Oil / Water Interface Meter

Instrument **Geotech Interface Meter (30M)**
Serial No. **3908**

airmet
Air-Met Scientific Pty Ltd
1300 137 067

Item	Test	Pass	Comments
Battery	Compartment	✓	
	Capacity	✓	
Probe	Cleaned/Decon.	✓	
	Operation	✓	
Connectors	Condition	✓	
		✓	
Tape Check	Cleaned	✓	
Connectors	Checked for cuts	✓	
Instrument Test	At surface level	✓	

Certificate of Calibration

This is to certify that the above instrument has been cleaned and tested.

Calibrated by: [redacted]

Calibration date: **8/09/2020**

Next calibration due: **7/11/2020**

Multi Parameter Water Meter

Instrument **YSI Quatro Pro Plus**
Serial No. **18J104341**

airmet
Air-Met Scientific Pty Ltd
1300 137 067

Item	Test	Pass	Comments
Battery	Charge Condition	✓	
	Fuses	✓	
	Capacity	✓	
Switch/keypad	Operation	✓	
Display	Intensity	✓	
	Operation (segments)	✓	
Grill Filter	Condition	✓	
	Seal	✓	
PCB	Condition	✓	
Connectors	Condition	✓	
Sensor	1. pH	✓	
	2. mV	✓	
	3. EC	✓	
	4. D.O	✓	
	5. Temp	✓	
Alarms	Beeper		
	Settings		
Software	Version		
Data logger	Operation		
Download	Operation		
Other tests:			

Certificate of Calibration

This is to certify that the above instrument has been calibrated to the following specifications:

Sensor	Serial no	Standard Solutions	Certified	Solution Bottle Number	Instrument Reading
1. pH 10.00		pH 10.00		347027	pH 10.03
2. pH 7.00		pH 7.00		330737	pH 7.10
3. pH 4.00		pH 4.00		349846	pH 4.07
4. mV		231.8mV		357172/357173	232mV
5. EC		2.75mS		343511	2.76mS
6. D.O		0.00ppm		1904288592	0.01ppm
7. Temp		21.0°C		MultiTherm	20.8°C

Calibrated by: [redacted]

Calibration date: **10/09/2020**

Next calibration due: **10/10/2020**

HydroTerra

Environmental Monitoring Specialists

Delivery Docket

Booking #: 16947
Booking Date: 07/09/2020
Customer PO#: PO PS121494-115

ABN 58 154 889 559
42/328 Reserve Road
Cheltenham VIC 3192
Phone: (03) 8683 0091
Email: rental.enquiries@hydroterra.com

Invoice To:

WSP Australia Pty Limited
GPO Box 5394
Sydney NSW 2001

Phone: 02 9272 1422

Delivery:
WSP [redacted]
Level 27, 680 George Street
Sydney NSW 2000

Phone: [redacted]

Estimated Date/Time From: 9/09/2020 2:01PM
Estimated Date/Time To: 21/09/2020 12:01PM
Staff: [redacted]

For HydroTerra Terms & Conditions, please refer to the hire page on the HydroTerra website
SDS available on request

Item Code	Description	Qty	Delivery	Pickup
MLL-7658	3001 LT Levelogger Edge, M10/F30	1	☐	☐
MLL-0930	3001 LT Levelogger Edge, M10/F30	1	☐	☐
MLL-4784	3001 LT Levelogger Edge, M10/F30	1	☐	☐
MBL-7459	3001 LT Barologger Edge, M1.5/F5	1	☐	☐
MOR-2985	3001 Optical Reader (USB) for the Levelogger	1	☐	☐
Freight	Freight - Delivery	1	☐	☐

Special Delivery Instructions:

Thank you for choosing HydroTerra, we appreciate your business!

Recipient's Printed Name: _____

Recipient's Signature: _____ **Date/Time:** _____

Signature of Driver: _____ **Date/Time:** _____

AMPCONTROL CSM PTY LTD
ABN: 35 000 770 141
2/71 Prince William Drive Seven Hills NSW 2147
Ph: +61 2 9620 9600 Fax: +61 2 9620 8277

JOB No: 1144436

REPAIR / SERVICE REPORT – CSM-SYD

CUSTOMER: InSite Remediation Services	CO No: 209324
	DATE: 10/03/2020
CUSTOMER WO No:	CUSTOMER PO No: MPE Truck_LH

WORK REQUIRED: January 2020 Service/Calibration – 79-2500 Hexane IR Detector

SERIAL No: 1066572001

WORK PERFORMED:

1. Reset gain in the software menu.
2. Service/Calibration of Gas Detection Equipment – making adjustments to zero and span calibration.

PARTS USED:

PART No	SERIAL No	DESCRIPTION	QTY

LABOUR COSTS

JOB START TIME:	REPAIRED / SERVICED BY: [redacted]
JOB FINISH TIME:	CUSTOMER NAME:
TRAVEL TIME:	CUSTOMER SIGNATURE:

CALIBRATION DETAILS: (SYSTEM / INSTRUMENTS)

DETECTOR / SENSOR (BY TYPE &/OR LOCATION)	READING PRIOR TO CALIBRATION	READING AFTER CALIBRATION BASED ON CAL.GAS SPEC
79-2500 Smart Transmitter		
s/n - 1066572001		
0-20,000ppm C_6H_{14}		
	-	
Zero		0.00%LEL, 4mA
Span	-	3000ppm, 16.4mA

CALIBRATION GAS USED:
Air 20.9%VOL in N2
Portagreen C6H14 0.3%Vol lot # 221346.

Insite Remediation Services

CALIBRATION CERTIFICATE

Manufacturer	**Austech Australia**	**Service Number:**	**008**
		Serial Number:	**1066572001**
		Part Number:	**79-2500IR**
Unit Model	**Hexane IR Unit**	**Order Number:**	**N/A**
		Date Serviced:	**05-08-20**

Customer:

Insite Remediation – [redacted]

Next Service:

01-02-21

Warranty Claim Procedure:

If the detector Serial Number is removed the unit must be accompanied by the last Calibration Certificate.

Unit Report

Condition received: Good

Comments on receiving unit

Unit clean and in good condition. Fitted to Vacuum Truck

Comments on completing service

Standard Calibration

All functions normal

Functional tests

Alarm operation: Not applicable **Display operation:** Checked

Circuit board: Checked **Battery test:** Not applicable

Sensor Report

HEXANE: 0 – 20,000ppm

Zero: 4 mA = 0%

Date Cell Fitted: Not applicable

Span: 3000ppm

Cell Number: N/A

Alarm: Not Applicable

Certificate Number: 030000016678/1

Span Gas Concentration:

Methane 50% LEL

Serviced by: [redacted]

Signature: _____

ALL INSTRUMENTS ARE CALIBRATED IN ACCORDANCE WITH AUSTRALIAN STANDARD AS 60079.29.1:2008
Calibration and Response Testing of Gas Detectors

APPENDIX H

RISING HEAD TEST SOP

Contaminated Land Management

Standard Operating Procedure 3.4: Slug Testing

1. Purpose and scope

This procedure (CLM SOP 3.4) outlines general protocols and work practices to be applied undertaking a slug test.

It is noted that other methods of slug testing are possible and that deviation from this SOP may be required in some circumstances. The rationale for any deviations from this SOP should be discussed and agreed to with the Project Manager (PM) prior to undertaking the works, documented during the works, and justified in the site assessment documentation.

2. References

- ASTM D4044-96 (2010) *Standard Test Method (Field Procedure) for Instantaneous Change in Head (Slug) Tests for Determining Hydraulic Properties of Aquifers*.
- ASTM D4104-96 (2010) *Standard Test Method (Analytical Procedure) for Determining Transmissivity of Nonleaky Confined Aquifers by Overdamped Well Response to Instantaneous Change in Head (Slug Tests)*.
- Bower, H., and R.C. Rice (1980) *A Slug Test for Determining the Hydraulic Properties of Tight Formations*, Water Resources Research, Vol. 16, No. 1 pp. 233–238.
- Hvorslev, M.J. (1951) *Time Lag and Soil Permeability in Ground-Water Observations*, Bull. No. 36, Waterways Exper. Sta. Corps of Engrs, U.S. Army, Vicksburg, Mississippi, pp. 1-50.

3. Equipment and input documentation

3.1 Input documentation

- Site specific Health, Environment and Safety Plan (HESP), Safe Work Method Statement (SWMS) and related OHSE documents.
- Sampling and analysis plan (SAP) which specifies the sampling objectives, sampling locations, sampling methods and quality control samples to be collected.

3.2 Equipment

- Personal protective equipment and other safety equipment as identified in the HESP.
- Camera and mobile phone.
- Field data recording form.
- Slug testing equipment: data logger/s i.e. level logger and barologger (optional depending on level logger model), interface meter, solid slug of a known volume or bailer, duct tape and/or clamp, stainless steel cable and reel or lifting cord (polyester or Kevlar to reduce stretching) for data logger, bailer and/or slug, spanner or key to open wells.
- Decontamination equipment including 3x clean buckets, phosphate free detergent e.g. Decon 90, scrubbing brushes, potable water and deionised water.

4. Slug testing

4.1 Pre-field work preparation

- Review the following information, alongside the SAP, prior to mobilising to site:
  - Bore logs and well construction details. Determine the total depth of the well, well diameter, and screen position and length.
  - Previous depth to groundwater measurements.
- Based on geological setting/profile, estimate the likely magnitude of recovery (e.g. minutes, hours, days). Ascertain whether the water level in each of wells to be tested is likely to be affected by external factors such as tidal fluctuations, rainfall recharge, groundwater extraction etc.
- Select an appropriate data logger for use in the slug test:
  - **Data loggers are rated for use at certain depths.** It is important to know before using a data logger what conditions the data logger will be used in. Data loggers are rated from five meters to 300 meters. Exceeding the depth rating of the data logger may yield inaccurate data. In addition, exceeding the rating by over 150% may also cause permanent damage to the instrument. If possible select a data logger that automatically compensates for atmospheric pressure (if not possible then include barologger).
  - **The application capabilities of data logger models vary.** For example, an AquaTROLL 200 is primarily for long-term monitoring or very slow aquifer tests (>2 hours recovery). The minimum measurement frequency of the AquaTROLL 200 is one minute. Faster recharging aquifers should be tested with a TROLL300, 500, or 700 (or equivalent). Some data loggers have automatic atmospheric pressure compensation (e.g. LevelTroll 500).
  - Make sure that the data logger has sufficient memory to cover the anticipated recovery period for two falling head/rising head test pairs at each well.
  - Data loggers with ceramic casing are available if corrosive substances or gross contamination in groundwater (e.g. NAPL) are anticipated.
- Determine if a barologger is required for the slug test (refer to the SAP). The need for a barologger will be determined by the level logger selected for use (i.e. whether or not the level logger automatically compensates for atmospheric pressure or not). A single barologger should be sufficient for the assessment of atmospheric changes at a site.
- Connect each data logger (level logger and/or barrologger to a computer on which appropriate data logger control software is installed. Synchronize the computer and data logger clocks (do this for all data loggers). Check the battery in the data logger to ensure full power supply.
- Select a logging rate – one reading per second is generally acceptable but will depend on the groundwater response rate, the number of tests to be conducted by each logger and the data logger memory capacity. Set the start and stop logging times for each data logger, ensuring that the tests are able to be completed within these times.
- Record the transducer ID/serial number/s (essential if multiple data loggers are being used) on the field data recording form.

4.2 Slug testing

- Decontaminate the data logger, cable, interface meter and slug.
- Open the well and manually measure depth to non-aqueous liquid (NAPL) (where present), depth to water (standing water level; SWL) and depth to the base of the well.
- If necessary, cover sharp edges of the well casing with duct tape to protect the data logger / slug cables.
- Slowly lower the data logger down the well and place it at least 0.5 m deeper than the anticipated depth of the slug. The depth of the data logger should not exceed the maximum design depth for the transducer used. The data logger should be at least 0.5 m above the base of the well. Record the installed depth of the data logger on the field data recording form. **Note 1,** if undertaking testing in monitoring wells with light non-aqueous phase liquid (LNAPL) present, care should be taken to minimise potential LNAPL smearing by minimising the induced changes in the SWL. **Note 2,** if using a barologger, this should never be submerged.
- Fasten the data logger cable at the top of the well so it cannot move. This could be achieved using duct tape or a clamp.
- Allow at least 15 minutes for the transducer to equilibrate to the well and for the cable to stretch.
- Measure the water level again to see if the level has returned to equilibrium after the insertion of the data logger in the water. If it has not, repeat this step in five minute intervals until equilibrium is reached. Record this information on the field data recording form.
- Lower the slug into the well and hold the slug just above the water level. Calculated and record the SWL change expected to be induced by the slug in the field record.
- Lower the slug quickly (but smoothly to avoid splashing or inducing a large groundwater disturbance) into the water. Record the post slug installation SWL and time that the slug was placed into the water in the field record.
- Monitor the water level until it has stopped changing or has recovered to within 95% of the static water level. Record the final SWL in the field record. The falling head portion of the test is now complete.
- Allow time for the water level to recover to a static condition and record the resultant SWL in the field record. Quickly (but smoothly to avoid splashing or inducing a large groundwater disturbance) pull the slug out of the water. Record the post slug removal SWL and time that the slug was pulled from the water in the field record.
- Monitor the water level until it has stopped changing or has recovered to within 95% of the static water level. Record the final SWL in the field record. The rising head portion of the test is now complete.
- Repeat the slug test in order to duplicate the test (i.e. obtain two falling head and two rising head tests).
- Retrieve equipment from the well and decontaminate the transducer, interface meter, and slug.

5. Interpretation

- Review the following information (obtained prior to undertaking the slug test): the depth to top and base of screen and filter pack, geology through the filter packed interval, and diameter of bore, well casing and screen.
- Review the data for each test for completeness and to identify the key moments during the test (e.g. logger insertion, pre-test SWL stabilisation, slug insertion etc.). Usable data should be extracted and adopted for interpretation and superfluous data discarded (note: the raw data file should not be edited).

- Analyse slug test using the AQTESOLV software. The analysis should be performed by an individual who is suitably experienced in the use of this software. An excel template that can be used for the analysis of slug test data using AQTESOLV can be found in the “CLM Technical\Groundwater\Slug Tests” folder on the WSP server.

6. Output documentation

The following documents/files shall be placed on the electronic project file as soon as possible upon completion of the fieldwork/analysis:

- Slug test field data recording form (CLM FM 3.4).
- Data logger output files.
- AQTESOLV input and output files.

7. Other important considerations

- The slug test method is one of a number of different methods that are used to evaluate the hydraulic conductivity of an aquifer. The procedure involves either adding (falling head) or removing (rising head) a slug of water or solid cylinder of known volume from a well rapidly, and measuring the artificial fluctuation of the groundwater level.

  Figure 1 below shows a graphical representation of a falling head and rising head slug test.

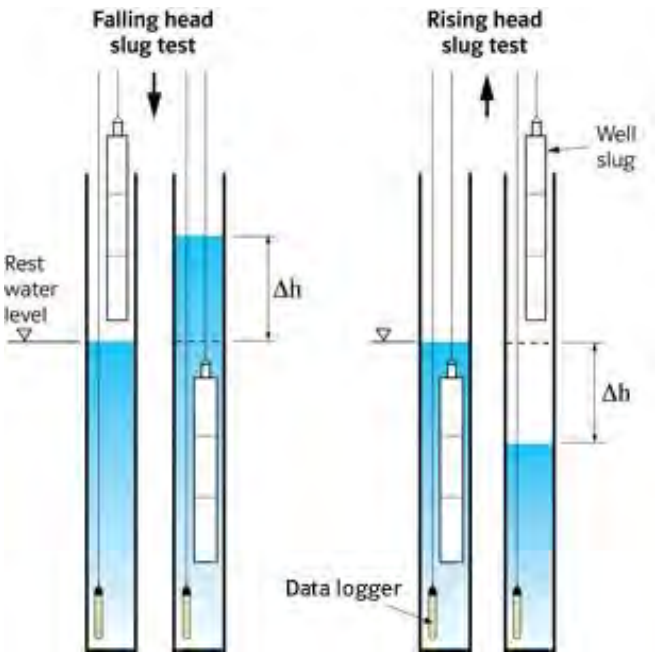


Figure 1 Graphical representation of falling head and rising head slug test

- Slug testing provides a bulk estimate of the average hydraulic conductivity of the screened interval within the aquifer. Slug testing cannot be used to calculate the hydraulic conductivity of discreet intervals within the aquifer unless the monitoring well is constructed specifically to target the interval of interest. Furthermore, the hydraulic conductivity is typically only representative of near-bore conditions.

Slug tests are typically dominated by the higher flowing layers/intervals and can therefore lead to an over estimation of aquifer hydraulic conductivity.

- The quality of the slug test outcome is highly dependent on the quality of the monitoring well. Hydraulic conductivities estimated by slug tests conducted in poorly developed wells will bear little resemblance to actual aquifer conditions.
- Falling head tests in unconfined aquifers can lead to an estimation of flow within the unsaturated zone (typically dominated by the filter pack) rather than the aquifer and as such, care must be taken in the interpretation of the slug test results in these instances.
- The time required for a slug test to be completed is a function of the volume of the slug, the hydraulic conductivity of the formation and the type of well completion. The slug volume should be large enough that a sufficient number of water level measurements can be made before the water level returns to equilibrium conditions. The length of the test may range from less than a minute to several hours.
- If the aquifer is highly fractured and may be considered equivalent porous media, then standard analytical solutions should be applicable. In situations with substantial secondary porosity then the analytical solutions are less reliable. As long as the flow around the well is radial, then the previously discussed analytical methods are valid, with varying degrees of certainty. If flow is non-radial, or highly restricted in narrow fractures, then standard analytical solutions are not appropriate and slug tests should not be performed.
- New monitoring wells should be properly developed and allowed to stabilise for at least one week prior to the commencement of a slug test. If there is any doubt in regards to the development of a well to be tested, it should be re-developed and allowed to stabilise (for at least one week) prior to testing.
- Where external factors may significantly affect groundwater SWLs, it may be prudent to undertake SWL measurement over a period of at least 1 day (even up to a week) in order to understand the magnitude of the affects prior to undertaking slug testing.

7.1 Data loggers

- Also known as level loggers or pressure transducers, these instruments are installed below the water level to record the pressure at the datum position (as inscribed) on the data logger. The pressure measured is the total of the weight of the water and the atmospheric pressure.
- Any brand/make of automatic water gauging equipment may be used to record the water level fluctuations. A typical system includes a data logger and associated software, for example, In-Situ Inc., RuggedTROLL 100 and Win-Situ software).
- In instances where the level logger used does not automatically compensate for atmospheric pressure, a barologger is required in order to isolate changes in atmospheric pressure from the total pressure recorded by the level logger. The barologger is typically installed within a well, but well above the water level. A barologger is a data logger with a small pressure range of approximately 1.5 m, which is adequate for measuring the barometric pressure. Typical readings range from 0.3 m to 1.0 m when the barologger is programmed with its operating altitude. Failure to input correct altitude results in incorrect absolute readings (but will not impact upon the correction of atmospheric pressure changes).

7.2 Slugs

- Solid slugs are typically manufactured from solid cylinders of Delrin with threaded connections to allow more than one slug section to be used. Two standard sizes are available for use in 50 mm and 100 mm diameter wells. Each size will achieve an approximate 1 m change in water level within the borehole lining. Slugs can also be constructed to size using appropriately sized PVC pipe, end caps and clean sand fill.

Figure 2 below shows solid slugs and data loggers that can be utilised during slug testing.

Figure 2 **Waterra Delrin solid slugs (left), In-situ Inc, RuggedTROLL 100 data loggers with BaroTROLL to record changes in water level, pressure and temperature**

8. Amendment details

Revision	Reviewer	Date	Approver	Date
A	[redacted]	22/10/2014	[redacted]	8/12/14

APPENDIX F

HISTORICAL SOIL AND FEBRUARY 2021 GME RESULTS

Ampol Holt (SITE ID: 22546)
Table F1
Groundwater Gauging and Physicochemical Data
February 2021 GME

Well ID	Gauging date	Well depth	Screened interval	Depth to groundwater	Top of Casing RL	Corrected groundwater elevation	Depth to LNAPL	Apparent thickness of LNAPL	Water quality parameter and sample collection date	Temperature	pH	Electrical conductivity	Dissolved oxygen	Redox potential	Adjusted redox
		mBTOC	mBTOC	mBTOC	mAHD	mAHD	mBTOC	m		°C	pH units	uS/cm	mg/L	mV	mV
EW01	24/2/2021	13.7	11.0-14.0	8.514	575.016	566.502	-	-	24/2/2021	19.0	9.23	543	0.77	-4.9	192.1
EW02	24/2/2021	14.0	11.0-14.0	8.725	575.035	566.310	-	-	24/2/2021	19.1	6.80	1225	0.30	-58.3	138.7
EW03	24/2/2021	15.0	9.0-15.0	8.887	575.494	566.607	-	-	24/2/2021	18.3	6.84	1115	0.61	85.4	282.4
MW01	24/2/2021	11.7	9.0-12.0	9.182	575.656	566.474	-	-	24/2/2021	18.2	8.58	882	1.20	32.1	229.1
MW02	24/2/2021	10.9	8.0-11.0	8.741	575.119	566.378	-	-	24/2/2021	19.0	6.41	308	0.70	81.4	278.4
MW04	24/2/2021	12.0	7.5-12.0	8.018	574.340	566.322	-	-	24/2/2021	18.9	7.81	1322	0.12	-90.7	106.3
MW05	24/2/2021	11.6	6.0-12.0	8.09	574.364	566.274	-	-	24/2/2021	18.8	5.62	1480	0.87	103.9	300.9
MW06	22/2/2021	12.8	8.5-13.5	8.403	574.541	566.138	-	-	22/2/2021	23.6	6.61	2984	1.62	350.4	547.4
MW07	22/2/2021	12.6	9.0-13.0	8.730	575.065	566.335	-	-	22/2/2021	25.1	7.08	2262	0.13	-82.6	114.4
MW08	22/2/2021	15.0	9.0-15.0	9.305	575.783	566.478	-	-	22/2/2021	25.4	7.21	2194	0.11	-80.1	116.9
MW09	22/2/2021	15.2	9.5-15.5	10.148	576.630	566.482	-	-	22/2/2021	20.3	6.85	1598	2.86	71.3	268.3
MW10	24/2/2021	13.5	8.5-13.5	10.413	576.660	566.247	-	-	24/2/2021	19.8	6.81	1351	0.48	183.6	380.6
MW11	24/2/2021	14.0	9.0-14.0	10.261	576.830	566.569	-	-	24/2/2021	18.8	5.69	833	0.42	397.0	594.0
MW12	23/2/2021	11.8	7.5-12.0	9.323	575.736	566.413	-	-	23/2/2021	17.8	7.09	1320	1.84	118.5	315.5
MW13	23/2/2021	10.5	7.0-11.0	8.406	574.771	566.365	-	-	23/2/2021	18.0	6.22	1220	0.99	132.2	329.2
MW14	23/2/2021	10.5	7.5-10.5	7.506	573.838	566.332	-	-	23/2/2021	18.8	9.45	1120	0.82	64.0	261.0
MW15	23/2/2021	10.9	6.5-11.0	7.300	573.518	566.267	7.235	0.065	23/2/2021	21.2	6.17	2000	0.86	112.9	309.9
MW16	23/2/2021	10.4	7.5-10.5	7.432	573.610	566.231	7.361	0.071	23/2/2021	19.6	6.95	1060	1.15	96.8	293.8
MW17	23/2/2021	9.9	7.0-10.0	7.357	573.581	566.224	-	-	23/2/2021	21.0	9.05	1033	1.41	39.4	236.4
MW18	23/2/2021	10.6	7.0-11.0	7.287	573.520	566.233	-	-	23/2/2021	24.1	6.80	1756	0.82	102.2	299.2
MW19	22/2/2021	11.8	8.0-12.0	7.461	574.102	566.641	-	-	22/2/2021	22.4	6.90	1604	0.39	100.1	297.1
MW20	22/2/2021	12.0	8.0-12.0	8.428	574.919	566.491	-	-	22/2/2021	-	-	-	-	-	-
MW21	22/2/2021	12.0	8.0-12.0	9.054	575.515	566.461	-	-	22/2/2021	19.7	7.02	1155	0.90	53.2	250.2
MW23	23/2/2021	12.9	7.8-12.8	9.905	576.391	566.486	-	-	23/2/2021	18.4	5.95	204.5	6.37	-45.9	151.1
MW24	23/2/2021	14.3	11.0-15.0	10.165	576.706	566.541	-	-	23/2/2021	18.1	6.86	1248	1.13	-139.9	57.1
MW25	23/2/2021	15.0	9.0-15.0	9.972	576.938	566.966	-	-	23/2/2021	18.0	5.98	1220	1.11	153.5	350.5
RW01	24/2/2021	3.9	1.0-4.0	2.513	575.061	572.548	-	-	24/2/2021	22.1	6.43	772	0.47	-47.9	149.1
S2-P1	23/2/2021	11.6	8.5-13.0	9.138	577.142	568.004	-	-	23/2/2021	18.2	8.16	1380	2.00	89.3	286.3
S2-P2	23/2/2021	9.9	6.0-10.0	6.683	572.976	566.293	-	-	23/2/2021	17.3	5.73	1250	2.46	120.5	317.5
S2-P3	23/2/2021	10.3	6.0-10.5	6.081	572.297	566.216	-	-	23/2/2021	17.6	8.63	1270	1.01	62.0	259.0
S2-P4	23/2/2021	10.4	6.0-10.5	5.816	571.941	566.125	-	-	23/2/2021	17.2	6.73	1350	0.94	111.8	308.8
S2-P5	22/2/2021	9.8	6.0-10.0	4.12	570.151	566.031	-	-	22/2/2021	18.8	5.40	1210	2.00	104.6	301.6
S2-P5B	22/2/2021	6.0	3.0-6.0	4.025	570.015	565.990	-	-	22/2/2021	17.8	6.59	1370	1.20	102.5	299.5
S2-P6	22/2/2021	9.3	5.0-9.0	2.728	568.759	566.031	-	-	22/2/2021	20.6	7.42	1350	1.40	100.6	297.6
S2-P6B	22/2/2021	5.0	3.0-5.0	2.819	568.826	566.007	-	-	22/2/2021	21.1	6.57	1360	0.46	114.5	311.5
S2-P7	22/2/2021	8.3	4.0-8.5	2.002	566.756	564.754	-	-	22/2/2021	19.7	9.37	1240	3.30	-31.9	165.1
S2-P8	23/2/2021	10.1	6.0-10.0	4.722	570.842	566.120	-	-	23/2/2021	20.3	7.08	1253	0.62	91.6	288.6
S2-P9A	Backfilled	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S2-P9B	23/2/2021	9.5	6.0-9.5	5.665	571.830	566.165	-	-	23/2/2021	19.7	7.23	1226	0.84	80.2	277.2
S2-P10	23/2/2021	11.5	7.0-11.0	7.112	573.360	566.248	-	-	23/2/2021	21.4	7.24	971	1.67	110.8	307.8
S2-P11	23/2/2021	12.0	6.0-12.0	7.142	573.588	566.446	-	-	23/2/2021	21.3	7.00	1022	0.78	-122.9	74.1
S2-P12	23/2/2021	10.6	6.0-12.0	8.004	574.490	566.486	-	-	23/2/2021	21.3	6.74	749	0.48	46.2	243.2
S2-C1	23/2/2021	13.3	7.0-13.0	8.924	577.536	568.612	-	-	23/2/2021	17.8	6.46	548	-	107.3	304.3
S2-C2	23/2/2021	10.1	8.0-12.0	5.539	571.152	565.613	-	-	23/2/2021	18.0	6.14	1280	1.54	102.8	299.8
S2-C3	22/2/2021	7.5	4.0-7.5	1.597	567.357	565.760	-	-	22/2/2021	20.9	7.92	1360	1.35	47.0	244.0
S2-C4	22/2/2021	7.0	4.5-7.5	1.346	567.174	565.828	-	-	22/2/2021	20.5	7.89	1310	1.29	36.7	233.7
S2-C5	22/2/2021	10.0	5.5-10.0	5.074	571.168	566.094	-	-	22/2/2021	22.3	6.53	1080	2.52	90.3	287.3
S2-C6	23/2/2021	9.9	5.5-10.0	5.631	571.702	566.071	-	-	23/2/2021	22.3	6.95	1286	1.61	96.9	293.9
S2-C7	23/2/2021	10.4	6.0-10.5	6.219	572.669	566.450	-	-	23/2/2021	20.2	6.96	1157	0.36	87.2	284.2
S2-C8	23/2/2021	10.5	6.0-10.5	6.298	573.074	566.776	-	-	23/2/2021	20.4	6.63	1279	0.86	82.3	279.3
S2-C9	23/2/2021	11.8	6.0-12.0	7.121	574.135	567.014	-	-	23/2/2021	20.6	6.48	614	0.95	74.7	271.7
S2-C10	23/2/2021	18.2	10.0-18.0	15.408	582.161	566.753	-	-	23/2/2021	19.4	5.56	1839	1.15	54.6	251.6
S2-R1	24/2/2021	6.5	3.5-6.5	4.391	570.415	566.024	-	-	24/2/2021	16.2	7.30	1090	3.15	119.8	316.8
S2-R2	24/2/2021	6.4	3.5-6.5	4.147	570.854	566.707	-	-	24/2/2021	17.4	7.10	1410	0.10	120.5	317.5
S2-R3	24/2/2021	6.5	3.5-6.5	4.005	571.308	567.303	-	-	24/2/2021	17.2	7.15	1264	2.46	219.2	416.2
S2-R4	24/2/2021	7.6	4.5-7.5	3.498	571.551	568.053	-	-	24/2/2021	17.1	6.91	996	1.53	159.6	356.6
S2-R5	24/2/2021	8.3	4.0-8.0	3.813	571.900	568.087	-	-	24/2/2021	17.2	7.22	1376	3.20	153.5	350.5
S2-R6	24/2/2021	8.0	4.0-8.0	4.998	572.223	567.225	-	-	24/2/2021	19.4	6.96	1402	0.62	149.7	346.7
IW1	24/2/2021	13.0	8.5-13.0	8.475	574.858	566.383	-	-	24/2/2021	20.1	-	11184	0.60	472.2	669.2
IW2	24/2/2021	11.8	7.5-12.0	9.125	575.584	566.459	-	-	24/2/2021	19.8	6.61	2287	0.67	325.6	522.6
IW3	24/2/2021	14.0	9.5-14.0	10.342	576.871	566.529	-	-	24/2/2021	18.2	3.25	16401	0.48	508.9	705.9
PEW1	24/2/2021	12.3	7.5-12.0	8.498	574.814	566.316	-	-	24/2/2021	19.4	6.75	1207	0.65	142.1	339.1
PMW1	24/2/2021	12.3	7.5-12.0	8.476	574.804	566.328	-	-	24/2/2021	19.0	7.15	1527	0.87	97.7	294.7
PMW2	24/2/2021	12.2	7.5-12.0	8.192	574.499	566.307	-	-	24/2/2021	19.5	6.96	1139	0.96	-26.3	170.7
PMW3	23/2/2021	11.8	7.0-11.5	7.505	573.785	566.280	-	-	23/2/2021	23.5	7.01	1286	1.20	95.5	292.5
PMW4	24/2/2021	12.0	7.5-12.0	8.253	574.576	566.323	-	-	24/2/2021	18.8	6.76	1123	0.55	97.9	294.9
S2-D1	23/2/2021	11.4	-	7.267	-	-	-	-	23/2/2021	19.3	6.27	834	0.58	122.3	319.3
S2-D2	22/2/2021	13.8	-	8.254	-	-	-	-	22/2/2021	22.2	5.68	371	0.40	252.7	449.7
									Minimum value	16.2	3.25	204.50	0.10	-139.90	57.10
									Maximum value	25.4	9.45	16401.00	6.37	508.90	705.90

Notes:
mBTOC: metres below top of casing
mAHD: metres relative to Australian Height Datum
ND: no detection
* denotes ground RL as no casing is present
Redox potential values have been corrected to standard hydrogen electrode values by adding 197 mV
Corrected groundwater elevation calculated using an LNAPL density of 0.75 kg/m^3 as follows
Corrected groundwater elevation = (T.O.C. Elevation - Depth to Water)+((Depth to Water - Depth to Product)*0.75)

Ampol Holt (SITE ID: 22546)
Table F2
Groundwater Gauging Data February 2020 - March 2021

Well ID	Location	Installed by and year	T.O.C Elevation	Well Depth	Gauging Date	Depth to Water	Depth to Product	Apparent LNAPL Thickness	Corrected Water Elevation
			(mAHD)	(mBTOC)		(mBTOC)	(mBTOC)	(m)	(mAHD)
EW01	On-site	GHD, 2010	575.016	15.2	15-Feb-20	11.830	8.842	2.988	565.43
					27-Mar-20	9.765	9.407	0.358	565.52
					3-Apr-20	9.680	9.628	0.052	565.38
					16-Apr-20	9.547	ND	-	565.47
					20-Apr-20	9.613	9.520	0.093	565.47
					13-May-20	9.513	9.510	0.003	565.51
					21-May-20	-	-	-	-
					15-Jun-20	9.411	9.378	0.033	565.63
					23-Jun-20	9.358	ND	-	565.66
					29-Sep-20	8.821	ND	-	566.20
					24-Feb-21	8.514	ND	-	566.50
EW02	On-site	GHD, 2010	575.035	14.1	15-Feb-20	11.745	9.050	2.695	565.31
					27-Mar-20	9.638	9.580	0.058	565.44
					3-Apr-20	9.755	9.705	0.050	565.32
					16-Apr-20	9.498	ND	-	565.54
					20-Apr-20	8.447	ND	-	566.59
					13-May-20	9.590	ND	-	565.45
					21-May-20	-	-	-	-
					15-Jun-20	9.304	ND	-	565.73
					23-Jun-20	9.270	ND	-	565.77
					9-Jul-20	9.260	ND	-	565.78
					23-Jul-20	9.407	ND	-	565.63
					29-Jul-20	9.392	ND	-	565.64
					6-Aug-20	9.394	ND	-	565.64
					13-Aug-20	9.105	ND	-	565.93
					20-Aug-20	9.000	ND	-	566.04
					26-Aug-20	8.969	ND	-	566.07
					3-Sep-20	9.096	ND	-	565.94
					29-Sep-20	8.933	ND	-	566.10
					8-Oct-20	8.802	8.800	0.002	566.23
					24-Feb-21	8.725	ND	-	566.31
EW03	On-site	GHD, 2010	575.494	12.7	15-Feb-20	9.942	ND	-	565.55
					27-Mar-20	9.868	ND	-	565.63
					3-Apr-20	10.832	ND	-	564.66
					16-Apr-20	9.761	ND	-	565.73
					20-Apr-20	9.744	ND	-	565.75
					13-May-20	9.640	ND	-	565.85
					21-May-20	-	-	-	-
					15-Jun-20	9.580	ND	-	565.91
					23-Jun-20	9.558	ND	-	565.94
					9-Jul-20	9.530	ND	-	565.96
					23-Jul-20	9.508	ND	-	565.99
					29-Jul-20	9.503	ND	-	565.99
					6-Aug-20	9.495	ND	-	566.00
					13-Aug-20	9.405	ND	-	566.09
					20-Aug-20	9.304	ND	-	566.19
					26-Aug-20	9.291	ND	-	566.20
					31-Aug-20	9.268	ND	-	566.23
					3-Sep-20	9.207	ND	-	566.29
					29-Sep-20	9.195	ND	-	566.30
					8-Oct-20	9.055	ND	-	566.44
					24-Feb-21	8.887	ND	-	566.61
MW01	On-site	AECOM, 2011	575.656	12.0	15-Feb-20	10.975	10.000	0.975	565.41
					27-Mar-20	10.318	10.081	0.237	565.52
					3-Apr-20	10.295	10.045	0.250	565.55
					16-Apr-20	10.011	ND	-	565.65
					20-Apr-20	10.117	9.970	0.147	565.65
					13-May-20	9.995	9.980	0.015	565.67
					21-May-20	-	-	-	-
					15-Jun-20	9.873	9.854	0.019	565.80
					23-Jun-20	9.838	9.832	0.006	565.82
					30-Jun-20	9.883	9.873	0.010	565.78
					9-Jul-20	9.830	9.800	0.030	565.85
					24-Jul-20	9.818	9.814	0.004	565.84
					28-Jul-20	9.782	9.779	0.003	565.88
					29-Jul-20	9.774	9.771	0.003	565.88
					6-Aug-20	9.444	9.439	0.005	566.22
					13-Aug-20	10.070	ND	-	565.59
					20-Aug-20	9.572	ND	-	566.08
					26-Aug-20	9.526	ND	-	566.13
					3-Sep-20	9.552	ND	-	566.10
					29-Sep-20	9.477	ND	-	566.18
					8-Oct-20	9.350	ND	-	566.31
					24-Feb-21	9.182	ND	-	566.47

Well ID	Location	Installed by and year	T.O.C Elevation (mAHD)	Well Depth (mBTOC)	Gauging Date	Depth to Water (mBTOC)	Depth to Product (mBTOC)	Apparent LNAPL Thickness (m)	Corrected Water Elevation (mAHD)
MW02	On-site	AECOM, 2011	575.119	11.0	15-Feb-20	10.769	9.345	1.424	565.42
					27-Mar-20	10.903	9.904	0.999	564.97
					3-Apr-20	10.095	9.620	0.475	565.38
					16-Apr-20	10.575	10.528	0.047	564.58
					20-Apr-20	9.785	9.461	0.324	565.58
					13-May-20	9.690	9.580	0.110	565.51
					21-May-20	-	-	-	-
					15-Jun-20	9.617	9.322	0.295	565.72
					23-Jun-20	9.374	9.367	0.007	565.75
					30-Jun-20	9.505	9.500	0.005	565.62
					9-Jul-20	9.470	9.440	0.030	565.67
					24-Jul-20	9.430	9.430	0.000	565.69
					28-Jul-20	9.568	9.527	0.041	565.58
					29-Jul-20	9.564	9.564	0.000	565.56
					6-Aug-20	9.614	9.543	0.071	565.56
					13-Aug-20	9.345	9.345	0.000	565.77
					20-Aug-20	9.208	9.194	0.014	565.92
					26-Aug-20	9.070	ND	-	566.05
					3-Sep-20	9.104	ND	-	566.02
					29-Sep-20	9.011	9.008	0.003	566.11
					8-Oct-20	8.295	ND	-	566.82
					24-Feb-21	8.741	ND	-	566.38
MW04	On-site	WSP, 2020	574.340	12.0	27-Mar-20	9.113	ND	-	565.23
					3-Apr-20	8.946	ND	-	565.39
					16-Apr-20	8.855	ND	-	565.49
					20-Apr-20	8.847	ND	-	565.49
					13-May-20	8.745	ND	-	565.60
					21-May-20	-	-	-	-
					15-Jun-20	8.693	ND	-	565.65
					23-Jun-20	8.666	ND	-	565.67
					9-Jul-20	8.655	ND	-	565.69
					23-Jul-20	8.623	ND	-	565.72
					29-Jul-20	8.604	ND	-	565.74
					6-Aug-20	8.601	ND	-	565.74
					13-Aug-20	8.497	ND	-	565.84
					20-Aug-20	8.385	ND	-	565.96
					26-Aug-20	8.357	ND	-	565.98
					31-Aug-20	8.319	ND	-	566.02
					3-Sep-20	8.308	ND	-	566.03
					28-Sep-20	8.296	ND	-	566.04
					8-Oct-20	8.190	ND		566.15
					24-Feb-21	8.018	ND	-	566.32
MW05	On-site	WSP, 2020	574.364	12.0	27-Mar-20	9.396	9.030	0.366	565.24
					3-Apr-20	9.548	8.816	0.732	565.37
					16-Apr-20	9.107	8.832	0.275	565.46
					20-Apr-20	9.337	8.759	0.578	565.46
					13-May-20	9.140	8.710	0.430	565.55
					21-May-20	-	-	-	-
					15-Jun-20	9.133	8.634	0.499	565.61
					23-Jun-20	8.716	8.709	0.007	565.65
					9-Jul-20	8.615	8.610	0.005	565.75
					24-Jul-20	8.689	8.689	0.000	565.68
					29-Jul-20	8.832	8.811	0.021	565.55
					6-Aug-20	8.801	8.785	0.016	565.58
					13-Aug-20	8.546	ND	-	565.82
					20-Aug-20	8.427	ND	-	565.94
					26-Aug-20	8.395	ND	-	565.97
					3-Sep-20	8.364	ND	-	566.00
					28-Sep-20	8.352	ND	-	566.01
					8-Oct-20	8.225	ND	-	566.14
					24-Feb-21	8.090	ND	-	566.27

Ampol Holt (SITE ID: 22546)
Table F2
Groundwater Gauging Data February 2020 - March 2021

Well ID	Location	Installed by and year	T.O.C Elevation (mAHD)	Well Depth (mBTOC)	Gauging Date	Depth to Water (mBTOC)	Depth to Product (mBTOC)	Apparent LNAPL Thickness (m)	Corrected Water Elevation (mAHD)
MW06	Boundary of the site	WSP, 2020	574.541	13.5	27-Mar-20	9.929	9.523	0.406	564.92
					3-Apr-20	9.228	9.080	0.148	565.42
					16-Apr-20	9.048	9.037	0.011	565.50
					20-Apr-20	9.034	9.012	0.022	565.52
					13-May-20	8.930	ND	-	565.61
					21-May-20	-	-	-	-
					15-Jun-20	8.881	ND	-	565.66
					23-Jun-20	8.850	ND	-	565.69
					9-Jul-20	8.825	ND	-	565.72
					23-Jul-20	8.806	ND	-	565.74
					29-Jul-20	8.786	ND	-	565.76
					6-Aug-20	8.779	ND	-	565.76
					13-Aug-20	8.657	ND	-	565.88
					20-Aug-20	8.561	ND	-	565.98
					26-Aug-20	8.564	ND	-	565.98
					31-Aug-20	8.526	ND	-	566.02
					3-Sep-20	8.483	ND	-	566.06
					29-Sep-20	8.488	ND	-	566.05
					8-Oct-20	8.350	ND	-	566.19
					22-Feb-21	8.403	ND	-	566.14
MW07	Boundary of the site	WSP, 2020	575.065	13.0	27-Mar-20	12.856	12.845	0.011	562.22
					3-Apr-20	11.435	9.645	1.790	564.97
					16-Apr-20	9.137	ND	-	565.93
					20-Apr-20	9.972	9.798	0.174	565.22
					13-May-20	9.700	9.698	0.002	565.37
					21-May-20	-	-	-	-
					15-Jun-20	9.580	ND	-	565.49
					19-Jun-20	9.400	ND	-	565.67
					23-Jun-20	9.343	ND	-	565.72
					9-Jul-20	9.315	ND	-	565.75
					23-Jul-20	9.268	ND	-	565.80
					29-Jul-20	9.278	ND	-	565.79
					6-Aug-20	9.258	ND	-	565.81
					13-Aug-20	9.185	ND	-	565.88
					20-Aug-20	9.068	ND	-	566.00
					26-Aug-20	9.070	ND	-	566.00
					31-Aug-20	9.000	ND	-	566.07
					3-Sep-20	8.994	ND	-	566.07
					29-Sep-20	9.000	ND	-	566.07
					8-Oct-20	8.850	ND	-	566.22
					22-Feb-21	8.730	ND	-	566.34
MW08	Boundary of the site	WSP, 2020	575.783	15.0	27-Mar-20	-	-	-	-
					3-Apr-20	10.241	ND	-	565.54
					16-Apr-20	10.158	ND	-	565.63
					20-Apr-20	10.143	ND	-	565.64
					13-May-20	10.045	ND	-	565.74
					21-May-20	-	-	-	-
					15-Jun-20	9.913	ND	-	565.87
					23-Jun-20	9.953	ND	-	565.83
					9-Jul-20	9.940	ND	-	565.84
					23-Jul-20	9.911	ND	-	565.87
					29-Jul-20	9.869	ND	-	565.91
					6-Aug-20	9.897	ND	-	565.89
					13-Aug-20	9.787	ND	-	566.00
					20-Aug-20	9.692	ND	-	566.09
					26-Aug-20	9.705	ND	-	566.08
					31-Aug-20	9.664	ND	-	566.12
					3-Sep-20	9.643	ND	-	566.14
					29-Sep-20	9.600	ND	-	566.18
					8-Oct-20	9.455	ND	-	566.33
					22-Feb-21	9.305	ND	-	566.48

Well ID	Location	Installed by and year	T.O.C Elevation (mAHD)	Well Depth (mBTOC)	Gauging Date	Depth to Water (mBTOC)	Depth to Product (mBTOC)	Apparent LNAPL Thickness (m)	Corrected Water Elevation (mAHD)
MW09	Boundary of the site	WSP, 2020	576.630	16.5	27-Mar-20	11.315	11.314	0.001	565.32
					3-Apr-20	11.093	ND	-	565.54
					16-Apr-20	11.020	ND	-	565.61
					20-Apr-20	11.008	ND	-	565.62
					13-May-20	10.903	ND	-	565.73
					21-May-20	-	-	-	-
					15-Jun-20	10.829	ND	-	565.80
					23-Jun-20	10.809	ND	-	565.82
					9-Jul-20	10.795	ND	-	565.84
					23-Jul-20	10.759	ND	-	565.87
					29-Jul-20	10.747	ND	-	565.88
					6-Aug-20	10.797	ND	-	565.83
					13-Aug-20	10.659	ND	-	565.97
					20-Aug-20	10.553	ND	-	566.08
					26-Aug-20	10.555	ND	-	566.08
					31-Aug-20	10.523	ND	-	566.11
					3-Sep-20	10.472	ND	-	566.16
					28-Sep-20	10.448	ND	-	566.18
					8-Oct-20	10.318	ND	-	566.31
					22-Feb-21	10.148	ND	-	566.48
MW10	On-site	WSP, 2020	576.660	14.5	27-Mar-20	12.030	11.410	0.620	565.10
					3-Apr-20	11.284	11.198	0.086	565.44
					16-Apr-20	11.412	ND	-	565.25
					20-Apr-20	11.113	ND	-	565.55
					13-May-20	11.019	11.015	0.004	565.64
					21-May-20	-	-	-	-
					15-Jun-20	10.952	10.940	0.012	565.72
					23-Jun-20	10.913	10.909	0.004	565.75
					30-Jun-20	11.075	11.075	0.000	565.59
					9-Jul-20	10.910	10.890	0.020	565.77
					24-Jul-20	10.879	10.877	0.002	565.78
					28-Jul-20	10.883	10.880	0.003	565.78
					29-Jul-20	10.884	10.864	0.020	565.79
					6-Aug-20	11.045	11.043	0.002	565.62
					13-Aug-20	10.862	ND	-	565.80
					20-Aug-20	10.682	ND	-	565.98
					26-Aug-20	11.815	ND	-	564.85
					3-Sep-20	10.583	ND	-	566.08
					28-Sep-20	10.556	10.553	0.003	566.11
					8-Oct-20	10.440	10.430	0.010	566.23
					24-Feb-21	10.413	ND	-	566.25
MW11	On-site	WSP, 2020	576.830	15.0	27-Mar-20	-	-	-	-
					3-Apr-20	11.250	ND	-	565.58
					16-Apr-20	11.167	ND	-	565.66
					20-Apr-20	11.136	ND	-	565.69
					13-May-20	11.040	ND	-	565.79
					21-May-20	-	-	-	-
					15-Jun-20	10.964	ND	-	565.87
					23-Jun-20	10.937	ND	-	565.89
					9-Jul-20	10.920	ND	-	565.91
					23-Jul-20	10.897	ND	-	565.93
					29-Jul-20	10.899	ND	-	565.93
					6-Aug-20	10.790	ND	-	566.04
					13-Aug-20	10.786	ND	-	566.04
					20-Aug-20	10.678	ND	-	566.15
					26-Aug-20	10.680	ND	-	566.15
					31-Aug-20	10.624	ND	-	566.21
					3-Sep-20	10.577	ND	-	566.25
					28-Sep-20	10.572	ND	-	566.26
					8-Oct-20	10.445	ND	-	566.39
					24-Feb-21	10.261	ND	-	566.57

Ampol Holt (SITE ID: 22546)
Table F2
Groundwater Gauging Data February 2020 - March 2021

Well ID	Location	Installed by and year	T.O.C Elevation (mAHD)	Well Depth (mBTOC)	Gauging Date	Depth to Water (mBTOC)	Depth to Product (mBTOC)	Apparent LNAPL Thickness (m)	Corrected Water Elevation (mAHD)
MW12	Off-site	WSP, 2020	575.736	12.0	3-Apr-20	10.270	10.205	0.065	565.51
					16-Apr-20	10.213	10.111	0.102	565.60
					20-Apr-20	10.199	10.100	0.099	565.61
					13-May-20	10.025	ND	-	565.71
					21-May-20	9.986	9.980	0.006	565.75
					15-Jun-20	9.973	ND	-	565.76
					19-Jun-20	10.013	ND	-	565.72
					23-Jun-20	9.951	ND	-	565.79
					9-Jul-20	9.930	ND	-	565.81
					23-Jul-20	9.902	ND	-	565.83
					29-Jul-20	9.885	ND	-	565.85
					6-Aug-20	9.978	ND	-	565.76
					13-Aug-20	9.789	ND	-	565.95
					20-Aug-20	9.680	ND	-	566.06
					26-Aug-20	9.636	ND	-	566.10
					31-Aug-20	9.602	ND	-	566.13
					3-Sep-20	9.586	ND	-	566.15
					28-Sep-20	9.595	ND	-	566.14
					23-Feb-21	9.323	ND	-	566.41
MW13	Off-site	WSP, 2020	574.771	11.0	3-Apr-20	9.312	ND	-	565.46
					16-Apr-20	9.223	ND	-	565.55
					20-Apr-20	9.217	ND	-	565.55
					13-May-20	9.118	ND	-	565.65
					21-May-20	-	-	-	-
					15-Jun-20	9.062	ND	-	565.71
					23-Jun-20	9.042	ND	-	565.73
					9-Jul-20	9.020	ND	-	565.75
					23-Jul-20	8.988	ND	-	565.78
					29-Jul-20	8.976	ND	-	565.80
					6-Aug-20	9.088	ND	-	565.68
					13-Aug-20	8.881	ND	-	565.89
					20-Aug-20	8.767	ND	-	566.00
					26-Aug-20	8.727	ND	-	566.04
					31-Aug-20	8.689	ND	-	566.08
					3-Sep-20	8.680	ND	-	566.09
					28-Sep-20	8.880	ND	-	565.89
					23-Feb-21	8.406	ND	-	566.37
MW14	Off-site	WSP, 2020	573.838	10.5	3-Apr-20	8.424	ND	-	565.41
					16-Apr-20	8.332	ND	-	565.51
					20-Apr-20	8.323	ND	-	565.52
					13-May-20	8.225	ND	-	565.61
					21-May-20	-	-	-	-
					15-Jun-20	8.169	ND	-	565.67
					23-Jun-20	8.143	ND	-	565.70
					9-Jul-20	8.128	ND	-	565.71
					23-Jul-20	8.101	ND	-	565.74
					29-Jul-20	8.082	ND	-	565.76
					6-Aug-20	8.088	ND	-	565.75
					13-Aug-20	7.974	ND	-	565.86
					20-Aug-20	7.866	ND	-	565.97
					26-Aug-20	7.828	ND	-	566.01
					31-Aug-20	7.785	ND	-	566.05
					3-Sep-20	7.789	ND	-	566.05
					28-Sep-20	7.793	ND	-	566.05
					23-Feb-21	7.506	ND	-	566.33

Ampol Holt (SITE ID: 22546)
Table F2
Groundwater Gauging Data February 2020 - March 2021

Well ID	Location	Installed by and year	T.O.C Elevation (mAHD)	Well Depth (mBTOC)	Gauging Date	Depth to Water (mBTOC)	Depth to Product (mBTOC)	Apparent LNAPL Thickness (m)	Corrected Water Elevation (mAHD)
MW15	Off-site	WSP, 2020	573.518	11.0	3-Apr-20	8.745	7.931	0.814	565.38
					16-Apr-20	8.635	7.848	0.787	565.47
					20-Apr-20	8.610	7.851	0.759	565.48
					13-May-20	8.435	7.785	0.650	565.57
					21-May-20	8.399	7.736	0.663	565.62
					15-Jun-20	8.342	7.741	0.601	565.63
					19-Jun-20	8.363	7.779	0.584	565.59
					23-Jun-20	8.308	7.705	0.603	565.66
					30-Jun-20	8.279	7.695	0.584	565.68
					30-Jun-20	7.942	7.820	0.122	565.67
					30-Jun-20	8.054	8.054	0.000	565.46
					9-Jul-20	7.900	7.830	0.070	565.67
					23-Jul-20	7.802	7.802	0.000	565.72
					28-Jul-20	7.866	7.794	0.072	565.71
					29-Jul-20	7.842	7.783	0.059	565.72
					6-Aug-20	7.849	7.787	0.062	565.72
					13-Aug-20	7.722	7.662	0.060	565.84
					20-Aug-20	7.631	7.552	0.079	565.95
					26-Aug-20	7.587	7.518	0.069	565.98
					31-Aug-20	7.565	7.490	0.075	566.01
					3-Sep-20	7.549	7.485	0.064	566.02
					28-Sep-20	7.578	7.517	0.061	565.99
					8-Oct-20	7.414	7.375	0.039	566.13
					23-Feb-21	7.300	7.235	0.065	566.27
MW16	Off-site	WSP, 2020	573.610	10.5	3-Apr-20	8.245	ND	-	565.37
					16-Apr-20	8.150	ND	-	565.46
					20-Apr-20	8.157	8.155	0.002	565.45
					13-May-20	8.054	ND	-	565.56
					21-May-20	8.017	8.008	0.009	565.60
					15-Jun-20	8.010	8.000	0.010	565.61
					19-Jun-20	8.065	8.025	0.040	565.58
					23-Jun-20	7.998	7.953	0.045	565.65
					30-Jun-20	7.942	7.942	0.000	565.67
					9-Jul-20	8.015	7.852	0.163	565.72
					23-Jul-20	7.925	7.925	0.000	565.69
					28-Jul-20	7.916	7.875	0.041	565.72
					29-Jul-20	7.993	7.900	0.093	565.69
					6-Aug-20	7.979	7.903	0.076	565.69
					13-Aug-20	7.843	7.765	0.078	565.83
					20-Aug-20	7.737	7.564	0.173	566.00
					26-Aug-20	7.705	7.629	0.076	565.96
					31-Aug-20	7.685	7.610	0.075	565.98
					3-Sep-20	7.612	7.604	0.008	566.00
					28-Sep-20	7.691	7.641	0.050	565.96
					8-Oct-20	7.485	ND	-	566.13
					23-Feb-21	7.432	7.361	0.071	566.23
MW17	Off-site	WSP, 2020	573.581	10.0	3-Apr-20	8.213	8.210	0.003	565.37
					16-Apr-20	8.123	ND	-	565.46
					20-Apr-20	8.135	8.133	0.002	565.45
					13-May-20	8.030	ND	-	565.55
					21-May-20	7.987	ND	-	565.59
					15-Jun-20	7.992	ND	-	565.59
					19-Jun-20	8.016	ND	-	565.57
					23-Jun-20	7.937	ND	-	565.64
					30-Jun-20	7.929	ND	-	565.65
					9-Jul-20	7.965	ND	-	565.62
					23-Jul-20	7.933	ND	-	565.65
					29-Jul-20	7.894	ND	-	565.69
					13-Aug-20	7.745	ND	-	565.84
					20-Aug-20	7.644	ND	-	565.94
					26-Aug-20	7.618	ND	-	565.96
					3-Sep-20	7.596	ND	-	565.99
					28-Sep-20	7.627	ND	-	565.95
					8-Oct-20	7.460	ND	-	566.12
					23-Feb-21	7.357	ND	-	566.22

Well ID	Location	Installed by and year	T.O.C Elevation (mAHD)	Well Depth (mBTOC)	Gauging Date	Depth to Water (mBTOC)	Depth to Product (mBTOC)	Apparent LNAPL Thickness (m)	Corrected Water Elevation (mAHD)
MW18	Off-site	WSP, 2020	573.520	11.0	3-Apr-20	-	-	-	-
					16-Apr-20	8.091	ND	-	565.43
					20-Apr-20	8.080	ND	-	565.44
					13-May-20	7.981	ND	-	565.54
					21-May-20	-	-	-	-
					15-Jun-20	7.918	ND	-	565.60
					23-Jun-20	7.853	ND	-	565.67
					9-Jul-20	7.870	ND	-	565.65
					23-Jul-20	7.856	ND	-	565.66
					29-Jul-20	7.836	ND	-	565.68
					6-Aug-20	7.817	ND	-	565.70
					13-Aug-20	7.696	ND	-	565.82
					20-Aug-20	7.584	ND	-	565.94
					26-Aug-20	7.606	ND	-	565.91
					31-Aug-20	7.535	ND	-	565.99
					3-Sep-20	7.533	ND	-	565.99
					28-Sep-20	7.551	ND	-	565.97
					23-Feb-21	7.287	ND	-	566.23
MW19	Off-site	WSP, 2020	574.102	12.0	3-Apr-20	-	-	-	-
					16-Apr-20	8.559	ND	-	565.54
					20-Apr-20	8.555	ND	-	565.55
					13-May-20	8.450	ND	-	565.65
					21-May-20	-	-	-	-
					15-Jun-20	8.391	ND	-	565.71
					23-Jun-20	8.359	ND	-	565.74
					9-Jul-20	8.358	ND	-	565.74
					23-Jul-20	8.329	ND	-	565.77
					29-Jul-20	8.311	ND	-	565.79
					6-Aug-20	8.314	ND	-	565.79
					13-Aug-20	8.189	ND	-	565.91
					20-Aug-20	8.088	ND	-	566.01
					26-Aug-20	8.065	ND	-	566.04
					31-Aug-20	8.065	ND	-	566.04
					3-Sep-20	8.015	ND	-	566.09
					28-Sep-20	7.997	ND	-	566.11
					22-Feb-21	7.461	ND	-	566.64
MW20	Off-site	WSP, 2020	574.919	12.0	3-Apr-20	9.360	ND	-	565.56
					16-Apr-20	9.277	ND	-	565.64
					20-Apr-20	9.263	ND	-	565.66
					13-May-20	9.165	ND	-	565.75
					21-May-20	-	-	-	-
					15-Jun-20	9.094	ND	-	565.83
					23-Jun-20	9.066	ND	-	565.85
					9-Jul-20	9.058	ND	-	565.86
					23-Jul-20	9.022	ND	-	565.90
					29-Jul-20	9.018	ND	-	565.90
					6-Aug-20	9.017	ND	-	565.90
					13-Aug-20	8.908	ND	-	566.01
					20-Aug-20	8.813	ND	-	566.11
					26-Aug-20	8.814	ND	-	566.11
					31-Aug-20	8.776	ND	-	566.14
					3-Sep-20	8.743	ND	-	566.18
					28-Sep-20	8.703	ND	-	566.22
					22-Feb-21	8.428	ND	-	566.49

Well ID	Location	Installed by and year	T.O.C Elevation (mAHD)	Well Depth (mBTOC)	Gauging Date	Depth to Water (mBTOC)	Depth to Product (mBTOC)	Apparent LNAPL Thickness (m)	Corrected Water Elevation (mAHD)
MW21	Off-site	WSP, 2020	575.515	12.0	3-Apr-20	10.002	ND	-	565.51
					16-Apr-20	9.922	ND	-	565.59
					20-Apr-20	9.913	ND	-	565.60
					13-May-20	9.811	ND	-	565.70
					21-May-20	9.767	ND	-	565.75
					15-Jun-20	9.703	ND	-	565.81
					23-Jun-20	9.708	ND	-	565.81
					9-Jul-20	9.701	ND	-	565.81
					23-Jul-20	9.661	ND	-	565.85
					29-Jul-20	9.662	ND	-	565.85
					6-Aug-20	9.659	ND	-	565.86
					13-Aug-20	9.565	ND	-	565.95
					20-Aug-20	9.464	ND	-	566.05
					26-Aug-20	9.483	ND	-	566.03
					31-Aug-20	9.420	ND	-	566.10
					3-Sep-20	9.375	ND	-	566.14
					28-Sep-20	9.359	ND	-	566.16
					22-Feb-21	9.054	ND	-	566.46
MW23	Off-site	WSP, 2020	576.391	12.9	3-Apr-20	-	-	-	-
					16-Apr-20	10.768	ND	-	565.62
					20-Apr-20	10.756	ND	-	565.64
					13-May-20	10.665	ND	-	565.73
					21-May-20	-	-	-	-
					15-Jun-20	10.571	ND	-	565.82
					23-Jun-20	10.545	ND	-	565.85
					9-Jul-20	10.540	ND	-	565.85
					23-Jul-20	10.496	ND	-	565.90
					13-Aug-20	10.376	ND	-	566.02
					20-Aug-20	10.263	ND	-	566.13
					26-Aug-20	10.303	ND	-	566.09
					31-Aug-20	10.250	ND	-	566.14
					3-Sep-20	10.232	ND	-	566.16
					28-Sep-20	10.208	ND	-	566.18
					23-Feb-21	9.905	ND	-	566.49
MW24	Off-site	WSP, 2020	576.706	15.0	3-Apr-20	-	-	-	-
					16-Apr-20	11.023	ND	-	565.68
					20-Apr-20	11.011	ND	-	565.70
					13-May-20	10.915	ND	-	565.79
					21-May-20	10.867	ND	-	565.84
					15-Jun-20	10.830	ND	-	565.88
					19-Jun-20	10.857	ND	-	565.85
					23-Jun-20	10.809	ND	-	565.90
					9-Jul-20	10.795	ND	-	565.91
					23-Jul-20	10.757	ND	-	565.95
					13-Aug-20	10.668	ND	-	566.04
					20-Aug-20	10.571	ND	-	566.14
					26-Aug-20	10.544	ND	-	566.16
					31-Aug-20	10.525	ND	-	566.18
					3-Sep-20	10.478	ND	-	566.23
					28-Sep-20	10.464	ND	-	566.24
					23-Feb-21	10.165	ND	-	566.54

Ampol Holt (SITE ID: 22546)
Table F2
Groundwater Gauging Data February 2020 - March 2021

Well ID	Location	Installed by and year	T.O.C Elevation (mAHD)	Well Depth (mBTOC)	Gauging Date	Depth to Water (mBTOC)	Depth to Product (mBTOC)	Apparent LNAPL Thickness (m)	Corrected Water Elevation (mAHD)
MW25	Off-site	WSP, 2020	576.938	15.0	3-Apr-20	-	-	-	-
					16-Apr-20	10.885	ND	-	566.05
					20-Apr-20	10.863	ND	-	566.08
					13-May-20	10.775	ND	-	566.16
					21-May-20				
					15-Jun-20	10.991	ND	-	565.95
					23-Jun-20	10.656	ND	-	566.28
					9-Jul-20	10.644	ND	-	566.29
					23-Jul-20	10.602	ND	-	566.34
					13-Aug-20	10.531	ND	-	566.41
					20-Aug-20	10.427	ND	-	566.51
					26-Aug-20	10.415	ND	-	566.52
					31-Aug-20	10.350	ND	-	566.59
					3-Sep-20	10.327	ND	-	566.61
					28-Sep-20	10.301	ND	-	566.64
					23-Feb-21	9.972	ND	-	566.97
RW01	On-site: tank pit recovery well	WSP, 2020	575.061	4.0	3-Apr-20	-	-	-	-
					16-Apr-20	-	-	-	-
					20-Apr-20	2.590	ND	-	572.47
					13-May-20	2.600	ND	-	572.46
					21-May-20	-	-	-	-
					15-Jun-20	2.787	ND	-	572.27
					23-Jun-20	-	-	-	-
					9-Jul-20	3.540	ND	-	571.52
					23-Jul-20	3.848	ND	-	571.21
					6-Aug-20	3.915	ND	-	571.15
					13-Aug-20	3.915	ND	-	571.15
					20-Aug-20	3.915	ND	-	571.15
					26-Aug-20	3.915	ND	-	571.15
					3-Sep-20	2.731	ND	-	572.33
					29-Sep-20	2.736	ND	-	572.33
					24-Feb-21	2.513	ND	-	572.55
S2-P1	Off-site	WSP, 2020	577.142	13.1	28-Sep-20	9.610	ND	-	567.532
					23-Feb-21	9.138	ND	-	568.004
S2-P2	Off-site	WSP, 2020	572.976	9.8	28-Sep-20	6.953	ND	-	566.023
					23-Feb-21	6.683	ND	-	566.293
S2-P3	Off-site	WSP, 2020	572.297	10.4	28-Sep-20	6.331	ND	-	565.966
					23-Feb-21	6.081	ND	-	566.216
S2-P4	Off-site	WSP, 2020	571.941	10.5	28-Sep-20	6.042	ND	-	565.899
					23-Feb-21	5.816	ND	-	566.125
S2-P5	Off-site	WSP, 2020	570.151	8.9	28-Sep-20	4.333	ND	-	565.818
					22-Feb-21	4.120	ND	-	566.031
S2-P5B	Off-site	WSP, 2020	570.015	6.0	14-Oct-20	4.110	ND	-	565.905
					22-Feb-21	4.025	ND	-	565.990
S2-P6	Off-site	WSP, 2020	568.759	9.1	28-Sep-20	2.930	ND	-	565.829
					22-Feb-21	2.728	ND	-	566.031
S2-P6B	Off-site	WSP, 2020	568.826	5.0	14-Oct-20	2.884	ND	-	565.942
					22-Feb-21	2.819	ND	-	566.007
S2-P7	Off-site	WSP, 2020	566.756	8.3	28-Sep-20	2.246	ND	-	564.510
					22-Feb-21	2.002	ND	-	564.754
S2-P8	Off-site	WSP, 2020	570.842	10.0	28-Sep-20	4.914	ND	-	565.928
					23-Feb-21	4.722	ND	-	566.120
S2-P9B	Off-site	WSP, 2020	571.830	9.6	28-Sep-20	5.904	ND	-	565.926
					23-Feb-21	5.665	ND	-	566.165
S2-P10	Off-site	WSP, 2020	573.360	10.6	28-Sep-20	7.379	ND	-	565.981
					23-Feb-21	7.112	ND	-	566.248
S2-P11	Off-site	WSP, 2020	573.588	11.9	28-Sep-20	7.432	ND	-	566.156
					23-Feb-21	7.142	ND	-	566.446
S2-P12	Off-site	WSP, 2020	574.490	10.6	28-Sep-20	8.303	ND	-	566.187
					23-Feb-21	8.004	ND	-	566.486

Well ID	Location	Installed by and year	T.O.C Elevation (mAHD)	Well Depth (mBTOC)	Gauging Date	Depth to Water (mBTOC)	Depth to Product (mBTOC)	Apparent LNAPL Thickness (m)	Corrected Water Elevation (mAHD)
S2-C1	Off-site	WSP, 2020	577.536	13.3	28-Sep-20	9.486	ND	-	568.050
					23-Feb-21	8.924	ND	-	568.612
S2-C2	Off-site	WSP, 2020	571.152	11.1	28-Sep-20	5.715	ND	-	565.437
					23-Feb-21	5.539	ND	-	565.613
S2-C3	Off-site	WSP, 2020	567.357	7.5	28-Sep-20	1.775	ND	-	565.582
					22-Feb-21	1.597	ND	-	565.760
S2-C4	Off-site	WSP, 2020	567.174	7.0	28-Sep-20	1.646	ND	-	565.528
					22-Feb-21	1.346	ND	-	565.828
S2-C5	Off-site	WSP, 2020	571.168	9.8	28-Sep-20	5.298	ND	-	565.870
					22-Feb-21	5.074	ND	-	566.094
S2-C6	Off-site	WSP, 2020	571.702	8.8	28-Sep-20	5.872	ND	-	565.830
					23-Feb-21	5.631	ND	-	566.071
S2-C7	Off-site	WSP, 2020	572.669	10.4	28-Sep-20	6.511	ND	-	566.158
					23-Feb-21	6.219	ND	-	566.450
S2-C8	Off-site	WSP, 2020	573.074	10.5	28-Sep-20	6.700	ND	-	566.374
					23-Feb-21	6.298	ND	-	566.776
S2-C9	Off-site	WSP, 2020	574.135	11.8	28-Sep-20	7.374	ND	-	566.761
					23-Feb-21	7.121	ND	-	567.014
S2-C10	Off-site	WSP, 2020	582.161	18.2	28-Sep-20	15.822	ND	-	566.339
					23-Feb-21	15.408	ND	-	566.753
S2-R1	Off-site	WSP, 2020	570.415	6.5	18-Nov-20	4.193	ND	-	566.222
					24-Feb-21	4.391	ND	-	566.024
S2-R2	Off-site	WSP, 2020	570.854	6.4	18-Nov-20	4.091	ND	-	566.763
					24-Feb-21	4.147	ND	-	566.707
S2-R3	Off-site	WSP, 2020	571.308	6.5	18-Nov-20	3.832	ND	-	567.476
					24-Feb-21	4.005	ND	-	567.303
S2-R4	Off-site	WSP, 2020	571.551	7.6	18-Nov-20	3.432	ND	-	568.119
					24-Feb-21	3.498	ND	-	568.053
S2-R5	Off-site	WSP, 2020	571.900	8.3	18-Nov-20	3.749	ND	-	568.151
					24-Feb-21	3.813	ND	-	568.087
S2-R6	Off-site	WSP, 2020	572.223	8.0	18-Nov-20	4.945	ND	-	567.278
					24-Feb-21	4.998	ND	-	567.225
IW1	On-site remediation well	WSP, 2020	574.858	13.0	29-Sep-20	8.911	ND	-	565.947
					24-Feb-21	8.475	ND	-	566.383
IW2	On-site remediation well	WSP, 2020	575.584	11.7	29-Sep-20	9.471	ND	-	566.113
					8-Oct-20	9.340	ND	-	566.244
					24-Feb-21	9.125	ND	-	566.459
IW3	On-site remediation well	WSP, 2020	596.073	14.0	29-Sep-20	10.774	ND	-	585.299
					8-Oct-20	10.613	ND	-	585.460
					24-Feb-21	10.342	ND	-	585.731
PEW1	On-site remediation well	WSP, 2020	574.814	12.4	29-Sep-20	8.757	ND	-	566.057
					8-Oct-20	8.640	ND	-	566.174
					24-Feb-21	8.498	ND	-	566.316
PMW1	On-site remediation well	WSP, 2020	574.804	12.3	28-Sep-20	8.751	8.747	0.004	566.056
					8-Oct-20	8.620	ND	-	566.184
					24-Feb-21	8.476	ND	-	566.328
PMW2	On-site remediation well	WSP, 2020	574.499	12.1	28-Sep-20	8.467	ND	-	566.032
					8-Oct-20	8.330	ND	-	566.169
					24-Feb-21	8.192	ND	-	566.307
PMW3	On-site remediation	WSP, 2020	573.785	11.8	29-Sep-20	7.757	ND	-	566.028
					23-Feb-21	7.505	ND	-	566.280
PMW4	On-site remediation well	WSP, 2020	574.576	12.0	29-Sep-20	8.521	ND	-	566.055
					8-Oct-20	8.398	ND	-	566.178
					24-Feb-21	8.253	ND	-	566.323
S2-D1	Off-site diamond core	WSP, 2020	-	11.6	29-Sep-20	7.545	ND	-	-
					23-Feb-21	7.267	ND	-	-
S2-D2	Off-site diamond core	WSP, 2020	-	13.8	29-Sep-20	8.540	ND	-	-
					22-Feb-21	8.254	ND	-	-

Notes:
ND - not detected
Corrected groundwater elevation calculated using an LNAPL density of 0.75 kg/m^3 as follows
Corrected groundwater elevation = (T.O.C. Elevation - Depth to Water)+((Depth to Water - Depth to Product)*0.75)

Ampol Holt (SITE ID: 22546)
Table F3
Utility Pit Monitoring Data

ID	Asset	Location	Accessible	PID (ppm)					Comment
				15-Apr-20	21-May-20	9-Jul-20	17-Sep-20	23-Feb-21	
UP01	Stormwater	N side Hardwick Cres (northern loop)	Y	0.0	0.0	0.0	0.0	0.0	Flows into Ginninderra Creek
UP02	Hydrant	N side Hardwick Cres (northern loop)	Y	-	-	-	0.0	0.0	
UP03	Sewer	N side Hardwick Cres (northern loop)	Y	-	-	-	0.0	0.0	
UP04	Comms	N side Hardwick Cres (northern loop)	Y	0.0	0.2	0.6	0.0	0.0	Telstra
UP05	HV/Comms	N side Hardwick Cres (northern loop)	Y	0.0	0.0	0.1	0.0	0.0	PMG
UP06	Hydrant	N side Hardwick Cres (northern loop)	Y	-	-	-	0.0	0.0	
UP07	Sullage Valve	N side Hardwick Cres (northern loop)	Y	-	-	-	0.0	0.0	
UP08	Stormwater	N side Hardwick Cres (northern loop)	Y	0.0	0.1	0.0	0.0	0.1	
UP09	HV/Comms	E side Flack St	Y	0.0	0.0	0.0	0.0	0.0	PMG
UP10	Comms	E side Flack St	Y	0.0	0.0	0.1	0.0	0.0	Telstra
UP11	Comms	E side Flack St	Y	0.0	0.0	0.2	0.0	0.0	Telstra
UP12	Comms	S side of Hardwick Cres (southern loop)	Y	0.0	0.1	0.0	0.0	0.0	
UP13	Stormwater	S side of Hardwick Cres (southern loop)	Y	0.0	0.1	0.0	0.0	0.0	
UP14	Gas	S side of Hardwick Cres (southern loop)	N	-	-	-	-	-	
UP15	Stormwater	S side of Hardwick Cres (southern loop)	Y	0.0	0.0	0.0	0.0	0.0	
UP16	Stormwater	N side of Hardwick Cres (southern loop)	Y	0.0	0.0	0.0	0.0	0.0	
UP17	Hydrant	N side of Hardwick Cres (southern loop)	Y	-	-	-	0.1	0.0	
UP18	Water	N side of Hardwick Cres (southern loop)	N	-	-	-	-	-	Redundant
UP19	Sullage Valve	N side of Hardwick Cres (southern loop)	Y	-	-	-	0.0	0.0	
UP20	Hydrant	N side of Hardwick Cres (southern loop)	Y	-	-	-	0.0	0.0	
UP21	Water Metre	W side Flack St	Y	0.0	0.0	0.0	0.0	0.0	
UP22	Sullage Valve	W side Flack St	N	-	-	-	-	-	
UP23	Hydrant	W side Flack St	Y	-	-	-	0.0	0.0	
UP24	Stormwater	W side Flack St	Y	0.0	0.0	0.1	0.0	0.0	
UP25	Unknown	W side Flack St	Y	-	-	-	0.0	0.0	Redundant - backfilled with soil
UP26	Stormwater	S side Hardwick Cres (northern loop)	Y	0.0	0.0	0.0	0.0	0.0	
UP27	Unknown	S side Hardwick Cres (northern loop)	Y	0.0	0.0	0.0	0.0	0.0	Likely comms
UP28	Stormwater	S side Hardwick Cres (northern loop)	N	-	-	0.0	-	-	Inspection cover
UP29	Comms	S side Hardwick Cres (northern loop)	Y	0.0	0.1	0.1	0.0	0.0	Telstra
UP30	Sewer	S side Hardwick Cres (northern loop)	N	-	-	-	-	-	
UP31	Sewer	S side Hardwick Cres (northern loop)	N	-	-	-	-	-	
UP32	Stormwater	S side Hardwick Cres (northern loop)	Y	0.0	0.0	0.0	0.0	0.0	
UP33	Comms	N side of Hardwick Cres (southern loop)	Y	-	0.0	0.0	0.0	0.0	Telstra

Caltex Holt (SITE ID: 22546)
Table F4
Stage 2 ESA - Soil Analytical Results

							TRH							BTEX							PAH	Soil Properties
							C6-C10 (F1)	C6-C10 (F1 minus BTEX)	C10-C16 (F2)	C10-C16 (F2 minus Naphthalene)	C16-C34 (F3)	C34-C40 (F4)	C10-C40 (Sum of total)	Benzene	Toluene	Ethylbenzene	Xylene (m & p)	Xylene (o)	Xylene Total	Total BTEX	Naphthalene	% Moisture
							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							10	10	25	25	90	100	50	0.1	0.1	0.1	0.2	0.1	0.3	0.2	0.1	0.1
CRC Care 2011 Table 4 HSL-A Low Density Residential (Direct Contact) [2]							-	4,400	3,300	-	4,500	6,300	-	100	14,000	4,500	-	-	12,000	-	1,400	-
CRC Care 2011 Table 4 HSL-C Recreational/Open Space (Direct Contact) [2]								5,100	3,800		5,300	7,400		120	18,000	5,300			15,000		1,900	
CRC Care 2011 Table 4 HSL-D Commercial / Industrial (Direct Contact) [2]							-	26,000	20,000	-	27,000	38,000	-	430	99,000	27,000	-	-	81,000	-	11,000	-
CRC Care 2011 Table B4 Intrusive Maintenance Worker (Direct Contact) [2]							-	82,000	62,000	-	85,000	120,000	-	1,100	120,000	85,000	-	-	130,000	-	29,000	-
CRC Care 2011 Table B3 Intrusive Workers, Sand [2]																						
0-2m							-	NL	-	NL	-	-	-	77	NL	NL	-	-	NL	-	NL	-
2-4m							-	NL	-	NL	-	-	-	160	NL	NL	-	-	NL	-	NL	-
>=4m							-	NL	-	NL	-	-	-	NL	NL	NL	-	-	NL	-	NL	-
NEPM 2013 Table 1A(3) Res A/B Soil HSL for Vapour Intrusion, Sand [1]																						
0-1m							-	45	-	110	-	-	-	0.5	160	55	-	-	40	-	3	-
1-2m							-	70	-	240	-	-	-	0.5	220	NL	-	-	60	-	NL	-
2-4m							-	110	-	440	-	-	-	0.5	310	NL	-	-	95	-	NL	-
>=4m							-	200	-	NL	-	-	-	0.5	540	NL	-	-	170	-	NL	-
NEPM 2013 Table 1A(3) Rec C Soil HSL for Vapour Intrusion, Sand [1]																						
0-1m							-	NL	-	NL	-	-	-	NL	NL	NL	-	-	NL	-	NL	-
1-2m							-	NL	-	NL	-	-	-	NL	NL	NL	-	-	NL	-	NL	-
2-4m							-	NL	-	NL	-	-	-	NL	NL	NL	-	-	NL	-	NL	-
>=4m							-	NL	-	NL	-	-	-	NL	NL	NL	-	-	NL	-	NL	-
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand [1]																						
0-1m							-	260	-	NL	-	-	-	3	NL	NL	-	-	230	-	3	-
1-2m							-	370	-	NL	-	-	-	3	NL	NL	-	-	NL	-	NL	-
2-4m							-	630	-	NL	-	-	-	3	NL	NL	-	-	NL	-	NL	-
>=4m							-	NL	-	NL	-	-	-	3	NL	NL	-	-	NL	-	NL	-
Location	**Landuse**	**Sample ID**	**Sample Date**	**Lab report**	**Depth (m)**	**PID (ppm)**																
S2-C1	Comm/Ind	S2-C1_0.5	9/16/2020	SE211260	0.4 - 0.5	0.4	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	11.0
		S2-C1_1.0	9/16/2020	SE211260	0.9 - 1	0.5	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	29.0
		S2-C1_2.0	9/18/2020	SE211427	1.9 - 2	0.2	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	18.6
		S2-C1_3.0	9/18/2020	SE211427	2.9 - 3	0.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	14.2
		S2-C1_4.0	9/18/2020	SE211427	3.9 - 4	0.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	9.5
		S2-C1_5.0	9/18/2020	SE211427	4.9 - 5	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	9.3
		S2-C1_6.0	9/18/2020	SE211427	5.9 - 6	0.2	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	9.6
		S2-C1_7.0	9/18/2020	SE211427	6.9 - 7	0.2	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	7.6
		S2-C1_8.0	9/18/2020	SE211427	7.9 - 8	0.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	11.7
		S2-C1_9.0	9/18/2020	SE211427	8.9 - 9	0.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	13.0
		S2-C1_10.0	9/18/2020	SE211427	9.9 - 10	0.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	9.9
		S2-C1_11.0	9/18/2020	SE211427	10.9 - 11	0.2	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	6.8
		S2-C1_12.0	9/18/2020	SE211427	11.9 - 12	0.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	22.8
		S2-C1_13.0	9/18/2020	SE211427	12.9 - 13	0.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	18.5
		S2-QA12	9/18/2020	SE211427	2.9 - 3	0.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	17.0
		S2-QA12A	9/18/2020	ES2033394	2.9 - 3	0.1	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<1	16.9
		S2-QA13	9/18/2020	SE211427	6.9 - 7	0.2	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	5.8
		S2-QA13A	9/18/2020	ES2033394	6.9 - 7	0.2	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<1	5.9
S2-C2	Comm/Ind	S2-C2_0.5	9/15/2020	SE211260	0.4 - 0.5	0.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	18.2
		S2-C2_1.0	9/15/2020	SE211260	0.9 - 1	0.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	16.8
		S2-C2_2.0	9/15/2020	SE211260	1.9 - 2	0.6	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	7.0
		S2-C2_4.0	9/15/2020	SE211260	3.9 - 4	0.2	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	7.4
		S2-C2_6.0	9/15/2020	SE211260	5.9 - 6	0.3	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	9.5
		S2-C2_8.0	9/15/2020	SE211260	7.9 - 8	0.4	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	6.8
		S2-C2_10.0	9/15/2020	SE211260	0.9 - 10	0.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	2.2
		S2-C2_12.0	9/16/2020	SE211260	11.9 - 12	0.5	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	3.2
S2-C3	Open space	S2-C3_0.1	9/14/2020	SE211260	0 - 0.1	0.8	<25	<25	<25	<25	<90	<120	<210	<0.1	0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	7.9
		S2-C3_0.5	9/14/2020	SE211260	0.4 - 0.5	1.0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	14.7
		S2-C3_1.0	9/14/2020	SE211260	0.9 - 1	1.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	18.7
		S2-C3_2.0	9/15/2020	SE211260	1.9 - 2	0.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	15.7
		S2-C3_4.0	9/15/2020	SE211260	3.9 - 4	0.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	5.9
		S2-C3_6.0	9/15/2020	SE211260	5.9 - 6	0.2	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	3.7
		S2-C3_7.0	9/15/2020	SE211260	6.9 - 7	0.3	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	10.1
		S2-QA10	9/15/2020	SE211260	6.9 - 7	0.3	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	10.3
		S2-QA10A	9/15/2020	SE211260	6.9 - 7	0.3	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<1	8.7
S2-C4	Open space	S2-C4_0.1	9/14/2020	SE211260	0 - 0.1	0.9	<25	<25	<25	<25	<90	<120	<210	<0.1	0.6	<0.1	<0.2	<0.1	<0.3	0.6	<0.1	16.7
		S2-C4_0.5	9/14/2020	SE211260	0.4 - 0.5	1.0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	24.0
		S2-C4_1.0	9/14/2020	SE211260	0.9 - 1	0.9	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	17.7
		S2-C4_2.0	9/15/2020	SE211260	1.9 - 2	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	8.7
		S2-C4_4.0	9/15/2020	SE211260	3.9 - 4	0.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	2.5
		S2-C4_6.0	9/15/2020	SE211260	5.9 - 6	0.2	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	10.2
S2-C5	Comm/Ind	S2-C5_1.0	9/11/2020	SE211260	0.9 - 1	0.6	<25	<25	<25	<25	<90	<120	<210	<0.1	0.2	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	16.5
		S2-C5_2.0	9/14/2020	SE211260	1.9 - 2	2.5	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	18.7
		S2-C5_4.0	9/14/2020	SE211260	3.9 - 4	2.9	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	9.7
		S2-C5_6.0	9/14/2020	SE211260	5.9 - 6	3.4	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	7.8
		S2-C5_8.0	9/14/2020	SE211260	7.9 - 8	4.7	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	11.7
		S2-C5_10.0	9/14/2020	SE211260	9.9 - 10	3.3	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	18.3

Caltex Holt (SITE ID: 22546)
Table F4
Stage 2 ESA - Soil Analytical Results

							TRH							BTEX							PAH	Soil Properties
							C6-C10 (F1)	C6-C10 (F1 minus BTEX)	C10-C16 (F2)	C10-C16 (F2 minus Naphthalene)	C16-C34 (F3)	C34-C40 (F4)	C10-C40 (Sum of total)	Benzene	Toluene	Ethylbenzene	Xylene (m & p)	Xylene (o)	Xylene Total	Total BTEX	Naphthalene	% Moisture
							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							10	10	25	25	90	100	50	0.1	0.1	0.1	0.2	0.1	0.3	0.2	0.1	0.1
CRC Care 2011 Table 4 HSL-A Low Density Residential (Direct Contact) [2]							-	4,400	3,300	-	4,500	6,300	-	100	14,000	4,500	-	-	12,000	-	1,400	-
CRC Care 2011 Table 4 HSL-C Recreational/Open Space (Direct Contact) [2]								5,100	3,800		5,300	7,400		120	18,000	5,300			15,000		1,900	
CRC Care 2011 Table 4 HSL-D Commercial / Industrial (Direct Contact) [2]							-	26,000	20,000	-	27,000	38,000	-	430	99,000	27,000	-	-	81,000	-	11,000	-
CRC Care 2011 Table B4 Intrusive Maintenance Worker (Direct Contact) [2]							-	82,000	62,000	-	85,000	120,000	-	1,100	120,000	85,000	-	-	130,000	-	29,000	-
CRC Care 2011 Table B3 Intrusive Workers, Sand [2]																						
0-2m							-	NL	-	NL	-	-	-	77	NL	NL	-	-	NL	-	NL	-
2-4m							-	NL	-	NL	-	-	-	160	NL	NL	-	-	NL	-	NL	-
>=4m							-	NL	-	NL	-	-	-	NL	NL	NL	-	-	NL	-	NL	-
NEPM 2013 Table 1A(3) Res A/B Soil HSL for Vapour Intrusion, Sand [1]																						
0-1m							-	45	-	110	-	-	-	0.5	160	55	-	-	40	-	3	-
1-2m							-	70	-	240	-	-	-	0.5	220	NL	-	-	60	-	NL	-
2-4m							-	110	-	440	-	-	-	0.5	310	NL	-	-	95	-	NL	-
>=4m							-	200	-	NL	-	-	-	0.5	540	NL	-	-	170	-	NL	-
NEPM 2013 Table 1A(3) Rec C Soil HSL for Vapour Intrusion, Sand [1]																						
0-1m							-	NL	-	NL	-	-	-	NL	NL	NL	-	-	NL	-	NL	-
1-2m							-	NL	-	NL	-	-	-	NL	NL	NL	-	-	NL	-	NL	-
2-4m							-	NL	-	NL	-	-	-	NL	NL	NL	-	-	NL	-	NL	-
>=4m							-	NL	-	NL	-	-	-	NL	NL	NL	-	-	NL	-	NL	-
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand [1]																						
0-1m							-	260	-	NL	-	-	-	3	NL	NL	-	-	230	-	3	-
1-2m							-	370	-	NL	-	-	-	3	NL	NL	-	-	NL	-	NL	-
2-4m							-	630	-	NL	-	-	-	3	NL	NL	-	-	NL	-	NL	-
>=4m							-	NL	-	NL	-	-	-	3	NL	NL	-	-	NL	-	NL	-
Location	**Landuse**	**Sample ID**	**Sample Date**	**Lab report**	**Depth (m)**	**PID (ppm)**																
S2-C6	Comm/Ind	S2-C6_0.5	9/10/2020	SE211058	0.4 - 0.5	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	16.8
		S2-C6_1.0	9/10/2020	SE211058	0.9 - 1	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	26.9
		S2-C6_2.0	9/14/2020	SE211260	1.9 - 2	1.6	<25	<25	<25	<25	<90	<120	<210	<0.1	0.3	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	20.4
		S2-C6_4.0	9/14/2020	SE211260	3.9 - 4	2.0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	4.6
		S2-C6_6.0	9/14/2020	SE211260	5.9 - 6	1.8	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	6.7
		S2-C6_8.0	9/14/2020	SE211260	7.9 - 8	2.2	<25	<25	<25	<25	<90	<120	<210	<0.1	0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	16.2
		S2-C6_9.0	9/14/2020	SE211260	8.9 - 9	2.1	<25	<25	<25	<25	<90	<120	<210	<0.1	0.2	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	17.0
		S2-C6_10.0	9/14/2020	SE211260	9.9 - 10	1.9	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	17.3
		S2-QA8	9/14/2020	SE211260	8.9 - 9	2.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	17.4
		S2-QA8A	9/14/2020	ES2032830	8.9 - 9	2.1	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<1	16.4
S2-C7	Comm/Ind	S2-C7_0.5	9/10/2020	SE211058	0.4 - 0.5	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	8.6
		S2-C7_1.0	9/10/2020	SE211058	0.9 - 1	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	22.9
		S2-C7_2.0	9/10/2020	SE211058	1.9 - 2	0.3	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	6.2
		S2-C7_3.0	9/10/2020	SE211058	2.9 - 3	0.5	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	2.4
		S2-C7_4.0	9/10/2020	SE211058	3.9 - 4	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	3.5
		S2-C7_5.0	9/10/2020	SE211058	4.9 - 5	1.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	7.0
		S2-C7_6.0	9/10/2020	SE211058	5.9 - 6	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	3.7
		S2-C7_7.0	9/10/2020	SE211058	6.9 - 7	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	17.5
		S2-C7_8.0	9/10/2020	SE211058	7.9 - 8	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	2.7
		S2-C7_9.0	9/10/2020	SE211058	8.9 - 9	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	16.9
		S2-C7_10.0	9/10/2020	SE211058	9.9 - 10	0.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	8.2
		S2-C7_10.5	9/10/2020	SE211058	10.4 - 10.5	1.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	14.5
		S2-QA5	9/10/2020	SE211058	9.9 - 10	0.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	5.9
		S2-QA5A	9/10/2020	ES2032304	9.9 - 10	0.1	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<1	9.9
S2-C8	Comm/Ind	S2-C8_0.5	9/16/2020	SE211260	0.4 - 0.5	0.2	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	13.5
		S2-C8_1.0	9/16/2020	SE211260	0.9 - 1	0.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	15.5
		S2-C8_2.0	9/17/2020	SE211427	1.9 - 2	0.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	4.0
		S2-C8_3.0	9/17/2020	SE211427	2.9 - 3	0.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	3.8
		S2-C8_4.0	9/17/2020	SE211427	3.9 - 4	0.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	3.8
		S2-C8_5.0	9/17/2020	SE211427	4.9 - 5	0.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	3.1
		S2-QA11	9/17/2020	SE211427	4.9 - 5	0.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	3.2
		S2-QA11A	9/17/2020	ES2033394	4.9 - 5	0.1	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<1	2.8
S2-C9	Comm/Ind	S2-C9_1.0	9/16/2020	SE211260	0.9 - 1	0.3	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	19.3
		S2-C9_2.0	9/17/2020	SE211427	1.9 - 2	1.5	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	5.5
		S2-C9_3.0	9/17/2020	SE211427	2.9 - 3	1.7	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	5.0
		S2-C9_4.0	9/17/2020	SE211427	3.9 - 4	1.9	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	4.8
S2-C10	Comm/Ind	S2-C10_1.0	9/16/2020	SE211260	0.9 - 1	0.5	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	26.3
		S2-C10_2.0	9/18/2020	SE211427	1.9 - 2	0.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	8.0
		S2-C10_3.0	9/18/2020	SE211427	2.9 - 3	0.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	7.1
		S2-C10_4.0	9/18/2020	SE211427	3.9 - 4	0.4	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	6.2
		S2-C10_5.0	9/18/2020	SE211427	4.9 - 5	0.2	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	5.4
		S2-C10_6.0	9/18/2020	SE211427	5.9 - 6	0.2	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	4.8
		S2-C10_7.0	9/18/2020	SE211427	6.9 - 7	0.2	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	5.3
		S2-C10_8.0	9/18/2020	SE211427	7.9 - 8	0.3	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	4.7
		S2-C10_9.0	9/18/2020	SE211427	8.9 - 9	0.3	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	3.9
		S2-C10_10.0	9/18/2020	SE211427	9.9 - 10	0.2	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	3.8
		S2-C10_11.0	9/18/2020	SE211427	10.9 - 11	0.3	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	3.7
		S2-C10_12.0	9/18/2020	SE211427	11.9 - 12	0.3	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	3.7
		S2-QA14	9/18/2020	SE211427	3.9 - 4	0.4	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<1	6.0
		S2-QA14A	9/18/2020	ES2033394	3.9 - 4	0.4	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<0.1	7.0
		S2-QA15	9/18/2020	SE211427	10.9 - 11	0.3	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	3.5
		S2-QA15A	9/18/2020	ES2033394	10.9 - 11	0.3	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<1	2.8
S2-D2	Comm/Ind	S2-D2_0.2	9/10/2020	SE211058	0.1 - 0.2	-	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	7.4
		S2-D2_0.5	9/10/2020	SE211058	0.4 - 0.5	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	20.5
		S2-D2_1.0	9/10/2020	SE211058	0.9 - 1	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	20.2

Caltex Holt (SITE ID: 22546)
Table F4
Stage 2 ESA - Soil Analytical Results

							TRH							BTEX							PAH	Soil Properties
							C6-C10 (F1)	C6-C10 (F1 minus BTEX)	C10-C16 (F2)	C10-C16 (F2 minus Naphthalene)	C16-C34 (F3)	C34-C40 (F4)	C10-C40 (Sum of total)	Benzene	Toluene	Ethylbenzene	Xylene (m & p)	Xylene (o)	Xylene Total	Total BTEX	Naphthalene	% Moisture
							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							10	10	25	25	90	100	50	0.1	0.1	0.1	0.2	0.1	0.3	0.2	0.1	0.1
CRC Care 2011 Table 4 HSL-A Low Density Residential (Direct Contact) [2]							-	4,400	3,300	-	4,500	6,300	-	100	14,000	4,500	-	-	12,000	-	1,400	-
CRC Care 2011 Table 4 HSL-C Recreational/Open Space (Direct Contact) [2]								5,100	3,800		5,300	7,400		120	18,000	5,300			15,000		1,900	
CRC Care 2011 Table 4 HSL-D Commercial / Industrial (Direct Contact) [2]							-	26,000	20,000	-	27,000	38,000	-	430	99,000	27,000	-	-	81,000	-	11,000	-
CRC Care 2011 Table B4 Intrusive Maintenance Worker (Direct Contact) [2]							-	82,000	62,000	-	85,000	120,000	-	1,100	120,000	85,000	-	-	130,000	-	29,000	-
CRC Care 2011 Table B3 Intrusive Workers, Sand [2]																						
0-2m							-	NL	-	NL	-	-	-	77	NL	NL	-	-	NL	-	NL	-
2-4m							-	NL	-	NL	-	-	-	160	NL	NL	-	-	NL	-	NL	-
>=4m							-	NL	-	NL	-	-	-	NL	NL	NL	-	-	NL	-	NL	-
NEPM 2013 Table 1A(3) Res A/B Soil HSL for Vapour Intrusion, Sand [1]																						
0-1m							-	45	-	110	-	-	-	0.5	160	55	-	-	40	-	3	-
1-2m							-	70	-	240	-	-	-	0.5	220	NL	-	-	60	-	NL	-
2-4m							-	110	-	440	-	-	-	0.5	310	NL	-	-	95	-	NL	-
>=4m							-	200	-	NL	-	-	-	0.5	540	NL	-	-	170	-	NL	-
NEPM 2013 Table 1A(3) Rec C Soil HSL for Vapour Intrusion, Sand [1]																						
0-1m							-	NL	-	NL	-	-	-	NL	NL	NL	-	-	NL	-	NL	-
1-2m							-	NL	-	NL	-	-	-	NL	NL	NL	-	-	NL	-	NL	-
2-4m							-	NL	-	NL	-	-	-	NL	NL	NL	-	-	NL	-	NL	-
>=4m							-	NL	-	NL	-	-	-	NL	NL	NL	-	-	NL	-	NL	-
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand [1]																						
0-1m							-	260	-	NL	-	-	-	3	NL	NL	-	-	230	-	3	-
1-2m							-	370	-	NL	-	-	-	3	NL	NL	-	-	NL	-	NL	-
2-4m							-	630	-	NL	-	-	-	3	NL	NL	-	-	NL	-	NL	-
>=4m							-	NL	-	NL	-	-	-	3	NL	NL	-	-	NL	-	NL	-
Location	**Landuse**	**Sample ID**	**Sample Date**	**Lab report**	**Depth (m)**	**PID (ppm)**																
S2-P1	Residential	S2-P1_0.5	9/7/2020	SE211012	0.4 - 0.5	1.4	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	23.4
		S2-P1_1.0	9/7/2020	SE211012	0.9 - 1	1.8	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	10.5
		S2-P1_2.0	9/11/2020	SE211260	1.9 - 2	0.2	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	9.1
		S2-P1_4.0	9/11/2020	SE211260	3.9 - 4	0.7	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	7.4
		S2-P1_6.0	9/11/2020	SE211260	5.9 - 6	0.5	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	6.0
		S2-P1_8.0	9/11/2020	SE211260	7.9 - 8	0.7	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	4.8
		S2-P1_10.0	9/11/2020	SE211260	9.9 - 10	0.8	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	7.7
		S2-P1_12.0	9/11/2020	SE211260	11.9 - 12	0.7	<25	<25	<25	<25	<90	<120	<210	<0.1	0.6	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	7.3
		S2-QA7	9/11/2020	SE211260	5.9 - 6	0.5	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	5.5
		S2-QA7A	9/11/2020	ES2032830	5.9 - 6	0.5	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<1	7.8
S2-P2	Comm/Ind	S2-P2_0.5	9/7/2020	SE211012	0.4 - 0.5	1.3	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	11.2
		S2-P2_1.0	9/7/2020	SE211012	0.9 - 1	0.4	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	12.7
		S2-P2_2.0	9/9/2020	SE211058	1.9 - 2	0.5	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	6.0
		S2-P2_3.0	9/9/2020	SE211058	2.9 - 3	2.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	6.0
		S2-P2_4.0	9/9/2020	SE211058	3.9 - 4	5.6	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	4.8
		S2-P2_5.0	9/9/2020	SE211058	4.9 - 5	4.8	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	3.8
		S2-P2_6.0	9/9/2020	SE211058	5.9 - 6	3.8	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	3.8
		S2-P2_7.0	9/9/2020	SE211058	6.9 - 7	726	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	0.1	4.4
		S2-P2_8.0	9/9/2020	SE211058	7.9 - 8	1159	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	0.2	1.1	0.6	1.7	1.9	0.7	5.5
		S2-P2_9.0	9/9/2020	SE211058	8.9 - 9	1679	<250	<250	<25	<25	<90	<120	<210	<1	25	4.1	15	5.1	20	49	<1	10.9
		S2-P2_10.0	9/9/2020	SE211058	9.9 - 10	10.5	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	3.5
S2-P3	Comm/Ind	S2-P3_0.5	9/7/2020	SE211012	0.4 - 0.5	1.8	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	13.3
		S2-P3_1.0	9/7/2020	SE211012	0.9 - 1	1.4	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	20.0
		S2-P3_2.0	9/9/2020	SE211058	1.9 - 2	0.7	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	15.7
		S2-P3_3.0	9/9/2020	SE211058	2.9 - 3	0.5	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	4.4
		S2-P3_4.0	9/9/2020	SE211058	3.9 - 4	0.3	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	4.3
		S2-P3_5.0	9/9/2020	SE211058	4.9 - 5	0.6	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	3.9
		S2-P3_6.0	9/9/2020	SE211058	5.9 - 6	0.7	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	4.4
		S2-P3_7.0	9/9/2020	SE211058	6.9 - 7	1.6	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	4.0
		S2-P3_8.0	9/9/2020	SE211058	7.9 - 8	2.0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	5.5
		S2-P3_9.0	9/9/2020	SE211058	8.9 - 9	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	6.2
		S2-P3_10.0	9/9/2020	SE211058	9.9 - 10	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	4.2
		S2-QA4	9/9/2020	SE211058	3.9 - 4	0.3	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	4.0
		S2-QA4A	9/9/2020	ES2032304	3.9 - 4	0.3	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<1	3.5
S2-P4	Residential	S2-P4_0.5	9/7/2020	SE211012	0.4 - 0.5	0.9	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	15.8
		S2-P4_1.0	9/7/2020	SE211012	0.9 - 1	1.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	16.7
		S2-P4_2.0	9/8/2020	SE211058	1.9 - 2	0.3	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	15.7
		S2-P4_3.0	9/8/2020	SE211058	2.9 - 3	0.2	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	16.9
		S2-P4_4.0	9/8/2020	SE211058	3.9 - 4	0.2	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	4.9
		S2-P4_5.0	9/8/2020	SE211058	4.9 - 5	0.3	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	3.6
		S2-P4_6.0	9/8/2020	SE211058	5.9 - 6	0.2	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	8.4
		S2-P4_7.0	9/8/2020	SE211058	6.9 - 7	0.3	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	5.7
		S2-P4_8.0	9/8/2020	SE211058	7.9 - 8	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	7.3
		S2-P4_9.0	9/8/2020	SE211058	8.9 - 9	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	5.2
		S2-P4_10.0	9/8/2020	SE211058	9.9 - 10	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	15.1
S2-P5	Residential	S2-P5_0.1	8/31/2020	SE210753	0 - 0.1	0	<25	<25	88	88	250	<120	330	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	17.3
		S2-P5_0.5	8/31/2020	SE210753	0.4 - 0.5	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	14.9
		S2-P5_1.0	8/31/2020	SE210753	0.9 - 1	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	13.4
		S2-P5_2.0	9/8/2020	SE211012	1.9 - 2	0.3	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	12.3
		S2-P5_3.0	9/8/2020	SE211012	2.9 - 3	0.7	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	10.0
		S2-P5_4.0	9/8/2020	SE211012	3.9 - 4	0.6	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	8.9
		S2-P5_5.0	9/8/2020	SE211012	4.9 - 5	0.4	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	4.7
		S2-P5_6.0	9/8/2020	SE211012	5.9 - 6	0.3	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	3.3
		S2-P5_7.0	9/8/2020	SE211012	6.9 - 7	0.2	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	4.0
		S2-P5_8.0	9/8/2020	SE211012	7.9 - 8	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	3.8
		S2-P5_9.0	9/7/2020	SE211012	8.9 - 9	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	13.5
S2-P5b	Residential	S2-P5b_0.2	10/7/2020	SE212161	0 - 0.2	0.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	15.2
		S2-P5b_0.5	10/7/2020	SE212161	0.4 - 0.5	0.2	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	11.7
		S2-P5b_1.0	10/7/2020	SE212161	0.9 - 1	0.6	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	11.4
		S2-P5b_2.0	10/7/2020	SE212161	1.9 - 2	0.3	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	20.5
		S2-P5b_3.0	10/7/2020	SE212161	2.9 - 2	0.3	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	10.7
		S2-P5b_4.0	10/7/2020	SE212161	3.9 - 4	0.4	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	7.3
		S2-P5b_5.0	10/7/2020	SE212161	4.9 - 5	0.4	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	6.8
		S2-P5b_6.0	10/7/2020	SE212161	5.9 - 6	0.5	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	5.7

Caltex Holt (SITE ID: 22546)
Table F4
Stage 2 ESA - Soil Analytical Results

							TRH							BTEX							PAH	Soil Properties
							C6-C10 (F1)	C6-C10 (F1 minus BTEX)	C10-C16 (F2)	C10-C16 (F2 minus Naphthalene)	C16-C34 (F3)	C34-C40 (F4)	C10-C40 (Sum of total)	Benzene	Toluene	Ethylbenzene	Xylene (m & p)	Xylene (o)	Xylene Total	Total BTEX	Naphthalene	% Moisture
							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							10	10	25	25	90	100	50	0.1	0.1	0.1	0.2	0.1	0.3	0.2	0.1	0.1
CRC Care 2011 Table 4 HSL-A Low Density Residential (Direct Contact) [2]							-	4,400	3,300	-	4,500	6,300	-	100	14,000	4,500	-	-	12,000	-	1,400	-
CRC Care 2011 Table 4 HSL-C Recreational/Open Space (Direct Contact) [2]								5,100	3,800		5,300	7,400		120	18,000	5,300			15,000		1,900	
CRC Care 2011 Table 4 HSL-D Commercial / Industrial (Direct Contact) [2]							-	26,000	20,000	-	27,000	38,000	-	430	99,000	27,000	-	-	81,000	-	11,000	-
CRC Care 2011 Table B4 Intrusive Maintenance Worker (Direct Contact) [2]							-	82,000	62,000	-	85,000	120,000	-	1,100	120,000	85,000	-	-	130,000	-	29,000	-
CRC Care 2011 Table B3 Intrusive Workers, Sand [2]																						
0-2m							-	NL	-	NL	-	-	-	77	NL	NL	-	-	NL	-	NL	-
2-4m							-	NL	-	NL	-	-	-	160	NL	NL	-	-	NL	-	NL	-
>=4m							-	NL	-	NL	-	-	-	NL	NL	NL	-	-	NL	-	NL	-
NEPM 2013 Table 1A(3) Res A/B Soil HSL for Vapour Intrusion, Sand [1]																						
0-1m							-	45	-	110	-	-	-	0.5	160	55	-	-	40	-	3	-
1-2m							-	70	-	240	-	-	-	0.5	220	NL	-	-	60	-	NL	-
2-4m							-	110	-	440	-	-	-	0.5	310	NL	-	-	95	-	NL	-
>=4m							-	200	-	NL	-	-	-	0.5	540	NL	-	-	170	-	NL	-
NEPM 2013 Table 1A(3) Rec C Soil HSL for Vapour Intrusion, Sand [1]																						
0-1m							-	NL	-	NL	-	-	-	NL	NL	NL	-	-	NL	-	NL	-
1-2m							-	NL	-	NL	-	-	-	NL	NL	NL	-	-	NL	-	NL	-
2-4m							-	NL	-	NL	-	-	-	NL	NL	NL	-	-	NL	-	NL	-
>=4m							-	NL	-	NL	-	-	-	NL	NL	NL	-	-	NL	-	NL	-
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand [1]																						
0-1m							-	260	-	NL	-	-	-	3	NL	NL	-	-	230	-	3	-
1-2m							-	370	-	NL	-	-	-	3	NL	NL	-	-	NL	-	NL	-
2-4m							-	630	-	NL	-	-	-	3	NL	NL	-	-	NL	-	NL	-
>=4m							-	NL	-	NL	-	-	-	3	NL	NL	-	-	NL	-	NL	-
Location	**Landuse**	**Sample ID**	**Sample Date**	**Lab report**	**Depth (m)**	**PID (ppm)**																
S2-P6	Residential	S2-P6_0.1	8/31/2020	SE210753	0 - 0.1	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	21.3
		S2-P6_0.5	8/31/2020	SE210753	0.4 - 0.5	-	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	17.0
		S2-P6_2.0	8/31/2020	SE210753	1.9 - 2	5.2	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	12.2
		S2-P6_3.0	9/1/2020	SE210753	2.9 - 3	33	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	5.9
		S2-P6_4.0	9/1/2020	SE210753	3.9 - 4	5.7	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	5.7
		S2-P6_5.0	9/1/2020	SE210753	4.9 - 5	3.0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	3.0
		S2-P6_6.0	9/1/2020	SE210753	5.9 - 6	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	2.2
		S2-P6_7.0	9/1/2020	SE210753	6.9 - 7	0.2	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	1.9
		S2-P6_8.0	9/1/2020	SE210753	7.9 - 8	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	10.9
		S2-P6_9.0	9/1/2020	SE210753	8.9 - 9	0.3	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	6.8
		S2-QA1	9/1/2020	SE210753	7.9 - 8	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	12.3
		S2-QA1A	9/1/2020	ES2031253	7.9 - 8	0	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<1	11.1
S2-P6b	Residential	S2-P6b_0.2	10/7/2020	SE212161	0 - 0.2	0.4	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	15.7
		S2-P6b_0.5	10/7/2020	SE212161	0.4 - 0.5	0.3	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	9.8
		S2-P6b_1.0	10/7/2020	SE212161	0.9 - 1	0.5	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	13.4
		S2-P6b_2.0	10/7/2020	SE212161	1.9 - 2	0.2	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	7.8
		S2-P6b_3.0	10/7/2020	SE212161	2.9 - 3	0.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	15.0
		S2-P6b_4.0	10/7/2020	SE212161	3.9 - 4	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	6.5
		S2-P6b_5.0	10/7/2020	SE212161	4.9 - 5	0.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	9.8
		S2-QA16	10/7/2020	SE212161	2.9 - 3	0.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	15.0
		S2-QA16A	10/7/2020	ES2035641	2.9 - 3	0.1	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<1	12.9
S2-P7	Open space	S2-P7_0.1	8/31/2020	SE210753	0 - 0.1	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	19.7
		S2-P7_0.5	8/31/2020	SE210753	0.4 - 0.5	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	17.6
		S2-P7_1.0	8/31/2020	SE210753	0.9 - 1	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	17.6
		S2-P7_2.0	9/1/2020	SE210753	1.9 - 2	0.6	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	11.7
		S2-P7_3.0	9/1/2020	SE210753	2.9 - 3	0.7	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	15.3
		S2-P7_4.0	9/1/2020	SE210753	3.9 - 4	1.2	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	6.8
		S2-P7_5.0	9/1/2020	SE210753	4.9 - 5	2.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	6.3
		S2-P7_6.0	9/1/2020	SE210753	5.9 - 6	3.0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	2.8
		S2-P7_7.0	9/1/2020	SE210753	6.9 - 7	2.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	3.8
		S2-P7_8.0	9/1/2020	SE210753	7.9 - 8	-	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	16.8
S2-P8	Comm/Ind	S2-P8_0.2	9/1/2020	SE210753	0.1 - 0.2	0.2	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	17.6
		S2-P8_0.5	9/1/2020	SE210753	0.4 - 0.5	1.4	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	15.9
		S2-P8_1.0	9/1/2020	SE210753	0.9 - 1	1.6	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	23.7
		S2-P8_2.0	9/7/2020	SE211012	1.9 - 2	0.3	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	9.2
		S2-P8_3.0	9/7/2020	SE211012	2.9 - 3	0.8	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	9.7
		S2-P8_4.0	9/7/2020	SE211012	3.9 - 4	0.4	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	9.4
		S2-P8_5.0	9/7/2020	SE211012	4.9 - 5	0.3	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	8.2
		S2-P8_6.0	9/7/2020	SE211012	5.9 - 6	0.8	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	7.3
		S2-P8_7.0	9/7/2020	SE211012	6.9 - 7	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	6.8
		S2-P8_7.6	9/7/2020	SE211012	7.5 - 7.6	0.2	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	8.8
		S2-P8_8.5	9/7/2020	SE211012	8.4 - 8.5	0.2	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	6.5
		S2-P8_9.5	9/7/2020	SE211012	9.4 - 9.5	0.8	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	13.9
		S2-QA3	9/7/2020	SE211012	6.9 - 7	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	8.7
		S2-QA3A	9/7/2020	ES2032170	6.9 - 7	0	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<1	7.9
S2-P9a	Comm/Ind	S2-P9A_0.2	9/1/2020	SE210753	0.1 - 0.2	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	3.1
		S2-P9A_0.5	9/1/2020	SE210753	0.4 - 0.5	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	25.1
		S2-P9A_1.0	9/1/2020	SE210753	0.9 - 1	0.4	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	22.6
		S2-P9A_2.0	9/1/2020	SE210753	1.9 - 2	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	8.3
		S2-P9A_3.0	9/1/2020	SE210753	2.9 - 3	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	4.7
		S2-P9A_4.0	9/1/2020	SE210753	3.9 - 4	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	5.9
		S2-P9A_5.0	9/1/2020	SE210753	4.9 - 5	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	5.4
		S2-P9A_6.0	9/1/2020	SE210753	5.9 - 6	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	6.4
		S2-P9A_7.0	9/1/2020	SE210753	6.9 - 7	0.7	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	7.4
		S2-P9A_8.0	9/1/2020	SE210753	7.9 - 8	0.9	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	5.1
		S2-P9A_8.4	9/1/2020	SE210753	8.3 - 8.4	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	6.4
		S2-P9A_10.0	9/1/2020	SE210753	9.9 - 10	0.5	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	9.2
		S2-P9A_10.5	9/1/2020	SE210753	10.4 - 10.5	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	3.3
		S2-P9A_11.0	9/1/2020	SE210753	10.9 - 11	0.4	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	10.7

Caltex Holt (SITE ID: 22546)
Table F4
Stage 2 ESA - Soil Analytical Results

							TRH							BTEX							PAH	Soil Properties
							C6-C10 (F1)	C6-C10 (F1 minus BTEX)	C10-C16 (F2)	C10-C16 (F2 minus Naphthalene)	C16-C34 (F3)	C34-C40 (F4)	C10-C40 (Sum of total)	Benzene	Toluene	Ethylbenzene	Xylene (m & p)	Xylene (o)	Xylene Total	Total BTEX	Naphthalene	% Moisture
							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							10	10	25	25	90	100	50	0.1	0.1	0.1	0.2	0.1	0.3	0.2	0.1	0.1
CRC Care 2011 Table 4 HSL-A Low Density Residential (Direct Contact) [2]							-	4,400	3,300	-	4,500	6,300	-	100	14,000	4,500	-	-	12,000	-	1,400	-
CRC Care 2011 Table 4 HSL-C Recreational/Open Space (Direct Contact) [2]								5,100	3,800		5,300	7,400		120	18,000	5,300			15,000		1,900	
CRC Care 2011 Table 4 HSL-D Commercial / Industrial (Direct Contact) [2]							-	26,000	20,000	-	27,000	38,000	-	430	99,000	27,000	-	-	81,000	-	11,000	-
CRC Care 2011 Table B4 Intrusive Maintenance Worker (Direct Contact) [2]							-	82,000	62,000	-	85,000	120,000	-	1,100	120,000	85,000	-	-	130,000	-	29,000	-
CRC Care 2011 Table B3 Intrusive Workers, Sand [2]																						
0-2m							-	NL	-	NL	-	-	-	77	NL	NL	-	-	NL	-	NL	-
2-4m							-	NL	-	NL	-	-	-	160	NL	NL	-	-	NL	-	NL	-
>=4m							-	NL	-	NL	-	-	-	NL	NL	NL	-	-	NL	-	NL	-
NEPM 2013 Table 1A(3) Res A/B Soil HSL for Vapour Intrusion, Sand [1]																						
0-1m							-	45	-	110	-	-	-	0.5	160	55	-	-	40	-	3	-
1-2m							-	70	-	240	-	-	-	0.5	220	NL	-	-	60	-	NL	-
2-4m							-	110	-	440	-	-	-	0.5	310	NL	-	-	95	-	NL	-
>=4m							-	200	-	NL	-	-	-	0.5	540	NL	-	-	170	-	NL	-
NEPM 2013 Table 1A(3) Rec C Soil HSL for Vapour Intrusion, Sand [1]																						
0-1m							-	NL	-	NL	-	-	-	NL	NL	NL	-	-	NL	-	NL	-
1-2m							-	NL	-	NL	-	-	-	NL	NL	NL	-	-	NL	-	NL	-
2-4m							-	NL	-	NL	-	-	-	NL	NL	NL	-	-	NL	-	NL	-
>=4m							-	NL	-	NL	-	-	-	NL	NL	NL	-	-	NL	-	NL	-
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand [1]																						
0-1m							-	260	-	NL	-	-	-	3	NL	NL	-	-	230	-	3	-
1-2m							-	370	-	NL	-	-	-	3	NL	NL	-	-	NL	-	NL	-
2-4m							-	630	-	NL	-	-	-	3	NL	NL	-	-	NL	-	NL	-
>=4m							-	NL	-	NL	-	-	-	3	NL	NL	-	-	NL	-	NL	-
Location	**Landuse**	**Sample ID**	**Sample Date**	**Lab report**	**Depth (m)**	**PID (ppm)**																
S2-P9b	Comm/Ind	S2-P9B_1.0	9/11/2020	SE211260	0.9 - 1	0.5	<25	<25	<25	<25	<90	<120	<210	<0.1	0.2	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	20.3
		S2-P9B_2.0	9/14/2020	SE211260	1.9 - 2	1.4	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	8.8
		S2-P9B_4.0	9/14/2020	SE211260	3.9 - 4	1.7	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	5.9
		S2-P9B_6.0	9/14/2020	SE211260	5.9 - 6	1.7	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	6.6
		S2-P9B_8.0	9/14/2020	SE211260	7.9 - 8	2.7	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	7.0
		S2-P9B_9.5	9/14/2020	SE211260	9.4 - 9.5	1.2	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	17.4
		S2-QA9	9/14/2020	SE211260	3.9 - 4	1.7	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	6.1
		S2-QA9A	9/14/2020	ES2032830	3.9 - 4	1.7	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<1	5.7
S2-P10	Comm/Ind	S2-P10_0.3	9/1/2020	SE210753	0.2 - 0.3	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	13.1
		S2-P10_0.5	9/1/2020	SE210753	0.4 - 0.5	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	10.0
		S2-P10_1.0	9/7/2020	SE211012	0.9 - 1	1.2	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	27.0
		S2-P10_2.0	9/7/2020	SE211012	1.9 - 2	0.2	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	13.5
		S2-P10_3.0	9/7/2020	SE211012	2.9 - 3	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	4.8
		S2-P10_4.0	9/7/2020	SE211012	3.9 - 4	0.2	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	5.2
		S2-P10_5.0	9/7/2020	SE211012	4.9 - 5	3.7	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	5.5
		S2-P10_6.0	9/7/2020	SE211012	5.9 - 6	3.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	4.8
		S2-P10_7.0	9/7/2020	SE211012	6.9 - 7	0.3	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	4.8
		S2-P10_8.0	9/7/2020	SE211012	7.9 - 8	66	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	3.8
		S2-P10_9.0	9/7/2020	SE211012	8.9 - 9	175	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	4.4
		S2-P10_9.5	9/7/2020	SE211012	9.4 - 9.5	1.3	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	6.3
		S2-P10_10.5	9/7/2020	SE211012	10.4 - 10.5	13.6	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	4.5
		S2-QA2	9/7/2020	SE211012	8.9 - 9	175	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	4.0
		S2-QA2A	9/7/2020	ES2032170	8.9 - 9	175	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<1	4.0
S2-P11	Comm/Ind	S2-P11_0.5	9/7/2020	SE211012	0.4 - 0.5	3.3	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	18.2
		S2-P11_1.0	9/7/2020	SE211012	0.9 - 1	3.7	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	15.0
		S2-P11_2.0	9/10/2020	SE211058	1.9 - 2	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	4.3
		S2-P11_3.0	9/10/2020	SE211058	2.9 - 3	0.7	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	6.2
		S2-P11_4.0	9/10/2020	SE211058	3.9 - 4	0.6	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	7.3
		S2-P11_5.0	9/10/2020	SE211058	4.9 - 5	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	2.6
		S2-P11_6.0	9/10/2020	SE211058	5.9 - 6	0.9	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	2.1
		S2-P11_7.0	9/10/2020	SE211058	6.9 - 7	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	1.8
		S2-P11_8.0	9/10/2020	SE211058	7.9 - 8	1.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	3.4
		S2-P11_10.0	9/10/2020	SE211260	9.9 - 10	0	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	3.5
S2-P12	Comm/Ind	S2-P12_0.5	9/7/2020	SE211012	0.4 - 0.5	3.2	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	14.2
		S2-P12_1.0	9/7/2020	SE211012	0.9 - 1	3.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	19.4
		S2-P12_2.0	9/11/2020	SE211260	1.9 - 2	0.6	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	10.3
		S2-P12_3.0	9/11/2020	SE211260	2.9 - 3	0.9	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	3.9
		S2-P12_5.0	9/11/2020	SE211260	4.9 - 5	1.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	5.2
		S2-P12_7.0	9/11/2020	SE211260	6.9 - 7	1.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	5.5
		S2-P12_9.0	9/11/2020	SE211260	8.9 - 9	1.6	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	5.8
		S2-QA6	9/11/2020	SE211260	4.9 - 5	1.1	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.6	<0.1	4.6
		S2-QA6A	9/11/2020	ES2032830	4.9 - 5	1.1	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<1	4.6

Notes:
Concentration expressed in mg/kg unless otherwise stated
[1] NEPM (2013) – Schedule B-1 Investigation Levels for Soil and Groundwater – Table 1A(3) Soil HSLs for vapour intrusion
[2] CRC CARE (2011) Technical Report No. 10 – Table B1 Soil vapour health screening levels
EQL - Estimated Quantitation Limit
NL - non limiting
Dash (-) denotes no criteria available

Concentration exceeding CRC Care 2011 Table 4 HSL-A Residential (Direct Contact)
Concentration exceeding CRC Care 2011 Table 4 HSL-C Recreational/Open Space (Direct Contact)
Concentrations exceeding CRC Care 2011 Table 4 HSL-D Commercial / Industrial (Direct Contact)
Concentrations exceeding CRC Care 2011 Table B4 Intrusive Maintenance Worker (Direct Contact)
Concentrations exceeding CRC Care 2011 Table B3 Intrusive Workers, Sand
Concentrations exceeding NEPM 2013 Table 1A(3) Res A Soil HSL for Vapour Intrusion, Sand
Concentrations exceeding NEPM 2013 Table 1A(3) Rec C Soil HSL for Vapour Intrusion, Sand
Concentrations exceeding NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand

Caltex Holt (SITE ID: 22546)
Table F5
Stage 2 ESA - Waste Classification Results

				Metals								TRH							TPH											
				Arsenic	Cadmium	Chromium (III+VI)	Copper	Lead	Mercury	Nickel	Zinc	C6-C10 (F1)	C6-C10 (F1 minus BTEX)	C10-C16 (F2)	C10-C16 (F2 minus Naphthalene)	C16-C34 (F3)	C34-C40 (F4)	C10-C40 (Sum of total)	TRH C37-C40	C6-C9	C10-C14	C15-C28	C29-C36	C10-C36 (Sum of total)	Benzene	Toluene	Ethylbenzene	Xylene (m & p)	Xylene (o)	Xylene Total
				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				1	0.3	0.5	0.5	1	0.05	0.5	2	25	25	25	25	90	120	210	100	20	20	45	45	110	0.1	0.1	0.1	0.2	0.1	0.3
NSW 2014 General Solid Waste CT1 (No Leaching)				100	20	100	-	100	4	40	-	-	-	-	-	-	-	-	-	650	-	-	-	10,000	10	288	600	-	-	1,000
NSW 2014 Restricted Solid Waste CT2 (No Leaching)				400	80	400	-	400	16	160	-	-	-	-	-	-	-	-	-	2,600	-	-	-	40,000	40	1,152	2,400	-	-	4,000
Field ID	**Date**	**Depth (m)**	**Lab Report**																											
S2-WC01	9/17/2020	0.3	SE211427	5	<0.3	9.5	47	29	<0.05	8.6	80	<25	<25	<25	<25	<90	<120	<210	<100	<20	<20	<45	<45	<110	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3
S2-WC02	9/17/2020	0.3	SE211427	5	<0.3	11	8.4	42	<0.05	6.1	41	<25	<25	<25	<25	<90	<120	<210	<100	<20	<20	<45	<45	<110	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3
S2-WC03	9/17/2020	0.3	SE211427	6	<0.3	15	6.4	44	<0.05	5.9	41	<25	<25	<25	<25	<90	<120	<210	<100	<20	<20	<45	<45	<110	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3
S2-WC04	9/17/2020	0.3	SE211427	8	<0.3	39	13	20	<0.05	15	64	<25	<25	<25	<25	<90	<120	<210	<100	<20	<20	<45	<45	<110	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3
S2-WC05	9/17/2020	0.3	SE211427	6	<0.3	20	8.9	9	<0.05	15	63	<25	<25	<25	<25	<90	<120	<210	<100	<20	<20	<45	<45	<110	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3
S2-WC06	9/17/2020	0.3	SE211427	7	<0.3	29	10	15	<0.05	13	84	<25	<25	<25	<25	<90	<120	<210	<100	<20	<20	<45	<45	<110	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3
S2-WC-DUP01	9/17/2020	0.3	SE211427	7	0.4	9.7	8.1	67	<0.05	7.2	120	<25	<25	<25	<25	<90	<120	<210	<100	<20	<20	<45	<45	<110	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3

				PAH																			Halogenated Benzenes	PCBs			Pesticides			Soil Properties
				1-Methylnaphthalene	2-methylnaphthalene	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a) pyrene	Benzo(g,h,i)perylene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	Naphthalene	Phenanthrene	Pyrene	Benzo(a)pyrene TEQ calc (Zero)	PAHs (Sum of total)	PAHs (Sum of positives)	Hexachlorobenzene	Arochlor 1268	Arodor 1262	PCBs (Sum of total)	Isodrin	Mirex	Parathion	% Moisture
				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				0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.8	0.8	0.1	0.2	0.2	1	0.1	0.1	0.2	1
NSW 2014 General Solid Waste CT1 (No Leaching)				-	-	-	-	-	-	0.8	-	-	-	-	-	-	-	-	-	-	200	200	-	-	-	50	-	-	-	-
NSW 2014 Restricted Solid Waste CT2 (No Leaching)				-	-	-	-	-	-	3.2	-	-	-	-	-	-	-	-	-	-	800	800	-	-	-	50	-	-	-	-
Field ID	**Date**	**Depth (m)**	**Lab Report**																											
S2-WC01	9/17/2020	0.3	SE211427	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.8	<0.8	<0.1	<0.2	<0.2	<1	<0.1	<0.1	<0.2	17.1
S2-WC02	9/17/2020	0.3	SE211427	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.8	<0.8	<0.1	<0.2	<0.2	<1	<0.1	<0.1	<0.2	16.2
S2-WC03	9/17/2020	0.3	SE211427	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.8	<0.8	<0.1	<0.2	<0.2	<1	<0.1	<0.1	<0.2	14.8
S2-WC04	9/17/2020	0.3	SE211427	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.8	<0.8	<0.1	<0.2	<0.2	<1	<0.1	<0.1	<0.2	7.5
S2-WC05	9/17/2020	0.3	SE211427	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.8	<0.8	<0.1	<0.2	<0.2	<1	<0.1	<0.1	<0.2	2.2
S2-WC06	9/17/2020	0.3	SE211427	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.8	<0.8	<0.1	<0.2	<0.2	<1	<0.1	<0.1	<0.2	12.8
S2-WC-DUP01	9/17/2020	0.3	SE211427	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.8	<0.8	<0.1	<0.2	<0.2	<1	<0.1	<0.1	<0.2	14.1

				Organophosphorous Pesticides									Organochlorine Pesticides																			
				Azinophos methyl	Bromophos-ethyl	Chlorpyrifos	Diazinon	Dichlorvos	Dimethoate	Ethion	Malathion	Methidathion	2,4-DDT	a-BHC	Aldrin	b-BHC	Chlordane (cis)	Chlordane (technical)	d-BHC	DDD	DDT	Dieldrin	Endosulfan I	Endosulfan II	Endosulfan sulphate	Endrin	Endrin aldehyde	g-BHC (Lindane)	Heptachlor	Heptachlor epoxide	Methoxychlor	o,p- DDD	o,p'-DDE	trans-Nonachlor
				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	µg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL				0.2	0.2	0.2	0.5	0.5	0.5	0.2	0.2	0.5	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.2	100	0.1	0.1	0.1	0.1	0.1	0.1	0.1
NSW 2014 General Solid Waste CT1 (No Leaching)				-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	60	60	60	-	-	-	-	-	-	-	-	-
NSW 2014 Restricted Solid Waste CT2 (No Leaching)				-	-	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	240	240	240	-	-	-	-	-	-	-	-	-
Field ID	**Date**	**Depth (m)**	**Lab Report**																															
S2-WC01	9/17/2020	0.3	SE211427	<0.2	<0.2	<0.2	<0.5	<0.5	<0.5	<0.2	<0.2	<0.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.2	<0.2	<0.1	<0.2	<100	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
S2-WC02	9/17/2020	0.3	SE211427	<0.2	<0.2	<0.2	<0.5	<0.5	<0.5	<0.2	<0.2	<0.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.2	<0.2	<0.1	<0.2	<100	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
S2-WC03	9/17/2020	0.3	SE211427	<0.2	<0.2	<0.2	<0.5	<0.5	<0.5	<0.2	<0.2	<0.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.2	<0.2	<0.1	<0.2	<100	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
S2-WC04	9/17/2020	0.3	SE211427	<0.2	<0.2	<0.2	<0.5	<0.5	<0.5	<0.2	<0.2	<0.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.2	<0.2	<0.1	<0.2	<100	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
S2-WC05	9/17/2020	0.3	SE211427	<0.2	<0.2	<0.2	<0.5	<0.5	<0.5	<0.2	<0.2	<0.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.2	<0.2	<0.1	<0.2	<100	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
S2-WC06	9/17/2020	0.3	SE211427	<0.2	<0.2	<0.2	<0.5	<0.5	<0.5	<0.2	<0.2	<0.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.2	<0.2	<0.1	<0.2	<100	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
S2-WC-DUP01	9/17/2020	0.3	SE211427	<0.2	<0.2	<0.2	<0.5	<0.5	<0.5	<0.2	<0.2	<0.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.2	<0.2	<0.1	<0.2	<100	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Notes:
Concentration expressed in mg/kg unless otherwise stated
(1) NSW EPA (2014) Waste Classification Guidelines, Part 1: Classifying waste - Table 1: CT1 & CT2 values for classifying waste by chemical assessment without theTCLP test
EQL - Estimated Quantitation Limit
Dash (-) denotes no criteria available
Concentration exceeding NSW 2014 General Solid Waste CT1 (No Leaching)
Concentrations exceeding NSW 2014 Restricted Solid Waste CT2 (No Leaching)

Ampol Holt (SITE ID: 22546)
Table F6
Groundwater Analytical Results
February 2021 GME

PS123812

						TRH							BTEXN								Natural attenuation parameters				
						C6-C10	C6-C10 minus BTEX (F1)	C10-C16	C10-C16 minus Naphthalene (F2)	C16-C34 (F3)	C34-C40 (F4)	C10-C40 (Sum of total)	Benzene	Toluene	Ethylbenzene	Xylene (m & p)	Xylene (o)	Xylene Total	Total BTEX	Naphthalene	Nitrate (as N) (filtered)	Sulphate (filtered)	Ferrous iron (filtered)	Methane	pH
						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	mg/L	mg/L	mg/L	µg/L	
EQL						20	20	60	60	100	100	100	0.5	0.5	0.5	1	0.5	1.5	1	0.5	0.005	1	0.05	5	
ADWG 2011 (May 2019 Update) - Health						-	-	-	-	-	-	-	1	800	300	-	-	600	-	-					
ANZG (2018) Freshwater 95% toxicant DGVs						-	-	-	-	-	-	-	950	180	80	75	350	-	-	16					
Environmental Guidelines for Petroleum Storage in the ACT						-	-	-	-	-	-	600	950	300	140	200	350	600	-	16					6.5-8.5
NEPM 2013 Table 1A(4) Comm/Ind HSL D GW for Vapour Intrusion, Sand																									
2-4m						-	6,000	-	-	-	-	-	5,000	NL	NL	-	-	NL	-	NL					
4-8m						-	6,000	-	-	-	-	-	5,000	NL	NL	-	-	NL	-	NL					
>=8m						-	7,000	-	-	-	-	-	5,000	NL	NL	-	-	NL	-	NL					
NEPM 2013 Table 1A(4) Rec HSL C GW for Vapour Intrusion, Sand																									
2-4m						-	NL	-	NL	-	-	-	NL	NL	NL	-	-	NL	-	NL					
4-8m						-	NL	-	NL	-	-	-	NL	NL	NL	-	-	NL	-	NL					
NEPM 2013 Table 1A(4) Res HSL A & B GW for Vapour Intrusion, Sand																									
2-4m						-	1,000	-	1,000	-	-	-	800	NL	NL	-	-	NL	-	NL					
4-8m						-	1,000	-	1,000	-	-	-	800	NL	NL	-	-	NL	-	NL					
>=8m						-	1,000	-	1,000	-	-	-	900	NL	NL	-	-	NL	-	NL					
Well ID	**Landuse**	**Sample ID**	**Sampling Date**	**Lab Report**	**Depth to Water (mBTOC)**	**LNAPL Thickness (m)**																			
EW01	Comm/Ind	EW01	24-Feb-21	SE216928	8.514	-	<250,000	63,000	1,700	1,700	3,100	<500	5,900	10,000	100,000	<2,500	5,500	2,600	8,100	120,000	<2,500	<0.005	8.5	0.35	31	9.23
EW02	Comm/Ind	EW02	24-Feb-21	SE216928	8.725	-	120,000	74,000	910	910	<500	<500	1,700	5,300	39,000	560	2,400	1,200	3,700	48,000	<500	-	-	-	-	6.80
EW03	Comm/Ind	EW03	24-Feb-21	SE216928	8.887	-	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	-	-	-	-	6.84
MW01	Comm/Ind	MW01	24-Feb-21	SE216928	9.182	-	110,000	49,000	6,500	6,500	8,200	<500	18,000	2,000	49,000	<1,000	8,100	4,300	12,000	64,000	<1,000	<0.005	130	0.20	8	8.58
MW02	Comm/Ind	MW02	24-Feb-21	SE216928	8.741	-	<250,000	50,000	4,400	4,400	3,800	<500	10,000	4,400	72,000	<2,500	7,300	3,700	11,000	87,000	<2,500	<0.005	5.3	<0.05	12	6.41
MW04	Comm/Ind	MW04	24-Feb-21	SE216928	8.018	-	7,400	3,700	270	260	<500	<500	330	1,400	2,100	<25	140	60	200	3,700	<25	<0.005	54	<0.05	<5	7.81
MW05	Comm/Ind	MW05	24-Feb-21	SE216928	8.090	-	<250,000	58,000	3,000	3,000	1,900	<500	6,500	9,800	88,000	<2,500	5,000	2,500	7,500	110,000	<2,500	<0.005	72	<0.05	17	5.62
MW06	Comm/Ind	MW06	22-Feb-21	SE216928	8.403	-	<250,000	72,000	2,600	2,600	3,400	<500	6,900	9,700	100,000	<2,500	5,900	2,800	8,600	120,000	<2,500	1.1	630	<0.05	12	6.61
MW07	Comm/Ind	MW07	22-Feb-21	SE216928	8.730	-	180,000	76,000	3,000	3,000	10,000	<500	15,000	9,400	85,000	<1,000	6,100	2,900	9,000	100,000	<1,000	<0.005	350	0.22	<5	7.08
MW08	Comm/Ind	MW08	22-Feb-21	SE216928	9.305	-	<50	<50	500	500	830	<500	1,400	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	-	-	-	-	7.21
MW09	Comm/Ind	MW09	22-Feb-21	SE216928	10.148	-	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	-	-	-	-	6.85
MW10	Comm/Ind	MW10	24-Feb-21	SE216928	10.413	-	260,000	110,000	5,100	5,100	1,100	<500	9,000	9,000	130,000	2,900	8,700	4,200	13,000	160,000	<2,500	0.017	150	<0.05	6	6.81
MW11	Comm/Ind	MW11	24-Feb-21	SE216928	10.261	-	<50	<50	<60	<60	<500	<500	380	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	-	-	-	-	5.69
MW12	Comm/Ind	MW12	23-Feb-21	SE216928	9.323	-	14,000	9,900	540	540	<500	<500	920	96	2,200	80	970	430	1,400	3,800	26	-	-	-	-	7.09
MW13	Comm/Ind	MW13	23-Feb-21	SE216928	8.406	-	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	-	-	-	-	6.22
MW14	Comm/Ind	MW14	23-Feb-21	SE216928	7.506	-	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	-	-	-	-	9.45
MW15	Residential	MW15	23-Feb-21	SE216928	7.300	0.065	250,000	83,000	1,800	1,800	<500	<500	3,000	12,000	150,000	<2,500	6,300	2,900	9,200	170,000	<2,500	<0.005	5.3	0.06	14	6.17
MW16	Residential	MW16	23-Feb-21	SE216928	7.432	0.071	290,000	98,000	6,700	6,700	1,100	<500	12,000	11,000	160,000	<2,500	8,800	4,100	13,000	190,000	<2,500	<0.005	30	<0.05	5	6.95
MW17	Residential	MW17	23-Feb-21	SE216928	7.357	-	<100,000	26,000	730	730	<500	<500	1,400	3,600	37,000	<1,000	2,900	1,400	4,300	45,000	<1,000	<0.005	8.8	0.16	6	9.05
MW18	Comm/Ind	MW18	23-Feb-21	SE216928	7.287	-	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	-	-	-	-	6.80
		QA01	23-Feb-21	SE216928		-	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	-	-	-	-	
		QA01A	23-Feb-21	ES2106973		-	<20	<20	<100	<100	<100	<100	<100	<1	<2	<2	<2	<2	<2	<1	<5	-	-	-	-	
MW19	Comm/Ind	MW19	22-Feb-21	SE216928	7.461	-	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	-	-	-	-	6.90
MW20	Comm/Ind	MW20	22-Feb-21	SE216928	8.428	-	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	-	-	-	-	-
MW21	Comm/Ind	MW21	22-Feb-21	SE216928	9.054	-	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	-	-	-	-	7.02
MW23	Residential	MW23	23-Feb-21	SE216928	9.905	-	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	-	-	-	-	5.95
MW24	Residential	MW24	23-Feb-21	SE216928	10.165	-	91,000	<50,000	1,000	920	1,900	<500	3,400	5,600	46,000	590	3,000	1,400	4,400	57,000	85	<0.005	41	0.09	6	6.86
MW25	Residential	MW25	23-Feb-21	SE216928	9.972	-	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	-	-	-	-	5.98
RW01	Comm/Ind	RW01	24-Feb-21	SE216928	2.513	-	290,000	94,000	2,600	2,600	<500	<500	4,000	14,000	170,000	3,000	8,300	4,200	13,000	200,000	<2,500	-	-	-	-	6.43
S2-P1	Comm/Ind	S2-P1	23-Feb-21	SE216928	9.138	-	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	-	-	-	-	8.16
S2-P2	Comm/Ind	S2-P2	23-Feb-21	SE216928	6.683	-	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	4.4	56	<0.05	<5	5.73
S2-P3	Comm/Ind	S2-P3	23-Feb-21	SE216928	6.081	-	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	-	-	-	-	8.63
S2-P4	Residential	S2-P4	23-Feb-21	SE216928	5.816	-	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	-	-	-	-	6.73
		QA02	23-Feb-21	SE216928		-	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	-	-	-	-	
		QA02A	24-Feb-21	ES2106973		-	<20	<20	<100	<100	<100	<100	<100	<1	<2	<2	<2	<2	<2	<1	<5	-	-	-	-	
S2-P5	Residential	S2-P5	22-Feb-21	SE216928	4.120	-	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	0.089	44	<0.05	<5	5.40
S2-P5b	Residential	S2-P5b	22-Feb-21	SE216928	4.025	-	<50	<50	390	390	<500	<500	390	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	-	-	-	-	6.59
S2-P6	Residential	S2-P6	22-Feb-21	SE216928	2.728	-	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	3.9	79	<0.05	16	7.42
S2-P6b	Residential	S2-P6b	22-Feb-21	SE216928	2.8190	-	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	-	-	-	-	6.57
S2-P7	Open space	S2-P7	22-Feb-21	SE216928	2.002	-	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	-	-	-	-	9.37
S2-P8	Residential	S2-P8	23-Feb-21	SE216928	4.722	-	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	-	-	-	-	7.08
S2-P9b	Residential	S2-P9b	23-Feb-21	SE216928	5.665	-	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	-	-	-	-	7.23
S2-P10	Comm/Ind	S2-P10	23-Feb-21	SE216928	7.112	-	72	69	<60	<60	<500	<500	<320	2.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	-	-	-	-	7.24
S2-P11	Comm/Ind	S2-P11	23-Feb-21	SE216928	7.142	-	<50	<50	60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	-	-	-	-	7.00
S2-P12	Comm/Ind	S2-P12	23-Feb-21	SE216928	8.004	-	54	54	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	-	-	-	-	6.74

Ampol Holt (SITE ID: 22546)
Table F6
Groundwater Analytical Results
February 2021 GME

PS123812

						TRH							BTEXN								Natural attenuation parameters				
						C6-C10	C6-C10 minus BTEX (F1)	C10-C16	C10-C16 minus Naphthalene (F2)	C16-C34 (F3)	C34-C40 (F4)	C10-C40 (Sum of total)	Benzene	Toluene	Ethylbenzene	Xylene (m & p)	Xylene (o)	Xylene Total	Total BTEX	Naphthalene	Nitrate (as N) (filtered)	Sulphate (filtered)	Ferrous iron (filtered)	Methane	pH
						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	mg/L	mg/L	mg/L	µg/L	
EQL						20	20	60	60	100	100	100	0.5	0.5	0.5	1	0.5	1.5	1	0.5	0.005	1	0.05	5	
ADWG 2011 (May 2019 Update) - Health						-	-	-	-	-	-	-	1	800	300	-	-	600	-	-					
ANZG (2018) Freshwater 95% toxicant DGVs						-	-	-	-	-	-	-	950	180	80	75	350	-	-	16					
Environmental Guidelines for Petroleum Storage in the ACT						-	-	-	-	-	-	600	950	300	140	200	350	600	-	16					6.5-8.5
NEPM 2013 Table 1A(4) Comm/Ind HSL D GW for Vapour Intrusion, Sand																									
2-4m						-	6,000	-	-	-	-	-	5,000	NL	NL	-	-	NL	-	NL					
4-8m						-	6,000	-	-	-	-	-	5,000	NL	NL	-	-	NL	-	NL					
>=8m						-	7,000	-	-	-	-	-	5,000	NL	NL	-	-	NL	-	NL					
NEPM 2013 Table 1A(4) Rec HSL C GW for Vapour Intrusion, Sand																									
2-4m						-	NL	-	NL	-	-	-	NL	NL	NL	-	-	NL	-	NL					
4-8m						-	NL	-	NL	-	-	-	NL	NL	NL	-	-	NL	-	NL					
NEPM 2013 Table 1A(4) Res HSL A & B GW for Vapour Intrusion, Sand																									
2-4m						-	1,000	-	1,000	-	-	-	800	NL	NL	-	-	NL	-	NL					
4-8m						-	1,000	-	1,000	-	-	-	800	NL	NL	-	-	NL	-	NL					
>=8m						-	1,000	-	1,000	-	-	-	900	NL	NL	-	-	NL	-	NL					
Well ID	**Landuse**	**Sample ID**	**Sampling Date**	**Lab Report**	**Depth to Water (mBTOC)**	**LNAPL Thickness (m)**																			
S2-C1	Comm/Ind	S2-C1	23-Feb-21	SE216928	8.924	-	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	-	-	-	-	6.46
S2-C2	Comm/Ind	S2-C2	23-Feb-21	SE216928	5.539	-	<50	<50	1,200	1,200	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	-	-	-	-	6.14
S2-C3	Open space	S2-C3	22-Feb-21	SE216928	1.597	-	<50	<50	<60	<60	<500	<500	<320	0.6	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	-	-	-	-	7.92
S2-C4	Open space	S2-C4	22-Feb-21	SE216928	1.346	-	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	-	-	-	-	7.89
S2-C5	Comm/Ind	S2-C5	22-Feb-21	SE216928	5.074	-	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	0.94	13	<0.05	<5	6.53
S2-C6	Comm/Ind	S2-C6	23-Feb-21	SE216928	5.631	-	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	-	-	-	-	6.95
S2-C7	Comm/Ind	S2-C7	23-Feb-21	SE216928	6.219	-	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	-	-	-	-	6.96
S2-C8	Comm/Ind	S2-C8	23-Feb-21	SE216928	6.298	-	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	-	-	-	-	6.63
S2-C9	Comm/Ind	S2-C9	23-Feb-21	SE216928	7.121	-	<50	<50	120	120	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	-	-	-	-	6.48
S2-C10	Residential	S2-C10	23-Feb-21	SE216928	15.408	-	<50	<50	1,600	1,600	<500	<500	1,600	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	15	260	<0.05	<5	5.56
S2-R1	Open space	S2-R1	24-Feb-21	SE216928	4.391	-	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	-	-	-	-	7.30
S2-R2	Open space	S2-R2	24-Feb-21	SE216928	4.147	-	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	-	-	-	-	7.10
S2-R3	Open space	S2-R3	24-Feb-21	SE216928	4.005	-	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	-	-	-	-	7.15
S2-R4	Open space	S2-R4	24-Feb-21	SE216928	3.498	-	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	-	-	-	-	6.91
S2-R5	Open space	S2-R5	24-Feb-21	SE216928	3.813	-	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	-	-	-	-	7.22
S2-R6	Open space	S2-R6	24-Feb-21	SE216928	4.998	-	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<3	<0.5	-	-	-	-	6.96
IW1	Comm/Ind	IW1	24-Feb-21	SE216928	8.475	-	160,000	69,000	24,000	24,000	4,800	<500	32,000	4,600	71,000	1,900	5,800	2,600	8,400	86,000	<1,000	0.97	2,400	<0.05	29	-
IW2	Comm/Ind	IW2	24-Feb-21	SE216928	9.125	-	23,000	18,000	1,300	1,200	<500	<500	2,400	88	3,100	370	1,300	550	1,900	5,500	<50	-	-	-	-	6.61
IW3	Comm/Ind	IW3	24-Feb-21	SE216928	10.342	-	16,000	8,700	11,000	11,000	4,500	<500	16,000	1,900	5,100	120	<200	110	270	7,400	<100	-	-	-	-	3.25
PEW1	Comm/Ind	PEW1	24-Feb-21	SE216928	8.498	-	<250,000	80,000	2,900	2,500	<500	<500	5,100	9,000	92,000	<2,500	5,700	3,000	8,600	110,000	<2,500	-	-	-	-	6.75
		QA03	24-Feb-21	SE216928		-	190,000	<100,000	1,600	1,300	<500	<500	2,600	8,000	85,000	<1,000	5,200	2,800	8,100	100,000	<1,000	-	-	-	-	
		QA03A	24-Feb-21	ES2106973		-	123,000	28,600	2,140	2,140	<100	<100	2,140	8,400	76,400	942	5,790	2,840	8,630	94,400	<200	-	-	-	-	
PMW1	Comm/Ind	PMW1	24-Feb-21	SE216928	8.476	-	<250,000	93,000	2,100	1,900	500	<500	4,400	11,000	130,000	2,900	7,300	3,400	11,000	160,000	<2,500	<0.005	200	<0.05	18	7.15
PMW2	Comm/Ind	PMW2	24-Feb-21	SE216928	8.192	-	<250,000	73,000	1,700	1,500	550	<500	3,700	13,000	92,000	<2,500	5,300	2,600	7,900	120,000	<2,500	-	-	-	-	6.96
		QA04	24-Feb-21	SE216928		-	200,000	<100,000	800	600	<500	<500	1,500	13,000	89,000	1,900	5,300	2,600	7,900	110,000	<1,000	-	-	-	-	
		QA04A	24-Feb-21	ES2106973		-	111,000	7,850	2,030	2,030	<100	<100	2,030	12,500	80,400	1,990	5,690	2,570	8,260	103,000	<100	-	-	-	-	
PMW3	Comm/Ind	PMW3	23-Feb-21	SE216928	7.505	-	190,000	76,000	1,100	910	<500	<500	2,300	9,300	92,000	1,100	4,800	2,300	7,000	110,000	<1,000	<0.005	59	<0.05	17	7.01
PMW4	Comm/Ind	PMW4	24-Feb-21	SE216928	8.253	-	160,000	69,000	1,100	970	790	<500	3,300	6,500	77,000	1,800	5,600	2,600	8,200	94,000	<1,000	-	-	-	-	6.76
S2-D1	Residential	S2-D1	23-Feb-21	SE216928	7.267	-	62,000	23,000	820	790	510	<500	1,900	2,900	32,000	1,400	1,500	760	2,300	39,000	<500	-	-	-	-	6.27
S2-D2	Comm/Ind	S2-D2	22-Feb-21	SE216928	8.254	-	5,400	2,200	<60	<60	<500	<500	<320	260	2,700	47	120	72	190	3,200	<25	-	-	-	-	5.68

Notes:
Only relevant criteria have been included. Concentrations are compared to HSL criteria for the corresponding landuse and depth at each location.

Ampol Holt (SITE ID: 22546)
Table F7
Historical Groundwater Results
February 2021 GME

					TRH NEPM (2013) Fractions							BTEX						PAH	Solvents	Metals
					TRH C6-C10	TRH C6 - C10 less BTEX (F1)	TRH C10 - C16 Fraction	TRH C10 - C16 less Naphthalene (F2)	TRH C16 - C34	TRH C34 - C40	TRH C10 - C40 (Total)	Benzene	Toluene	Ethylbenzene	Xylene (m & p)	Xylene (o)	Xylene (Total)	Naphthalene	Ethanol	Lead (filtered)
					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
EQL					20	20	60	60	100	100	100	0.5	0.5	0.5	1	0.5	1.5	0.1	50	1
ADWG 2011 (May 2019 Update) - Health					-	-	-	-	-	-	-	1	800	300			600	-	-	10
ANZG (2018) Freshwater 95% toxicant DGVs					-	-	-	-	-	-	-	950	180	80	75	350	-	16	1,400	3.4
Environmental Guidelines for Petroleum Storage in the ACT					-	-	-	-	-	-	600	950	300	140	-	350	600	16	1,400	3.4
NEPM 2013 Table 1A(4) Comm/Ind HSL D GW for Vapour Intrusion, Sand >=8m					-	7,000	-	NL	-	-	-	5,000	NL	NL	-	-	NL	NL	-	-
NEPM 2013 Table 1A(4) Rec HSL C GW for Vapour Intrusion, Sand >=8m					-	NL	-	NL	-	-	-	-	NL	NL	-	-	NL	NL	-	-
NEPM 2013 Table 1A(4) Rec HSL A GW for Vapour Intrusion, Sand >=8m					-	1,000	-	1,000	-	-	-	900	NL	NL	-	-	NL	NL	-	-
Location Code	**Landuse**	**Field ID**	**Date**	**DTW (mBTOC)**																
EW01 (existing prior to 2020)	Comm/Ind	CH5	10-Feb-10	-	ND	-	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
		EW1	29-Mar-11	-	<20	-	<50	-	<100	<50	-	<1	<5	<2	<2	<2	-	-	-	<1
		EW1	23-May-13	-	<10	<10	<50	<50	<100	<100	-	<1	<1	<1	<2	<1	-	-	-	<1
		EW01	13-Nov-14	-	<20	<20	<100	<100	<100	<100	-	<1	<2	<2	<2	<2	<2	-	-	9
		EW1	22-Sep-16	-	<20	<20	<50	<50	<100	<100	<100	<1	<1	<1	<1	<2	<3	<10	<500	-
		EW1	3-Jul-18	-	<50	<50	<60	<60	<500	<500	<650	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.4	NL	3
		EW01	24-Sep-19	-	<50	<50	<60	<60	<500	<500	<530	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	<1000	<1
		EW01	21-Apr-20	9.613	232,000	65,800	2,490	2,490	760	<100	3,250	**17,500**	**133,000**	**3,050**	8,770	**3,900**	**12,700**	162	15,100	2
		EW01	28-Sep-20	8.821	<250,000	<250,000	2,000	1,800	850	<500	4,500	**15,000**	**130,000**	**3,200**	9,600	**3,900**	**13,000**	<2,500	-	-
		EW01	24-Feb-21	8.514	<250,000	63,000	1,700	1,700	3,100	<500	5,900	**10,000**	**100,000**	**<2,500**	5,500	**2,600**	**8,100**	<2,500	-	-
EW02 (existing prior to 2020)	Comm/Ind	CH5	10-Feb-10	-	ND	-	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
		EW2	29-Mar-11	-	140	-	110	-	<100	<50	110	20	<5	26	38	4	42	-	-	<1
		EW2	23-May-13	-	54	54	<50	<50	<100	<100	-	<1	<1	<1	<2	<1	-	-	-	<1
		EW02	13-Nov-14	-	40	40	<50	<50	<100	<100	-	2	<2	<2	<2	<2	<2	-	-	<1
		EW2	3-Sep-15	-	70	70	<100	<100	<100	<100	-	<1	<2	<2	<2	<2	<2	<5	-	-
		EW2	22-Sep-16	-	40	40	<50	<50	<100	<100	<100	<1	<1	<1	<1	<2	<3	<10	<500	-
		EW2	3-Jul-18	-	<50	<50	150	150	<500	<500	<650	0.6	<0.5	<0.5	<1	<0.5	<1.5	<0.4	<1000	<1
		EW02	24-Sep-19	-	<50	220	<60	<60	<500	<500	<530	5.2	<0.5	<0.5	<1	<0.5	<1.5	<0.5	<1000	<1
		EW02	21-Apr-20	8.447	235,000	66,400	2,110	2,110	530	<100	2,640	**17,200**	**136,000**	**2,910**	8,700	**3,820**	**12,500**	158	<50	<1
		EW02	28-Sep-20	8.933	<250,000	<250,000	1,600	1,400	4,900	<500	7,600	**17,000**	**130,000**	**<2,500**	8,300	**3,600**	**12,000**	<2,500	-	-
		EW02	24-Feb-21	8.725	120,000	74,000	910	910	<500	<500	1,700	**5,300**	**39,000**	560	2,400	**1,200**	**3,700**	<500	-	-
EW03 (existing prior to 2020)	Comm/Ind	CH1	10-Feb-10	-	ND	-	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
		EW3	29-Mar-11	-	<20	-	<50	-	<100	<50	-	<1	<5	<2	<2	<2	-	-	-	<1
		EW3	23-May-13	-	<10	<10	<50	<50	<100	<100	-	<1	<1	<1	<2	<1	-	-	-	<1
		EW03	13-Nov-14	-	<20	<20	<100	<100	<100	<100	-	<1	<2	<2	<2	<2	<2	-	-	-
		EW3	22-Sep-16	-	<20	<20	<50	<50	<100	<100	<100	<1	<1	<1	<1	<2	<3	<10	<500	-
		EW3	3-Jul-18	-	<50	<50	<60	<60	<500	<500	<650	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.4	<1000	<1
		EW03	24-Sep-19	-	<50	<50	<60	<60	<500	<500	<530	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	<1000	<1
		EW03	21-Apr-20	9.744	700	320	<100	<100	<100	<100	<100	39	263	10	42	28	70	2.7	<50	<1
		EW03	28-Sep-20	9.195	260	130	<60	<60	<500	<500	<320	3.8	46	25	32	23	55	<0.5	-	-
		EW03	24-Feb-21	8.887	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
MW01 (existing prior to 2020)	Comm/Ind	MW01	29-Mar-11	-	<20	-	<50	-	<100	<50	-	<1	<5	<2	<2	<2	-	-	-	<1
		MW01	23-May-13	-	<10	<10	<50	<50	<100	<100	-	<1	<1	<1	<2	<1	-	-	-	<1
		MW01	3-Sep-15	-	<20	<20	<100	<100	150	<100	150	<1	<2	<2	<2	<2	<2	<5	-	-
		MW01	22-Sep-16	-	<20	<20	<50	<50	<100	<100	<100	<1	<1	<1	<1	<2	<3	<10	<500	-
		MW01	3-Jul-18	-	<50	<50	<60	<60	<500	<500	<650	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.4	<1000	1
		MW01	24-Sep-19	-	<50	<50	<60	<60	<500	<500	<530	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	<1000	<1
		MW01	21-Apr-20	10.117	231,000	82,300	1,880	1,880	5,230	<100	7,110	**12,800**	**119,000**	**3,120**	9,660	**4,150**	**13,800**	146	<50	<1
		MW01	28-Sep-20	9.477	250,000	130,000	8,500	8,000	10,000	<500	22,000	**3,500**	**78,000**	**9,600**	14,000	**6,100**	**20,000**	<1,000	-	-
		MW01	24-Feb-21	9.182	110,000	49,000	6,500	6,500	8,200	<500	18,000	**2,000**	**49,000**	**<1,000**	8,100	**4,300**	**12,000**	<1,000	-	-
MW02 (existing prior to 2020)	Comm/Ind	MW02	29-Mar-11	-	<20	-	340	-	<100	<50	340	<1	<5	<2	<2	<2	-	-	-	<1
		MW02	23-May-13	-	260	260	1200	1200	100	100	-	<1	<1	<1	<2	<1	-	-	-	<1
		MW02	13-Nov-14	-	9,830	4,400	740	740	<100	<100	-	<20	**1,480**	**585**	2,280	**1,090**	**3,370**	-	-	2
		MW02	3-Sep-15	-	50	50	150	150	190	<100	340	<1	<2	<2	<2	<2	<2	<5	-	-
		MW02	22-Sep-16	-	<20	<20	<50	<50	<100	<100	<100	<1	<1	<1	<1	<2	<3	<10	<500	-
		MW02	3-Jul-18	-	<50	<50	<60	<60	<500	<500	<650	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.4	<1000	1
		MW02	24-Sep-19	-	<50	<50	100	100	<500	<500	<530	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	<1000	<1
		MW02	21-Apr-20	9.785	242,000	87,800	1,250	1,250	1,500	<100	2,750	**15,200**	**124,000**	**2,690**	8,580	**3,780**	**12,400**	91.5	<50	2
		MW02	28-Sep-20	9.011	<250,000	<250,000	4,700	4,400	2,200	<500	9,300	**13,000**	**170,000**	**3,400**	13,000	**5,600**	**19,000**	<2,500	-	-
		MW02	24-Feb-21	8.741	<250,000	50,000	4,400	4,400	3,800	<500	10,000	**4,400**	**72,000**	**<2,500**	7,300	**3,700**	**11,000**	<2,500	-	-

Ampol Holt (SITE ID: 22546)
Table F7
Historical Groundwater Results
February 2021 GME

					TRH NEPM (2013) Fractions							BTEX						PAH	Solvents	Metals
					TRH C6-C10	TRH C6 - C10 less BTEX (F1)	TRH C10 - C16 Fraction	TRH C10 - C16 less Naphthalene (F2)	TRH C16 - C34	TRH C34 - C40	TRH C10 - C40 (Total)	Benzene	Toluene	Ethylbenzene	Xylene (m & p)	Xylene (o)	Xylene (Total)	Naphthalene	Ethanol	Lead (filtered)
					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
EQL					20	20	60	60	100	100	100	0.5	0.5	0.5	1	0.5	1.5	0.1	50	1
ADWG 2011 (May 2019 Update) - Health					-	-	-	-	-	-	-	1	800	300			600	-	-	10
ANZG (2018) Freshwater 95% toxicant DGVs					-	-	-	-	-	-	-	950	180	80	75	350	-	16	1,400	3.4
Environmental Guidelines for Petroleum Storage in the ACT					-	-	-	-	-	-	600	950	300	140	-	350	600	16	1,400	3.4
NEPM 2013 Table 1A(4) Comm/Ind HSL D GW for Vapour Intrusion, Sand >=8m					-	7,000	-	NL	-	-	-	5,000	NL	NL	-	-	NL	NL	-	-
NEPM 2013 Table 1A(4) Rec HSL C GW for Vapour Intrusion, Sand >=8m					-	NL	-	NL	-	-	-	-	NL	NL	-	-	NL	NL	-	-
NEPM 2013 Table 1A(4) Rec HSL A GW for Vapour Intrusion, Sand >=8m					-	1,000	-	1,000	-	-	-	900	NL	NL	-	-	NL	NL	-	-
Location Code	**Landuse**	**Field ID**	**Date**	**DTW (mBTOC)**																
MW04	Comm/Ind	MW04	21-Apr-20	8.847	40	<20	<100	<100	<100	<100	<100	15	8	<2	3	2	5	<1.0	<50	<1
		MW04	28-Sep-20	8.296	<2,500	<2,500	<60	<60	<500	<500	<320	620	140	<25	50	27	78	<25	-	-
		MW04	24-Feb-21	8.018	7,400	3,700	270	260	<500	<500	330	**1,400**	**2,100**	<25	140	60	200	<25	-	-
MW05	Comm/Ind	MW05	21-Apr-20	9.337	312,000	104,000	3,880	3,880	2,000	<100	5,880	**18,500**	**170,000**	**3,450**	10,900	**4,790**	**15,700**	237	<50	<1
		MW05	28-Sep-20	8.352	<250,000	<250,000	3,800	3,300	2,900	<500	9,600	**11,000**	**140,000**	**3,400**	13,000	**5,200**	**18,000**	<2,500	-	-
		MW05	24-Feb-21	8.090	<250,000	58,000	3,000	3,000	1,900	<500	6,500	**9,800**	**88,000**	**<2,500**	5,000	**2,500**	**7,500**	<2,500	-	-
MW06	Comm/Ind	MW06	21-Apr-20	9.034	211,000	61,600	1,310	1,310	2,920	<100	4,230	**12,600**	**121,000**	**2,900**	9,010	**3,910**	**12,900**	101	<50	<1
		MW06	28-Sep-20	8.488	<250,000	<250,000	4,500	4,200	5,700	<500	14,000	**14,000**	**160,000**	**3,900**	14,000	**5,800**	**20,000**	<2,500	-	-
		MW06	22-Feb-21	8.403	<250,000	72,000	2,600	2,600	3,400	<500	6,900	**9,700**	**100,000**	**<2,500**	5,900	**2,800**	**8,600**	<2,500	-	-
MW07	Comm/Ind	MW07	21-Apr-20	9.972	246,000	75,500	3,700	3,360	5,040	<100	8,740	**16,600**	**136,000**	**2,990**	10,300	**4,620**	**14,900**	280	<50	2
		MW07	28-Sep-20	9.000	120,000	<100,000	5,000	4,000	19,000	<500	27,000	**10,000**	**88,000**	**2,000**	9,200	**4,100**	**13,000**	<1,000	-	-
		MW07	22-Feb-21	8.730	180,000	76,000	3,000	3,000	10,000	<500	15,000	**9,400**	**85,000**	**<1,000**	6,100	**2,900**	**9,000**	<1,000	-	-
MW08	Comm/Ind	MW08	21-Apr-20	10.143	<20	<20	<100	<100	<100	<100	<100	<1	<2	<2	<2	<2	<2	<1.0	<50	<1
		MW08	28-Sep-20	9.600	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
		MW08	22-Feb-21	9.305	<50	<50	500	500	830	<500	1,400	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
MW09	Comm/Ind	MW09	21-Apr-20	11.008	240	110	<100	<100	<100	<100	<100	6	93	5	16	11	27	<1.0	<50	<1
		MW09	28-Sep-20	10.448	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
		MW09	22-Feb-21	10.148	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
MW10	Comm/Ind	MW10	21-Apr-20	11.113	568,000	318,000	1,180	<100	540	<100	1,720	**15,000**	**186,000**	**8,240**	28,600	**12,200**	**40,800**	131	<50	<1
		MW10	28-Sep-20	10.556	440,000	270,000	3,700	3,200	990	<500	7,700	**11,000**	**140,000**	**3,600**	13,000	**5,600**	**19,000**	<2,500	-	-
		MW10	24-Feb-21	10.413	260,000	110,000	5,100	5,100	1,100	<500	9,000	**9,000**	**130,000**	**2,900**	8,700	**4,200**	**13,000**	<2,500	-	-
MW11	Comm/Ind	MW11	21-Apr-20	11.136	<20	<20	<100	<100	<100	<100	<100	<1	<2	<2	<2	<2	<2	<1.0	<50	<1
		MW11	28-Sep-20	10.572	60	<50	<60	<60	<500	<500	<320	22	2.4	4.3	5	2.1	7.6	<0.5	-	-
		MW11	24-Feb-21	10.261	<50	<50	<60	<60	<500	<500	380	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
MW12	Comm/Ind	MW12	21-Apr-20	10.199	204,000	53,300	810	590	<100	<100	810	**9,160**	**124,000**	**3,090**	10,300	**4,160**	**14,500**	108	<50	<1
		MW12	28-Sep-20	9.595	<50,000	<50,000	2,200	2,000	<500	<500	4,200	**970**	**29,000**	**1,300**	6,800	**2,700**	**9,500**	<500	-	-
		MW12	23-Feb-21	9.323	14,000	9,900	540	540	<500	<500	920	96	**2,200**	80	970	430	**1,400**	26	-	-
MW13	Comm/Ind	MW13	21-Apr-20	9.217	<20	<20	<100	<100	<100	<100	<100	<1	<2	<2	<2	<2	<2	<1.0	<50	<1
		MW13	28-Sep-20	8.880	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
		MW13	23-Feb-21	8.406	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
MW14	Comm/Ind	MW14	21-Apr-20	8.323	<20	<20	<100	<100	<100	<100	<100	<1	<2	<2	<2	<2	<2	<1.0	<50	<1
		MW14	28-Sep-20	7.793	<50	<50	99	96	<500	<500	430	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
		MW14	23-Feb-21	7.506	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
MW15	Residential	MW15	21-Apr-20	8.610	260,000	90,000	1,570	1,570	110	<100	1,680	**15,000**	**139,000**	**3,050**	8,960	**4,000**	**13,000**	121	<50	<1
		MW15	28-Sep-20	7.578	420,000	250,000	4,100	3,700	<500	<500	8,100	**12,000**	**130,000**	**3,500**	12,000	**5,100**	**17,000**	<2,500	-	-
		MW15	23-Feb-21	7.300	250,000	83,000	1,800	1,800	<500	<500	3,000	**12,000**	**150,000**	**<2,500**	6,300	**2,900**	**9,200**	<2,500	-	-
MW16	Residential	MW16	21-Apr-20	8.157	272,000	119,000	16,000	16,000	1,230	180	17,400	**13,500**	**120,000**	**3,330**	11,300	**4,800**	**16,100**	<200	<50	<1
		MW16	28-Sep-20	7.691	<250,000	<250,000	22,000	21,000	2,300	570	40,000	**13,000**	**150,000**	**3,100**	12,000	**4,800**	**17,000**	<2,500	-	-
		MW16	23-Feb-21	7.432	290,000	98,000	6,700	6,700	1,100	<500	12,000	**11,000**	**160,000**	**<2,500**	8,800	**4,100**	**13,000**	<2,500	-	-
MW17	Residential	MW17	21-Apr-20	8.135	186,000	66,100	1,470	1,470	170	<100	1,640	**9,370**	**97,600**	**2,500**	7,380	**3,050**	**10,400**	69.8	<50	<1
		MW17	28-Sep-20	7.627	<100,000	<100,000	850	780	<500	<500	1,900	**6,500**	**69,000**	**1,600**	5,700	**2,200**	**7,900**	<1,000	-	-
		MW17	23-Feb-21	7.357	<100,000	26,000	730	730	<500	<500	1,400	**3,600**	**37,000**	**<1,000**	2,900	**1,400**	**4,300**	<1,000	-	-
MW18	Comm/Ind	MW18	21-Apr-20	8.080	<20	<20	<100	<100	<100	<100	<100	<1	<2	<2	<2	<2	<2	<1.0	<50	<1
		MW18	28-Sep-20	7.551	<50	<50	<60	<60	<500	<500	480	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
		MW18	23-Feb-21	7.287	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
MW19	Comm/Ind	MW19	21-Apr-20	8.555	<20	<20	<100	<100	140	<100	140	<1	<2	<2	<2	<2	<2	<1.0	<50	<1
		MW19	28-Sep-20	7.997	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
		MW19	22-Feb-21	7.461	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
MW20	Comm/Ind	MW20	21-Apr-20	9.263	<20	<20	<100	<100	<100	<100	<100	<1	<2	<2	<2	<2	<2	<1.0	<50	<1
		MW20	28-Sep-20	8.703	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
		MW20	22-Feb-21	8.428	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
MW21	Comm/Ind	MW21	21-Apr-20	9.913	<20	<20	<100	<100	100	<100	100	<1	<2	<2	<2	<2	<2	<1.0	<50	<1
		MW21	28-Sep-20	9.359	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
		MW21	22-Feb-21	9.054	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
MW23	Comm/Ind	MW23	21-Apr-20	10.756	<20	<20	<100	<100	<100	<100	<100	<1	<2	<2	<2	<2	<2	<1.0	<50	<1
		MW23	28-Sep-20	10.208	<50	<50	<60	<60	<500	<500	<320	<0.5	2.3	<0.5	<1	<0.5	<1.5	<0.5	-	-
		MW23	23-Feb-21	9.905	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-

Ampol Holt (SITE ID: 22546)
Table F7
Historical Groundwater Results
February 2021 GME

					TRH NEPM (2013) Fractions							BTEX						PAH	Solvents	Metals
					TRH C6-C10	TRH C6 - C10 less BTEX (F1)	TRH C10 - C16 Fraction	TRH C10 - C16 less Naphthalene (F2)	TRH C16 - C34	TRH C34 - C40	TRH C10 - C40 (Total)	Benzene	Toluene	Ethylbenzene	Xylene (m & p)	Xylene (o)	Xylene (Total)	Naphthalene	Ethanol	Lead (filtered)
					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
EQL					20	20	60	60	100	100	100	0.5	0.5	0.5	1	0.5	1.5	0.1	50	1
ADWG 2011 (May 2019 Update) - Health					-	-	-	-	-	-	-	1	800	300			600	-	-	10
ANZG (2018) Freshwater 95% toxicant DGVs					-	-	-	-	-	-	-	950	180	80	75	350	-	16	1,400	3.4
Environmental Guidelines for Petroleum Storage in the ACT					-	-	-	-	-	-	600	950	300	140	-	350	600	16	1,400	3.4
NEPM 2013 Table 1A(4) Comm/Ind HSL D GW for Vapour Intrusion, Sand >=8m					-	7,000	-	NL	-	-	-	5,000	NL	NL	-	-	NL	NL	-	-
NEPM 2013 Table 1A(4) Rec HSL C GW for Vapour Intrusion, Sand >=8m					-	NL	-	NL	-	-	-	-	NL	NL	-	-	NL	NL	-	-
NEPM 2013 Table 1A(4) Rec HSL A GW for Vapour Intrusion, Sand >=8m					-	1,000	-	1,000	-	-	-	900	NL	NL	-	-	NL	NL	-	-
Location Code	**Landuse**	**Field ID**	**Date**	**DTW (mBTOC)**																
MW24	Comm/Ind	MW24	21-Apr-20	11.011	54,600	15,700	320	320	<100	<100	320	**2,760**	**32,000**	**614**	2,440	**1,050**	**3,490**	28.2	<50	<1
		MW24	28-Sep-20	10.464	<50,000	<50,000	560	460	<500	<500	1,500	**3,700**	**35,000**	**740**	4,600	**1,800**	**6,400**	<500	-	-
		MW24	23-Feb-21	10.165	91,000	<50,000	1,000	920	1,900	<500	3,400	**5,600**	**46,000**	**590**	3,000	**1,400**	**4,400**	85	-	-
MW25	Comm/Ind	MW25	21-Apr-20	10.863	<20	<20	<100	<100	<100	<100	<100	<1	<2	<2	<2	<2	<2	<1.0	<50	<1
		MW25	28-Sep-20	10.301	<50	<50	<60	<60	<500	<500	<320	<0.5	2.0	<0.5	<1	<0.5	<1.5	<0.5	-	-
		MW25	23-Feb-21	9.972	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
S2-P1	Comm/Ind	S2-P1	28-Sep-20	9.610	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	<1,000	<1
		S2-P1	23-Feb-21	9.138	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
S2-P2	Comm/Ind	S2-P2	28-Sep-20	6.953	11,000	6,500	560	510	<500	<500	950	110	**2,800**	76	810	310	**1,100**	45	<1,000	<1
		S2-P2	23-Feb-21	6.683	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
S2-P3	Comm/Ind	S2-P3	28-Sep-20	6.331	<50	<50	<60	<60	<500	<500	<320	2.5	3.9	1.2	2	1.6	3.8	0.5	<1,000	<1
		S2-P3	23-Feb-21	6.081	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
S2-P4	Residential	S2-P4	28-Sep-20	6.042	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	<1,000	<1
		S2-P4	23-Feb-21	5.816	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
S2-P5	Residential	S2-P5	28-Sep-20	4.333	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	<1,000	<1
		S2-P5	22-Feb-21	4.120	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
S2-P5b	Residential	S2-P5b	14-Oct-20	4.110	<50	<50	<60	<60	<500	<500	<320	0.7	1.9	<0.5	<1	<0.5	<1.5	<0.5	<1,000	<1
		S2-P5b	22-Feb-21	4.025	<50	<50	390	390	<500	<500	390	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
S2-P6	Residential	S2-P6	28-Sep-20	2.930	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	<1,000	<1
		S2-P6	22-Feb-21	2.728	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
S2-P6b	Residential	S2-P6b	14-Oct-20	2.884	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	<1,000	<1
		S2-P6b	22-Feb-21	2.819	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
S2-P7	Open space	S2-P7	28-Sep-20	2.246	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	<1,000	<1
		S2-P7	22-Feb-21	2.002	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
S2-P8	Comm/Ind	S2-P8	28-Sep-20	4.914	54	<50	<60	<60	<500	<500	<320	8.2	7.1	<0.5	2	2.8	5.1	0.7	<1,000	<1
		S2-P8	23-Feb-21	4.722	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
S2-P9a	Residential	S2-P9 DEEP	29-Sep-20	-	<50	<50	<60	<60	<500	<500	<320	41	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
		S2-P9 SHALLOW	29-Sep-20	-	<50	<50	<60	<60	<500	<500	<320	23	1.2	<0.5	<1	<0.5	<1.5	<0.5	-	-
S2-P9b	Residential	S2-P9B	28-Sep-20	5.904	<50	<50	<60	<60	<500	<500	<320	9.1	<0.5	<0.5	<1	<0.5	<1.5	<0.5	<1,000	<1
		S2-P9b	23-Feb-21	5.665	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
S2-P10	Comm/Ind	S2-P10	28-Sep-20	7.379	1,500	860	85	84	<500	<500	<320	200	210	22	170	85	260	8.2	<1,000	<1
		S2-P10	23-Feb-21	7.112	72	69	<60	<60	<500	<500	<320	2.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
S2-P11	Comm/Ind	S2-P11	28-Sep-20	7.432	<50	<50	<60	<60	<500	<500	<320	<0.5	0.9	<0.5	<1	0.8	<1.5	<0.5	<1,000	<1
		S2-P11	23-Feb-21	7.142	<50	<50	60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
S2-P12	Comm/Ind	S2-P12	28-Sep-20	8.303	<50	<50	<60	<60	<500	<500	<320	1.0	12	<0.5	<1	0.6	<1.5	<0.5	<1,000	<1
		S2-P12	23-Feb-21	8.004	54	54	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
S2-C1	Comm/Ind	S2-C1	28-Sep-20	9.486	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	<1,000	<1
		S2-C1	23-Feb-21	8.924	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
S2-C2	Comm/Ind	S2-C2	28-Sep-20	5.715	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	<1,000	<1
		S2-C2	23-Feb-21	5.539	<50	<50	1,200	1,200	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
S2-C3	Open space	S2-C3	28-Sep-20	1.775	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	<1,000	<1
		S2-C3	22-Feb-21	1.597	<50	<50	<60	<60	<500	<500	<320	0.6	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
S2-C4	Open space	S2-C4	28-Sep-20	1.646	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	<1,000	<1
		S2-C4	22-Feb-21	1.346	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
S2-C5	Comm/Ind	S2-C5	28-Sep-20	5.298	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	<1,000	<1
		S2-C5	22-Feb-21	5.074	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
S2-C6	Comm/Ind	S2-C6	28-Sep-20	5.872	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	<1,000	<1
		S2-C6	23-Feb-21	5.631	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
S2-C7	Comm/Ind	S2-C7	28-Sep-20	6.511	<50	<50	<60	<60	<500	<500	<320	<0.5	0.9	<0.5	<1	<0.5	<1.5	<0.5	<1,000	<1
		S2-C7	23-Feb-21	6.219	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
S2-C8	Comm/Ind	S2-C8	28-Sep-20	6.700	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	<1,000	<1
		S2-C8	23-Feb-21	6.298	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
S2-C9	Comm/Ind	S2-C9	28-Sep-20	7.374	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	<1,000	<1
		S2-C9	23-Feb-21	7.121	<50	<50	120	120	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
S2-C10	Comm/Ind	S2-C10	28-Sep-20	15.822	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	<1,000	<1
		S2-C10	23-Feb-21	15.408	<50	<50	1,600	1,600	<500	<500	1,600	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-

Ampol Holt (SITE ID: 22546)
Table F7
Historical Groundwater Results
February 2021 GME

					TRH NEPM (2013) Fractions							BTEX						PAH	Solvents	Metals
					TRH C6-C10	TRH C6 - C10 less BTEX (F1)	TRH C10 - C16 Fraction	TRH C10 - C16 less Naphthalene (F2)	TRH C16 - C34	TRH C34 - C40	TRH C10 - C40 (Total)	Benzene	Toluene	Ethylbenzene	Xylene (m & p)	Xylene (o)	Xylene (Total)	Naphthalene	Ethanol	Lead (filtered)
					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
EQL					20	20	60	60	100	100	100	0.5	0.5	0.5	1	0.5	1.5	0.1	50	1
ADWG 2011 (May 2019 Update) - Health					-	-	-	-	-	-	-	1	800	300			600	-	-	10
ANZG (2018) Freshwater 95% toxicant DGVs					-	-	-	-	-	-	-	950	180	80	75	350	-	16	1,400	3.4
Environmental Guidelines for Petroleum Storage in the ACT					-	-	-	-	-	-	600	950	300	140	-	350	600	16	1,400	3.4
NEPM 2013 Table 1A(4) Comm/Ind HSL D GW for Vapour Intrusion, Sand >=8m					-	7,000	-	NL	-	-	-	5,000	NL	NL	-	-	NL	NL	-	-
NEPM 2013 Table 1A(4) Rec HSL C GW for Vapour Intrusion, Sand >=8m					-	NL	-	NL	-	-	-	-	NL	NL	-	-	NL	NL	-	-
NEPM 2013 Table 1A(4) Rec HSL A GW for Vapour Intrusion, Sand >=8m					-	1,000	-	1,000	-	-	-	900	NL	NL	-	-	NL	NL	-	-
Location Code	**Landuse**	**Field ID**	**Date**	**DTW (mBTOC)**																
S2-R1	Open space	S2-R1	19-Nov-20	4.193	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	<1,000	<1
		S2-R1	24-Feb-21	4.391	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
S2-R2	Open space	S2-R2	19-Nov-20	4.091	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	<1,000	<1
		S2-R2	24-Feb-21	4.147	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
S2-R3	Open space	S2-R3	19-Nov-20	3.832	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	<1,000	<1
		S2-R3	24-Feb-21	4.005	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
S2-R4	Open space	S2-R4	19-Nov-20	3.432	<50	<50	<60	<60	<500	<500	<320	<0.5	0.7	<0.5	<1	<0.5	<1.5	<0.5	<1,000	<1
		S2-R4	24-Feb-21	3.498	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
S2-R5	Open space	S2-R5	19-Nov-20	3.749	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	<1,000	<1
		S2-R5	24-Feb-21	3.813	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
S2-R6	Open space	S2-R6	19-Nov-20	4.945	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	<1,000	<1
		S2-R6	24-Feb-21	4.998	<50	<50	<60	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
S2-D1	Residential	S2-D1	28-Sep-20	7.545	78,000	<50,000	400	350	840	<500	1,500	**3,100**	**35,000**	**610**	2,000	**840**	**2,800**	<500	-	-
		S2-D1	23-Feb-21	7.267	62,000	23,000	820	790	510	<500	1,900	**2,900**	**32,000**	**1,400**	1,500	**760**	**2,300**	<500	-	-
S2-D2	Comm/Ind	S2-D2	29-Sep-20	8.540	2,700	<2,500	160	150	<500	<500	470	160	**1,700**	45	160	66	230	<25	-	-
		S2-D2	22-Feb-21	8.254	5,400	2,200	<60	<60	<500	<500	<320	260	**2,700**	47	120	72	190	<25	-	-
IW1	Comm/Ind	IW1	29-Sep-20	8.911	250,000	140,000	8,700	8,500	1,800	<500	12,000	**7,900**	**94,000**	**1,700**	5,800	**2,400**	**8,200**	<1,000	-	-
		IW1	24-Feb-21	8.475	160,000	69,000	24,000	24,000	4,800	<500	32,000	**4,600**	**71,000**	**1,900**	5,800	**2,600**	**8,400**	<1,000	-	-
IW2	Comm/Ind	IW2	29-Sep-20	9.471	180,000	<100,000	10,000	9,900	1,500	<500	14,000	**7,600**	**75,000**	**2,400**	8,200	**3,300**	**11,000**	<1,000	-	-
		IW2	24-Feb-21	9.125	23,000	18,000	1,300	1,200	<500	<500	2,400	88	**3,100**	370	1,300	550	**1,900**	<50	-	-
IW3	Comm/Ind	IW3	28-Sep-20	10.774	<50	<50	100	100	<500	<500	<320	<0.5	<0.5	<0.5	<1	<0.5	<1.5	<0.5	-	-
		IW3	24-Feb-21	10.342	16,000	8,700	11,000	11,000	4,500	<500	16,000	1,900	5,100	120	<200	110	270	<100	-	-
PEW1	Comm/Ind	PEW1	29-Sep-20	8.757	440,000	<250,000	2,400	2,000	630	<500	5,100	**20,000**	**180,000**	**4,800**	13,000	**5,300**	**18,000**	<2,500	-	-
		PEW1	24-Feb-21	8.498	<250,000	80,000	2,900	2,500	<500	<500	5,100	**9,000**	**92,000**	**<2,500**	5,700	**3,000**	**8,600**	<2,500	-	-
PMW1	Comm/Ind	PMW1	28-Sep-20	8.751	290,000	<250,000	2,400	1,900	<500	<500	4,600	**10,000**	**130,000**	**3,900**	11,000	**4,800**	**16,000**	<2,500	-	-
		PMW1	24-Feb-21	8.476	<250,000	93,000	2,100	1,900	500	<500	4,400	**11,000**	**130,000**	**2,900**	7,300	**3,400**	**11,000**	<2,500	-	-
PMW2	Comm/Ind	PMW2	29-Sep-20	8.467	310,000	<250,000	1,500	1,300	<500	<500	3,100	**17,000**	**140,000**	**3,400**	9,400	**4,000**	**13,000**	<2,500	-	-
		PMW2	24-Feb-21	8.192	<250,000	73,000	1,700	1,500	550	<500	3,700	**13,000**	**92,000**	**<2,500**	5,300	**2,600**	**7,900**	<2,500	-	-
PMW3	Comm/Ind	PMW3	28-Sep-20	7.757	200,000	71,000	1,600	1,400	<500	<500	3,000	**11,000**	**110,000**	**2,100**	6,500	**2,700**	**9,200**	<500	-	-
		PMW3	23-Feb-21	7.505	190,000	76,000	1,100	910	<500	<500	2,300	**9,300**	**92,000**	**1,100**	4,800	**2,300**	**7,000**	<1,000	-	-
PMW4	Comm/Ind	PMW4	28-Sep-20	8.521	280,000	100,000	1,900	1,600	<500	<500	3,800	**12,000**	**150,000**	**3,300**	9,800	**4,200**	**14,000**	<500	-	-
		PMW4	24-Feb-21	8.253	160,000	69,000	1,100	970	790	<500	3,300	**6,500**	**77,000**	**1,800**	5,600	**2,600**	**8,200**	<1,000	-	-
RW01	Comm/Ind	RW01	21-Apr-20	2.590	241,000	60,000	1,740	1,740	<100	<100	1,740	**17,600**	**146,000**	**3,530**	9,680	**4,200**	**13,900**	83.8	3,340	<1
		RW01	28-Sep-20	2.736	<250,000	<250,000	4,000	3,600	860	<500	7,100	**20,000**	**170,000**	**4,000**	12,000	**5,000**	**17,000**	<2,500	-	-
		RW01	24-Feb-21	2.513	290,000	94,000	2,600	2,600	<500	<500	4,000	**14,000**	**170,000**	**3,000**	8,300	**4,200**	**13,000**	<2,500	-	-

Notes:
Concentration expressed in µg/L unless otherwise stated
Elevalted LORs greater than the assessment criteria are considered to be exceedances
(1) ANZAST (2018) – Water quality guidelines (95% trigger values for fresh water have been used)
(2) National Health and Medical Research Council (NHMRC)/National Resource Management Ministerial Council (NRMMC) (2011) – Australian Drinking Water Guidelines 6.
(3) NEPM (2013) – Schedule B-1 Investigation Levels for Soil and Groundwater – Table 1A(4) Groundwater HSLs for vapour intrusion
(4) ACT EPA (2019) Environmental Guidelines for Petroleum Storage in the ACT - as provided in the site's Environmental Authorisation (EA) No. 0749
EQL - Estimated Quantitation Limit
NL - non limiting
Dash (-) denotes no criteria available

Concentration exceeding ACT Petroleum Storage Guidelines 2019
Concentrations exceeding NEPM 2013 Table 1A(4) Comm/Ind HSL D GW for Vapour Intrusion, Sand ≥8 metres
Concentrations exceeding NEPM 2013 Table 1A(4) Rec HSL C GW for Vapour Intrusion, Sand ≥8 metres
Concentrations exceeding NEPM 2013 Table 1A(4) Res HSL A & B GW for Vapour Intrusion, Sand, ≥8 metres
Concentrations exceeding ANZAST (2018) – Water quality guidelines, Fresh Waters, 95%
Concentrations exceeding ANZG 2018 Drinking Water Guidelines 6

BOLD - Concentrations exceeding ANZG 2018 Drinking Water Guidelines 6 in addition to other criteria values

Ampol Holt (SITE ID: 22546)
Table F8
Natural Attenuation Results
February 2021 GME

PS123812

								BTEXN					Natural attenuation parameters						
				C6-C10 minus BTEX (F1)	C10-C16 minus Naphthalene (F2)	C16-C34 (F3)	C34-C40 (F4)	C10-C40 (Sum of total)	Benzene	Toluene	Ethylbenzene	Xylene Total	Naphthalene	Nitrate (as N) (filtered)	Sulphate (filtered)	Ferrous Iron (filtered)	Methane	Dissolved oxygen	pH
				µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	µg/L	mg/L	
EQL				20	60	100	100	100	0.5	0.5	0.5	1.5	0.5	0.005	1	0.05	5		
Well ID	**Sampling Date**	**Depth to Water (mBTOC)**	**LNAPL Thickness (m)**																
Background/Non-impacted boundary wells																			
S2-C5	22-Feb-21	5.074	-	<50	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1.5	<0.5	0.94	13	<0.05	<5	2.52	6.53
S2-P2	23-Feb-21	6.683	-	<50	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1.5	<0.5	4.4	56	<0.05	<5	2.46	5.73
S2-P5	22-Feb-21	4.120	-	<50	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1.5	<0.5	0.089	44	<0.05	<5	2	5.4
S2-P6	22-Feb-21	2.728	-	<50	<60	<500	<500	<320	<0.5	<0.5	<0.5	<1.5	<0.5	3.9	79	<0.05	16	1.4	7.42
S2-C10	23-Feb-21	15.408	-	<50	1,600	<500	<500	1,600	<0.5	<0.5	<0.5	<1.5	<0.5	15	260	<0.05	<5	1.15	5.56
Impacted wells																			
EW01	24-Feb-21	8.514	-	63,000	1,700	3,100	<500	5,900	10,000	100,000	<2,500	8,100	<2,500	<0.005	8.5	0.35	31	0.77	9.23
MW01	24-Feb-21	9.182	-	49,000	6,500	8,200	<500	18,000	2,000	49,000	<1,000	12,000	<1,000	<0.005	130	0.20	8	1.2	8.58
MW02	24-Feb-21	8.741	-	50,000	4,400	3,800	<500	10,000	4,400	72,000	<2,500	11,000	<2,500	<0.005	5.3	<0.05	12	0.7	6.41
MW04	24-Feb-21	8.018	-	3,700	260	<500	<500	330	1,400	2,100	<25	200	<25	<0.005	54	<0.05	<5	0.12	7.81
MW05	24-Feb-21	8.090	-	58,000	3,000	1,900	<500	6,500	9,800	88,000	<2,500	7,500	<2,500	<0.005	72	<0.05	17	0.87	5.62
MW06	22-Feb-21	8.403	-	72,000	2,600	3,400	<500	6,900	9,700	100,000	<2,500	8,600	<2,500	1.1	630	<0.05	12	1.62	6.61
MW07	22-Feb-21	8.730	-	76,000	3,000	10,000	<500	15,000	9,400	85,000	<1,000	9,000	<1,000	<0.005	350	0.22	<5	0.13	7.08
MW10	24-Feb-21	10.413	-	110,000	5,100	1,100	<500	9,000	9,000	130,000	2,900	13,000	<2,500	0.017	150	<0.05	6	0.48	6.81
MW15	23-Feb-21	7.300	0.065	83,000	1,800	<500	<500	3,000	12,000	150,000	<2,500	9,200	<2,500	<0.005	5.3	0.06	14	0.86	6.17
MW16	23-Feb-21	7.432	0.071	98,000	6,700	1,100	<500	12,000	11,000	160,000	<2,500	13,000	<2,500	<0.005	30	<0.05	5	1.15	6.95
MW17	23-Feb-21	7.357	-	26,000	730	<500	<500	1,400	3,600	37,000	<1,000	4,300	<1,000	<0.005	8.8	0.16	6	1.41	9.05
MW24	23-Feb-21	10.165	-	<50,000	920	1,900	<500	3,400	5,600	46,000	590	4,400	85	<0.005	41	0.09	6	1.13	6.86
IW1	24-Feb-21	8.475	-	69,000	24,000	4,800	<500	32,000	4,600	71,000	1,900	8,400	<1,000	0.97	2,400	<0.05	29	0.6	-
PMW1	24-Feb-21	8.476	-	93,000	1,900	500	<500	4,400	11,000	130,000	2,900	11,000	<2,500	<0.005	200	<0.05	18	0.87	7.15
PMW3	23-Feb-21	7.505	-	76,000	910	<500	<500	2,300	9,300	92,000	1,100	7,000	<1,000	<0.005	59	<0.05	17	1.2	7.01

Caltex Holt (SITE ID: 22546)
Table F9
Stage 2 ESA - Historical Soil Results from Stage 1 ESA

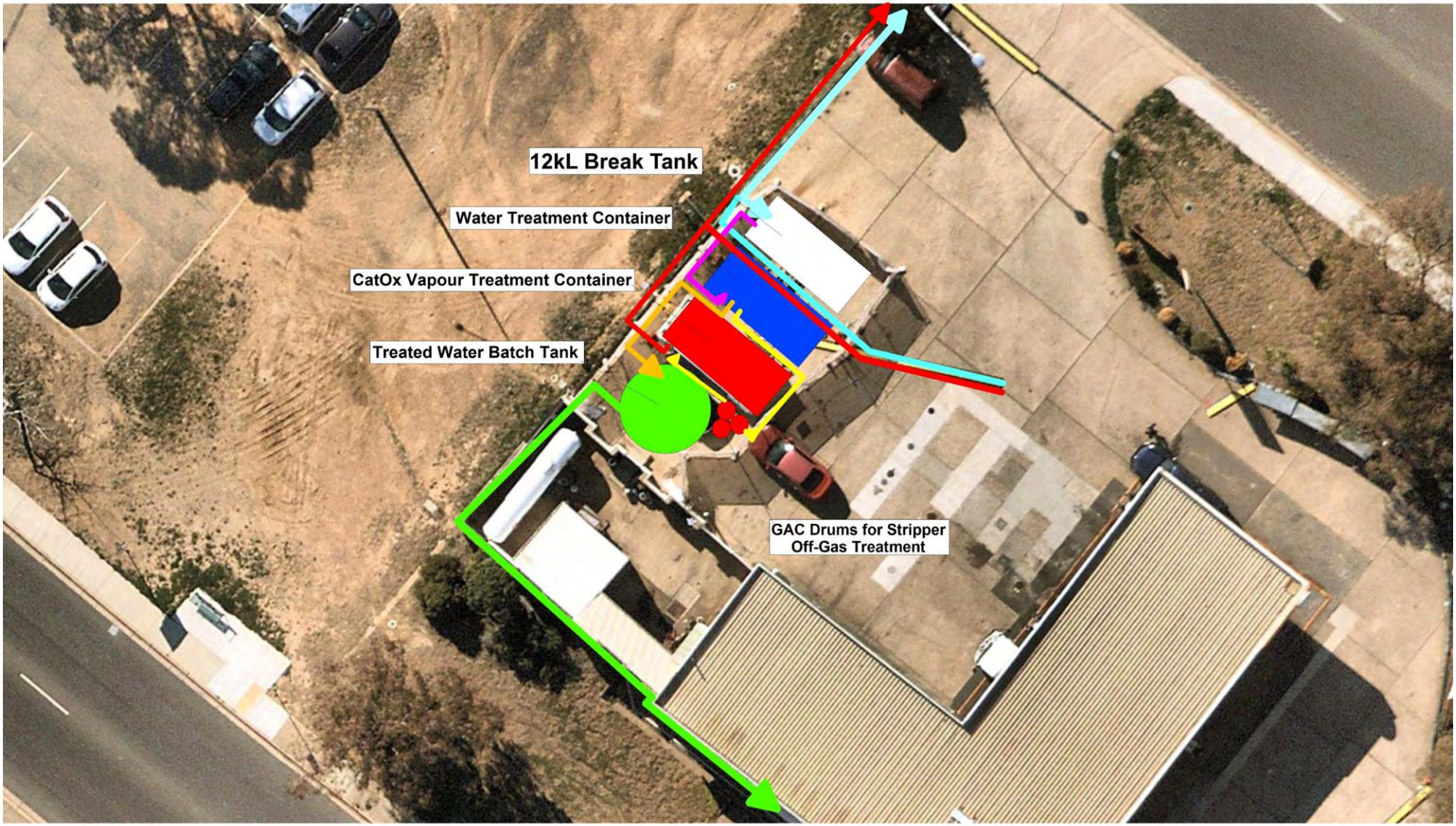
					TRH NEPM (2013)							BTEX							PAH
					TRH C6-C10	TRH C6 - C10 less BTEX (F1)	TRH >C10 - C16 Fraction	TRH C10 - C16 less Naphthalene (F2)	TRH >C16 - C34	TRH >C34 - C40	TRH C10 - C40 (Total)	Benzene	Toluene	Ethylbenzene	Xylene (m & p)	Xylene (o)	Xylene (Total)	Naphthalene
					mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
EQL					10	10	25	25	90	100	50	0.1	0.1	0.1	0.2	0.1	0.3	0.1
CRC Care 2011 Table 4 HSL-A Residential (Direct Contact) [2]					4,400	-	3,300	-	4,500	6,300	-	100	14,000	4,500	-	-	12,000	1,400
CRC Care 2011 Table 4 HSL-D Commercial / Industrial (Direct Contact) [2]					26,000	-	20,000	-	27,000	38,000	-	430	99,000	27,000	-	-	81,000	11,000
CRC Care 2011 Table B4 Intrusive Maintenance Worker (Direct Contact) [2]					82,000	-	62,000	-	85,000	120,000	-	1,100	120,000	85,000	-	-	130,000	29,000
CRC Care 2011 Table B3 Intrusive Workers, Sand [2]																		
0-2m					-	NL	-	NL	-	-	-	77	NL	NL	-	-	NL	NL
2-4m					-	NL	-	NL	-	-	-	160	NL	NL	-	-	NL	NL
>=4m					-	NL	-	NL	-	-	-	NL	NL	NL	-	-	NL	NL
NEPM 2013 Table 1A(3) Res A Soil HSL for Vapour Intrusion, Sand [1]																		
0-1m					-	45	-	110	-	-	-	0.5	160	55	-	-	40	3
1-2m					-	70	-	240	-	-	-	0.5	220	NL	-	-	60	NL
2-4m					-	110	-	440	-	-	-	0.5	310	NL	-	-	95	NL
>=4m					-	200	-	NL	-	-	-	0.5	540	NL	-	-	170	NL
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand [1]																		
0-1m					-	260	-	NL	-	-	-	3	NL	NL	-	-	230	3
1-2m					-	370	-	NL	-	-	-	3	NL	NL	-	-	NL	NL
2-4m					-	630	-	NL	-	-	-	3	NL	NL	-	-	NL	NL
>=4m					-	NL	-	NL	-	-	-	3	NL	NL	-	-	NL	NL
Location Code	**Landuse Criteria**	**Field ID**	**Date**	**Lab Report Number**														
MW04	Comm/Ind	MW04_2.0-2.1	3/24/2020	ES2011204	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW04_5.0-5.1	3/24/2020	ES2011204	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW04_8.0-8.1	3/24/2020	ES2011204	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW04_12.0-12.1	3/24/2020	ES2011204	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
MW05	Comm/Ind	MW05_3.0-3.1	3/24/2020	ES2011204	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW05_7.0-7.1	3/24/2020	ES2011204	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW05_10.0-10.1	3/24/2020	ES2011204	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW05_12.0-12.1	3/24/2020	ES2011204	4,950	1,820	280	270	<100	<100	280	23.2	2,180	181	552	192	744	12
		QC01	3/24/2020	ES2011204	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		QC01-A	3/24/2020	SE204939	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.1
MW06	Comm/Ind	MW06_1.9-2.0	3/26/2020	ES2011204	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW06_6.9-7.0	3/26/2020	ES2011204	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW06_10.9-11.0	3/24/2020	ES2011204	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW06_12.9-13.0	3/24/2020	ES2011204	935	612	120	120	<100	<100	120	<0.5	168	26.0	93.2	35.6	129	3
MW07	Comm/Ind	MW07_1.4-1.5	3/25/2020	ES2011204	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW07_5.9-6.0	3/25/2020	ES2011204	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
MW09	Comm/Ind	MW09_1.9-2.0	3/26/2020	ES2011204	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW09_7.9-8.0	3/26/2020	ES2011204	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW09_12.9-13.0	3/26/2020	ES2011204	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW09_15.9-16.0	3/26/2020	ES2011204	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
MW10	Comm/Ind	MW10_3.9-4.0	3/26/2020	ES2011204	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW10_10.9-11.0	3/26/2020	ES2011204	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW10_11.9-12.0	3/26/2020	ES2011204	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW10_13.9-14.0	3/26/2020	ES2011204	57	53	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	2.7	1.7	4.4	1
MW11	Comm/Ind	MW11_2.0-2.1	3/27/2020	ES2011204	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW11_5.0-5.1	3/27/2020	ES2011204	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW11_8.0-8.1	3/27/2020	ES2011204	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW11_10.0-10.1	3/27/2020	ES2011204	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
MW12	Comm/Ind	MW12_2.9-3.0	3/30/2020	ES2011204	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW12_4.9-5.0	3/30/2020	ES2011204	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW12_7.9-8.0	3/30/2020	ES2011204	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW12_9.9-10.0	3/30/2020	ES2011204	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW12_10.4-10.5	3/30/2020	ES2011204	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
MW13	Comm/Ind	MW13_4.9-5.0	3/30/2020	ES2011204	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW13_6.9-7.0	3/30/2020	ES2011204	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW13_7.9-8.0	3/30/2020	ES2011204	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW13_8.9-9.0	3/30/2020	ES2011204	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		QC02	3/30/2020	ES2011204	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		QC02-A	3/30/2020	SE204939	<25	<25	<25	<25	<90	<120	<210	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.1
MW14	Comm/Ind	MW14_3.9-4.0	3/30/2020	ES2011204	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW14_5.9-6.0	3/30/2020	ES2011204	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW14_8.9-9.0	3/30/2020	ES2011204	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW14_9.9-10.0	3/30/2020	ES2011204	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
MW15	Residential	MW15_3.0-3.1	3/31/2020	ES2012670	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW15_6.0-6.1	3/31/2020	ES2012670	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW15_9.0-9.1	3/31/2020	ES2012670	190	144	<50	<50	<100	<100	<50	<0.2	11.1	5.4	20.4	9.2	29.6	2
		MW15_10.5-10.6	3/31/2020	ES2012670	620	391	<50	<50	<100	<100	<50	1.4	149	14.4	46.3	17.6	63.9	2
		QC3	3/31/2020	ES2012670	229	178	<50	<50	<100	<100	<50	<0.2	10.6	6.3	23.1	10.6	33.7	2
		QC2A	3/31/2020	SE205402	200	130	86	83	<90	<120	<210	<0.2	13	8.7	31	15	46	4.4
MW16	Residential	MW16_3.9-4.0	4/1/2020	ES2012670	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW16_5.9-6.0	4/1/2020	ES2012670	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW16_7.9-8.0	4/1/2020	ES2012670	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW16_8.9-9.0	4/1/2020	ES2012670	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
MW17	Residential	MW17_4.9-5.0	4/1/2020	ES2012670	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW17_6.9-7.0	4/1/2020	ES2012670	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW17_8.9-9.0	4/1/2020	ES2012670	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW17_9.9-10.0	4/1/2020	ES2012670	132	104	<50	<50	<100	<100	<50	<0.2	5.6	3.2	13.0	5.7	18.7	2
		QC04	4/1/2020	ES2014995	102	76	<50	<50	<100	<100	<50	<0.2	6.0	2.9	11.6	5.2	16.8	1
		QC04A	4/1/2020	ES2014995	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
MW18	Comm/Ind	MW18_3.9-4.0	4/9/2020	ES2012670	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW18_5.9-6.0	4/9/2020	ES2012670	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW18_8.9-9.0	4/9/2020	ES2012670	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
MW19	Comm/Ind	MW19_1.5-1.6	4/8/2020	ES2012670	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW19_1.9-2.0	4/8/2020	ES2012670	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW19_7.9-8.0	4/8/2020	ES2012670	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW19A_1.9-2.0	4/1/2020	ES2012670	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
MW20	Comm/Ind	MW20_4.9-5.0	4/1/2020	ES2012670	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW20_7.9-8.0	4/1/2020	ES2012670	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW20_11.9-12.0	4/1/2020	ES2012670	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
MW21	Comm/Ind	MW21_2.9-3.0	4/2/2020	ES2012670	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW21_5.9-6.0	4/2/2020	ES2012670	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW21_9.9-10.0	4/2/2020	ES2012670	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW21_11.9-12.0	4/2/2020	ES2012670	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
MW23	Residential	MW23_3.9-4.0	4/6/2020	ES2012670	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW23_7.9-8.0	4/6/2020	ES2012670	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW23_10.9-11.0	4/6/2020	ES2012670	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW23_12.9-13.0	4/6/2020	ES2012670	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
MW24	Residential	MW24_4.9-5.0	4/7/2020	ES2012670	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW24_8.9-9.0	4/7/2020	ES2012670	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW24_11.9-12.0	4/7/2020	ES2012670	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW24_13.9-14.0	4/7/2020	ES2012670	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
MW25	Residential	MW25_3.9-4.0	4/6/2020	ES2012670	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
		MW25_6.9-7.0	4/6/2020	ES2012670	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
RW01	Comm/Ind	RW1-10-4-8	4/7/2020	ES2014995	<10	<10	<50	<50	<100	<100	<50	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1
QAQC	N/A	Trip Blank	4/20/2020	ES2014995	<10	<10	-	-	-	-	-	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<1

Notes:
Concentration expressed in mg/kg unless otherwise stated
[1] NEPM (2013) – Schedule B-1 Investigation Levels for Soil and Groundwater – Table 1A(3) Soil HSLs for vapour intrusion
[2] CRC CARE (2011) Technical Report No. 10 – Table B1 Soil vapour health screening levels
EQL - Estimated Quantitation Limit
NL - non limiting
Dash (-) denotes no criteria available

Concentration exceeding CRC Care 2011 Table 4 HSL-A Residential (Direct Contact)
Concentrations exceeding CRC Care 2011 Table 4 HSL-D Commercial / Industrial (Direct Contact)
Concentrations exceeding CRC Care 2011 Table B4 Intrusive Maintenance Worker (Direct Contact)
Concentrations exceeding CRC Care 2011 Table B3 Intrusive Workers, Sand
Concentrations exceeding NEPM 2013 Table 1A(3) Res A Soil HSL for Vapour Intrusion, Sand
Concentrations exceeding NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand

APPENDIX G

INSITE REMEDIATION SYSTEM DESIGN DRAWINGS



Legend

= Soil Vapour from Wells to CatOx
= Contaminated Water from Wells to Break Tank
= Contaminated Water from Break Tank to WTS
= Treated Water to Batch Treated Batch Tank
= Treated Water from Batch Tank to Sewer Discharge
= Stripper Off-Gas to GAC and CatOx Treatment

Figure 2 – WSP Caltex Holt WTS and CatOx Site Layout Diagram

Project No: IR02650

Project Name: WSP Caltex Holt

Client: WSP/Caltex

Site Address: 1 Hardwick Crescent, Holt ACT 2615

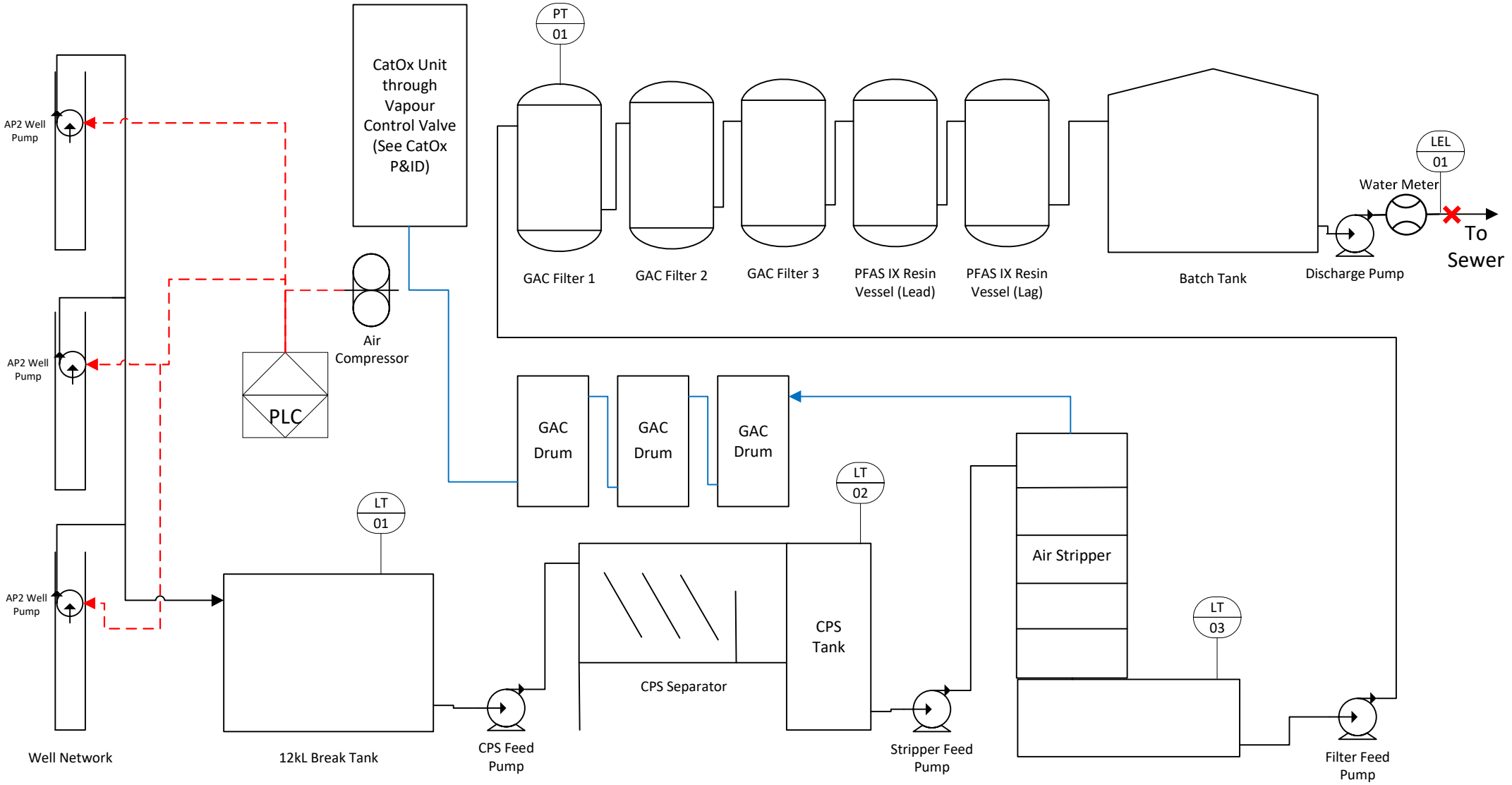
Date: 20/10/2020

Scale:

No Scale

Revision V1

Drawn by: [redacted]



Legend

PT = Pressure Transmitter

LT = Level Transmitter

LEL = Lower Explosive Limit Meter

PLC = Programmable Logic Controller

= Fluid Flow

= Air Supply

= Air Stripper Off-Gas

= Sample Point

Figure 1 *– WSP Caltex Holt WTS Schematic*

Project No: IR02650

Project Name: WSP Caltex Holt

Client: WSP/Caltex

Site Address: 1 Hardwick Crescent, Holt ACT 2615

Date: 23/04/2021

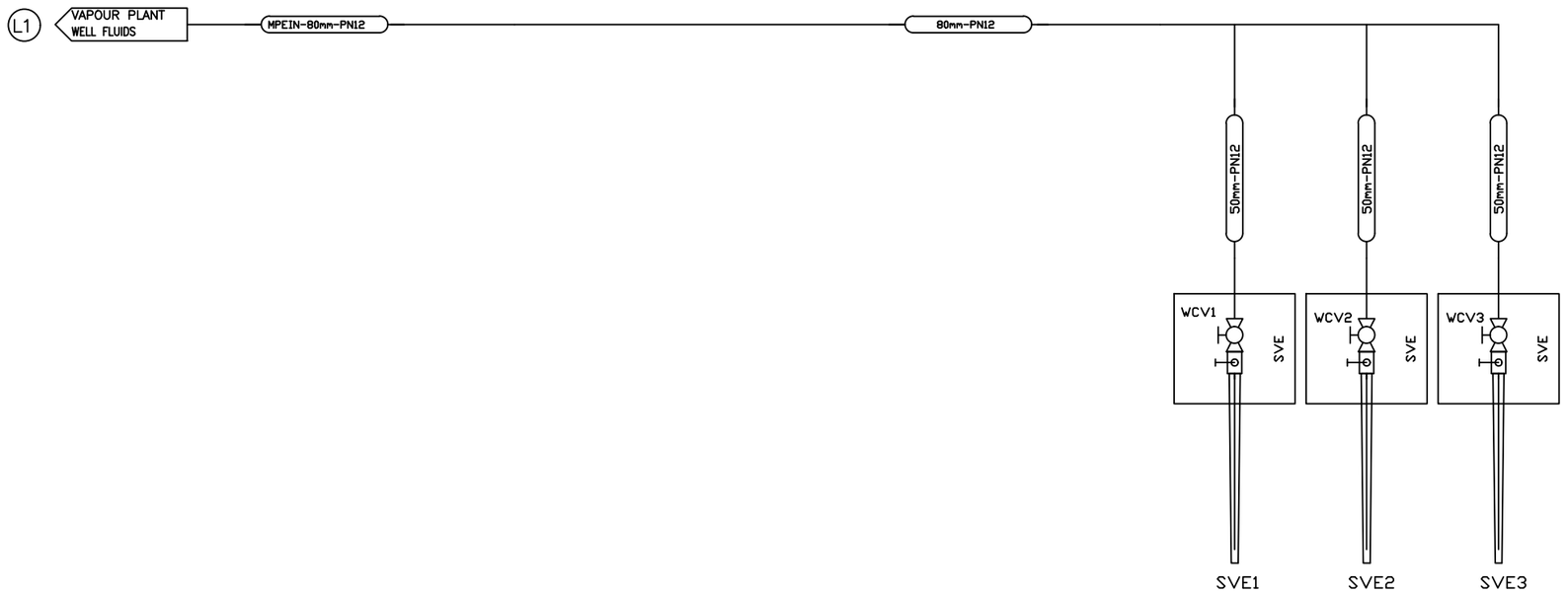
Scale:

No Scale

Revision V2

Drawn by [redacted]

WELL FIELD
TO FIGURE 12



ISSUE	DATE	AMENDMENTS	APPD	ISSUE	DATE	AMENDMENTS
B	26/08/08	Addition of MPE5&6				
A	04/10/05	Original Issue				

A3

CHECKED:

APPROVED:

P&ID SVE WELL FIELD

PURPOSE: Process design schematic.

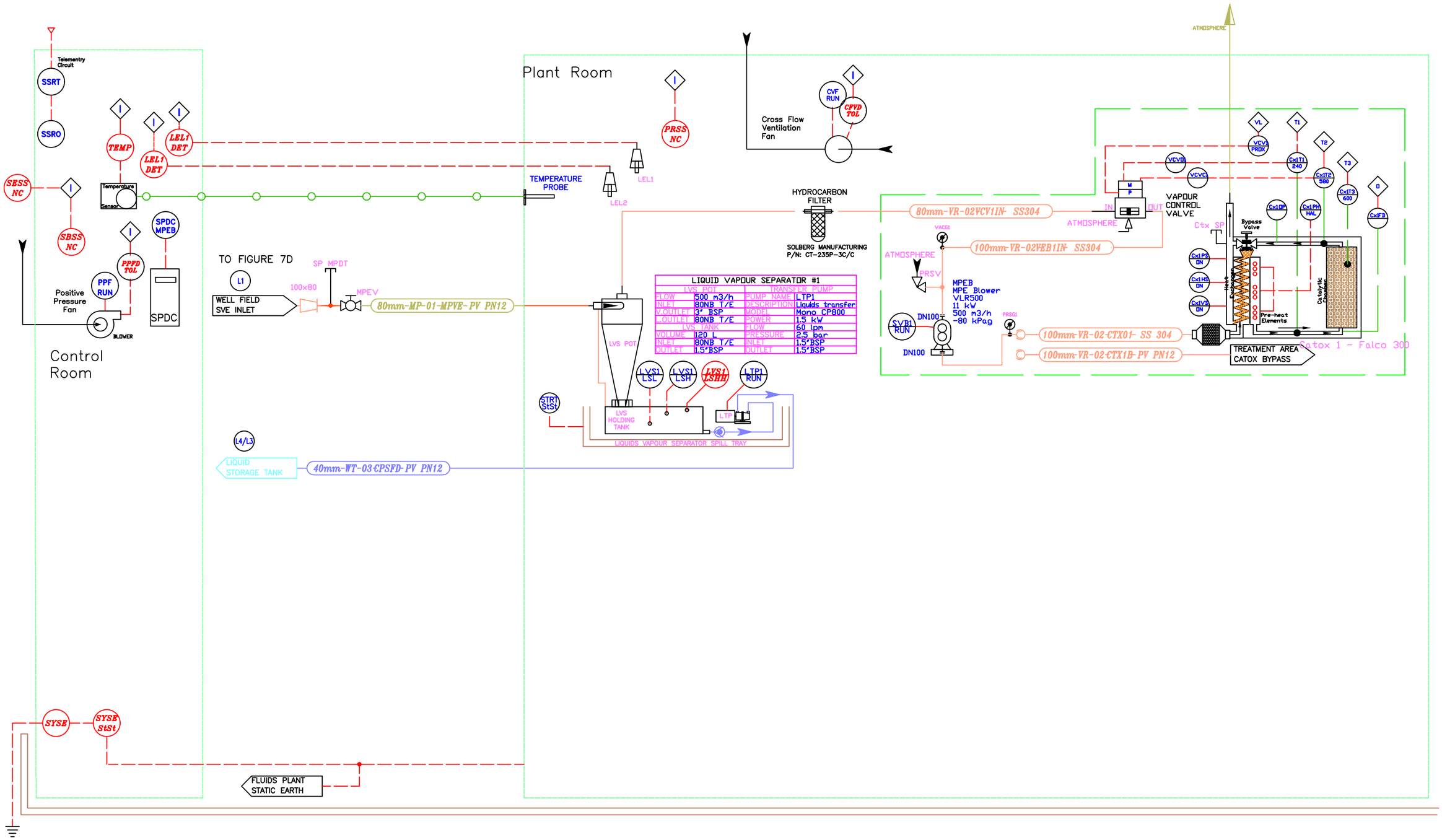
LOCATION: 373 – 375 Armidale Road TAMWORTH, NSW

DESIGNED: [redacted] DATE: 07/08/2007

DRAWN: [redacted] REV. NO: A

Job Number: ENVIRHOD00251CA

Figure: **7d**



A	04/10/05	Original Issue	AS	CJ								
ISSUE	DATE	AMENDMENTS	DRN	CKD	APPD	ISSUE	DATE	AMENDMENTS	DRN	CKD	APPD	

A3

CHECKED:

APPROVED:

InSite REMEDIATION SERVICES

PURPOSE: GMD

LOCATION:

DESIGNED: CJ

DATE: 13-09-2011

Job Number:

Figure: 12

DRAWN: AS

REV. NO: A

APPENDIX H

EPA VICTORIA PUBLICATION 840.2

The cleanup and management of polluted groundwater

EPA VICTORIA | Environment Protection Authority Victoria

Publication 840.2* April 2016
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Guideline

These guidelines provide details on EPA's requirements and expectations for developing and implementing the cleanup and management of polluted groundwater, to ensure the protection of human health and the environment.

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1. Protection of groundwater quality in Victoria

Groundwater is an important and often overlooked part of the environment. Groundwater discharges to surface water, supporting ecosystems (for example, rivers and wetlands) and is utilised for a range of beneficial uses including drinking, irrigation, stock and industrial uses.

The focus of groundwater quality protection is on the prevention of groundwater pollution, however, where groundwater has become polluted, it must be cleaned up and managed to ensure the ongoing protection of human health and the environment.

Where polluted groundwater has been identified, EPA Victoria's (EPA's) role is to require cleanup. If it is impracticable to clean up groundwater to the level needed to restore beneficial uses, EPA may accept that cleanup to the extent practicable has occurred and that, subject to appropriate ongoing management, further cleanup is not required. Polluted groundwater can be identified by investigations prompted either by the application of EPA's statutory tools (for example, notices) and programs (for example, environmental audits) or by investigations that do not directly involve EPA, such as corporate risk management programs and land sale agreements. Where polluted groundwater is identified but cleanup has not been required by statutory means or by EPA programs, it is recommended that EPA be consulted regarding the cleanup/management strategy.

Any plan for cleanup and/or management of polluted groundwater should specifically address Sections 3 to 8 of these guidelines. A generic procedure for the cleanup and management of polluted groundwater is presented in appendix 1. These guidelines are primarily directed towards circumstances where investigations have found pollution to exist.

1.1 The State Environment Protection Policy (SEPP) (Groundwaters of Victoria) 1997

The *State Environment Protection Policy (SEPP) (Groundwaters of Victoria)* 1997 (Groundwater SEPP) sets out a framework for the protection of groundwater quality in Victoria.

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The *Groundwater SEPP* identifies the:

- segments of the groundwater environment according to total dissolved solids (TDS) (approximates the salinity of the groundwater)
- beneficial uses to be protected in each segment of the groundwater environment (for example, potable water supply, agriculture, parks and gardens, and maintenance of ecosystems)
- groundwater quality objectives by which to measure the protection of these beneficial uses.

The *Groundwater SEPP* requires the protection of *existing* and *potential* beneficial uses of groundwater from pollution. Unless stated otherwise in these guidelines, the term 'beneficial uses' refers to both existing and potential uses.

A beneficial use may be considered 'existing' where there is a receptor (bore, spring or creek) in the vicinity of the site.

'Potential' beneficial uses are those that could be supported by the background groundwater quality. Some potential beneficial uses are more likely to be realised than others. A potential beneficial use of groundwater is considered 'likely' in circumstances including, but not limited to, where:

- groundwater is used in the same hydrogeological setting nearby or elsewhere in Victoria
- the existing and likely future land uses, both at the site and in the vicinity of the site, are compatible with the beneficial use.

Contamination is defined in the *Groundwater SEPP* as a change in water quality that produces a noticeable or measurable change in groundwater characteristics. Clause 10(3) of the *Groundwater SEPP* states that groundwater quality is to be maintained as close as practicable to background levels (that is, to minimise any change to groundwater quality).

Pollution of groundwater includes situations where groundwater quality is changed such that the groundwater is no longer suitable for a beneficial use. Such situations are defined as occurring where groundwater quality objectives for any protected beneficial use (referred to in table 3 of the *Groundwater SEPP*) are exceeded or where there is otherwise a detriment to a beneficial use (for example, irrigation water becomes odorous to such an extent that it is no longer used).

The groundwater quality objectives for most beneficial uses of groundwater apply at any point in the aquifer from which groundwater could be abstracted for use via a bore. However, for the beneficial use 'maintenance of ecosystems', the objectives apply at the point of discharge to surface water (that is, prior to dilution and mixing with the surface water). Where contaminated groundwater present at a site could discharge to surface water, the quality of the discharging groundwater should not exceed the *Groundwater SEPP* objectives for 'maintenance of ecosystems'.

Where groundwater has been polluted:

- Groundwater should be cleaned up such that the protection of beneficial uses (existing and potential) is restored. In some cases this will not be possible or feasible, however, in all cases polluted groundwater must be cleaned up to the extent practicable (as described in Section 6.2 of these guidelines).
- Cleanup and management must address the full extent of groundwater pollution both onsite and offsite.
- Ongoing management must continue until the protection of beneficial uses is restored (that is, the groundwater is no longer polluted) or EPA is satisfied that ongoing groundwater management is not required or can cease.

2. The role of EPA in the cleanup and management of polluted groundwater

EPA implements the *Groundwater SEPP* through its statutory tools (that is, works approvals, licences and notices), programs such as environmental auditing and through the provision of information to industry and the broader community.

Where EPA becomes aware of groundwater pollution, it may require cleanup and/or management of polluted groundwater (consistent with these guidelines) by notice under Sections 31A/B and 62A of the *Environment Protection Act 1970*. Such notices are issued in accordance with EPA's Enforcement Policy (EPA Publication 384) after considering the degree and extent of pollution and likelihood of detriment posed to beneficial uses.

Where polluted groundwater is identified through a statutory environmental audit, EPA may use its statutory tools to give effect to the conditions of any statement of environmental audit related to groundwater pollution, or to otherwise require cleanup.

Responsible parties are encouraged to inform EPA of groundwater pollution at the earliest opportunity to enable consistency and certainty in the outcome for the responsible party. Responsible parties, typically the polluter and/or occupier, are those responsible for the cleanup and management of polluted groundwater consistent with the abatement and cleanup provisions of the *Environment Protection Act 1970*. If sought, EPA will provide advice on:

- whether source removal or groundwater cleanup has occurred to the extent practicable (see Sections 4.1 and 6.2 in these guidelines)
- risk assessment methodology used to derive groundwater quality objectives where there is no stated objective or where *Groundwater SEPP* objectives may be inappropriate (see Section 5 below)
- cleanup objectives (where they are above *Groundwater SEPP* objectives) (see Section 6 below)

- the preparation and implementation of any plan to manage polluted groundwater (including agreeing to monitoring requirements, trigger levels, contingency plans, controls on groundwater use and periodic review of practicability of cleanup) (see Section 7)
- when to cease cleanup and management of polluted groundwater (that is, when beneficial uses are protected) (see Section 7.6).

Regardless of whether EPA is directly involved in the cleanup and management of polluted groundwater at or from a site, only EPA can determine:

- the segment to which groundwater in any aquifer belongs (clause 8, *Groundwater SEPP*) and therefore the beneficial uses to be protected
- whether a beneficial use specified in table 2 of the Groundwater SEPP does not apply (for example, where there is insufficient aquifer yield to sustain a beneficial use or the background quality is detrimental to a beneficial use, or where a use is impracticable due to one or more soil characteristics) (clause 9(2), *Groundwater SEPP*)
- whether there is no unacceptable risk posed to any beneficial use of groundwater by a non-aqueous phase liquid (NAPL) present in an aquifer (clause 18, *Groundwater SEPP*)
- whether groundwater has been cleaned up to the extent practicable (clause 19, *Groundwater SEPP*) or in accordance with Section 13.6 of EPA Publication 759, which details the role of environmental auditors in these determinations
- whether *the Groundwater* SEPP objectives will be met at the completion of the project and no detriment will occur to beneficial uses beyond the premises for groundwater remediation projects involving the injection of uncontaminated water or the reinjection of treated water into the aquifer (clause 20, *Groundwater SEPP*).

In order to gain a determination from EPA on these matters, the responsible party should:

1) write to EPA providing relevant information, a scientifically reasoned opinion and seeking advice
2) await advice from EPA
3) complete cleanup/management in accordance with the EPA advice or direction.

EPA can also advise on other regulatory requirements related to the cleanup and management of polluted groundwater (see Section 8 of these guidelines).

Where polluted groundwater is identified and remains in place after cleanup to the extent practicable has occurred, it is EPA's role to inform relevant rural water authorities and make information available to the community in accordance with Section 9 of these guidelines.

3. Characterisation of groundwater and aquifers

Prior to any cleanup and/or management of polluted groundwater, groundwater and aquifer characterisation should be undertaken to assess the nature, extent and degree of pollution. It may also provide information about the groundwater and the aquifer that is useful in assessing the risk posed by the pollution and in the design of cleanup activities. Note that where an imminent hazard is identified, some immediate cleanup action is necessary prior to the completion of groundwater and aquifer characterisation.

Groundwater and aquifer characterisation involves collecting data to define:

- site geology and hydrogeology (for example, aquifer type and configuration, porosity type, identification of preferential pathways, and groundwater flow direction and velocity, including spatial and temporal variability of these parameters)
- the extent of the plume, and the nature and spatial and temporal distribution of contaminants within the plume and surrounding media (for example, type and concentration ranges of the contaminant(s), contaminant phase distribution including non-aqueous phase distribution and partitioning between groundwater, aquifer material and gas, contaminant transformation processes including transformation rate estimates and sorption capacity)
- the current and potential impact of contaminants on beneficial uses of the groundwater (for example, background groundwater TDS, other relevant groundwater quality indicators and aquifer yield data). This assists in determining the beneficial uses that apply to the groundwater and the potential for the plume configuration to change over time (for example, pumping from a nearby bore and tidal or seasonal influences).

When combined with a thorough investigation of available cleanup technologies (Section 6.1 in these guidelines), such characterisation assists in identifying practicable cleanup options.

For detailed guidance on groundwater sampling, refer to EPA Publication 669, *Groundwater Sampling Guidelines*.

4. Source removal and control

Possible sources of groundwater pollution include unsealed storage or production areas, leaking product pipelines, historical waste disposal activities (for example, pouring liquid waste into quarries/trenches), leaking underground petroleum storage systems, contaminated aquifer material (for example, soil or rock) and non-aqueous phase liquid (NAPL – for example, petroleum products).

4.1 Source removal

The removal or control of the source is a necessary first step in the cleanup or management of polluted groundwater. Early actions taken to locate and remove or

control the source may greatly reduce the extent of the pollution and the risk posed to existing beneficial uses (and the cost of cleanup). It may not be possible to meet cleanup or management objectives if there is a continuous supply of contaminants to the groundwater.

The presence of NAPL in contact with (for example, floating on top of) groundwater is in itself pollution of groundwater. NAPL is also a source of further groundwater pollution by the dissolution of water soluble components of the NAPL into the groundwater.

The *Groundwater SEPP* requires that:

'Where non-aqueous phase liquid is present in an aquifer, it must be removed unless the Authority [EPA Victoria] is satisfied that there is no unacceptable risk posed to any beneficial use by the non-aqueous phase liquid.'

In most cases, where NAPL is present in an aquifer, it must be removed.

Examples of current source removal techniques include removal or decommissioning of primary sources (for example, storage tanks/pipes), excavation and removal, pump and treat, flushing (in situ), soil vapour extraction and dual-phase extraction. References such as the USEPA publication *Treatment technologies for site clean up: Annual status report* provide a guide to available source removal/control technologies.

In some cases it may be impracticable to remove the source of groundwater pollution (for example, dense NAPL within complex subsurface geology). Section 6.2 of these discusses the factors considered by EPA in determining the practicability of groundwater cleanup. These apply equally to assessing 'practicability' of source removal. Any assessment that source removal is impracticable should be clearly documented to assist in discussion with EPA, referencing each of the factors set out in Section 6.2.

4.2 Source control

Where complete source removal is impracticable, the source must be removed to the extent that is practicable and treatment/control measures must be implemented as follows:

- The source must be contained and/or treated so that migration of polluted groundwater is minimised (onsite in most circumstances). Examples of containment technologies include the installation of a physical barrier system (such as capping or a slurry wall) or hydraulic containment.
- Source control must operate for the entire duration that the source is present. If the pollutant source degrades over time, the source control may cease only when the source no longer causes detriment to a protected beneficial use. If the pollutant source does not degrade, the source control must operate indefinitely, or until such time that technology is available to remove the source.
- Any source control measure must be supported by groundwater quality monitoring that demonstrates that it protects the beneficial uses of the groundwater remote from the source (for example, at the site boundary).

Any source control measures proposed to be implemented should be clearly documented to assist in discussion with EPA.

5. The role of risk assessment in cleanup and management of polluted groundwater

Whenever groundwater quality is changed such that it exceeds the relevant groundwater quality objectives, it is considered polluted and must be cleaned up. A site-specific risk assessment, using a method acceptable to EPA, may play an important role in the cleanup and management of polluted groundwater, as the nature and timing of the cleanup activities may be influenced by the risk posed by that pollution. Risk assessment is appropriate in the following circumstances:

- to determine the degree of existing exposure and therefore the influence on the practicability and the urgency of the cleanup activities (see Section 6.2 in these guidelines)
- where EPA advises that risk assessment derived groundwater quality objectives are appropriate (for example, where groundwater quality objectives for organic toxicants for the beneficial use 'stock watering' default to criteria derived for drinking water to protect human health)
- to derive cleanup objectives where cleanup to restore beneficial uses is demonstrated to be impracticable.

Where risk assessment derived objectives are intended to be used, the methodology and key assumptions should be clearly documented to assist in discussion with EPA.

6. Cleanup of polluted groundwater

The goal for any cleanup of polluted groundwater is to restore the protection of beneficial uses of the groundwater both onsite and offsite. Restoration of the beneficial uses of groundwater is achieved when the groundwater quality objectives of the *Groundwater SEPP* are met (see Section 5 of these guidelines if contaminants are present for which there are no groundwater quality objectives in the *Groundwater SEPP*).

Where cleanup to meet *Groundwater SEPP* objectives is not practicable (Section 6.2 in these guidelines), alternate cleanup objectives should be derived that reflect cleanup to the extent practicable; considering the extent and degree of pollution, likelihood of detriment to beneficial uses and the efficiency of the selected cleanup technology. Cleanup objectives for 'maintenance of ecosystems' should be derived for a site such that *Groundwater SEPP* objectives are met at the point of discharge to a surface water body (see Section 1.1 in these guidelines).

6.1 Selection of groundwater cleanup technologies

Cleanup technologies should be assessed for their ability to meet cleanup objectives, resulting in the most effective and practicable technology(s) being selected.

Effective cleanup technologies are identified following:

- the collection and analysis of groundwater and aquifer characterisation data (see Section 2 in these guidelines)
- extensive review of groundwater cleanup technologies.

Examples of groundwater cleanup technologies include pump and treat systems, air sparging, air stripping with activated carbon adsorption and permeable reactive walls. Some suggested further reading on groundwater cleanup technologies is included in Section 10.

Some groundwater cleanup technologies will involve discharge to surface water, land and/or air. These must not pollute the receiving environment and the regulatory requirements related to such discharges are discussed in Section 8.

6.2 The practicability of cleanup of polluted groundwater

Polluted groundwater should be cleaned up such that the protection of beneficial uses is restored. Where acceptable to EPA, groundwater may be cleaned up to the extent practicable. EPA's role is to determine the practicability of a cleanup and if it is impracticable to clean up the groundwater, to determine any ongoing management measures necessary to restore beneficial uses. Where it is thought that it is impracticable to clean up polluted groundwater to restore beneficial uses, EPA should be consulted.

In determining the practicability of cleanup of polluted groundwater, EPA will take into account technical, logistical and financial considerations.

- **Technical** considerations include the physical ability to remove the pollution within a reasonable timeframe. For example, the chemical and physical properties of the pollutant(s), the groundwater and aquifer characteristics and the availability of technology(s) capable of effectively removing the pollution from the aquifer.
- **Logistical** considerations include access to the site, availability of materials and infrastructure, and the disposal of wastes.
- **Financial** considerations include the cost of cleanup, including equipment, installation, maintenance and waste treatment.

The cleanup measures adopted shall be cost-effective and commensurate with the significance of the environmental issues being addressed (including but not limited to consideration of the likelihood of beneficial uses being realised). These considerations will be made with due consideration of approaches adopted for other sites.

Cleanup of groundwater to restore the protection of beneficial uses should occur within a *reasonable timeframe*. The following considerations assist in defining a 'reasonable timeframe':

- the adequacy of interim measures to protect existing and likely beneficial uses of groundwater until the protection of beneficial uses is restored (for example, reliability of groundwater use controls during the cleanup process)
- whether cleanup will be achieved before pollution migrates offsite and/or affects existing beneficial uses
- community views on the timing and extent of cleanup (particularly if the plume is offsite).

Shorter timeframes to clean up pollution are warranted where there is greater likelihood of detriment to existing and likely beneficial uses of groundwater. A strong preference is afforded to options that result in cleanup in a shorter period of time. This reduces the risk of harm arising from the use of the groundwater. The most effective and timely groundwater cleanup may be provided by a combination of individual technologies.

If it is thought that cleanup to meet groundwater quality objectives (*Groundwater SEPP*) is impracticable:

- the evaluation of practicability should be clearly documented against each of the criteria set out in the previous text box and appendix 2 in these guidelines for consideration by EPA
- cleanup to the extent practicable is still necessary to minimise the impact on beneficial uses
- groundwater pollution and the use of groundwater should be managed (in accordance with Section 7 in these guidelines) so there are no detrimental effects on existing or potential beneficial uses of the groundwater
- the practicability of groundwater cleanup should be periodically reassessed.

The process for gaining a determination from EPA on 'clean up to the extent practicable' is provided in Section 2 of these guidelines. Additional guidance on the role of environmental auditors in these determinations is included in Section 13.6 of EPA Publication 759. A list of information to be included in such a submission to EPA is included in appendix 2.

7. Managing polluted groundwater

When cleanup to protect beneficial uses is not practicable (or where cleanup has not yet occurred or is currently occurring), polluted groundwater should be managed to ensure the protection of human health and the environment. Management of polluted groundwater includes the following key components:

- cleanup objectives (that reflect cleanup to the extent practicable) (see Section 6 in these guidelines)
- groundwater monitoring
- trigger levels

- a contingency plan
- controls on the use of polluted groundwater, including the provision of information to ensure that affected landholders or subsequent landholders are aware of the polluted groundwater and the beneficial uses that are precluded
- periodic review of the practicability of the groundwater cleanup (to meet the *Groundwater SEPP* objectives) where this has previously been determined to be impracticable.

The preparation and implementation of any plan to manage polluted groundwater should incorporate these key components. EPA should be consulted in the preparation of such a plan.

7.1 Groundwater monitoring

Cleanup and/or management of polluted groundwater should, where appropriate, be accompanied by a groundwater monitoring program. This should specify such details as the location and frequency of sampling, as well as the measurements (that is, groundwater elevation and analyses) necessary to evaluate whether cleanup/management is performing as required. The groundwater monitoring program should provide for:

- monitoring of the groundwater elevation in each bore, enabling the determination of groundwater flow direction and rate that may indicate changes in any risks posed
- monitoring of the spatial and temporal variation in pollutant distribution, including detecting any unexpected expansion in the plume
- verification of the effectiveness of groundwater cleanup and management, and detecting changes in environmental conditions (for example, hydrogeological, geochemical and microbiological) that may reduce the effectiveness of the cleanup technology
- verification of the attainment of cleanup objectives (that is, protection of beneficial uses or objectives that reflect cleanup to the extent practicable)
- confirmation that beneficial uses of groundwater are protected outside the plume
- detection of new releases of contaminants to the environment that could impact on the effectiveness of the cleanup/management
- identification of any potentially toxic and/or mobile transformation products from the cleanup process.

The frequency of groundwater monitoring must be determined on a site-specific basis and include consideration of the:

- extent of the pollution
- contaminant type and properties
- local and regional hydrogeology (for example, flow direction and rate)
- presence of existing beneficial uses of groundwater in the vicinity of the plume
- quality of existing groundwater elevation and quality data.

The frequency of groundwater monitoring should be adequate to detect potential changes in the site conditions, while allowing sufficient time to implement contingency plans to protect receptors if an unexpected change occurs. For example, quarterly sampling of each bore may be considered sufficient to establish consistent trends in groundwater quality for a site where pollution remains onsite, groundwater flow velocity is low (less than 10 m a year) and there are no existing uses precluded by the pollution.

Refer to EPA Publication 669, *Groundwater Sampling Guidelines*, for guidance on sampling groundwater.

7.2 Trigger levels

A groundwater monitoring program should include 'trigger levels' that indicate if the current cleanup technology is not meeting, or will not meet, cleanup objectives. Trigger levels specify a concentration of contaminant(s) that is unacceptable at a critical location. These 'triggers' may signal unsatisfactory performance of the cleanup/management by indicating:

- an insufficient reduction in contaminant concentration
- an increase in contaminant concentration (possibly indicating a new release)
- migration and/or expansion of the plume.

Where trigger levels are exceeded, a contingency plan should be implemented that ensures cleanup objectives are attained (see Section 7.3 of these guidelines).

7.3 Contingency plan

A contingency plan is a description of the response in the event of 'trigger levels' being reached. It may involve the implementation of an alternative cleanup technology or simply a modification of the selected cleanup technology. Contingency plans should be prepared at the time of the initial technology selection and should be flexible, allowing for the incorporation of new information (for example, advances in cleanup technologies or toxicological data used to estimate the risk to groundwater receptors).

7.4 Controls on the use of polluted groundwater during cleanup/management

The use of polluted groundwater (both onsite and offsite) should be prevented (where appropriate) and/or information should be made available to potentially affected parties indicating the beneficial uses precluded by pollution.

The prevention of the use of polluted groundwater may include:

- controls on groundwater use and bore construction
- placing covenants on land titles of affected premises for information.

Note that the following legal requirements apply to the provision of information to subsequent owner/occupiers, including information about polluted groundwater:

- The occupier of any premises on whom a notice has been served (by EPA) under Sections 31 A/B (pollution abatement) and 62A (cleanup) of the *Environment Protection Act 1970* which is still in force, must notify any person who proposes to become an occupier of that premises as to the requirements contained in the notice and the steps, if any, that have been taken to comply with that notice (Section 60A, *Environment Protection Act 1970*).
- Where a statement of environmental audit has been issued (by an environmental auditor appointed by EPA) with respect to any premises and a certificate of environmental audit has not been issued subsequent to the statement, the occupier of the premises must provide a copy of the statement to any person who proposes to become the occupier of the premises (Section 53ZE, *Environment Protection Act 1970*).
- A vendor should provide information in relation to polluted groundwater at the time of sale of land. Legal obligations for information provision arising from a contract for the sale of land are set out in Section 32 of the *Sale of Land Act 1962*.

In all cases, any person who becomes aware of groundwater pollution at and from a premises should inform EPA and any other parties who may be affected (for example, the owner/occupier of any premises under which polluted groundwater occurs or is expected to occur).

EPA may assist in the dissemination of information by identifying a 'groundwater quality restricted use zone' (see Section 9 of these guidelines).

7.5 Periodic review of the practicability of cleanup of polluted groundwater

Where cleanup to restore the protection of beneficial uses is determined to be impracticable, periodic review of the practicability of groundwater cleanup (to meet *Groundwater SEPP* objectives) should be undertaken. This involves an assessment of information including:

- research of new/updated (and available) cleanup technologies
- data from the groundwater monitoring program (for example, geochemical data, plume/contaminant migration, contaminant concentrations and transformations)
- updated assessments of the risk posed to existing and potential beneficial uses of the groundwater, both onsite and offsite (for example, toxicological data).

7.6 When can management of polluted groundwater cease?

Management of polluted groundwater (including quality monitoring) should continue until the beneficial uses of groundwater onsite and offsite have been restored.

Evidence of the contraction or stabilisation of a plume of polluted water may not be an acceptable basis to cease monitoring and management of the plume, as this may not guarantee that the beneficial uses of the groundwater are, and will continue to be, protected. EPA should be consulted on decisions to cease groundwater monitoring and management.

A groundwater quality management plan (GQMP) cessation submission to EPA should be auditor verified (see Section 7.1 of Appendix 2), and prepared using the information listed in the GQMP cessation checklist (see Attachment B).

8. Regulatory requirements related to cleanup and management of polluted groundwater

Some groundwater cleanup technologies will involve discharge to aquifers, surface water, land and/or air. Discharges during groundwater cleanup must not pollute the receiving environment.

The discharge activity may require a licence or works approval from EPA. Information on these requirements can be found in the *Environment Protection (Scheduled Premises and Exemptions) Regulations* 1996.

Where a pilot study is proposed to be conducted to test a new cleanup technology that will ultimately produce a discharge that requires a licence or works approval, EPA may consider a research, development and demonstration project (RDD) application pursuant to Section 19D of the *Environment Protection Act 1970*.

8.1 Cleanup involving discharges to an aquifer

Cleanup technologies such as 'pump and treat' may involve the continual treatment and return of polluted groundwater to the aquifer, with the level of pollution being reduced at each treatment cycle. Other cleanup technologies involve the discharge of water to the aquifer containing substances with contaminant reducing properties (for example, nutrients to assist the growth of bacteria that degrade some contaminants).

Cleanup technologies that involve discharge to an aquifer must comply with clause 20 of the *Groundwater SEPP*. This clause allows the re-injection of treated groundwater to an aquifer, as part of a groundwater cleanup project. Under these circumstances EPA must be satisfied that there will be no detriment to any beneficial use beyond the premises boundaries and that groundwater quality objectives will be met upon completion of cleanup. Section 2 in these guidelines provides information on how to seek this determination from EPA prior to commencing cleanup.

9. Groundwater quality restricted use Zones

Groundwater quality restricted use zones (GQRUZs) are referred to in clause 19 of the *Groundwater SEPP* (as amended in March 2002). GQRUZs (previously known as polluted groundwater zones) are areas of aquifers that have been identified by EPA where one or more beneficial use(s) of the groundwater are precluded by pollution. GQRUZs may be of local or regional scale and may relate to a specific or diffuse source. EPA may identify an area

as a GQRUZ where it has determined that cleanup to the extent practicable has occurred.

EPA will provide information (for example, location, approximate degree and extent of pollution within the GQRUZ) to the groundwater resource manager and relevant rural water authority. EPA may also provide relevant information to other affected parties, catchment management authorities (CMAs) and local government.

In accordance with clause 19 of the *Groundwater SEPP*, EPA will require polluted groundwater within GQRUZs to be cleaned up to the extent practicable and the periodic reassessment of the practicability of cleanup. EPA will maintain a list of GQRUZs.

Irrespective of whether a GQRUZ has been identified by EPA, polluted groundwater, where cleanup to protect those beneficial uses is not practicable, should be managed in accordance with these guidelines.

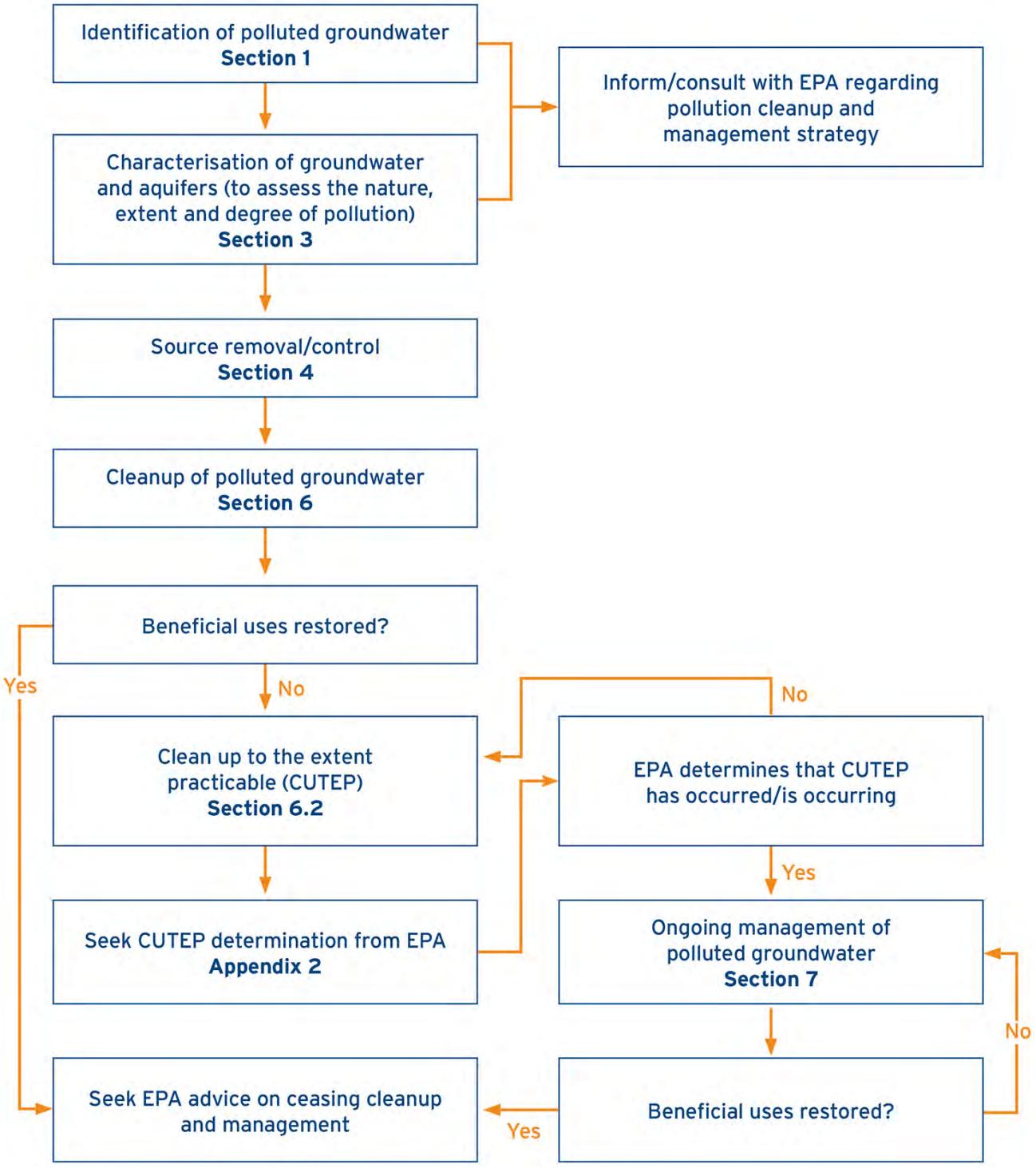
Other publicly available information that may relate to polluted groundwater is available on the EPA internet site (www.epa.vic.gov.au) and includes:

- information about groundwater quality in Victoria including the identified groundwater quality restricted use zones (GQRUZ). (For further information on identified GQRUZs, refer to EPA Publication 862)
- the priority sites register, a register of all sites for which EPA requires action relating to site contamination. This action may include cleanup and/or management of polluted groundwater. (For further information on the priority sites register, refer to EPA Publication 735)
- a list of sites for which statements of environmental audit have been issued by environmental auditors appointed by EPA. Statements of environmental audit may indicate that the quality of groundwater at or from a site may preclude one or more beneficial uses and include the auditor's opinion concerning any cleanup and/or management necessary.

10. Suggested further reading

- EPA 2000, *Groundwater sampling guidelines*, publication 669, EPA Victoria.
- Victorian Government 1997, *State Environment Protection Policy (Groundwaters of Victoria), Victoria Government Gazette No. S 160*, Government Printer, Melbourne, December 1997.
- USEPA 1999, *Treatment technologies for site clean up: Annual status report (Ninth Edition),* United States Environmental Protection Agency, EPA-542-R99-001, April 1999.
- USEPA 1998, *Abstracts of remediation case studies, volume 3,* United States Environmental Protection Agency, EPA-542-R98-010, September 1998.

Appendix 1: Recommended procedure for cleanup and management of polluted groundwater



Appendix 2: CUTEP Information guide

This guide relates to the documentation required to provide sufficient detail for decisions relating to 'clean up to the extent practicable' (CUTEP) as part of environmental audits. The purpose of this document is to provide a guide for:

- the preparation of a CUTEP submission provided to EPA by an auditor stating an opinion regarding a CUTEP determination to be made by EPA (in accordance with EPA Publication 759)

or

- the information that is required to be included in an auditor-determined CUTEP and the audit report (in accordance with EPA Publication 759).

Details regarding the criteria for whether EPA or an auditor determines CUTEP for each site are provided in EPA Publication 759. EPA has drafted this document based on the experience gained in reviewing CUTEP submissions and making CUTEP determinations between 2002 and 2013.

Please note that the following information is to be provided as part of the CUTEP submission or audit report in addition to the requirements discussed in EPA Publication 840. For both auditor determined, and EPA-determined CUTEPs, submissions should be provided to EPA with a CUTEP checklist (see attachment A).

1.0 Background

Provide the following:

- a site description (include the current site plan and details of the current certificates of title)
- a summary of the site history and use, including:
  - a brief summary of the reason for CUTEP (for example, statutory notice, proposed change in site use, etc.)
  - a brief summary of the general site history and contamination
  - a brief summary of the current and proposed beneficial use(s) and/or development
  - summary information on the key pollution issue that is the reason for the CUTEP determination being sought
  - review and refer to relevant surrounding land uses and nearby audit reports (where applicable and relevant to the CUTEP determination) being made or sought.

2.0 Site conditions prior to cleanup and conceptual site model

The intention of this information is to summarise the site setting and document the condition of the site prior to cleanup activities. This is often referred to as the 'conceptual site model' and given that groundwater is the key concern, this must be supported by relevant information (outlined below).

The conceptual site model should be developed in accordance with the *National Environment Protection (Assessment of Site Contamination) Measure 1999* (as amended 2013) (the NEPM) and EPA Publication 668 *Guidelines for Hydrogeological (Groundwater Quality) Assessments*.

2.1 Geology and hydrogeology

Provide an overview of the hydrogeology of the site in its sub-regional setting. This should be prepared using the guidance provided in EPA Publication 668 *Guidelines for Hydrogeological (Groundwater Quality) Assessments*. This should include (but not be limited to) a description of the following on a regional and local scale where relevant (with accompanying illustrations, cross-sections and tabulated data as appropriate for the site):

- Geology and aquifers - that is, a brief description of each lithological unit, for example, thickness, type and the identification of each aquifer, aquitard and hydraulic properties of aquifer(s).
- Groundwater occurrence and flow - including the depth to groundwater, presence of any potentiometric surface, flow direction, estimated seepage velocity, hydraulic conductivity, transmissivity and yield). Also describe any groundwater mounding, multiple aquifer interactions, preferential pathways, spatial and temporal variations in groundwater quality or contaminant concentrations (where present).
- Groundwater chemistry – identify the natural salinity/total dissolved solids (TDS) of the groundwater in each aquifer so as to identify the segment protected by the State Environment Protection Policy (*Groundwaters of Victoria*) (Groundwater SEPP). Additional information on the geochemistry of the aquifer may be relevant.
- Groundwater resource utilisation – a summary of current known bores and their use in the vicinity of the site (for example, within 2 km of the site or as appropriate).

It is also recommended the overview refers to at least one hydrogeological cross-section and/or a conceptual site model.

2.2 Source(s) of pollution

The conclusion that a site is (or is likely to be) a source of groundwater pollution is typically supported by one or more of the following key factors:

- Site history information indicates/confirms that the contaminant of concern was once used at the site or activities at the site have altered natural conditions leading to the mobilisation of naturally occurring or anthropogenically introduced contaminants.
- The contaminant of concern was detected in soil or vapour samples during the soil sampling program, noting that some contaminants may be difficult to identify in soil samples (for example, chlorinated hydrocarbons in shallow soils).
- Groundwater is polluted by the contaminant of concern.
- Upgradient or onsite sampling (current or data from surrounding sites) demonstrates the contaminant is not from a regional or alternate source.

A clear and logical description of the above factors should be provided for each contaminant that is subject to the CUTEP determination.

Where a site is not considered to be the source of groundwater pollution, the suspected source of pollution should be identified, along with evidence to support any such conclusion. In order to do this, in addition to evidence from the site, it may be necessary to review and discuss the following:

- soil and groundwater data for adjacent sites (for example, where audit reports have previously been completed)
- soil and/or groundwater data collected offsite and beyond the influence of any contaminant from the site
- any other information deemed relevant to support the conclusion that a source of groundwater pollution is located offsite or represents background concentrations exceeding relevant groundwater quality objectives.

2.3 Contaminant transport pathways and mechanisms

Discuss the mechanisms/pathways by which the contaminant(s):

- has, or is likely to have, moved through the soil profile and polluted the groundwater
- are dispersed within/by the aquifer. This should be linked to and explain the extent of groundwater contamination prior to, and after, cleanup.

2.4 Potential receptors/beneficial uses

Discuss the potential receptors/beneficial uses which may be impacted by the contaminant(s):

- Provide information with respect to potential receptors including groundwater extraction and groundwater discharge to surface waters.
- Provide information on soil vapour related to groundwater pollution.
- In relation to surrounding groundwater extraction, note the type of use, the bore screening depth interval/aquifer, direction and distance from the site.
- This discussion should include existing and potential future receptors/beneficial uses and include consideration of foreseeable changes to the site and surrounding site(s) that may create a new and/or altered exposure pathway(s).

3.0 Summary of cleanup works undertaken

A summary of all relevant soil and groundwater cleanup works undertaken must be provided.

For **soil** this should be a brief overview, and include the following:

- a brief summary of *relevant* soil remediation works - this summary should focus on the characterisation of the contamination status of the site and *source* removal (that is, soil remediation relevant to the identified groundwater pollution). For example:
  - For a site where groundwater is polluted with petroleum hydrocarbons, this would include removal of underground fuel storage tanks and associated petroleum hydrocarbon contaminated soil, but not other soil remediation activities unrelated to the groundwater pollution issue for which the CUTEP determination is being made
- an estimate of the initial contaminant source mass
- an estimate of the contaminant source mass removed
- an estimate of the residual contaminant source mass (if any)
- where complete source removal is/was impracticable, provide information with respect to any source control measures employed (if any). Information/data to support the performance of any source control measure should also be provided.

For **groundwater** this should be an overview, and include (but not be limited to) the following:

- justification/discussion of the type of cleanup/management technology employed (including a review of potential cleanup technologies considered)
- any cleanup benchmark or field trials and their results
- period of cleanup
- number of cleanup events and type
- effect of the cleanup undertaken, including discussion of any contaminant rebound/s or reduced concentrations of contaminants/reduction of contaminant source mass, that is, what evidence is there that the cleanup has been effective.

4.0 Extent and nature of groundwater pollution after cleanup

Provide a clear description of the extent and nature of groundwater pollution that is subject to the CUTEP determination (that is, the status of groundwater post any soil and/or groundwater cleanup works (if any) that have occurred). As a minimum:

- Discuss the adequacy of the groundwater monitoring well network to assess the lateral and vertical extent of groundwater pollution identified.

  This discussion should refer to the guidelines for 'Delineating groundwater contamination' provided in Section 8.3 of the NEPM 1999 (as amended 2013).

- Discuss the frequency and total number of groundwater monitoring events used to define the extent of groundwater pollution.

  With respect to the frequency of groundwater monitoring, consideration should also be given to seasonal and tidal factors, and the potential for these factors to affect the groundwater monitoring results.

  This discussion should also comment on the trends in the groundwater data.

- In order to collect sufficient and reliable data to establish representative groundwater concentrations and trends, the following is recommended:

  - a number of monitoring events at each monitoring location that allows the current condition of groundwater to be reproducibly assessed (that is, representative data), generally considered to be greater than three monitoring events
  - an interval should be allowed between each monitoring event suitable for the hydrogeological environment, contaminants of concern and the return (or near return) of equilibrium in the aquifer following cleanup events.

  Note that deviation from the above requirements may be justified in some cases. Where this occurs, justification for the deviation must be clearly documented.

- Provide a summary table for each beneficial use that is precluded by the groundwater pollution, including the corresponding contaminant(s) causing the pollution (see attachment B for an example). The summary table should also include naturally elevated or background elevated analytes in groundwater, as well as regional pollution (see attachment C for an example).

- Provide commentary on the likelihood of the beneficial use(s) being realised, now or in the future, including those precluded by pollution.

- Provide a figure(s) showing the extent of groundwater pollution for each relevant contaminant of concern.

- For sites where an assessment of the risk **to human health** of the groundwater pollution is completed, provide information and conclusions of the risk assessment, including the estimated excess lifetime cancer risk and hazard quotient (where relevant to the type of risk assessment undertaken).

Note that EPA Publication 668 provides further details regarding hydrogeological assessments.

5.0 Plume stability and future behaviour

Provide an assessment of plume stability and estimated/projected future plume behaviour. This should include an estimate of the time it will take for each beneficial use to be restored **without** any further cleanup/management in the context of climatic and seasonal variability.

A number of approaches are available for assessing plume stability and modelling/estimating the future behaviour of groundwater pollution. These range from simple data assessments through to complex mathematical modelling. The applicability of these approaches is site specific and dependant on several factors, including site conceptualisation, data availability, purpose of the modelling and risk posed by the pollution.

Examples of predictive plume behaviour are noted below:

- extrapolation and/or assessment of existing groundwater concentration data trends
- use of natural attenuation parameter data to estimate future trends
- analytical modelling of groundwater flow and contaminant transport
- numerical modelling of groundwater flow and contaminant transport.

6.0 Assessment of the feasibility of (further) groundwater cleanup/management

In cases where no active groundwater cleanup/management has occurred, the feasibility of any potential groundwater cleanup needs to be assessed and discussed for the purpose of the CUTEP submission. In cases where groundwater cleanup has already occurred, then the feasibility of further groundwater cleanup to restore the protected beneficial uses must be provided.

- Provide an assessment of the potential cleanup technologies that that could be implemented. This assessment should include technical, logistical, financial and reasonable timeframe considerations (as required by EPA Publication 840). However, other criteria may also be considered based on relevant site-specific factors.

- Application of a 'staged' screening process may also be appropriate in some cases. For example, 'step 1' may first screen out potential cleanup technologies that are not technically feasible without the need to

provide a detailed discussion of logistical, cost and timeframe considerations.

Documents used to support the screening process should be referenced; for example, the USEPA *Superfund Remedy Report* (http://www.epa.gov/superfund/remedytech/srr/).

'Step 2' may then further assess the technically feasible cleanup technologies against the other criteria.

- Where the cost of a cleanup technology is included, the itemised costs for components that make up the total cost should also be provided. (It can also be relevant to disclose the costs of site cleanup to date as a guide to the levels of effort expended). Note the costs provided should be directly related to the potential cleanup works. For example:
  - capital cost
  - operation and maintenance cost per year
  - environmental monitoring and reporting costs (for example, groundwater monitoring).
- Provide the expected timeframe for the restoration of beneficial use(s) based on the implementation of each cleanup option considered.
- Provide an argument that further cleanup of groundwater pollution is not commensurate with the significance of the environmental issues being addressed and the benefit that would be achieved.

7.0 Management of polluted groundwater

7.1 Ongoing monitoring

Where ongoing groundwater monitoring is proposed, provide a plan (for example, a groundwater quality management plan (GQMP)) or information detailing the following:

- background information relevant to provide an understanding of the purpose and scope of the GQMP
- a description of the proposed monitoring schedule, including:
  - the identification of each well to be sampled and/or maintained
  - the frequency of sampling proposed
  - the analytical schedule
  - the period of monitoring proposed.
- triggers for further action based on the results of the monitoring program (for example, occurrence of NAPL, concentrations of contaminants of concern, changes in flow direction, existence of new nearby groundwater users, etc.)
- reporting requirements for the monitoring program, including identification of the responsibility for doing so (for example, site owner)
- the criteria for cessation of the monitoring program (for example, verification provided by the auditor to EPA seeking consent to cease monitoring or 53V environmental audit).

EPA may require a s53V environmental audit to cease monitoring, the circumstances include:

- where NAPL exists and extends off-site
- where a groundwater plume impacts a large area
- where sensitive receptors exist, such as existing extractive bores, nearby receiving water bodies and potential vapour risk derived from groundwater, etc.

Where ongoing groundwater monitoring is **not** proposed, provide a statement justifying this approach supported by multiple lines of evidence.

7.2 Recommendation of the identification of a groundwater quality restricted use zone (GQRUZ)

EPA identifies GQRUZs where groundwater pollution precludes a protected beneficial use of groundwater. EPA requires auditors to recommend a GQRUZ boundary in the CUTEP submission. EPA currently identifies sites:

- **as** a GQRUZ (where pollution remains onsite)

or

- **within a** GQRUZ (where pollution extends offsite).

The following information needs to be provided to EPA prior to a CUTEP determination being finalised (regardless of whether it is EPA or auditor-determined):

- the recommended location and size of the GQRUZ based on title boundaries (or the inferred extent offsite where the title boundary is not appropriate)
- the precluded beneficial uses of groundwater based on the remaining groundwater pollution
- documented evidence that property owners affected by GQRUZs that extend offsite have been consulted. In addition, evidence that any queries by the affected owners have been answered by the site owner/polluter, auditor or EPA (as required)
- a recommendation regarding the criteria for removal or amendment of the GQRUZ.

Additional guidance regarding the style of communication with offsite affected property owners is included in this document as attachment D.

7.3 Management of polluted groundwater

Provide information with respect to how the groundwater pollution should be managed following the determination of CUTEP. This may include:

- a map in the audit report showing the proposed extent of the groundwater quality restricted use zone (GQRUZ)
- where the groundwater pollution extends offsite, provide evidence of communication with offsite property owners affected by the proposed GQRUZ
- the proposed condition(s) to be included in the Statement of Environmental Audit related to the extraction of polluted groundwater onsite
- a summary of the ongoing management plan or requirements.

Attachment A – CUTEP checklist

To be attached to CUTEP submission made to EPA Victoria, or audit report where the auditor has determined CUTEP.

Site address: _____

IBIS No: _____CARMS No: _____

Information included		Section/page discussed	Please tick off
Title details			
Land area			
Past use			
Surrounding land use (North, South, East and West)			
Proposed future use			
Geology			
Groundwater depth (m)			
Groundwater flow direction			
Nearest surface water receptor (distance and direction)			
Bore search (2 km radius)			
Groundwater segment (note – most conservative segment should be used)			
Beneficial uses of groundwater identified			
Summary table of precluded beneficial uses, with associated contaminants, as per attachment C			
Remediation options table	**Discussion of specific options**		
	Cost		
	Technical feasibility		
	Logistical feasibility		
Vapour risk considered			
GQMP	**Responsible party identified**		
	Cost – establishment and annual		
	Duration		
Water quality summary table showing results from all rounds of monitoring (ug/L)			
Separate table showing latest water quality results that are above guidelines (ug/L) as per attachment D (as a hard- and soft-copy Word document)			
An opinion on the source of all contaminants over criteria in the groundwater (e.g. onsite source, offsite source, co-source)			
Groundwater and soil contamination maps			
Hydrogeological cross-section(s) of the site showing (as a minimum) geology, groundwater levels, groundwater bores and any relevant features (e.g. USTs, excavations, utility services, building structures, etc.)			
Discussion of proposed GQRUZ (if applicable). **This should include sufficient information to identify it and an associated figure.** Note - a meeting should be held with EPA to discuss the GQRUZ. The GQRUZ itself should cover the known/modelled extent of all known precluded extractive beneficial uses.			
Details and records of communications with offsite property owners associated with the GQRUZ (if applicable)			
Any other issues of significance (e.g. Enforcement Notice, significant public interest)			
A clear and concise executive summary providing all of the above information			

Note that this is the base level of information required for a CUTEP submission. More complex issues will require additional information.

We recognise that some aspects of the CUTEP checklist may not be relevant in certain site scenarios. In this case the requirement does not need to be met, but a clear reason needs to be provided. This may be achieved through a comment in the checklist, or a reference to where this argument is provided in the audit report.

Attachment B – GQMP cessation checklist

To be attached to GQMP cessation submission made to EPA Victoria.

Site Address: _____

IBIS No: _____CARMS No: _____

Information included	Section/Page discussed	Please tick off
Site address and land area		
Title details		
Background information – Date of CUTEP/GQRUZ determined/identified (if applicable) – Statement of Environmental Audit condition regarding GQMP (if applicable) – Precluded beneficial uses of groundwater (prior to GQMP implementation) – A discussion on mechanism to cease monitoring (i.e. 53V audit to cease GQMP is not warranted where a 53V audit was previously recommended[1])		
GQMP requirements – Monitoring frequency and period, bore networks and analytes – Trigger conditions/contingency – End points or mechanism for monitoring cessation		
Summary of implementation of groundwater monitoring program – A total of groundwater monitoring events (GMEs) undertaken since GQMP – Level of compliance with GQMP		
Summary of groundwater monitoring results reviewed since GQMP implementation – Groundwater flow direction – Historical concentrations, trends of contaminant concentrations – Plume stabilisation – Groundwater quality summary table showing results (↔g/L)		
Current groundwater conditions – Separate table showing latest water quality results that are above relevant guidelines (↔g/L) – Maps of groundwater contamination, plume extent etc.		
Assessment of risks to beneficial uses and the environment – Changes of groundwater uses in the vicinity of the site since GQMP implementation – Updated bore research information – Potential impacts to human health and the environment – Risks to beneficial uses		
Opinions on whether triggers (or end points) of GQMP have been met and GQMP can be ceased		
Opinion on whether the GQRUZ identified should be retained, amended or revoked (if applicable)		
Any other issues of significance (e.g. remedial notice, significant public interest)		
A clear and concise executive summary providing all of the above information		

*Note that this is the base level of information required for a GQMP cessation submission. More complex sites will require additional information.

[1] Auditors can make a recommendation to EPA that a s53V environmental audit is not required for sites where a historical CUTEP determination has been made.

Attachment C – Example of precluded beneficial use summary table

Precluded beneficial use	**Contaminant(s)**
Maintenance of ecosystems	TPH (C_6-C_{36}), arsenic, zinc (n), nitrate (b)
Potable water	NA
Mineral water	NA
Agriculture, parks and gardens	TPH (C_6-C_{36}), arsenic, zinc (n)
Stock watering	NA
Primary contact recreation	nitrate (b)
Industrial water use	TDS
Buildings and structures	NE

Notes:

(n) – naturally occurring

(b) – background/regional pollution

NA – Not applicable

NE – No exceedance

Attachment D – Example of current groundwater analytical results summary table

The following template should be reproduced for the following:

- analytes considered by the auditor to be natural and hence not pollution
- analytes considered by the auditor to be sourced from the site
- analytes considered by the auditor to be from an upgradient source
- analytes considered by the auditor to be representative of regional pollution

	Concentration range (μg)/L			**Guideline values (μg/L) (Reference guideline)**							
Contaminant	**Regional aquifer** (Site aquifer formation, approximate depth to groundwater in mbgl)			**Maintenance of ecosystems – Fresh water**	**Maintenance of ecosystems – Marine water**	**Potable water**	**Stock watering**	**Primary contact recreation**	**Agriculture parks and gardens**	**Industrial**	**Buildings and structures**
	Upgradient	**Onsite**	**Downgradient**								

Notes:

Attachment E – Supplementary requirements for stakeholder communication for offsite Groundwater Quality Restricted Use Zones (GQRUZ)

Summary

Where an offsite GQRUZ is proposed, the auditee (the site owner/occupier) is required to communicate with affected stakeholders. These guidelines explain communication requirements, including:

- submission of a stakeholder communication plan for EPA review, via their auditor
- informing stakeholders of the application for GQRUZ identification
- notifying stakeholders of the outcome once EPA makes its determination.

1. Aims, scope and overview

Aim

The aim of this attachment is to guide auditees (site owner/occupiers), their consultants and auditors in conducting effective communication with stakeholders affected by an offsite GQRUZ. The purpose of GQRUZ communication is to enable stakeholder input in to EPA's GQRUZ identification, and to notify stakeholders of restrictions if an offsite GQRUZ is identified.

Scope

This attachment specifies stakeholder consultation requirements only in relation to GQRUZ – i.e. EPA's decision to manage residual contamination through restricting groundwater use. Stakeholder engagement will be required at many prior stages of the contaminated site assessment process, as set out earlier in this publication (see section 7.4 – Controls on the use of polluted groundwater during clean up/manangement) and in the National Environment Protection (Assessment of Site Contamination) Measure 1999 (as amended 2013) Schedule 8 – Community Engagement and Risk Communication2 (the NEPM). Communication regarding GQRUZ should not be the first time stakeholders are engaged about a site.

The intent of a GQRUZ (refer to Section 9) is to inform stakeholders of risks relating to extraction of groundwater via a bore or direct access of shallow groundwater. A GQRUZ is not intended to manage groundwater pollution that poses a hazard offsite in other ways, e.g. a direct contact risk to construction workers, soil contamination offsite, a vapour risk, or a risk to surface waters. In these circumstances further communication measures may be required by EPA.

Overview

Stakeholders affected by an offsite GQRUZ proposal must be communicated with at two stages.
Stage 1 communications: provide stakeholders an opportunity to input into EPA's CUTEP decision

Stage 2 communication: notify stakeholders of restrictions once a decision is made.

To ensure this communication is effective, EPA requires development and execution of a site-specific communication plan demonstrating how affected stakeholders will be identified, and what communication methods and key messages will be used to reach them at each stage.

For most sites, the communication plan will be simple and limited to completion of the attached 2-page "communication plan" template. However, any communication plan should be scaled to the complexity of the site, including considerations such as the risk, the number of properties affected, and the level of community interest.

Further detail and supporting resources are provided in the sections to follow. Section 2 shows the timing of GQRUZ communications activities in relation to the CUTEP application process, and the respective roles of the site owner/occupier and their consultant, the auditor, and EPA. Section 3 provides guidance on communication plans. Section 4 includes tools to support owner/occupiers/consultants, including an example communication plan template and letters.

[2] National Environment Protection Measure (Assessment of Site Contamination) Measure 1999 (as amended 2013), Schedule 8, Guideline on Community Engagement and Risk Communication

2. GQRUZ communication process, timing and roles and responsibilities

Figure 1 and the text below set out the main stages of GQRUZ communication, timing in relation to the CUTEP application process, and responsibilities of the owner/occupier, assessor, auditor and EPA at each stage.

Summary of process and timing

1. A GQRUZ communication plan must be developed covering stage 1 and 2 communications. EPA can assist with communication plan development on request.
2. The communication plan is included with the CUTEP submission. EPA reviews the plan against guidance in this publication within 3 weeks, comments on its adequacy, and provides a draft GQRUZ map.
3. Stage 1 of the communication plan is implemented, allowing 2 weeks for stakeholders to respond to communication. Documentation and evidence of implementation are gathered as specified in the communications (comms) plan.
4. The auditor notifies EPA when stage 1 is complete. EPA makes its decision on whether CUTEP can be determined and a GQRUZ will be identified.
5. Stage 2 of the communication plan is implemented with evidence documented in the audit report.

Table 1: the CUTEP application process and associated GQRUZ communications actions

	CUTEP application process step	GQRUZ communications action
1	Auditor submits CUTEP notification and arranges optional CUTEP briefing with EPA (6 weeks prior to CUTEP submission).	Owner/occupier/consultant prepare communication plan, and auditor reviews. EPA assistance with communication plan can be requested at CUTEP briefing
2	Auditor submits CUTEP.	Communications plan is included with CUTEP submission.
3	EPA conducts initial review of CUTEP submission, GQRUZ, and comms. plan (Within 3 weeks of CUTEP submission) against this publication. EPA comments on adequacy of these to the auditor. The draft GQRUZ map is produced.	Auditor advises site owner/occupier of any required changes to comms plan based on EPA advice. Site owner/occupier and consultant update comms plan. Once the comms plan is agreed by all parties, the site owner/occupier and consultant start stage 1 communication.
4	Auditor responds to any initial review queries. EPA continues detailed review of CUTEP submission while awaiting GQRUZ comms responses.	Allow two weeks for stakeholder feedback. Owner/occupier/consultant collate stage 1 communications evidence and responses. Auditor reviews and notifies EPA when complete.
5	EPA determines CUTEP (Within 8 weeks of CUTEP submission, not including time with auditor). EPA considers any feedback from stakeholders as part of its CUTEP assessment.	Owner/occupier/consultant start stage 2 communications. Evidence of stage 2 comms. provided to auditor and documented in audit report.
6	Auditor finalises s53X environmental audit report.	

Table 2: Summary of GQRUZ communication roles and responsibilities

Role	Responsibility
Site owner/occupier	• Development and implementation of communication plan • Respond to stakeholder queries
Auditor	• Review of communication plan to confirm it complies with this guidance and NEPM Sch 8 • Review and document evidence that plan has been implemented. • Respond to stakeholder queries
EPA	• Provide guidance and resources as set out in this attachment • Assistance on request with developing/implementing a communication plan • Confirmation of communication plan • Respond to stakeholder queries

3. Step by step guide to developing a communication plan

A communications plan must be submitted to EPA with the CUTEP submission. This plan may either be completed according to the template on the following pages, or follow another format, provided the below steps are conducted.

1. Identify the communications purpose

In the context of GQRUZ communications, this is to:

- Inform stakeholders about the quality of groundwater and the proposed restrictions.
- Give stakeholders the opportunity to respond and ask questions prior to GQRUZ identification.
- Inform stakeholders if EPA approves identification of a GQRUZ.

2. Identifying and understanding stakeholders

Refer to the NEPM s4.1.2-3 for details on identifying stakeholders and understanding their communication needs. For GQRUZ, stakeholders are individuals/organisations with a potential to extract groundwater within the GQRUZ, including:

- Both owners and occupiers of any private properties within the proposed GQRUZ. For apartment complexes, the owner's corporation rather than individuals may be contacted.
- Owners or occupiers of other land – e.g. Council or VicRoads for roadways.

Utility owners with underground infrastructure would not normally need to be contacted unless they are a land owner/occupier, but should be considered on a site by site basis depending on their likelihood of accessing groundwater.

Once stakeholders are known, undertaken a simple stakeholder analysis to understand the communication needs of these individuals/groups. For example:

- Communication challenges – such as English proficiency, or internet literacy.
- Level of familiarity with the concept of groundwater
- Level of prior knowledge concerning the contamination at the audit site.

3. Developing key messages

The NEPM Schedule 8 s4.1.5 provides guidance on developing site specific key messages. In summary, these should explain (1) the nature of the risk (2) the potential impacts to the stakeholder (3) the basis for statements about the site (e.g. outcomes of site investigations) (4) efforts to address the contamination issue, and (3) how the stakeholder can get involved in the process. They should also consider how the risk may be perceived by the stakeholder.
Messages for stage 1 communications should include:

i. The purpose of communications – to advise site owners/ occupiers that a GQRUZ is proposed at their property
ii. A warning that groundwater may pose a health risk if extracted (but does not otherwise pose a risk).
iii. A reference to any prior communications with the stakeholder regarding the contamination.
iv. References to introductory background information on groundwater and GQRUZ (e.g. GQRUZ website).
v. Reference to information on contamination at the site and investigations to date (e.g. attachment/contact person)
vi. Advice that the site owner will be required to advise future prospective purchasers of the GQRUZ.
vii. Instructions on how the stakeholder can obtain further information and provide feedback. This should include timeframes, contact details for the site owner/occupier/the auditor/EPA and if required, arrangements for language translation organised by the owner/occupier.
viii. A summary of next steps, including GQRUZ identification, stage 2 communications, finalisation of the s53X environmental audit report, and any ongoing groundwater monitoring plan.
ix. A copy of the draft GQRUZ map

Messages for stage 2 communications should include:

i. That a GQRUZ has been identified that affects the stakeholder's site.
ii. A reference to communications with the stakeholder to date.
iii. Advice that the site owner will be required to advise future prospective purchasers of the GQRUZ.
iv. A list of contact details for the site owner, the auditor and EPA.
v. A list of next steps – for example, the s53X audit report will be finalised, any ongoing monitoring arrangements.
vi. A copy of the finalised GQRUZ map.

4. Deciding on communication methods

The NEPM s5 explains how to choose a communication method that has the best chance of reaching stakeholders at the site. The communication method would usually include a formal letter for both Stage 1 and Stage 2, delivered by a method that generates evidence of receipt. To increase chances that letters are opened and read, efforts should be made to personally address or deliver letters. The communication plan should explain how contact details of stakeholders will be sought (e.g. a Council or Utility record search). Other communication methods, such as public meetings, should be considered as supplementary measures, and should be used where suited to the site.

GQRUZ Communication Plan Template

The template on the following two pages can be used by an audit site owner/occupier and their consultants in preparing a communication plan for an offsite GQRUZ, to be submitted to EPA Victoria. Using this template is not compulsory but plans must meet Attachment D requirements.

GQRUZ communication stages

Stage	Timing	Purpose	Activities
1	Between CUTEP submission and CUTEP determination	Seek stakeholders' input prior to CUTEP determination and GQRUZ identification (EPA requirement)	• Owner/occupier/their consultant must draft a communication plan and provide it to the auditor. The auditor will review the plan and submit to EPA with CUTEP submission. EPA will provide feedback to the auditor on the plan and GQRUZ extent within 3 weeks. • The owner/occupier/their consultant then execute the plan. Communications recipients must be given at least 2 weeks to respond. • The owner/occupier/consultant will provide evidence of communications and a summary of any feedback to the auditor. The auditor will confirm with EPA that the communication plan has been executed and share any feedback relevant to CUTEP determination.
2	After CUTEP determination	Inform stakeholders of the CUTEP determination and GQRUZ identification (EPA requirement)	• If EPA identifies a GQRUZ, the auditor will be informed. The owner/occupier/consultant should then undertake stage 2 communications. • Evidence of these will need to be submitted to the auditor before the audit report can be finalised.

Stakeholders ***Audit site owner/occupier - please fill out for the appropriate stakeholders (add more rows if necessary)***

Stakeholder	Contact details (name, address, phone, email)	Communication needs and interests	Most effective communication methods
Private property owners	*May be individuals or body corporate*	*(e.g. English proficiency, age, internet access, understanding of groundwater)*	*(e.g. one-to-one talks, small group meetings, community meetings, open days at the polluting site, mailed letters, other)*
Private property occupiers			
Public land owners			
Public land occupiers			
Other			

Communication plan details – stage 1 and stage 2

Please complete the following tables for stage 1 and stage 2 communications

Stage 1 communications

Stakeholder	Relationship to site	Method(s) of communication	Proposed date of communications	Communications materials and key messages	Provisions for stakeholder to respond	Documentation and evidence
E.g. Mrs Smith	***E.g. owner of affected property***	***E.g. letter sent via registered post***	***E.g. immediately after plan and GQRUZ reviewed by auditor and EPA***	***What do you want the stakeholder to understand? What will be the content of communications? Please either attach example communications materials (e.g. a draft letter) or detail key messages.)***	***How can the stakeholder respond to the GQRUZ proposal? E.g. phone contact details for the site owner/owner/occupier, the auditor and EPA will be provided on the letter.***	***How will evidence of communications be obtained? For example, express post tracking information to show delivery, or a contact register for hand-delivered letters***

Stage 2 communications

Stakeholder	Relationship to site	Method of communication	Proposed date of communications	Communications materials and key messages	Provisions for stakeholder to obtain further information	Documentation and evidence

APPENDIX I

SAQP – GROUNDWATER & VAPOUR ASSESSMENT

AMPOL AUSTRALIA PETROLEUM PTY LTD

SAMPLING ANALYSIS & QUALITY PLAN (SAQP) - GROUNDWATER AND SOIL VAPOUR

CALTEX HOLT SERVICE STATION - SITE ID 22546

MAY 2021

Sampling Analysis & Quality Plan (SAQP) - Groundwater and Soil Vapour
Caltex Holt service station - Site ID 22546

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REV	DATE	DETAILS
0	3 December 2020	Draft
1	8 December 2020	Final – taking into consideration comments from EPA auditor
2	18 May 2021	Final – Inclusion of soil vapour monitoring

	NAME	DATE	SIGNATURE
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ABBREVIATIONS

ALS	Australian Laboratory Services
ASLP	Australian Standard Leaching Procedure
BGL	Below ground level
BTEXN	Benzene, toluene, ethyl benzene, xylene, naphthalene
C_6–C_{10}	Light hydrocarbon chain groups (for example, petrol)
C_{10}–C_{16}	Medium hydrocarbon chain groups (for example, kerosene)
C_{16}–C_{34}	Heavy hydrocarbon chain groups (for example, diesel)
C_{34}–C_{40}	Heavy hydrocarbon chain groups (for example, lube oil)
CSM	Conceptual site model
EA	Environmental authorisation
ENM	Excavated natural material
EPA	Environment Protection Authority
GIL	Groundwater investigation level
GME	Groundwater monitoring event
HESP	Health environment and safety plan
HSL	Health screening level
IAA	Interim audit advice
LNAPL	Light non-aqueous phase liquid
LOR	Limit of reporting
m	Metres
mAHD	Metres Australian Height Datum
mBTOC	Metres below top of casing
mBGL	Metres below ground level
mV	Millivolt
NATA	National Association of Testing Authorities
NDD	Non-destructive digging
NEPM	National Environmental Protection Measure
PAH	Polycyclic aromatic hydrocarbon
PID	Photo-ionisation detector
PSH	Phase separated hydrocarbon
PULP	Premium unleaded petrol
QA/QC	Quality assurance/quality control
RPD	Relative percentage difference
SWL	Standing water level
TCLP	Toxicity characteristic leaching procedure
TRH	Total recoverable hydrocarbons
ULP	Unleaded petrol
UPSS	Underground petroleum storage system
UST	Underground storage tank

1 INTRODUCTION

Ampol Australia Petroleum Pty Ltd (Ampol) (formally Caltex Australia Petroleum Pty Ltd (Caltex)) engaged WSP Australia Pty Limited (WSP) to prepare a sampling, analysis and quality plan (SAQP) for groundwater and soil vapour at the Caltex Holt service station, 1 Hardwick Crescent, Holt, Australian Capital Territory (ACT) (Site ID: 22546) (the site). The site regional location setting plan and site layout plan is presented in Figures 1 and 2, of Appendix A, respectively.

1.1 BACKGROUND

During February 2020, in response to a suspected loss of fuel at the site, Ampol engaged WSP to assist in the spill response investigations and works to mitigate the loss of product at the service station. Following the information gained from the initial spill response works, subsequent detailed intrusive site assessment and an onsite remediation pilot trial, WSP has compiled a remediation action plan (RAP) for the site.

This SAQP addresses the remediation phase of the works – including all the proposed groundwater and soil vapour monitoring during the remediation works.

1.2 PURPOSE

The purpose of this SAQP is to describe the work scope and methodologies and the rationale for the chosen work plan.

1.3 OBJECTIVE

The objective of the planned work is to assess:

- The effectiveness of the remediation system in reducing light non-aqueous phase liquid (LNAPL) and dissolved phase hydrocarbons in groundwater during the remediation phase;
- Changes in LNAPL and contaminant concentrations, and the extent of the hydrocarbon plume during the remediation phase; and
- The contaminant concentrations and extent of the hydrocarbon plume after the remediation works have been completed.

1.4 PROPOSED SCOPE OF WORK

The proposed work scope will comprise the following elements:

- Monthly groundwater gauging of key monitoring wells;
- Sampling of groundwater wells at the following frequencies:
  - Quarterly groundwater sampling of selected wells;
  - Bi-annual sampling of all wells on and around the site;
- Bi-annual soil vapour sampling of key soil vapour bores;
- Reporting related to these groundwater sampling events.

1.5 TECHNICAL FRAMEWORK

This SAQP was prepared with reference to or consideration of the following regulations and guidelines:

- ACT EPA 2017, *Contaminated Sites Environment Protection Policy.*
- ACT EPA 2019, *Environmental Guidelines for Petroleum Storage in the ACT*
- ANZG 2018, *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*
- CRC CARE 2015, *A practitioner's guide for the analysis, management and remediation of LNAPL, CRC CARE Technical Report no. 34.*
- Environment ACT 2000, *ACT's Environmental Standards: Assessment & Classification of Liquid & Non-liquid Wastes*
- *Environmental Protection Act 1997.*
- *Environmental Protection Regulation 2005.*
- *National Environment Protection (Assessment of Site Contamination) Measure 1999* (NEPM; as amended 2013).
- NSW EPA 2014, *Technical Note: Investigation of Service Station Sites*.
- NSW EPA 2020, *Guidelines for Consultants Reporting on Contaminated Sites*.

Further to the above, ACT Government provides a number of information sheets which outline some additional considerations relevant to the site. These include:

- ACT EPA 2014, *Information Sheet 1 – Decommissioning, assessment and audit of sites containing above ground or underground fuel storage tanks.*
- ACT EPA 2014, Information Sheet 2 – *Requirements for the assessment and validation of former service station sites.*
- ACT EPA 2014, Information Sheet 3 – *Requirements for the assessment and validation of sites containing above ground or underground fuel storage tanks.*
- ACT EPA 2019, Information Sheet 9 – *Management of groundwater impacted by light non-aqueous phase liquids (LNAPL).*

In addition to the above, consideration has been given to the ACT Government (March 2019), *Kippax Group Centre – Master Plan* document in the planning, scoping and design of this SAQP.

2 SITE INFORMATION

2.1 SITE IDENTIFICATION

The site is located within a mixed commercial and residential area in Holt, ACT. General site details are summarised below in Table 2.1. Figure 1 shows the regional site location and setting, with the site layout shown in Figure 2.

Table 2.1 Summary of general information

SITE NAME	CALTEX KIPPAX HOLT SERVICE STATION
Site address	1 Hardwick Crescent, Holt ACT 2615
Caltex site identification	22546
Legal identification	Block 1, Section 53, Holt
Local government area	ACT Government
Zoning	CZ2: Business Zone
Current land use	Service station with on-site retail shop and mechanic workshop

2.2 FUEL STORAGE INFRASTRUCTURE

There are five known underground storage tanks (USTs) and one decommissioned aboveground former liquefied petroleum gas (LPG) storage tank at the site. The location of the USTs is shown in Figure 2. The storage information is given below in Table 2.2, based on the information provided from Caltex. There are no records for other storage tanks outside of the current tank farm other than an above ground waste oil tank behind (to the south-west) the mechanical workshop building.

Table 2.2 Petroleum storage information

TANK NUMBER	PRODUCT	SIZE (L)
T1 UST	Vortex 95 premium unleaded petrol (PULP)	27,400
T2 UST	Diesel	27,400
T3 UST	Unleaded petrol with 10% ethanol (E10)	27,400
T4 UST	Former Vortex 98 PULP (out of service from 14 February 2020 and temporarily abandoned from 1 April 2020 – tank empty)	20,000
T5 UST	Unleaded petrol with 10% ethanol (E10)	59,400
T6 AST	Decommissioned (formerly LPG)	7,500

2.3 SURROUNDING LAND USE

Surrounding land uses include:

- **North:** Hardwick Crescent with residential properties (Zara Gardens) to the north-east (approximately 22 m from the site boundary) and commercial properties (Scott Chambers Building) north (approximately 29 m from the site boundary);

- **East:** Flack Street with the Raiders Belconnen and open-air recreation sports field beyond to the north-east (approximately 20 m from the site boundary);
- **South:** Hardwick Crescent with residential properties (Canberra Masonic Homes) beyond to the south-west (approximately 21 m from the site boundary); and
- **West:** open-air bitumen carpark (immediately adjacent to the site boundary).

Utility facilities including maintenance pits, drains and inspection covers relating to electrical, communications, water, sewer and stormwater infrastructure are located in all cardinal directions surrounding the site.

2.4 GEOLOGY AND HYDROGEOLOGY

2.4.1 GEOLOGY

Based on a review of Abell 1992, *Canberra 1: 100,000 scale geological map*, the site is underlain by the Late Silurian Deakin Volcanics, which is predominantly comprised of rhyodacitic ignimbrite with minor volcaniclastic and sedimentary units. Further, the 1:50,000 Geology of Canberra, Queanbeyan, and Environs (1980) geological map also indicates that the site is underlain by the Deakin Volcanics. The geological legend indicates that volcanic bedrock comprises Tuff and Tuffaceous Shale. Structurally, there are a number of major faults that have displaced the bedrock in close proximity of the site. A north-north west splay of the Deakin Fault having an orientation of approximate 165° crosses through the site. Although this fault is the dominant fault in the area there is likely to be a number of structures/joints that would be subparallel to the fault, and also conjugate joint sets which would strike approximately 45° to the main fault direction (Abell, 1992).

The subsurface conditions at the site observed in the monitoring well boreholes drilled during previous assessment works comprised a thin layer of Gravelly Silt Topsoil to approximately 0.2 mBGL in the grassed areas adjacent to the site, to a Sandy Gravel Road base to approximately 0.3m below the bitumen in the roads. At some locations the bedrock was exposed at the surface. The upper part of the bedrock comprised a yellow orange, highly to moderately weathered Tuff with alternating bands of harder and softer rock. Below approximately 8 m the profile continued as moderately to slightly weathered, grey brown Tuff. The Tuff comprises coarse phenocrysts in a finer grained matrix. At two locations MW07 and MW19 the bedrock has been recrystalised and fragmented and is likely to be the result of heating of the bedrock during faulting and these locations are likely to have been drilled into the fault zone.

Overall, it appears that the geology encountered at the site is consistent with the geological desktop study.

2.4.2 HYDROGEOLOGY

The 1:100,000 Hydrogeology of the Australian Capital Territory and Environs (1984) map indicates that groundwater is anticipated to be hosted in layers of dacitic, rhydodacitic, ignimbrite and bedded tuffs with minor shale, sandstone, limestone and ashstone of the Late Silurian era. The hydrogeological units are fractured with higher yielding zones associated with the upper and lower portions of the individual ash-flow tuffs and interbedded sediments. Groundwater quality tends to be variable with an estimated yield > 1.0 litres per second (L/s) and a total dissolved solid (TDS) concentration between 500-1000 milligrams per litre (mg/L).

Groundwater within the shallow aquifer was intersected at 8 mBGL to 10 mBGL on and immediately surrounding the service station site during previous assessment works, with shallower groundwater noted in areas to the north (e.g. the open space parkland north of Scott Chambers and Zara Gardens), where the surface elevation decreases. Groundwater is inferred to flow in a north-east direction. Yields were noted to be variable when developing the wells ranging from <0.1 L/minute to 4.5 L/minute.

A search of ACT EPA records for groundwater monitoring bores associated with potential contaminated sites within a 1 km radius of the site was requested by WSP on 4 June 2020. The ACT EPA provided the following information on 5 June 2020:

"Office of the Environment Protection Authority records indicate that there are environmental monitoring bores at the 7 Eleven service station located at Block 1 Section 52 Holt. These bores are associated with environmental monitoring required under the site's environmental authorisation (EA) under the Environment Protection Act 1997.

Dissolved phase hydrocarbon impacts have been detected in groundwater samples at the site in perched groundwater and a shallow aquifer (at depths of between 6.0 and 10.0 mBGL). Groundwater flow has been found to be to the north-northeast."

Block 1 Section 52 Holt is located approximately 400 m north of the ESA investigation area. Potential off-site dissolved phase hydrocarbon impacts associated with Block 1 Section 52 Holt are unlikely to have impacted the site and nearby surrounding properties, as the ESA investigation area being approximately 400 m upgradient from the groundwater flow direction identified at Block 1 Section 52 Holt.

A review of the ACTmapi Cadastre and imagery water bore layer and the Bureau of Meteorology Australian Groundwater Explorer portal (which references the National Groundwater Information System) both undertaken on 23 April 2020 indicated that there are no registered bores within a 500 m radius of the site. To confirm that no potential unregistered groundwater abstraction bores were located within the near vicinity of the site, WSP performed a desktop survey of the area by review of aerial photographs from December 2019 (a period where Canberra was in drought and any significant water usage on gardens would be highlighted) and a walkover of the nominated area looking for evidence of possible groundwater bores (well covers, signs and pumps). The result of the desktop survey and walkover by WSP of nominated area surrounding the site undertaken on 4 June 2020 provided no visual evidence of potential unregistered groundwater abstraction bores in those areas mentioned.

The nearest surface water feature is an unnamed water body, a stormwater outlet and creek line, located approximately 580 m north of the site that empties into Ginninderra Creek, approximately 870 m to the north of the site. The stormwater outlet diverts water flow captured from runoff in the Holt area with a number of stormwater drains marked in the area that the stormwater flows directly into Ginninderra Creek. Ginninderra Creek is a tributary of the Murrumbidgee River, which is a major water body located approximately 7.35 km west of the site.

2.5 LOCAL LITHOLOGY

The lithology or geology encountered across the study area underlying paved and unpaved area observed during the drilling investigations generally comprised a thin layer of fill, silty or gravelly clay (either natural or disturbed natural) in the unpaved areas. However, in some instances the surface directly overlies the rock formation. The underlying rock is characterised by highly and moderately weathered orange/brown Tuff to a depth of approximately 6 mBGL. This geologic unit is underlain by grey brown slightly weathered Tuff to depths of generally approximately 9 to 10 mBGL. Beyond these depths and to the lower vertical extent of the borehole excavation (to the end of the boreholes) the Tuff is darker grey in appearance and can generally be considered "unweathered" rock.

The saturated zone within the rock profile was observed to occur towards the base of the slightly weathered bedrock at depths between 7.5 m BGL and 9.5 m BGL. These observations were made during drilling of 14 boreholes via a sonic drill rig.

In addition to the boreholes drilled using sonic and auger/air hammer methods, two boreholes (S2-D1 and S2-D2) were installed using diamond core techniques. Diamond coring allows a solid core to be obtained from the subsurface with minimal disturbance where structural features of the profile could be observed and aligned with depth. Key findings of the diamond coring are listed below:

- The primary structural features identified during logging were steeply dipping fractures of between 45°and 60° which are mostly joints associated with the main fault that crosses through the site;
- Sub-horizontal to 20° dipping flow surfaces were also identified in the drill cores; and
- A number of fractures were associated with high PID readings indicative of elevated volatiles.

Field observations of the cored profiles and borehole imaging support the presence of discontinuities in the rock geology profile in the study area. These discontinuities are in the form of parted fractures, both open (void spaces) and closed (infilled or partially infilled with clay or other minerals), flow surfaces and other minor preferential flow structures. These structures are likely relatively short in length compared to the wide distribution of impacts across the study area.

The fracture/flow surface network is likely to be a vast network of discontinuous, relatively narrow preferential flow paths (predominantly approximately ≤1 mm aperture thickness) that intersect other discontinuities in both the sub-horizontal and sub-vertical planes leading to a complex system of structurally controlled preferential groundwater migration pathways. These preferential flow structures (fractures, flow surfaces and discontinuities) are the likely mechanism by which hydrocarbon impacted groundwater and LNAPL has migrated away from the source area at the site to areas of the study area that are not only hydraulically down gradient, but hydraulically cross-gradient and upgradient (in some instances). Likewise, this mechanism explains the occurrence of non-impacted wells adjacent or nearby impacted wells.

2.6 TOPOGRAPHY

Regionally, there is an elevated land area to the south of the site and the overall regional fall is to the north. Surveyed heights of the ground surface show the greatest elevations for the vapour pin location along Powell St, south-west of the site (S2C10: 582.239 mAHD). The wells located along Hardwick Crescent on the southern side of the service station are lower than Powell Street (MW25: 577.079 mAHD; MW24: 576.776 mAHD & MW23 576.517 mAHD) and lowest for wells in the park area on the northern side of Zara Gardens (S2P6: 568.819 mAHD; S2P7: 566.881 mAHD). Thus, the current investigation area shows a topographical fall of approximately 15.4 m, from south to north over a distance of 250m, which equates to an average topographical gradient of approximately 6.16%.

2.7 SUMMARY OF PREVIOUS INVESTIGATIONS

The known environmental reports, management plans and authorisations for the site are listed below in chronological order. A summary of the scope or outcome of each is outlined in detail within the Appendix B.

- GHD 2010, *Report for Holt Caltex Service Station, 1 Hardwick Crescent, Phase 2 Environmental site assessment*;
- AECOM 2011, *Groundwater Monitoring Well Report, Caltex Holt (22546), Corner Hardwick Crescent and Flack Street, Holt, ACT*;
- Caltex Australia 2013, *Environmental management plan Caltex Holt (22546)*;
- WSP (formerly Parsons Brinckerhoff) 2013, *2013 Round 1 – ACT Groundwater monitoring event*;
- WSP 2014, *2013 Round 4 – ACT Groundwater monitoring event*;
- WSP 2015, *Classification of stockpiled material at Caltex Holt Service Station (22546) Corner Hardwick Crescent and Flack Street, Holt, ACT*;
- URS Australia 2015, *Final Groundwater Data Memo – Kippax service station (22546);*
- ACT EPA 2016, *Environmental authorisation letter*;
- GHD 2017, *22546 – Caltex Kippax Service Station, 1 Hardwick Crescent, Holt, ACT, 2615 Groundwater monitoring event – September 2016*;
- WSP 2017, *Caltex Kippax Holt service station (Site ID: 22546), 1 Hardwick Crescent, Holt ACT 2615: Groundwater monitoring event*;
- WSP 2018, *Caltex Kippax Holt service station (Site ID: 22546), 1 Hardwick Crescent, Holt ACT 2615: Groundwater monitoring event*;

- WSP 2019, *Caltex Kippax Holt service station (Site ID: 22546), 1 Hardwick Crescent, Holt ACT 2615: Groundwater monitoring event*;
- WSP March 2020a, *Caltex Kippax Holt service station (Site ID: 22546), 1 Hardwick Crescent, Holt ACT 2615: Assessment of Vapour Risks*;
- WSP May 2020b, *Tier 1 Risk Assessment (Off-site), Caltex Holt Service Station, 1 Hardwick Crescent Holt, ACT, Site ID: 22546 (Rev0 – Draft)*; and
- WSP August 2020c, *Environmental Site Assessment Report, Caltex Holt service station (Site ID: 22546), 1 Hardwick Crescent Holt ACT.*
- WSP December 2020d, *Environmental Site Assessment Report, Caltex Holt service station (Site ID: 22546), 1 Hardwick Crescent Holt ACT.*
- WSP December 2020e, *Vapour Risk Assessment (Off-Site), Caltex Holt service station (Site ID: 22546), 1 Hardwick Crescent Holt ACT.*
- WSP December 2020f, *Remediation Pilot Trial Report, Caltex Holt service station (Site ID: 22546), 1 Hardwick Crescent Holt ACT.*
- WSP May 2021a, *Draft Groundwater Monitoring Event, Caltex Holt service station (Site ID: 22546), 1 Hardwick Crescent Holt ACT.*
- WSP May 2021b, *Draft Summertime Vapour Sampling, Caltex Holt service station (Site ID: 22546), 1 Hardwick Crescent Holt ACT.*

3 CONCEPTUAL SITE MODEL

Environmental assessment works at the site are continuing and the conceptual site model (CSM) is being developed as more data is gathered. The sections below present is an update to the CSM (previously presented in the Stage 1 ESA (WSP, August 2020) and Stage 2 ESA (WSP, December 2020)) based on relevant findings from the recent February GME works (WSP, May 2021). The CSM relates to vapour source, pathways and receptors. Figures 4a to 4g of the RAP show the cross-section location plans, and Figures 5a through 5e of the RAP present five selected cross sections through the site and provides a graphical depiction of the site CSM. The alignments for the five cross sections were chosen as they were considered to provide the best overview of the study area in terms of the interaction of the source area with the various receptors in the surrounding areas.

3.1 PHYSICAL SETTING

3.1.1 TOPOGRAPHY

Regionally, land to the south and south-east of the site is elevated and the overall regional slope is to the north and west. Locally, the site is situated at an average elevation of 576 metres Australian Height Datum (mAHD) at the centre of the site and generally sloping downward towards the north and north-west. The elevation at the upslope southern side of the site is approximately 578 mAHD and the northern side is at 574 mAHD.

3.1.2 REGIONAL GEOLOGY

The 1980 Geology of Canberra, Queanbeyan, and Environs (1: 50 000) geological map indicates that the site is underlain by the Deakin Volcanics. The geological legend indicates that volcanic bedrock comprises purple and green Tuff and Tuffaceous Shale, of which only the former was observed during the drilling investigation program.

Structurally, there are a number of major faults that have displaced the bedrock in close proximity of the site. A north-northwest splay of the Deakin Fault having an orientation of approximately 150° to 165° crosses through the site. Although this fault is the dominant fault in the area there is likely to be a number of structures and joints that would be subparallel to the fault, and also conjugate joint sets which would strike approximately 45° to the main fault direction.

There is a syncline approximately 200 metres north east of the site. Tuff lava flow surfaces are likely to dip in this direction in the approximate direction of groundwater flow and which are also likely to provide preferential pathways of groundwater (and petrol impacts) in that direction.

3.1.3 ENCOUNTERED GEOLOGY

The geology encountered during the Stage 2 ESA drilling program generally comprised a thin layer of silty or gravelly natural or disturbed natural clay. This surface residual soil profile, typically not more than 2 metres deep, was underlain by highly and moderately weathered orange/brown Tuff to a depth of approximately 6 mBGL. This geologic unit is underlain by grey brown slightly weathered Tuff to depths of approximately 9 to 10 mBGL. Beyond these depths and to the lower vertical extent of the borehole drilling program (to the end of the boreholes) the Tuff is darker grey unweathered rock.

The Tuff bedrock generally comprised of coarse phenocrysts or quartz and feldspar in a fine to coarse crystalline matrix. The highly weathered bedrock is generally soft rock, while the moderately to slightly weathered bedrock is generally medium hard to hard rock. The unweathered rock is generally very hard rock.

3.1.4 HYDROGEOLOGY

Depth to the water strikes ranges from 6 mBGL to 17 mBGL in the study area. Within the study area, the difference between the upslope and downslope elevation is 15.4 metres, whereas the difference in the elevation of the water strikes is only 4.4 metres across the same distance, and thus the groundwater gradient is gentler than the topography of the area.

The water strikes in all boreholes occurred in the zone of the grey/brown Tuff, slightly weathered to unweathered rock. There exist discontinuities (fractures) within the rock in the saturated zone i.e. preferential flow surfaces that control the migration of groundwater around the study area. Additionally, where hydrocarbon impact was observed during drilling coincides where the initial water strike was observed in the bore holes.

Depth to the groundwater ranged from 15.8 to 1.6 mBTOC. The groundwater gradient, based on examination of the plots of the standing groundwater elevations, is towards the north.

The groundwater appears to be semi-confined or confined. An indicative measure of the degree of aquifer confinement may be the difference between the elevation of the water strike and the elevation of the standing water in that well (standing head). The standing head ranged from 0.1 to 4.9 metres across the study area. The pattern of the standing head was generally greater in downslope areas than upslope areas.

There are fractures in the rock geology profile in the study area. These are present as parted fractures, both open (void spaces) and closed (infilled or partially infilled with clay or other minerals), flow surfaces and other minor preferential flow structures. The fracture network in the saturated zone is likely to be a network of discontinuous, relatively narrow preferential flow paths that intersect other fractures in both the sub-horizontal and sub-vertical planes leading to a complex system of structurally controlled preferential groundwater migration pathways.

3.2 CONTAMINANTS OF CONCERN

The analytical results from the groundwater monitoring have provided clear evidence that the contaminants in groundwater are sourced from petrol. Additionally, samples for fingerprinting of the LNAPL encountered in some wells were also collected. The fingerprinting report identified the LNAPL as premium unleaded petrol having been in the environment for between one and a half to two and a half years, however the fuel loss was identified in February 2020; approximately seven months prior to LNAPL sampling. The results of the fingerprinting analysis identified the source of the LNAPL to be slightly degraded Vortex 98 unleaded petrol, of the same type as that released from UST 4 in the fuel loss incident.

The contaminants of concern are therefore the compounds comprising premium unleaded petrol, largely characterised by:

- Benzene, toluene, ethylbenzene, xylenes, naphthalene (BTEXN); and
- petroleum hydrocarbon fractions C_6-C_{10} and >C_{10}-C_{16} as indicators of petrol.

Lead and ethanol are not considered contaminants of concern at the site resulting from the fuel loss, they are however required to be analysed (in certain circumstances) as stipulated in the site's Environmental Authorisation (EA number 0749, dated 3 May 2016).

3.3 CONTAMINATED MEDIA

The media impacted by contamination includes the following:

- Vadose zone in the immediate vicinity of the original fuel loss incident;
- Saturated soil within the water bearing zone of the Tuff formation;
- Groundwater on and off site. Although the potentiometric levels show there is a clear northly gradient in the groundwater, the hydrocarbon impacted groundwater has migrated in a radial pattern away from the site along preferential pathways formed by fractures in the Tuff bedrock, within the saturated zone, and along zones of softer rock due to greater weathering; and
- Vapours within the pores of soil in equilibrium with soil and groundwater within the area of impact on site as referred to in the previous bullet point.

3.4 CONTAMINANT MIGRATION MECHANISMS

Fuel known to have leaked from the base of the tank is likely to have entered the weathered Tuff and be distributed (predominantly) vertically, with some radial distribution due the head pressure of the fuel and / or fracturing within the Tuff. The fuel is likely to have intercepted groundwater at a depth of approximately 9 mBGL.

As previously identified, there are two dominant mechanisms controlling the migration of groundwater at the site. The predominant flow is controlled by the gradient resulting in a northerly flow, and the secondary groundwater migration is influenced by preferential pathways caused as a result of a network of discontinuities within the Tuff geology. The dominance of the natural groundwater flow gradient is observed by the pattern of hydrocarbon impact showing much of the impacted wells to the north of the site. The occurrence of impacts in other cardinal directions can be explained by taking into account the influence of preferential pathways.

Exposure to volatile hydrocarbons through the inhalation of vapours is the risk driving pathways to human receptors. Groundwater contaminated with volatile hydrocarbons can diffuse through vadose zone from the impacted groundwater. In terms of mass flux of vapour, the major source is the groundwater smear zone which contains the 'smeared' hydrocarbon mass in the profile above the saturated zone.

Off-site, away from the source of fuel loss, the contaminated medium is the saturated ground horizon in which the contamination is migrating in a dissolved and phase separated form. The groundwater smear zone intercepting unsaturated soil may be considered a distinct medium within the lithology. While groundwater migration is the mechanism for the lateral transport of the contamination, the smear zone above the transient level of the saturated zone (i.e. the potentiometric level), is the source of the diffusive vapour pathway. Thus, the physical nature, thickness and porosity of the smear zone is a major controlling factor in the generation of vapours.

The structure and features of the vadose zone, above the smear zone, including air filled porosity, will influence the flux rates, more so than concentration of vapours in the profile. Existence of vertical preferential migration pathways may have a significant bearing on the vapour flux rates towards the ground surface.

Weather influences, particularly rainfall and temperature can have strong influence on the vertical migration pathway for soil vapours. Diffusive flux rates of contaminant vapours are greatly influenced by water filled porosity within the vadose zone – as affected by rainfall, and soil profile temperature affects vapour pressures of VOCs and hence the resulting diffusive flux rates.

3.5 SOURCE – PATHWAYS – RECEPTORS EVALUATION

3.5.1 SOURCE AND PATHWAYS

The primary source of the contaminants was fuel loss of unleaded petrol (Vortex 98 PULP) from an underground storage tank (Depot 4) and the primary migration pathway is as liquid transport in groundwater flows, as dissolved phase and phase separated hydrocarbons.

A secondary subsequent source of contaminants is hydrocarbon vapour diffusion from the dissolved and phase separated hydrocarbons in the groundwater upwards through the vadose zone. The ultimate pathway leading to vapour intrusion into buildings as diffusive and advective flows into buildings.

3.5.2 RECEPTORS

ECOLOGICAL RECEPTORS

The nearest surface water feature is an unnamed channel, a stormwater outlet, that flows only during rain events, located approximately 580 m north-west of the site. The unnamed channel is unlikely to be used for recreational purposes but could potentially support a down-stream freshwater ecosystem, however groundwater analytical results for the perimeter wells to the north and north-west, S2-P7, S2-C3, S2-C4, S2-C5 and S2-C6, approximately 80 – 100 m from the site,

indicated no hydrocarbon impacts. Furthermore, the depth at which groundwater was intersected within the investigation area ranged from 6 mBGL to 17 mBGL, and it is likely that the groundwater depth at the stormwater drain is too deep to discharge into the drain. The more substantial surface body, Ginninderra Creek, is more distant from the service station, at 870 m and is thus out of reach of the hydrocarbon plume. On this basis, the ecological receptor risk pathway is considered incomplete.

HUMAN HEALTH RECEPTORS

The local area is served with reticulated town water and a review of the ACTMapi (www.actmapi.act.gov.au) groundwater database conducted on 29 October 2020 indicated that there are no registered groundwater boreholes within a 500 m radius of the site, and generally at depths of greater than 6m. Thus, the probability of humans (both residents and/or workers) having exposure to abstracted groundwater via dermal contact or ingestion is low.

On 4 June 2020, WSP conducted a desktop survey and walkover of areas surrounding the site for evidence of unregistered bores and the use of those bores. The survey did not identify any unregistered bores. However, this doesn't rule out the potential for unregistered bores to exist nearby.

Groundwater is not abstracted at the service station site or surrounding properties for any other purpose than remediation/recovery and monitoring, and the depth to groundwater (approximately 6 metres deep at its shallowest in the study area) indicates that the probability of incidental intersection of the impacted groundwater during routine intrusive maintenance works is considered minimal. Where workers are potentially in contact with the water or are performing the remediation and groundwater monitoring activities, those workers follow the appropriate WHS guidelines to mitigate their exposure risks.

The risk of exposure to hydrocarbons in groundwater by on-site and off-site workers, including intrusive (trench) maintenance workers by means of vapour inhalation, dermal contact and ingestion is unlikely. Firstly, vapour intrusion into the sales building and workshop was assessed and deemed acceptable (WSP, March 2020). Secondly, utility pits surrounding the site have been routinely monitored with a photo-ionisation detector (PID) since the project commenced and no elevated vapour concentrations have been detected. Soil vapour testing in the previous works showed that concentrations were less than health screening level criteria (CRC Care Technical Report No 10) for maintenance workers' vapour exposure in shallow trenches. This risk-receptor pathway of vapour intrusion is therefore considered incomplete.

A further possible exposure pathway is the intrusion of vapours arising from hydrocarbon impacted groundwater and the smear zone created by fluctuations in levels of impacted groundwater. The receptors are the occupants of the buildings on three nominated properties (Zara Gardens, Scott Chambers Building and Raiders Belconnen) determined from earlier screening level assessments of soil vapour, to be potentially exposed to VOC vapours from the migration pathways. The receptors include any person occupying a building for any length of time. The Vapour Risk Assessment (off-site) (WSP October 2020) concluded that the pathway of vapour intrusion into buildings off site has an acceptable risk levels for building occupants. Therefore, the risk-receptor pathway is considered incomplete.

A summary of potential risk pathways and receptors is presented in Table 3.1.

Table 3.1 Risk level assessment for relevant source-pathway-receptor linkages

Potential Receptor	Potential Exposure Pathway	Risk from Exposure Through the Pathway (Is the Linkage Complete & is there a Risk?)
Ecological: Surface water bodies	Discharge of groundwater into surface water bodies – stormwater channel or Ginninderra Creek to the north-west	Considered to be an incomplete pathway as groundwater impacts were not identified in the perimeter wells of the current investigation area approximately 120 m from the source location; therefore, no unacceptable risk.

Potential Receptor	Potential Exposure Pathway	Risk from Exposure Through the Pathway (Is the Linkage Complete & is there a Risk?)
Users of groundwater bores registered for water supply	Abstraction of groundwater for beneficial purpose	There are currently no known users of groundwater within 500 m of the service station. Possible exposure pathways if water is accessed and used are: ingestion; dermal contact; contamination of soil if groundwater is used for irrigation. There are currently no known groundwater extraction bores, with irrigation of the playing fields in Block 47 Section 53 and the Raiders Club utilising mains water. Thus, the risk pathways are believed to be currently incomplete.
Residents and occupiers of commercial buildings	Vapour intrusion	The pathway of vapour intrusion into buildings on and off the site has assessed to result in acceptable risk levels for building occupants. Accordingly, this pathway can be considered incomplete.
Human receptors on open space land	Vapour inhalation	Due to considerable atmospheric dispersion above unconfined open space (the car parking area to the west of the site, and open fields to the north east and east), the level of risk has been shown to be acceptable. The pathway can thus be considered incomplete.
Sub-surface maintenance workers (intrusive trench workers)	Inhalation of vapour in shallow excavation trenches	Soil vapour testing in the earlier environmental site assessment works showed that concentrations were less than screening level criteria (CRC Care Technical Report No 10) for workers' vapour exposure in shallow trenches. This risk-receptor pathway is therefore considered incomplete.
Sub-surface maintenance workers (intrusive trench workers)	Ingestion and direct contact with impacted groundwater or soil	Considered an incomplete pathway. The groundwater is too deep for excavation workers to come into contact with and potential soil contamination is believed to be confined to the service station.

3.6 LNAPL CONCEPTUAL SITE MODEL

In response to the requirements of ACT EPA (2019) *Information Sheet 9* and considering the presence of LNAPL detected at a thickness greater than 3 mm at the site (and also off-site), an LNAPL CSM (LCSM) is required to be developed and presented as part of the site assessment process.

3.6.1 LNAPL CHEMICAL PROPERTIES

LNAPL was found to have a chromatographic profile typical of a slightly degraded Vortex 98 unleaded petrol product. Based on the absence of groundwater impacts in September 2019, and the understanding that the leak possibly commenced in late 2019 (detected in early February 2020), it is estimated that the age of the LNAPL is approximately 1 year.

A compositional analysis of the BTEXN component of the LNAPL was also undertaken. The BTEXN component of the LNAPL was identified to make up 18.2% to 34.2 % of the total product across the analysed samples; with the latter more typical of petrol composition. The percentage of benzene was consistent across all samples, which was close to 1%, which meets the Australian regulation of benzene content of petrol of 1%.

3.6.2 LNAPL MOBILITY AND BODY STABILITY

The groundwater monitoring event of 22-24 February 2021 identified LNAPL in wells MW15 and MW16 with measured thicknesses of 0.065 m and 0.071 m respectively. Since the commencement of the works program at the site, regular gauging of the groundwater monitoring well network have been undertaken. Over the course of the 2020-2021 works, the measured LNAPL thickness measured in wells appear to be generally declining across the monitoring well network. The declining thicknesses of LNAPL on-site are at least partially due to the ongoing product recovery measures and / or the rise in groundwater levels across the general area encompassing the well network.

An assessment of LNAPL transmissivity was performed by means of a bail down test on the 21 May 2020. The off-site and downgradient well MW15 was selected for the assessment due to its proximity to sensitive receptors (Zara Gardens residents). Initial gauging of well MW15 prior to undertaking the bail down test showed an apparent LNAPL thickness of 0.663 m. LNAPL transmissivity was estimated at 0.076 m^2/day and indicates that the LNAPL may be recoverable (i.e. is greater than LNAPL transmissivity range of 0.009–0.07 m^2/day (ITRC, 2009)). However, recent attempts during the September 2020 pilot trials to conduct LNAPL transmissivity testing were not be possible due to the reduced LNAPL thicknesses.

As the contamination to groundwater is a recent occurrence, not enough time has passed the for biodegradation of natural attenuation parameters to occur and therefore produce a meaningful result, and the is only limited data collected to date. However, geochemical indicators of microbial activity, and thereby potential natural attenuation processes, were noted by the reduction of pH and DO when comparing the results between the GMEs undertaken in Stage 1 and Stage 2 ESA works.

3.6.3 LNAPL SOURCE – PATHWAYS – RECEPTORS

A summary of the potential receptors of the LNAPL impact detected on and off-site, the potential exposure pathways and an assessment of the likelihood of risk from exposure to the LNAPL through the potential pathway is presented in Table 3.2.

Table 3.2 Source-pathway-receptor linkages related to LNAPL

Potential Receptor	Potential Exposure Pathway	Risk from Exposure Through the Pathway (is the linkage complete & is there a risk?)
Ecological: Surface water bodies	Discharge of LNAPL into surface water bodies – stormwater channel or Ginninderra Creek to the north-west	Considered to be an incomplete pathway as LNAPL was not identified in the perimeter wells of the investigation area approximately 120 m from the source location; therefore, no unacceptable risk.
Users of groundwater bores registered for water supply	Abstraction of groundwater impacted with LNAPL for beneficial purpose	There are currently no known registered users of groundwater within 500 m of the service station. Possible exposure pathways if water is accessed and used are: ingestion; dermal contact; contamination of soil if groundwater is used for irrigation. There are currently no known groundwater extraction bores, with irrigation of the playing fields in Block 47 Section 53 and the Raiders Club utilising mains water. Thus, the exposure pathway associated with groundwater abstraction is incomplete.

Potential Receptor	Potential Exposure Pathway	Risk from Exposure Through the Pathway (is the linkage complete & is there a risk?)
Residents and occupiers of commercial buildings	Vapour arising from the LNAPL intrudes and accumulates in buildings	The pathway of vapour intrusion into buildings on and off the site was assessed to result in acceptable risk levels for building occupants. Accordingly, this pathway can be considered incomplete.
Human receptors on open space land	Vapour arising from the LNAPL is inhaled	Due to considerable atmospheric dispersion above unconfined open space (the car parking area to the west of the site, and open fields to the north east and east), the level of risk has been shown to be acceptable. The pathway can thus be considered incomplete.
Sub-surface maintenance workers (intrusive trench workers)	Vapour arising from the LNAPL enters shallow excavation trenches and is then inhaled	Soil vapour testing in the earlier environmental site assessment works showed that concentrations were less than health screening level criteria (CRC Care Technical Report No 10) for workers' vapour exposure in shallow trenches. This risk-receptor pathway is therefore considered incomplete.
Sub-surface maintenance workers (intrusive trench workers)	Ingestion and direct contact with LNAPL impacted groundwater or soil	The groundwater is too deep (>4m) for excavation workers to come into contact with and potential soil contamination is believed to be confined to the service station. This risk-receptor pathway is therefore considered incomplete.

4 PROPOSED ASSESSMENT METHODOLOGIES

4.1 SAMPLE DESIGN AND RATIONALE

In order to assess the effectiveness of the remediation strategy during and post remediation, systematic groundwater monitoring will be undertaken. The sampling events will be undertaken to provide data on the temporal distribution and migration of the LNAPL and dissolved phase plume and to what extent the concentrations of hydrocarbons are reduced (or not).

The locations and the rationale of monitoring event is presented in Table 4.1.

Table 4.1 Proposed assessment locations and rationale

ASSESSMENT METHOD/MODE	LOCATION	MATRIX	PARAMETER MEASURED	RATIONALE
Monthly Gauging (Attachment A – Figure 3a)	MW01 MW24 MW02 PMW1 MW04 PMW2 MW05 PMW4 MW06 PEW1 MW07 IW01 MW09 IW02 MW10 IW03 MW11 EW01 MW12 EW02 MW15 EW03 MW16 S2-P2 MW17	Groundwater LNAPL	- LNAPL Presence/Absence - LNAPL Thickness - Groundwater Level	- The purpose of these GMEs is to the monitor trends in LNAPL thickness in key selected wells. - These wells have been selected due to the historical presence of LNAPL, as well as providing good coverage of the site.
Quarterly Groundwater Sampling (Attachment A – Figure 3b)	MW01 MW16 MW02 MW17 MW04 MW24 MW05 PMW1 MW06 PMW3 MW07 IW01 MW10 EW01 MW15 S2-P2	Groundwater LNAPL	- LNAPL Presence/Absence - LNAPL Thickness - Groundwater Level - Hydrocarbons (TPH & BTEXN)	- The purpose of these GMEs is to the monitor trends in LNAPL thickness and hydrocarbon concentrations in key selected wells. - If no LNAPL is present, then the groundwater will be sampled and analysed for dissolved phase hydrocarbons. - These wells have been selected due to the historical presence of LNAPL, as well as providing good coverage of the site.
Bi-annual Groundwater Sampling (Attachment A – Figures 3c and 3d)	All wells, with selected wells for Monitored Natural Attenuation (MNA) related parameters[1 & 2] (attachment A – Figure 3d)	Groundwater LNAPL	- LNAPL Presence/Absence - LNAPL Thickness - Groundwater Level - Hydrocarbons (TPH & BTEXN) - Selected wells for MNA[1,2] related parameters	- The purpose of these GMEs is to the monitor trends in LNAPL thickness and hydrocarbon concentrations in all wells. - If no LNAPL is present, then the groundwater will be sampled and analysed for dissolved phase hydrocarbons - MNA related parameters in selected wells will be analysed to assist with the long-term assessment of MNA.

ASSESSMENT METHOD/MODE	LOCATION		MATRIX	PARAMETER MEASURED	RATIONALE
Bi-annual Soil Vapour Sampling (Attachment A – Figure 3e)	SV01S SV02S SV02D SV03S SV03D SV04S SV04D SV05S SV05D SV06S	SS1 SS2 SS3 SVB1Z SVB2Z SS2SC	Soil vapour	Samples are to be analysed for a broad range of volatile petroleum hydrocarbons from C_5 to C_{15} (including BTEXN and NEPM fractions F1 and F2).	- The purpose of the vapour sampling is to the monitor trends in soil vapour in soil vapour bores and sub-slab pins on- and off-site (and largely within the assumed influence of the remediation system), and to monitor the risk of exposure of the off-site receptors (e.g. Zara Gardens residents) to soil vapours.

1 – MNA Parameters = nitrite, nitrate, sulphate, ferrous iron, dissolved methane & alkalinity as bicarbonate.
2 – Selected wells include MW01, MW02, MW04 – MW07, MW10, MW15 – MW17, MW24, PMW1, PMW3, IW01, EW01, S2-P2, S2-P5, S2-P6, S2-C5 and S2-C10 (these additional wells are outlined within Appendix A – Figure 3d).

4.2 METHODOLOGIES

4.2.1 GAUGING AND GROUNDWATER SAMPLING

Field methodologies to be adopted during the remediation monitoring program will be consistent with WSP environmental site assessment standard operating procedures (SOP) and industry best practice. A summary of the monitoring methodologies to be utilised are presented in Table 4.2.

Table 4.2 Summary of groundwater sampling methodologies.

ACTIVITY	DETAILS
Approvals	All required approvals, plans, traffic management and controls will be sought and received prior to mobilisation to the site.
Well gauging	Wells will be gauged for depth to standing water level (SWL) and the presence of LNAPL using an air, oil, water interface probe. In the event LNAPL is detected, a HDPE disposable bailer will be used to confirm the thickness.

ACTIVITY	DETAILS
Well purging and sampling	Sampling of the groundwater monitoring wells will be conducted in general accordance with ACT EPA (2019), *Environmental Guidelines for Petroleum Storage in the ACT*. Sampling methodologies discussed below also take into consideration the requirements of the site's EA (no. 0749). Sampling is to be undertaken using HydraSleeve® no-purge samplers in wells without LNAPL. In wells with LNAPL a bailer will be used to obtain a sample of the dissolved phase only, ensuring that LNAPL was excluded from the sampling bottles. Groundwater sampling will be conducted with reference to and consideration of Australian/New Zealand Standard. *Water Quality sampling, Part 11: Guidance on sampling of ground waters, AS/NZS 5667.11, 1998*. To ensure that the HydraSleeve® no-purge samplers are providing reliable samples, parallel testing during future monitoring events may be conducted using alternative methods (e.g. low flow sampling) to provide confidence in the measurements. Field parameters (pH, dissolved oxygen, redox, electrical conductivity and temperature) will be monitored using a down-well water quality meter in wells without LNAPL. Where LNAPL is detected in wells, a sample of the groundwater will be decanted from the bailer and poured carefully into a separate vessel, the water quality meter probes placed into the water and readings recorded. The instrument is to be calibrated by the rental equipment supplier prior to dispatch to the field scientists. The groundwater will also be visually assessed for turbidity and evidence of contamination such as odour or visible hydrocarbon sheen.
Groundwater laboratory analytical schedule	Samples collected from all previously existing and new groundwater samples will be analysed for: TRH and BTEXN. As noted in Section 4.1, selected wells will be analysed for MNA parameters. Primary samples and intra-laboratory duplicate samples will be analysed by NATA accredited laboratories.
Groundwater QA/QC samples	Groundwater sample field blind duplicate pairs will be collected at a frequency of 1 pair of duplicates for every 20 primary samples collected. A field prepared rinsate blank will be prepared for each day of sampling. Laboratory prepared and supplied trip blank and trip spike waters will be transported with the sample batch during the sample event and provided to the selected primary laboratory for analysis with the sample batch.
Sample preservation	Samples will be collected in clean laboratory supplied containers with the required preservatives. Sample analyses will be undertaken by NATA accredited laboratories. Groundwater samples will be stored on ice in a cooler immediately after sampling. Samples will be kept chilled prior to and during delivery to the selected laboratories under 'chain of custody' documentation.
Equipment Decontamination	All reusable sampling equipment will be cleaned with suitable phosphate free detergent and rinsed with water between sampling episodes.
Waste disposal	Any waste water arising during the works will be removed from site by an appropriately licensed contractor and taken to an appropriately licensed waste receiving facility.

ACTIVITY	DETAILS
Synthesis of collected data into interpretive operations and maintenance (O&M) report	The information collected during the monitoring works will be synthesised into a biannual O&M report. The report will be an interpretive report that will present all the relevant information in the preceding six months.

4.2.2 SOIL VAPOUR SAMPLING

A total of 12 soil vapour bores (SV01S, SV02S, SV02D, SV03S, SV03D, SV04S, SV04D, SV05S, SV05D, SV06S, SVB1Z, and SVB2Z) and four sub-slab vapour measurement locations (SS1 – SS3 and SS2SC) will be sampled during the bi-annual sampling events.

The soil vapour bores and sub-slab vapour measurement locations will be sampled using USEPA TO-17 method described in *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air – Compendium Method TO-17*. The method involves the pumping (active sampling) of a set volume of air through an Air Toxics tube. For each sampling point a soil vapour sample will also collected on a carbon tube as a back-up sample in the event that the VOC mass collected on the Air Toxics tube is too great and outside instrument calibration range. Intra laboratory duplicate primary samples will be taken at a rate of 1 in 10 samples. One blank sample will be sent to the lab for testing at a rate of one blank per batch.

Immediately prior to sampling the location, the line will be purged of stagnant air using a PID, which is also used as a final check of the degree of volatile hydrocarbon impact in the bore.

In order to identify whether atmospheric air is being drawn down the bore during the taking of the sample, a shroud will be placed over the top of the bore. An isopropanol-soaked cloth will be placed in an opened zip-lock bag to allow the shroud to fill with the leak detector compound (isopropanol). Isopropanol will be included in the analytical suite – and if detected, indicates some degree of leakage – or infiltration of isopropanol downwards through the profile. Analysis of the concentration of isopropanol in the shroud allows for a percentage leak calculation. Generally, a leak rate of 10 % is considered acceptable.

The samples will be analysed at a NATA accredited laboratory under ISO 17025. Samples will be analysed for a broad range of volatile petroleum hydrocarbons from C_5 to C_{15} (including BTEXN and NEPM fractions F1 and F2). Analysis will be by gas chromatography – mass spectrometry (GC-MS).

In addition to the vapour sampling and PID measurements at each location, ground gases will be measured using a ground gas meter (e.g. Geotech GA5000). These meters will be used to measure ground gas concentrations of CH_4, CO_2, O_2, H_2S and CO.

Locations off all sub-slab and soil vapour bore sampling locations that are to be sampled are shown in Figure 3e, Appendix A.

5 DATA QUALITY PLANNING

5.1.1 DATA QUALITY OBJECTIVES

The initial, fundamental and prerequisite step in quality assurance for groundwater monitoring is to choose sampling and analytical methods that can provide the data that are necessary to meet the project's objective. A second and equally critical prerequisite is to design a sampling pattern that enable the data to be interpreted, such that the question to be answered can be addressed (i.e. to investigate the effectiveness of the remediation strategy).

Schedule B2 of the NEPM 2013 presents guidance on certain aspects of quality assurance planning and recommends that a systematic planning process is used to ensure the quality of data collected for site assessments. The NEPM 2013 states:

"*In its simplest form, the planning process should consider:*

- *the overall objective of the site assessment;*
- *the decision(s) to be made on the basis of the site assessment findings;*
- *the constraints on the assessment (financial, time and logistical); and*
- *the degree of flexibility to conduct follow-up investigations."*

The intent of a data quality planning process is to identify the sampling design and methodologies needed to undertake measurements that are sufficient to meet the study objectives. A second aspect of data quality control is the process of assuring the quality of the data collected which in turn involves the controls on how samples are collected. A third aspect is how the reliability of the analytical results is determined.

For the current project, the practical considerations for data quality planning are to design a sampling program that enables or ensures:

- Contaminants can be detected if present at concentrations exceeding background levels;
- The collection of sufficient data to enable the project objectives to be met;
- The selection of sampling locations that were relevant to the project objectives;
- The use of appropriate sampling methodologies applying standard documented operating procedures;
- Sufficient duplication to provide confidence in the precision of the data;
- Careful sample handling and transport; and
- Use of an analytical laboratory that is expert in the analytical methods required by the sampling.

5.1.2 STATEMENT OF DATA QUALITY OBJECTIVES

The NSW EPA's '*Guidelines for the NSW Site Auditor Scheme (3rd edition)*', 2017, requires that, when undertaking an environmental assessment or remediation program, the consultant has properly addressed and adopted data quality objectives (DQOs) for the investigation or validation program and that the consultant's report includes the following:

- A statement of pre-determined DQOs for field and laboratory procedures, including quantitative DQOs;
- A plan to achieve pre-determined DQOs; and
- Procedures to be undertaken if the data do not meet the expected DQOs.

The US EPA has produced a document describing a process for quality assurance planning for projects and identifies seven steps and considerations in describing data quality objectives. The document, USEPA 2000, *Guidance for the Data Objective Process and Data Quality Objectives Process for Hazardous Waste Site Investigations* specifies that the Data

Quality Objectives process is a seven-step planning approach to develop sampling designs for data collection activities that support decision making.

For the proposed investigation WSP has adapted the US EPA's seven step DQO process to the project objectives. A description of the process is given below in Table 5.1.

Table 5.1 Data Quality Objectives

ITEM	METHODOLOGY
State the Problem	This step involves clarifying the issue to be resolved – i.e. the problem that initiated the study. In this case, the problem is to produce reliable data that allows accurate characterisation and determination of trends of the concentrations of hydrocarbon contaminants in groundwater, so that the effectiveness of the remediation strategy can be assessed.
Identify the Decision	The decision to be made is whether the data, when compared to relevant assessment criteria and remediation goals, demonstrate decreasing contamination trends and the acceptable contaminant conditions with respect to site suitability. More specifically for this site, the decisions to be made are: — Has the nature and extent of the groundwater / soil vapour contamination in and beyond the site boundary been adequately characterised and suitably remediated? — Has the nature and extent of the LNAPL present in and beyond the site boundary been assessed and suitably remediated? — Is there a statistically significant decreasing trend in hydrocarbon concentrations in groundwater and / or soil vapour? — Does the contamination pose an unacceptable risk to the off-site human and/or ecological receptors?
Identify the Inputs to the Decision	This process identifies the information that is needed to resolve the problem and make a decision. This involves: acceptance of the data collection, investigation, sampling and analytical methods and acceptance of the quality of the data and its completeness. If sufficient data of suitable quality are not collected, plans for the collection of additional quality data would be needed. The gauging and analytical data from the sampling of groundwater and soil vapour collected during the site works, will be evaluated for completeness and quality. National and ACT government endorsed criteria for assessing the results will be the basis of decisions on data completeness and quality.
Define the Study Boundaries	The boundaries of the investigation are: — **Spatial boundaries:** the spatial boundary of the investigation area is defined as the geographical extent of all wells extending in all directions from the site (see Figure 7c (Appendix A)). — **Vertical boundaries:** the vertical boundaries correspond to the depths of the bases of the monitoring wells. — **Temporal boundaries:** the date of the project inception to the completion of the remediation works under the proposed investigation plan.

ITEM	METHODOLOGY
Develop a Decision Rule	These steps involve the choosing of parameters and action levels on which to base a decision. Published values for acceptable exposure levels and risk levels will be used as the basis of the decision. The parameters of interest are the listed contaminants of concern, and the concentrations thereof, in groundwater and soil vapour. An assessment of the concentrations of the contaminants of concern in the sampling locations tested will be undertaken to ensure that the data gaps have been adequately investigated. Groundwater and soil vapour results would be compared to a range of assessment criteria for different receptor endpoints to determine the potential exposure routes.
Specify Tolerable Limits on Decision Errors	This step concerns the interpretation of the data – whether the data indicates a problem exists or does not exist. In the case of this project, the decision to be made is whether the site has been suitably remediated and if there may be an unacceptable risk to off-site receptors. The consequences of a false negative decision (no risk indicated, stable or reducing plume) is more serious than a false positive decision. Therefore, the limit for the false negative decision will be set at a low detection level (of contamination).
Optimise the Design	This step involves processes and considerations for designing a resource effective sampling and analysis program. This assessment has been designed considering knowledge of the fuel leak, information from previous assessment works, and the presence of LNAPL near off-site receptors. The resource effective data collection design that is expected to satisfy the DQOs is described in detail above.

5.1.3 DATA QUALITY PROTOCOLS - GROUNDWATER

A summary of the quality assurance and quality control (QA/QC) protocols to be followed for collecting and analysing the groundwater monitoring works are presented in Table 5.2.

Table 5.2 Summary of QA/QC protocols

ITEM	DESCRIPTION
General	Work will be undertaken following WSP's standard field procedures, which are based on industry accepted standard practice.
Equipment decontamination	Any dedicated sampling equipment will be decontaminated after the collection of each sample by washing with phosphate-free detergent (such as Decon 90) and potable water, followed by a final distilled water rinse. One rinsate blank will be collected per day of sampling for groundwater and analysed for the contaminants of concern. All results should be non-detect.
Transport	Samples will be stored in an ice brick-cooled esky and transported to the laboratory. To ensure the integrity of the samples from collection to receipt by the analytical laboratory, samples will be sent by courier to the laboratories under 'chain of custody', describing sample preservation, and transport duration.

ITEM	DESCRIPTION
Sample QA samples and RPD assessment	Field and laboratory groundwater QA samples will be analysed as follows: — intra-laboratory duplicate samples at a rate of 1 in 20 primary samples — inter-laboratory duplicate samples at a rate of 1 in 20 primary samples. Relative per cent differences (RPDs) will be calculated for the primary and duplicate samples for assessment of data quality, in particular for assessment of the reproducibility of the analytical data measurements or 'precision' given the adopted field and laboratory methods. There are no Australian reference guidelines for the acceptable degree of difference (as assessed by relative percent difference (RPD)) for groundwater. Acceptability of an RPD value is dependent on measured concentrations, relative to the detection limit. Generally, where the measured concentration is more than one order of magnitude greater than the detection limit, RPDs within 100% are acceptable. When the detection limits are at trace levels, even an RPD of 100% for values 10 times the detection limit is entirely acceptable as both values are still at very minor levels. Using RPDs in evaluating the precision of the duplicate sample results becomes valuable only when one or both of the measured concentrations are within the same order of magnitude of the unacceptable risk levels. For groundwater samples, another factor affecting the usefulness of RPD assessments of duplicates is the presence of colloidal droplets of phase separated contaminant (i.e. LNAPL). The concentration as analysed may be very dependent on the amount of mass in droplet form entrained into the duplicate pairs of samples. In such cases RPDs may exceed 100% although both samples represent saturated or supersaturated concentrations and can thus be interpreted as representing a similar degree of groundwater impact. When one or both of the duplicate samples give a concentration less than the detection limit, measures of percent differences have no value and are therefore not calculated. Other means of evaluating a large difference must be used.
Holding Times	Holding times are the maximum permissible elapsed time in days from the collection of the sample to its extraction and/or analysis. All extraction and analyses should be completed within standard guidelines.
Field/trip blanks and Spikes	For sampling programmes, the trip blanks will consist of laboratory-supplied deionised water. One trip blank will be analysed per sample batch. These samples will be analysed for the purpose of monitoring for contamination during sampling or transit. A laboratory supplied trip spike water sample will also be analysed per sample batch. The field/trip blanks and spikes will be analysed for TRH (C_6-C_{10}) and BTEXN.
Sample handling	All groundwater samples will be stored in chilled eskies after collection and during transport by courier to the laboratory. Prior to delivery to the laboratory, a chain of custody form (COC) will be completed. The COC will be signed and accompany the samples. Upon receipt by the laboratory, COC and/or samples receipt notices will be returned to confirm the receipt, condition of samples and specified analysis.
Assessment of groundwater sample data quality	In the event that the data is considered to be compromised and not meet the expected data quality objectives, the potential to collect further or additional data validation samples will be discussed with the project stakeholders.
QA/QC Conclusion	The QA/QC indicators should either all comply with the required standards or show no non-conformances that would have a significant effect on the quality of the data.

5.1.4 DATA QUALITY PROTOCOLS – SOIL VAPOUR

General field considerations

Field data quality control for soil vapour sampling involves the following processes:

- Ensuring that soil vapour bores or sub-slab sampling fittings are constructed such that leaks can be excluded from the sampling process. A leak measurement and detection system (shroud test) will be included in the process of sample collection (see below further explanation);
- Avoidance of cross contamination by using location dedicated sampling apparatus for each sampling location;
- Proper handling of the sampling tubing to avoid any exposure of the sampling tubes to contaminants other than during their deployment;
- Sample identification and sampler identification will be recorded;
- Weather observations will be recorded; and
- Locations of samples will be shown on figure to be included in the project report.

Soil vapour sampling representativeness

To ensure that representative soil vapour samples are obtained a liquid leak check compound, isopropyl alcohol (IPA), will be applied to a towel which is placed in an open bag within a shroud covering the sampling point. To ensure that a sufficiently high concentration of IPA is present within the shroud, the shroud is first screened with a PID to provide an indicative concentration. In addition, a sample of the air contained in the shroud is collected using a carbon tube and analysed for IPA. In the event that the vapour bore has a preferential pathway for air entry from the atmosphere (i.e. a leak), IPA would be drawn down the bore from under the shroud and would be included in the vapour sample. Concentrations of IPA will be determined for each sample.

Assessment of soil vapour sample data quality

There are no Australian reference guidelines for the acceptable degree of difference (as assessed by relative percent difference (RPD)) for soil vapour concentration measurements. Acceptability of an RPD value is dependent on measured concentrations relative to the detection limit. Generally, where the measured concentration is more than one order of magnitude greater than the detection limit, RPDs within 100% are acceptable. When the detection limits are at trace levels, even an RPD of 100% for values, 10 times the detection limit is entirely acceptable as both values are still at very minor levels. Using RPDs in evaluating the precision of the duplicate sample results becomes valuable only when one or both of the measured concentrations are within the same order of magnitude of the unacceptable risk levels.

Trip blanks will accompany the shipment of TO-17 Air Toxics tubes during the entire journey from the preparing laboratory to the field sampling location, and back to the analytical laboratory. The trip blanks are to be analysed for the same suite of analytes as the primary samples.

5.1.5 LABORATORY DATA QUALITY

The laboratories selected will meet WSP in-house compliance requirements under the respective ISO 9001 QA programs. They will perform their own internal QA/QC programs and will use appropriate detection limits for the analyses to be undertaken. The following ranges were be used as guidelines to acceptable results:

- Surrogates: 70–130% recovery.
- Matrix spikes: 70–140% recover (organics) and 80–120% (inorganics).
- Control samples – 80–120% (water).
- Duplicate samples: RPD less than 30%.
- Method blanks: < PQL.

6 REFERENCE GUIDANCE FOR CONTAMINANT CONCENTRATIONS

6.1 GROUNDWATER

To assess the significance of contaminant concentrations in groundwater encountered during the remediation and subsequent validation, reference is to be made to the NEPM (NEPC, 2013) guidelines, specifically Schedule B1 Guideline on Investigation Levels for Soil and Groundwater (Schedule B1), for assessment criteria, where available. Schedule B1 provides a framework for the use of investigation and screening levels based on human health and environmental risks. Schedule B1 of the NEPM (2013) defines groundwater investigation levels (GILs) that have been developed for a broad range of metals and organic contaminants in groundwater. GILs are based on the following guidelines:

- Australian and New Zealand Conservation Council/Agriculture, and Resource Management Council of Australia and New Zealand 2000, *National water quality management strategy. Australian and New Zealand guidelines for fresh and marine water quality***.** This guideline has been superseded by an online resource prepared by the Australian and New Zealand and Australian State and Territory Governments (ANZG) in May 2018.
- National Health and Medical Research Council (NHMRC)/National Resource Management Ministerial Council (NRMMC) 2011, *Australian Drinking Water Guidelines 6*.

In the context of a contaminated site assessment, groundwater is considered to be contaminated when its quality is such that it is not suitable for the current or realistic future use or presents the likelihood of causing an unacceptable environmental or human health impact in the discharge environment.

For assessing groundwater quality, it is necessary to assess the potential uses of groundwater hydraulically down-gradient of the site being investigated. The nearest surface water feature is a stormwater outlet, (that flows only during rain events) and is located approximately 580 m north-west of the site. That channel is understood to empty into Ginninderra Creek, approximately 870 m to the north of the site. Ginninderra Creek is a tributary of the Murrumbidgee River, which is a major water body located approximately 7.35 km west of the site. Ginninderra Creek is considered to not likely to be used for recreational purposes and supports freshwater ecosystems. The unnamed channel is very unlikely to be used for recreational purposes but could potentially support a down-stream freshwater ecosystem. As these guidelines apply to receiving waters, it is generally conservative to apply these to groundwater discharging to receiving waters. It is considered that GILs for fresh water are applicable for investigating chemical concentrations in groundwater at the site because the possible receiving body is fresh water influenced.

It is important to note that these are not threshold values at which an environmental problem is likely to occur if exceeded. Rather, if the trigger values are exceeded then further action is required which may include either further site-specific investigations to assess whether there is an actual problem or management/remedial action should be reassessed. The groundwater reference criteria for ecological protection and drinking water resources, considered relevant to the current investigation of groundwater, are listed in Table 6.1.

Table 6.1 Groundwater reference criteria

ANALYTE	ECOLOGICAL PROTECTION CRITERIA-FRESHWATERS[1] (µg/L)	DRINKING WATER GUIDELINES[2] (µg/L)
Benzene	950	1
Toluene	180[2]	800
Ethylbenzene	80[2]	300

ANALYTE	ECOLOGICAL PROTECTION CRITERIA-FRESHWATERS[1] (µg/L)	DRINKING WATER GUIDELINES[2] (µg/L)
Total xylene	-	600
Xylene (o-)	350[2]	-
Xylene (m- and p-)	75[2]	-
Lead	3.4	10
Ethanol	1,400	-
Benzo(a)pyrene	0.2	0.01

Notes:
1. ANZAST (2018) – Water quality guidelines (95% trigger values for fresh water have been used)
2. National Health and Medical Research Council (NHMRC)/National Resource Management Ministerial Council (NRMMC) (2011) – Australian Drinking Water Guidelines 6.

Health Screening Levels (HSLs) are applicable to the assessment of vapour intrusion risks arising from petroleum hydrocarbons in contaminated groundwater. The adopted hydrocarbon fraction ranges for the HSLs are based on TRH concentrations after subtraction of BTEX compounds and naphthalene. HSLs do not apply to wells with LNAPL as it is assumed that the groundwater at those locations exceed the criteria.

These HSLs have been developed for sand, silt and clay soils based on soil texture classifications. Where there is reasonable doubt as to the appropriate soil texture to select, either a conservative selection should be made (i.e. select coarsest applicable grain size such as sand) or laboratory analysis carried out to determine particle size and hence soil texture sub-class. As particle size analysis previously could not be undertaken due to the drilling methodology employed (solid flight auger and air hammer, which pulverise the weathered and/or fresh rock into small fragments and dust), the most conservative option was selected, and the adopted assessment criteria was thus based on a subsurface profile comprising sand. This selection was on the basis that the profile consisted of highly weathered rock and not consistent in structure and type. The HSLs have been incorporated in Schedule B1 in the context of a wider site assessment framework for petroleum hydrocarbon contamination. They are intentionally conservative and are based on a reasonable worst-case scenario generic land use settings.

For this assessment, both the HSL A/B (residential) and the HSL D (commercial/industrial setting) will be adopted, for three different depths of groundwater (2m to <4m, 4m to <8m, and greater than 8 m) due to the varying depths of groundwater across the area of concern. The NEPM 2013 lists HSLs for open space as well as for intrusion into buildings. All HSL values for open space are listed as “non-limiting” meaning that the groundwater concentrations required to produce vapours that may present an exposure risk in open space, cannot be reached in the dissolved phase. Thus, dissolve phase hydrocarbons in groundwater cannot produce unacceptable vapour risks in open space atmospheres. While the adopted HSLs for groundwater have been provided in Table 6.2 as an initial screening tool, it is important to note that the vapour intrusion risks at the site were assessed via the soil vapour assessments.

Table 6.2 Groundwater health screening levels

CHEMICALS	HSL A/B: RESIDENTIAL SAND (µg/L) [1]			HSL D: COMMERCIAL/ INDUSTRIAL SAND (µg/L) [1]		
	2m to <4m	4m to <8m	>8 m	2m to <4m	4m to <8m	>8 m
pH	–	–	–	–	–	–
TRH F1 (C_6-C_{10} minus BTEX)	1,000	1,000	1,000	6,000	6,000	7,000
TRH C_6-C_9	–	–	–	–	–	–
TRH F2 (>C_{10}-C_{16} minus naphthalene)	1,000	1,000	1,000	NL	NL	NL
TRH C_{10}-C_{40}	–	–	–	–	–	–

CHEMICALS	HSL A/B: RESIDENTIAL SAND (µg/L) [1]			HSL D: COMMERCIAL/ INDUSTRIAL SAND (µg/L) [1]		
	2m to <4m	4m to <8m	>8 m	2m to <4m	4m to <8m	>8 m
Benzene	800	800	900	5,000	5,000	5,000
Toluene	NL	NL	NL	NL	NL	NL
Ethylbenzene	NL	NL	NL	NL	NL	NL
m- & p- xylene	–	–	–	–	–	–
o-xylene	–	–	–	–	–	–
Xylene	NL	NL	NL	NL	NL	NL
Naphthalene	NL	NL	NL	NL	NL	NL
Ethanol	–	–	–	–	–	–
Lead	–	–	–	–	–	–
Benzo(a)pyrene	–	–	–	–	–	–

Notes:

1. NEPM (2013) – Schedule B-1 Investigation Levels for Soil and Groundwater – Table 1A(4) Groundwater HSLs for vapour intrusion

NL not limiting i.e. the soil vapour source concentration for a petroleum mixture could not exceed a level that would result in the maximum allowable vapour risk for the given scenario

- No criteria available

For groundwater monitoring of a service station site in the ACT, monitoring should be undertaken in accordance with the specification outlined in the ACT EPA (2019) *Environmental Guidelines for Petroleum Storage in the ACT.* This guideline states that monitoring should be undertaken annually where groundwater monitoring wells are installed and should be analysed for the organic and inorganic substances outlines in Table 1 of the guideline. The groundwater monitoring parameters have been included for assessment during groundwater sampling and provided in Table 6.3.

Table 6.3 ACT EPA groundwater monitoring criteria

CHEMICALS	ACT EPA GROUNDWATER MONITORING CRITERIA (µg/L) [1]
pH	6.5-8.5
TRH C_6-C_9	-
TRH C_{10}-C_{40}	600
Benzene	950
Toluene	300
Ethylbenzene	140
m- & p- xylene	200
o-xylene	350
Xylene	600
Naphthalene	16
Ethanol	1,400
Lead	3.4

Notes:

1. As provided in the site's Environmental Authorisation (EA) No. 0749

- No criteria available

6.2 SOIL VAPOUR

Soil vapour concentration measurements are used as a screening level line of evidence in the evaluation of potential vapour intrusion risks. The soil vapour criteria are the health screening levels (HSLs) from NEPM 2013 for soil vapour. The criteria relevant to the investigations are shown in Table 6.4.

Table 6.4 Soil vapour health screening levels (HSLs) for petroleum hydrocarbons

CHEMICALS	HSL A Residential Sand <1 m (µg/m^3) [1]	HSL A: Residential Sand – 1 to <2 m (µg/m^3) [1]	HSL A: Residential sand – 4 to <8 m (µg/m^3) [1]	HSL D: comm/ industrial sand <1 m (µg/m^3) [1]	HSL D: comm/ industrial sand – 1 to <2 m (µg/m^3) [1]	HSL D: comm/ industrial Sand – 4 to <8 m (µg/m^3) [1]
Benzene	1,000	3,000	10,000	4,000	10,000	65,000
Toluene	1,300,000	3,800,000	15,000,000	4,800,000	16,000,000	84,000,000
Ethylbenzene	330,000	1,100,000	4,300,000	1,300,000	4,600,000	25,000,000
Total xylene	220,000	750,000	3,000,000	840,000	3,200,000	18,000,000
Naphthalene	800	3,000	10,000	3,000	15,000	75,000
TRH F1	180,000	640,000	2,600,000	680,000	2,800,000	15,000,000
TRH F2	130,000	560,000	2,400,000	500,000	2,400,000	NL

Notes:

1 NEPM (2013) – Schedule B-1 Investigation Levels for soil vapour

2 NL - Indicates that the unacceptable concentration (i.e., the HSL for the substance) cannot be reached by volatilisation from the pure substance

7 REPORTING

During operation of the remediation system, monitoring of the system performance shall be undertaken on a regular basis. The reports on performance of the remediation system and the associated monitoring will be prepared in general accordance with the NSW EPA 2020, *Guidelines for Consultants reporting on contaminated Land: Contaminated land guidelines* (every six months), and will include:

- Results of the groundwater gauging and sampling;
- Results of the soil vapour sampling;
- Time series plots for LNAPL thicknesses (hydrographs);
- Trend analysis of groundwater concentrations (Mann Kendall);
- Time series plots for recovered hydrocarbon mass and water/air effluent collected;
- Mass of hydrocarbon removed and treated;
- Mass destruction estimate addressed by related natural attenuation processes;
- Volumes of water discharged and aquifer draw-down response (i.e. well hydrograph tracking); and
- Review of asymptotic performance on key hydrocarbon mass removal parameters.

The report will make an assessment of the effectiveness of the remediation and determine if the operation of the remediation system should continue taking into account the overall net benefit to the community for continued operation of the system (in the balance of the benefits of hydrocarbon reduction, risk profile changes, versus the costs of energy consumption / carbon footprint, waste generation, and costs).

8 LIMITATIONS

1 This Report has been prepared by WSP Pty Limited ("WSP") for the benefit of Ampol Australia Petroleum Pty Ltd ("Ampol") (formally Caltex Australia Petroleum Pty Ltd (Caltex)), the registered proprietor or tenant of the site requested to be investigated by WSP ("Site") under its agreement with Ampol dated 21 March 2018 ("Agreement").

2 The nature and extent of the environmental consulting and remediation works at the Site detailed in the Report reflects the scope of the Services set out in the Request for Proposal under the Agreement and the Scope of Works set out in Schedule 1 of the Agreement ("Scope of Works").

3 A potential purchaser (but not including a purchaser's successor in title) of the Site may rely on the findings contained in the Report for the purpose of considering the possible (but not actual) level of contamination of or at that Site at the time of the contamination assessment of the Site was undertaken ("Permitted Purpose").

4 The registered proprietor of the land to which the report relates at the time of writing the report (but not including any proprietor's successor in title) may rely on the findings contained in the Report for the purpose of assessing the possible level of contamination of that Site ("Permitted Purpose") and subject to the limitations set out in the Scope of Works.

5 The findings contained in the Report are subject to the qualifications, assumptions and limitations set out in the Report or otherwise communicated to, or by, Ampol. To the extent of any inconsistency between this Limitation Statement and the qualifications, assumptions and limitations in the Report, this Limitation Statement shall prevail.

6 The Report may contain information provided by others. Except as otherwise stated in the Report, WSP has not verified the accuracy or completeness of this information. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the Report ("Conclusions") are based in whole or in part on this information, those Conclusions are contingent upon the accuracy and completeness of that information. WSP accepts no responsibility for the reliability, accuracy, completeness or adequacy of information provided by others.

7 WSP has prepared the Report without regard to any special or particular interest of any person (including that of a potential purchaser), other than Ampol when undertaking the Services or setting out its findings in the Report.

8 The Report can only be relied upon for the Permitted Purpose and may not be relied upon for any other purpose and does not purport to recommend or induce a decision to make (or not make) any purchase, disposal, investment, divestment, financial commitment or otherwise in relation to the Site ("Investment Decision").

9 Matters material to a potential purchaser, may have been omitted from the Report, or may not have been investigated because of the scope of the Services. It follows that a potential purchaser should be cognisant of the restrictions inherent in or otherwise set out in the Report and should commission the preparation of a contamination assessment of the Site that caters for its own interests and scope of services, and which will provide findings in relation to the level of contamination of or at the Site at the time the potential purchaser is making an Investment Decision.

10 The Report has not and will not be updated for events occurring after the date of the Report or any other matter which may have a material effect on its contents which come to light after the date of the Report. WSP will not be obliged to inform a potential purchaser of any matter arising or coming to its attention after the date of the Report, which may affect or qualify the Report.

11 WSP is not liable to a potential purchaser in respect of errors or omissions in the Report which a potential purchaser knows of, or ought to be aware of, from:

- **a** its own actual knowledge and inquiries
- **b** inquiries made by its advisers; or
- **c** matters which a potential purchaser should have been aware of by making reasonable inquiry (including the inquiries recommended at Item 9 above).

12 To the fullest extent permitted at law, WSP, its related bodies corporate, its officers, employees and agents assume no liability and will not be liable to any potential purchaser for, or in relation to, any losses, damages or expenses (including any indirect, consequential or punitive losses or damages or any amounts for loss of income or profit, revenue or loss of opportunity to earn profit, loss of production, loss of contract, increased operational costs, loss of business opportunity, business interruption and pure economic loss) of any kind (and whether arising in contract, tort (including negligence), under statute, in equity or otherwise, suffered or incurred by a potential purchaser (or any other third party) arising out of or in connection with any matter outside the ambit of the Permitted Purpose in relation to the Report or findings expressed in the Report.

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- WSP 2019, *Caltex Kippax Holt service station (Site ID: 22546), 1 Hardwick Crescent, Holt ACT 2615: Groundwater monitoring event*.
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- WSP August 2020c, *Environmental Site Assessment Report, Caltex Holt service station (Site ID: 22546), 1 Hardwick Crescent Holt ACT.*
- WSP December 2020d, *Environmental Site Assessment Report, Caltex Holt service station (Site ID: 22546), 1 Hardwick Crescent Holt ACT.*
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APPENDIX A

FIGURES

REMMAD technical services
geotechnical & environmental drafting support

InSite REMEDIATION SERVICES

Figure prepared for WSP by
InSite Remediation Services Pty Ltd

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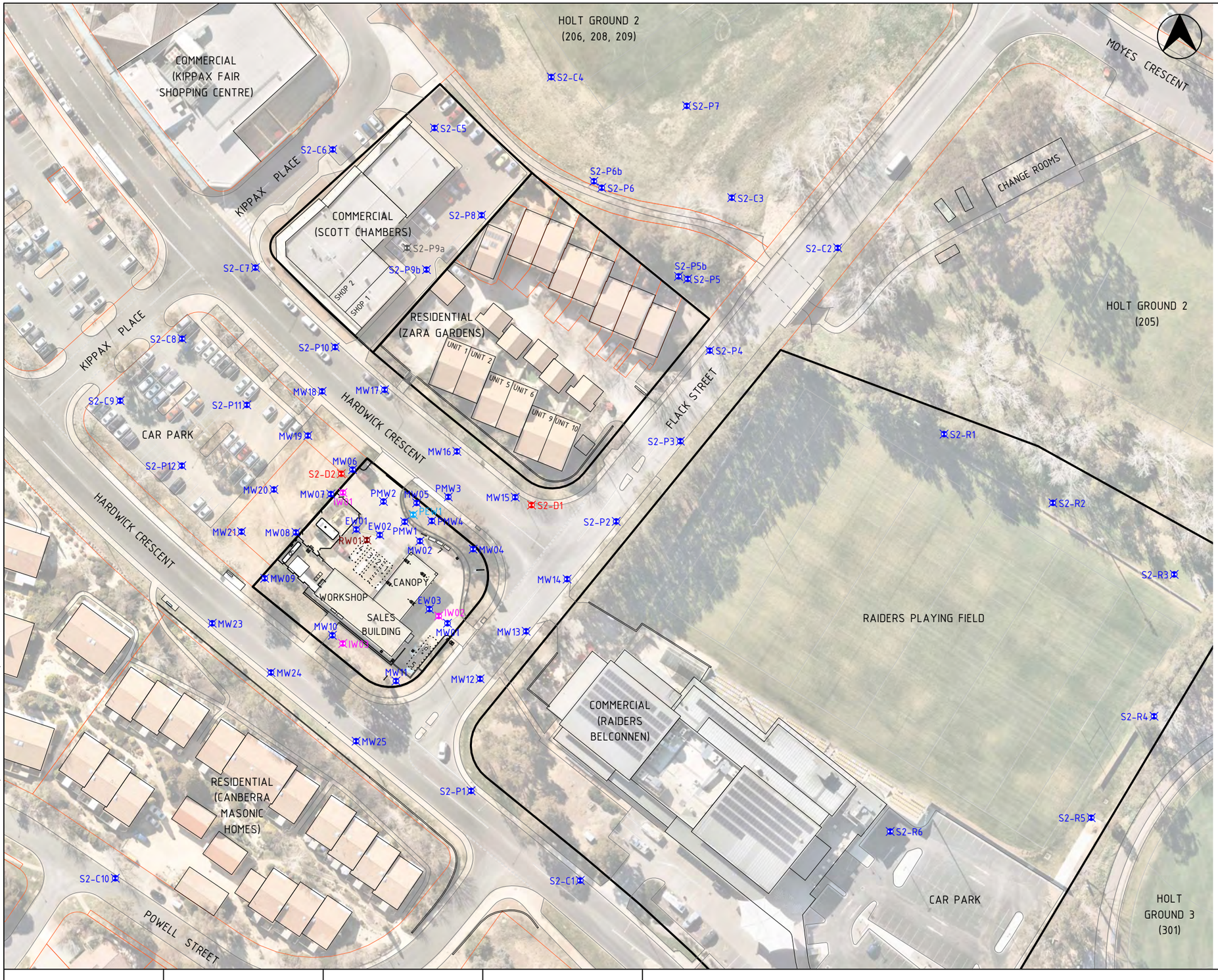
CALTEX HOLT SERVICE STATION

1 HARDWICK CRESCENT

HOLT ACT

FIGURE 1
SITE LOCATION

D:\Google Drive\WSP\HOLT\FIGURES GME 2021 FEB\V1\CALTEX HOLT GME FEB 2021 F01 V1.vwx | Tue, 4 May 2021 11:59:07 AM | drawn by laurie white at www.reumad.com.au



LEGEND

- PROPERTY BOUNDARY
- BLOCK / SECTION BOUNDARY
- #### GROUNDWATER MONITORING WELL
- PEW## EXTRACTION WELL
- IW## INJECTION WELL
- RW## RECOVERY WELL
- S2-D# CORED BOREHOLE
- #### BACKFILLED OR DESTROYED WELL

0 25m

1:050 AT A3 APPROXIMATE

REFERENCE: CALTEX 'DANGEROUS GOODS PLAN' DRAWING NO. 22546-DG REV. B DATED 25/11/2011 AND VERIS SURVEY 217267.01 DATED 02/10/2020 SUPPLIED BY CLIENT.

REMMAD technical services geotechnical & environmental drafting support

InSite REMEDIATION SERVICES

Figure prepared for WSP by InSite Remediation Services Pty Ltd

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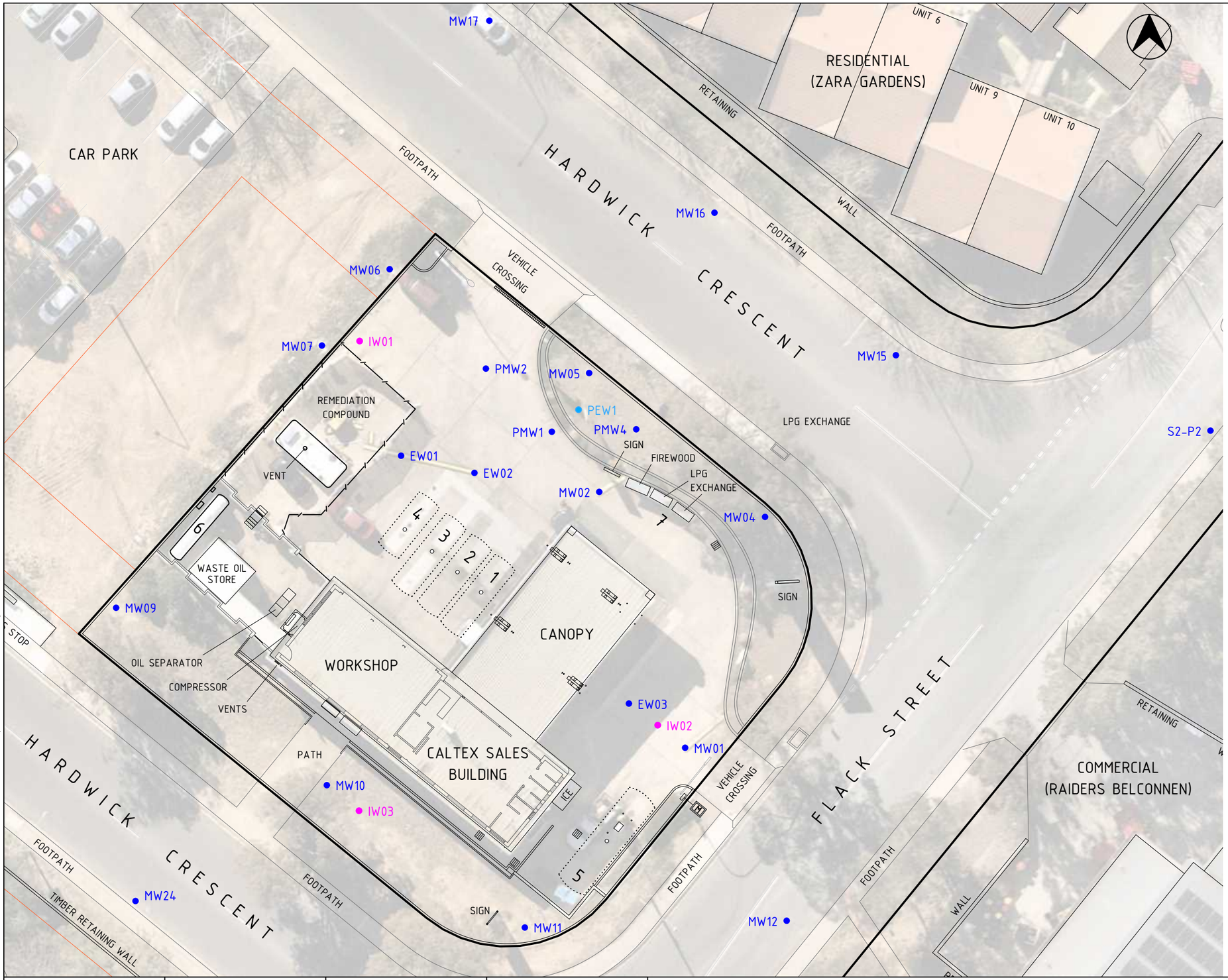
CALTEX HOLT SERVICE STATION

1 HARDWICK CRESCENT

HOLT ACT

FIGURE 2
SITE LAYOUT & GROUNDWATER MONITORING LOCATION NETWORK



LEGEND

- PROPERTY BOUNDARY
- BLOCK / SECTION BOUNDARY
- MW## GROUNDWATER MONITORING WELL
- EW## GROUNDWATER MONITORING WELL
- PMW## GROUNDWATER MONITORING WELL
- S2-P# GROUNDWATER MONITORING WELL
- S2-C# GROUNDWATER MONITORING WELL
- PEW## EXTRACTION WELL
- IW## INJECTION WELL

TANK SCHEDULE

TANK	TYPE	PRODUCT	CLASS	CAPACITY	USAGE
1	UST	V95	3	27,400L	IN USE
2	UST	DIESEL	C1	27,400L	IN USE
3	UST	E10	3	27,400L	IN USE
4	UST	V98	3	20,000L	NOT IN USE
5	UST	ULP	3	59,400L	IN USE
6	AST	LPG	2.1	7,500L	NOT IN USE
7	LPG EXCHANGE		2.1	9x4kg, 42x9kg	IN USE

NOTE

LPG TANK (TANK 6) DECOMMISSIONED, NITROGEN PURGED.

0 10m

1:340 AT A3 APPROXIMATE

REFERENCE: CALTEX 'DANGEROUS GOODS PLAN' DRAWING NO. 22546-DG REV. B DATED 25/11/2011 AND VERIS SURVEY 217267.01 DATED 02/10/2020 SUPPLIED BY CLIENT.

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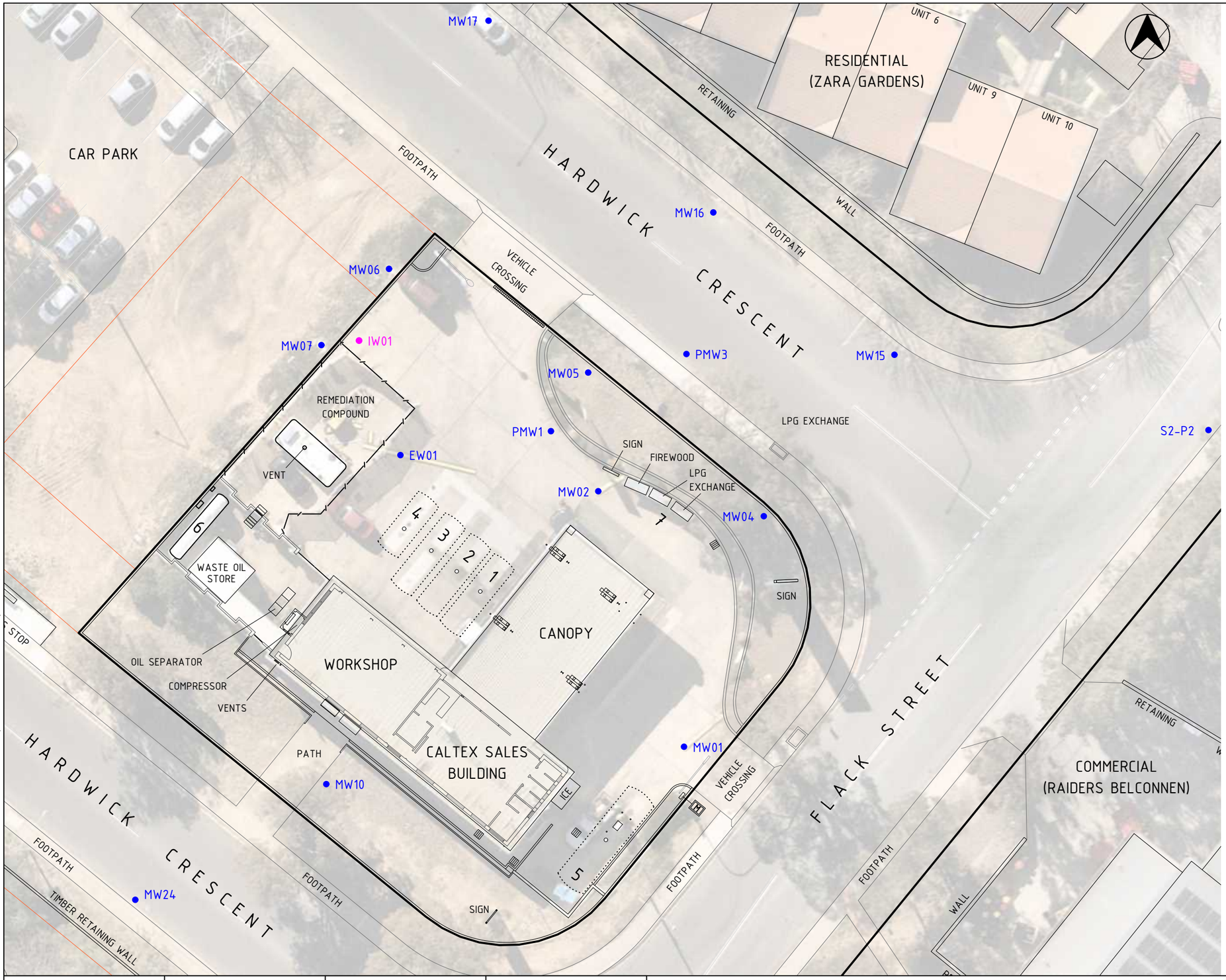
CALTEX HOLT SERVICE STATION
1 HARDWICK CRESCENT
HOLT ACT

FIGURE 3a
Monthly Gauging Locations

aerial image nearmap august 2020
block & section data from http://www.actmapi.act.gov.au

D:\Google Drive\InSite Remediation\Holt\FIGURES\FIGURES SVR 2020 SEPT\V3\CALTEX HOLT SVR F02a V3.vwx | Tue, 13 Oct 2020 7:54:23 AM | drawn by laurie white at www.reumad.com.au



LEGEND

- PROPERTY BOUNDARY
- BLOCK / SECTION BOUNDARY
- MW## ● GROUNDWATER MONITORING WELL
- EW## ● GROUNDWATER MONITORING WELL
- PMW## ● GROUNDWATER MONITORING WELL
- S2-P# ● GROUNDWATER MONITORING WELL
- S2-C# ● GROUNDWATER MONITORING WELL
- IW## ● INJECTION WELL

TANK SCHEDULE

TANK	TYPE	PRODUCT	CLASS	CAPACITY	USAGE
1	UST	V95	3	27,400L	IN USE
2	UST	DIESEL	C1	27,400L	IN USE
3	UST	E10	3	27,400L	IN USE
4	UST	V98	3	20,000L	NOT IN USE
5	UST	ULP	3	59,400L	IN USE
6	AST	LPG	2.1	7,500L	NOT IN USE
7	LPG EXCHANGE		2.1	9x4kg, 42x9kg	IN USE

NOTE

LPG TANK (TANK 6) DECOMMISSIONED, NITROGEN PURGED.

0 10m

1:340 AT A3 APPROXIMATE

REFERENCE: CALTEX 'DANGEROUS GOODS PLAN' DRAWING NO. 22546-DG REV. B DATED 25/11/2011 AND VERIS SURVEY 217267.01 DATED 02/10/2020 SUPPLIED BY CLIENT.

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InSite Remediation Services

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CALTEX HOLT SERVICE STATION
1 HARDWICK CRESCENT
HOLT ACT

FIGURE 3b
Quarterly Groundwater Sampling Locations

HOLT GROUND 2
(206, 208, 209)

COMMERCIAL
(KIPPAX FAIR
SHOPPING CENTRE)

KIPPAX PLACE

COMMERCIAL
(SCOTT CHAMBERS)

SHOP 2
SHOP 1

RESIDENTIAL
(ZARA GARDENS)

UNIT 1
UNIT 2
UNIT 5
UNIT 6
UNIT 9
UNIT 10

KIPPAX PLACE

CAR PARK

HARDWICK CRESCENT

HARDWICK CRESCENT

MOYES CRESCENT

CHANGE ROOMS

HOLT GROUND 2
(205)

FLACK STREET

RAIDERS PLAYING FIELD

CANOPY

WORKSHOP

SALES
BUILDING

COMMERCIAL
(RAIDERS
BELCONNEN)

CAR PARK

HOLT GROUND 3
(301)

RESIDENTIAL
(CANBERRA
MASONIC
HOMES)

POWELL STREET

S2-C4 S2-P7 S2-C5 S2-C6 S2-P6 S2-C3 S2-P8 S2-C2 S2-P9A S2-P9B S2-C7 S2-P5 S2-C8 S2-P10 S2-P4 MW18 MW17 S2-C9 S2-P11 MW19 MW16 S2-P3 S2-R1 S2-P12 MW06 MW20 MW07 IW01 PMW2 MW05 PMW3 MW15 S2-R2 PEW1 EW01 EW02 PMW1 PMW4 S2-P2 MW21 MW08 RW01 MW02 MW04 MW09 MW14 S2-R3 EW03 IW02 MW23 MW10 IW03 MW01 MW13 MW24 MW11 MW12 S2-R4 MW25 S2-P1 S2-R5 S2-R6 S2-C10 S2-C1

LEGEND

- PROPERTY BOUNDARY
- BLOCK / SECTION BOUNDARY
- #### GROUNDWATER MONITORING WELL
- PEW## EXTRACTION WELL
- IW## INJECTION WELL
- RW## RECOVERY WELL

0 25m

1:050 AT A3 APPROXIMATE

REFERENCE: CALTEX 'DANGEROUS GOODS PLAN' DRAWING NO. 22546-DG REV. B DATED 25/11/2011 AND VERIS SURVEY 217267.001 DATED 20/11/2020 SUPPLIED BY CLIENT. COORD SYSTEM MGA 55 (2020).

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InSite REMEDIATION SERVICES
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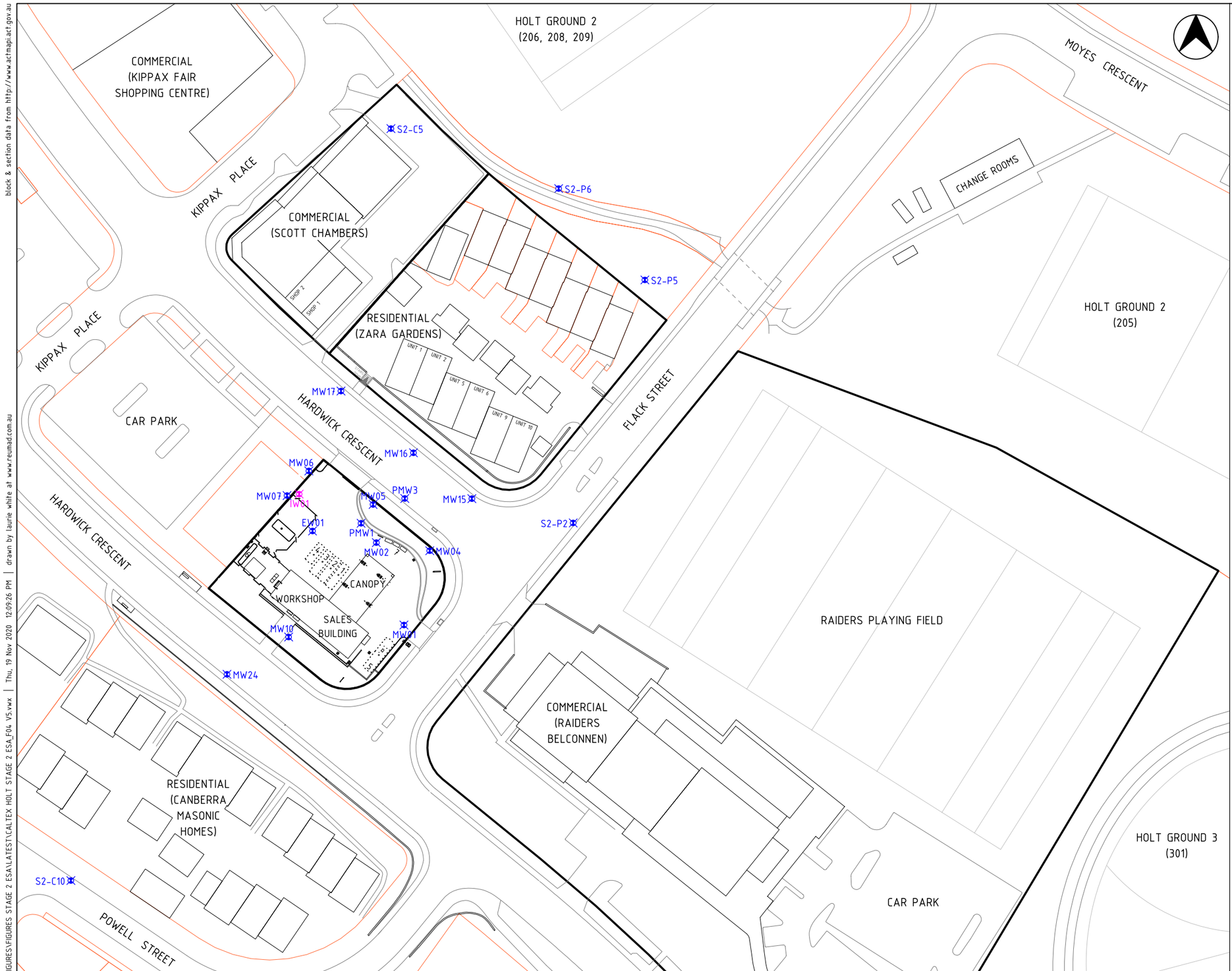
CALTEX HOLT SERVICE STATION
1 HARDWICK CRESCENT
HOLT ACT

FIGURE 3c
Bi-Annual Groundwater Monitoring Locations



LEGEND

PROPERTY BOUNDARY

BLOCK / SECTION BOUNDARY

GROUNDWATER MONITORING WELL

IW## INJECTION WELL

0 25m

1:050 AT A3 APPROXIMATE

REFERENCE: CALTEX 'DANGEROUS GOODS PLAN' DRAWING NO. 22546-DG REV. B DATED 25/11/2011 AND VERIS SURVEY 217267.001 DATED 20/11/2020 SUPPLIED BY CLIENT. COORD SYSTEM MGA 55 (2020).

REUMAD technical services
geotechnical & environmental drafting support

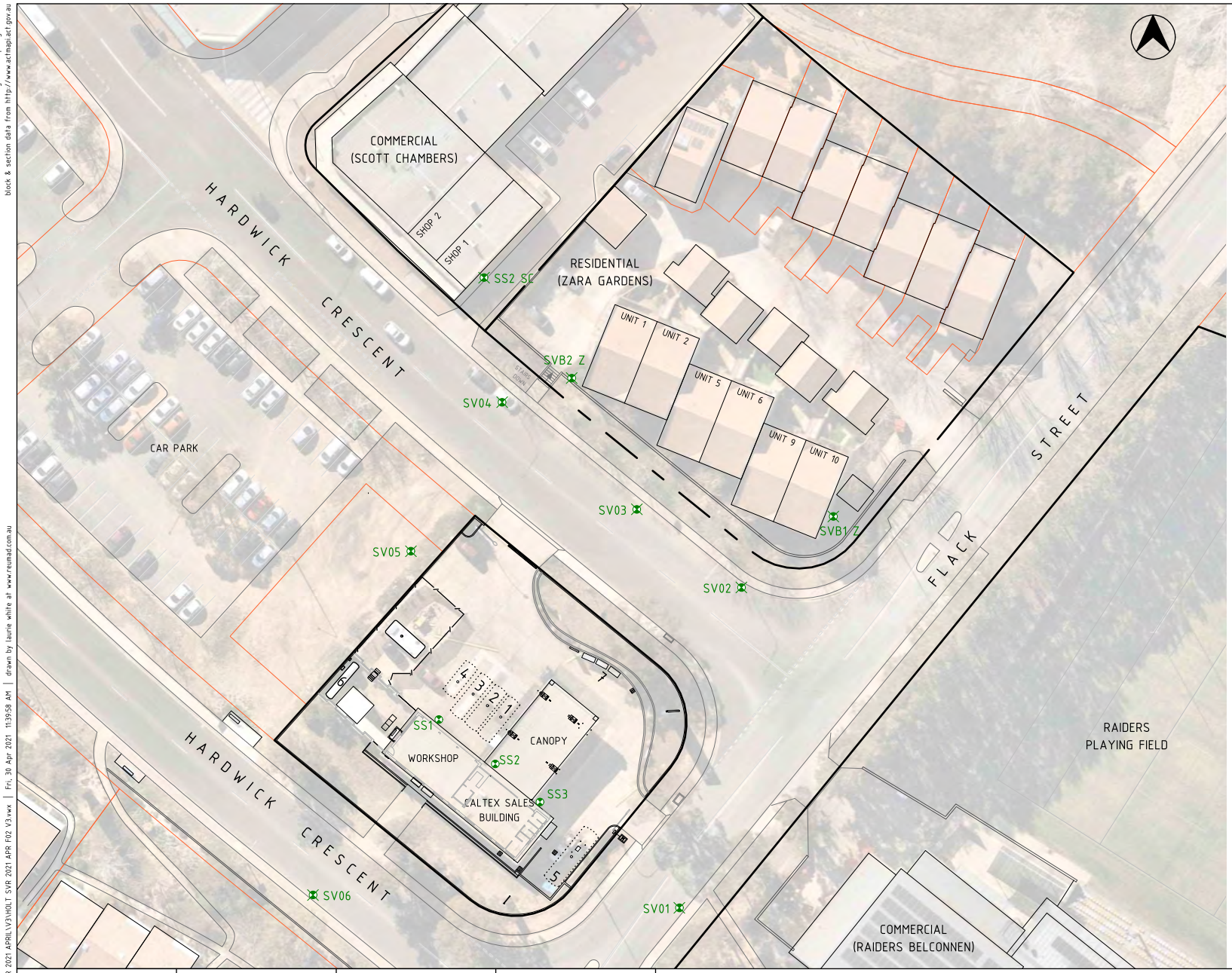
InSite REMEDIATION SERVICES
Figure prepared for WSP by InSite Remediation Services Pty Ltd

AMPOL

wsp

CALTEX HOLT SERVICE STATION
1 HARDWICK CRESCENT
HOLT ACT

FIGURE 3d
MNA Parameter Groundwater Monitoring Locations



LEGEND

- PROPERTY BOUNDARY
- BLOCK / SECTION BOUNDARY
- SV## SOIL VAPOUR BORE
- SS## SUB SLAB SOIL VAPOUR PIN

TANK SCHEDULE

TANK	TYPE	PRODUCT	CLASS	CAPACITY	USAGE
1	UST	V95	3	27,400L	IN USE
2	UST	DIESEL	C1	27,400L	IN USE
3	UST	E10	3	27,400L	IN USE
4	UST	V98	3	20,000L	NOT IN USE
5	UST	ULP	3	59,400L	IN USE
6	AST	LPG	2.1	7,500L	NOT IN USE
7	LPG EXCHANGE		2.1	9x4kg, 42x9kg	IN USE

NOTE

LPG TANK (TANK 6) DECOMMISSIONED, NITROGEN PURGED.
WELLS CONNECTED TO RECOVERY SYSTEM: MW01, MW02, MW05, MW06, MW07, MW10, EW01 & EW02.

0 10m

1:600 AT A3 APPROXIMATE

REFERENCE: CALTEX 'DANGEROUS GOODS PLAN' DRAWING NO. 22546-DG REV. B DATED 25/11/2011 SUPPLIED BY CLIENT.

Figure prepared for WSP by InSite Remediation Services Pty Ltd

CALTEX HOLT SERVICE STATION
1 HARDWICK CRESCENT
HOLT ACT

FIGURE 3e
BI-ANNUAL SOIL VAPOUR SAMPLING LOCATIONS

APPENDIX B

SUMMARY OF PREVIOUS INVESTIGATIONS

1 HOLT CALTEX PREVIOUS ENVIRONMENTAL / REMEDIATION WORKS

1.1 SUMMARY OF PREVIOUS INVESTIGATIONS

The known environmental reports, management plans and authorisations for the site are listed below in chronological order. A summary of the scope or outcome of each is presented in this section.

- GHD 2010, *Report for Holt Caltex Service Station, 1 Hardwick Crescent, Phase 2 Environmental site assessment*.
- AECOM 2011, *Groundwater Monitoring Well Report, Caltex Holt (22546), Corner Hardwick Crescent and Flack Street, Holt, ACT*.
- Caltex Australia 2013, *Environmental management plan Caltex Holt (22546)*.
- WSP (formerly Parsons Brinckerhoff) 2013, *2013 Round 1 – ACT Groundwater monitoring event*.
- WSP 2014, *2013 Round 4 – ACT Groundwater monitoring event*.
- WSP 2015, *Classification of stockpiled material at Caltex Holt Service Station (22546) Corner Hardwick Crescent and Flack Street, Holt, ACT*.
- URS Australia 2015, *Final Groundwater Data Memo – Kippax service station (22546).*
- ACT EPA 2016, *Environmental authorisation letter*.
- GHD 2017, *22546 – Caltex Kippax Service Station, 1 Hardwick Crescent, Holt, ACT, 2615 Groundwater monitoring event – September 2016*.
- WSP 2017, *Caltex Kippax Holt service station (Site ID: 22546), 1 Hardwick Crescent, Holt ACT 2615: Groundwater monitoring event*.
- WSP 2018, *Caltex Kippax Holt service station (Site ID: 22546), 1 Hardwick Crescent, Holt ACT 2615: Groundwater monitoring event*.
- WSP 2019, *Caltex Kippax Holt service station (Site ID: 22546), 1 Hardwick Crescent, Holt ACT 2615: Groundwater monitoring event*.
- WSP March 2020a, *Caltex Kippax Holt service station (Site ID: 22546), 1 Hardwick Crescent, Holt ACT 2615: Assessment of Vapour Risks*.
- WSP May 2020b, *Tier 1 Risk Assessment (Off-site), Caltex Holt Service Station, 1 Hardwick Crescent Holt, ACT, Site ID: 22546 (Rev0 – Draft)*.
- WSP August 2020c, *Environmental Site Assessment Report, Caltex Holt Service Station, 1 Hardwick Crescent Holt, ACT, Site ID: 22546 (Rev4)*.
- WSP August 2020c, *Environmental Site Assessment Report, Caltex Holt service station (Site ID: 22546), 1 Hardwick Crescent Holt ACT.*
- WSP December 2020d, *Environmental Site Assessment Report, Caltex Holt service station (Site ID: 22546), 1 Hardwick Crescent Holt ACT.*
- WSP December 2020e, *Vapour Risk Assessment (Off-Site), Caltex Holt service station (Site ID: 22546), 1 Hardwick Crescent Holt ACT.*
- WSP December 2020f, *Remediation Pilot Trial Report, Caltex Holt service station (Site ID: 22546), 1 Hardwick Crescent Holt ACT.*

- WSP December 2021a, *Draft Groundwater Monitoring Event, Caltex Holt service station (Site ID: 22546), 1 Hardwick Crescent Holt ACT.*
- WSP December 2021b, *Draft Summertime Vapour Sampling, Caltex Holt service station (Site ID: 22546), 1 Hardwick Crescent Holt ACT.*

GHD 2010, PHASE 2 ENVIRONMENTAL SITE ASSESSMENT

GHD were commissioned by Caltex to undertake contamination assessment at the site, with the objective to assess the status of soil and groundwater contamination at the site and if identified how potential contamination may affect the site's ongoing use as a service station facility. The scope of works included:

- A limited desktop-based assessment of the site.
- Drilling of six soil sampling boreholes (CH1 to CH6) to a depth of 4 mBGL and the collection of soil samples.
- Conversion of three borehole into groundwater monitoring wells (CH1, CH4 and CH5) in a triangulated pattern around the underground petroleum storage system (UPSS) and the collection of groundwater samples.
- Laboratory analysis of the soil and groundwater samples for total petroleum hydrocarbons (TPH), BTEX, polycyclic aromatic hydrocarbons (PAHs) and lead.

Results of the GHD (2010) Phase 2 environmental assessment found that standing water levels for groundwater were measured between 10.190 m below top of casing (mBTOC) and 10.570 mBTOC with a groundwater flow in a north and north-west direction. Soil and groundwater analytical results were below the laboratory limit of reporting (LOR) for TPH, BTEX and PAH, while concentrations of lead were found to be below the site assessment criteria (SAC).

GHD concluded that there was no evidence that would suggest the site has been impacted by hydrocarbon contamination.

AECOM 2011, GROUNDWATER MONITORING WELL REPORT

AECOM were commissioned by Caltex to install groundwater monitoring wells and undertake a groundwater monitoring event (GME) at the site. The objective of the investigation was to assess the groundwater conditions at the site with respect to potential hydrocarbon impacts from the UPSS infrastructure. The scope of works included:

- Drilling of two soil boreholes (BH01 and BH02) to a depth of approximately 12 mBGL and the collection of soil samples.
- Installation of two groundwater monitoring wells (MW01 and MW02) at the borehole locations and the collection of groundwater samples.
- Collection of groundwater samples from the three existing groundwater monitoring wells installed by GHD. These well were renamed from CH1, CH4 and CH5 to EW1 to EW3.
- Laboratory analysis of the soil and groundwater samples for TPH, BTEX and lead.

The AECOM (2011) GME found standing water levels in groundwater monitoring wells to be between 8.588 mBTOC and 9.230 mBTOC, with a groundwater flow to the north and north-east. Concentrations of contaminants in soil samples were below the laboratory LOR for TPH and BTEX and below the SAC for lead. A slight hydrocarbon odour and sheen was observed in MW02 and BTEX compounds were detected in EW2, but all groundwater results were less than the adopted groundwater assessment criteria.

AECOM concluded that the investigation adequately assessed the groundwater conditions at the site within the vicinity of the UPSS infrastructure.

CALTEX 2013, ENVIRONMENTAL MANAGEMENT PLAN

The Caltex (2013) environmental management plan outlines the procedures for loss monitoring, incident management, maintenance schedule and groundwater monitoring.

WSP 2013, GROUNDWATER MONITORING EVENT

WSP (as Parsons Brinckerhoff) undertook a GME of four groundwater monitoring wells (EW1 to EW3 and MW02; MW01 was not sampled) in May 2013. The scope of works involved the sampling of the groundwater monitoring wells and laboratory analysis of the groundwater samples for TRH, BTEX and lead. Key outcomes of the GME are as follows:

- Minor concentrations of TRH C6-C10 and TRH >C10-C16 in wells MW02 and EW2 and concentrations of TRH C15-C28 in well MW02 were identified.
- Concentrations of BTEX compounds in all wells were below the laboratory LOR. BTEX concentration that were reported in the AECOM 2011 GME in well EW2 were no longer present.
- All groundwater results were below the adopted SAC.
- Standing water levels for the groundwater monitoring wells were measured between 8.809 mBTOC and 9.486 mBTOC, with a groundwater flow direction inferred to the north and north-west; based on the AECOM 2011 GME.

WSP 2014, GROUNDWATER MONITORING EVENT

WSP (as Parsons Brinckerhoff) undertook a GME of four groundwater monitoring wells (EW1 to EW3 and MW02; MW01 was not sampled) in November 2014. The scope of works involved the sampling of the groundwater monitoring wells and laboratory analysis of the groundwater samples for TRH, BTEX, ethanol and lead. Key outcomes of the GME are as follows:

- Minor concentrations of TRH C6-C10 in groundwater sample from wells MW02 and EW2 and TRH >C10-C16 in groundwater sampled from well MW02 below the SAC were identified. MW02 recorded a TRH C10-C40 of 740 µg/L which exceeded the SAC.
- Minor concentrations of BTEX compounds in well EW2 below the SAC were identified. Concentrations of toluene (1,400 µg/L), ethylbenzene (585 µg/L) and xylenes (3,370 µg/L) recorded in well MW02 exceeded the SAC.
- Concentrations of lead were below the SAC in most samples with the exception of well EW1 which recorded a lead concertation of 9 µg/L which exceeded the SAC.
- Concentrations of ethanol were below the laboratory LOR in all samples.
- Standing water levels for the groundwater monitoring wells were measured between 8.560 mBTOC and 8.918 mBTOC, with a groundwater flow direction inferred to the north-east.

WSP 2015, CLASSIFICATION OF STOCKPILED MATERIAL

WSP (as Parsons Brinckerhoff) were commissioned by Caltex to prepare a waste classification of 4 cubic metres (m^3) of soil excavated during sign replacement works at the site. The objective of the works was to classify the excavated soils for disposal at an appropriate facility in accordance with ACT EPA guidelines. The scope of works involved the collection of soil samples from the stockpile which were analysed for TRH, BTEX, PAH, heavy metals and asbestos. The results of the waste classification reported the following:

- Concentrations of TRH, BTEX and PAH were reported to be below the laboratory LOR.
- No asbestos was detected in the samples.
- Concentrations of heavy metals were reported to be below the general solid waste contaminant threshold values.

- The stockpiled material was classified as general solid waste (non-putrescible).

URS 2015, GROUNDWATER MONITORING EVENT

URS undertook a GME of three groundwater monitoring wells (EW2, MW01 and MW02; EW1 and EW3 were not sampled) in September 2015. The scope of works involved the sampling of the groundwater monitoring wells on site and laboratory analysis of the groundwater samples for TRH, BTEX and PAH; lead was considered to not be a contaminant of concern. The results from the GME can be summarised as follows:

- Groundwater was observed to be slightly turbid with no sheens or odours.
- Concentrations of TRH C6-C10 in wells MW02 and EW2, concentrations of TRH >C10-C16 in well MW02 and concentrations of TRH >C16-C34 in wells MW01 and MW02 were identified. With the recorded TRH concentrations below the SAC.
- Concentrations of BTEX compounds or PAHs were below the laboratory LOR in all samples.
- All groundwater results were below the adopted SAC. It is noted that the groundwater samples were not assessed against the assessment criteria outlined in the site's Environmental Authorisation (EA).
- Standing water levels for all the groundwater monitoring wells were measured between 8.549 mBTOC and 9.100 mBTOC, with a groundwater flow direction inferred to the north and north-east; based on the regional topography and hydrology.

URS concluded that any potential risks from groundwater petroleum hydrocarbon impacts to onsite and nearby off-site receptors are low and acceptable.

ACT EPA 2016, ENVIRONMENTAL AUTHORISATION LETTER

The ACT EPA (2016) Environmental Authorisation letter is a variation to the EA that was granted on 19 October 2011. The notable variation to the 2011 EA is the inclusion of ethanol as a groundwater parameter as well as adjustments to the criteria values for other groundwater parameters.

GHD 2017, GROUNDWATER MONITORING EVENT

GHD undertook a GME of five groundwater monitoring wells (EW1 to EW3, MW01 and MW02) in September 2016. The scope of works involved the sampling of the groundwater monitoring wells on site and laboratory analysis of the groundwater samples for TRH, BTEXN, ethanol and lead. The results from the GME can be summarised as follows:

- LNAPL was not recorded in any well, however slight hydrocarbon odours were noted in wells EW1, EW2, MW01 and MW02.
- Concentrations of TRH and BTEXN were below the laboratory LOR in most samples with the exception of minor concentrations of TRH F1 in well EW2.
- Concentrations of ethanol and lead were below the laboratory LOR in all samples.
- Standing water levels for all the groundwater monitoring wells were measured between 7.918 mBTOC and 8.530 mBTOC. Groundwater flow direction was not conclusive due to the uncertainty surrounding the previously surveyed relative levels.

WSP 2017, GROUNDWATER MONITORING EVENT

WSP undertook a GME of five groundwater monitoring wells (EW1 to EW3, MW01 and MW02) in July 2017. The scope of works involved the sampling of the groundwater monitoring wells on site and laboratory analysis of the groundwater samples for TRH, BTEX, ethanol and lead. The results from the GME can be summarised as follows:

- All hydrocarbon concentrations in groundwater were either below the laboratory LORs or below the adopted assessment criteria.
- Minor concentrations of ethanol were detected below the adopted assessment criteria in monitoring well MW01.

- The field measured pH in monitoring well MW02 fell outside of the acceptable criteria stipulated in the EA but was within the historical range and was considered to be the result of natural groundwater conditions.
- All groundwater results were below the adopted SAC.
- Standing water levels for the groundwater monitoring wells were measured between 8.618 mBTOC and 9.282 mBTOC. The groundwater was inferred to flow towards the north to north-east; however, there was still uncertainty regarding flow direction of groundwater due to the location of the monitoring wells.

WSP 2018, GROUNDWATER MONITORING EVENT

WSP undertook a GME of five groundwater monitoring wells (EW1 to EW3, MW01 and MW02) in July 2018. The scope of works involved the sampling of the groundwater monitoring wells on site and laboratory analysis of the groundwater samples for TRH, BTEX, ethanol and lead. The results from the GME can be summarised as follows:

- All hydrocarbon results were either below the laboratory LORs or below the adopted assessment criteria, however, groundwater sampled from EW2 and MW02 were identified with minor detections of medium fraction hydrocarbon chains (TRH C10-C16), located in the central northern portion of the site.
- Minor concentrations of benzene below the SAC were recorded in EW2.
- Minor concentrations of lead below the SAC were recorded in EW1, MW01 and MW02.
- Concentrations of ethanol were below the laboratory LOR in all samples.
- The field measured pH ranged from 6.58 to 6.82, indicating circumneutral conditions and were within the acceptable criteria.
- All groundwater results were below the adopted SAC.
- Standing water levels for the groundwater monitoring wells were measured between 9.072 mBTOC and 9.737 mBTOC. There was still uncertainty regarding flow direction of groundwater due to the location of the monitoring wells.

WSP 2019, GROUNDWATER MONITORING EVENT

WSP undertook a GME of five groundwater monitoring wells (EW1 to EW3, MW01 and MW02) in September 2019. The scope of works involved the sampling of the groundwater monitoring wells on site and laboratory analysis of the groundwater samples for TRH, BTEX, ethanol and lead. The results of GME reported the following:

- All hydrocarbon results were either below the laboratory LORs or below the adopted assessment criteria, however, concentrations of TRH C6-C10 were present in monitoring well EW2, located in the central northern portion of the site.
- Minor concentrations of benzene and total BTEX below the SAC and were recorded in EW2.
- Concentrations of ethanol and lead were below the laboratory LOR in all samples.
- The field measured pH ranged from 7.01 to 7.71, indicating circumneutral conditions and were within the acceptable criteria.
- All groundwater results were below the adopted SAC.
- Standing water levels for the groundwater monitoring wells were measured between 8.490 mBTOC and 10.081 mBTOC. The groundwater was inferred to flow towards the north to north-east; however, there was still uncertainty regarding flow direction of groundwater due to the location of the monitoring wells.

WSP MARCH 2020, ASSESSMENT OF VAPOUR RISKS

In March 2020 WSP conducted an investigation of potential vapour intrusion risks to users of the service station from a confirmed fuel loss. Lost fuel was identified as LNAPL and measured in previously installed on-site monitoring wells. The scope of work comprised:

- Measurement of soil vapour concentrations beneath the forecourt pavement.
- Measurement of soil vapour fluxes diffusing through the floor slab of the sales building and the workshop.
- Measurement of ambient air concentrations of volatile organic compounds (VOCs) (targeting petrol vapours) in the buildings and outside on the forecourt.
- Continuous measurement of photo-ionisation detector (PID) readings within the sales building – to look for evidence of possible advective flows into the sales building.

Sub-slab soil vapour concentrations were measured at three locations outside the workshop and the sales building. VOCs characteristic of petrol vapour were detected at all three locations but at low concentrations. The low concentrations, all well below the adopted assessment criteria, indicated that an unacceptable vapour intrusion risk to occupants and visitors to the buildings was unlikely.

Surface flux was measured on the floors of the workshop and sales building at a total of six locations. The results show that all flux rates were trace or low. All the BTEX compounds had very minor flux strengths which would not contribute significantly to indoor air concentrations.

Measured ambient indoor and outdoor air concentrations of VOCs were typical of Australian service stations. With the exception of benzene, the concentrations of all VOCs of concern were either greatly less than the risk-based criteria or were not detected.

The continuous recording of VOCs using a PID instrument showed no evidence of advective pressure driven flows of soil vapours into the building. It was concluded from this record that advective vapour intrusion was not occurring at levels of concern.

No unacceptable human health risk was identified from the intrusion of vapours from the sub-floor indoors or the ground outdoors and, with respect to soil vapours, the site was suitable to continue operating as a service station.

WSP MAY 2020, TIER 1 RISK ASSESSMENT

In May 2020, WSP prepared a draft Tier 1 Risk Assessment to assess the potential risks to human health both on- and off-site from impacted soil and groundwater following a fuel loss..

- The assessment used the outer ring of 13 monitoring wells installed March 2020, during the Environmental Site Assessment (WSP, August 2020). The conceptual site model (CSM) was updated and the following potential source-pathway-receptors were identified: Vapour intrusion from contaminated groundwater into residential buildings on Hardwick Crescent (north and south of the service station)
- Vapour intrusion from contaminated groundwater into commercial buildings on Flack Street (east of the service station).
- Intrusive maintenance workers in trenches and services trenches in locations over contaminated groundwater.
- Human consumption of groundwater if abstraction bores are installed in areas affected by the hydrocarbon contamination.
- Dermal contact with extracted groundwater.

The Tier 1 Risk Assessment identified a need, with a high level of certainty, for follow-up measurements of soil vapour to ascertain whether the vapour intrusion pathway-receptor linkages are complete and to quantify the risk if the pathway were shown to be complete. As a result, six soil vapour bores were added to the ESA scope (WSP, August 2020) as described below.

WSP AUGUST 2020, ENVIRONMENTAL SITE ASSESSMENT

In February 2020, , WSP commenced a program of ESA works to investigate possible risks to human health and to the environment caused by hydrocarbon impacts to the soil and groundwater resulting from the fuel loss.

The purpose of the ESA was to characterise the contamination on the service station and surrounding land to evaluate the possibility that the contamination migrating off-site may present a risk to off-site receptors.

The scope of work undertaken comprised:

- Drilling and installation of 22 new groundwater monitoring wells on and off-site. The wells were drilled in two concentric rings around the service station to assess the extent of the contamination migration; one inner ring of 8 wells and one outer ring of 13 wells
- Logging, collection and analysis of 76 primary soil samples from the boreholes during the drilling of the new groundwater monitoring wells
- A GME comprising the collection and analysis of 27 primary groundwater samples from the five existing (EW01 to EW03, MW01 and MW02) and the 22 new monitoring wells (MW04 to MW21, MW23 to MW25 and RW01)
- Monitoring of air quality within utility pits surrounding the site using a photoionisation detector (PID)
- Drilling of six new soil vapour bores (SV1 to SV6) in the Hardwick Crescent and Flack Street roadways and installation of 12 soil vapour implants with implants installed at 2 m and 6 m below ground level (BGL). Soil vapour bore locations were co-located with groundwater wells known to be impacted
- Collection and analysis of 12 soil vapour samples from each soil vapour implant location.
- No hydrocarbon impacts were identified in the soil in the bores in the unsaturated zone. Hydrocarbons were detected in the saturated zone.

Groundwater sample results indicated that hydrocarbon impacts had migrated in diverse directions. Preferential migration of LNAPL along rock faults or along the more permeable bands in the rock profile were considered the most probable reason for the diverse spread of the hydrocarbon impacts in groundwater. The site surface and groundwater levels indicated a groundwater flow direction of north to north-east, however, the presence of LNAPL and/or contaminant concentrations in groundwater to the east, south and west of the site indicates another pathway of migration counter to the potentiometric gradient. The extent of dissolved phase groundwater impacts appeared to have been delineated to the north-west and west, however, based on the geological and hydrogeological conditions of the local area and variability of groundwater results from the wells located to the east and south, it was considered that there was potential for undefined preferential migration pathways to exist to the north-west and west of the site. The extent of the groundwater impacts to the north, east and south was not determined.

Soil vapours were measured at 6 m deep to assess vapour near the saturated zone and at 2 m to assess vapour intrusion risks to off-site buildings.

Two soil vapour bores were installed approximately 15 m from residential buildings on Hardwick Crescent to the south-west of the site. HSLs for residential and commercial land use were exceeded at a depth of 2 m in one bore and exceeded at a depth of 6 m depth in both bores. The residential buildings are of slab on grade foundation construction, 1.5 m lower than the road level which may result in a greater potential for vapour intrusion risk than was indicated by the vapour bore measurements.

Soil vapour concentrations were reported below the HSL in the soil vapour bore installed on Flack Street (near commercial properties to the south-east of the site) and adjacent to residential properties to the south-west of the site. Potential vapour intrusion risks at these residential and commercial properties are considered low.

Soil vapour concentrations were below the HSLs in the vacant open space land to the west of the site. It was unlikely that there would be an unacceptable vapour risk in this open space, for open space use, nor for residential or commercial/industrial use, were the site to be developed. However, if the site were to be developed for any use other than open space, testing at additional sampling locations would be advisable to confirm no unacceptable risk existed.

Works commenced to assess the potential risks to the residential properties on the northern side of Hardwick Crescent, and possibly to the commercial units also on the northern side of Hardwick Crescent further westward.

WSP DECEMBER 2020, VAPOUR RISK ASSESSMENT (OFF-SITE)

The objectives of the off-site risk assessment were to assess the risks to off site commercial and residential properties from potential vapour intrusion as identified in WSP, May 2020.

The three private properties identified as having potential risk of unacceptable vapour intrusion were:

- Raiders Belconnen sports club – building complex, about 20 m to the east of the service station;
- Zara Gardens residential complex (ground floor and level 1 units and townhouses) to the north-east approximately 22 m from the service station boundary; and
- Scott Chambers commercial building comprising a series of retail shops and commercial offices located about 29 m to the north of the service station.

The vapour investigations involved the measurement of VOC vapours from sub-slab fittings and soil vapour bores, and surface vapour flux measurements in pavement or garden areas immediately outside the three building complexes. If a vapour intrusion risk was identified at this point, WSP proposed to undertake the measurement of VOC vapours in the indoor air and vapour fluxes from inside flooring areas.

The outdoor soil vapour concentrations at the Raiders Belconnen sports club were low and no unacceptable vapour intrusion risk to the occupants of the clubhouse building was identified, thus no indoor assessment was deemed to be necessary.

The first phase outdoor assessment at Zara Gardens residential complex comprised soil vapour bore and sub-slab vapour sampling at the first row of ground floor residential units. Concentrations of the light alkanes were high and US EPA sourced criteria for n-pentane and n-hexane were exceeded in two of six sampling locations. The presence of high concentrations of light petroleum hydrocarbons, including exceedances of the US EPA guidelines in the vapour intrusion screening level (VISL) data base lead to the instigation of indoor air concentration assessment. During this assessment five of the six ground floor units, of slab on grade construction, backing onto Hardwick Crescent, were sampled for indoor air and indoor vapour flux. Concentrations of benzene and naphthalene exceeded the reference criterion. Exposure criteria were applied to the reference criterion for benzene and the vapour intrusion risk for that compound was also shown to be acceptable. The presence of naphthalene in one unit at concentrations exceeding the reference concentration was determined to be from an indoor source not related to vapour intrusion

At the Scott Chambers building two sub-slab vapour sampling points were installed in pavement outside Shop1. Several light aliphatic compounds were detected at substantial concentrations, none of which have criteria for vapour intrusion risk in the NEPM 2013. Of those aliphatics, n-pentane exceeded the US EPA criteria. As a result, two shops in the Scott Chambers retail/commercial building closest to the service station were tested for indoor and outdoor ambient air VOC concentrations and for indoor vapour flux. Shop 1 showed elevated concentrations in ambient air of toluene, ethylbenzene, xylenes and methylbutane, although none exceeded its reference criterion (none exists for methylbutane which is not considered to have significant toxicity).

The vapour fluxes of ethylbenzene and xylene from the floor of Shop 1, and the resulting elevated indoor air concentrations, were attributable to the freshly painted floor. The source of the elevated indoor air concentration of toluene was considered likely to be a product used in the barber shop as vapour fluxes from the floor show very minor contribution of toluene. In conclusion, the ambient indoor air and vapour flux measurements in the two shops tested in Scott Chambers showed no evidence of unacceptable vapour intrusion risk

No unacceptable vapour intrusion risk was identified at the off-site properties during the season of testing. There remained uncertainty as to the possible influence of warmer weather on the risk. Limited and targeted re-testing in warm weather was considered likely to resolve the uncertainty of seasonal effect on risk level.

WSP DECEMBER 2020, ENVIRONMENTAL SITE ASSESSMENT – STAGE 2

The purpose of this ESA was to present the results of a concluding stage of investigations regarding the nature and extent of contamination relating to the fuel loss. The report also provides a conclusion as to the suitability of impacted areas off-site for their current permitted uses under the ACT Territory Plan from a contamination perspective.

Thirty-eight groundwater wells were installed in three stages of 'step-out', at increasing distances from the service station. These wells have shown that hydrocarbon impacts in groundwater have migrated outwards from the service station in several directions along preferential migration pathways. Although the potentiometric levels show there is a clear north to north-easterly gradient to the groundwater, the hydrocarbon impacted groundwater has migrated in a radial pattern away from the site along preferential pathways formed by fractures in the Tuff bedrock, within the saturated zone, and along zones of softer rock due to greater weathering. The lateral extent of an individual fracture or series of fractures, or zones of softer rock could not be determined. The borehole imaging shows a multitude of fine fractures that are likely to be typically short in length, but frequently interconnect. Some of the zones of preferential migration may terminate, thus limiting the migration of the hydrocarbons, other than by the much slower process of diffusion and seepage through more competent rock.

Based on the results of the Stage 2 ESA, and from a contamination perspective, it is considered that all land uses identified on and around the site are suitable (based on the current site configurations), however in the event the service station site or the sites in the immediate vicinity of the service station were to be redeveloped, further assessment work would be required to ensure that the site is suitable for the future land use (under the ACT Territory plan).

WSP DECEMBER 2020, GROUNDWATER MONITORING EVENT (DRAFT)

The objectives of the GME were:

- assess the status of the groundwater contamination with respect to the occurrence and distribution of LNAPL;
- assess temporal trends in the degree of groundwater impacts on and off site; and
- determine if PFAS is present in groundwater, and if present, determine is the PFAS is a regional issue or site sourced. The PFAS assessment was completed to satisfy a request from Icon Water as part of the ongoing trade waste negotiations for the proposed remediation system at the site.

Based on the results, the following conclusions were made:

- Although LNAPL or saturated hydrocarbon impacts were observed in on-site wells and in the first 'step-out' ring of monitoring wells, delineation of the plume has been achieved by wells in all directions from the site reporting hydrocarbon concentrations below or only marginally above the laboratory LOR.
- Although concentrations of hydrocarbons in groundwater exceeded the adopted assessment criteria, the level of risk identified for all potential source-pathway-receptor linkages remains low.
- Results of natural attenuation parameter analysis indicate that natural attenuation of hydrocarbon impacts by biodegradation is likely to be occurring at the site.
- Results of PFAS sampling indicate regional impacts rather than an on-site source of PFAS contamination.
- The February 2021 GME is considered to comply with the SAQP and statutory requirements for the site.

WSP DECEMBER 2020, SUMMERTIME VAPOUR SAMPLING (DRAFT)

The summer season sampling did not show an overall upward bias in vapour concentrations. The differences that were observed were not consistent across locations and across compounds and evidence for difference due to seasonal change was lacking. As such, the summertime sampling confirmed the outcome and conclusions from the earlier cool-season sampling that vapour intrusion risk for those targeted properties were acceptable.

There were, however, differences in detail between the winter and summer sampling events as were most apparent in the soil vapour bores of the roadways and outside the Zara Gardens residential units. These differences are not attributed to seasonal effects as they were not consistent across analytes and locations. These small scale and temporal differences had also been seen in groundwater sampling which showed marked temporal and spatial variability.

The determinant data for risk assessment was that of indoor air concentrations in the Zara Gardens ground floor units and Scott Chambers shops 1 and 2.

There was an apparent overall trend towards lower indoor air concentrations of VOCs for the February 2021 sampling, but caution should be exercised when interpreting the possible trend. There are a number of factors which may be influencing the concentrations. Units 1 and 6 had had changes in occupants leading to potential differences in products used in the homes and ventilation rates of the homes is likely to have increased in the summer period.

The driver for vapour intrusion risks from the intrusion of petroleum hydrocarbon sourced soil vapours is typically benzene and to a lesser extent, the other aromatics. Soil vapour concentrations had convincingly shown in both seasonal sampling events that aromatics were at low concentrations in bores outside the Zara Gardens ground floor units. It was concluded that the presence of the aromatic compounds within the indoor air of the units was largely a result of indoor sources plus the low ambient background outside air. In the wintertime sampling benzene concentrations had been somewhat elevated in unit 1. Summertime sampling showed benzene to have fallen to typical outdoor ambient levels, following a change in occupancy of that unit. Other units, 2, 5 and 10 also showed benzene levels typical of outdoor ambient air concentrations. Unit 6 had slightly elevated concentrations, both in wintertime and summertime sampling, but less than the criterion unadjusted for exposure (i.e.,< 1.7 $\mu g/m^3$). However, unit 9 showed one result that exceeded the criterion (5.05 $\mu g/m^3$ at sample Unit 9 AA2). That result has prompted a resampling in April 2021 for which results showed lower concentrations considerably less than the criterion (i.e.,< 1.7 $\mu g/m^3$).

The other compound that could have had an influence on vapour intrusion risk was naphthalene. It had been found in unit 9 in the winter sampling at concentrations exceeding the acceptable ambient air criterion (unadjusted for exposure duration). However, its presence was attributed to the use of 'mothballs' and sufficient evidence was available from soil vapour and indoor flux to conclude that there was little or no contribution from the soil vapours. In the summertime sampling naphthalene was detected at even higher concentrations in unit 9, and at increased, but acceptable concentrations in units 2, 5, 6 and 10.

In summary, the observed changes in concentrations between the winter and summer sampling events is considered more likely to be due to changes in occupancy of the units and to greater ventilation rates in summer. No overall summertime increase is apparent in the data.

Finally, concerning the results for the Scott Chambers shops 1 and 2, the February 2021 sampling indoor air hydrocarbon concentrations were low and largely reflective of outdoor ambient air. The high indoor air concentrations of toluene, ethylbenzene and xylene that had been found in shop 1 in winter-spring sampling were not present in the summertime sampling – assumed to be a consequence of the disappearance of volatiles from the painted floor and walls. In shop 2, which had not been affected by repainting in winter, there was no overall sign of an increase for the summer sampling. Concentrations were low on both occasions, so the small differences were of no significance.

In conclusion, following the summertime resampling of indoor ambient air, plus the supporting lines of evidence from indoor vapour fluxes and soil vapour concentrations, it is evident that the risk profile for the three properties investigated has not changed and all remain at acceptable risk levels.

APPENDIX B

UPSS REPLACEMENT RAP

AMPOL AUSTRALIA PETROLEUM PTY LTD

REMEDIATION ACTION PLAN FOR UPSS REPLACEMENT

AMPOL HOLT SERVICE STATION (STORE ID: 22546)

APRIL 2021

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Remediation Action Plan for UPSS Replacement
Ampol Holt Service Station (Store ID: 22546)

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ABBREVIATIONS

ANZECC	Australian and New Zealand Environment and Conservation Council
ASRIS	Australian Soil Resource Information System
ASS	Acid sulfate soils
BTEXN	Benzene, toluene, ethylbenzene, xylene and naphthalene
CEMP	Construction environmental management plan
COPC	Contaminants of potential concern
CRC CARE	Cooperative Research Council for Contamination Assessment and Remediation for the Environment
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DA	Development application
HIL	health based investigation levels
HSL	Health screening levels
LEP	Local environmental plan
LNAPL	Light non-aqueous phase liquid, liquid petroleum products usually detected on the groundwater table, also known as free product or separate phase.
LPG	Liquefied petroleum gas
mAHD	Metres above Australian Height Datum
mBGL	Metres below ground level
mBTOC	Metres below top of casing
mg/kg	Milligram per kilogram (or part per million)
mg/L	Milligram per litre (or part per million)
ND (nd)	Not detected above the PQL
NHMRC	National Health and Medical Research Council
NOHSC	National Occupational Health and Safety Commission
NSW DECCW	NSW Department of Environment, Climate Change and Water
NSW DUAP	NSW Department of Urban Affairs and Planning

NSW EPA	NSW Environmental Protection Agency
PAH	Polycyclic aromatic hydrocarbon
POEO Act	*Protection of the Environment Operations Act 1997*
RAP	Remediation action plan
SAS	Site audit statement
SEPP55	State Environmental Planning Policy No 55—Remediation of Land
STEL	Short term exposure limit
TWA	Time weighted average
UPSS	Underground petroleum storage system
UST	Underground storage tank/s
VOC	Volatile organic compound

EXECUTIVE SUMMARY

Ampol Australia Petroleum Pty Ltd (Ampol) (previously Caltex Australia Petroleum Pty Ltd) commissioned WSP Australia Pty Ltd (WSP) to prepare a remediation action plan (RAP) for replacement of the underground petroleum storage system (UPSS) at the Caltex Holt service station (Site ID 22546), located at 1 Hardwick Crescent, Holt, Australian Capital Territory (ACT) (the site).

The existing UPSS consists of five underground storage tanks (USTs), fuel bowsers and their associated fuel and vent lines in addition to one decommissioned liquefied petroleum gas (LPG) aboveground storage tank (AST). A RAP is required to document the proposed remedial work associated with the fuel infrastructure and to provide a framework for the remediation and/or management of the hydrocarbon impacted soil in the vicinity of the fuel infrastructure to be removed. This RAP will be provided to the ACT Government Environment, Planning and Sustainable Development Directorate (EPD) in conjunction with a development application (DA).

After the fuel infrastructure is removed, the soils around the infrastructure shall be excavated as necessary to remove contamination considered unsuitable for the continuing use of the site, to extent practicable. Validation soil samples will be collected from the walls and the floor of the excavations. The soil samples will be tested for total recoverable hydrocarbons (TRH), benzene, toluene, ethylbenzene, xylene and naphthalene (BTEXN), polycyclic aromatic hydrocarbons (PAH) and lead.

The soil results will be compared to the soil health screening levels (HSLs) for vapour intrusion risk and direct contact risk and health investigation levels (HILs) for combined exposure pathways of vapour intrusion to buildings and direct dermal contact or ingestion.

It is estimated the excavations will result in a minimum of 900 m^3 of waste soil. The estimation is based on the size of the tanks to be removed and some allowance for excavation of fuel lines but does not include additional excavation volumes required if significant contamination (i.e. concentrations greater than nominated site assessment criteria) is encountered. The excavated soil will be assessed against the nominated site assessment criteria for its suitability to be re-used on-site. If the excavated soil is contaminated, that is, concentrations are greater than remediation criteria, it will be classified and disposed of at a licensed landfill or recycling facility. After the installation of the new fuel infrastructure, the excavation will be reinstated with re-used excavated soils and/or certified clean fill.

A UPSS validation report will be prepared to document the procedures and results of the UPSS removal, soil excavation and validation activities in accordance with the ACT EPA 2020, Information Sheet 11 – *Environment Protection Authority Report Submission Requirements,* and will demonstrate that the site is suitable for continued use as a service station. The validation report will also include documentation for all soil disposed off-site and material imported to the site.

1 INTRODUCTION

1.1 PURPOSE

Ampol Australia Petroleum Pty Ltd (Ampol) (formally Caltex Australia Petroleum Pty Ltd (Caltex)) commissioned WSP Australia Pty Ltd (WSP) to prepare a remediation action plan (RAP) for the underground petroleum storage system (UPSS) replacement works at the Caltex Holt service station, 1 Hardwick Crescent, Holt, Australian Capital Territory (ACT) (Site ID: 22546). The service station hereafter is referred to as the site.

Ampol is planning to replace the underground petroleum storage system (UPSS) at the site. A RAP is required to document the proposed remediation works associated with the tank replacement works and to provide a framework for the remediation and/or management of the hydrocarbon impacted soil near the fuel infrastructure to be removed. This RAP will be provided to the ACT Government Environment, Planning and Sustainable Development Directorate (EPD) in conjunction with a development application (DA).

1.2 OBJECTIVE

The objective of the RAP is to document the remediation actions required and provide a framework for the work practices and environmental management techniques to be implemented while undertaking removal and replacement of the UPSS at the site.

1.3 SCOPE OF THE RAP

The RAP includes:

- a summary of the site conditions and surrounding environment;
- a summary of the known contamination status of the site and its surroundings;
- assessment of the data gaps that may require further investigation;
- identification of remediation goals;
- an outline of the validation requirements;
- timing and schedule of the remedial work;
- site management issues;
- contingency management issues; and
- work health and safety (WHS) issues.

1.4 STATUTORY REGULATION OF THE SITE

Following the formal notification of the product loss to the ACT EPA, on 3 March 2020 the EPA issued Environmental Protection Order (EPO) No: 50048. Amongst other actions relating to the management and mitigation of the suspected fuel loss, the order required Ampol to *"undertake an assessment of the risk to human health of the occupants and visitors of the site to demonstrate that the site is suitable to continue operating"*. This assessment was conducted during mid to late March 2020 and a report was produced by WSP and was submitted to the EPA (Ref: PS118985-CLM-AVIR-8115 Rev2, dated 31 March 2020) (WSP March 2020a).

In addition to the EPO, the EPA issued a notification requiring Ampol to commission an environmental audit of contaminated land for the site (letter file ref: 10/3998, dated 13 March 2020). A NSW EPA and ACT EPA approved contaminated land site auditor was engaged by Ampol for the purpose of the audit. The audit is to address the following key requirements:

1. Determine the nature and extent of contamination both on and off-site from the identified release of petroleum product at the site;
2. Determine the appropriateness of all investigations and remedial actions undertaken to date and the appropriateness of any proposed assessment and management strategies for the site;
3. Provide commentary on the consultant's findings, past current and future, with respect to the level of risk the contamination posed to both on and off-site receptors;
4. Provide a conclusion as to the suitability of all impacted areas (both on and off-site) for their current permitted uses under the ACT Territory Plan from a contamination perspective; and
5. Be undertaken and submitted in accordance with the requirements of the Authority's Contaminated Sites Environment Protection Policy 2017 and the Authority's endorsed guidance.

The completed Audit report was submitted to ACT EPA on 11 December 2011.

As part of the Audit, a separate RAP was developed (WSP, December 2020) with the following objectives:

- Review and assess the suitability of remediation options to manage and mitigate the identified hydrocarbon impacts in groundwater at the site;
- Ensure the effectiveness of the remedial options is clear and based on all available data;
- Provide Ampol with remedial options that offer value and assist in moving the site (and affected sites) towards end point classification in a timely fashion; and
- Provide Ampol with recommended additional measures which will assist with refining the final remedial strategy.

The December 2020 RAP outlined the proposed technology for the remediation of LNAPL impacts (soil vapour extraction (SVE) and pumping), and the monitoring and validation plan during and following the active remediation works.

1.5 TECHNICAL FRAMEWORK

The RAP was prepared in general accordance with the following guidelines:

- ACT EPA 2017, *Contaminated Sites Environment Protection Policy;*
- ACT EPA 2019, *Environmental Guidelines for Petroleum Storage in the ACT;*
- Environment ACT 2000, *ACT's Environmental Standards: Assessment & Classification of Liquid & Non-liquid Wastes;*
- *Environmental Protection Act 1997;*
- *Environmental Protection Regulation 2005;*
- *National Environment Protection (Assessment of Site Contamination) Measure 1999* (NEPM; as amended 2013);
- Safe Work Australia 2018, *Workplace Exposure Standards for Airborne Contaminants*
- NSW EPA 2014, *Technical Note: Investigation of Service Station Sites*;
- NSW EPA 2020, *Assessment and Management of Hazardous Ground Gases: Contaminated Land Guidelines;*
- NSW EPA 2020, *Guidelines for Consultants Reporting on Contaminated Land: Contaminated Land Guidelines; and*

- *Work Health and Safety Act 2011* (NSW).

Further to the above, ACT Government provides a number of information sheets which outline some additional considerations relevant to the site. These include:

- ACT EPA 2014, Information Sheet 4 - *Requirements for the reuse and disposal of contaminated soil in the ACT.*
- ACT EPA 2019, Information Sheet 9 – *Management of groundwater impacted by light non-aqueous phase liquids (LNAPL); and*
- ACT EPA 2020, Information Sheet 11 – *Environment Protection Authority Report Submission Requirements.*

2 SITE BACKGROUND INFORMATION

2.1 SITE IDENTIFICATION AND DESCRIPTION

The site is located within a mixed commercial and residential area in Holt, ACT. Figure 1 shows the regional site location and setting. The site identification details are provided below in Table 2.1

Table 2.1 Site identification details

SITE NAME	AMPOL KIPPAX HOLT SERVICE STATION
Site address	1 Hardwick Crescent, Holt ACT 2615
Ampol site identification	22546
Legal identification	Block 1, Section 53, Holt
Latitude & Longitude	35°13'27.22"S 149° 1'15.49"E
Geographic Coordinates	683925.187 E 6100219.083 N (Zone 55)
Current Site Owners / Occupiers	Ampol Australia Petroleum Pty Ltd
Site Area	~2083 m^2
Local government area	ACT Government
Zoning	CZ2: Business Zone
Current land use	Service station with on-site retail shop and mechanic workshop

2.2 FUEL STORAGE INFRASTRUCTURE

There are five known underground storage tanks (USTs) and one decommissioned aboveground former liquefied petroleum gas (LPG) storage tank at the site. The location of the current USTs is shown in Figure 1, Appendix A. The storage information is given below in Table 2.3, based on the information provided from Ampol. There are no records for other storage tanks outside of the current tank farm other than an above ground waste oil tank behind (to the south-west) the mechanical workshop building.

Table 2.2 Petroleum storage information

TANK NUMBER	PRODUCT	SIZE (L)
T1 UST	Vortex 95 premium unleaded petrol (PULP)	27,400
T2 UST	Diesel	27,400
T3 UST	Unleaded petrol with 10% ethanol (E10)	27,400
T4 UST	Former Vortex 98 PULP (out of service from 14 February 2020 and temporarily abandoned from 1 April 2020 – tank currently empty)	20,000
T5 UST	Unleaded petrol with 10% ethanol (E10)	59,400
T6 AST	Decommissioned (formerly LPG)	7,500

The existing USTs listed above is to be replace by two 90 kL compartmentalised USTs. The proposed plans for the demolition / removal of the existing UPSS and the installation of the new UPSS is shown in Appendix B.

2.3 SURROUNDING LAND USE

Surrounding land uses include:

- **North:** Hardwick Crescent with residential properties (Zara Gardens) to the north-east (approximately 22 m from the site boundary) and commercial properties (Scott Chambers Building) north (approximately 29 m from the site boundary);
- **East:** Flack Street with the Raiders Belconnen and open-air recreation sports field beyond to the north-east (approximately 20 m from the site boundary);
- **South:** Hardwick Crescent with residential properties (Canberra Masonic Homes) beyond to the south-west (approximately 21 m from the site boundary); and
- **West:** open-air bitumen carpark (immediately adjacent to the site boundary).

Utility facilities including maintenance pits, drains and inspection covers relating to electrical, communications, water, sewer and stormwater infrastructure are located in all cardinal directions surrounding the site.

2.4 PHYSICAL SETTING

2.4.1 TOPOGRAPHY

Regionally, there is an elevated land area to the south of the site and the overall regional fall is to the north. Surveyed heights of the ground surface show the greatest elevations for the vapour pin location along Powell St, south-west of the site (S2C10: 582.239 mAHD). The wells located along Hardwick Crescent on the southern side of the service station are lower than Powell Street (MW25: 577.079 mAHD; MW24: 576.776 mAHD & MW23 576.517 mAHD) and lowest for wells in the park area on the northern side of Zara Gardens (S2P6: 568.819 mAHD; S2P7: 566.881 mAHD). Thus, the investigation area shows a topographical fall of approximately 15.4 m, from south to north over a distance of 250m, which equates to an average topographical gradient of approximately 6.16%.

2.4.2 GEOLOGY

Based on a review of Abell 1992, *Canberra 1: 100,000 scale geological map*, the site is underlain by the Late Silurian Deakin Volcanics, which is predominantly comprised of rhyodacitic ignimbrite with minor volcaniclastic and sedimentary units. Further, the 1:50,000 Geology of Canberra, Queanbeyan, and Environs (1980) geological map also indicates that the site is underlain by the Deakin Volcanics. The geological legend indicates that volcanic bedrock comprises Tuff and Tuffaceous Shale. Structurally, there are a number of major faults that have displaced the bedrock in close proximity of the site. A north-north west splay of the Deakin Fault having an orientation of approximate 165° crosses through the site. Although this fault is the dominant fault in the area there is likely to be a number of structures/joints that would be subparallel to the fault, and also conjugate joint sets which would strike approximately 45° to the main fault direction (Abell, 1992).

The subsurface conditions at the site observed in the monitoring well boreholes drilled during previous assessment works comprised a thin layer of Gravelly Silt Topsoil to approximately 0.2 mBGL in the grassed areas adjacent to the site, to a Sandy Gravel Road base to approximately 0.3m below the bitumen in the roads. At some locations the bedrock was exposed at the surface. The upper part of the bedrock comprised a yellow orange, highly to moderately weathered Tuff with alternating bands of harder and softer rock. Below approximately 8 m the profile continued as moderately to slightly weathered, grey brown Tuff. The Tuff comprises coarse phenocrysts in a finer grained matrix. At two locations MW07 and MW19 the bedrock has been recrystalised and fragmented and is likely to be the result of heating of the bedrock during faulting and these locations are likely to have been drilled into the fault zone.

Overall, it appears that the geology encountered at the site is consistent with the geological desktop study.

2.4.3 HYDROGEOLOGY

The 1:100,000 Hydrogeology of the Australian Capital Territory and Environs (1984) map indicates that groundwater is anticipated to be hosted in layers of dacitic, rhydodacitic, ignimbrite and bedded tuffs with minor shale, sandstone, limestone and ashstone of the Late Silurian era. The hydrogeological units are fractured with higher yielding zones associated with the upper and lower portions of the individual ash-flow tuffs and interbedded sediments. Groundwater quality tends to be variable with an estimated yield > 1.0 litres per second (L/s) and a total dissolved solid (TDS) concentration between 500-1000 milligrams per litre (mg/L). Previous assessment works 21 new groundwater wells were installed that target the shallow aquifer with groundwater intersected at 8 mBGL to 10 mBGL with groundwater inferred to flow in a north-east direction. Yields were noted to be variable when developing the wells ranging from <0.1 L/minute to 4.5 L/minute.

A search of ACT EPA records for groundwater monitoring bores associated with potential contaminated sites within a 1 km radius of the site was requested by WSP on 4 June 2020. The ACT EPA provided the following information on 5 June 2020:

> *"Office of the Environment Protection Authority records indicate that there are environmental monitoring bores at the 7 Eleven service station located at Block 1 Section 52 Holt. These bores are associated with environmental monitoring required under the site's environmental authorisation (EA) under the Environment Protection Act 1997.*
>
> *Dissolved phase hydrocarbon impacts have been detected in groundwater samples at the site in perched groundwater and a shallow aquifer (at depths of between 6.0 and 10.0 mBGL). Groundwater flow has been found to be to the north-northeast."*

Block 1 Section 52 Holt is located approximately 400 m north of the ESA investigation area. Potential off-site dissolved phase hydrocarbon impacts associated with Block 1 Section 52 Holt are unlikely to have impacted the site and nearby surrounding properties, as the ESA investigation area being approximately 400 m upgradient from the groundwater flow direction identified at Block 1 Section 52 Holt.

A review of the ACTmapi Cadastre and imagery water bore layer and the Bureau of Meteorology Australian Groundwater Explorer portal (which references the National Groundwater Information System) both undertaken on 23 April 2020 indicated that there are no registered bores within a 500 m radius of the site. To confirm that no potential unregistered groundwater abstraction bores were located within the near vicinity of the site, WSP performed a desktop survey of the area by review of aerial photographs from December 2019 (a period where Canberra was in drought and any significant water usage on gardens would be highlighted) and a walkover of the nominated area looking for evidence of possible groundwater bores (well covers, signs and pumps). The result of the desktop survey and walkover by WSP of nominated area surrounding the site undertaken on 4 June 2020 provided no visual evidence of potential unregistered groundwater abstraction bores in those areas mentioned.

The nearest surface water feature is an unnamed water body, a stormwater outlet and creek line, located approximately 580 m north of the site that empties into Ginninderra Creek, approximately 870 m to the north of the site. The stormwater outlet diverts water flow captured from runoff in the Holt area with a number of stormwater drains marked in the area that the stormwater flows directly into Ginninderra Creek. Ginninderra Creek is a tributary of the Murrumbidgee River, which is a major water body located approximately 7.35 km west of the site.

3 SUMMARY OF CONTAMINATION AND POTENTIAL HEALTH RISKS

3.1 SUMMARY OF PREVIOUS SITE INVESTIGATIONS

Reports are available on investigations and groundwater monitoring at the service station dating back to 2010. Those reports related to routine assessment of contamination that could emanate from fuel storage infrastructure. An assessment of waste soil from an on-site signage upgrade was also included in the early reports. Since 2011 low concentrations of benzene, toluene, ethylbenzene and xylene (BTEX), lead, ethanol and total recoverable hydrocarbons (TRH) C_6-C_{10} have been detected in groundwater, however, concentrations did not exceed the adopted assessment criteria.

Investigations following the fuel loss detected in February 2020 were specifically targeted to understand the risks to on and off-site receptors as a result of the incident as well as to obtain a deeper understanding of the site to facilitate future management and remediation measures. The on-site vapour risk assessment, WSP March 2020, was the first of a program of work developed to understand the nature and extent of impacts from the fuel loss detected in February 2020.

The known environmental reports, management plans and authorisations for the site are listed below in chronological order. A summary of the scope or outcome of each is outlined in detail within the Appendix C.

- GHD 2010, *Report for Holt Caltex Service Station, 1 Hardwick Crescent, Phase 2 Environmental site assessment*;
- AECOM 2011, *Groundwater Monitoring Well Report, Caltex Holt (22546), Corner Hardwick Crescent and Flack Street, Holt, ACT*;
- Caltex Australia 2013, *Environmental management plan Caltex Holt (22546)*;
- WSP (formerly Parsons Brinckerhoff) 2013, *2013 Round 1 – ACT Groundwater monitoring event*;
- WSP 2014, *2013 Round 4 – ACT Groundwater monitoring event*;
- WSP 2015, *Classification of stockpiled material at Caltex Holt Service Station (22546) Corner Hardwick Crescent and Flack Street, Holt, ACT*;
- URS Australia 2015, *Final Groundwater Data Memo – Kippax service station (22546);*
- ACT EPA 2016, *Environmental authorisation letter*;
- GHD 2017, *22546 – Caltex Kippax Service Station, 1 Hardwick Crescent, Holt, ACT, 2615 Groundwater monitoring event – September 2016*;
- WSP 2017, *Caltex Kippax Holt service station (Site ID: 22546), 1 Hardwick Crescent, Holt ACT 2615: Groundwater monitoring event*;
- WSP 2018, *Caltex Kippax Holt service station (Site ID: 22546), 1 Hardwick Crescent, Holt ACT 2615: Groundwater monitoring event*;
- WSP 2019, *Caltex Kippax Holt service station (Site ID: 22546), 1 Hardwick Crescent, Holt ACT 2615: Groundwater monitoring event*;
- WSP March 2020a, *Caltex Kippax Holt service station (Site ID: 22546), 1 Hardwick Crescent, Holt ACT 2615: Assessment of Vapour Risks*;
- WSP May 2020b, *Tier 1 Risk Assessment (Off-site), Caltex Holt Service Station, 1 Hardwick Crescent Holt, ACT, Site ID: 22546 (Rev0 – Draft)*;

- WSP August 2020c, *Environmental Site Assessment Report, Caltex Holt service station (Site ID: 22546), 1 Hardwick Crescent Holt ACT.*
- WSP December 2020d, *Environmental Site Assessment Report, Caltex Holt service station (Site ID: 22546), 1 Hardwick Crescent Holt ACT.*
- WSP December 2020e, *Vapour Risk Assessment (Off-Site), Caltex Holt service station (Site ID: 22546), 1 Hardwick Crescent Holt ACT.*
- WSP December 2020f, *Remediation Pilot Trial Report, Caltex Holt service station (Site ID: 22546), 1 Hardwick Crescent Holt ACT.*
- WSP December 2020g, *Remediation Action Plan, Caltex Holt service station (Site ID: 22546), 1 Hardwick Crescent Holt ACT.*

A summary of the scope or outcome of each of these reports is outlined in detail within Appendix C.

3.2 EXTENT OF HYDROCARBON CONTAMINATION

3.2.1 SOIL IMPACTS

During Stage 1 ESA (WSP, March 2020), soil samples were collected and analysed from the eight site boundary wells and the 13 wells drilled in the outer ring. Most of the sampling locations were on the surrounding roads, and were distant from the site's UPSS and thus the vadose zone of the profile was not expected to have been impacted by the fuel spill. The laboratory testing results confirmed the assumption, with no detections of hydrocarbons in soil above the saturated zone. The shallowest depth at which an impacted soil sample was detected was 9 m at MW15. All samples with detections of hydrocarbons were in the saturated zone.

Detections of TRH and BTEXN compounds were identified at depth in boreholes MW05, MW06, MW10, MW15 and MW17, however the detected concentrations in the majority of the samples do not exceed the site assessment criteria; with the exception of the following:

- benzene in sample MW05_12.0-12.1 which recorded a concentration of 23.2 mg/kg, which exceeds the HSL D criterion of 3 mg/kg for a sample depth >4 mBGL;
- benzene in sample MW15_10.5-10.6 which recorded a concentration of 1.4 mg/kg, which exceeds the HSL A criterion of 0.5 mg/kg for a sample depth >4 mBGL; and
- TRH C_6-C_9 less BTEX (F1) in sample MW15_10.5-10.6 which recorded a concentration of 391 mg/kg, which exceeds the HSL A criterion of 200 mg/kg for a sample depth >4 mBGL.

It is noted that the groundwater in these equivalent locations has detections of significant TRH and BTEXN impacts and are likely to be the source of the impacts identified in the soil.

During the Stage 2 ESA, field screening of the boreholes for VOCs with a PID indicated the following:

- Nil to low concentrations of VOCs (<10 ppm) were detected in the majority of the soils and weathered rock screened with a PID;
- Elevated PID readings (>50 ppm) were detected at sampling locations S2-P2 (from 7 to 9.5 mBGL) and S2-P10 (from 8 to 10.5 mBGL). The maximum PID reading was detected was 1,679 ppm detected at a depth of 9 mBGL within the borehole S2-P2; and
- Olfactory indications and field screening of soils with a PID suggest that potential soil impacts are likely to be present near the depth were hydrocarbon impacted groundwater is intersected.

The laboratory results indicated that most of the COPCs scheduled for analysis in soil samples collected during Stage 2 ESA works including TRH and BTEXN, were not detected above the laboratory LOR, with the exceptions of the following:

- Minor detections of toluene were detected at the sample locations, S2-C3_0.1m, S2-C4_0.1m, S2-C5_0.1m, , S2-C6_2.0m, S2-C6_8.0m, S2-C6_9.0m and S2-P1_12.0m ,S2-P9b_1.0m. The toluene concentrations detected were below the adopted site assessment criteria.
- The TRH F2 and F3 concentrations of 88 mg/kg and 250 mg/kg respectively were above the LOR but below the adopted site assessment criteria at sampling location S2-P5_0.1m within the topsoil profile. The soil samples collected at further depths from the same borehole did not reveal any detectable concentrations. Hence the TRH F2 and F3 detections are considered to be attributed to natural organic matter (NOM) rather than petroleum impacts related to the fuel spill.
- Minor BTEXN concentrations were recorded within the sample S2-P2_7.0m and S2-P2_8.0 m. All recorded concentrations were below the adopted site assessment criteria. The BTEXN concentration detected are located within the capillary fringe or saturated zone and are representative of the groundwater plume.

In summary, all the Stage 2 ESA soil samples collected and analysed recorded analytical results below their respective assessment criteria and are not considered posing significant risks to receptors.

It is noted that toluene detections within the soil samples are likely attributed to a manufacturing, handling or laboratory process fault causing minor contamination to the sampling containers. The minor toluene detections were also noted in the field rinsate blank samples collected from 8 September to 14 September 2020, which also supports potential contamination of the sampling container, rather than insufficient decontamination processes, as no other analytes were detected.

3.2.2 GROUNDWATER IMPACTS

Prior to the loss of fuel, the 2019 GME (WSP, 2019) identified minor concentrations of medium fraction hydrocarbon chains (TRH C_{10}-C_{16}) in wells EW2 and MW02 and low concentrations of benzene in well EW2. Naphthalene, lead and ethanol was not detected in any of the monitoring wells samples. All analytical results were either below the laboratory LORs or below the adopted assessment criteria; indicating that historic site conditions have had a negligible effect on the current site conditions.

Since February 2020, the Stage 1 and 2 ESA have installed a number of wells on the service station or in the very near vicinity, which brought the total number of wells near the source area to 23 (EW01 - EW03; IW1 - IW3; MW01 – MW11; PEW1; PMW1 – PMW4; and RW01). Of those 23 near-source wells, 16 were heavily impacted with dissolved phase hydrocarbon impacts and some showed the presence of LNAPL. For the purposes of this report, the descriptor ‘heavily impacted’ has been nominated as dissolved phase concentrations of total BTEX of greater than 80,000 ug/L, with or without the presence of LNAPL. These results show that there was widespread impact to groundwater at and in the near vicinity of the service station.

The groundwater wells installed in three stages of ‘step-out’ at increasing distances from the service station, have shown that hydrocarbon impacts in groundwater have migrated outwards from the service station in several directions along separate migration pathways. Although the potentiometric levels show there is a clear north-easterly gradient to the groundwater, the hydrocarbon impacted groundwater has migrated in a radial pattern away from the site along preferential pathways formed by fractures in the Tuff bedrock, within the saturated zone, and along zones of softer rock due to greater weathering. The lateral extent of an individual fracture or series of fractures, or zones of softer rock, could not be determined. The borehole imaging shows a multitude of fine fractures that are typically short in length, but frequently interconnect. However, it is likely that some of the zones of preferential migration may terminate, thus limiting the migration of the hydrocarbons, other than by the much slower process of diffusion and seepage through more competent rock.

The monitoring wells installed for the second and third 'step-out', i.e. the wells designated S2-P1 to S2-P12, and at greater distance, wells S2-C1 to S2-C10, effectively defined the extent of the preferential migration pathways for identified pathways with the exception of the migration beneath the Raiders playing field.

On the basis of the degree of hydrocarbon impact (hydrocarbon dissolved phase concentrations and periodic appearances of LNAPL, the most prominent migration pathways have been to the north towards Scott Chambers, north-northeast towards Zara Gardens, and north-east towards the Raiders playing field. Those north to north-easterly preferential migration pathways are generally consistent with the hydraulic gradient and their flows are likely to be enhanced by the gradient.

The outermost wells, S2-C1 to S2-C10, have defined a zone of non-impacted groundwater and thus define the extend of the impacts, with the exception of the migration pathway beneath the Raiders playing field (i.e. due to the impacts detected in one well in Flack Street (S2-P2)). As a result of the undelineated impacts in S2-P2, six additional wells were installed and sampled in November 2020 to determine the extent of the contaminated groundwater within the Raiders Belconnen property away from the source on the service station.

The six wells located surrounding the playing field, within the Raiders Belconnen property (S2-R1 to S2-R6), all reported concentrations of hydrocarbon (TRH and BTEXN), lead and ethanol below the laboratory limit of reporting / applicable site assessment criteria, and thus it is considered that the impacts reported at S2-P2 is now delineated.

A sewer main and stormwater pipe traverse the open space to the north of the Zara Gardens residential complex. Comparing the invert levels of those pipelines with the standing water levels of wells in that open space area, shows that the pipelines are not in contact with the groundwater at the time of measurements. As the groundwater is currently around 1.2 m below the stormwater invert level (referenced to well S2-P6) and 0.7 m below the sewer main (referenced to well S2-P7), those conduits are not likely to be impacted by possible future hydrocarbon impacted groundwater – in the event that migration were to travel to the open space to the north of Zara Gardens.

The nearest surface water feature is an unnamed channel, a stormwater outlet, that flows only during rain events, located approximately 580 m north-west of the site. The unnamed channel is very unlikely to be used for recreational purposes but could potentially support a down-stream freshwater ecosystem. However, it is too far distant to have any reasonable probability of being a receptor of the hydrocarbons in groundwater in the future, and the current extent of the contamination has been shown to be less than 100 m. The more substantial surface body, Ginninderra Creek, is more distant from the service station, at 870 m and is thus out of reach of the hydrocarbon plume. On this basis, the ecological receptor risk pathway is considered incomplete.

3.2.3 SOIL VAPOUR IMPACTS

Investigations to date into the possible risk from vapour intrusion into the service station buildings – the sales building and mechanic workshop – comprised the testing of soil vapour beneath the forecourt at three locations outside the buildings and the measurement of surface floor fluxes and indoor air concentrations in the buildings. The on-site vapour testing showed low and acceptable vapour intrusion risks to the commercial occupants of the on-site buildings.

Initial off-site soil vapour investigations showed hydrocarbon vapours to be present at the 6 m depth in six off-site soil vapour bores located on the surrounding roads and open space. Lower concentrations were measured at the 2 m sample depth indicating that attenuation of the hydrocarbon vapours with decreasing depth is occurring.

Further vapour investigations were conducted using receptor targeted soil vapour and indoor air and indoor flux measurements at the Raiders Belconnen sports club, residential buildings within the Zara Gardens complex, and shops in the Scott Chambers commercial building.

The primary line of evidence for the determination of vapour intrusion risk for occupiers of residential units at Zara Gardens and commercial shops at Scott Chambers was indoor air measurements of VOCs. Secondary lines of evidence, soil vapour and surface vapour flux, were used to assist in the interpretation of the ambient air data. All the lines of evidence supported the conclusion that at those two properties there was no unacceptable vapour intrusion risk at the time

(during the season) of testing. There remains uncertainty as to the possible influence of warmer weather on the risk. Limited and targeted re-testing in warm weather would likely resolve the uncertainty of seasonal effect on risk level.

For the Raiders Belconnen property, screening level risk indicators – from sub-slab soil vapour measurements, were sufficient evidence on which to conclude that indoor air sampling was not required to confirm the absence of unacceptable vapour intrusion risk. However, the same caveat over seasonal effects applies.

A further consideration concerning uncertainty is the possibility of an increasing degree of soil vapour impacts affecting the targeted properties. It is possible that the vapour intrusion risk level may increase if contaminant migration in groundwater increases in the form of an expansion of phase separated hydrocarbons, or other changes to the vadose zone occur having an effect on vapour generation and diffusion. Such uncertainty can be examined through seasonal re-testing.

3.2.3.1 SOIL VAPOUR SEASONAL VARIATION

As noted above, there remains a low-level uncertainty as to the possible influence of warmer weather on the potential risk posed by soil vapours. Limited and targeted re-testing in warm weather would likely resolve the uncertainty of seasonal effect on risk level. Additional vapour sampling is proposed during the warmer summer months to gather additional data and further refine the risk assessment with regards to vapour.

The vapour sampling conducted on the off-site properties (Zara Gardens Residential Complex, Scott Chambers Building, Raiders Belconnen) has been replicated during the warmer summer months (e.g. January or February 2021) to gather additional (seasonal) data to confirm that there is no unacceptable risk to off-site receptors, with the results yet to be reported at the time of writing. These works included the following:

- Indoor air and surface flux sampling in the six ground floor units of Zara Gardens and Shops 1 and 2 of the Scott Chambers Building;
- Outdoor surface flux sampling around the six ground floor units of Zara Gardens; and
- Soil vapour sampling from the 15 sub-slab soil vapour pins and nine soil vapour bores located on Zara Gardens Residential Complex, Scott Chambers Building, Raiders Belconnen and on Hardwick Crescent (adjacent to MW24).

4 CONCEPTUAL SITE MODEL

Environmental assessment works at the site are continuing and the conceptual site model (CSM) is being developed as more data is gathered. The CSM relates to vapour source, pathways and receptors. Figures 4a to 4g shows the cross-section location plans, and Figures 5a through 5e inclusive present five selected cross sections through the site and provides a graphical depiction of the site CSM. The alignments for the five cross sections were chosen as they were considered to provide the best overview of the study area in terms of the interaction of the source area with the various receptors in the surrounding areas.

4.1 PHYSICAL SETTING

The physical setting of the site, including topography, geology, hydrogeology, and surrounding land use is detailed in Section 2.

4.2 CONTAMINANTS OF CONCERN

The analytical results from the groundwater monitoring have provided clear evidence that the contaminants in groundwater are sourced from petrol. Additionally, samples for fingerprinting of the LNAPL encountered in some wells were also collected. The fingerprinting report identified the LNAPL as premium unleaded petrol having been in the environment for between one and a half to two and a half years, however the fuel loss was identified in February 2020; approximately seven months prior to LNAPL sampling. The results of the fingerprinting analysis identified the source of the LNAPL to be slightly degraded Vortex 98 unleaded petrol, which is the same type of fuel that was released from UST 4 in the fuel loss incident.

The contaminants of concern are therefore the compounds comprising premium unleaded petrol, largely characterised by:

- BTEXN; and
- petroleum hydrocarbon fractions C_6-C_{10} and >C_{10}-C_{16} as indicators of petrol.

Lead and ethanol are not considered contaminants of concern at the site resulting from the fuel loss, they are however required to be analysed (in certain circumstances) as stipulated in the site's Environmental Authorisation (EA number 0749, dated 3 May 2016).

Analysis of polycyclic aromatic hydrocarbons (PAH) and heavy metal (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc) may also be necessary for waste classification purposes.

4.3 CONTAMINATED MEDIA

The media impacted by contamination includes the following:

- Vadose zone in the immediate vicinity of the original fuel loss incident;
- Saturated soil within the water bearing zone of the Tuff formation;
- Groundwater on and off site. Although the potentiometric levels show there is a clear northly gradient in the groundwater, the hydrocarbon impacted groundwater has migrated in a radial pattern away from the site along preferential pathways formed by fractures in the Tuff bedrock, within the saturated zone, and along zones of softer rock due to greater weathering; and
- Vapours within the pores of soil in equilibrium with soil and groundwater within the area of impact on site as referred to in the previous bullet point.

4.4 CONTAMINANT MIGRATION MECHANISMS

Fuel known to have leaked from the base of the tank is likely to have entered the weathered Tuff and be distributed (predominantly) vertically, with some radial distribution due the head pressure of the fuel and / or fracturing within the Tuff. The fuel is likely to have intercepted groundwater at a depth of approximately 9 mBGL.

As previously identified, there are two dominant mechanisms controlling the migration of groundwater at the site. The predominant flow is controlled by the gradient resulting in a northerly flow, and the secondary groundwater migration is influenced by preferential pathways caused as a result of a network of discontinuities within the Tuff geology. The dominance of the natural groundwater flow gradient is observed by the pattern of hydrocarbon impact showing much of the impacted wells to the north of the site. The occurrence of impacts in other cardinal directions can be explained by taking into account the influence of preferential pathways.

Exposure to volatile hydrocarbons through the inhalation of vapours is the risk driving pathways to human receptors. Groundwater contaminated with volatile hydrocarbons can diffuse through vadose zone from the impacted groundwater. In terms of mass flux of vapour, the major source is the groundwater smear zone which contains the 'smeared' hydrocarbon mass in the profile above the saturated zone.

Off-site, away from the source of fuel loss, the contaminated medium is the saturated ground horizon in which the contamination is migrating in a dissolved and phase separated form. The groundwater smear zone intercepting unsaturated soil may be considered a distinct medium within the lithology. While groundwater migration is the mechanism for the lateral transport of the contamination, the smear zone above the transient level of the saturated zone (i.e. the potentiometric level), is the source of the diffusive vapour pathway. Thus, the physical nature, thickness and porosity of the smear zone is a major controlling factor in the generation of vapours.

The structure and features of the vadose zone, above the smear zone, including air filled porosity, will influence the flux rates, more so than concentration of vapours in the profile. Existence of vertical preferential migration pathways may have a significant bearing on the vapour flux rates towards the ground surface.

Weather influences, particularly rainfall and temperature can have strong influence on the vertical migration pathway for soil vapours. Diffusive flux rates of contaminant vapours are greatly influenced by water filled porosity within the vadose zone – as affected by rainfall, and soil profile temperature affects vapour pressures of VOCs and hence the resulting diffusive flux rates.

4.5 SOURCE – PATHWAYS – RECEPTORS EVALUATION

4.5.1 SOURCE AND PATHWAYS

The primary source of the contaminants was fuel loss of unleaded petrol (Vortex 98 PULP) from an underground storage tank (Depot 4) and the primary migration pathway is as liquid transport in groundwater flows, as dissolved phase and phase separated hydrocarbons.

A secondary subsequent source of contaminants is hydrocarbon vapour diffusion from the dissolved and phase separated hydrocarbons in the groundwater upwards through the vadose zone. The ultimate pathway leading to vapour intrusion into buildings as diffusive and advective flows into buildings.

4.5.2 RECEPTORS

ECOLOGICAL RECEPTORS

The nearest surface water feature is an unnamed channel, a stormwater outlet, that flows only during rain events, located approximately 580 m north-west of the site. The unnamed channel is unlikely to be used for recreational purposes but could potentially support a down-stream freshwater ecosystem, however groundwater analytical results for the perimeter wells to the north and north-west, S2-P7, S2-C3, S2-C4, S2-C5 and S2-C6, approximately 80 – 100 m from the site,

indicated no hydrocarbon impacts. Furthermore, the depth at which groundwater was intersected within the investigation area ranged from 6 mBGL to 17 mBGL, and it is likely that the groundwater depth at the stormwater drain is too deep to discharge into the drain. The more substantial surface body, Ginninderra Creek, is more distant from the service station, at 870 m and is thus out of reach of the hydrocarbon plume. On this basis, the ecological receptor risk pathway is considered incomplete.

HUMAN HEALTH RECEPTORS

The local area is served with reticulated town water and a review of the ACTMapi (www.actmapi.act.gov.au) groundwater database conducted on 29 October 2020 indicated that there are no registered groundwater boreholes within a 500 m radius of the site, and generally at depths of greater than 6m. Thus, the probability of humans (both residents and/or workers) having exposure to abstracted groundwater via dermal contact or ingestion is low.

On 4 June 2020, WSP conducted a desktop survey and walkover of areas surrounding the site for evidence of unregistered bores and the use of those bores. The survey and did not identify any unregistered bores. However, this doesn't rule out the potential for unregistered bores to exist nearby.

Groundwater is not abstracted at the service station site or surrounding properties for any other purpose than remediation/recovery and monitoring, and the depth to groundwater (approximately 6 metres deep at its shallowest in the study area) indicates that the probability of incidental intersection of the impacted groundwater during routine intrusive maintenance works is considered minimal. Where workers are potentially in contact with the water or are performing the remediation and groundwater monitoring activities, those workers follow the appropriate WHS guidelines to mitigate their exposure risks.

The risk of exposure to hydrocarbons in groundwater by on-site and off-site workers, including intrusive (trench) maintenance workers by means of vapour inhalation, dermal contact and ingestion is unlikely. Firstly, vapour intrusion into the sales building and workshop was assessed and deemed acceptable (WSP, March 2020). Secondly, utility pits surrounding the site have been routinely monitored with a photo-ionisation detector (PID) since the project commenced and no elevated vapour concentrations have been detected. Soil vapour testing in the previous works showed that concentrations were less than health screening level criteria (CRC Care Technical Report No 10) for maintenance workers' vapour exposure in shallow trenches. This risk-receptor pathway of vapour intrusion is therefore considered incomplete.

A further possible exposure pathway is the intrusion of vapours arising from hydrocarbon impacted groundwater and the smear zone created by fluctuations in levels of impacted groundwater. The receptors are the occupants of the buildings on three nominated properties (Zara Gardens, Scott Chambers Building and Raiders Belconnen) determined from earlier screening level assessments of soil vapour, to be potentially exposed to VOC vapours from the migration pathways. The receptors include any person occupying a building for any length of time. The Vapour Risk Assessment (off-site) (WSP October 2020) concluded that the pathway of vapour intrusion into buildings off site has an acceptable risk levels for building occupants. Therefore, the risk-receptor pathway is considered incomplete.

There does exist a data gap regarding the nature and extent of the contamination beyond the eastern extent of the groundwater monitoring well network in the direction of the playing field at Raiders Belconnen. The transect of vapour bores on the Raiders playing field embankment identified a trajectory of preferential migration of hydrocarbons in groundwater away to the east, however the extent of hydrocarbon impacts in groundwater is unknown.

A summary of potential risk pathways and receptors is presented in Table 4.1.

Table 4.1 Risk level assessment for relevant source-pathway-receptor linkages

Potential Receptor	Potential Exposure Pathway	Risk from Exposure Through the Pathway (Is the Linkage Complete & is there a Risk?)
Ecological: Surface water bodies	Discharge of groundwater into surface water bodies – stormwater channel or Ginninderra Creek to the north-west	Considered to be an incomplete pathway as groundwater impacts were not identified in the perimeter wells of the current investigation area approximately 120 m from the source location; therefore, no unacceptable risk.
Users of groundwater bores registered for water supply	Abstraction of groundwater for beneficial purpose	There are currently no known users of groundwater within 500 m of the service station. Possible exposure pathways if water is accessed and used are: ingestion; dermal contact; contamination of soil if groundwater is used for irrigation. There are currently no known groundwater extraction bores, with irrigation of the playing fields in Block 47 Section 53 and the Raiders Club utilising mains water. Thus, the risk pathways are believed to be currently incomplete.
Residents and occupiers of commercial buildings	Vapour intrusion	The pathway of vapour intrusion into buildings on and off the site has assessed to result in acceptable risk levels for building occupants. Accordingly, this pathway can be considered incomplete.
Human receptors on open space land	Vapour inhalation	Due to considerable atmospheric dispersion above unconfined open space (the car parking area to the west of the site, and open fields to the north east and east), the level of risk has been shown to be acceptable. The pathway can thus be considered incomplete.
Sub-surface maintenance workers (intrusive trench workers)	Inhalation of vapour in shallow excavation trenches	Soil vapour testing in the earlier environmental site assessment works showed that concentrations were less than screening level criteria (CRC Care Technical Report No 10) for workers' vapour exposure in shallow trenches. This risk-receptor pathway is therefore considered incomplete.
Sub-surface maintenance workers (intrusive trench workers)	Ingestion and direct contact with impacted groundwater or soil	Considered an incomplete pathway. The groundwater is too deep for excavation workers to come into contact with and potential soil contamination is believed to be confined to the service station.

4.6 LNAPL CONCEPTUAL SITE MODEL

In response to the requirements of ACT EPA (2019) *Information Sheet 9* and considering the presence of LNAPL detected at a thickness greater than 3 mm at the site (and also off-site), an LNAPL CSM (LCSM) is required to be developed and presented as part of the site assessment process.

4.6.1 LNAPL CHEMICAL PROPERTIES

LNAPL was found to have a chromatographic profile typical of a slightly degraded Vortex 98 unleaded petrol product. Based on the absence of groundwater impacts in September 2019, and the understanding that the leak possibly

commenced in late 2019 (detected in early February 2020), it is estimated that the age of the LNAPL is approximately 1 year.

A compositional analysis of the BTEXN component of the LNAPL was also undertaken. The BTEXN component of the LNAPL was identified to make up 18.2% to 34.2 % of the total product across the analysed samples; with the latter more typical of petrol composition. The percentage of benzene was consistent across all samples, which was close to 1%, which meets the Australian regulation of benzene content of petrol of 1%.

4.6.2 LNAPL PHYSICAL PROPERTIES

As the LNAPL was identified to be a slightly degraded Vortex 98 unleaded petrol, the following physical properties were obtained from the safety data sheet for Vortex 98, as issued by Ampol Australia Petroleum Pty Ltd (Version 3.1, dated: 8 April 2019):

- Specific gravity: 0.74;
- Vapour pressure: 62 kPa max @ 37.8 °C in Sydney; and
- Relative vapour density: 3.5 (air = 1).

4.6.3 LNAPL MOBILITY AND BODY STABILITY

The groundwater monitoring event of 28 September 2020, identified LNAPL in wells MW02, MW07, MW10, MW15 and MW16 with apparent thickness ranging from 0.003 m to 0.061 m. Since the commencement of the works program at the site, regular gauging of the groundwater monitoring well network have been undertaken. Over the course of the 2020 works, apparent LNAPL thickness measured in wells appear to be generally declining across the monitoring well network. The declining thicknesses of LNAPL on-site are at least partially due to the ongoing product recovery measures and / or the rise in groundwater levels across the general area encompassing the well network.

An assessment of LNAPL transmissivity was performed by means of a bail down test on the 21 May 2020. The off-site and downgradient well MW15 was selected for the assessment due to its proximity to sensitive receptors (Zara Gardens residents). Initial gauging of well MW15 prior to undertaking the bail down test showed an apparent LNAPL thickness of 0.663 m. LNAPL transmissivity was estimated at 0.076 m^2/day and indicates that the LNAPL may be recoverable (i.e. is greater than LNAPL transmissivity range of 0.009–0.07 m^2/day (ITRC, 2009)). However, recent attempts to conduct LNAPL transmissivity testing have not be possible due to the reduced LNAPL thicknesses.

Geochemical indicators of the occurrence of natural attenuation processes were observed via the reduction of pH and DO when comparing the physicochemical results between the groundwater monitoring undertaken in April 2020 and September 2020. .

4.6.4 LNAPL SOURCE – PATHWAYS – RECEPTORS

A summary of the potential receptors of the LNAPL impact detected on and off-site, the potential exposure pathways and an assessment of the likelihood of risk from exposure to the LNAPL through the potential pathway is presented in Table 4.2.

Table 4.2 Source-pathway-receptor linkages related to LNAPL

Potential Receptor	Potential Exposure Pathway	Risk from Exposure Through the Pathway (is the linkage complete & is there a risk?)
Ecological: Surface water bodies	Discharge of LNAPL into surface water bodies – stormwater channel or Ginninderra Creek to the north-west	Considered to be an incomplete pathway as LNAPL was not identified in the perimeter wells of the investigation area approximately 120 m from the source location; therefore, no unacceptable risk.
Users of groundwater bores registered for water supply	Abstraction of groundwater impacted with LNAPL for beneficial purpose	There are currently no known registered users of groundwater within 500 m of the service station. Possible exposure pathways if water is accessed and used are: ingestion; dermal contact; contamination of soil if groundwater is used for irrigation. There are currently no known groundwater extraction bores, with irrigation of the playing fields in Block 47 Section 53 and the Raiders Club utilising mains water. Thus, the exposure pathway associated with groundwater abstraction is incomplete.
Residents and occupiers of commercial buildings	Vapour arising from the LNAPL intrudes and accumulates in buildings	The pathway of vapour intrusion into buildings on and off the site was assessed to result in acceptable risk levels for building occupants. Accordingly, this pathway can be considered incomplete.
Human receptors on open space land	Vapour arising from the LNAPL is inhaled	Due to considerable atmospheric dispersion above unconfined open space (the car parking area to the west of the site, and open fields to the north east and east), the level of risk has been shown to be acceptable. The pathway can thus be considered incomplete.
Sub-surface maintenance workers (intrusive trench workers)	Vapour arising from the LNAPL enters shallow excavation trenches and is then inhaled	Soil vapour testing in the earlier environmental site assessment works showed that concentrations were less than health screening level criteria (CRC Care Technical Report No 10) for workers' vapour exposure in shallow trenches. This risk-receptor pathway is therefore considered incomplete.
Sub-surface maintenance workers (intrusive trench workers)	Ingestion and direct contact with LNAPL impacted groundwater or soil	The groundwater is too deep (>4m) for excavation workers to come into contact with and potential soil contamination is believed to be confined to the service station. This risk-receptor pathway is therefore considered incomplete.

5 REMEDIATION GOALS AND STRATEGIES

5.1 REMEDIATION OBJECTIVES

The primary objective of the UPSS replacement is to install new tanks and lines, and at the same time to remove former fuel infrastructure and any significantly contaminated soil around the infrastructure. Another objective is to ensure that the site is suitable for continued use as a service station.

5.2 PROPOSED REMEDIATION AND ASSESSMENT WORKS

The UPSS will be excavated and the USTs, fuel lines, bowsers and associated fuel infrastructure, will be removed. After removal of the tanks and lines, soils from the walls and floors of the excavation will be sampled to characterise the remaining soils. Exposed soils resulting from the removal of above ground infrastructure will also be sampled and analysed for the contaminants of concern. Further assessment and remediation may be undertaken if residual soil impacts are assessed as posing a risk to future commercial site users or groundwater.

The site layout is to be reconfigured during the works which may result in the loss of some existing groundwater monitoring wells. Replacement and repositioning of wells may be required to ensure the monitoring well network is adequate to monitor groundwater conditions at the site. Where required, new wells will be installed to target areas of known LNAPL contamination and will be constructed to the same specifications as the original wells.

5.3 REMEDIAL ENDPOINTS

The UPSS replacement and soil remediation works will be considered to be completed when:

- The UPSS infrastructure has been removed and replaced.
- Concentrations of contaminants in soil around and beneath the UPSS are assessed as not posing a risk to future site users or off-site receptors.

5.4 SOIL VALIDATION CRITERIA

This RAP has been prepared for assessing the hydrocarbon impacts in soil at the site after the removal of the tanks. Therefore, the potential human receptors relevant to this investigation are the site operators and the excavation and maintenance workers at the service station. The exposure pathways identified were vapour intrusion into buildings and shallow trenches, dermal contact and ingestion. Based on the potential receptors identified and the exposure pathways, the applicable remediation criteria are the HSLs for vapour intrusion risk at commercial/industrial land use settings (HSL D) in sandy soils and health-based investigation levels (HILs) for commercial and industrial settings (HIL-D). The HSLs and HILs for commercial users are provided in the NEPM (2013). For the intrusive maintenance workers, the recommended assessment criteria for vapour and direct contact pathways provided in the Cooperative Research Council for Contamination Assessment and Remediation for the Environment (CRC CARE) Technical Report no. 10 (Friebel and Nadebaum, 2011) have been adopted.

Following the installation of the new tanks, the excavation will be reinstated with imported fill, and then paved with concrete. As such, direct contact with soils is unlikely for ongoing commercial workers at the site but possible for intrusive maintenance workers. The direct contact criteria presented in CRC CARE Technical Report no. 10 (Friebel and Nadebaum, 2011) will be adopted.

As the site will be used as a service station, the ecological screening levels (for the protection of plants and terrestrial organisms) for petroleum hydrocarbons have limited relevance and have not been included in the assessment.

The HSLs for the commercial site users and the intrusive maintenance workers are summarised in Table 5.1 and Table 5.2.

Table 5.1 Adopted soil HSLs and HILs for commercial/industrial land use

CHEMICAL	HSL D (mg/kg) IN SANDY SOILS[1]				HIL D[2] (mg/kg)
	0 m to <1 m	1 m to <2 m	2 m to <4 m	4 m+	
TRH C_6-C_{10} minus BTEX (F1)	260	370	630	NL	-
TRH >C_{10}-C_{16} minus naphthalene (F2)	NL[4]	NL	NL	NL	-
Benzene	3	3	3	3	-
Toluene	NL	NL	NL	NL	-
Ethylbenzene	NL	NL	NL	NL	-
Xylenes	230	NL	NL	NL	-
Naphthalene	NL	NL	NL	NL	-
Carcinogenic PAHs (as BaP TEQ)	-	-	-	-	40
Total PAHs	-	-	-	-	4000
Lead	-	-	-	-	1500

(1) Table 1A(3) Soil HSLs for vapour intrusion (NEPM, 2013)
(2) Table 1A(1) Health investigation levels for soil contaminants (NEPM, 2013)

NL - not limiting

- criteria are not available

BaP TEQ – Benzo(a)pyrene toxicity equivalency quotient

Table 5.2 Adopted soil HSLs for intrusive maintenance workers

CHEMICAL	HSL (mg/kg) IN SANDY SOILS[1]			HSL FOR DIRECT CONTACT (mg/kg)[2]
	0 m to <2 m	2 m to <4 m	4 m+	
TRH F1	NL	NL	NL	82,000
TRH F2	NL	NL	NL	62,000
TRH >C_{16}- C_{34}	-	-	-	85,000
TRH >C_{34}- C_{40}	-	-	-	120,000
Benzene	77	160		1,000
Toluene	NL	NL	NL	120,000
Ethylbenzene	NL	NL	NL	85,000
Xylenes	NL	NL	NL	130,000
Naphthalene	NL	NL	NL	29,000

(1) Table A3 Soil health screening levels for vapour intrusion (mg/kg) (CRC CARE Technical Report no. 10, Friebel and Nadebaum, 2011)
(2) Table B4 Soil health screening levels for direct contact (mg/kg) (CRC CARE Technical Report no. 10, Friebel and Nadebaum, 2011)

5.5 WASTE DISPOSAL CRITERIA

Prior to the transportation of soils off-site for disposal, the excavated soils shall be tested then classified. The classification of excavated soils will be classified in accordance with ACT EPA 2000, *ACT's Environmental Standards: Assessment and Classification of Liquid and Non-liquid Wastes*. A summary of the waste acceptance criteria is included in Table 5.3 below.

Table 5.3 Waste classification guidelines

CHEMICALS	CT (without TCLP)[1]			SCC (with TCLP)[2]					
	Maximum value for classification without TCLP			Maximum values for leachable concentration and specific contaminant concentrations when used together					
	Inert Waste (CT1)	Solid Waste (CT2)	Industrial Waste (CT3)	Inert Waste		Solid Waste		Industrial Waste	
				TCLP1	SCC1	TCLP2	SCC2	TCLP3	SCC3
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/L)	(mg/kg)	(mg/L)	(mg/kg)	(mg/L)	(mg/kg)
TPH C_6–C_9	na	na	na	na	650	na	650	na	2,600
TPH C_{10}–C_{36}	na	na	na	na	5,000	na	10,000	na	40,000
Benzene	1	10	40	0.05	18	0.5	18	2	72
Toluene	28.8	288	1,152	1.44	518	14.4	518	57.6	2,073
Ethyl benzene	60	600	2,400	3	1,080	30	1,080	120	4,320
Total xylene	100	1,000	4,000	5	1,800	50	1,800	200	7,200
Benzo(a)pyrene	0.08	0.8	3.2	0.004	10	0.04	10	0.16	23
Total PAHs	20	200	800	na	200	na	200	na	800
Arsenic	10	100	400	0.5	500	5	500	20	2,000
Cadmium	2	20	80	0.1	100	1	100	4	400
Chromium (VI)	10	100	400	0.5	1,900	5	1,900	20	7,600
Lead	10	100	400	0.5	1,500	5	1,500	20	6,000
Mercury	0.4	4	16	0.02	50	0.2	50	0.8	200
Nickel	4	40	160	0.2	1,050	2	1,050	8	4,200

(1) Extracted from Table A3 in *ACT's Environmental Standards: Assessment and Classification of Liquid and Non-liquid Wastes*, Environment ACT, June 2000

(2) Extracted from Table A4 in *ACT's Environmental Standards: Assessment and Classification of Liquid and Non-liquid Wastes*, Environment ACT, June 2000

5.6 GROUNDWATER

This RAP does not include specific remediation of groundwater at the site, however a separate (December 2020) RAP has been prepared (as part of the Audit completed for the site) that addresses the remediation and management of the LNAPL / groundwater impacts at the site (WSP, 2020g).

5.7 DATA QUALITY OBJECTIVES

Systematic planning is critical to successful implementation of any assessment and is used to define the type, quantity and quality of data needed to inform decisions. The United States Environmental Protection Agency (US EPA) has defined a process for establishing data quality objectives (DQOs) (US EPA, 2000a and 2000b), which has been referenced in National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1) (NEPM) Schedule B2 – Guideline on Site Characterisation ((National Environmental Protection Council (NEPC), 2013).

DQOs ensure that:

- the study objectives are set
- appropriate types of data are collected (based on contemporary land use and chemicals of potential concern)
- the tolerance levels are set for potential decision making errors.

The DQO process is a seven-step iterative planning approach. The outputs of the DQO process are qualitative and quantitative statements which are developed in the first six steps. They define the purpose of the data collection effort, clarify what the data should represent to satisfy this purpose and specify the performance requirements for the quality of information to be obtained from the data. The output from the first six steps is then used in the seventh step to develop the data collection design that meets all performance criteria and other design requirements and constraints. The DQO process adopted for the UPSS replacement and soil remediation works is outlined in Table 5.4.

Table 5.4 Data quality objective process

STEP	DESCRIPTION	OUTCOMES
1	State the problem	Ampol intends to upgrade the current UPSS at the Holt service station and in the process remove hydrocarbon impacted soils in the vicinity of the UPSS. The objective of the remedial works is to reduce the mass of contamination in the substrate at the site and hence reduce the potential for ongoing contamination of groundwater. To ensure the works are undertaken in accordance with relevant regulations and assess the mass of hydrocarbon removed during the works, assessment of the excavated soils is required and measurement of contaminant concentrations in soil remaining onsite.
2	Identify the decisions	The decisions to be made are as follows: — What are the residual soil contamination concentrations at the site? — Does the contamination pose a risk to on and offsite receptors? — If there is a risk, what is the most appropriate remedial/management strategy to be employed at the site?
3	Identify the inputs to the decision	The inputs required to make the above decisions are: — the results of previous investigations — field and analytical data to be collected during the works — national and ACT EPA made, endorsed or approved criteria for assessing the results.

STEP	DESCRIPTION	OUTCOMES
4	Define the study boundaries/ constraints on data	The boundaries of the investigation have been identified as follows: — Spatial boundaries: the spatial boundary of the site is defined as the site boundary. The vertical extent of the study area is defined as the depth to impacted groundwater. The site boundary is shown on Figure 1. — Temporal boundaries: As the data and information obtained from the previous investigations has been relied upon, the temporal boundary will be from the date of the oldest available assessment data to the date of acquisition of the final laboratory results
5	Develop a decision rule	The purpose of this step is to define the parameters of interest, specify the action levels and combine the outputs of the previous DQO steps into an 'if…then…' decision rule that defines the conditions that would cause the decision maker to choose alternative actions. The parameters of interest are concentrations of contaminants of concern and interest in soil, groundwater and soil vapour. An assessment of the concentrations of the contaminants of concern will be undertaken to ensure the site has been adequately investigated. Soil, groundwater and soil vapour results will be compared to a range of assessment criteria for different receptor endpoints from various exposure routes to determine whether there is a risk posed to the receptor. For the purposes of assessing this site (with commercial/industrial end point), the following questions need to be satisfied with the following if/then outcomes: — if any contaminant odours emanating from site soils are identified, then a sample of soil will be collected and further assessment undertaken through analytical testing of contaminant concentrations in the soil. Results will be compared to the assessment criteria detailed in Section 5.4. — if soils have been found to contain contaminant concentrations above the investigation levels, then soil and/or groundwater will be subject to further remedial action or management. — if the site remedial strategy is proved to be insufficient in assessing the site, then further investigative or remedial works will be implemented.
6	Specify limits on decision errors	The acceptable limits on decision errors to be applied in the investigation and the manner of addressing possible decision errors have been developed based on the data quality indicators (DQIs) of precision, accuracy, representativeness, comparability and completeness and are presented in Table 5.5 and Table 5.6.
7	Optimise the design for obtaining data	The purpose of this step is to identify a resource-effective data collection design for generating data that satisfies the DQOs. This assessment has been designed considering the information and data from the previous assessments. The resource-effective data collection design that is expected to satisfy the DQOs is described in Sections below.

DQIs for sampling techniques and laboratory analyses of collected representative soil and groundwater samples define the acceptable level of error required for this validation assessment. The adopted field methodologies and data obtained were assessed by reference to the following measures:

— Accuracy – a quantitative measure of the closeness of reported data to the true value.

— Comparability – a qualitative parameter expressing the confidence with which one data set can be compared with another.

— Completeness – a measure of the amount of useable data (expressed as a per cent) from a data collection activity.

— Representativeness – the confidence (expressed qualitatively) that data are representative of each media present on the site.

— Precision – a quantitative measure of the variability (or reproducibility) of data.

A summary of the field and laboratory DQIs for the validation assessment are provided in Table 5.5 and Table 5.6.

Table 5.5 DQIs for field techniques

DQI
Precision
Standard operating procedures (SOPs) appropriate and complied with.
Collection of intra-laboratory duplicates
Accuracy
WSP SOPs appropriate and complied with
Collection and analysis of inter-laboratory duplicates
Collection of rinsate blanks, trip blanks and spikes
Representativeness
Appropriate media sampled
Comparability
Same SOPs used on each occasion
Experienced sampler
Climatic conditions (temperature, rainfall, wind)
Same type of samples collected
Completeness
SOPs appropriate and complied with
All required samples collected

Table 5.6 DQIs for laboratory analysis

DQI	Acceptable Limits
Accuracy	
Laboratory prepared trip blanks (one per batch)	Non-detect for contaminants analysed
Rinsate blanks (one per day)	Non-detect for contaminants analysed
Method blanks	Non-detect for contaminants analysed
Matrix and surrogate spikes and laboratory control samples	Laboratory specific
Matrix spike duplicates	Laboratory specific
Reference materials	Laboratory specific
Reagent blanks	Non-detect for contaminants analysed
Comparability	
Sample analytical methods used (including clean-up)	As per NEPM (NEPC, 2013)

Same units (justify/quantify if different)	-
Same laboratories (justify/quantify if different)	-
Sample practical quantitation limit (PQLs)	< nominated criteria
Completeness	
All critical samples analysed	-
All required analytes analysed	-
Appropriate methods and PQLs	As per NEPM (NEPC, 2013)
Sample documentation complete	As per NEPM (NEPC, 2013)
Sample holding times complied with	As per NEPM (NEPC, 2013)
Representativeness	
All required samples analysed	-
Precision	
Blind (intra-laboratory) duplicates and split (inter-laboratory) duplicates at rate of 1:20 primary samples for the same analysis of primary samples (not including asbestos, pH, cation exchange capacity (CEC), organic or clay content)	Variable (see Table 7.1)
Laboratory duplicates	Laboratory specific
Laboratory prepared trip spikes (one per batch for volatiles)	70–130%
National Association of Testing Authorities (NATA) certified laboratories used	-

6 REMEDIATION APPROACH – SOURCE REMOVAL METHODOLOGY

6.1 PRELIMINARIES

Prior to commencement of remedial works at the site, the following activities would need to be completed:

- provision of the RAP to the ACT Government EPD;
- receipt of all relevant regulatory approvals for the tank replacement works;
- preparation of a health, environmental and safety plan (HESP) prior to commencement of site works;
- induction of all site personnel to ensure that they are aware of the health, environmental and safety management requirements relating to the excavation of potentially contaminated soils; and
- confirmation that the contractor conducting the excavation has adequate safety equipment (for example, adequate fencing, barrier boards, barricades and warning signage) to secure the work area and minimise the danger to contractor personnel and the public for the duration of the tank replacement works.

6.2 GENERAL

All excavation works should be undertaken by licensed contractors, experienced in the decommissioning, removal and installation of fuel infrastructure and the remediation of contaminated soils.

As a minimum, the following Codes of Practice are applicable to the work and a copy of each should be obtained by the contractor. Standards should be the most recent version available unless otherwise specified:

- AS 4976:200, The removal of underground storage tanks; and
- AS 1940 Section 9, The storage and handling of flammable and combustible liquids.

An environmental scientist should be present during the excavation works to assess the contamination status of the soil excavated from around the tanks and to determine whether further excavation of tank pit walls and floor is required to remove heavily contaminated soil. Anticipated excavation extents are presented on Figure 2, Appendix A.

6.3 PRIMARY SOURCE REMOVAL

The pavement will be broken to allow access to the tanks and fuel lines. Tanks must be cleaned prior to excavation by draining all product, vapour venting and de-gassing. Once tanks are cleaned, they will be gas-tested for vapours and then deemed safe by an appropriately qualified person. The tank atmosphere and the excavation area shall be checked regularly for presence of vapour until the tank is removed from the site. Following removal, tanks must be properly labelled and disposed of.

All applicable permits must be obtained prior to the beginning of any work associated with tank clearance. All liquid product and residue removed from the tank shall be handled in accordance with appropriate standards and local regulations associated with environmentally hazardous materials and dangerous goods. The contractor shall submit written procedures to complete the following activities outlined below:

- draining pipes and pumping out tanks;
- removal of pipework;

- removal of tank from ground;
- labelling of tanks;
- transporting of tanks; and
- tank destruction.

6.4 SOIL SAMPLING AND CHARACTERISATION

Following the tank removal and subsequent excavation, soil samples will be collected from the walls and floor of the excavation. All soil samples will be screened in the field using a handheld photo ionisation detector (PID) to measure indicative concentrations of volatile organic compounds (VOCs). Samples will be analysed for the contaminants of potential concern, i.e. TRH, BTEXN, PAH and lead. Due to the likely presence of contamination beneath USTs, the depth of excavation would be extended to a depth of up to 4.5m BGL (where practicable, noting the presence of bedrock) to remove the underlying contaminated material.

The tank pit characterisation will be undertaken in accordance with the NSW EPA (2014b) *Technical Note: Investigation of Service Station Sites***.** Section 2.6 of this technical note states that:

> *Where a UST is removed, as a guide, sampling should be one sample from beneath the centre of the UST if tank length is less than 4 m and at least one sample from each of the four walls. If the tank is 4–10 m long, at least two samples from each of the four walls and under each end. If the tank is longer than 10 m, at least three samples from each of the four walls and under each end are taken. This applies to each tank in the same tank pit.*

Figure 3, in Appendix A, shows the proposed validation sampling locations. Quality assurance/quality control (QA/QC) samples will also have to be collected and analysed as described in Section 5.7.

The excavations will be left open while waiting for laboratory results. If validation samples exceed the nominated assessment reference values, further excavation may be required.

6.5 GROUNDWATER SAMPLING

Assessment of groundwater is not part of the scope of this document. The remediation, management and monitoring of groundwater is covered under the December 2020 RAP (WSP, 2020g) and the Environmental Authorisation (EA) for the site. Groundwater sampling will be conducted at a minimum of six monthly intervals at the site.

6.6 REPORTING

At the completion of the site works, a UPSS validation report will be prepared in general accordance with the UPSS Regulation and guidance. The UPSS validation report will detail the methodologies and results of the validation works. A checklist of the reporting requirement is provided in the NSW DECCW (2008) *Guidelines for Implementing the Protection of the Environment Operation (Underground Petroleum Storage System) Regulation – Technical note: Site Validation Reporting* and in the NSW EPA (2020) *Consultants Reporting of Contaminated Land*.

6.7 MANAGEMENT OF EXCAVATED SOILS

At least five USTs, the fuel bowsers and the fuel lines will be removed from the service station. It is estimated that up to 600 m^3 of waste soil will require excavation from the existing tank farm and around the fuel infrastructure. The volume of soil to be excavated was estimated based on the sizes of the tanks, the expected contamination at depth and some allowances for fuel lines and chasing of some soil beneath the tank farm (if possible (noting the presence of bedrock)).

The allowances do not include additional lateral excavation required if significant contamination (i.e. concentrations greater than nominated site assessment criteria) is encountered on tank pit walls.

To allow for the re-development of the site, the excavation of a further volume of soil is required to allow for the installation of two compartmentalised USTs. It is estimated that a further 300m^3 of soil will be excavated from the south east corner of the site, toward the intersection of Hardwick Crescent and Flack Street. As this area is away from the main primary sources of impact, the allowances do not include additional excavation required if significant contamination (i.e. concentrations greater than nominated site assessment criteria).

The excavated soils shall be segregated into separate stockpiles based on field observations, such as soil type, field PID readings, visual and olfactory evidence of contamination and depths (i.e. above or below the tanks) where the soils are excavated. The NEPM (2013) Schedule B2, Guideline on Site Characterisation, outlines the minimum number of samples for assessment of stockpiles. For stockpile volumes less than 200 m^3, the recommended sampling frequency is 1 per 25 m^3. For stockpiles greater than 200 m^3, lower sampling rates should be suitable for calculating the 95% upper confidence level (UCL). All the stockpile soil samples shall be analysed for TRH, BTEX, PAH and lead as a minimum. Samples will be collected directly from the excavator bucket or using a decontaminated trowel to ensure soil samples are collected from a minimum depth of 300 mm below the stockpile surface.

The excavated soils will be temporarily stockpiled on-site while awaiting laboratory results. The soils are to be stockpiled on plastic sheets and the stockpile areas are to be securely bunded using silt fencing and silt socks and/or hay bales to prevent water or silt-laden runoff from entering or leaving the stockpiles or the site. Plastic sheeting may be required to be placed over the stockpile to minimise wind-blown dust and/or odours.

Excavated soils may be suitable for re-use on site if contaminant concentrations are less than the site assessment criteria (see Section 5.4), and the site has sufficient area to accommodate the material. In addition, any soils intended to be retained and beneficially reused on site should not exhibit discolouration (staining), be malodourous or have abnormal consistency i.e.. contain abundant fill, rubble or asbestos, and engineering suitability must also be considered. If contaminant concentrations or characteristics do not meet these criteria, the following steps can be considered (all of the options presented below must be accompanied by written prior approval from the site auditor and ACT EPA):

- a beneficial reuse application for the material to be reused at a third-party facility (or at another Ampol site in ACT) may be prepared, pending Auditor and ACT EPA approval.
- disposal at an appropriately licensed ACT landfill facility, such as Mugga Lane. For disposal, the soil analytical results will be compared guideline values in the waste classification guidelines (ACT EPA, 2000; see Section 5.5). Any soil disposed of from the site must be in accordance with the requirements of the EPU as set out in ACT EPA Information Sheet 4. Appropriately licensed ACT contractors must be engaged for the removal, transport and disposal of all contaminated soils from the site. If the soils are disposed off-site, disposal dockets for tracking of waste will be maintained by the contractor for inclusion in the UPSS validation report.

6.8 REINSTATEMENT OF THE EXCAVATION

Following excavation and validation of the tank pit and the subsequent soil excavations, the new USTs will be installed into the new UST excavation. The voids in the old tank pit and between the new tanks and the new pit will be reinstated. The fill used for reinstatement will be suitable for the intended use based on the following procedures.

6.8.1 REUSE OF EXCAVATED SOIL

Excavated soils with contaminant concentrations below the site assessment criteria may be reused on-site. The material should be assessed for its potential to pose risk to human and ecological receptors. The material will not be considered suitable for reuse if contaminant concentrations exceed assessment criteria or potential risks are identified.

6.8.2 VIRGIN EXCAVATED NATURAL MATERIAL / COMMERCIALLY QUARRIED MATERIAL

Where virgin excavated natural material (VENM) or a commercially quarried material is required for backfilling, it should be certified as VENM and / or be assessed to determine that it is suitable for the intended use. This would involve:

- reviewing the history of the source of the material;
- a visual inspection for foreign material or unusual staining; and
- confirmation sampling.

All analytical results are required to be indicative of the absence of anthropogenic contamination and to be less than the criteria reported in Section 5.4.

7 SITE SAFETY PLAN

A HESP will be prepared prior to performing on-site works associated with this RAP. The HESP will address the health and safety of residents and workers in the surrounding area. As a minimum, it will consider:

- site security;
- potential exposure to contamination;
- excavation safety;
- vibration;
- noise;
- odour; and
- dust.

Work associated with the remediation of the site will conform, at a minimum, to the requirements of the SafeWork NSW requirements and associated Regulations. Typically, the HESP will address the following issues:

- regulatory requirements;
- responsibilities;
- hazard identification and control;
- chemical hazard control;
- sample and chemical handling procedures;
- personal protective equipment;
- work zones;
- decontamination procedures;
- emergency response plans;
- contingency plans; and
- incident reporting.

8 CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN

A construction environmental management plan (CEMP) should be developed as industry best practice for the site remediation works to ensure that the on-site and off-site environment is not adversely impacted during the remediation works. The CEMP should address and take into consideration the issues discussed in the following sections. The CEMP should be prepared by the civil contractor.

8.1 VEHICLE TRAFFIC

The remediation works may slightly increase vehicle traffic in the vicinity of the site. Where necessary, details of traffic management will be incorporated into the CEMP to control traffic movement associated with the works and mitigate any disruption to local residents and road users.

8.2 ODOUR AND VAPOUR

The remediation works may result in significant vapours and odours being released into the atmosphere, particularly when excavation of potentially contaminated soil is carried out. At these times, consideration should be given to prevailing weather conditions and if distinct odours are detected then site works should stop until the odours can be reduced or controlled.

The site supervisor shall monitor all open excavations and remediated soils with a PID to ensure ambient air concentrations are within the acceptable work safe limits. Concentrations of PID monitoring shall be recorded by field staff and submitted for review on a daily basis to ensure the daily average VOC concentration is below the time-weighted average (TWA) for benzene (i.e. 1 ppm) in accordance with the Safe Work Australia *Workplace Exposure Standards for Airborne Contaminants* (Safework, 2018). There is no peak, ceiling or short term exposure limit (STEL) for benzene, however the *Guidance on the Interpretation of Exposure Standards for Airborne Contaminants* (Safework, 2013) indicates that ambient air concentrations of any airborne contaminant should not exceed three times the TWA exposure standard for more than 30 minutes per 8 hour day and should not exceed five times the TWA exposure standard at any time during works (Safework, 2013). As a result, if ambient air concentrations of VOCs exceed 3 ppm for over 30 minutes, work will have to cease for the day or control measures implemented. If at any time during works, ambient levels exceed 5 ppm, works will stop immediately and not re-commence until appropriate control measures are implemented.

Alternative control measures could be implemented, including the following:

- workers may be fitted with vapour masks or respirators for continuation of site works in the area; and
- wetting down the excavated soil with the use of water sprays containing odour suppressant.

8.3 DUST

Dust will be visually monitored during the earthworks and areas generating excessive dust will be sprayed with water to reduce the dust levels. Soil that is to be stockpiled should be covered or wetted down to minimise potential dust generation.

During excavation and transport of any soil off site, truck wheels should be cleaned or driven through a constructed wash bay or similar control (e.g. rumble grid) to prevent potentially contaminated soil from being transported onto local roads.

8.4 PLANT AND MACHINERY

It is the responsibility of the remediation contractor to ensure that all plant and machinery used on the site is properly maintained and in good working condition. Any plant or machinery used should be appropriate for the task.

8.5 NOISE

Increased noise levels may result from the use of on-site and off-site mechanical equipment during the course of the remediation works. To mitigate any noise which may arise as a result of site works, all works should be carried out during normal working hours and in accordance with ACT regulations on this matter.

Noise control measures to be implemented during the remediation works may include:

- specified entry controls for construction vehicles entering and leaving the site;
- suitable construction techniques and methodologies;
- use of quieter equipment; and
- restricted use of reversing alarms and all equipment should be fitted with alarm types that adjust output sound levels according to the prevailing ambient noise level.

All practical measures will be taken to minimise generation of noise, and contact information for enquires or complaints will be posted on the site entrance gate.

8.6 WATER AND SEDIMENT MANAGEMENT

8.6.1 SURFACE WATER

Soil stockpiled during excavation works should be suitably contained to prevent run-off of any potentially contaminated water or soil to the surrounding environment, including the stormwater system. Control measures should be established to prevent surface water run-off entering and leaving excavation and stockpile areas. Control measures may include:

- temporary bunding or diversion drains;
- impermeable sheeting placed under and/or over stockpiles;
- silt fences/silt socks to surround stockpiles; and
- protection of existing drains with silt fencing/sand bags.

These mitigation measures should be regularly inspected to ensure that they are in good condition and if necessary upgraded where their performance is deteriorating.

8.6.2 SUBSURFACE SEEPAGE AND ACCUMULATED EXCAVATION WATER

Where possible, excavation surfaces are expected to be left open for short durations only to minimise the potential of any surface water entering work areas. If water does accumulate (e.g. rainfall or groundwater ingress) then it will be required to be removed prior to validation and reinstatement. Any water accumulated within excavations will be sampled and analysed for TRH, BTEXN, PAH and lead. Management and/or disposal options will be formulated upon receipt of the analytical results.

8.6.3 SEDIMENT

Drains, gutters, roads and access ways shall be free of sediment in accordance with regulatory requirements. Where required, gutters and roadways shall be swept regularly to keep them free from sediment. As for surface water, control measures should be implemented.

The erosion and sediment controls put in place during the civil works must be in accordance with:

- Environment Protection Guidelines for Construction and Land Development in the ACT (ACT EPA, 2011); and
- The "Blue Book" – Managing Urban Stormwater: Soils and Construction (Landcom, 2004).

8.7 EQUIPMENT AND CLEANING OPERATIONS

During remediation, controls will be placed on the operation and movement of equipment. General procedures that will be implemented include the following:

- Excavation equipment will be washed in an environmentally sound manner prior to leaving the site.
- If necessary, effective truck wheel-washing facilities will be provided to ensure that contaminated soil is not tracked off-site.
- No trucks or equipment carrying contaminated soils should be allowed to move across unsealed ground surfaces, with the exception of designated transport corridors.

All contaminated soil requiring off-site disposal will be transported to an appropriate landfill facility. All transport trucks loaded with contaminated soil for off-site disposal should be sealed and the load securely covered to prevent wind-blown emissions or spillages. Covers should be in place until the final unloading. All truck tailgates should be securely fixed prior to loading and immediately after unloading soils and all vehicles are to be operated in a manner so as to prevent loss of soils during loading, transport and unloading activities.

As part of the CEMP, a preferred transport route to the nominated facility is required to be identified.

8.8 SITE SECURITY

During construction works, work areas will be barricaded or secured by a chain-wire fence, which will remain in place for the duration of the remediation works in order to exclude public visitors. Appropriate safety and/or warning signs will be posted in accordance with the WorkSafe ACT requirements. If an excavation is to be left open while the environmental project manager and contractor are not on site for a substantial period of time (such as overnight), a temporary fence will be erected around the excavation. Should the excavation be deeper than 1.5 m, the edges of the excavation should be battered to a 45 degree slope or benched into 1 m steps based on industry best practices.

8.9 WORKING HOURS

Working hours should be undertaken in accordance with the conditions of development consent. Any works to be conducted outside the normal working hours needs to have prior agreement with Ampol and the ACT Government EPD.

8.10 CONTACT INFORMATION

Contact details of the appropriate civil contractors and the Ampol Project Manager should be displayed in a prominent location at the site (such as the entrance or site office). Any incidents should be initially reported to the site manager, who will prepare an incident report for the Ampol Project Manager as soon as practicable.

8.11 COMMUNITY CONSULTATION

Community notification will be carried out in accordance with the DA. The Council will also publicly advertise and/or notify the adjoining landowners during the development application process in accordance with the Council's notification policies. The notice will include:

- indication that UPSS replacement work is to be undertaken, and the nature of these works;
- the time and date such work is to commence;
- the phone number of a person present on the premises whilst remediation works are being undertaken; and
- the Ampol contact information and processes required for registering any complaints.

8.12 INCIDENT RESPONSE

Responses to incidents occurring on site will be in accordance with Ampol emergency and evacuation procedures and incident reporting procedures. A health and safety plan and incident contact number/s are to be kept in an on-site register. All other relevant emergency contact numbers such as police, fire brigade and hospital will be listed in the HESP and posted on site for easy access.

Local contractors (including a plumber and electrician) should be on call in case an incident is reported by the site workers or local residents.

8.13 CONTINGENCY MANAGEMENT

Contingency plans for anticipated environmental problems that may arise during the remediation works are summarised below in Table 8.1.

Table 8.1 Contingency management plans

ANTICIPATED PROBLEMS	CORRECTIVE ACTIONS
Chemical/fuel spill	Stop work, notify relevant emergency contacts and Ampol. Use accessible soil or appropriate absorbent material on site to absorb the spill (if practicable). Stockpile the impacted soil in a secure location, sample and determine the appropriate disposal/treatment option.
Excessive dust	Use water sprays to suppress the dust or stop the site activities generating the dust until it abates.
Excessive noise	Identify the source, isolate the source if possible, and modify the actions of the source. Ensure hearing protection is worn if the noise cannot be reduced.
Excessive odours/vapours	If excessive organic odours/vapours are being generated, stop works and monitor ambient air across the site for organic vapours with a PID and odours at site boundaries. Implement control measures including respirators for site workers, use of odour suppressants, and wetting down of excavated soil.
Excessive rainfall	Ensure sediment and surface water controls are operating correctly. If possible, divert surface water away from active work areas and/or excavations.
Water in excavations	Collect samples and assess against relevant assessment criteria to enable disposal options to be formulated.

ANTICIPATED PROBLEMS	CORRECTIVE ACTIONS
Leaking machinery or equipment	If possible, stop the identified leak and clean up the spill with absorbent material. Stockpile the impacted soil in a secure location, sample and determine the appropriate disposal/treatment option.
Failure of erosion or sedimentation control measures	Stop work and repair the failed control measure.
Unearthing unexpected fill or waste	Stop activities and contact Ampol. Prepare a management plan to address the issue if necessary.
Equipment failures	Ensure that spare equipment is on hand at the site or ensure that the failed equipment can be serviced by on-site personnel or a local contractor.
Complaint management	Notify Ampol following the complaint and report the complaint in accordance with management procedures. If possible, implement control measures to address the reason/s for complaint.
Asbestos	If potential asbestos material is identified in the soil, notify Ampol and the consultant Project Managers. Asbestos monitoring may be required to continue works.

9 REMEDIATION ACTION PLAN SUMMARY

The purpose of this RAP is to provide a framework to validate the removal of UPSS infrastructure and hydrocarbon impacted soils to levels suitable for continued petroleum use. The actions required to carry out the RAP are summarised as follows:

- engage an underground services locator to identify the position of any services prior to any excavation works;
- remove concrete and excavate to expose USTs;
- drain pumps and pipework;
- remove the residual product in the USTs and degas the USTs to make safe for removal and transport off-site for destruction;
- disposal of the USTs off site by a licensed waste contractor;
- remove the associated infrastructure;
- excavate soil from the new compartmentalised UST footprint, to the required depth;
- collect soil samples from the excavations for USTs and fuel lines for analysis;
- remove any impacted soils that are considered unsuitable, which are to be classified in accordance with ACT EPA 2000, *ACT's Environmental Standards: Assessment and Classification of Liquid and Non-liquid Wastes*, and disposed off site at a suitably licenced facility;
- backfill the resulting excavations with approved clean imported VENM, ENM and/or excavated soil found to be suitable for reuse;
- assess groundwater at the site after the removal of UPSS infrastructure and installation of new infrastructure; and
- report on the work completed.

10 REFERENCES

- ACT EPA 2017, *Environmental authorisation no. 0749.*
- ACT EPA 2017*, Contaminated Sites Environment Protection Policy.*
- ACT EPA 2019, *Environmental Guidelines for Petroleum Storage in the ACT.*
- ACT EPA 2014, Information Sheet 4 - *Requirements for the reuse and disposal of contaminated soil in the ACT.*
- ACT EPA 2019, Information Sheet 8 – *Requirements for the Classification and Reuse of Drilling Mud Waste in the ACT.*
- ACT EPA 2019, Information Sheet 9 – *Management of groundwater impacted by light non-aqueous phase liquids (LNAPL).*
- ACT EPA 2020, Information Sheet 11 – *Environment Protection Authority Report Submission Requirements.*
- ANZECC/ARMCANZ 2000, National water quality management strategy: Australian and New Zealand guidelines for fresh and marine water quality
- ANZG 2018, Australian and New Zealand guidelines for fresh and marine water quality
- Australian Standard 4976 *The Removal and Disposal of Underground Petroleum Storage*
- CSIRO 2017, 'Acid Sulfate Soil Risk Map', *Australian Soil Resource Information System*, http://www.asris.csiro.au (accessed 24 March 2021)
- Environment ACT 2000, *ACT's Environmental Standards: Assessment & Classification of Liquid & Non-liquid Wastes.*
- Environmental Protection Act 1997.
- Environmental Protection Regulation 2005.
- Friebel, E & Nadebaum, P 2011, 'Health screening levels for petroleum hydrocarbons in soil and groundwater. Part 1: Technical development document', CRC CARE *Technical Report* no. 10, CRC for Contamination Assessment and Remediation for the Environment, Adelaide, Australia
- National Environment Protection Council 2013, *National Environment Protection (Assessment of Site Contamination) Measure 1999*
- NHMRC 2008, *Guidelines for Managing Risks in Recreational Water 2008*
- NSW EPA 2014, *Technical Note: Investigation of Service Station Sites.*
- NSW EPA 2020, *Assessment and Management of Hazardous Ground Gases: Contaminated Land Guidelines*.
- NSW EPA 2020, *Guidelines for Consultants reporting on contaminated Land: Contaminated land guidelines*.
- GHD 2010, *Report for Holt Caltex Service Station, 1 Hardwick Crescent, Phase 2 Environmental site assessment*;
- AECOM 2011, *Groundwater Monitoring Well Report, Caltex Holt (22546), Corner Hardwick Crescent and Flack Street, Holt, ACT*;
- Caltex Australia 2013, *Environmental management plan Caltex Holt (22546)*;
- WSP (formerly Parsons Brinckerhoff) 2013, *2013 Round 1 – ACT Groundwater monitoring event*;
- WSP 2014, *2013 Round 4 – ACT Groundwater monitoring event*;

- WSP 2015, *Classification of stockpiled material at Caltex Holt Service Station (22546) Corner Hardwick Crescent and Flack Street, Holt, ACT*;
- URS Australia 2015, *Final Groundwater Data Memo – Kippax service station (22546);*
- GHD 2017, *22546 – Caltex Kippax Service Station, 1 Hardwick Crescent, Holt, ACT, 2615 Groundwater monitoring event – September 2016*;
- Safe Work Australia 2018, *Workplace Exposure Standards for Airborne Contaminants*
- WSP 2017, *Caltex Kippax Holt service station (Site ID: 22546), 1 Hardwick Crescent, Holt ACT 2615: Groundwater monitoring event*;
- WSP 2018, *Caltex Kippax Holt service station (Site ID: 22546), 1 Hardwick Crescent, Holt ACT 2615: Groundwater monitoring event*;
- WSP 2019, *Caltex Kippax Holt service station (Site ID: 22546), 1 Hardwick Crescent, Holt ACT 2615: Groundwater monitoring event*;
- WSP March 2020a, *Caltex Kippax Holt service station (Site ID: 22546), 1 Hardwick Crescent, Holt ACT 2615: Assessment of Vapour Risks*;
- WSP May 2020b, *Tier 1 Risk Assessment (Off-site), Caltex Holt Service Station, 1 Hardwick Crescent Holt, ACT, Site ID: 22546 (Rev0 – Draft)*; and
- WSP August 2020c, *Environmental Site Assessment Report, Caltex Holt service station (Site ID: 22546), 1 Hardwick Crescent Holt ACT.*
- WSP December 2020d, *Environmental Site Assessment Report, Caltex Holt service station (Site ID: 22546), 1 Hardwick Crescent Holt ACT.*
- WSP December 2020e, *Vapour Risk Assessment (Off-Site), Caltex Holt service station (Site ID: 22546), 1 Hardwick Crescent Holt ACT.*
- WSP December 2020f, *Remediation Pilot Trial Report, Caltex Holt service station (Site ID: 22546), 1 Hardwick Crescent Holt ACT.*
- WSP December 2020g, *Remediation Action Plan, Caltex Holt service station (Site ID: 22546), 1 Hardwick Crescent Holt ACT.*

11 LIMITATIONS

1 This Report has been prepared by WSP Australia Pty Limited ("WSP") for the benefit of Ampol Limited ("Ampol"), the registered proprietor or tenant of the site requested to be investigated by WSP ("Site") under its agreement with Ampol dated 31 March 2018 ("Agreement").

2 The nature and extent of the environmental consulting and remediation works at the Site detailed in the Report reflects the scope of the Services set out in the Request for Proposal under the Agreement and the Scope of Works set out in Schedule 4 Templates, Item 1 – Scope of the Agreement.

3 A potential purchaser (but not including a purchaser's successor in title) of the Site may rely on the findings contained in the Report for the purpose of considering the possible (but not actual) level of contamination of or at that Site at the time of the contamination assessment of the Site was undertaken ("Permitted Purpose").

4 The registered proprietor of the land to which the report relates at the time of writing the report (but not including any proprietor's successor in title) may rely on the findings contained in the Report for the purpose of assessing the possible level of contamination of that Site ("Permitted Purpose") and subject to the limitations set out in Schedule 4 Templates, Item 1 – Scope of the Agreement.

5 The findings contained in the Report are subject to the qualifications, assumptions and limitations set out in the Report or otherwise communicated to, or by, Ampol. To the extent of any inconsistency between this Limitation Statement and the qualifications, assumptions and limitations in the Report, this Limitation Statement shall prevail.

6 The Report may contain information provided by others. Except as otherwise stated in the Report, WSP has not verified the accuracy or completeness of this information. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the Report ("Conclusions") are based in whole or in part on this information, those Conclusions are contingent upon the accuracy and completeness of that information. WSP accepts no responsibility for the reliability, accuracy, completeness or adequacy of information provided by others.

7 WSP has prepared the Report without regard to any special or particular interest of any person (including that of a potential purchaser), other than Ampol when undertaking the Services or setting out its findings in the Report.

8 The Report can only be relied upon for the Permitted Purpose and may not be relied upon for any other purpose and does not purport to recommend or induce a decision to make (or not make) any purchase, disposal, investment, divestment, financial commitment or otherwise in relation to the Site ("Investment Decision").

9 Matters material to a potential purchaser, may have been omitted from the Report, or may not have been investigated because of the scope of the Services. It follows that a potential purchaser should be cognisant of the restrictions inherent in or otherwise set out in the Report and should commission the preparation of a contamination assessment of the Site that caters for its own interests and scope of services, and which will provide findings in relation to the level of contamination of or at the Site at the time the potential purchaser is making an Investment Decision.

10 The Report has not and will not be updated for events occurring after the date of the Report or any other matter which may have a material effect on its contents which come to light after the date of the Report. WSP will not be obliged to inform a potential purchaser of any matter arising or coming to its attention after the date of the Report, which may affect or qualify the Report.

11 WSP is not liable to a potential purchaser in respect of errors or omissions in the Report which a potential purchaser knows of, or ought to be aware of, from:

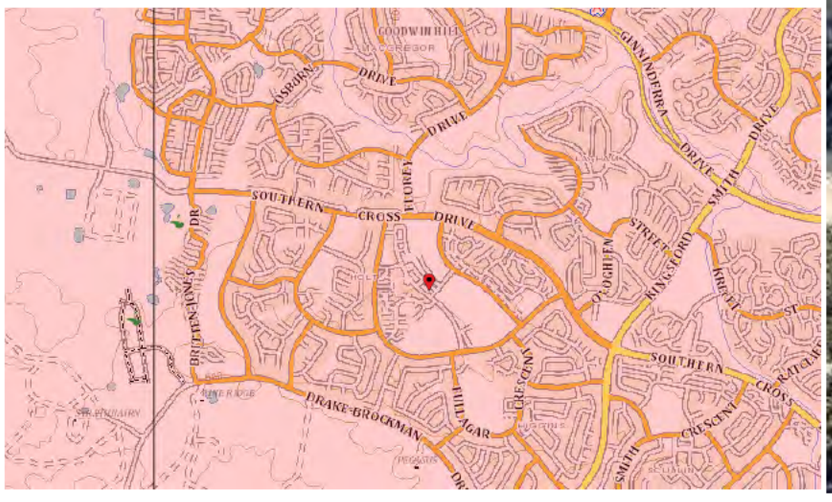
- **a** its own actual knowledge and inquiries
- **b** inquiries made by its advisers; or
- **c** matters which a potential purchaser should have been aware of by making reasonable inquiry (including the inquiries recommended at Item 9 above).

12 To the fullest extent permitted at law, WSP, its related bodies corporate, its officers, employees and agents assume no liability and will not be liable to any potential purchaser for, or in relation to, any losses, damages or expenses (including any indirect, consequential or punitive losses or damages or any amounts for loss of income or profit, revenue or loss of opportunity to earn profit, loss of production, loss of contract, increased operational costs, loss of business opportunity, business interruption and pure economic loss) of any kind (and whether arising in contract, tort (including negligence), under statute, in equity or otherwise, suffered or incurred by a potential purchaser (or any other third party) arising out of or in connection with any matter outside the ambit of the Permitted Purpose in relation to the Report or findings expressed in the Report.

APPENDIX A

FIGURES

DEPOT	PRODUCT TYPE	VOLUME (L)	STATUS
1	V95	27,400	
2	Diesel	27,400	
3	E10	27,400	
4	V98	20,000	Out of service from 14 February 2020.
5	E10	59,400	
6	LPG	7,500	Decommissioned



Legend

- Site boundary
- Underground Storage Tanks
- Decommissioned LPG Tank
- Bowsers
- Fill points
- Monitoring well

Base map source: Near Maps (2020)

Figure 1 – Site location and current site layout
Ampol Holt
1 Hardwick Crescent, Holt, Australian Capital Territory (ACT)

0 20 m