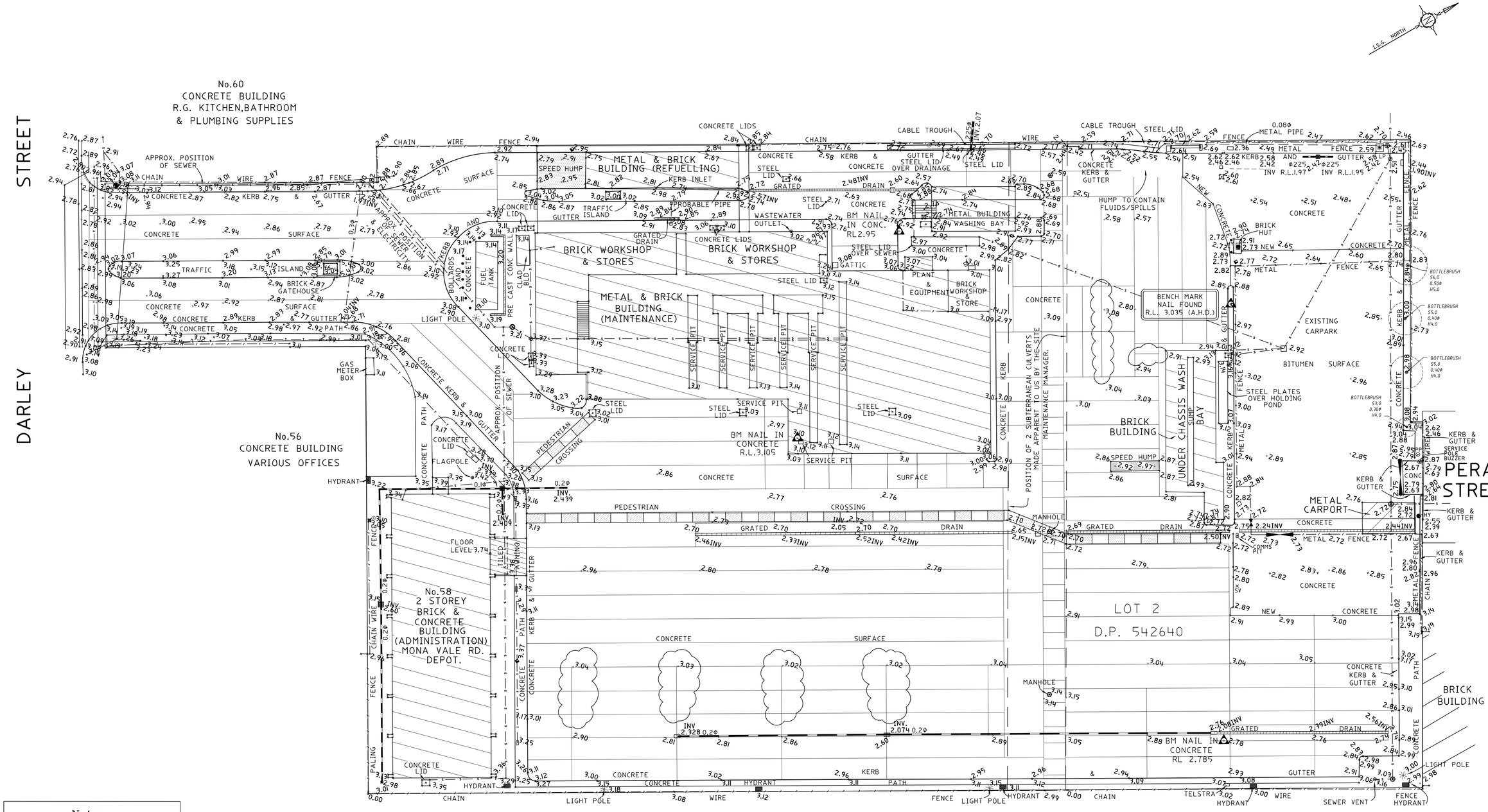
Table A4 Surface vapour flux in two commercial buildings
Relative Percent Differences (RPDs)
Taronga Place, Mona Vale. February 2020
Passive flux chamber method - Radiello SD 130 tubes. 12 day deployment

ANALYTE	Units	detection limit	Flux 2 Joinery workshop	Flux 2 dup joinery workshop	RPD
1,1,1,2-tetrachloroethane	µg/tube	0.02	nd	nd	-
1,1,1-Trichloroethane	µg/tube	0.02	nd	nd	-
1,1,2-Trichloroethane	µg/tube	0.02	nd	nd	-
1,1-dichloroethene	µg/tube	0.02	nd	nd	-
1,1,2,2-tetrachloroethane	µg/tube	0.02	nd	nd	-
1,1-Dichloroethane	µg/tube	0.02	1.3	1.2	3%
1,2-Dichloroethene (trans)	µg/tube	0.02	nd	nd	-
1,1-Dichloropropene	µg/tube	0.02	nd	nd	-
1,2-Dibromoethane	µg/tube	0.02	nd	nd	-
1,2,4-trimethyl benzene	µg/tube	0.02	13	39	102%
1,2-dichloroethene (cis)	µg/tube	0.02	nd	nd	-
1,2-dichloropropane	µg/tube	0.02	nd	nd	-
1,3-dichloropropane	µg/tube	0.02	nd	nd	-
1,3,5-trimethyl benzene	µg/tube	0.02	nd	nd	-
1,4 dichlorobenzene	µg/tube	0.02	nd	nd	-
1,3-dichlorobenzene	µg/tube	0.02	nd	nd	-
1,2-dichlorobenzene	µg/tube	0.02	nd	nd	-
1-methyl naphthalene	µg/tube	0.02	nd	nd	-
2,2,4-trimethyl pentane	µg/tube	0.02	0.31	0.28	9%
2,2-dimethyl butane	µg/tube	0.02	nd	nd	-
2,4-Dimethylpentane	µg/tube	0.02	0.22	0.21	7%
2-Methyl naphthalene	µg/tube	0.02	nd	nd	-
2-Methylbutane	µg/tube	0.02	nd	nd	-
2-chloro-1,3-butadiene	µg/tube	0.02	nd	nd	-
3-Methylhexane	µg/tube	0.02	1.2	1.1	8%
3-Methylpentane	µg/tube	0.02	nd	nd	-
Benzene	µg/tube	0.02	0.15	0.19	23%
Carbon tetrachloride	µg/tube	0.02	nd	nd	-
Chlorobenzene	µg/tube	0.02	nd	nd	-
Chloroform	µg/tube	0.02	nd	nd	-
Cyclohexane	µg/tube	0.02	0.42	0.34	22%
dimethyl cyclohexane	µg/tube	0.02	nd	nd	-
Dimethylhexane	µg/tube	0.02	nd	nd	-
Ethylbenzene	µg/tube	0.02	5.5	7.7	34%
Ethylcyclohexane	µg/tube	0.02	0.13	0.53	121%
Ethylcyclopentane	µg/tube	0.02	nd	nd	-
Hexachlorobutadiene	µg/tube	0.02	nd	nd	-
Isopropyl benzene	µg/tube	0.02	1.3	4.5	111%
m&p-Xylene	µg/tube	0.02	24	35	36%
MEK	µg/tube	0.02	nd	nd	-
Methylcyclohexane	µg/tube	0.02	nd	nd	-
Napthalene	µg/tube	0.02	0.4	0.5	18%
n-Decane	µg/tube	0.02	47	115	83%
n-Dodecane	µg/tube	0.02	25	35	34%
n-Heptane	µg/tube	0.02	1.2	1.5	24%
n-hexane	µg/tube	0.02	1.3	1.2	3%
n-Nonane	µg/tube	0.02	6.3	31.3	133%
n-Octane	µg/tube	0.02	1.3	3.4	87%
n-Tetradecane	µg/tube	0.02	2.9	3.8	29%
n-Tridecane	µg/tube	0.02	7.8	11	37%
n-Undecane	µg/tube	0.02	90	180	66%
o-Xylene	µg/tube	0.02	8.5	18	72%
p-cymene	µg/tube	0.02	2.1	3.2	41%
n-pentane	µg/tube	0.02	nd	nd	-
Propyl benzene	µg/tube	0.02	2.6	6.7	87%
Propyl cyclohexane	µg/tube	0.02	nd	nd	-
sec butyl benzene	µg/tube	0.02	2.2	6.2	97%
Styrene	µg/tube	0.02	0.39	0.90	78%
Tetrachloroethylene	µg/tube	0.02	nd	0.0	-
Toluene	µg/tube	0.02	32	35	8%
Trichloroethylene	µg/tube	0.02	nd	nd	-
Trimethyl benzene isomer	µg/tube	0.02	nd	nd	-
C6-C10	µg/tube	5	340	810	82%
>C10-C14	µg/tube	5	nd	48	-

APPENDIX C

SURVEYS AND SERVICE PLANS

A1



Notes:

- NO SURVEY OF BOUNDARY INTENDED BY THIS PLAN.
- VISIBLE SERVICES ONLY LOCATED.
- LINE OF UNDERGROUND SERVICE WHERE SHOWN, ARE LOCATED BY PHYSICAL EVIDENCE OR SCALED FROM RELEVANT AUTHORITY SERVICE PLANS.
- POSITION OF SERVICES SHOULD BE CONFIRMED PRIOR TO ANY EXCAVATION.
- THIS PLAN HAS BEEN PREPARED FOR THE EXCLUSIVE USE OF McMILLAN BRITTON & KELL PTY.LTD.
- LOT BOUNDARIES SHOWN ON PLAN ARE TAKEN FROM LAND TITLES OFFICE RECORDS.

LEGEND :-

+2.51	- DENOTES SPOT LEVEL.
●HY	- DENOTES HYDRANT.
※LP	- DENOTES LIGHT POLE
○PP	- DENOTES POWER POLE.
×SV	- DENOTES STOP VALVE.
●	- DENOTES BOLLARD.

ISSUE	DATE	AMENDMENTS	BY
G	26/9/2014	DETAIL ADDED (33849)	M.P.
F	31/7/2014	DETAIL ADDED	M.P.
E	28/4/99	EXPANSION JOINTS AMENDED.	P.A.
D	9/4/99	FINAL ISSUE	P.A.
C	30/3/99	EXPANSION JOINTS ADDED	P.A.
B	21/1/99	FIRST ISSUE	DJG
A	13/1/99	PRELIMINARY ISSUE	D.J.G.

HORIZONTAL
CO-ORDINATE SYSTEM: ASSUMED
MARKS ADOPTED:
EAST: NORTH:

VERTICAL
DATUM A.H.D.
B.M. ADOPTED: SSM24507
R.L.: 2.621
SOURCE: S.C.I.M.S.

SCALES
HORIZONTAL: 1:300
VERTICAL: N/A
FIELD SHEETS:
Date of Survey 9/12/98

SURVEYOR M.Mc.
DRAWN A.B.S.
CHECKED M.Mc.
APPROVED

PLAN

SHOWING DETAIL & LEVELS OVER MONA VALE S.T.A. BUS DEPOT.

58 DARLEY STREET, MONA VALE

Degotardi Smith & Partners
CONSULTING SURVEYORS ESTABLISHED 1957
11/19-23 Bridge Street | Pymble
NSW 2073 | Australia
t. (+61) 2 9440 1100
f. (+61) 2 9440 1055
e. surveys@degotardi.com.au
w. www.degotardi.com.au

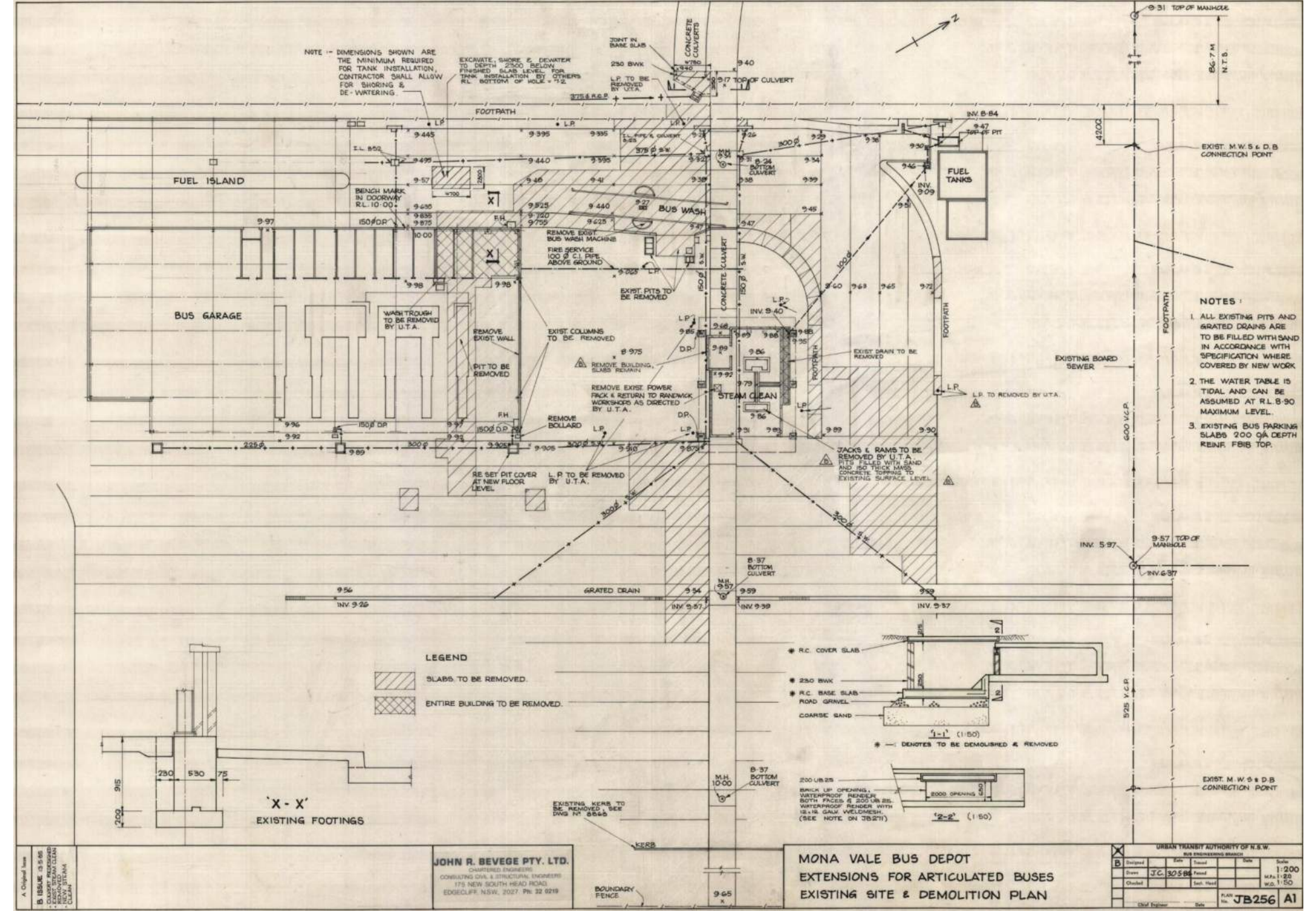
Quality Management ISO 9001 Global-Mark.com.au®

L.G.A. PITTWATER

SHEET 1 OF 1

REVISION DATE: G 26/9/2014

CAD FILE NO. 26513A01.DWG



A Original Issue

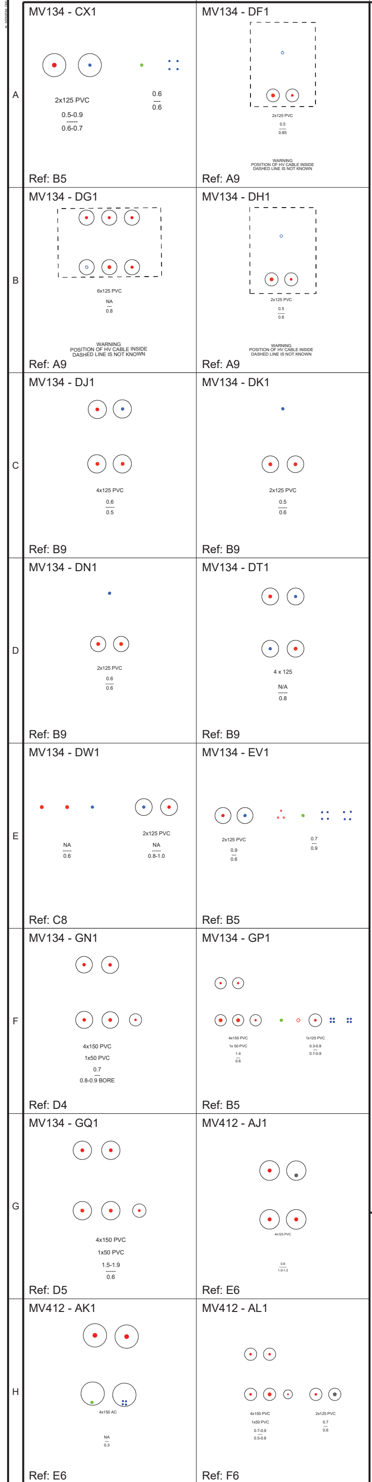
B ISSUE 13·5·85
CURRENT RECORDED
• REMOVED STEAM CLEAN
• NEW STEAM CLEAN

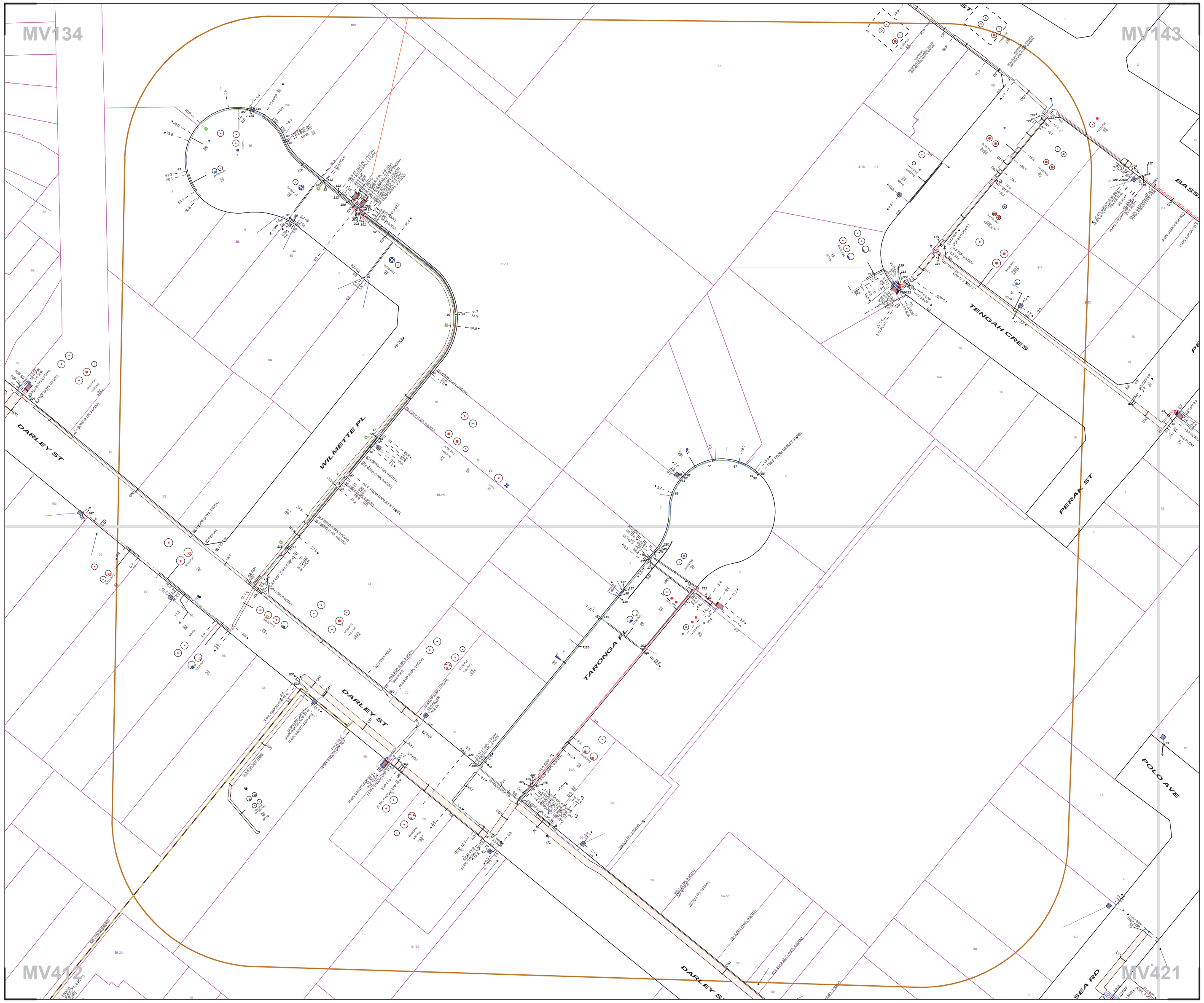
JOHN R. BEVEGE PTY. LTD.
CHARTERED ENGINEERS
CONSULTING CIVIL & STRUCTURAL ENGINEERS
175 NEW SOUTH HEAD ROAD
EDGECLIFF, N.S.W. 2027. Ph: 32 0219

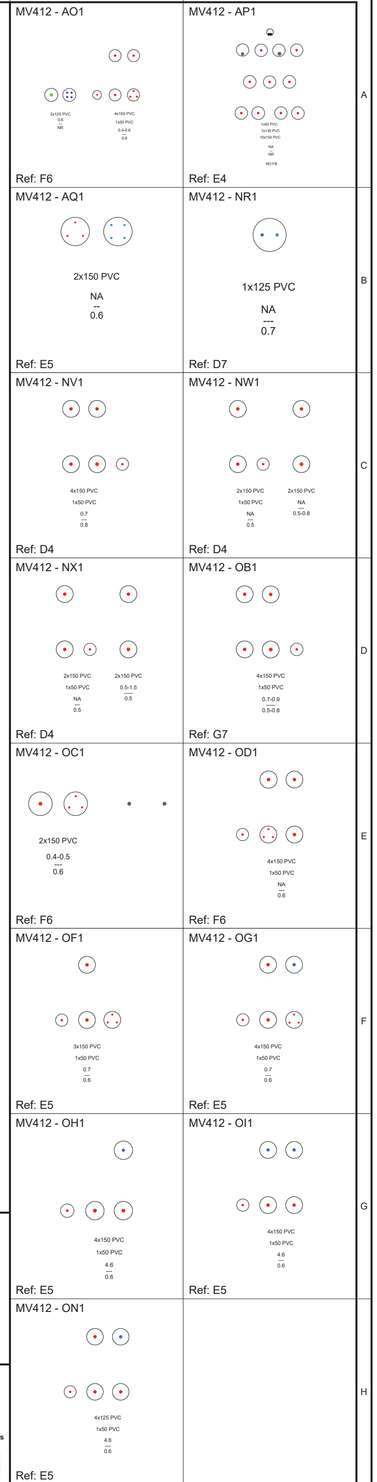
MONA VALE BUS DEPOT
EXTENSIONS FOR ARTICULATED BUSES
EXISTING SITE & DEMOLITION PLAN

URBAN TRANSIT AUTHORITY OF N.S.W.
BUS ENGINEERING BRANCH

B	Designed		Date	Traced		Date	Scale 1:200
	Drawn	J.C.	30·5·86	Passed			M.Ps 1:20
	Checked			Sect. Head			W.D. 1:50
				Chief Engineer		Date	PLAN No. JB256 A1







JOINT DETAIL REPORT

No.	Bk-Pg	Pl/Cvr	Joint Location
Map: MV134			
7	1726-77	0.90/0.50	NA
33	1726-81	0.60/0.70	12.5m North of PEG
35	1726-86	0.50/0.50	NA
36	SN80-19	4.60/0.60	Lots 5(No.67) & 9(No.3) DP221136
43	1884-79	3.00/0.70	NA
45	1884-79	3.00/0.70	NA
46			NA
47	1793-4	0.50/0.90	NA
48	1765-70	0.40/0.70	NA
49	1764-23	0.30/0.90	NA
50	1765-52	1.10/0.50	0.65m north of Bdy
51	1830-12	0.60/0.50	NA
52	1727-2	1.60/0.80	2.8 KL
53	2076-54	0.55/0.50	IN ONE TROUGHING
54	2076-54	0.55/0.50	IN ONE TROUGHING
55	2076-43	0.60/0.90	1.1 SE OF KIOSK
56	1830-25	0.70/0.60	NA
57	1829-26	0.10/0.60	NA
58	2076-53	0.50/0.80	71.7 NE OF DARLEY ST BL IN ONE TROUGHING
59	2076-53	0.50/0.80	71.7 NE OF DARLEY DT BL IN ONE TROUGHING
60	1765-56	0.30/0.60	NA
61	2076-38	0.90/0.60	NA
62			NA
63	1765-46	1.10/0.70	NA
64	1829-31	1.00/0.90	NA
65	1928-13		NA
66	1792-76	0.90/0.60	NA
67	1765-12	1.00/0.70	NA
86	1726-23	/0.60	2.8 KL
90	1726-23	/0.60	2.8 KL
91	1766-16		NA
92	1765-56	0.30/0.70	NA
93	1829-31	0.90/0.70	NA
98	SN135-037	0.50/0.70	1.3M SOUTH OF SUB BDY
101	SN148-035	0.80/1.00	38m from Wilmette Pl W.PL Ext
111	SN148-035	0.40/0.90	39.1m from Wilmette Pl W. PL Ext
112	SN148-035	0.50/1.00	49m from Wilmette Pl W PL Ext

No.	Bk-Pg	Pl/Cvr	Joint Location
113	SN148-035	0.50/1.00	50.2m from Wilmette Pl W PL Ext
118	SN127-060	/0.45	5.2M W OF No 12 WPL 1.0M N OF KIOSK
119	SN127-060	/0.45	5.2M W OF No 12 WPL 0.5M N OF KIOSK
120	SN148-103	/0.50	4.0M W OF No12 WPL 0.4 N OF SUB
121	SN148-103	/0.50	2.8M W OF No12 WPL 0.2 N OF SUB
124	SN148-102	/0.50	6.0M STH OF KERB FACE 2.8M EAST OF KERB FACE
127	SN148-102	/0.50	6.0M STH OF KERB FACE 3.0M EAST OF KERB FACE
134	UN03-0306	0.80/0.80	APPROX 1.3m FROM TENGAH CRS CNR
135	UN03-0306	/0.80	APPROX 66.0m FROM BASSETT ST CNR PL
148			SAO196044
149			SAO196044
202	UN10-0793	2.60/0.90	0.6M E FROM S 16796 E LV BDY
256	UN10-0781	1.60/0.90	6.4M STH OF SUB EASEMENT NPL
259	UN10-0805	/0.70	3.5 NW OF EASTERN EASEMENT FENCELINE.
266	UN11-0051	1.60/0.60	6.5 SE OF NW SIDE OF SUB16317 1.6 NW OF PL
Map: MV412			
1		2.70/0.80	
2		2.10/0.80	
3		0.40/0.60	
4		0.70/0.60	
45	1792-36	0.80/3.00	
46	1726-22	0.70/3.00	
47		0.40/0.80	
48	1765-13	1.00/0.70	
49	1726-16	2.90/0.70	
50	1726-19	0.80/6.00	
115	2076-53	0.50/0.07	
116	2076-53	0.50/	
117		0.80/0.60	
118	1793-51	0.50/0.60	
119	1726-16	2.70/0.70	
120	1973-18	0.80/0.60	
121	1792-1	3.90/0.50	72.5 N OF CNR
176	1792-36	2.60/0.80	
177	1792-57	0.80/0.60	
202	1726-16	3.50/0.70	
249	SN135-017	0.50/0.70	104.3m north of Darley St
250	SN135-017	0.50/0.70	105.1m north of Darley St
251			

No.	Bk-Pg	Pl/Cvr	Joint Location
324	NS06-0498	1.00/0.70	2.3 NW OF TARONGA PL
471	UN10-0783	2.80/0.40	15.2 SE TORONGA PL & DARLEY ST NE CNR
475	UN10-0783	0.70/0.70	6.8 NE TORONGA PL & DARLEY ST NE CNR
476	UN10-0783	0.50/0.70	6.3 NE TORONGA PL & DARLEY ST NE CNR
480			CAPTURED FOR CONNECTIVITY PUPOSE ONLY NO RECORDS FOR THIS JOINT AS OF 30/1/11
496	UN11-0866	0.70/0.70	6.2 NE TORONGA PL & DARLEY ST NE CNR
497	UN11-0866	0.40/0.70	7.5 NE TORONGA PL & DARLEY ST NE CNR
499			
500			BASE OF POLE MV-3061
501			BASE OF POLE MV-3061

WARNING

Ausgrid's plans show the position of assets at the time of installation and may not account for subsequent changes to road alignments, fences or buildings.
The plans show no more than the presence or absence of Ausgrid assets in the street.
Persons working near electricity networks must exercise care and will be held responsible for any damage caused.
You must excavate by hand or use vacuum excavation to establish the location of Ausgrid underground cables and associated assets.
Underground: Working near a cable may result in electric shock even if no contact is made. Any work in the vicinity of any cable should only be performed using safe work methods developed in accordance with the recommendations included in WorkCover Code of Practice for Excavation and WorkCover Guide for Work Near Underground Assets
as well as recommendations of Ausgrid's Network Standard NS156.
Overhead: Do not excavate near poles or towers until the stability of the foundation has been assessed by Ausgrid. Cables or earth conductors may be present close to substations, poles or towers.
Workers must maintain safe approach distances and follow applicable WorkCover Codes of Practice.
NOTE: You must keep this plan on site during excavation works and have on site a person trained to read this plan.

ISG GRID

MV1341	MV1342	MV1431
MV1343	MV1344	MV1433
MV4121	MV4122	MV4211

GRID

138H1	138J1	138K1
138H2	138J2	138K2
138H3	138J3	138K3

GMLA0

Distribution - 30769786

INFORMATION ON THIS PLAN ONLY VALID FOR 30 DAYS FROM ISSUE DATE

24 Sep 2013

Page 1 of 2

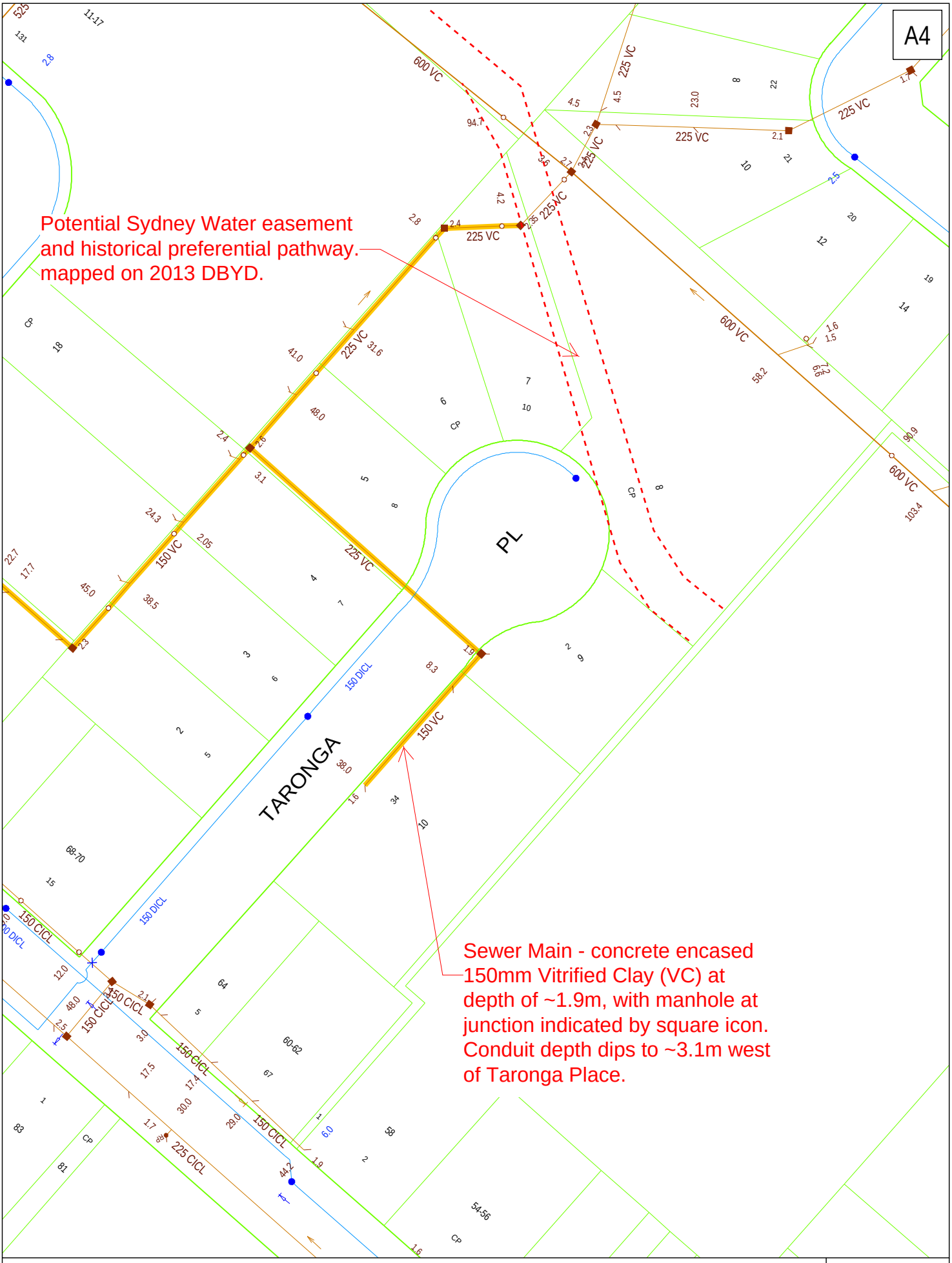
N

1:593

0 — 36 metres

Ausgrid

A0 MOCS_std_plot



DBYD Address:
n/a Darley Street
Mona Vale NSW 2103

DBYD Job No: 7505744
DBYD Sequence No: 34407885

No warranty is given that the information shown is complete or accurate.

SYDNEY WATER CORPORATION

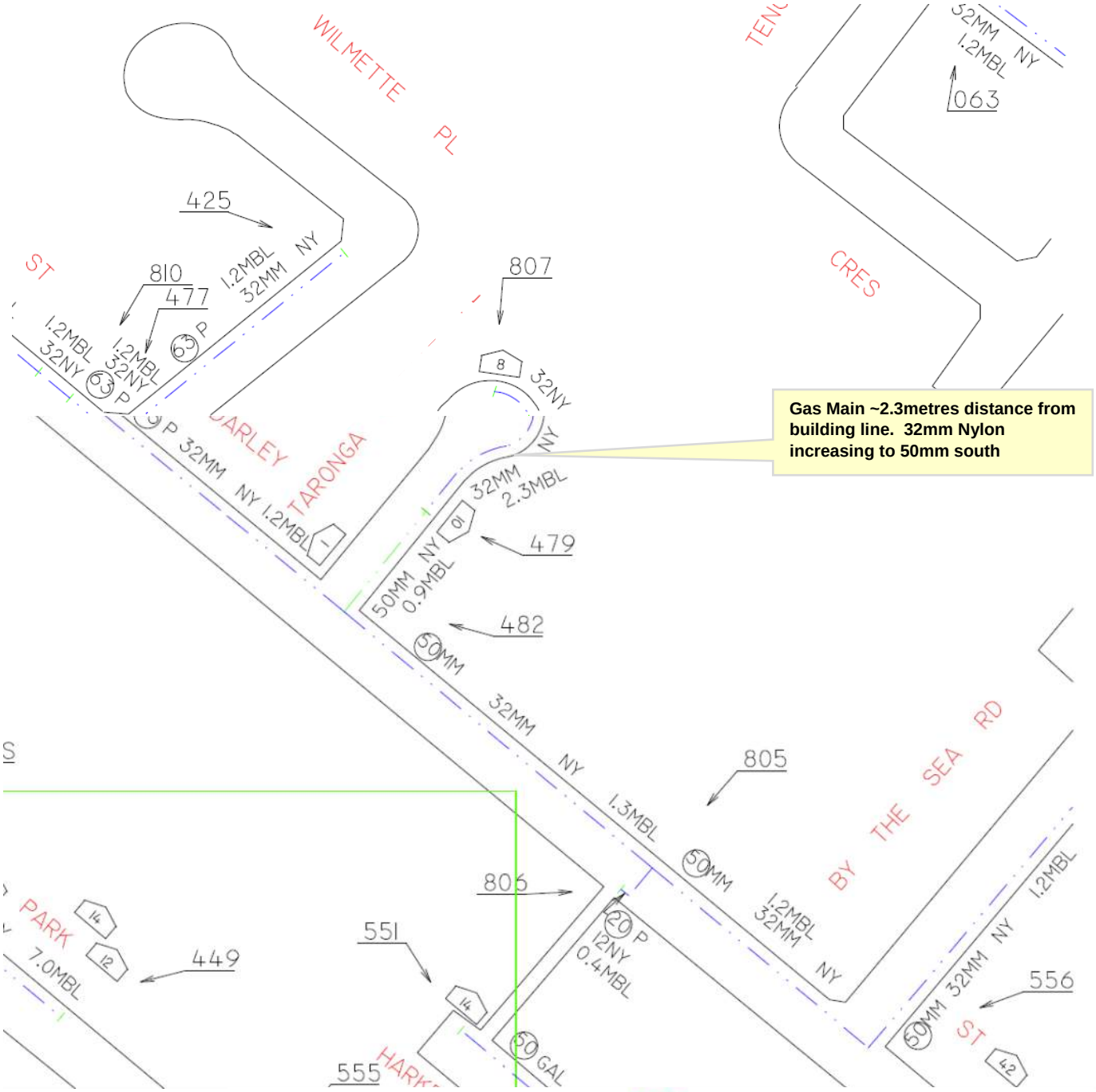
Scale: 1:1000

Date of Production: 09/06/2014

Plan 1 of 1

N

0m 5m 10m 15m 20m



KEY

MAX ALLOWABLE OPERATING PRESSURE

T	TRUNK MAIN	7000 kPa
P	PRIMARY MAIN	3500 kPa
S	SECONDARY MAIN	1050 kPa
		300 kPa
		210 kPa
		7 kPa
400		400 kPa
100		100 kPa
		2 kPa
	PROPOSED MAINS	

	VALVE
	SYSTEM PRESSURE REGULATOR
S	SIPHON
123	NETWORK NODES
123S	ITEM DETAIL SKETCH AVAILABLE
1098	VALVE NUMBER (OLD NUMBERING)
6NB	6 INCH CAST IRON MAIN
150MM	150MM STEEL MAIN
110MM PE/NY	110MM POLYETHYLENE/NYLON MAIN
(6)NB 50MM NY	50MM NYLON INSERTED INTO 6NB MAIN CAST IRON MAIN
1.2MBL	DISTANCE IN METRES OF MAIN FROM BUILDING LINE (TOLERANCE OF 0.4M)
1957	YEAR LAID
	MUNICIPALITY BOUNDARY
	NETWORK BOUNDARY
123	HOUSE NUMBER
PR 11-2 3	STEEL MAIN PROJECT NUMBER
P	PRESSURE MONITORING STATION

APPENDIX D

BORELOGS

Borehole Log

Hole ID. **SB1**

WSP Environment & Energy

Level 1, 41 McLaren Street
North Sydney NSW 2060
Office: +61 (0)2 8925 6700
www.wspenvironmental.com

Project Name:	**STA - Contaminated Site Assessment - Mona Vale**	Date Started:	**19/12/2011**
Project Number:	**3075**	Date Completed:	**19/12/2011**
Location / Site:	**58 Darley Street, Mona Vale NSW**	Hole Depth:	**2.70 m**
Client:	**State Transit Authority**	Ground Level:	**----------**
Drilling Company:	**Epoca Environmental Pty Ltd**	Easting:	**----------**
Drill Method:	**Hand Auger / Push Tube**	Northing:	**----------**
Logged By:	**Rod Gray**	Sheet:	**1 of 1**

Method	Water Level	Depth (m)	RL (m)	Graphic Log	USCS Symbol	Material Type	Material Description	Moisture	Samples / Tests: PID ppm	Samples / Tests: ID No.	Samples / Tests: DUP TRIP QC	Observations / Comments
							Surface: Concrete					
CC		0.20					**CONCRETE**.					
Hand Auger		0.5				Fill	**FILL** - Sand with Gravel, grey / brown, medium grained.	moist	1.3	SB1 / 0.3m		Hydrocarbon odour.
									29.6	SB1 / 0.5m		
		0.70					**SAND** - yellow, medium grained.	moist				Hydrocarbon odour.
		1.0							46.1	SB1 / 1.0m		
Push Tube		1.5			SP	Natural			185.3	SB1 / 1.5m		
		2.0					Grey below 2.0m.		191.2	SB1 / 2.0m	Dup1 Trip1	
		2.5					Yellow / brown below 2.4m.					
		2.70							2.6	SB1 / 2.7m		
		3.0					**End of Hole at 2.70 m**					

Observations		Notes
Asbestos	No visual evidence of asbestos noted during drilling.	
Staining	No visual evidence of contamination (e.g. staining / precipitate) noted during drilling.	
Odour	Olfactory (e.g. hydrocarbon odour) evidence of contamination noted during drilling.	
Groundwater	No groundwater encountered during drilling.	

REUMAD

Log Drawn By: Laurie White
Contact: laurie.white@reumad.com.au

Checked By: **Rod Gray** Date: **30/01/2012**

WSP LOG LT MONA VALE 3045.GPJ WSP.GDT 1/30/12 5:22:28 PM

Borehole Log

Hole ID. **SB2**

WSP Environment & Energy

Level 1, 41 McLaren Street
North Sydney NSW 2060
Office: +61 (0)2 8925 6700
www.wspenvironmental.com

Project Name:	**STA - Contaminated Site Assessment - Mona Vale**	Date Started:	**20/12/2011**
Project Number:	**3075**	Date Completed:	**20/12/2011**
Location / Site:	**58 Darley Street, Mona Vale NSW**	Hole Depth:	**1.40 m**
Client:	**State Transit Authority**	Ground Level:	**----------**
Drilling Company:	**Epoca Environmental Pty Ltd**	Easting:	**----------**
Drill Method:	**Hand Auger**	Northing:	**----------**
Logged By:	**Rod Gray**	Sheet:	**1 of 1**

Method	Water Level	Depth (m)	RL (m)	Graphic Log	USCS Symbol	Material Type	Material Description	Moisture	Samples / Tests: PID ppm	Samples / Tests: ID No.	Samples / Tests: DUP TRIP QC	Observations / Comments
							Surface: Concrete					
CC		0.20				Fill	**CONCRETE**.					
Hand Auger		0.50				Fill	**FILL** - Sand, yellow / grey / orange, medium grained.	moist	0.1	SB2 / 0.3m		
		0.70			SP	Natural	**PEAT. Silty SAND** - dark brown, medium grained.	moist	13.1	SB2 / 0.6m		Hydrocarbon odour.
		1.0			SP	Natural	**SAND with Gravel inclusions** - yellow / brown, medium grained.	moist	230.3	SB2 / 1.0m		Hydrocarbon odour.
		1.40					Increasing gravel component.		567	SB2 / 1.4m	Dup2 Trip2	
		1.5					**End of Hole at 1.40 m**					
		2.0										
		2.5										
		3.0										

Observations

Asbestos	No visual evidence of asbestos noted during drilling.
Staining	No visual evidence of contamination (e.g. staining / precipitate) noted during drilling.
Odour	Olfactory (e.g. hydrocarbon odour) evidence of contamination noted during drilling.
Groundwater	No groundwater encountered during drilling.

Notes

REUMAD

Log Drawn By: Laurie White
Contact: laurie.white@reumad.com.au

Checked By: **Rod Gray** Date: **30/01/2012**

WSP LOG LT MONA VALE 3045.GPJ WSP.GDT 1/30/12 5:22:29 PM

Borehole Log

Hole ID. **SB3**

WSP Environment & Energy

Level 1, 41 McLaren Street
North Sydney NSW 2060
Office: +61 (0)2 8925 6700
www.wspenvironmental.com

Project Name:	**STA - Contaminated Site Assessment - Mona Vale**	Date Started:	**20/12/2011**
Project Number:	**3075**	Date Completed:	**20/12/2011**
Location / Site:	**58 Darley Street, Mona Vale NSW**	Hole Depth:	**1.50 m**
Client:	**State Transit Authority**	Ground Level:	**----------**
Drilling Company:	**Epoca Environmental Pty Ltd**	Easting:	**----------**
Drill Method:	**Hand Auger**	Northing:	**----------**
Logged By:	**Rod Gray**	Sheet:	**1 of 1**

Method	Water Level	Depth (m)	RL (m)	Graphic Log	USCS Symbol	Material Type	Material Description	Moisture	Samples / Tests: PID ppm	Samples / Tests: ID No.	Observations / Comments
							Surface: Concrete				
CC		0.20				Fill	**CONCRETE**.				
Hand Auger	1.4m 20/12/2012	0.50				Fill	**FILL** - Sand, yellow, medium grained.	moist	1.3	SB3 / 0.3m	No olfactory evidence of contamination present in soil.
		0.90			CL	Natural	**PEAT. Silty CLAY** - dark brown, soft.	moist	6.3	SB3 / 0.6m	
		1.0			CL	Natural	**PEAT. Sandy CLAY** - orange / brown, soft.	moist	27.2	SB3 / 1.0m	
		1.30			SC	Natural	**Clayey SAND** - yellow / brown, medium grained.	moist			
		1.50						wet	4.7	SB3 / 1.5m	
							End of Hole at 1.50 m				
		2.0									
		2.5									
		3.0									

Observations

Asbestos	No visual evidence of asbestos noted during drilling.
Staining	No visual evidence of contamination (e.g. staining / precipitate) noted during drilling.
Odour	No olfactory (e.g. hydrocarbon odour) evidence of contamination noted during drilling.
Groundwater	Groundwater encountered during drilling.

Notes

REUMAD

Log Drawn By: Laurie White
Contact: laurie.white@reumad.com.au

Checked By: **Rod Gray** Date: **30/01/2012**

WSP LOG LT MONA VALE 3045.GPJ WSP.GDT 1/30/12 5:22:30 PM

Borehole Log

Hole ID. **SB4**

WSP Environment & Energy

Level 1, 41 McLaren Street
North Sydney NSW 2060
Office: +61 (0)2 8925 6700
www.wspenvironmental.com

Project Name:	**STA - Contaminated Site Assessment - Mona Vale**	Date Started:	**19/12/2011**
Project Number:	**3075**	Date Completed:	**19/12/2011**
Location / Site:	**58 Darley Street, Mona Vale NSW**	Hole Depth:	**2.70 m**
Client:	**State Transit Authority**	Ground Level:	**----------**
Drilling Company:	**Epoca Environmental Pty Ltd**	Easting:	**----------**
Drill Method:	**Hand Auger / Push Tube**	Northing:	**----------**
Logged By:	**Rod Gray**	Sheet:	**1 of 1**

Method	Water Level	Depth (m)	RL (m)	Graphic Log	USCS Symbol	Material Type	Material Description	Moisture	Samples / Tests: PID ppm	Samples / Tests: ID No.	Observations / Comments
							Surface: Concrete				
CC		0.20				Fill	**CONCRETE**.				
Hand Auger		0.50				Fill	**FILL** - Sand, yellow / grey, medium grained.	moist	0.9	SB4 / 0.3m	
		0.70			CL	Natural	**PEAT. Sandy CLAY** - dark brown, soft.	moist	1.2	SB4 / 0.6m	
		1.0					**SAND with Gravel** - yellow, medium grained.	moist	1.1	SB4 / 1.0m	
Push Tube	1.6m 19/12/2011	1.5			SP				225	SB4 / 1.5m	Hydrocarbon odour.
		2.0						wet	469.3	SB4 / 2.0m	
		2.5									
		2.70							2.3	SB4 / 2.7m	
		3.0					**End of Hole at 2.70 m**				

Observations		Notes
Asbestos	No visual evidence of asbestos noted during drilling.	
Staining	No visual evidence of contamination (e.g. staining / precipitate) noted during drilling.	
Odour	Olfactory (e.g. hydrocarbon odour) evidence of contamination noted during drilling.	
Groundwater	Groundwater encountered during drilling.	

REUMAD

Log Drawn By: Laurie White
Contact: laurie.white@reumad.com.au

Checked By: **Rod Gray** Date: **30/01/2012**

WSP LOG LT MONA VALE 3045.GPJ WSP.GDT 1/30/12 5:22:31 PM

Borehole Log

Hole ID. **SB5**

WSP Environment & Energy

Level 1, 41 McLaren Street
North Sydney NSW 2060
Office: +61 (0)2 8925 6700
www.wspenvironmental.com

Project Name:	**STA - Contaminated Site Assessment - Mona Vale**	Date Started:	**19/12/2011**
Project Number:	**3075**	Date Completed:	**19/12/2011**
Location / Site:	**58 Darley Street, Mona Vale NSW**	Hole Depth:	**2.70 m**
Client:	**State Transit Authority**	Ground Level:	**----------**
Drilling Company:	**Epoca Environmental Pty Ltd**	Easting:	**----------**
Drill Method:	**Hand Auger / Push Tube**	Northing:	**----------**
Logged By:	**Rod Gray**	Sheet:	**1 of 1**

Method	Water Level	Depth (m)	RL (m)	Graphic Log	USCS Symbol	Material Type	Material Description	Moisture	Samples / Tests: PID ppm	Samples / Tests: ID No.	Observations / Comments
							Surface: Concrete				
CC		0.20				Fill	**CONCRETE**.				
Hand Auger						Fill	**FILL** - Sand, yellow, medium grained.	moist	0.1	SB5 / 0.3m	
		0.50				Fill	**FILL** - Clay, grey / orange / red mottled, stiff.	moist	0.5	SB5 / 0.6m	Dark staining. H/carbon odour.
		0.60				Natural	**SAND with Gravel** - yellow, medium grained.	moist	0.7	SB5 / 1.0m	
	1.4m 19/12/2011	1.0			SP	Natural	Grey below 1.2m.	wet	77.1	SB5 / 1.5m	Hydrocarbon odour.
Push Tube		1.5							132.5	SB5 / 2.0m	
		2.0									
		2.5							1.3	SB5 / 2.7m	
		2.70					**End of Hole at 2.70 m**				
		3.0									

Observations

Asbestos	No visual evidence of asbestos noted during drilling.
Staining	No visual evidence of contamination (e.g. staining / precipitate) noted during drilling.
Odour	Olfactory (e.g. hydrocarbon odour) evidence of contamination noted during drilling.
Groundwater	Groundwater encountered during drilling.

Notes

REUMAD

Log Drawn By: Laurie White
Contact: laurie.white@reumad.com.au

Checked By: **Rod Gray** Date: **30/01/2012**

WSP LOG LT MONA VALE 3045.GPJ WSP.GDT 1/30/12 5:22:32 PM

Borehole Log

Hole ID. **SB6**

WSP Environment & Energy

Level 1, 41 McLaren Street
North Sydney NSW 2060
Office: +61 (0)2 8925 6700
www.wspenvironmental.com

Project Name:	**STA - Contaminated Site Assessment - Mona Vale**	Date Started:	**19/12/2011**
Project Number:	**3075**	Date Completed:	**19/12/2011**
Location / Site:	**58 Darley Street, Mona Vale NSW**	Hole Depth:	**1.60 m**
Client:	**State Transit Authority**	Ground Level:	**----------**
Drilling Company:	**Epoca Environmental Pty Ltd**	Easting:	**----------**
Drill Method:	**Hand Auger**	Northing:	**----------**
Logged By:	**Rod Gray**	Sheet:	**1 of 1**

Method	Water Level	Depth (m)	RL (m)	Graphic Log	USCS Symbol	Material Type	Material Description	Moisture	Samples / Tests: PID ppm	Samples / Tests: ID No.	Observations / Comments
							Surface: Concrete				
CC		0.20				Fill	**CONCRETE**.				
Hand Auger	1.3m 19/12/2011	0.5				Fill	**FILL** - Sand, yellow, medium grained.	moist	0.2	SB6 / 0.3m	No olfactory evidence of contamination present in soil.
		0.70							0.1	SB6 / 0.5m	
		0.80			CL	Natural	**PEAT. Sandy CLAY** - brown / orange, soft.	moist			
		0.90			SP		**Gravelly SAND** - brown, medium grained, ironstone gravel.	moist			
		1.0			SP		**SAND** - orange / yellow, medium grained, with minor clay.	moist	0.2	SB6 / 1.0m	
		1.5						wet			
		1.60							0.1	SB6 / 1.6m	
							End of Hole at 1.60 m				
		2.0									
		2.5									
		3.0									

Observations

Asbestos	No visual evidence of asbestos noted during drilling.
Staining	No visual evidence of contamination (e.g. staining / precipitate) noted during drilling.
Odour	No olfactory (e.g. hydrocarbon odour) evidence of contamination noted during drilling.
Groundwater	Groundwater encountered during drilling.

Notes

Log Drawn By: Laurie White
Contact: laurie.white@reumad.com.au

Checked By: **Rod Gray** Date: **30/01/2012**

WSP LOG LT MONA VALE 3045.GPJ WSP.GDT 1/30/12 5:22:33 PM

Borehole Log

Hole ID. **SB7**

WSP Environment & Energy

Level 1, 41 McLaren Street
North Sydney NSW 2060
Office: +61 (0)2 8925 6700
www.wspenvironmental.com

Project Name:	**STA - Contaminated Site Assessment - Mona Vale**	Date Started:	**20/12/2011**
Project Number:	**3075**	Date Completed:	**20/12/2011**
Location / Site:	**58 Darley Street, Mona Vale NSW**	Hole Depth:	**1.50 m**
Client:	**State Transit Authority**	Ground Level:	**----------**
Drilling Company:	**Epoca Environmental Pty Ltd**	Easting:	**----------**
Drill Method:	**Hand Auger**	Northing:	**----------**
Logged By:	**Rod Gray**	Sheet:	**1 of 1**

Method	Water Level	Depth (m)	RL (m)	Graphic Log	USCS Symbol	Material Type	Material Description	Moisture	Samples / Tests: PID ppm	Samples / Tests: ID No.	Observations / Comments
							Surface: Concrete				
CC		0.20					**CONCRETE**.				
Hand Auger		0.5				Fill	**FILL** - Gravelly Sand, orange / brown, medium grained.	moist	0.0	SB7 / 0.3m	No olfactory evidence of contamination present in soil.
		0.90							0.0	SB7 / 0.6m	
		1.0					**FILL** - Sand, yellow, medium grained.	moist	0.0	SB7 / 1.0m	
		1.30									
		1.50			CL	Natural	**PEAT. Sandy CLAY** - dark brown, soft, medium grained.	moist	0.0	SB7 / 1.5m	
		2.0					**End of Hole at 1.50 m**				
		2.5									
		3.0									

Observations

Asbestos	|	No visual evidence of asbestos noted during drilling.
Staining	|	No visual evidence of contamination (e.g. staining / precipitate) noted during drilling.
Odour	|	No olfactory (e.g. hydrocarbon odour) evidence of contamination noted during drilling.
Groundwater	|	No groundwater encountered during drilling.

Notes

REUMAD

Log Drawn By: Laurie White
Contact: laurie.white@reumad.com.au

Checked By: **Rod Gray** Date: **30/01/2012**

WSP LOG LT MONA VALE 3045.GPJ WSP.GDT 1/30/12 5:22:34 PM

Borehole Log

Hole ID. **SB8**

WSP Environment & Energy

Level 1, 41 McLaren Street
North Sydney NSW 2060
Office: +61 (0)2 8925 6700
www.wspenvironmental.com

Project Name:	**STA - Contaminated Site Assessment - Mona Vale**	Date Started:	**20/12/2011**
Project Number:	**3075**	Date Completed:	**20/12/2011**
Location / Site:	**58 Darley Street, Mona Vale NSW**	Hole Depth:	**0.90 m**
Client:	**State Transit Authority**	Ground Level:	**----------**
Drilling Company:	**Epoca Environmental Pty Ltd**	Easting:	**----------**
Drill Method:	**Hand Auger**	Northing:	**----------**
Logged By:	**Rod Gray**	Sheet:	**1 of 1**

Method	Water Level	Depth (m)	RL (m)	Graphic Log	USCS Symbol	Material Type	Material Description	Moisture	Samples / Tests: PID ppm	Samples / Tests: ID No.	Observations / Comments
							Surface: Concrete				
CC		0.20					**CONCRETE**.				
Hand Auger		0.5				Fill	**FILL** - Sand with Gravel inclusions, light brown, medium grained.	moist	0.3	SB8 / 0.3m	No olfactory evidence of contamination present in soil.
		0.70							0.7	SB8 / 0.6m	
		0.90					**FILL** - Clay, grey / orange / brown, stiff, wood fragments.	moist			
		1.0					**Hole Terminated at 0.90 m** due to refusal on unknown object.				
		1.5									
		2.0									
		2.5									
		3.0									

Observations		Notes
Asbestos	No visual evidence of asbestos noted during drilling.	
Staining	No visual evidence of contamination (e.g. staining / precipitate) noted during drilling.	
Odour	No olfactory (e.g. hydrocarbon odour) evidence of contamination noted during drilling.	
Groundwater	No groundwater encountered during drilling.	

REUMAD

Log Drawn By: Laurie White
Contact: laurie.white@reumad.com.au

Checked By: **Rod Gray** Date: **30/01/2012**

WSP LOG LT MONA VALE 3045.GPJ WSP.GDT 1/30/12 5:22:35 PM

Monitoring Well Log

Hole ID. **SB09**

WSP Environment & Energy

Level 1, 41 McLaren Street
North Sydney NSW 2060
Office: +61 (0)2 8925 6700
www.wspenvironmental.com

Project Name:	**Mona Vale STA - Delineation**	Date Started:	**13/08/2012**
Project Number:	**31801**	Date Completed:	**13/08/2012**
Location / Site:	**58 Darley Street, Mona Vale NSW**	Hole Depth:	**2.00 m**
Client:	**State Transit Authority**	Ground Level:	**----------**
Drilling Company:	**HartGeo Pty Ltd**	Easting:	**----------**
Drill Method:	**Hand Auger / Solid Flight Auger**	Northing:	**----------**
Logged By:	**Joshua Byrne**	Sheet:	**1 of 1**

Method	Water Level	Depth (m)	RL (mAHD)	Graphic Log	USCS Symbol	Material Type	Material Description	Moisture	Samples / Tests: PID ppm	Samples / Tests: ID No.	Observations / Comments
							Surface: Concrete				
CC		0.18				Fill	**CONCRETE**.				
Hand Auger		0.5				Fill	**FILL** - Silty Sand, orange / brown.	dry to moist	3.3	SB09_0.5m	No visual or olfactory signs of contamination.
Hand Auger		0.80			SM	Natural	**Silty SAND** - orange brown / grey blue.	moist to wet	174.5	SB09_1.0m	Hydrocarbon odour. Staining.
Solid Flight Auger	1.5m 13/08/2012	1.20			CL	Natural	**Gravelly CLAY** - grey / white.	very moist	243.1	SB09_1.5m	Hydrocarbon odour. Staining.
Solid Flight Auger		2.00							210.5	SB09_2.0m	Hydrocarbon odour. Staining.
		2.5					**End of Hole at 2.00 m**				
		3.0									

Observations		Notes
Asbestos	No visual evidence of asbestos noted during drilling.	
Staining	Visual evidence of contamination (e.g. staining / precipitate) noted during drilling.	
Odour	Olfactory (e.g. hydrocarbon odour) evidence of contamination noted during drilling.	
Groundwater	Groundwater encountered during drilling.	

REUMAD

Log Drawn By: Laurie White
Contact: laurie.white@reumad.com.au

Checked By: **Joshua Byrne** Date: **30/08/2012**

WSP LOG LT MONA VALE 31801.GPJ WSP.GDT 8/31/12 9:55:41 AM

Monitoring Well Log

Hole ID. **SB10**

WSP Environment & Energy

Level 1, 41 McLaren Street
North Sydney NSW 2060
Office: +61 (0)2 8925 6700
www.wspenvironmental.com

Project Name:	**Mona Vale STA - Delineation**	Date Started:	**13/08/2012**
Project Number:	**31801**	Date Completed:	**13/08/2012**
Location / Site:	**58 Darley Street, Mona Vale NSW**	Hole Depth:	**2.00 m**
Client:	**State Transit Authority**	Ground Level:	**----------**
Drilling Company:	**HartGeo Pty Ltd**	Easting:	**----------**
Drill Method:	**Hand Auger / Solid Flight Auger**	Northing:	**----------**
Logged By:	**Joshua Byrne**	Sheet:	**1 of 1**

Method	Water Level	Depth (m)	RL (mAHD)	Graphic Log	USCS Symbol	Material Type	Material Description	Moisture	Samples / Tests: PID ppm	Samples / Tests: ID No.	Observations / Comments
							Surface: Concrete				
CC		0.18				Fill	**CONCRETE**.				
Hand Auger		0.5				Fill	**FILL** - Silty Sand, dark orange / brown, with organic matter inclusions.	moist	0.0	SB10_0.5m	No visual or olfactory signs of contamination.
		0.80									
Solid Flight Auger		1.0			SM	Natural	**Silty SAND** - orange / brown.	moist	0.6	SB10_1.0m	Hydrocarbon odour.
		1.20									
		1.5			SP	Natural	**Gravelly SAND** - grey / white.	very moist	120.9	SB10_1.5m	Hydrocarbon odour.
		2.00				Natural	With red clay & gravel inclusions.		151.7	SB10_2.0m	Hydrocarbon odour.
							End of Hole at 2.00 m				
		2.5									
		3.0									

Observations		Notes
Asbestos	No visual evidence of asbestos noted during drilling.	
Staining	No visual evidence of contamination (e.g. staining / precipitate) noted during drilling.	
Odour	Olfactory (e.g. hydrocarbon odour) evidence of contamination noted during drilling.	
Groundwater	No groundwater encountered during drilling.	

REUMAD

Log Drawn By: Laurie White
Contact: laurie.white@reumad.com.au

Checked By: **Joshua Byrne** Date: **30/08/2012**

WSP LOG LT MONA VALE 31801.GPJ WSP.GDT 8/31/12 9:55:42 AM

Monitoring Well Log

Hole ID. **SB11**

WSP Environment & Energy

Level 1, 41 McLaren Street
North Sydney NSW 2060
Office: +61 (0)2 8925 6700
www.wspenvironmental.com

Project Name:	**Mona Vale STA - Delineation**	Date Started:	**13/08/2012**
Project Number:	**31801**	Date Completed:	**13/08/2012**
Location / Site:	**58 Darley Street, Mona Vale NSW**	Hole Depth:	**1.90 m**
Client:	**State Transit Authority**	Ground Level:	**----------**
Drilling Company:	**HartGeo Pty Ltd**	Easting:	**----------**
Drill Method:	**Hand Auger / Solid Flight Auger**	Northing:	**----------**
Logged By:	**Joshua Byrne**	Sheet:	**1 of 1**

Method	Water Level	Depth (m)	RL (mAHD)	Graphic Log	USCS Symbol	Material Type	Material Description	Moisture	Samples / Tests: PID ppm	Samples / Tests: ID No.	Observations / Comments
							Surface: Concrete				
CC		0.18				Fill	**CONCRETE**.				
Hand Auger		0.5				Fill	**FILL** - Silty Sand, brown / grey.	damp	1.4	SB11_0.5m	No visual or olfactory signs of contamination.
Hand Auger		0.70			CL	Natural	**Silty CLAY** - dark brown / red.	damp			
Hand Auger		0.80			SM	Natural	**Silty SAND** - dark brown.	damp			
Solid Flight Auger	1.7m 13/08/2012	1.00			SM	Natural	**Silty SAND** - light orange / brown.	moist	8.1	SB11_1.0m	No visual or olfactory signs of contamination.
Solid Flight Auger	1.7m 13/08/2012	1.50			SM	Natural	With gravel inclusions at 1.4m. **Silty SAND** - orange brown / grey.	moist	92.4	SB11_1.5m	Hydrocarbon odour.
Solid Flight Auger	1.7m 13/08/2012	1.70			SP	Natural	**Gravelly SAND** - grey / white, blue / grey staining.	moist to wet	147.3	SB11_1.9m	Hydrocarbon odour. Staining.
		1.90					**End of Hole at 1.90 m**				
		2.0									
		2.5									
		3.0									

Observations		Notes
Asbestos	No visual evidence of asbestos noted during drilling.	
Staining	Visual evidence of contamination (e.g. staining / precipitate) noted during drilling.	
Odour	Olfactory (e.g. hydrocarbon odour) evidence of contamination noted during drilling.	
Groundwater	Groundwater encountered during drilling.	

REUMAD

Log Drawn By: Laurie White
Contact: laurie.white@reumad.com.au

Checked By: **Joshua Byrne** Date: **30/08/2012**

WSP LOG LT MONA VALE 31801.GPJ WSP.GDT 8/31/12 9:55:43 AM

Monitoring Well Log

Hole ID. **SB12**

WSP Environment & Energy

Level 1, 41 McLaren Street
North Sydney NSW 2060
Office: +61 (0)2 8925 6700
www.wspenvironmental.com

Project Name:	**Mona Vale STA - Delineation**	Date Started:	**13/08/2012**
Project Number:	**31801**	Date Completed:	**13/08/2012**
Location / Site:	**58 Darley Street, Mona Vale NSW**	Hole Depth:	**1.80 m**
Client:	**State Transit Authority**	Ground Level:	**----------**
Drilling Company:	**HartGeo Pty Ltd**	Easting:	**----------**
Drill Method:	**Hand Auger / Solid Flight Auger**	Northing:	**----------**
Logged By:	**Joshua Byrne**	Sheet:	**1 of 1**

Method	Water Level	Depth (m)	RL (mAHD)	Graphic Log	USCS Symbol	Material Type	Material Description	Moisture	Samples / Tests: PID ppm	Samples / Tests: ID No.	Observations / Comments
							Surface: Concrete				
CC		0.30				Fill	**CONCRETE**.				
Hand Auger		0.5			SM	Natural	**Silty SAND** - orange / brown.	moist	2.0	SB12_0.5m	No visual or olfactory signs of contamination.
Solid Flight Auger	1.5m 13/08/2012	1.0							182.6	SB12_1.0m	Hydrocarbon odour.
		1.20									
		1.5			SM		**Silty SAND** - brown orange / grey.	moist	207.5	SB12_1.5m	Hydrocarbon odour. Minor staining.
		1.60									
		1.80			SM		**Silty SAND** - white / grey.	very moist	260.8	SB12_1.8m	Hydrocarbon odour.
		2.0					**End of Hole at 1.80 m**				
		2.5									
		3.0									

Observations		
Asbestos	|	No visual evidence of asbestos noted during drilling.
Staining	|	Visual evidence of contamination (e.g. staining / precipitate) noted during drilling.
Odour	|	Olfactory (e.g. hydrocarbon odour) evidence of contamination noted during drilling.
Groundwater	|	Groundwater encountered during drilling.

Notes

Log Drawn By: Laurie White
Contact: laurie.white@reumad.com.au

Checked By: **Joshua Byrne** Date: **30/08/2012**

WSP LOG LT MONA VALE 31801.GPJ WSP.GDT 8/31/12 9:55:44 AM

Monitoring Well Log

Hole ID. **SB13**

WSP Environment & Energy

Level 1, 41 McLaren Street
North Sydney NSW 2060
Office: +61 (0)2 8925 6700
www.wspenvironmental.com

Project Name:	**Mona Vale STA - Delineation**	Date Started:	**13/08/2012**
Project Number:	**31801**	Date Completed:	**13/08/2012**
Location / Site:	**58 Darley Street, Mona Vale NSW**	Hole Depth:	**1.80 m**
Client:	**State Transit Authority**	Ground Level:	**----------**
Drilling Company:	**HartGeo Pty Ltd**	Easting:	**----------**
Drill Method:	**Hand Auger / Solid Flight Auger**	Northing:	**----------**
Logged By:	**Joshua Byrne**	Sheet:	**1 of 1**

Method	Water Level	Depth (m)	RL (mAHD)	Graphic Log	USCS Symbol	Material Type	Material Description	Moisture	Samples / Tests: PID ppm	Samples / Tests: ID No.	Observations / Comments
							Surface: Concrete				
CC		0.28				Fill	**CONCRETE**.				
Hand Auger		0.5				Fill	**FILL** - Sandy Gravel.	moist	0.0	SB13_0.5m	No visual or olfactory signs of contamination.
Hand Auger		0.60			SP	Natural	**SAND** - orange / brown, with marine deposit inclusions.				
Hand Auger		1.00							0.0	SB13_1.0m	No visual or olfactory signs of contamination.
Solid Flight Auger		1.20			SP	Natural	**Silty SAND** - dark brown.	moist			
Solid Flight Auger	1.6m 13/08/2012	1.5			SP	Natural	**Silty SAND** - orange / brown.	moist	0.0	SB13_1.5m	No visual or olfactory signs of contamination.
Solid Flight Auger		1.60									
Solid Flight Auger		1.80			SP	Natural	**Silty SAND** - grey / white.	very moist	16.8	SB13_1.8m	Hydrocarbon odour.
		2.0					**End of Hole at 1.80 m**				
		2.5									
		3.0									

Observations		Notes
Asbestos	No visual evidence of asbestos noted during drilling.	
Staining	No visual evidence of contamination (e.g. staining / precipitate) noted during drilling.	
Odour	Olfactory (e.g. hydrocarbon odour) evidence of contamination noted during drilling.	
Groundwater	Groundwater encountered during drilling.	

REUMAD

Log Drawn By: Laurie White
Contact: laurie.white@reumad.com.au

Checked By: **Joshua Byrne** Date: **30/08/2012**

WSP LOG LT MONA VALE 31801.GPJ WSP.GDT 8/31/12 9:55:45 AM

Monitoring Well Log

Hole ID. **SB14**

WSP Environment & Energy

Level 1, 41 McLaren Street
North Sydney NSW 2060
Office: +61 (0)2 8925 6700
www.wspenvironmental.com

Project Name:	**Mona Vale STA - Delineation**	Date Started:	**13/08/2012**
Project Number:	**31801**	Date Completed:	**13/08/2012**
Location / Site:	**58 Darley Street, Mona Vale NSW**	Hole Depth:	**2.00 m**
Client:	**State Transit Authority**	Ground Level:	**----------**
Drilling Company:	**HartGeo Pty Ltd**	Easting:	**----------**
Drill Method:	**Hand Auger / Solid Flight Auger**	Northing:	**----------**
Logged By:	**Joshua Byrne**	Sheet:	**1 of 1**

Method	Water Level	Depth (m)	RL (mAHD)	Graphic Log	USCS Symbol	Material Type	Material Description	Moisture	Samples / Tests: PID ppm	Samples / Tests: ID No.	Observations / Comments
							Surface: Concrete				
CC		0.18				Fill	**CONCRETE**.				
Hand Auger		0.5			CL		**Silty CLAY** - dark brown.	dry to moist	4.3	SB14_0.5m	No visual or olfactory signs of contamination.
		0.80									
		1.0			SM	Natural	**Silty SAND** - orange / brown.	moist	5.8	SB14_1.0m	No visual or olfactory signs of contamination.
		1.20									
Solid Flight Auger	1.5m 13/08/2012	1.5			SM		**Silty SAND** - light orange / brown.	very moist to wet	1.1	SB14_1.5m	Hydrocarbon odour.
		1.80									
		2.00			SP		**Silty Gravelly SAND** - orange / red / brown.	wet	1.7	SB14_2.0m	Hydrocarbon odour.
		2.5					**End of Hole at 2.00 m**				
		3.0									

Observations		Notes
Asbestos	No visual evidence of asbestos noted during drilling.	
Staining	No visual evidence of contamination (e.g. staining / precipitate) noted during drilling.	
Odour	Olfactory (e.g. hydrocarbon odour) evidence of contamination noted during drilling.	
Groundwater	Groundwater encountered during drilling.	

REUMAD

Log Drawn By: Laurie White
Contact: laurie.white@reumad.com.au

Checked By: **Joshua Byrne** Date: **30/08/2012**

WSP LOG LT MONA VALE 31801.GPJ WSP.GDT 8/31/12 9:55:46 AM

Monitoring Well Log

Hole ID. **MW01**

WSP Environment & Energy

Level 1, 41 McLaren Street
North Sydney NSW 2060
Office: +61 (0)2 8925 6700
www.wspenvironmental.com

Project Name:	**STA - Contaminated Site Assessment - Mona Vale**	Date Started:	**19/12/2011**
Project Number:	**3075**	Date Completed:	**19/12/2011**
Location / Site:	**58 Darley Street, Mona Vale NSW**	Hole Depth:	**3.50 m**
Client:	**State Transit Authority**	Ground Level:	----------
Drilling Company:	**Epoca Environmental Pty Ltd**	Easting:	----------
Drill Method:	**HA / PT / SFA**	Northing:	----------
Logged By:	**Rod Gray**	Sheet:	**1 of 1**

Method	Water Level	Depth (m)	RL (m)	Graphic Log	USCS Symbol	Material Type	Material Description	Moisture	Samples / Tests: PID ppm	Samples / Tests: ID No.	Observations / Comments	Well Details	Well Construction
							Surface: Concrete						
CC		0.20					**CONCRETE**.						
Hand Auger		0.5				Fill	**FILL** - Sand, brown / orange, medium grained.	moist	0.1	MW01 / 0.3m			Gattic
									0.1	MW01 / 0.5m		0.50	Bentonite
		1.0							0.1	MW01 / 1.0m		1.00	
Push Tube	1.6m 19/12/2011	1.40			CL		**PEAT. Sandy CLAY** - light brown / dark grey, medium grained.	moist	3.8	MW01 / 1.5m	Hydrocarbon odour. Sheen on water.		Gravel Pack
		1.5					**Gravelly SAND** - brown / grey, coarse grained, fine gravel.	wet					
		1.55			SP								Screen
		2.0							126.9	MW01 / 2.0m			
		2.20				Natural	**SAND** - yellow / grey / brown, medium.	wet					
Solid Flight Auger		2.5											
					SP				0.3	MW01 / 2.7m			
		3.0										3.00	Cave-in
		3.50					**End of Hole at 3.50 m**						
		4.0											

Observations

Asbestos	No visual evidence of asbestos noted during drilling.
Staining	No visual evidence of contamination (e.g. staining / precipitate) noted during drilling.
Odour	Olfactory (e.g. hydrocarbon odour) evidence of contamination noted during drilling.
Groundwater	Groundwater encountered during drilling.

Notes

Log Drawn By: Laurie White
Contact: laurie.white@reumad.com.au

Checked By: **Rod Gray** Date: **30/01/2012**

WSP LOG LT MONA VALE 3045.GPJ WSP.GDT 1/30/12 5:22:22 PM

Monitoring Well Log

Hole ID. **MW02**

WSP Environment & Energy

Level 1, 41 McLaren Street
North Sydney NSW 2060
Office: +61 (0)2 8925 6700
www.wspenvironmental.com

Project Name:	**STA - Contaminated Site Assessment - Mona Vale**	Date Started:	**19/12/2011**
Project Number:	**3075**	Date Completed:	**19/12/2011**
Location / Site:	**58 Darley Street, Mona Vale NSW**	Hole Depth:	**3.50 m**
Client:	**State Transit Authority**	Ground Level:	----------
Drilling Company:	**Epoca Environmental Pty Ltd**	Easting:	----------
Drill Method:	**HA / PT / SFA**	Northing:	----------
Logged By:	**Rod Gray**	Sheet:	**1 of 1**

Method	Water Level	Depth (m)	RL (m)	Graphic Log	USCS Symbol	Material Type	Material Description	Moisture	Samples / Tests: PID ppm	Samples / Tests: ID No.	Observations / Comments
							Surface: Concrete				
CC		0.20					**CONCRETE**.				
Hand Auger						Fill	**FILL** - Sand, minor Clay, white / brown, medium grained.	moist	1.1	MW02 / 0.3m	No olfactory evidence of contamination present in soil.
		0.5							1.0	MW02 / 0.5m	
		0.70					**PEAT. Sandy CLAY** - dark brown, soft, medium grained.	moist			
		1.0			CL				1.0	MW02 / 1.0m	
		1.10					**Sandy CLAY** - orange / yellow, medium grained.	moist			
Push Tube	1.6m 19/12/2011				CL						
		1.50					**SAND** - yellow / white, medium grained, minor clay present 1.5 to 2.0m.	wet	0.3	MW02 / 1.6m	
		2.0				Natural			0.3	MW02 / 2.0m	
		2.5			SP		Increasing grey colour with depth.				
Solid Flight Auger									0.2	MW02 / 2.7m	
		3.0									
		3.50					**End of Hole at 3.50 m**				
		4.0									

Well Details / Well Construction: Gattic; Bentonite 0.40; 0.70; Gravel Pack; Screen; 2.70; Cave-in

Observations

Asbestos	No visual evidence of asbestos noted during drilling.
Staining	No visual evidence of contamination (e.g. staining / precipitate) noted during drilling.
Odour	No olfactory (e.g. hydrocarbon odour) evidence of contamination noted during drilling.
Groundwater	Groundwater encountered during drilling.

Notes

REUMAD

Log Drawn By: Laurie White
Contact: laurie.white@reumad.com.au

Checked By: **Rod Gray** Date: **30/01/2012**

WSP LOG LT MONA VALE 3045.GPJ WSP.GDT 1/30/12 5:22:24 PM

Monitoring Well Log

Hole ID. **MW03**

WSP Environment & Energy

Level 1, 41 McLaren Street
North Sydney NSW 2060
Office: +61 (0)2 8925 6700
www.wspenvironmental.com

Project Name:	**STA - Contaminated Site Assessment - Mona Vale**	Date Started:	**19/12/2011**
Project Number:	**3075**	Date Completed:	**19/12/2011**
Location / Site:	**58 Darley Street, Mona Vale NSW**	Hole Depth:	**3.50 m**
Client:	**State Transit Authority**	Ground Level:	----------
Drilling Company:	**Epoca Environmental Pty Ltd**	Easting:	----------
Drill Method:	**HA / PT / SFA**	Northing:	----------
Logged By:	**Rod Gray**	Sheet:	**1 of 1**

Method	Water Level	Depth (m)	RL (m)	Graphic Log	USCS Symbol	Material Type	Material Description	Moisture	Samples / Tests: PID ppm	Samples / Tests: ID No.	Observations / Comments	Well Details	Well Construction
							Surface: Concrete						
CC		0.20				Fill	**CONCRETE**.						
HA		0.5				Fill	**FILL** - Clayey Sand, yellow / orange, medium grained.	moist	0.1 0.3	MW03 / 0.3m MW03 / 0.5m	No olfactory evidence of contamination present in soil.	Gattic 0.40 Bentonite	
HA		0.70			CL	Natural	**PEAT. Sandy CLAY** - dark brown, soft, medium grained.	moist	0.9	MW03 / 1.0m		0.90 Gravel Pack	
Push Tube	1.6m 19/12/2011	1.30			SP	Natural	**SAND, minor Clay** - yellow / orange, medium grained.	moist	0.4	MW03 / 1.5m		Screen	
		1.80				Natural		wet					
Solid Flight Auger		2.0			SP	Natural	**SAND** - white / brown / grey, medium grained.	wet	0.3	MW03 / 2.5m		2.90 Cave-in	
		3.50					**End of Hole at 3.50 m**						
		4.0											

Observations

Asbestos	No visual evidence of asbestos noted during drilling.
Staining	No visual evidence of contamination (e.g. staining / precipitate) noted during drilling.
Odour	No olfactory (e.g. hydrocarbon odour) evidence of contamination noted during drilling.
Groundwater	Groundwater encountered during drilling.

Notes

Log Drawn By: Laurie White
Contact: laurie.white@reumad.com.au

Checked By: **Rod Gray** Date: **30/01/2012**

WSP LOG LT MONA VALE 3045.GPJ WSP.GDT 1/30/12 5:22:25 PM

Monitoring Well Log

Hole ID. **MW04**

WSP Environment & Energy

Level 1, 41 McLaren Street
North Sydney NSW 2060
Office: +61 (0)2 8925 6700
www.wspenvironmental.com

Project Name:	**STA - Contaminated Site Assessment - Mona Vale**	Date Started:	**19/12/2011**
Project Number:	**3075**	Date Completed:	**19/12/2011**
Location / Site:	**58 Darley Street, Mona Vale NSW**	Hole Depth:	**3.50 m**
Client:	**State Transit Authority**	Ground Level:	----------
Drilling Company:	**Epoca Environmental Pty Ltd**	Easting:	----------
Drill Method:	**HA / PT / SFA**	Northing:	----------
Logged By:	**Rod Gray**	Sheet:	**1 of 1**

Method	Water Level	Depth (m)	RL (m)	Graphic Log	USCS Symbol	Material Type	Material Description	Moisture	Samples / Tests: PID ppm	Samples / Tests: ID No.	Observations / Comments	Well Details	Well Construction
							Surface: Concrete						
CC		0.20				Fill	**CONCRETE**.						
Hand Auger		0.40				Fill	**FILL** - Sand, with Gravel, orange / yellow, medium grained.	moist	0.2	MW04 / 0.3m	No olfactory evidence of contamination present in soil.		
Hand Auger		0.5			CL	Natural	**PEAT. Sandy CLAY** - dark brown, medium grained.	moist	0.1	MW04 / 0.5m		0.50	Gattic; Bentonite
Hand Auger		0.95				Natural	**SAND** - yellow / white, medium grained.	moist	0.1	MW04 / 1.0m		1.00	
Push Tube	1.6m 19/12/2011	1.5				Natural		wet					Gravel Pack
Push Tube		2.0			SP	Natural	With ironstone gravel inclusions 1.9 to 2.3m.						Screen
Push Tube		2.5				Natural	Dark grey band 2.2 to 2.4m.		0.0	MW04 / 2.3m			
Solid Flight Auger		3.0				Natural			0.1	MW04 / 3.0m		3.00	Cave-in
Solid Flight Auger		3.50				Natural	**End of Hole at 3.50 m**						
		4.0											

Observations

Asbestos	No visual evidence of asbestos noted during drilling.
Staining	No visual evidence of contamination (e.g. staining / precipitate) noted during drilling.
Odour	No olfactory (e.g. hydrocarbon odour) evidence of contamination noted during drilling.
Groundwater	Groundwater encountered during drilling.

Notes

REUMAD

Log Drawn By: Laurie White
Contact: laurie.white@reumad.com.au

Checked By: **Rod Gray** Date: **30/01/2012**

WSP LOG LT MONA VALE 3045.GPJ WSP.GDT 1/30/12 5:22:26 PM

Monitoring Well Log

Hole ID. **MW05**

WSP Environment & Energy

Level 1, 41 McLaren Street
North Sydney NSW 2060
Office: +61 (0)2 8925 6700
www.wspenvironmental.com

Project Name:	**Mona Vale STA - Delineation**	Date Started:	**13/08/2012**
Project Number:	**31801**	Date Completed:	**13/08/2012**
Location / Site:	**58 Darley Street, Mona Vale NSW**	Hole Depth:	**4.00 m**
Client:	**State Transit Authority**	Ground Level:	----------
Drilling Company:	**HartGeo Pty Ltd**	Easting:	----------
Drill Method:	**Hand Auger / Solid Flight Auger**	Northing:	----------
Logged By:	**Joshua Byrne**	Sheet:	**1 of 1**

Method	Water Level	Depth (m)	RL (mAHD)	Graphic Log	USCS Symbol	Material Type	Material Description	Moisture	Samples / Tests: PID ppm	Samples / Tests: ID No.	Samples / Tests: DUP TRIP QC	Observations / Comments
							Surface: Concrete					
CC		0.18				Fill	**CONCRETE**.					
Hand Auger		0.5				Fill	**FILL** - Silty Sand, orange / brown.	dry to moist	126.7	MW05_0.5m		No visual or olfactory signs of contamination.
		0.80										
	1.3m 13/08/2012	1.0			SM	Natural	**Silty SAND** - orange / yellow / brown, blue / grey staining.	dry to moist	118.5	MW05_1.0m	Dup1 Trip1	Hydrocarbon odour. Staining.
		1.30										
Solid Flight Auger		1.5			SP		**Silty Gravelly SAND** - orange brown / white grey.	moist to wet	120.1	MW05_1.5m		Hydrocarbon odour. Staining.
		2.0							178.9	MW05_2.0m		Hydrocarbon odour. Staining.
		2.50										
		3.0			SM		**Silty SAND** - orange / grey.	wet				
		3.5										
		4.00					**End of Hole at 4.00 m**					
		4.5										
		5.0										

Well Details: Gattic; 0.50 Bentonite; 0.80; 1.00 Gravel Pack; Screen; 3.50 Cave-in

Well Construction

Observations

Asbestos	No visual evidence of asbestos noted during drilling.
Staining	Visual evidence of contamination (e.g. staining / precipitate) noted during drilling.
Odour	Olfactory (e.g. hydrocarbon odour) evidence of contamination noted during drilling.
Groundwater	Groundwater encountered during drilling.

Notes

Log Drawn By: Laurie White
Contact: laurie.white@reumad.com.au

Checked By: **Joshua Byrne** Date: **30/08/2012**

WSP LOG LT MONA VALE 31801.GPJ WSP.GDT 8/31/12 9:55:37 AM

Monitoring Well Log

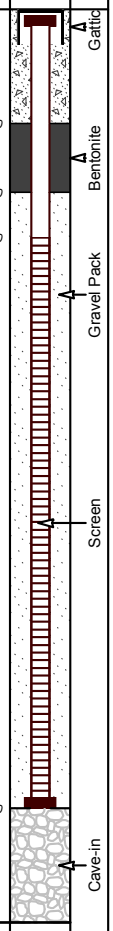
Hole ID. **MW06**

WSP Environment & Energy

Level 1, 41 McLaren Street
North Sydney NSW 2060
Office: +61 (0)2 8925 6700
www.wspenvironmental.com

Project Name:	**Mona Vale STA - Delineation**	Date Started:	**13/08/2012**
Project Number:	**31801**	Date Completed:	**13/08/2012**
Location / Site:	**58 Darley Street, Mona Vale NSW**	Hole Depth:	**4.00 m**
Client:	**State Transit Authority**	Ground Level:	----------
Drilling Company:	**HartGeo Pty Ltd**	Easting:	----------
Drill Method:	**Hand Auger / Solid Flight Auger**	Northing:	----------
Logged By:	**Joshua Byrne**	Sheet:	**1 of 1**

Method	Water Level	Depth (m)	RL (mAHD)	Graphic Log	USCS Symbol	Material Type	Material Description	Moisture	Samples / Tests: PID ppm	Samples / Tests: ID No.	Observations / Comments
Hand Auger		0.10				Fill	**TOPSOIL**.				
							FILL - Gravelly Sandy, brown.	dry	9.0	MW06_0.5m	No visual or olfactory signs of contamination.
		0.80									
Solid Flight Auger	1.5m 13/08/2012	1.0			SM		**Silty SAND** - orange / brown.	dry to moist	2.8	MW06_1.0m	No visual or olfactory signs of contamination.
		1.5							0.0	MW06_1.5m	No visual or olfactory signs of contamination.
		1.80									
		2.0			SM		**Silty SAND** - blue / grey, blue / grey staining.	very moist	23.8	MW06_2.0m	Hydrocarbon odour. Staining.
		2.20				Natural					
		2.5			SP		**SAND** - orange / brown, with shell inclusions.	very moist			
		3.0									
		3.5									
		4.00									
		4.5					**End of Hole at 4.00 m**				
		5.0									



Observations		Notes
Asbestos	No visual evidence of asbestos noted during drilling.	
Staining	Visual evidence of contamination (e.g. staining / precipitate) noted during drilling.	
Odour	Olfactory (e.g. hydrocarbon odour) evidence of contamination noted during drilling.	
Groundwater	Groundwater encountered during drilling.	

REUMAD

Log Drawn By: Laurie White
Contact: laurie.white@reumad.com.au

Checked By: **Joshua Byrne** Date: **30/08/2012**

WSP LOG LT MONA VALE 31801.GPJ WSP.GDT 8/31/12 9:55:39 AM

Monitoring Well Log

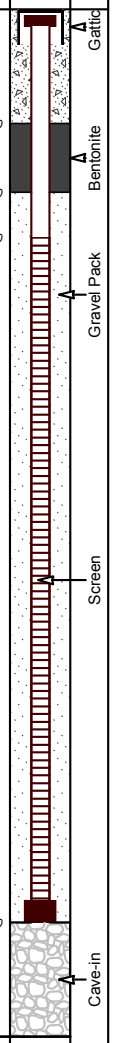
Hole ID. **MW07**

WSP Environment & Energy

Level 1, 41 McLaren Street
North Sydney NSW 2060
Office: +61 (0)2 8925 6700
www.wspenvironmental.com

Project Name:	**Mona Vale STA - Delineation**	Date Started:	**13/08/2012**
Project Number:	**31801**	Date Completed:	**13/08/2012**
Location / Site:	**58 Darley Street, Mona Vale NSW**	Hole Depth:	**4.50 m**
Client:	**State Transit Authority**	Ground Level:	----------
Drilling Company:	**HartGeo Pty Ltd**	Easting:	----------
Drill Method:	**Hand Auger / Solid Flight Auger**	Northing:	----------
Logged By:	**Joshua Byrne**	Sheet:	**1 of 1**

Method	Water Level	Depth (m)	RL (mAHD)	Graphic Log	USCS Symbol	Material Type	Material Description	Moisture	Samples / Tests: PID ppm	Samples / Tests: ID No.	Observations / Comments
							Surface: Concrete				
CC		0.17				Fill	**CONCRETE**.				
Hand Auger		0.5				Fill	**FILL** - Silty Clay / Sand, dark orange / brown.	moist	9.8	MW07_0.5m	No visual or olfactory signs of contamination.
Hand Auger		0.80				Natural	**Silty CLAY / SAND** - orange / brown.	moist	10.2	MW07_1.0m	No visual or olfactory signs of contamination.
Hand Auger		1.0			CL	Natural			5.1	MW07_1.5m	Slight hydrocarbon odour.
Hand Auger	1.7m 13/08/2012	1.5				Natural					
Hand Auger		1.70				Natural					
Solid Flight Auger		1.90			SM	Natural	**Silty SAND** - orange / brown.	moist			
Solid Flight Auger		2.0			SP	Natural	**Gravelly SAND** - white / grey.	very moist	142.6	MW07_2.0m	Hydrocarbon odour. Staining.
Solid Flight Auger		2.50				Natural					
Solid Flight Auger		3.0			SM	Natural	**Silty SAND** - orange / grey.	very moist			
Solid Flight Auger		3.5				Natural					
Solid Flight Auger		4.0				Natural					
Solid Flight Auger		4.50				Natural					
		5.0					**End of Hole at 4.50 m**				



Observations		Notes
Asbestos	No visual evidence of asbestos noted during drilling.	
Staining	Visual evidence of contamination (e.g. staining / precipitate) noted during drilling.	
Odour	Olfactory (e.g. hydrocarbon odour) evidence of contamination noted during drilling.	
Groundwater	Groundwater encountered during drilling.	

REUMAD

Log Drawn By: Laurie White
Contact: laurie.white@reumad.com.au

Checked By: **Joshua Byrne** Date: **30/08/2012**

WSP LOG LT MONA VALE 31801.GPJ WSP.GDT 8/31/12 9:55:40 AM

Monitoring Well Log

Hole ID. **MW08**

WSP Environment & Energy
Level 1, 41 McLaren Street
North Sydney NSW 2060
Office: +61 (0)2 8925 6700
www.wspenvironmental.com

Project Name:	**Mona Vale STA - Offsite Delineation**	Date Started:	**12/11/2012**
Project Number:	**34820**	Date Completed:	**12/11/2012**
Location / Site:	**58 Darley Street, Mona Vale NSW**	Hole Depth:	**4.00 m**
Client:	**State Transit Authority**	Ground Level:	----------
Drilling Company:	**HartGeo Pty Ltd**	Top of Casing:	----------
Drill Method:	**Hand Auger / Solid Stem Auger**	Easting:	----------
Logged By:	**Adeline Menet**	Northing:	----------

Method	Water Level	Depth (m)	RL (mAHD)	Graphic Log	USCS Symbol	Material Type	Material Description	Moisture	Samples / Tests: PID ppm	Samples / Tests: ID No.	Observations / Comments	Well Details	Well Construction
Hand Auger		0.10				Natural	**Silty TOPSOIL** - brown.						
					SM		**Silty SAND** - dark brown, loose, very fine grained.	dry	0.5	MW08_0.1	No odour.		Gatic
		0.5					Colour change to darker brown at 0.5m.		0.5	MW08_0.7			Bentonite
		1.00										0.800	
Solid Stem Auger	2.1m 12/11/2012				SC		**Clayey SAND** - light brown / orange, loose, fine grained.	moist	0.2	MW08_1.0		1.000	Gravel Pack
		1.5					Becoming reddish orange in colour.		0.3	MW08_1.5			
		2.00							1.1	MW08_2.0			
							SAND - loose, coarse grained.	moist					
		2.5					Becomes wet at 2.1m, some dark colouration.	wet			Slight hydrocarbon odour.		Screen
		3.0			SP				19.2	MW08_3.0			
		3.5											
		4.00					**End of Hole at 4.000 m**						

Observations		Notes
Asbestos	No visual evidence of asbestos noted during drilling.	
Staining	No visual evidence of contamination (e.g. staining / precipitate) noted during drilling.	
Odour	Olfactory (e.g. odour) evidence of contamination noted during drilling.	
Groundwater	Groundwater encountered during drilling.	

REUMAD

Log Drawn By: Laurie White
Contact: laurie.white@reumad.com.au

Checked By: **Adeline Menet** Date: **28/03/2013**

WSP LOG LT MONA VALE 34820.GPJ WSP.GDT 28/3/13 3:35:57 PM

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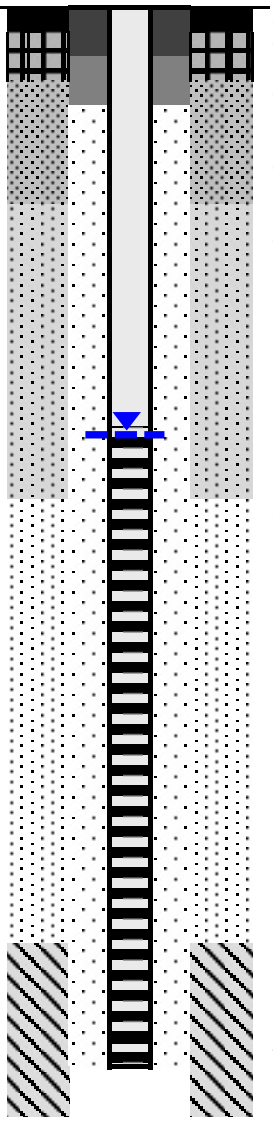
25 RIVER ROAD
SHOALHAVEN HEADS NSW 2535

ENVIRONMENTAL BOREHOLE CONSTRUCTION LOG

BORE NUMBER: MW8B

PROJECT No:	ENRS0212	**DATE DRILLED:**	10/06/2014
LOCATION:	Rd rsv adj Plan SP31257	**LOGGED BY:**	Rohan Last
CLIENT:	AES on behalf of STA.	**DRILLED BY:**	Nealings Drilling (Neal Stapleton)
SURFACE RL:	3.22	**DRILL METHOD:**	Hollow Flight Auger
EASTING:	342996.15	**HOLE DIAMETER:**	150mm
NORTHING:	6272656.64	**FINAL DEPTH:**	4.25m

Depth Metres	Well Log	Construction	Sample ID	PID	SPT	Graphic Log	Description
							Ground Surface
0.0		8mm Hex Key Gatic Cover 0.0-0.2m Cement sanitary seal					0-0.05 Asphalt 0.05-0.35 gravel sub-base
0.2		0.2-0.4m Bentonite sanitary seal					0.35-0.85 Silty sand, dark brown
0.4							
0.6		0.0-1.88m 50mm PVC casing					
0.8							0.85-2.0 Silty sand, pale brown
1.0		0.4-4.25m Gravel Pack graded					
1.2							
1.4		1.88-4.25m Slotted PVC Screen					
1.6							
1.8							
2.0		**SWL 1.75mbgl 10/6/2014**					2.0-3.8 Silty sand, grey
2.2							
2.4							
2.6							
2.8							
3.0							
3.2							
3.4							
3.6							
3.8							3.8-4.5 Sandy clay, grey
4.0							
4.2		TOTAL DEPTH 4.25mBGL					
4.4							
4.6							
4.8							
5.0							

Notes:
Descriptions are based on observations and hand testing of grab samples.
Mechanical Tests were not performed unless otherwise stated

Monitoring Well Log

Hole ID. **MW09**

WSP Environment & Energy
Level 1, 41 McLaren Street
North Sydney NSW 2060
Office: +61 (0)2 8925 6700
www.wspenvironmental.com

Project Name:	**Mona Vale STA - Offsite Delineation**	Date Started:	**12/11/2012**
Project Number:	**34820**	Date Completed:	**12/11/2012**
Location / Site:	**58 Darley Street, Mona Vale NSW**	Hole Depth:	**4.00 m**
Client:	**State Transit Authority**	Ground Level:	----------
Drilling Company:	**HartGeo Pty Ltd**	Top of Casing:	----------
Drill Method:	**Hand Auger / Solid Stem Auger**	Easting:	----------
Logged By:	**Adeline Menet**	Northing:	----------

Method	Water Level	Depth (m)	RL (mAHD)	Graphic Log	USCS Symbol	Material Type	Material Description	Moisture	Samples / Tests: PID ppm	Samples / Tests: ID No.	Observations / Comments	Well Details	Well Construction
							Concrete on surface.						
CC		0.20					**CONCRETE**.				No odour.		Gatic
Hand Auger		0.50			CL		**Silty Sandy CLAY** - light brown, with blue / orange / dark grey colouration, soft.	moist	0.5	MW09_0.3			
		0.90			CL		**Silty Sandy CLAY** - dark brown, soft, fine grained sand, organic matter present.	moist	28.8	MW09_0.5			Bentonite
Solid Stem Auger	2m 12/11/2012	1.0			SM	Natural	**Silty SAND** - light brown / orange, loose, medium grained.	moist	6.0	MW09_1.0		0.800 1.000	Gravel Pack
		2.0					Very wet at 2.0m.	very wet	270.6	MW09_2.0	Hydrocarbon odour.		Screen
		4.00					**End of Hole at 4.000 m**						

Observations		Notes
Asbestos	No visual evidence of asbestos noted during drilling.	
Staining	No visual evidence of contamination (e.g. staining / precipitate) noted during drilling.	
Odour	Olfactory (e.g. odour) evidence of contamination noted during drilling.	
Groundwater	Groundwater encountered during drilling.	

REUMAD

Log Drawn By: Laurie White
Contact: laurie.white@reumad.com.au

Checked By: **Adeline Menet** Date: **28/03/2013**

WSP LOG LT MONA VALE 34820.GPJ WSP.GDT 28/3/13 3:35:58 PM

Monitoring Well Log

Hole ID. **MW10**

WSP Environment & Energy
Level 1, 41 McLaren Street
North Sydney NSW 2060
Office: +61 (0)2 8925 6700
www.wspenvironmental.com

Project Name:	**Mona Vale STA - Offsite Delineation**	Date Started:	**22/03/2013**
Project Number:	**34820**	Date Completed:	**22/03/2013**
Location / Site:	**58 Darley Street, Mona Vale NSW**	Hole Depth:	**4.00 m**
Client:	**State Transit Authority**	Ground Level:	**----------**
Drilling Company:	**HartGeo Pty Ltd**	Top of Casing:	**----------**
Drill Method:	**Hand Auger / Solid Stem Auger**	Easting:	**332702**
Logged By:	**Adeline Menet**	Northing:	**6240318**

Method	Water Level	Depth (m)	RL (mAHD)	Graphic Log	USCS Symbol	Material Type	Material Description	Moisture	Samples / Tests: PID ppm	Samples / Tests: ID No.	Observations / Comments	Well Details	Well Construction
CC		0.15					**ASPHALT**.						
Hand Auger					SC	Natural	**Clayey SAND** - pink, coarse grained. Crushed ironstone from 0.4 to 0.6mbgl.	moist	1.3	MW10_0.2			Gatic
		0.70			SC		**Clayey SAND** - black, very fine grained, minor gravel inclusions (<2mm Ø).	moist	26.6	MW10_0.7	Black shiny appearance. Slight hydrocarbon odour.	0.700	Bentonite
		1.20					**SAND** - light grey, fine grained, gravel inclusions (<2mm Ø).	moist	14.3	MW10_1.2		1.000	Gravel Pack
Solid Stem Auger	2.1m 22/03/2013	2.0			SP			very moist wet	345	MW10_2.0	Hydrocarbon odour.		
		3.5					Shell fragments at 3.4mbgl.						Screen
		4.00					**SAND** - light grey, fine grained, shell inclusions.	wet	93.2	MW10_4.0	Hydrocarbon odour.		
							End of Hole at 4.000 m						

Observations		Notes
Asbestos	No visual evidence of asbestos noted during drilling.	
Staining	No visual evidence of contamination (e.g. staining / precipitate) noted during drilling.	
Odour	Olfactory (e.g. odour) evidence of contamination noted during drilling.	
Groundwater	Groundwater encountered during drilling.	

REUMAD

Log Drawn By: Laurie White
Contact: laurie.white@reumad.com.au

Checked By: **Adeline Menet** Date: **28/03/2013**

WSP LOG LT MONA VALE 34820.GPJ WSP.GDT 28/3/13 3:35:59 PM

Monitoring Well Log

Hole ID. **MW11**

WSP Environment & Energy
Level 1, 41 McLaren Street
North Sydney NSW 2060
Office: +61 (0)2 8925 6700
www.wspenvironmental.com

Project Name:	**Mona Vale STA - Offsite Delineation**	Date Started:	**12/11/2012**
Project Number:	**34820**	Date Completed:	**12/11/2012**
Location / Site:	**58 Darley Street, Mona Vale NSW**	Hole Depth:	**4.50 m**
Client:	**State Transit Authority**	Ground Level:	----------
Drilling Company:	**HartGeo Pty Ltd**	Top of Casing:	----------
Drill Method:	**Hand Auger / Solid Stem Auger**	Easting:	----------
Logged By:	**Adeline Menet**	Northing:	----------

Method	Water Level	Depth (m)	RL (mAHD)	Graphic Log	USCS Symbol	Material Type	Material Description	Moisture	Samples / Tests: PID ppm	Samples / Tests: ID No.	Observations / Comments	Well Details	Well Construction
Hand Auger		0.20				Fill	**FILL** - GRAVEL / SAND.				No odour.		Gatic
		0.50					**FILL** - Clayey SAND, dark brown / grey, loose, medium grained.	dry to moist	10.4	MW11_0.3			Bentonite
		0.90					**FILL** - Silty SAND, dark grey, very dark colouration, loose, with plastic bags.	moist	24.2	MW11_0.7	Hydrocarbon odour.	0.700	
Solid Stem Auger	2.2m 12/11/2012	1.0			SC	Natural	**Clayey SAND** - yellow / light brown, loose, coarse grained.	moist	5.3	MW11_1.0		1.000	Gravel Pack
		1.5							2.5	MW11_1.5			
		2.0							1.0	MW11_2.0			
		2.50					Wet at 2.2m.	wet					
		3.0			SP		**SAND** - grey / blue, coarse grained.	wet	0.4	MW11_3.0	No odour.		Screen
		3.5											
		4.00										4.000	
		4.50			CL		**CLAY** - grey / blue, stiff.	wet					
							End of Hole at 4.500 m						

Observations		Notes
Asbestos	No visual evidence of asbestos noted during drilling.	
Staining	No visual evidence of contamination (e.g. staining / precipitate) noted during drilling.	
Odour	Olfactory (e.g. odour) evidence of contamination noted during drilling.	
Groundwater	Groundwater encountered during drilling.	

REUMAD

Log Drawn By: Laurie White
Contact: laurie.white@reumad.com.au

Checked By: **Adeline Menet** Date: **28/03/2013**

WSP LOG LT MONA VALE 34820.GPJ WSP.GDT 28/3/13 3:36:01 PM

Monitoring Well Log

Hole ID. **MW12**

WSP Environment & Energy
Level 1, 41 McLaren Street
North Sydney NSW 2060
Office: +61 (0)2 8925 6700
www.wspenvironmental.com

Project Name:	**Mona Vale STA - Offsite Delineation**	Date Started:	**12/11/2012**
Project Number:	**34820**	Date Completed:	**12/11/2012**
Location / Site:	**58 Darley Street, Mona Vale NSW**	Hole Depth:	**4.00 m**
Client:	**State Transit Authority**	Ground Level:	----------
Drilling Company:	**HartGeo Pty Ltd**	Top of Casing:	----------
Drill Method:	**Hand Auger / Solid Stem Auger**	Easting:	----------
Logged By:	**Adeline Menet**	Northing:	----------

Method	Water Level	Depth (m)	RL (mAHD)	Graphic Log	USCS Symbol	Material Type	Material Description	Moisture	Samples / Tests: PID ppm	Samples / Tests: ID No.	Samples / Tests: DUP TRIP QC	Observations / Comments	Well Details	Well Construction
CC		0.10					**ASPHALT**.							
Hand Auger					SM	Natural	**Silty SAND** - light brown, loose, coarse grained.	moist to wet	0.3	MW12_0.2		No odour.		Gatic
		0.50							0.5	MW12_0.5				Bentonite
					CL		**Silty Sandy CLAY** - dark brown, soft.	moist					0.700	
		1.0							0.4	MW12_1.0			1.000	
		1.30												Gravel Pack
		1.5			CL		**Silty Sandy CLAY** - dark brown, soft to stiff. Sandy content increasing with depth.	moist	0.4	MW12_1.5	Dup01 Trip01			
		1.90												
Solid Stem Auger	2m 12/11/2012	2.0					**SAND** - grey, some dark colouration, loose. Wet from 2.0m.	moist / wet	0.5	MW12_2.0		Slight hydrocarbon odour.		Screen
		2.5												
		3.0			SP		Some shell fragments present below 3.0m.		0.6	MW12_3.0		No odour.		
		3.5												
		4.00					**End of Hole at 4.000 m**							

Observations

Asbestos	No visual evidence of asbestos noted during drilling.
Staining	No visual evidence of contamination (e.g. staining / precipitate) noted during drilling.
Odour	Olfactory (e.g. odour) evidence of contamination noted during drilling.
Groundwater	Groundwater encountered during drilling.

Notes

Log Drawn By: Laurie White
Contact: laurie.white@reumad.com.au

Checked By: **Adeline Menet** Date: **28/03/2013**

WSP LOG LT MONA VALE 34820.GPJ WSP.GDT 28/3/13 3:36:02 PM

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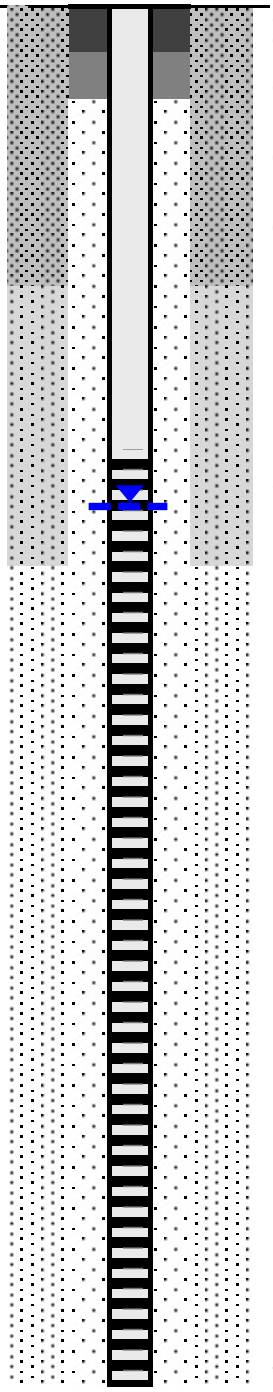
ENVIRONMENTAL BOREHOLE CONSTRUCTION LOG

BORE NUMBER: MW12B

PROJECT No:	ENRS0212	**DATE DRILLED:**	10/06/2014
LOCATION:	Rd rsv adj Lot 34 DP708050	**LOGGED BY:**	Rohan Last
CLIENT:	AES on behalf of STA.	**DRILLED BY:**	Nealings Drilling (Neal Stapleton)
SURFACE RL:	2.68	**DRILL METHOD:**	Hollow Flight Auger
EASTING:	343044.64	**HOLE DIAMETER:**	150mm
NORTHING:	6272731.85	**FINAL DEPTH:**	5.88m

Depth Metres	Well Log	Construction	Sample ID	PID	SPT	Graphic Log	Description
							Ground Surface
0.0		8mm Hex Key Gatic Cover 0.0-0.2m Cement sanitary seal 0.2-0.4m Bentonite sanitary seal 0.0-1.88m 50mm PVC casing 0.4-5.88m Gravel Pack graded 1.88-5.88m Slotted PVC Screen **SWL 2.18mbgl 10/6/2014** TOTAL DEPTH 5.88mBGL					0-1.2 Silty sand, dark brown 1.2-2.4 Silty sand, yellow, med fine 2.4-6.0 Silty sand, grey, some shells and partially cemented sand

Notes:
Descriptions are based on observations and hand testing of grab samples.
Mechanical Tests were not performed unless otherwise stated

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25 RIVER ROAD
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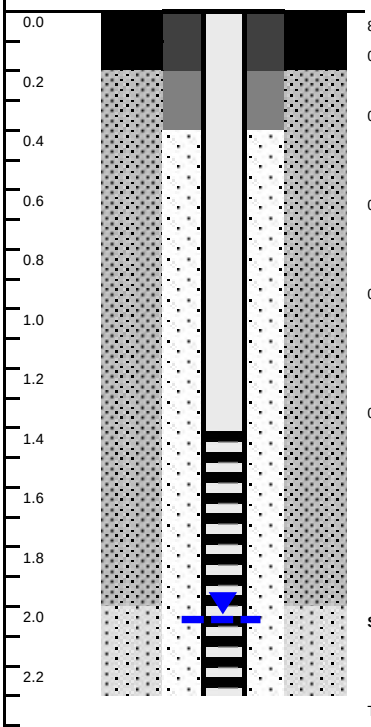
ENVIRONMENTAL BOREHOLE CONSTRUCTION LOG

BORE NUMBER: MW13

PROJECT No:	ENRS0212	**DATE DRILLED:**	25/10/2013
LOCATION:	Lot 2 DP542640 (Bore License 10BL605455)	**LOGGED BY:**	Rohan Last
CLIENT:	AES on behalf of STA.	**DRILLED BY:**	Highland Drilling (Brett Delamont)
SURFACE RL:	-	**DRILL METHOD:**	Solid Flight Auger
EASTING:	343033.13 (mga 56)	**HOLE DIAMETER:**	100mm
NORTHING:	6272645.45	**DEPTH:**	2.25m



**Constructed to maximum depth limited by collapsing sands.

Depth Metres	Sample ID	PID	SPT	Graphic Log	Description
					Ground Surface
0.0					0-0.2 Concrete
0.2					0.2-0.5 Silty sand, dark brown
0.5	0.5				0.5-1.0 Silty sand, pale brown
1.0	1.0				1.0-2.0 Silty sand, dark brown
2.0	2.0				2.0-3.0 Silty sand, pale brown
3.0	3.0				3.0-3.1 Clay, red/brown

Notes:
Descriptions are based on observations and hand testing of grab samples.
Mechanical Tests were not performed unless otherwise stated

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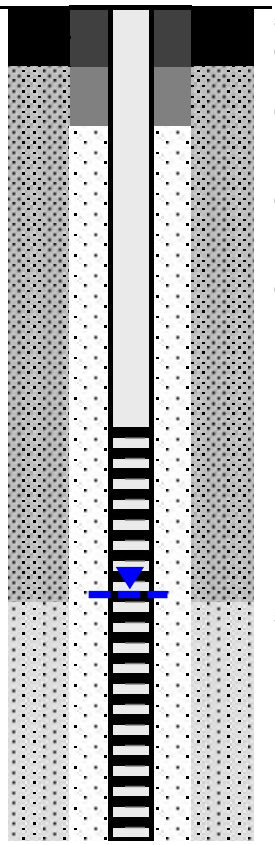
25 RIVER ROAD
SHOALHAVEN HEADS NSW 2535
t/f: 02 9037 4708 m: 0401 518 443

ENVIRONMENTAL BOREHOLE CONSTRUCTION LOG

BORE NUMBER: MW14

PROJECT No:	ENRS0212	**DATE DRILLED:**	25/10/2013
LOCATION:	Lot 2 DP542640 (Bore License 10BL605455)	**LOGGED BY:**	Rohan Last
CLIENT:	AES on behalf of STA.	**DRILLED BY:**	Highland Drilling (Brett Delamont)
SURFACE RL:	-	**DRILL METHOD:**	Casing advance, wireline with water.
EASTING:	343048.84 (mga 56)	**HOLE DIAMETER:**	120mm
NORTHING:	6272666.07	**DEPTH:**	2.77m

Depth Metres	Well Log	Construction	Sample ID	PID	SPT	Graphic Log	Description
							Ground Surface
0.0		8mm Hex Key Gatic Cover 0.0-0.2m Cement sanitary seal					0-0.2 Concrete
0.2		0.2-0.4m Bentonite sanitary seal					0.2-3.0 Silty sand, pale brown
0.4			0.5				
0.6		0.0-1.27m 50mm PVC casing					
0.8		0.4-2.77m Gravel Pack graded					
1.0			1.0				
1.2		1.27-2.77m Slotted PVC Screen					
1.4							
1.6							
1.8							
2.0		**SWL 1.99mbgl 2/11/2013**	2.0				
2.2							
2.4							
2.6							
2.8		TOTAL DEPTH 2.77m					
3.0			3.0				3.0-3.1 Clay, red/brown
3.2							
3.4							
3.6							
3.8							
4.0							

Notes:
Descriptions are based on observations and hand testing of grab samples.
Mechanical Tests were not performed unless otherwise stated

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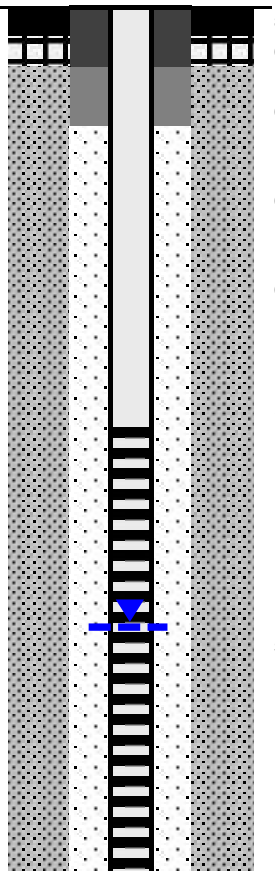
ENVIRONMENTAL BOREHOLE CONSTRUCTION LOG

BORE NUMBER: MW15

PROJECT No:	ENRS0212	**DATE DRILLED:**	25/10/2013
LOCATION:	Rd rsv adj. Lot 6 DP701913 (Bore License 10BL605456)	**LOGGED BY:**	Rohan Last
CLIENT:	AES on behalf of STA.	**DRILLED BY:**	Highland Drilling (Brett Delamont)
SURFACE RL:	-	**DRILL METHOD:**	Casing advance, wireline with water.
EASTING:	342985.62 (mga 56)	**HOLE DIAMETER:**	120mm
NORTHING:	6272668.50	**DEPTH:**	2.91m

Depth Metres	Well Log	Construction	Sample ID	PID	SPT	Graphic Log	Description
							Ground Surface
0.0		8mm Hex Key Gatic Cover					0-0.1 Bitumen
		0.0-0.2m Cement sanitary seal					0.1-0.2 Gravel road base
0.2							0.2-1.0 Silty sand, red/brown
		0.2-0.4m Bentonite sanitary seal					
0.4							
0.6		0.0-1.41m 50mm PVC casing					
0.8							
		0.4-2.91m Gravel Pack graded					
1.0			1.0				1.0-3.0 Sand, brown
1.2							
		1.41-2.91m Slotted PVC Screen					
1.4							
1.6							
1.8							
2.0			2.0				
		SWL 2.1mbgl 2/11/2013					
2.2							
2.4							
2.6							
2.8							
		TOTAL DEPTH 2.91m					
3.0							3.0-3.1 Clay, red/brown
3.2							
3.4							
3.6							
3.8							
4.0							

Notes:
Descriptions are based on observations and hand testing of grab samples.
Mechanical Tests were not performed unless otherwise stated

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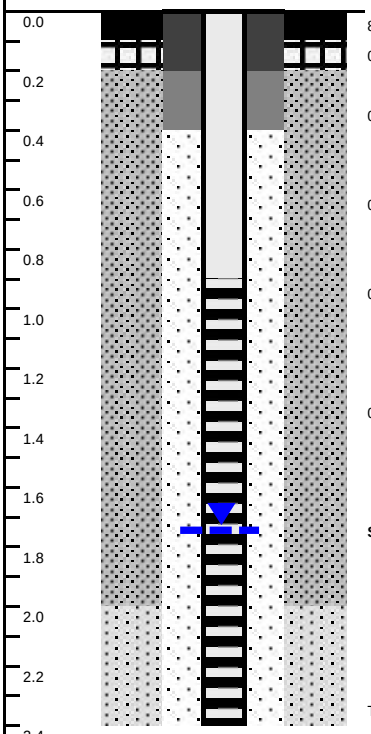
ENVIRONMENTAL BOREHOLE CONSTRUCTION LOG

BORE NUMBER: MW16

PROJECT No:	ENRS0212	**DATE DRILLED:**	25/10/2013
LOCATION:	Rd rsv adj. Lot 8 DP701913 (Bore License 10BL605456)	**LOGGED BY:**	Rohan Last
CLIENT:	AES on behalf of STA.	**DRILLED BY:**	Highland Drilling (Brett Delamont)
SURFACE RL:	-	**DRILL METHOD:**	Casing advance, wireline with water.
EASTING:	343014.12 (mga 56)	**HOLE DIAMETER:**	120mm
NORTHING:	6272712.66	**DEPTH:**	2.36m



Depth Metres	Sample ID	PID	SPT	Graphic Log	Description
					Ground Surface
0.0					0-0.1 Bitumen
					0.1-0.2 Gravel road base
0.2					0.2-1.0 Silty sand, pale brown
1.0					1.0-2.0 Silty sand, dark brown
2.0	2.0				2.0-2.5 Sand, brown
2.5					2.5-3.0 Claystone, red (Bald Hill Claystone)

Notes:
Descriptions are based on observations and hand testing of grab samples.
Mechanical Tests were not performed unless otherwise stated

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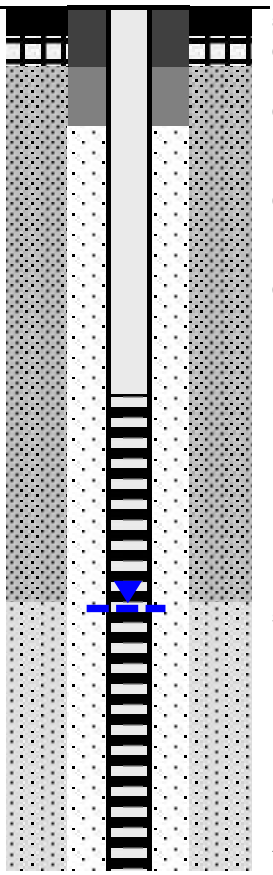
ENVIRONMENTAL BOREHOLE CONSTRUCTION LOG

BORE NUMBER: MW17

PROJECT No:	ENRS0212	**DATE DRILLED:**	25/10/2013
LOCATION:	Rd rsv adj. Lot131 DP708044 (Bore License 10BL605456)	**LOGGED BY:**	Rohan Last
CLIENT:	AES on behalf of STA.	**DRILLED BY:**	Highland Drilling (Brett Delamont)
SURFACE RL:	-	**DRILL METHOD:**	Casing advance, wireline with water.
EASTING:	342917.65 (mga 56)	**HOLE DIAMETER:**	120mm
NORTHING:	6272774.65	**DEPTH:**	2.83m

Depth Metres	Well Log	Construction	Sample ID	PID	SPT	Graphic Log	Description
							Ground Surface
0.0		8mm Hex Key Gatic Cover					0-0.1 Bitumen
		0.0-0.2m Cement sanitary seal					0.1-0.2 Gravel road base
0.2							0.2-1.0 Silty sand, pale brown
		0.2-0.4m Bentonite sanitary seal					
0.4							
0.6		0.0-1.33m 50mm PVC casing					
0.8							
		0.4-2.83m Gravel Pack graded					
1.0							1.0-2.0 Silty sand, red/brown
1.2							
		1.33-2.83m Slotted PVC Screen					
1.4							
1.6							
1.8							
2.0		**SWL2.04mbgl 2/11/2013**	2.0				2.0-2.85 Sand, brown
2.2							
2.4							
2.6							
2.8		TOTAL DEPTH 2.83m					
							2.85-3.0 Claystone, red
3.0							(Bald Hill Claystone)
3.2							
3.4							
3.6							
3.8							
4.0							

Notes:
Descriptions are based on observations and hand testing of grab samples.
Mechanical Tests were not performed unless otherwise stated

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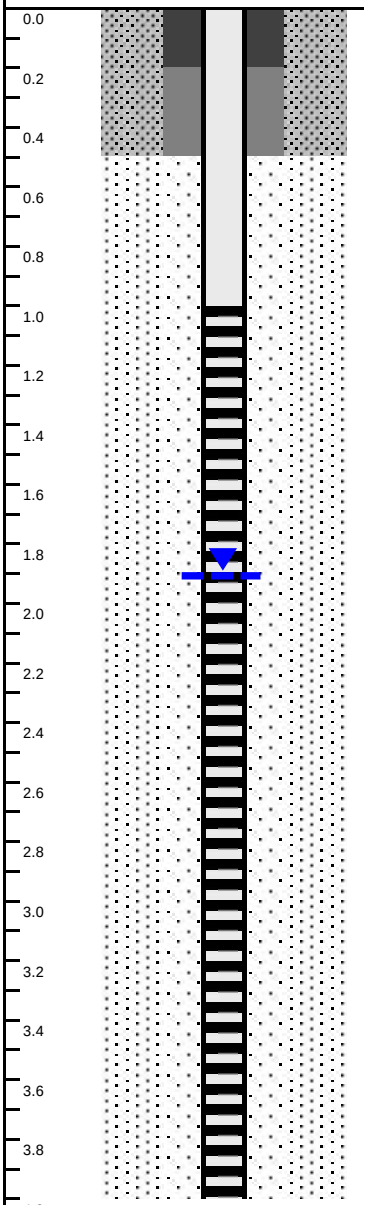
ENVIRONMENTAL BOREHOLE CONSTRUCTION LOG

BORE NUMBER: BH18

PROJECT No:	ENRS0212	**DATE DRILLED:**	03/09/2015
LOCATION:	Lot 2 DP 701913	**LOGGED BY:**	Rohan Last
CLIENT:	AES on behalf of STA.	**DRILLED BY:**	Highland Drilling (Brett Delamont)
SURFACE RL:	-	**DRILL METHOD:**	Casing advance - Air
EASTING:	343033.19 not surveyed	**HOLE DIAMETER:**	160mm
NORTHING:	6272695.48	**DEPTH:**	4.0m



Depth Metres	Construction	Sample ID	PID	SPT	Graphic Log	Description
						Ground Surface
0.0	8mm Hex Key Gatic Cover					0-0.5 Sitly soil and fill
0.2	0.0-0.2m Cement sanitary seal					
0.4	0.2-0.5m Bentonite sanitary seal					
0.5		0.5				0.5-4.0 Medium white sands
0.6	0.0-1.0m 100mm PVC casing					
0.8	0.8-4.0m Gravel Pack 2mm graded					
1.0		1.0				
1.2	1.0-4.0m Slotted 100mm PVC Screen					
1.4						
1.6						
1.8	**SWL 1.92mbgl 2/11/2013**					
2.0		2.0				
2.2						
2.4						
2.6						
2.8						
3.0		3.0				
3.2						
3.4						
3.6						
3.8						
4.0	TOTAL DEPTH 4.0m					4.0 Target Depth Reached

Notes:
Descriptions are based on observations and hand testing of grab samples.
Mechanical Tests were not performed unless otherwise stated

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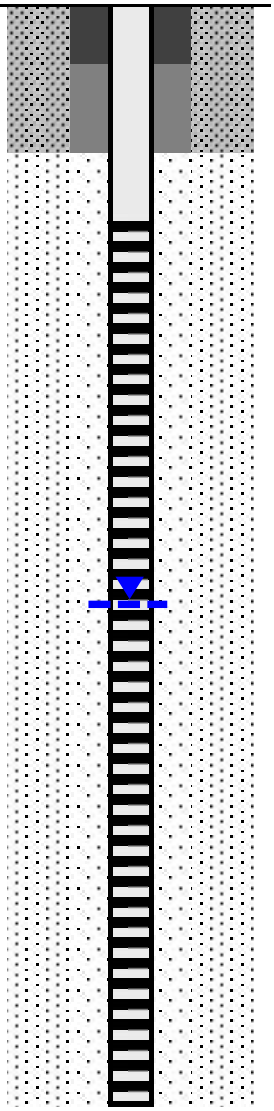
ENVIRONMENTAL BOREHOLE CONSTRUCTION LOG

BORE NUMBER: BH19

PROJECT No:	ENRS0212	**DATE DRILLED:**	03-09-15
LOCATION:	Rd Rsv adj Lot 34 DP 708050	**LOGGED BY:**	Rohan Last
CLIENT:	AES on behalf of STA.	**DRILLED BY:**	Highland Drilling (Brett Delamont)
SURFACE RL:	3.08 top of plate 3.01 top of PVC	**DRILL METHOD:**	Casing advance - Air
EASTING:	343017.09	**HOLE DIAMETER:**	160mm
NORTHING:	6272682.25	**DEPTH:**	3.71 m

Depth Metres	Well Log	Construction	Sample ID	PID	SPT	Graphic Log	Description
							Ground Surface
0.0		8mm Hex Key Gatic Cover					0-0.5 Sitly soil and fill
0.2		0.0-0.2m Cement sanitary seal					
0.4		0.2-0.6m Bentonite sanitary seal					
0.6		0.0-71m 100mm PVC casing	0.5				0.5-4.0 Medium white sands
0.8							
1.0		0.6-4.0m Gravel Pack 2mm graded	1.0				
1.2							
1.4		0.71-3.71m Slotted PVC Screen					
1.6							
1.8							
2.0		**SWL 2.026mbgl 8/9/2016**	2.0				
2.2							
2.4							
2.6							
2.8							
3.0			3.0				
3.2							
3.4							
3.6							
3.8		TOTAL DEPTH 3.76m					3.71 Target Depth Reached
4.0							

Notes:
Descriptions are based on observations and hand testing of grab samples.
Mechanical Tests were not performed unless otherwise stated

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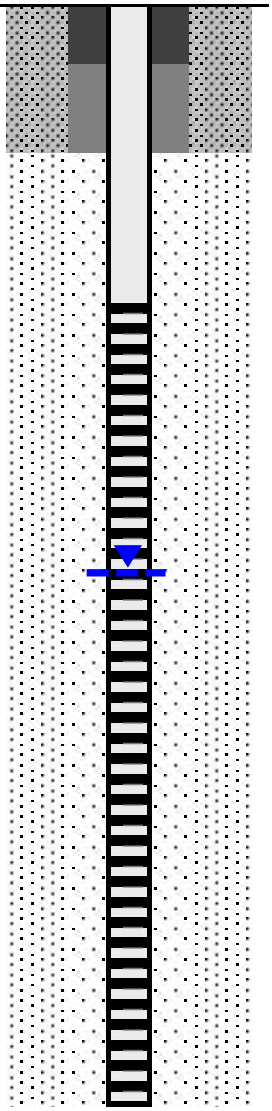
ENVIRONMENTAL BOREHOLE CONSTRUCTION LOG

BORE NUMBER: BH20

PROJECT No:	ENRS0212	**DATE DRILLED:**	21-06-16
LOCATION:	Rd Reserve adj Lot 2 DP 701913	**LOGGED BY:**	Rohan Last
CLIENT:	AES on behalf of STA.	**DRILLED BY:**	Highland Drilling (Brett Delamont)
SURFACE RL:	2.69mAHD top top of plate, 2.63mAHD top of PVC	**DRILL METHOD:**	Casing advance - Air
EASTING:	343034.29	**HOLE DIAMETER:**	160mm
NORTHING:	6272700.83	**DEPTH:**	3.72 m

Depth Metres	Well Log	Construction	Sample ID	PID	SPT	Graphic Log	Description
							Ground Surface
0.0		8mm Hex Key Gatic Cover					0-0.5 Sitly soil and fill
0.2		0.0-0.2m Cement sanitary seal					
0.4		0.2-0.5m Bentonite sanitary seal					0.5-4.0 Medium white sands
0.6		0.0-0.72m 100mm PVC casing					
0.8							
1.0		0.5-3.72m Gravel Pack 2mm graded					
1.2							
1.4		0.72-3.72m Slotted 100mm PVC Screen					
1.6							
1.8		**SWL 1.856 mbgl 8/09/2016**					
2.0							
2.2							
2.4							
2.6							
2.8							
3.0							
3.2							
3.4							
3.6		TOTAL DEPTH 3.72m					
3.8							
4.0							4.0 Target Depth Reached

Notes:
Descriptions are based on observations and hand testing of grab samples.
Mechanical Tests were not performed unless otherwise stated

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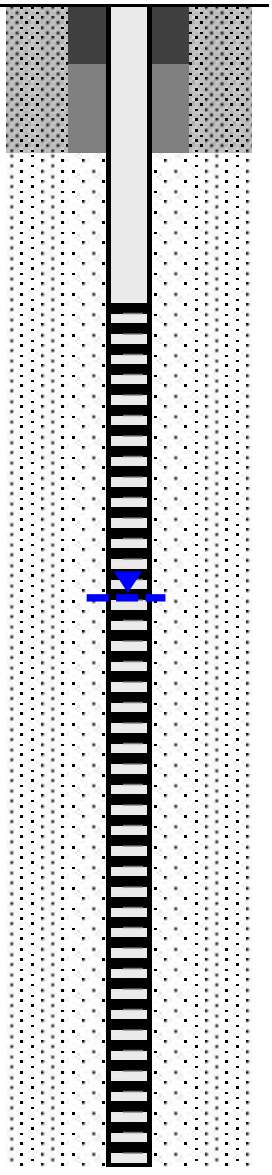
ENVIRONMENTAL BOREHOLE CONSTRUCTION LOG

BORE NUMBER: BH21

PROJECT No:	ENRS0212	**DATE DRILLED:**	21-06-16
LOCATION:	Rd Reserve adj Lot 2 DP 701913	**LOGGED BY:**	Rohan Last
CLIENT:	AES on behalf of STA.	**DRILLED BY:**	Highland Drilling (Brett Delamont)
SURFACE RL:	2.79mAHD top top of plate, 2.72mAHD top of PVC	**DRILL METHOD:**	Casing advance - Air
EASTING:	343022.72	**HOLE DIAMETER:**	160mm
NORTHING:	6272695.72	**DEPTH:**	3.91 m

Depth Metres	Well Log	Construction	Sample ID	PID	SPT	Graphic Log	Description
							Ground Surface
0.0		8mm Hex Key Gatic Cover 0.0-0.2m Cement sanitary seal 0.2-0.6m Bentonite sanitary seal 0.0-0.91m 100mm PVC casing 0.6-3.91m Gravel Pack 2mm graded 0.91-3.91m Slotted 100mm PVC Screen **SWL 2.07 mbgl 8/09/2016** TOTAL DEPTH 3.91m					0-0.5 Sitly soil and fill 0.5-4.0 Medium white sands 4.0 Target Depth Reached

Notes:
Descriptions are based on observations and hand testing of grab samples.
Mechanical Tests were not performed unless otherwise stated

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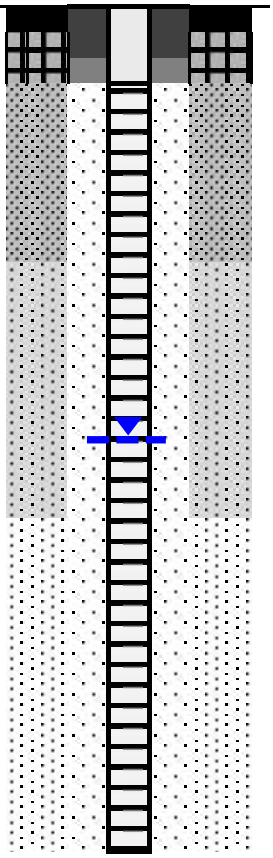
ENVIRONMENTAL BOREHOLE CONSTRUCTION LOG

BORE NUMBER: MW22

PROJECT No:	ENRS0212	**DATE DRILLED:**	21/06/2016
LOCATION:	Taronga Place Rd rsv, Mona Vale	**LOGGED BY:**	Rohan Last
CLIENT:	AES on behalf of STA.	**DRILLED BY:**	Highland Drilling (Brett Delamont)
SURFACE RL:	2.67mAHD top of plate, 2.6mAHD top of PVC	**DRILL METHOD:**	Casing advance - Air & water
EASTING:	343028.28	**HOLE DIAMETER:**	100 mm
NORTHING:	6272716.98	**FINAL DEPTH:**	3.31 m

Depth Metres	Well Log	Construction	Sample ID	PID	SPT	Graphic Log	Description
							Ground Surface
0.0		8mm Hex Key Gatic Cover 0.0-0.15m Cement sanitary seal	No Soil samples collected during drilling				0-0.1 Asphalt 0.1-0.3 gravel sub-base
0.2		0.15-0.3m Bentonite sanitary seal					0.3-1.0 Silty sand, dark brown
0.4							
0.6		0.0-0.31m 50mm PVC casing					
0.8							
1.0		0.3-3.31m Gravel Pack graded					1.0-2.0 Silty sand, pale brown
1.2							
1.4							
1.6		**SWL 1.68 mbgl 8/09/2016**					
1.8							
2.0							2.0-3.5 Silty sand, grey
2.2							
2.4							
2.6							
2.8							
3.0		0.31-3.31m Slotted PVC Screen					
3.2							
3.4		TOTAL DEPTH 3.31mBGL					TDR 3.5 m
3.6							
3.8							
4.0							
4.2							
4.4							
4.6							
4.8							
5.0							

Notes:
Descriptions are based on observations and hand testing of grab samples.
Mechanical Tests were not performed unless otherwise stated

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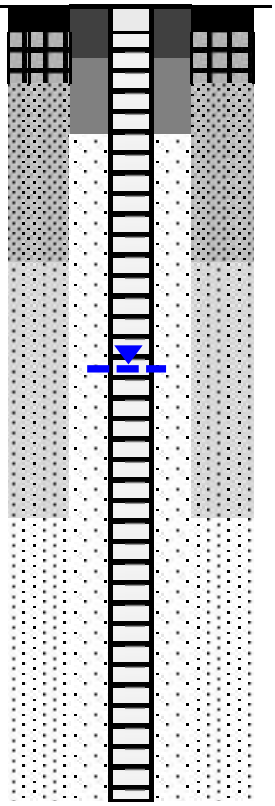
ENVIRONMENTAL BOREHOLE CONSTRUCTION LOG

BORE NUMBER: MW23

PROJECT No:	ENRS0212	**DATE DRILLED:**	21/06/2016
LOCATION:	Taronga Place Rd rsv, Mona Vale	**LOGGED BY:**	Rohan Last
CLIENT:	AES on behalf of STA.	**DRILLED BY:**	Highland Drilling (Brett Delamont)
SURFACE RL:	Pending Survey	**DRILL METHOD:**	Casing advance - Air & water
EASTING:	343105.00	**HOLE DIAMETER:**	100 mm
NORTHING:	6272731.00	**FINAL DEPTH:**	3.08 m

Depth Metres	Well Log	Construction	Sample ID	PID	SPT	Graphic Log	Description
							Ground Surface
0.0		8mm Hex Key Gatic Cover 0.0-0.2m Cement sanitary seal	No Soil samples collected during drilling				0-0.1 Asphalt 0.1-0.3 gravel sub-base
0.2		0.2-0.5m Bentonite sanitary seal					0.3-1.0 Silty sand, dark brown
0.4							
0.6		0.0-0.08m 50mm PVC casing					
0.8							
1.0		0.5-3.08m Gravel Pack graded					1.0-2.0 Silty sand, pale brown
1.2							
1.4		**SWL 1.41 mbgl 12/09/2016**					
1.6							
1.8							
2.0							2.0-3.08 Silty sand, grey
2.2							
2.4		0.08-3.08m Slotted PVC Screen					
2.6							
2.8							
3.0		TOTAL DEPTH 3.08mBGL					TDR 3.08 m
3.2							
3.4							
3.6							
3.8							
4.0							
4.2							
4.4							
4.6							
4.8							
5.0							

Notes:
Descriptions are based on observations and hand testing of grab samples.
Mechanical Tests were not performed unless otherwise stated

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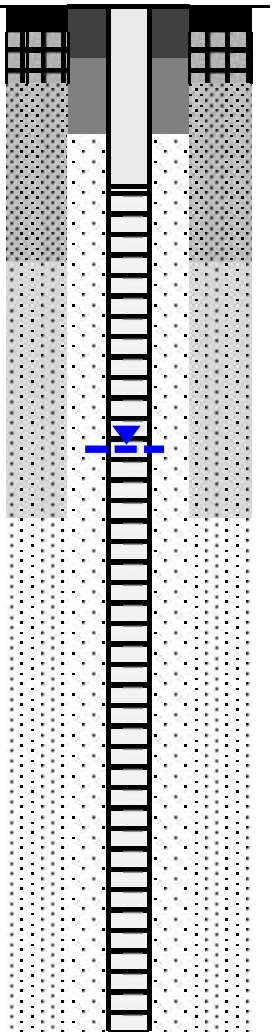
ENVIRONMENTAL BOREHOLE CONSTRUCTION LOG

BORE NUMBER: MW24

PROJECT No:	ENRS0212	**DATE DRILLED:**	21/06/2016
LOCATION:	Taronga Place Rd rsv, Mona Vale	**LOGGED BY:**	Rohan Last
CLIENT:	AES on behalf of STA.	**DRILLED BY:**	Highland Drilling (Brett Delamont)
SURFACE RL:	Pending Survey	**DRILL METHOD:**	Casing advance - Air & water
EASTING:	343094.00	**HOLE DIAMETER:**	100 mm
NORTHING:	6272718.00	**FINAL DEPTH:**	3.99 m

Depth Metres	Well Log	Construction	Sample ID	PID	SPT	Graphic Log	Description
							Ground Surface
0.0		8mm Hex Key Gatic Cover 0.0-0.2m Cement sanitary seal	No Soil samples collected during drilling				0-0.1 Asphalt 0.1-0.3 gravel sub-base
0.2		0.2-0.89m Bentonite sanitary seal					0.3-1.0 Silty sand, dark brown
0.4							
0.6		0.0-0.99m 50mm PVC casing					
0.8							
1.0		0.89-3.99m Gravel Pack graded					1.0-2.0 Silty sand, pale brown
1.2							
1.4							
1.6		**SWL 1.47 mbgl 12/09/2016**					
1.8							
2.0							2.0-3.99 Silty sand, grey
2.2							
2.4							
2.6							
2.8							
3.0		0.99-3.99m Slotted PVC Screen					
3.2							
3.4							
3.6							
3.8							
4.0		TOTAL DEPTH 3.99mBGL					TDR 3.99 m
4.2							
4.4							
4.6							
4.8							
5.0							

Notes:
Descriptions are based on observations and hand testing of grab samples.
Mechanical Tests were not performed unless otherwise stated

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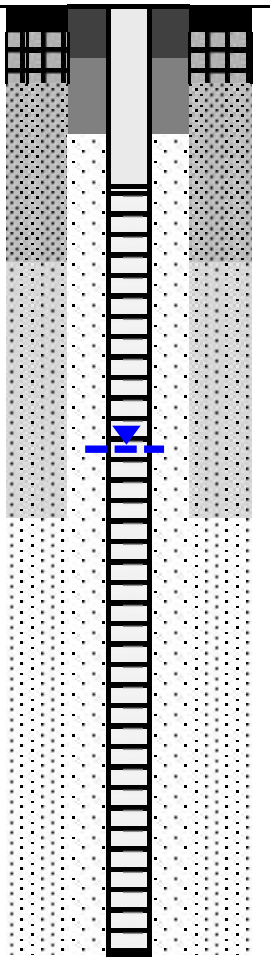
ENVIRONMENTAL BOREHOLE CONSTRUCTION LOG

BORE NUMBER: MW25

PROJECT No:	ENRS0212	**DATE DRILLED:**	23/06/2016
LOCATION:	Taronga Place Rd rsv, Mona Vale	**LOGGED BY:**	Rohan Last
CLIENT:	AES on behalf of STA.	**DRILLED BY:**	Highland Drilling (Brett Delamont)
SURFACE RL:	2.75mAHD top of plate, 2.67mAHD top of PVC	**DRILL METHOD:**	Casing advance - Air & water
EASTING:	343007.79	**HOLE DIAMETER:**	100 mm
NORTHING:	6272705.16	**FINAL DEPTH:**	3.77 m

Depth Metres	Well Log	Construction	Sample ID	PID	SPT	Graphic Log	Description
							Ground Surface
0.0		8mm Hex Key Gatic Cover 0.0-0.2m Cement sanitary seal	No Soil samples collected during drilling				0-0.1 Asphalt 0.1-0.3 gravel sub-base
0.2		0.2-0.5m Bentonite sanitary seal					0.3-1.0 Silty sand, dark brown
0.4							
0.6		0.0-0.77m 50mm PVC casing					
0.8							
1.0		0.77-3.77m Gravel Pack graded					1.0-2.0 Silty sand, pale brown
1.2							
1.4							
1.6		**SWL 1.76 mbgl 8/09/2016**					
1.8							
2.0							2.0-3.5 Silty sand, grey
2.2							
2.4							
2.6							
2.8		0.77-3.77m Slotted PVC Screen					
3.0							
3.2							
3.4							
3.6		TOTAL DEPTH 3.77mBGL					
3.8							TDR 3.8 m
4.0							
4.2							
4.4							
4.6							
4.8							
5.0							

Notes:
Descriptions are based on observations and hand testing of grab samples.
Mechanical Tests were not performed unless otherwise stated

ENVIRONMENT & NATURAL RESOURCE SOLUTIONS
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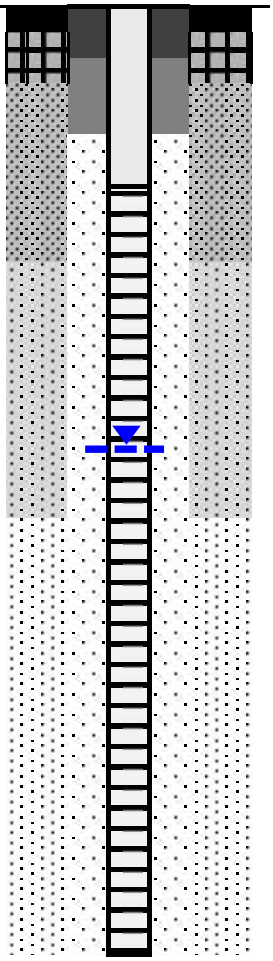
ENVIRONMENTAL BOREHOLE CONSTRUCTION LOG

BORE NUMBER: MW26

PROJECT No:	ENRS0212	**DATE DRILLED:**	23/06/2016
LOCATION:	Taronga Place Rd rsv, Mona Vale	**LOGGED BY:**	Rohan Last
CLIENT:	AES on behalf of STA.	**DRILLED BY:**	Highland Drilling (Brett Delamont)
SURFACE RL:	2.58mAHD top of plate, 2.51mAHD top of PVC	**DRILL METHOD:**	Casing advance - Air & water
EASTING:	343025.25	**HOLE DIAMETER:**	100 mm
NORTHING:	6272733.38	**FINAL DEPTH:**	3.64 m

Depth Metres	Well Log	Construction	Sample ID	PID	SPT	Graphic Log	Description
							Ground Surface
0.0		8mm Hex Key Gatic Cover 0.0-0.2m Cement sanitary seal	No Soil samples collected during drilling				0-0.1 Asphalt 0.1-0.3 gravel sub-base
0.2		0.2-0.5m Bentonite sanitary seal					0.3-1.0 Silty sand, dark brown
0.4							
0.6		0.0-0.64m 50mm PVC casing					
0.8							
1.0		0.5-3.64m Gravel Pack graded					1.0-2.0 Silty sand, pale brown
1.2							
1.4							
1.6		**SWL 1.64 mbgl 8/09/2016**					
1.8							
2.0							2.0-3.5 Silty sand, grey
2.2							
2.4							
2.6							
2.8		0.64-3.64m Slotted PVC Screen					
3.0							
3.2							
3.4							
3.6		TOTAL DEPTH 3.64mBGL					TDR 3.7 m
3.8							
4.0							
4.2							
4.4							
4.6							
4.8							
5.0							

Notes:
Descriptions are based on observations and hand testing of grab samples.
Mechanical Tests were not performed unless otherwise stated

BOREHOLE ENVIRONMENTAL LOG

BOREHOLE NO.

MW28

SHEET 1 OF 1

Client:	**State Transit Authority of NSW**	Date Commenced:	**12/18/19**
Project:	**PS111744**	Date Completed:	**12/18/19**
Borehole Location:	**STA Mona Vale Bus Depot**	Recorded By:	**James Robinson**
Project Number:	**PS111744**	Log Checked By:	**JR**

Drill Model/Mounting:	**Comacchio GEO 205**	Driller:	**Stratacore**	Surface RL:	**~4.6**
Borehole Diameter:	**195 mm**	Driller Lic No:		Co-ords:	**E 33.674291 N -151.307002**

Borehole Information / Field Material Description

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 RL(m) / DEPTH(m)	6 Field PID (ppm)	7 SAMPLE	8 GRAPHIC LOG	9 SOIL/ROCK MATERIAL FIELD DESCRIPTION	10 Field pH	11 MOISTURE	12 RELATIVE DENSITY /CONSISTENCY	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
CC			180mm flushmount gatic - 50mm class 18 PVC casing grout to surface		1.6	B&J		CONCRETE grey with river stones	7.0			
JET			Bentonite pellet seal (plug)	0.20				Silty SAND light brown / yellow fine to medium grained sand		M		
			2mm sand filterpack		6.2	B&J			7.0			
			50mm machine slotted class 18 PVC screen	1	7.2	B&J			7.0			
				1.30				SAND yellow / light brown fine grained				
HFA					1	B&J			7.0			
		▽		2	1.9	B&J			7.0	W		
					7.9	B&J			7.0			
				3.00 3	10	B&J		SAND with Clay yellow / light brown fine grained sand	7.0			
					5.9	B&J			7.0			
					6.1	B&J			7.0			
				4.00 4				TARGET DEPTH REACHED END OF BOREHOLE AT 4.00 m				

This borehole log should be read in conjunction with WSP's accompanying standard notes.

BOREHOLE ENVIRONMENTAL LOG

BOREHOLE NO.

MW29

SHEET 1 OF 1

Client:	**State Transit Authority of NSW**	Date Commenced:	**12/18/19**
Project:	**PS111744**	Date Completed:	**12/18/19**
Borehole Location:	**STA Mona Vale Bus Depot**	Recorded By:	**James Robinson**
Project Number:	**PS111744**	Log Checked By:	**JR**

Drill Model/Mounting:	**Comacchio GEO 205**	Driller:	**Stratacore**	Surface RL:	**~4.6**
Borehole Diameter:	**195 mm**	Driller Lic No:		Co-ords:	**E 33.674614 N -151.306988**

Borehole Information | **Field Material Description**

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 RL(m) / DEPTH(m)	6 Field PID (ppm)	7 SAMPLE	8 GRAPHIC LOG	9 SOIL/ROCK MATERIAL FIELD DESCRIPTION	10 Field pH	11 MOISTURE	12 RELATIVE DENSITY /CONSISTENCY	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
CC			180mm flushmount gatic - 50mm class 18 PVC casing grout to surface					CONCRETE grey with riverstones				
JET			Bentonite pellet seal (plug)	0.20	43.2	B&J		Sandy CLAY with Silt Yellow w/grey/light brown mottles trace fine to medium sandstone gravel (white)	7	M		
			2mm sand filterpack		18.6	B&J		becoming yellow	7			
				0.90				Silty SAND with Clay grey, with common yellow/brown mottles fine to medium grained sand				
			50mm machine slotted class 18 PVC screen	1	36.2	B&J			7			
					39.1	B&J		becoming Silty SAND trace Clay	7			
HFA				2	37.0	B&J			7	W		
								becoming Silty SAND				
						B&J			7			
				3	37.8	B&J			7			
						B&J			7			
					22.	B&J			7			
				4.00 4				TARGET DEPTH REACHED END OF BOREHOLE AT 4.00 m				

This borehole log should be read in conjunction with WSP's accompanying standard notes.

BOREHOLE ENVIRONMENTAL LOG

BOREHOLE NO.

MW30

SHEET 1 OF 1

Client:	**State Transit Authority of NSW**	Date Commenced:	**12/18/19**
Project:	**PS111744**	Date Completed:	**12/18/19**
Borehole Location:	**STA Mona Vale Bus Depot**	Recorded By:	**James Robinson**
Project Number:	**PS111744**	Log Checked By:	**JR**

Drill Model/Mounting:	**Comacchio GEO 205**	Driller:	**Stratacore**	Surface RL:	**~4.4**
Borehole Diameter:	**195 mm**	Driller Lic No:		Co-ords:	**E 33.674614 N -151.306699**

Borehole Information | **Field Material Description**

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 RL(m) / DEPTH(m)	6 Field PID (ppm)	7 SAMPLE	8 GRAPHIC LOG	9 SOIL/ROCK MATERIAL FIELD DESCRIPTION	10 Field pH	11 MOISTURE	12 RELATIVE DENSITY /CONSISTENCY	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
CC			180mm flushmount gatic - 50mm class 18 PVC casing grout to surface					CONCRETE grey with riverstones				
JET			Bentonite pellet seal (plug)	0.20	26.5	B&J		Clayey SAND with silt yellow sands, grey/light brown fine particles trace fine to medium sandstone gravel	7	M		
			2mm sand filterpack		34.6	B&J			7			
				0.90				Silty SAND Yellow/Red light brown trace fine to medium gravel/shells/carbonates				
			50mm machine slotted class 18 PVC screen	1	32.1	B&J			7			
HFA					37.9	B&J			7			
										W		
				2	31.1	B&J			7			
						B&J			7			
				3	34.0	B&J			7			
						B&J			7			
					36.6	B&J			7			
				4.00 4				TARGET DEPTH REACHED END OF BOREHOLE AT 4.00 m				

This borehole log should be read in conjunction with WSP's accompanying standard notes.

BOREHOLE ENVIRONMENTAL LOG

BOREHOLE NO.

MW31

SHEET 1 OF 1

Client:	**State Transit Authority of NSW**	Date Commenced:	**12/17/19**
Project:	**PS111744**	Date Completed:	**12/17/19**
Borehole Location:	**Adjacent to Taronga Place**	Recorded By:	**James Robinson**
Project Number:	**PS111744**	Log Checked By:	**JR**

Drill Model/Mounting:	**Comacchio GEO 205**	Driller:	**Stratacore**	Surface RL:	**~4.6**
Borehole Diameter:	**195 mm**	Driller Lic No:		Co-ords:	**E 33.674294 N -151.306427**

Borehole Information | **Field Material Description**

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 RL(m) / DEPTH(m)	6 Field PID (ppm)	7 SAMPLE	8 GRAPHIC LOG	9 SOIL/ROCK MATERIAL FIELD DESCRIPTION	10 Field pH	11 MOISTURE	12 RELATIVE DENSITY /CONSISTENCY	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
JET			180mm flushmount gatic - 50mm class 18 PVC casing grout to surface		39.3	B&J		TOPSOIL - Silty LOAM brown fine to medium grained	7	D		
				0.15				Silty SAND brown fine grained subrounded to rounded sands				
			Bentonite pellet seal (plug)		45.9	B&J			7			
			2mm sand filterpack					becoming dark brown				
			50mm machine slotted class 18 PVC screen	1.00 1	33.2	B&J		Clayey SAND yellow brown fine grained sand	7	M		
HFA					28.4	B&J		becoming yellow red	7			
				2.00 2	29.8	B&J		SAND yellow red, yellow brown, mottled fine to coarse grained sub angular to subrounded sands	7	W		
					33.9	B&J			7			
				3	44.8	B&J			7			
					33.2	B&J			7			
					24.3	B&J			7			
				4.00 4				TARGET DEPTH REACHED END OF BOREHOLE AT 4.00 m				

This borehole log should be read in conjunction with WSP's accompanying standard notes.

BOREHOLE ENVIRONMENTAL LOG

BOREHOLE NO.

MW32

SHEET 1 OF 1

Client:	**State Transit Authority of NSW**	Date Commenced:	**12/17/19**
Project:	**PS111744**	Date Completed:	**12/17/19**
Borehole Location:	**Adjacent to Taronga Place**	Recorded By:	**James Robinson**
Project Number:	**PS111744**	Log Checked By:	**JR**

Drill Model/Mounting:	**Comacchio GEO 205**	Driller:	**Stratacore**	Surface RL:	**~4.7**
Borehole Diameter:	**195 mm**	Driller Lic No:		Co-ords:	**E 33.674206 N -151.306279**

Borehole Information / Field Material Description

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 RL(m) / DEPTH(m)	6 Field PID (ppm)	7 SAMPLE	8 GRAPHIC LOG	9 SOIL/ROCK MATERIAL FIELD DESCRIPTION	10 Field pH	11 MOISTURE	12 RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
CC			180mm flushmount gatic - 50mm class 18 PVC casing grout to surface	0.18				CONCRETE grey with riverstones				
JET			Bentonite pellet seal (plug)		5.9	B&J		Clayey SAND with Silt Red brown with grey mottles fine grained sands trace very fine gravel	7	M		
			2mm sand filterpack		4.7	B&J		becoming black	7			
			50mm machine slotted class 18 PVC screen	1	19.7	B&J			7			
				1.20				Silty SAND with Clay yellow red/ lightbrown fine to medium grained sand				
HFA					16.2	B&J		trace clay	7			
		▷		2	18.2	B&J			7	W		
					12.3	B&J			7			
				2.60								
				3	21.1	B&J			7			
					0.5	B&J			7			
				4.00 4				TARGET DEPTH REACHED END OF BOREHOLE AT 4.00 m				

This borehole log should be read in conjunction with WSP's accompanying standard notes.

BOREHOLE ENVIRONMENTAL LOG

BOREHOLE NO.

MW33

SHEET 1 OF 1

Client:	**State Transit Authority of NSW**	Date Commenced:	**12/17/19**
Project:	**PS111744**	Date Completed:	**12/17/19**
Borehole Location:	**Adjacent to Taronga Place**	Recorded By:	**James Robinson**
Project Number:	**PS111744**	Log Checked By:	**JR**

Drill Model/Mounting:	**Comacchio GEO 205**	Driller:	**Stratacore**	Surface RL:	**~4.8**
Borehole Diameter:	**195 mm**	Driller Lic No:		Co-ords:	**E 33.674083 N -151.306382**

Borehole Information / Field Material Description

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 RL(m) / DEPTH(m)	6 Field PID (ppm)	7 SAMPLE	8 GRAPHIC LOG	9 SOIL/ROCK MATERIAL FIELD DESCRIPTION	10 Field pH	11 MOISTURE	12 RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
JET			180mm flushmount gatic - 50mm class 18 PVC casing grout to surface	0.15	6.2	B&J		TOPSOIL: Silty LOAM brown	7	D		
			Bentonite pellet seal (plug)					Clayey SAND yellow with pink mottles medium to coarse angular to sub rounded sand		M		
					5.1	B&J			7			
			2mm sand filterpack					Becoming black/very dark brown gradual transitioin to fine to coarse gravel				
			50mm machine slotted class 18 PVC screen	1	7.9	B&J			7.5			
								containing fine gravel				
				1.30				SAND Light grey/ yellow fine grained sands trace gravels and shell fragments Ø<2mm				
HFA					8.9	B&J						
		▷		2	9.8	B&J			8	W		
					7	B&J						
				3	8	B&J		shell fragments increasing	8			
					6.6	B&J						
					5.6	B&J			7.5			
				4.00 4				TARGET DEPTH REACHED END OF BOREHOLE AT 4.00 m				

This borehole log should be read in conjunction with WSP's accompanying standard notes.

BOREHOLE ENVIRONMENTAL LOG

BOREHOLE NO.

MW35

SHEET 1 OF 1

Client:	**State Transit Authority of NSW**	Date Commenced:	**12/17/19**
Project:	**PS111744**	Date Completed:	**12/17/19**
Borehole Location:	**Adjacent to Taronga Place**	Recorded By:	**James Robinson**
Project Number:	**PS111744**	Log Checked By:	**JR**

Drill Model/Mounting:	**Comacchio GEO 205**	Driller:	**Stratacore**	Surface RL:	**~4.9**
Borehole Diameter:	**195 mm**	Driller Lic No:		Co-ords:	**E 33.673843 N -151.306927**

Borehole Information / Field Material Description

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 RL(m) / DEPTH(m)	6 Field PID (ppm)	7 SAMPLE	8 GRAPHIC LOG	9 SOIL/ROCK MATERIAL FIELD DESCRIPTION	10 Field pH	11 MOISTURE	12 RELATIVE DENSITY /CONSISTENCY	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
JET			180mm flushmount gatic - 50mm class 18 PVC casing grout to surface		14.6	B&J		TOPSOIL : Silty LOAM	7	D		
				0.15				Silty SAND brown medium to coarse grained sands		M		
			Bentonite pellet seal (plug)		14	B&J			7			
			2mm sand filterpack	0.60				Silty CLAYEY SAND dark brown				
				1	17.3	B&J			7			
			50mm machine slotted class 18 PVC screen					becoming sandier				
HFA					11.8	B&J			7			
				1.80				SAND grey with black mottles		W		
				2	14.7	B&J			8.5			
					16.2	B&J		shell fragments	8.5			
				3	9.5	B&J			8.5			
					10	B&J			8.5			
					12.6	B&J			7.5			
				4.00 4				TARGET DEPTH REACHED END OF BOREHOLE AT 4.00 m				

This borehole log should be read in conjunction with WSP's accompanying standard notes.

BOREHOLE ENVIRONMENTAL LOG

BOREHOLE NO.

MW36

SHEET 1 OF 1

Client:	**State Transit Authority of NSW**	Date Commenced:	**06/01/20**
Project:	**PS111744**	Date Completed:	**06/01/20**
Borehole Location:	**STA Monavale Bus Depot**	Recorded By:	**James Robinson**
Project Number:	**PS111744**	Log Checked By:	**JR**

Drill Model/Mounting:	**Hand Auger**	Driller:	**Stratacore**	Surface RL:	**~4.6**
Borehole Diameter:	**195 mm**	Driller Lic No:		Co-ords:	**E 33.674024 N -151.307271**

Borehole Information | **Field Material Description**

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 RL(m) / DEPTH(m)	6 Field PID (ppm)	7 SAMPLE	8 GRAPHIC LOG	9 SOIL/ROCK MATERIAL FIELD DESCRIPTION	10 Field pH	11 MOISTURE	12 RELATIVE DENSITY /CONSISTENCY	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
CC		N F G W E	180mm flushmount gatic - 50mm class 18 PVC casing - grout to surface Bentonite pellet seal (plug) 2mm sand filterpack 50mm machine slotted class 18 PVC screen	0.20				CONCRETE Grey with riverstones				
HA					0.7	B&J		FILL : gravelly SAND trace Clay yellow brown Fine to coarse sands well graded with fine to medium grained Sub-angular to sub-rounded Unweathered sandstone		M		
					0.9	B&J						
				1	1.0	B&J						
				1.20				SAND dark brown fine to medium grained				
				1.40	0.2	B&J		TARGET DEPTH REACHED END OF BOREHOLE AT 1.40 m				
				2								
				3								
				4								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

BOREHOLE ENVIRONMENTAL LOG

BOREHOLE NO.

MW37

SHEET 1 OF 1

Client:	**State Transit Authority of NSW**	Date Commenced:	**12/17/19**
Project:	**PS111744**	Date Completed:	**12/17/19**
Borehole Location:	**8 Taronga Place, Mona Vale**	Recorded By:	**James Robinson**
Project Number:	**PS111744**	Log Checked By:	**JR**

Drill Model/Mounting:	**Comacchio GEO 205**	Driller:	**Stratacore**	Surface RL:	**~4.9**
Borehole Diameter:	**195 mm**	Driller Lic No:		Co-ords:	**E 33.673764 N -151.307061**

Borehole Information | **Field Material Description**

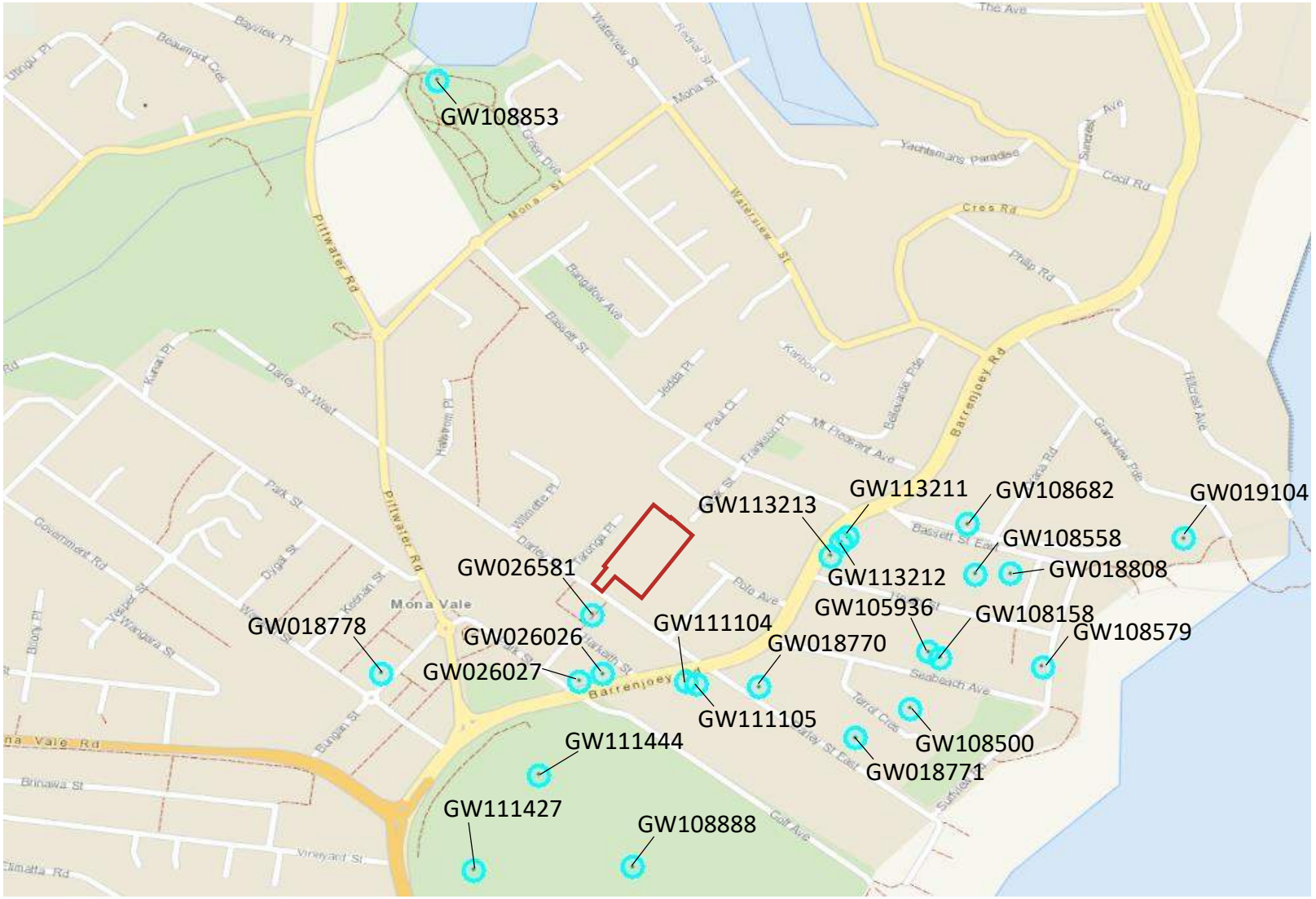
1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 RL(m) / DEPTH(m)	6 Field PID (ppm)	7 SAMPLE	8 GRAPHIC LOG	9 SOIL/ROCK MATERIAL FIELD DESCRIPTION	10 Field pH	11 MOISTURE	12 RELATIVE DENSITY /CONSISTENCY	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
JET			180mm flushmount gatic - 50mm class 18 PVC casing - grout to surface Bentonite pellet seal (plug)	0.05	0.2	B&J		Degraded Black ASPHALT				
				0.20				FILL: Sandy GRAVEL (DGB) Black, fine to medium grained angular to sub angular gravels Brown/Yellow, fine to coarse well graded, angular to sub-rounded sands	7	M		
			2mm sand filterpack		0.5	B&J		FILL: Clayey SAND LightBrown to yellow fine to coarse angular to subrounded well grained sands fine to medium angular to subrounded sandstone gravels becoming loose yellow to lightbrown	7			
			50mm machine slotted class 18 PVC screen	1	0.2	B&J			7			
					0.3	B&J			7			
				1.65				layer of crushed sandstone				
		▷		1.80				Clayey SAND Light brown fine to medium grained sands		W		
				2.00 2	0.9	B&J		TARGET DEPTH REACHED END OF BOREHOLE AT 2.00 m	7			
				3								
				4								

RELATIVE DENSITY /CONSISTENCY: FB VS, VL S, L F, MD ST, D VST, VD H

This borehole log should be read in conjunction with WSP's accompanying standard notes.

APPENDIX E

BORESEARCH DATA



Basemap Source: www.bom.gov.au

Figure E1 - Bore search Results
PS111744 GME May 19
STA Bus Depot, 58 Darley Street Mona Vale

Table E1 Summary of Registered Bores

BORE ID	LATITUDE	LONGITUDE	DRILLED DATE	BORE DEPTH (M)	PURPOSE	STATUS	HYDRAULIC DIRECTION FROM SITE WELLS
GW113213	-33.674575	151.310606	22/05/2012	2.5	Monitoring	Functional	Up-gradient or separate groundwater catchment
GW018770	-33.676968	151.309292	1/08/1960	40.2	Water Supply	Unknown	Separate aquifer
GW108579	-33.676603	151.314472	9/03/2007	6.6	Water Supply	Functioning	Up-gradient or separate groundwater catchment
GW108158	-33.676434	151.312609	7/05/2006	6.3	Water Supply	Functioning	Up-gradient or separate groundwater catchment
GW111104	-33.676867	151.307964	15/06/2010	4	Monitoring	Functional	Up-gradient or separate groundwater catchment
GW111427	-33.680312	151.304088	25/02/2008	103	Other	Functioning	Separate aquifer
GW111444	-33.678578	151.305275	25/02/2008	103	Other	Functioning	Separate aquifer
GW108682	-33.673988	151.31311	23/03/2007	3.5	Water Supply	Functioning	Up-gradient or separate groundwater catchment
GW111105	-33.676922	151.308156	15/06/2010	5	Monitoring	Functional	Up-gradient or separate groundwater catchment
GW108558	-33.674909	151.313243	5/02/2007	4.3	Water Supply	Functioning	Up-gradient or separate groundwater catchment
GW018778	-33.67672	151.302393	1/10/1960	124.9	Water Supply	Unknown	Separate aquifer
GW035791	-33.677903	151.311053	1/12/1960	59.4	Water Supply	Functioning	Separate aquifer
GW105936	-33.676328	151.312399	19/05/2005	-	Unknown	Unknown	Up-gradient or separate groundwater catchment
GW113211	-33.67423	151.310911	22/05/2012	3	Monitoring	Functional	Up-gradient or separate groundwater catchment
GW113212	-33.674329	151.310791	22/05/2012	2.5	Monitoring	Functional	Up-gradient or separate groundwater catchment
GW108500	-33.677364	151.312053	10/11/2006	4	Water Supply	Functioning	Up-gradient or separate groundwater catchment
GW026581	-33.675645	151.306243	1/01/1967	92.9	Water Supply	Unknown	Cross-gradient, separate aquifer
GW018808	-33.674893	151.313884	1/12/1960	91.4	Water Supply	Unknown	Separate aquifer
GW026026	-33.67673	151.306438	1/11/1966	51.8	Water Supply	Unknown	Separate aquifer
GW026027	-33.67686	151.306004	1/12/1966	61.5	Water Supply	Unknown	Separate aquifer
GW018771	-33.677903	151.311053	1/11/1960	100.5	Water Supply	Functioning	Separate aquifer
GW019104	-33.67426	151.317056	1/02/1961	47.2	Water Supply	Unknown	Separate aquifer
GW108853	-33.665883	151.303422	6/10/2007	5	Other	Functioning	Down-gradient
GW108888	-33.680253	151.306989	2/06/2008	73	Other	Functioning	Separate aquifer

APPENDIX F

NSW EPA CORRESPONDENCE

Environment Protection Authority (EPA)

NOTICE OF APPROVAL OF VOLUNTARY MANAGEMENT PROPOSAL

(Section 17 of the *Contaminated Land Management Act 1997*)

Approval No.: **20141707**

Approval Date: **8 May 2015**

Area No.: **3378**

The approved proposal consists of this approval document and the attached proposal, which comprises three Parts: Part 1 – Preliminary Details; Part 2 – Undertakings; and Part 3 – Performance Schedule.

Proponent: **State Transit Authority**

Site: **NSW State Transport Authority Mona Vale Depot at 58 Darley Street, Mona Vale NSW 2103**

Proposal Date: **27 April 2015**

BACKGROUND

The EPA is satisfied that the terms of the proposal, as modified by the conditions of this approval, are appropriate.

For the purposes of section 17(4) of the *Contaminated Land Management Act 1997* (CLM Act), the EPA is not satisfied that the proponent has taken all reasonable steps to identify and find every owner and notional owner of the land and every person responsible for significant contamination of the land and given those parties identified an opportunity to participate in the formulation and carrying out of the proposal on reasonable terms.

The contents of Part 1, Part 2 and Part 3 of the attached proposal form part of the terms of the approved proposal.

For the purposes of section 9(1) of the CLM Act, the EPA has had regard to the principles of ecologically sustainable development in assessing and approving this Voluntary Management Proposal and has also sought the implementation of those principles in the management of the site under this approved proposal.

APPROVAL AND CONDITIONS

The EPA approves the proposal subject to the following conditions. These conditions form part of the terms of the approved proposal.

1. Each feature and milestone of the proposal is to be completed by the date specified in the proposal. Failure to satisfactorily complete any component by the due date for that feature or milestone may be taken as a failure to carry out the terms of the proposal for the purposes of section 17(6) of the CLM Act.
2. The proponent cannot recover contributions under Part 3 Division 6 of the CLM Act.

3. Make available for inspection by any person, free of charge, and provide a copy to any person for a reasonable fee, any document required to be prepared and submitted to the EPA under this voluntary management proposal. It is not necessary to disclose:

    (i) any information contained in those documents that relates to any manufacturing or other industrial or commercial secrets or working processes; or

    (ii) any personal information, within the meaning of the *Privacy and Personal Information Protection Act 1998* or *Privacy Act 1988* (Cth), contained in those documents.

4. Where this proposal requires the proponent or any other person to give a document to the EPA, that document may be given to the EPA:

    (i) By delivering the document by hand to: Manager Contaminated Sites, NSW Environment Protection Authority, Level 14, 59-61 Goulburn Street, Sydney, NSW, 2000

    (ii) By posting the document to: Manager Contaminated Sites, NSW Environment Protection Authority. PO Box A290, Sydney South, NSW, 1232.

    (iii) By faxing the document to Manager Contaminated Sites on (02) 9995 6603

    (iv) By emailing the document to contaminated.sites@epa.nsw.gov.au

ADDITIONAL INFORMATION

5. The EPA may still exercise any powers it has under the CLM Act, or any other legislation, in relation to the site.

6. The EPA may require the proponent to pay all or any costs incurred by the EPA in connection with any one or more of the following:

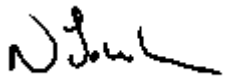
    a. Assessing and settling the terms of the approved voluntary management proposal;

    b. Monitoring action under the approved voluntary management proposal;

    c. Seeking the compliance of the proponent with the approved voluntary management proposal;

    d. Any other matter associated with, or incidental to, the matters set out in paragraphs a. to c. above.

Signed:



8 May 2015

NIALL JOHNSTON
Manager Contaminated Sites
Environment Protection Authority

(by delegation)

VOLUNTARY MANAGEMENT PROPOSAL UNDER THE CONTAMINATED LAND MANAGEMENT ACT 1997

Part 1

Preliminary Details

1. Proponent's Details

(a) Name and contact details

If a registered company, company name:
Trading as:
ACN:

If not a registered company, your full name(s):

Trading as:	State Transit Authority
ABN:	51750635629
Phone:	02 9245 5700
Fax:	
Email:	
Postal address:	Level 4, 15 Bourke Road, Mascot NSW
Postcode:	2020
EPA licence number (if applicable):	n/a

(b) Who the EPA should contact with technical enquiries about the proposal

Name:	David Gosling
Employer/Company:	State Transit Authority
Position title:	Environment Manager
Type of business:	Public Transport
Phone (business):	[redacted]
Phone (after hours):	
Fax:	
Email:	

2. Site to which proposal applies

The site to which the proposal applies ("the site") is:

Site Identification Details	
Address	58 Darley Street, Mona Vale, NSW
Lot / DP	Lot 2 DP 542640
Local Government Area	Pittwater Council
Land Zoning	4(b1) Light Industrial B1
Current Landuse	Bus Depot
Site Area	17,100 m2 (approximately)
Lat/Long	33°40'28.02"S 151°18'25.70"E
Site Map	Attachment A.

3. The contamination

Soil and/or groundwater and/or surface water at the site are contaminated with substances and the contamination is significant enough to warrant regulation under the *Contaminated Land Management Act 1997*. The substances of concern ("the contaminants") are:

Total Petroleum Hydrocarbons (C10-C36)
Polycyclic Aromatic Hydrocarbons including Naphthalene

4. The management proposal

The management proposal ("the proposal") comprises:

a) the information set out above;
b) the actions, works and other components set out in the following documents:
WSP Group Remediation Action Plan 31 May 2013 and WSP Group Amended Remediation Action Plan (to be developed)
Australian Environmental Services Various Remediation Works – Mona Vale 6 September, 2013
State Transit Authority Quotation Professional Services Form 217 Australian Environmental Services Submission 10/9/2013;
ENRS Offsite Groundwater Monitored Natural Attenuation Reports, Rounds 1 Baseline, January 2014, Round 2, June 2014, Round 3 October 2014 & Round 4, February 2015.

c) the undertakings set out in Part 2 of this document; and
d) the performance schedule set out in Part 3 of this document.

Part 2

Undertakings Included in Voluntary Management Proposal

Explanatory Note:
Before the EPA can approve a voluntary management proposal under section 17 of the Contaminated Land Management Act 1997, it has a statutory obligation to satisfy itself that the terms of the proposal (as modified by any conditions to be imposed by the EPA) submitted to it under section 17 are appropriate. In addition to including an appropriate investigation plan, remedial action plan or other plan of management, to be acceptable to the EPA a proposal would usually include the undertakings set out below. These undertakings are important and will form part of the terms of the proposal. If the proposal is approved, they must be complied with in order for the EPA to be satisfied that the terms of the proposal have been carried out.

THE PROPOSAL INCLUDES THE FOLLOWING UNDERTAKINGS:

General

1. All works or activities carried out in connection with the proposal, including sampling and preparation of associated reports ("the activities"), will be carried out in accordance with applicable provisions of *State Environmental Planning Policy 55 – Remediation of Land* and any requirements imposed under it in relation to the activities.
2. All matters listed as relevant to a remediation action plan by the EPA's *Guidelines for Consultants Reporting on Contaminated Sites* (1997) will be taken into account in the carrying out of the activities.
3. All the activities will be carried out consistently with guidelines made or approved under section 105 of the CLM Act.
   (See www.epa.nsw.gov.au/clm/guidelines.htm)
4. All the activities will be carried out in compliance with applicable NSW environmental legislation, and in particular:
   i) All the activities, including:
      (1) the processing, handling, movement and storage of materials and substances used to carry out the activities; and
      (2) the treatment, storage, processing, reprocessing, transport and disposal of waste generated by the activities

      will be carried out in a competent manner;
   ii) All plant and equipment installed at the site or used in connection with the activities:
      (1) will be maintained in a proper and efficient condition; and
      (2) will be operated in a proper and efficient manner.
5. All the activities at the site will be carried out in a manner that prevents or minimises the emission of dust, odour and noise from the site.
6. Waste generated or stored at the Site will be assessed and classified in accordance with the EPA's *Waste Classification Guidelines Part 1: Classifying Waste.*

   (See www.epa.nsw.gov.au/waste/envguidlns/index.htm)

7. All waste transported from the Site that is required by the *Protection of the Environment (Waste) Regulation 2005* to be tracked must be tracked using the EPA's on-line tracking system or an alternative tracking system approved in writing by the EPA.

   (See www.epa.nsw.gov.au/owt/aboutowt.htm)

8. The proponent will make this voluntary management proposal available to the public free of charge and consents to the EPA placing this proposal on its public website.

9. The proponent will make all documents referred to in, and required to be prepared under, this voluntary management proposal available to the public free of charge, unless the proponent identifies commercial-in-confidence or private/personal information (including information relating to a third party) within those documents. In these cases, the proponent will remove such information from the documents to make the documents suitable for public release.

10. The proponent will:

    i) prior to the implementation of the proposal provide for the EPA's approval a strategy for communicating about that implementation, particularly the actual management works, with members of the public who are likely to have a real interest in or be affected by that implementation; and

    ii) implement the strategy as approved in writing by the EPA.

Monitoring, Record Keeping & Reporting

11. At least until the EPA has notified the proponent that the EPA no longer considers that the contamination is significant enough to warrant regulation under the *Contaminated Land Management Act 1997*, record and retain all monitoring data and information and provide this record to the EPA at any reasonable time if so requested by the EPA and as specifically provided under the proposal.

    [Note: Specific details of monitoring and data reporting requirements, requirements for progress reports, etc are to be set out in the performance schedule in Part 3 of this document.]

12. The EPA will be informed in writing within 7 days of the proponent becoming aware of information or data indicating a material change:

    a) in conditions at the site, or

    b) in its surrounding environment,

    which could adversely affect the prospects of successful management of the site or result in harm to the environment.

13. The EPA will be informed in writing within 7 days of the proponent becoming aware of any failure, either by the proponent or any other person, to comply with any term of the proposal.

14. The EPA will be informed in writing as soon as practicable of any notification by the proponent, its employees or its agents to an appropriate regulatory authority other than the EPA of any pollution incident at the site within the meaning of the *Protection of the Environment Operations Act 1997.*

    (See http://www.epa.nsw.gov.au/licensing/dutytonotify.htm)

Performance Schedule

15. The performance schedule which is in Part 3 of this document will be adhered to.

Part 3

Performance Schedule

Explanatory Notes:

The performance schedule required must provide a clear and concise list of:

- *key milestones and dates by which they are to be achieved and*
- *the objectives and principal features of the investigation or remedial action plan.*

The performance schedule is very important because it provides a concise set of performance indicators which will be used, along with an evaluation of compliance with the terms in Part 2 of this document, to assess whether or not the terms of the proposal have been carried out.

To be acceptable to the EPA, the performance schedule ***must*** *include precise, measurable and time-bounded performance indicators. Where it is appropriate for the investigation or other management to be done in stages, performance measures for each stage must be provided. EPA approval of later stages will be dependent on the completion and/or performance of earlier stages being demonstrated to the EPA's satisfaction.*

The performance schedule should adhere to the structure set out in the following table.

PART 3 - PERFORMANCE SCHEDULE The schedule should concisely set out:
1. Objectives of the proposal
2. Principal features of the proposal a. Capital works b. Investigation and/or Remediation c. Monitoring
3. Reporting requirements and timeframes for submission of reports
4. Key milestones and deadlines for investigation or remediation activities

An example of a performance schedule is set out on the next page.

Example of a performance schedule

PERFORMANCE SCHEDULE

1. Objectives of the proposal

The main objectives of the remediation program are to:

- Assess extent of soil and groundwater contamination,
- Assess the risks posed by the contamination, and
- Remove phase separated hydrocarbon (PSH) from groundwater to the extent practicable.

The proposed remediation strategy aims to ensure that the site is rendered suitable for unrestricted commercial/industrial land use, and that potential contamination risks to future site occupiers and the surrounding natural environment are minimised.

The Remediation Action Plan (RAP) is proposed to be implemented such that the site complies, where practicable, with relevant guidelines, including:

- National Environmental Protection (Assessment of Site Contamination) Measure 1999, (April 2013)
- NEPM HIL: F (1999) Soil Investigation Levels for Commercial/Industrial land use;
- NSW EPA (2004) Technical Note: Investigation of Service Station Sites;
- NSW EPA (2001) Guidelines for Consultants Reporting on Contaminated Sites
- NSW EPA (2007) Guidelines for the Assessment and Management of Groundwater Contamination
- NSW DEC (2006) Guidelines for the NSW Site Auditor Scheme; and
- State Environmental Planning Policy No. 55 (1998) – Remediation of Land (SEPP 55).

2. Principal features of the proposal

The principal features of the Remediation Action Proposal include, but are not limited to:

a. Capital works

P1. Source Abandonment, Soil Excavation and Offsite Disposal Backfilling and compaction of spill capture pit with clean sand. Excavation of heaviest contaminated soils adjacent pit within impacted zone. Classification and disposal of contaminated soils to licensed waste facility.

P2. Installation of additional 2 onsite monitoring wells on the Mona Vale site to provide for enhanced free phase recovery from groundwater.

P3. Installation of additional 3 offsite monitoring wells to the existing 5 offsite wells to further delineate the extent of contamination and provide for monitoring of natural attenuation in offsite wells.

P4. Installation of additional offsite monitoring well(s) between MW10 and MW17 to further delineate extent of offsite contamination.

P5. Installation of additional onsite monitoring well(s), at strategic upstream location to detect for potential onsite migration of contaminants and to act as a GW quality control.

P6. Installation of additional offsite monitoring well downgradient of former pump shed in North Western corner of bus depot to monitor and characterise any offsite contamination from former above and below ground fuelling system.

P7. MPE Pilot Trial utilising two existing offsite wells (MW9 & MW10) to determine efficiency of remedial process in existing hydro-geologies.

P8. Upon results of trial implement multiple full MPE events, extracting product and impacted groundwater from existing offsite well and newly installed wells (5 to 8) within the contaminant plume to accelerate free phase recovery. .

b. Remediation

P9. Carry out passive skimming of phase separated hydrocarbons at:

(i) Onsite monitoring well MW1, 2 & 3 along the western boundary of the refuel area,

(ii) Including monthly maintenance of free phase recovery system to adjust/modify the compressed air pumping mechanism to maximise the recovery of separated phase hydrocarbon, minimise any migration of impacted groundwater off the source site, and draw back on the offsite hydrocarbon plume.

P10. Upon completion of successful pilot implement multiple MPE events, utilising new and existing wells, to remove free phase in existing hydro-geologies.

c. Monitoring

P11. Quarterly monitoring of 8 offsite wells (4 quarterly rounds) as installed to establish baseline and subsequent data sets for monitored natural attenuation and to provide source data for the conduct of a Human Health and Environmental Risk Assessment.

P12. Conduct of a Human Health and Environmental Risk Assessment

P13. Depending upon outcomes of P9 and P10 continued 6 monthly GW Monitoring for 2 years and yearly thereafter, to monitor wells for proof of natural attenuation, until levels are at or below guideline levels.

d. Additional Considerations beyond the Remediation Action Plan

P14. Based upon the findings of the Human Health and Environmental Risk Assessment State Transit will commission the development of a site specific Environmental Management Plan to manage under a slab capping and EMP the risk of residual contamination to staff and contractor resulting from civil works that could potentially expose contaminated soils or groundwater.

P15. Where Monitored Natural Attenuation is occurring but not at a rate considered to be acceptable in terms of minimising offsite risk, State Transit would investigate the use of Oxygen Releasing Compounds with existing offsite monitoring wells to promote and accelerate the natural attenuation process.

P16. The original WSPGroup Remediation Action Plan (17/6/2013) is to be revised and updated to reflect the remedial strategies outlined in this Voluntary Management Proposal.

P17. Implement agreed Voluntary Management Proposal Community Communications Action Plan as attached and review plan every 12 months, or more frequently as required.

3. Key milestones for investigation, remediation and other actions

All works set out in the proposal must be completed by the deadlines specified below:

Works	***Deadline***
P1. Source Abandonment, Soil Excavation and Offsite Disposal	Completed
P2. Installation of two additional monitoring wells for enhanced free phase recovery within groundwater impacted zone	Completed
P3. Installation of additional 3 offsite wells to existing network of 5 wells for the purpose of delineation and monitoring of natural attenuation.	Completed
P9. Passive skimming of onsite MW 1, 2 & 3 with monthly maintenance of compressed air operated system increased to monthly to ensure recovery system efficiency	Ongoing, continued operation of free phase recovery system to be reviewed in June 2015.
P4, P5 & P6 Installation of additional offsite wells to delineate contaminate plume between existing MW10 and MW17 and well down-gradient of former pump shed and installation of additional onsite wells to detect potential onsite migration and/or act as GW monitoring quality control.	June 2015
P7. Pilot MPE event for (MW9 + MW10) to enhance offsite free-phase LNAPL recovery and draw back on dissolved phase contamination plume for zone of influence.	MPE Pilot to commence in May 2015
P8. Upon results of trial implement multiple full MPE events, extracting product and impacted groundwater from existing offsite well and newly installed wells (5 to 8) within the contaminant plume to accelerate free phase recovery. .	Dependant upon outcome of P7 full MPE event to commence in July 2015
P11. Quarterly monitoring of 8 offsite wells (4 quarterly rounds) as installed to establish baseline and subsequent data sets for monitored natural attenuation and to provide source data for the conduct of a Human Health and Environmental Risk Assessment.	All four rounds completed
P12. Conduct of a human health and environmental risk assessment	October 2015
P13. Depending upon outcomes of P9 and P10 continued 6 monthly GW Monitoring for 2 years, to monitor wells for proof of natural attenuation, until levels at or below adopted guideline levels.	March 2017
P14. Development of a site specific Environmental Management Plan, for ongoing monitoring and management of residual onsite contamination, under a concrete slab capping.	Feb 2016 if required.
P15. Where Monitored Natural Attenuation is occurring but not at a rate considered to be acceptable in terms of minimising offsite risk, State Transit would investigate the use of Oxygen Releasing Compounds with existing offsite monitoring wells to promote and accelerate the natural attenuation process.	Dependant upon outcome of P6 & P7.

4. Reporting requirements and timeframe for submission of reports

The EPA must be provided with the following reports by the deadlines specified below:

Report	***Deadline***
P11. First Round Offsite Groundwater Monitoring Report.	March 2014 (completed)
P11. Second Round Offsite Groundwater Monitoring.	October 2014 (completed)
P11. Third Round Offsite Groundwater Monitoring	January 2015 (completed)
P11. Fourth Round Offsite Groundwater Monitoring	March 2015 (completed)
P7. Results of MPE Pilot (MW9 & MW10)	June 2015
P8. Results of multiple MPE Events	October 2015
P12. Human Health and Environmental Risk Assessment	December 2015
P13. Subsequent 6 monthly rounds of offsite groundwater monitoring for MNA.	Sept 2015 (1st 6 monthly round) Mar 2016 (2nd round) Sept 2016 (3rd round) Mar 2017 (4th round)
P14. Site Environmental Management Plan	Feb 2016 if required
P16 Revision of WSPGroup Remediation Action Plan	Jun 2015.
P17. Annual revision of Mona Vale VMP Communication Plan	Jan 2016

Signature of proponent

This application for approval of this voluntary management proposal may only be signed by a person(s) with the legal authority to sign it. The various ways in which the application may be signed, and the people who may sign the application, are set out in the categories below.

Please tick (✓) the box next to the category that describes how this application is being signed.

If the proponent is:		**The application must be signed and certified by one of the following:**
an individual	☐	the individual.
a company	☐	the common seal being affixed in accordance with the *Corporations Act 2001, or*
	☐	two directors, or
	☐	a director and a company secretary, or
	☐	if a proprietary company that has a sole director who is also the sole company secretary – by that director.
a public authority other than a council	☒	the chief executive officer of the public authority, or
	☐	by a person delegated to sign on the public authority's behalf in accordance with its legislation (Please note: a copy of the relevant instrument of delegation must be attached to this application).
a local council	☐	the general manager in accordance with s.377 of the *Local Government Act 1993* ('LG Act'), or
	☐	the seal of the council being affixed in a manner authorised under the LG Act.

We (the proponent):

- ***apply for approval of the voluntary management proposal set out in this proposal and in any documents referred to in Part 1.4 of this proposal***
- ***declare that the information in this proposal form (including any attachment or document referred to in Part 1.4 of this proposal) is not false or misleading.***

Signature	[redacted] [Signed]	Signature	[redacted] [Signed]
Name (printed)	David Gosling	Name (printed)	Peter Rowley
Position	Environment Manager	Position	Chief Executive
Date	20 April, 2015	Date	20/4/15

Seal (if signing under seal):

Environment Protection Authority

Notice to amend approved voluntary management proposal

(Section 44 of the Contaminated Land Management Act 1997)

Notice Number 20164409; Area Number 3378

Background

The land to which this notice applies was declared as “significantly contaminated land” (declaration No. 20141101) by the Environment Protection Authority (EPA), and has been the subject of an EPA-approved voluntary management proposal (approval No. 20141707).

Land to which this notice applies

Description	Address
Lot 2 in DP542640	58 Darley Street, Mona Vale NSW 2103

Amendment of approved VMP

An amendment to the voluntary management proposal (the VMP) is required due to delays in several works and reporting milestones arising from matters associated with seeking permits for site access, and subcontractor delays. In addition, a reappraisal of the proposal strategy is required to ensure more effective remediation beyond what was prescribed in the Remedial Action Plan (RAP):

- WSP (2015) *Remedial Action Plan (Revised, 2015), State Transit Mona Vale Bus Depot – 58 Darley Street, Mona Vale NSW, 18 May 2015.*

All works set out in the amended proposal must be completed by the deadlines specified below:

Works	*Deadline*
T1. Undertake remediation in accordance with the RAP (WSP, 2015), as updated in this notice, and the following additional guidelines: • NSW EPA (2015) *Technical Note: Light Non-Aqueous Phase Liquid Assessment and Remediation.* • CRC Care Technical Report No 6. *Technical impracticability of further remediation for LNAPL – impacted soils and aquifers* • CRC Care Technical Report No 18. *Selecting and assessing strategies for remediating LNAPL in soils and aquifers* • CRC Care Technical Report No 23 *Petroleum hydrocarbon vapour intrusion assessment: Australian guidance.*	**Ongoing,** for duration of VMP.
T2. Active skimming of **onsite** of wells MW13, MW5 & MW14 within fuelling area with bi-monthly maintenance of compressed air operated system increased to monthly to ensure recovery system efficiency	**Ongoing**, continued operation of free phase recovery system until Phase Separate Hydrocarbon removed from these wells to the extent practicable.
T3. Installation of additional off-site wells to delineate the groundwater contamination located between existing MW10 and MW17. Installation of additional off-site well down-gradient of former pump shed. Installation of additional on-site wells to detect potential onsite migration and/or act as groundwater monitoring quality control.	**July 2016**
T4. Conduct of a human health and environmental risk assessment (HHERA) in accordance with: • *Schedule B4 and B5a of National Environmental Protection (Assessment of Site Contamination) Measure 1999 and* • *CRC CARE Technical Report 23: Petroleum hydrocarbon vapour intrusion assessment: Australian guidance*	**June 2016**
T5. Installation of two additional 100 mm Recovery Wells in Taronga Place to aid in recovery of Phase Separate Hydrocarbons (PSH) from hydrocarbon plume.	Works are to be undertaken if the HHERA determines that light non-aqueous phase liquid (LNAPL) in groundwater poses a significant risk, requiring its removal. **August 2016**
T6. Continued 6 monthly GW Monitoring for 2 years, of all offsite wells, and those onsite wells demonstrating evidence of contamination, for proof of natural attenuation, or until levels at or below adopted guideline levels.	6th Round **July 2016** 7th Round **February 2017** 8th Round **August 2017**
T7. Development of a site specific Environmental Management Plan, for ongoing monitoring and management of residual onsite contamination, under a concrete slab capping.	**February 2017** if there is an ongoing risk identified by the HHERA, arising from the groundwater contamination.
T8. Where Monitored Natural Attenuation is occurring but not at a rate considered to be acceptable in terms of minimising offsite risk, State Transit would investigate the use of Oxygen Releasing Compounds with existing offsite monitoring wells to promote and accelerate the natural attenuation process.	Dependent upon outcome of HHERA **(T4)** and successive rounds of Groundwater Monitoring **(T6).**
T9. Establishment of continuous PSH extraction and storage system located off-site to extract PSH from selected productive recovery wells with periodic recordings of volumes collected for disposal. Review effectiveness of system every three months. Clean	**October 2016** (if HHERA warrants further PSH extraction, and given landowner permission to locate

pumps every two months, adjust timing and suction pressures according to well production and recharge rates.	extraction and storage system on their site)
T10. Review of remedial and monitoring work, closure of the VMP.	STA is to meet with the EPA to review the effectiveness of remedial works under the VMP, and/or submit request for extension to VMP if required by **December 2016** and closure of VMP by **December 2017**

The EPA must be provided with the following reports by the deadlines specified below:

Report	*Deadline*
R1. Human Health and Environmental Risk Assessment Report (report to be peer reviewed by technical advisor before issued to the EPA)	**August 2016**
R2. Subsequent 6 monthly rounds of offsite groundwater monitoring for MNA.	**September 2016** (6th round) **April 2017** (7th round) **October 2017** (8th round)
R3. Report upon volumes collected from recovery wells using the continuous extraction system over 3 monthly intervals, including results of periodic SWL and PSH gauging.	**October 2016** (if HHRA warrants further PSH extraction)
R4. Site Environmental Management Plan for Bus Depot and offsite Industrial Premises.	**February 2017** To be developed and submitted only if there is an ongoing risk arising from the groundwater contamination (refer to R1)
R5. Annual revision of Mona Vale VMP Communication Plan	**March** annually for duration of VMP.
R6. Annual Remediation System Performance Review Reports - reports detailing the findings of the remediation works, risk assessments, recommendations for further remedial works, and/or ongoing groundwater monitoring (if required).	**June 2016, June 2017**, and/or annually for duration of VMP.

[Signed]

NIALL JOHNSTON
Manager Contaminated Sites
Environment Protection Authority

Date: 20 May 2016

NOTE:

Information recorded by the EPA

Section 58 of the CLM Act requires the EPA to maintain a public record. A copy of this notice will be included in the public record.

Information recorded by councils

Section 59 of the CLM Act requires the EPA to give a copy of this notice to the relevant local council. The council may then make appropriate consequential modifications to the planning certificate issued in relation to the land to which this notice applies pursuant to s149 of the *Environmental Planning and Assessment Act 1979*.

Relationship to other regulatory instrument

This repeal notice does not affect the provisions of any relevant environmental planning instruments which apply to the land or provisions of any other environmental protection legislation administered by the EPA.

Previous regulatory instrument

As of 1 July 2009, all current declarations of investigation area and declarations of remediation site are taken to be declarations of significantly contaminated land, all current investigation orders and remediation orders are taken to be management orders and all current agreed voluntary investigation proposals and agreed voluntary remediation proposals are taken to be approved voluntary management proposals.

Environment Protection Authority

Notice to amend approved voluntary management proposal

(Section 44 of the Contaminated Land Management Act 1997)

Notice Number 20174407, Area Number 3378

Background

The land to which this notice applies was declared as "significantly contaminated land" (declaration No. 20141101) by the Environment Protection Authority (EPA), and has been the subject of an EPA-approved voluntary management proposal (Notice No. 20141707, and as amended through (Notice No. 20164409).

Land to which this notice applies

Description	Address
Lot 2 in DP542640	58 Darley Street, Mona Vale NSW 2103

Amendment of approved VMP

An amendment to the voluntary management proposal (the VMP) is required to reflect agreed changes to the remedial strategy as follows:

Amendment	Detail
Soil vapour gas assessments	There is a need to conduct soil vapour gas studies as required by the EPA, additional to the existing Human Health and Ecological Risk Assessment (VMP reporting item **R1, completed**) and to further assess potential human health risk within adjacent neighbouring industrial/commercial properties, for which site access has been denied. Additional soil vapour monitoring is also required to account for seasonal and temporal changes. This amends the VMP by inclusion of new items **T11 (complete), T12, R7 (complete)** and **R8**.
Revised remedial strategy	A reappraisal of the existing offsite active Phase Separated Hydrocarbon (PSH) extraction strategy using suction spear indicates that it was not cost effective or efficient enough in recovering PSH, whereas a strategy of regularly maintained 100 mm and 50 mm Geotech passive skimmers from selected monitoring wells with measurable product will result in slow but regular extraction of PSH at low cost in response to changing hydrogeological conditions with an enhanced reporting proposal to the EPA. Subsequent appraisal of the off site passive skimming strategy in February 2017 indicated that it is a suitable remedial option only if employed with other more active options, including extending onsite active PSH recovery system to offsite PSH impacted wells, or via the implementation of a series of Multi-phase vacuum extraction (MPVE) events. If technically feasible and access is granted, the existing onsite PC controlled compressed air driven PSH system is to be extended to PSH impacted wells MW19, MW20 and MW21. If not technically feasible State Transit will commission multiple separate MPVE with reporting after each three successive events. This amends the VMP items **T9** and **R3**.
Environment Management Plan for on site and off site properties	There is a requirement for development of an Environmental Management Plan (EMP), for ongoing monitoring and management of residual onsite contamination, under a concrete slab capping, and also to address offsite risks associated with the contamination. This amends the VMP item **T7** and **R4**. It is expected the EMP would be revised at the completion of the remediation and once a Site Audit Statement is issued for the on site and off site areas.
Indoor Air Quality assessments	Where additional soil gas vapour measures assessing temporal and seasonal variations indicate a potential indoor air quality risk, undertake direct Indoor Air Quality assessments or modelling of indoor air quality for commercial/industrial premises affected by the plume where landowner permission is granted (new item **T13**).
Engagement of an EPA Accredited Site Auditor	Engage an EPA Accredited Auditor to review and audit remediation with a view of providing a Site Audit Statement and Report as to the suitability of on and offsite lands for continued commercial/industrial land use and the enforceability of the EMPs (new items **T14** and **R10**)
Community consultation	STA is to meet with the EPA and stakeholders to discuss the remediation progress annually (new item **T15**).

The above changes are proposed to ensure more effective remediation beyond what was prescribed in the Remedial Action Plan (RAP):

- WSP (2015) *Remedial Action Plan (Revised, 2015), State Transit Mona Vale Bus Depot – 58 Darley Street, Mona Vale NSW, 18 May 2015.*

All works set out in the amended proposal must be completed by the deadlines specified below:

Works	***Deadline***
T1. Undertake remediation in accordance with the RAP (WSP, 2015), as updated in this notice, and the following additional guidelines: • NSW EPA (2015) *Technical Note: Light Non-Aqueous Phase Liquid Assessment*	**Ongoing,** for duration of VMP.

and Remediation. • CRC Care Technical Report No 6. *Technical impracticability of further remediation for LNAPL – impacted soils and aquifers* • CRC Care Technical Report No 18. *Selecting and assessing strategies for remediating LNAPL in soils and aquifers* • CRC Care Technical Report No 23 *Petroleum hydrocarbon vapour intrusion assessment: Australian guidance.*	
T2. Active skimming of **onsite** of wells MW13, MW5 & MW14 within fuelling area with bi-monthly maintenance of compressed air operated system increased to monthly to ensure recovery system efficiency	**Ongoing**, continued operation of free phase recovery system until Phase Separate Hydrocarbon removed from these wells to the extent practicable.
T6. Continued 6 monthly GW Monitoring, of all offsite wells, and those onsite wells demonstrating evidence of contamination, for proof of natural attenuation, or until levels at or below adopted guideline levels.	7th Round **24 February 2017 (completed)** 8th Round **25 August 2017**
T7. Development of a site specific and enforceable Environmental Management Plan, for - On site: ongoing monitoring and management of residual onsite contamination, under a concrete slab capping and - Off site: covering commercial properties, council owned land and service easements within Taronga Place affected by the groundwater plume to manage the risk of contact with contaminated water, exposure to vapours and ongoing groundwater remediation and/or monitoring.	**7 April 2017** (**completed**)
T8. Where Monitored Natural Attenuation is occurring but not at a rate considered to be acceptable in terms of minimising offsite risk, State Transit would investigate the use of Oxygen Releasing Compounds with existing offsite monitoring wells to promote and accelerate the natural attenuation process.	Dependent upon outcome of HHERA **(T4)** and successive rounds of Groundwater Monitoring **(T6).**
T9. Establishment of 100 mm and 50 mm Geotech passive skimmers with regular maintenance to recover PSH from MW9, 19, 20 and 21, with well gauging and recordings of volumes collected for disposal. Review effectiveness of passive recovery system in reducing LNAPL thickness after three months. If effective continue with passive PSH recovery until LNAPL reduced to the extent practicable. If ineffective consider extension of onsite PSH extraction system to offsite PSH impacted wells (refer to item **T16**).	**27 January 2017 (completed)**
T10. Review of remedial and monitoring work, closure of the VMP.	STA is to meet with the EPA to review the effectiveness of remedial works under the VMP, and/or submit request for extension to VMP if required by **December 2016 (completed)** and closure of VMP by **December 2018.**
T11. Active onsite Soil Vapour Gas Studies to quantify risk, supplement existing HHERA and to assist in inferring Human Health Risk in adjacent properties.	**30 January 2017 (completed)**
T12. Conduct additional (greater than 1) onsite or offsite Soil Vapour Assessments to account for seasonal and temporal variables in vapour risk and providing multiple lines of evidence for certainty in vapour risk conclusions.	**31 July 2017**
T13. Conduct direct Indoor Air Quality assessments or modelling of indoor air quality for commercial/industrial premises within or in close proximity to the north and south boundaries of the delineated contaminant plume to quantify vapour risk, where landowner permission is granted.	**30 September 2017**
T14. Engage an EPA Accredited Contaminated Sites Auditor to audit remediation with view of issuing a Site Audit Statement once remediation is complete, as to the suitability of on and offsite lands for continued commercial/industrial land use.	**31 October 2017**
T15. STA is to meet with the EPA and stakeholders to discuss the remediation progress.	**before 31 December annually, and for the duration of the VMP,**
T16. Transition to active groundwater extraction system off site to target Phase Separate Hydrocarbon (PSH) impacted wells and undertake monthly reporting of recovered volumes. If the active system is not able to be installed due to land access permissions or technical issues, recommence Multiphase Vacuum Extraction Events (multiple per annum) with three monthly	**11 August 2017**

consolidated reporting of successive MPE events until PSH thickness is reduced to the extent practicable.	

The EPA must be provided with the following reports by the deadlines specified below:

Report	*Deadline*
R1. Human Health and Environmental Risk Assessment Report (report to be peer reviewed by technical advisor before issued to the EPA)	**August 2016 (submitted)**
R2. Subsequent 6 monthly rounds of offsite groundwater monitoring with assessment of chemicals of concern and monitored natural attenuation parameters.	**September 2016** (6th round) (**submitted)** **21 April 2017** (7th round) **(submitted)** **27 October 2017** (8th round)
R3. Report upon volumes collected from recovery wells using the extraction system at 3 monthly intervals, including results of periodic SWL and PSH gauging.	**28 February 2017 (submitted),** **31 March 2017 (submitted), then every three months thereafter.**
R4. Health Safety and Environment Management Plan for Bus Depot and offsite Industrial Premises. Development and application of an appropriate health and safety and environment management plan for both on site and off site land affected by the plume.	**7 April 2017 (submitted)**
R5. Annual revision of Mona Vale VMP and Communications Plan	**30 April 2017** and annually for duration of VMP.
R6. Annual Remediation System Performance Review Reports - reports detailing the findings of the remediation works, risk assessments, recommendations for further remedial works, and/or ongoing groundwater monitoring (if required).	**30 June 2017**, and/or annually for duration of VMP.
R7. Soil Vapour Assessment Report at the STA site immediately up hydraulic gradient of the Taronga Place businesses, in order to assess the risk to human health from vapour intrusion in this area.	**16 January 2017 (complete)**
R8. Additional Soil Vapour Assessment Reports, highlighting season and temporal variation in soil vapour monitoring and providing multiple lines of evidence for soil vapour risk conclusions.	**30 November 2017**
R9. Indoor Air Quality Assessments or Modelling Reports, if warranted under **T12** and if access is granted, to quantify Vapour risk for specific businesses within or at the boundaries of contaminant plume to the North and South of Pittwater Joinery.	**29 December 2017**
R10. A Site Audit Statement and Site Audit Report certifying suitability of on and offsite lands for continued commercial/industrial land use, and upon satisfactory completion of remediation works. The SAS and SAR is to be accompanied by an Environmental Management Plan (EMP) for: - The current site. - all affected off-site industrial properties (with all Lots and DPs listed) certifying suitability for ongoing use as “commercial/industrial” subject to a compliance with an EMP; and - council-owned public land (i.e., roads, sidewalks and nature strips) certifying suitability for ongoing use as a road, sidewalk and nature strip subject to a compliance with an EMP	**31 March 2018**
R11. Submit reports on the performance of and recovered volumes from either the: - active off site PSH remediation system, or - multiple off site MPE events.	**31 August 2017, and three monthly intervals thereafter**

[Signed]

26 June 2017

SARAH GARDNER
Executive Director, Hazardous Incidents and Environmental Health
Environment Protection Authority

NOTE:

Information recorded by the EPA

Section 58 of the CLM Act requires the EPA to maintain a public record. A copy of this notice will be included in the public record.

Information recorded by councils

Section 59 of the CLM Act requires the EPA to give a copy of this notice to the relevant local council. The council may then make appropriate consequential modifications to the planning certificate issued in relation to the land to which this notice applies pursuant to s149 of the *Environmental Planning and Assessment Act 1979*.

Relationship to other regulatory instrument

This repeal notice does not affect the provisions of any relevant environmental planning instruments which apply to the land or provisions of any other environmental protection legislation administered by the EPA.

Previous regulatory instrument

As of 1 July 2009, all current declarations of investigation area and declarations of remediation site are taken to be declarations of significantly contaminated land, all current investigation orders and remediation orders are taken to be management orders and all current agreed voluntary investigation proposals and agreed voluntary remediation proposals are taken to be approved voluntary management proposals.