

Clyde Western Area Remediation Project (WARP) SSD-9302

Annual Report

Reporting Period: 01 July 2021 to 30 June 2022

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1 Introduction

Viva Energy Australia Pty Ltd (Viva Energy) owns the land associated with the former Clyde Refinery (the 'Site') located at Durham Street, Rosehill on the Camellia Peninsula. Viva Energy currently operates the Clyde Terminal on part of the Site; however, a large part of the former refinery land in the south-western part of the Site (the 'Western Area') is no longer required for operational purposes. As such, Viva Energy is undertaking the remediation of contaminated soils in the Western Area to a standard suitable for future commercial / industrial land uses.

The Western Area Remediation Project (WARP) was designated state significant development due to the scale of the proposed works and an Environmental Impact Statement (EIS) was prepared. On 7 May 2020, The Minister for Planning and Places approved the development application (SSD 9302) for the Clyde WARP.

The Clyde Terminal site and the Western Area are shown in Figure 1.

Viva Energy are proposing to stage the remediation of the Western Area as follows:

- Stage 1 – Former Process West
- Stage 2 – Former Utilities and Movements
- Stage 3 – Former Process East.

The Stage 1 to 3 areas are shown in Figure 2.

Remediation of the Stage 1 area was completed between October 2020 and February 2021. A Site Audit Statement (SAS) No. 055/2127799 was issued in February 2021 confirming the successful completion of remediation works and the suitability of the Stage 1 area for future commercial / industrial land uses. A further Site Audit Statement for Stage 1 was issued on 29 November 2021 (SAS No. 065/2127799) which assessed that ongoing groundwater monitoring for the Stage 1 area was not required. A further Site Audit Statement and Report (SAS No. 073/2127799) was then issued, dated 2 May 2022, which documented the updated Long-Term Environmental Management Plan (LTEMP) for the Stage 1 area.

Remediation of the Stage 2 area was completed between September 2021 and May 2022. Site Audit Statements (and associated Audit Reports) were issued for the following sub-stages of Stage 2, confirming successful completion of remediation works and the suitability of the Stage 2 areas for future commercial / industrial land uses.

- Audit Area 1 (AA1): Site audit statement no. 068-2127799, issued on 23 December 2021.
- Audit Area 2 (AA2): Site audit statement no. 072-2127799, issued on 14 April 2022.
- Audit Area 3 (AA3): Site audit statement no. 075-2127799, issued on 14 June 2022.

A proposed subdivision of Stage 2, known as Lot 64 located in the southern portion of Stage 2, is currently subject to detailed remedial planning for the capping and long term management of this area. Remediation of Lot 64 is therefore ongoing, with completion of works and the Site Audit Statement anticipated in 2023.

Figures 3 to 6 illustrate the audit areas and remediation areas for the Stage 2 works.

The content of this Annual Report provides relevant details of the Stage 2 remediation works and meets the requirements of SSD 9302 condition C12. Table 1 below lists the requirements and the corresponding sections where each specific requirement is addressed.

Table 1: Annual review and reporting requirements

Condition C12 requirement	Report section
Within 12 months of the commencement of the remediation works, and every year thereafter until the completion of demobilisation, or other timing as may be agreed by the Planning Secretary, the Applicant shall review and report on the environmental performance of the development. The report shall:	
(a) be submitted to the Planning Secretary and EPA;	
(b) describe the works that were carried out in the previous year and the works to be carried out in the coming year;	Section 2
(c) include a comprehensive review of the monitoring results and complaints records of the development over the previous year, to demonstrate the effectiveness of the remediation works, including a comparison of: <ul style="list-style-type: none"> i. air quality monitoring data with relevant limits or performance measures/criteria; ii. water discharges with established discharge criteria for contaminants of concern; iii. groundwater monitoring data with background data and trigger levels established in accordance with condition B22; iv. detail community consultation activities during the year, including any alterations to works or mitigation measures implemented to address community concerns; 	Section 3
(d) identify any non-compliances over the last year, and describe what actions were (or are being) taken to ensure compliance; and	Section 4
(e) describe what contingency measures would be implemented over the coming year to improve the environmental performance of the Development, should any issues be identified with the effectiveness of the remediation works.	Section 5

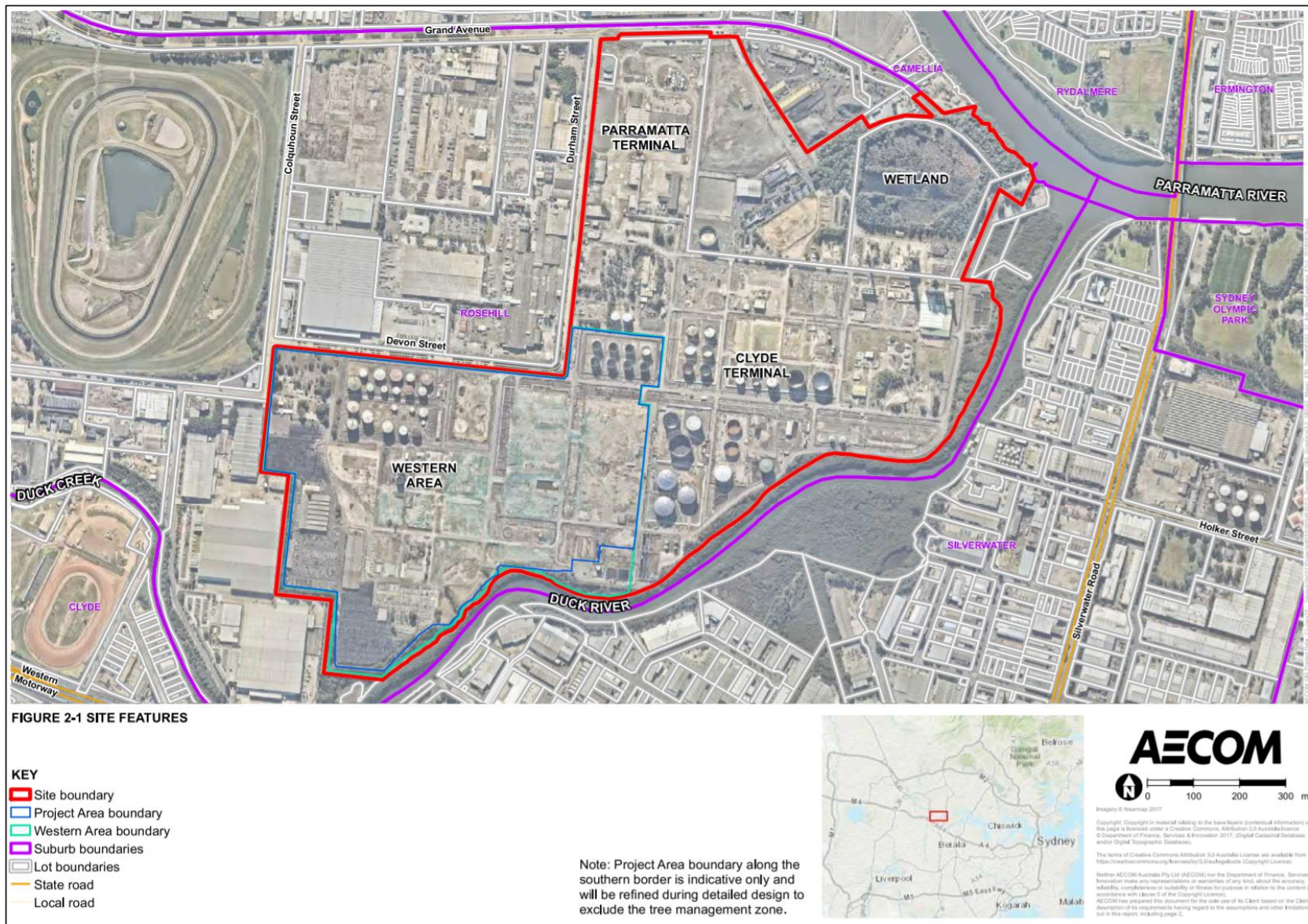


Figure 1 – Clyde Terminal and the Western Area

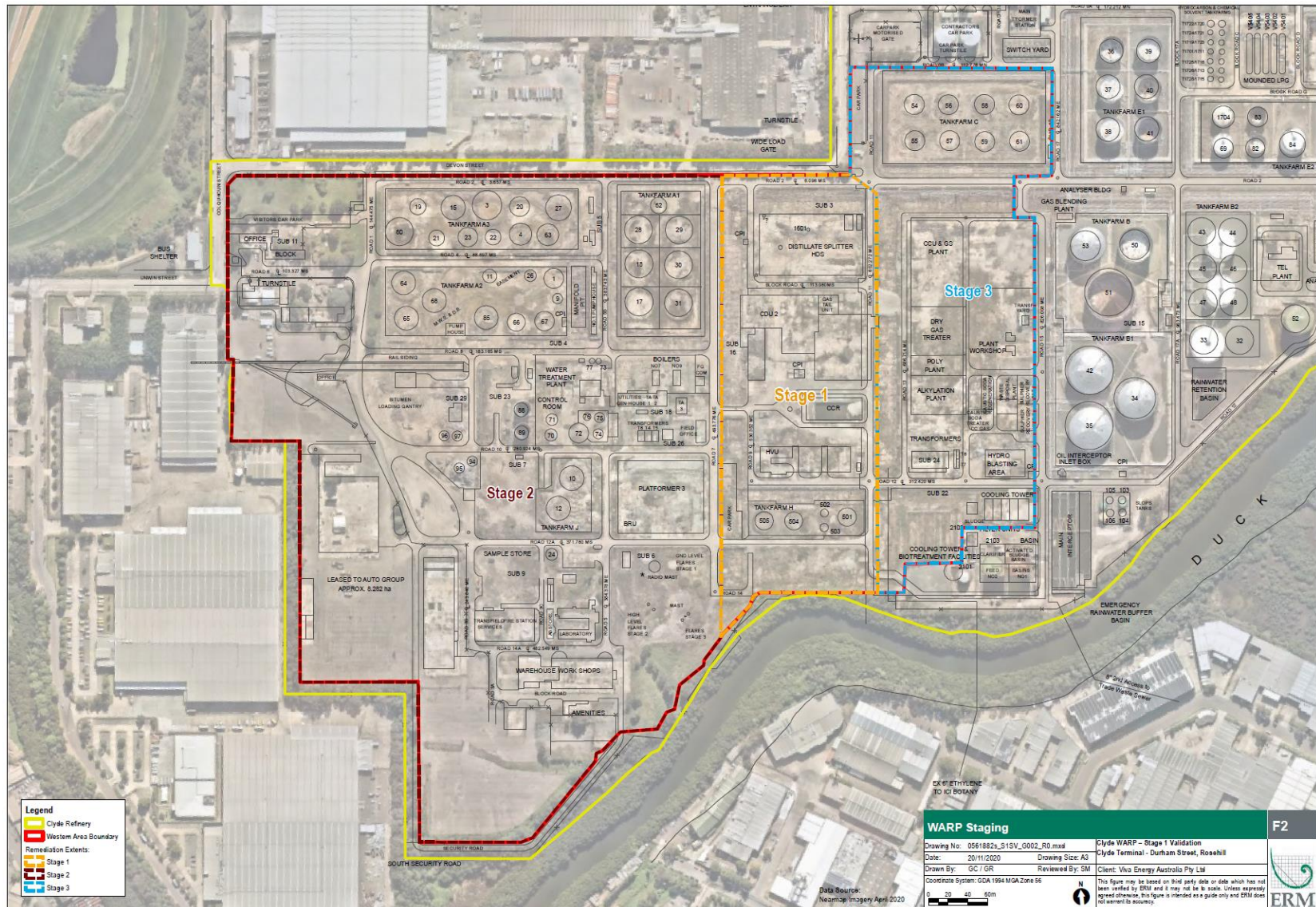


Figure 2 – Clyde WARP Stages 1, 2 and 3

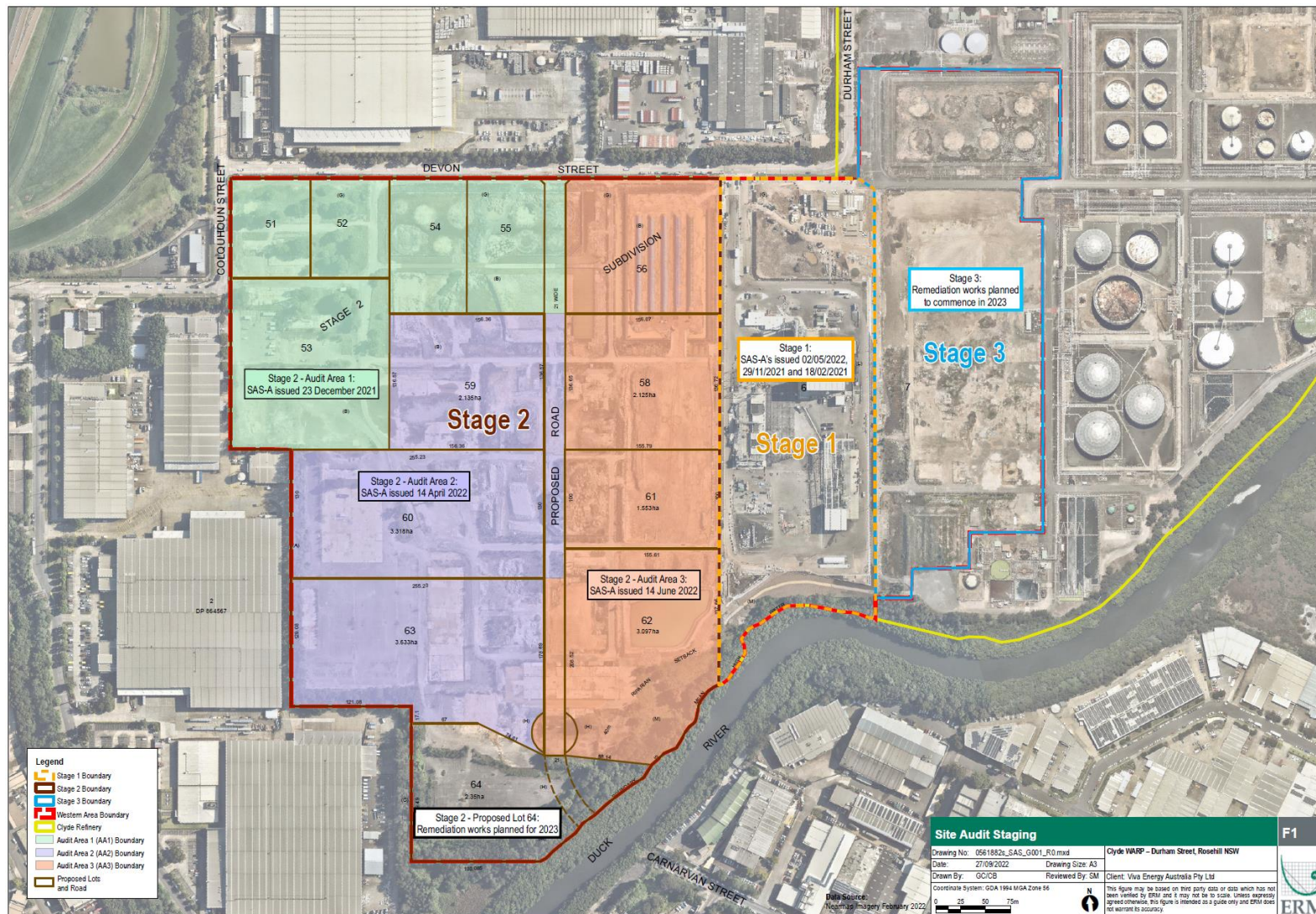


Figure 3 – Stage 2 Site audit staging

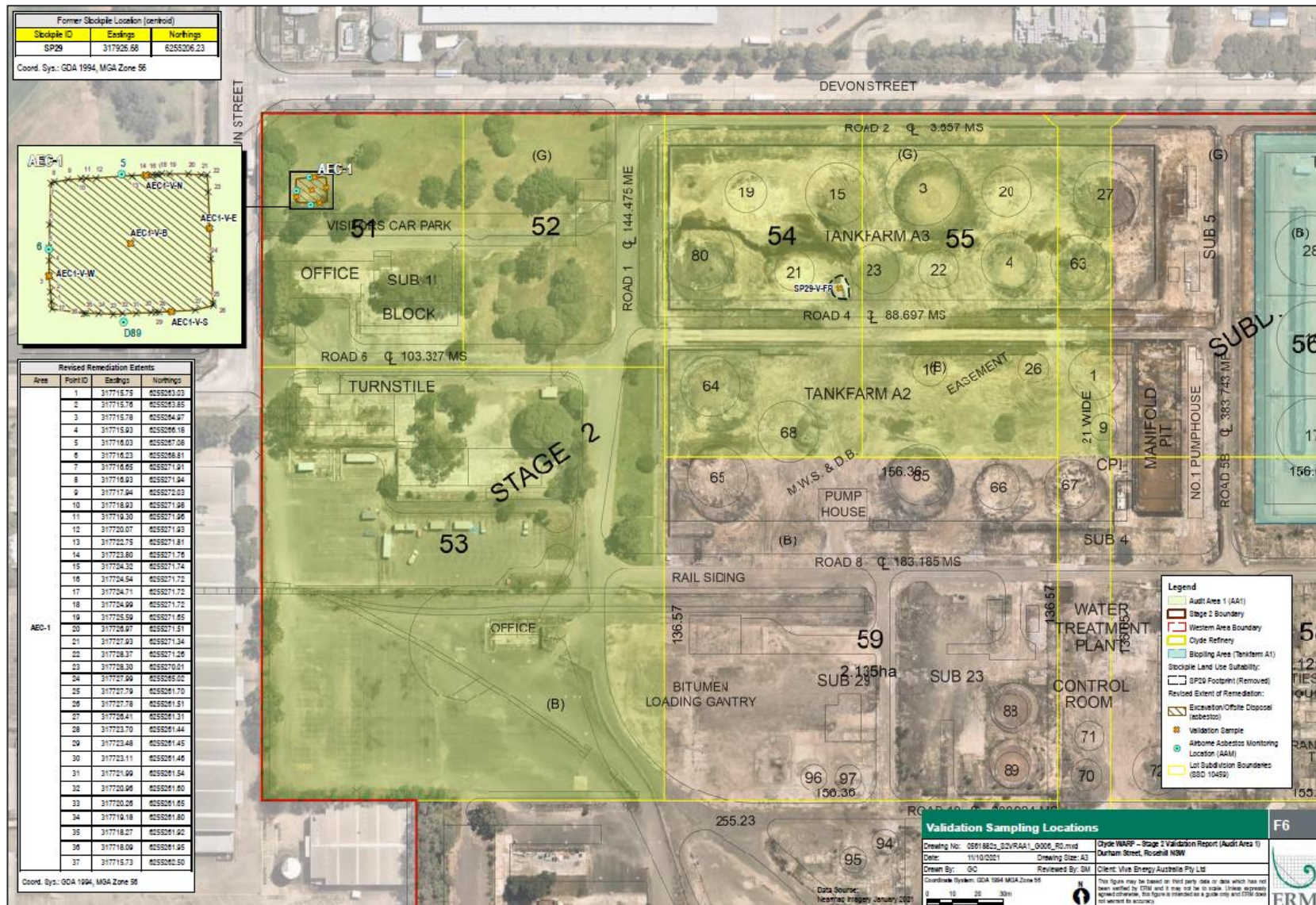


Figure 4 – Stage 2 AA1 remediated areas

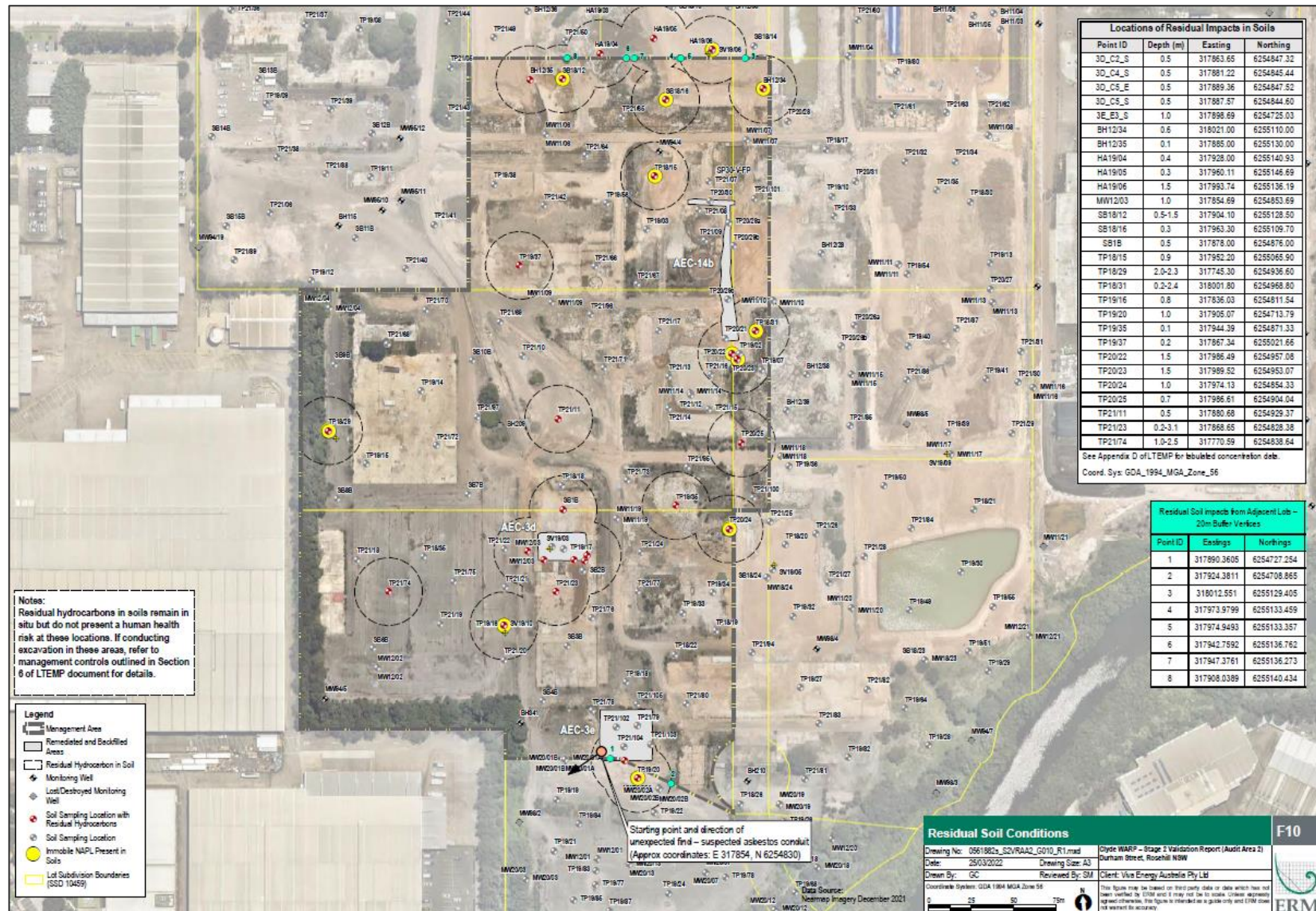


Figure 5 – Stage 2 AA2 remediated areas

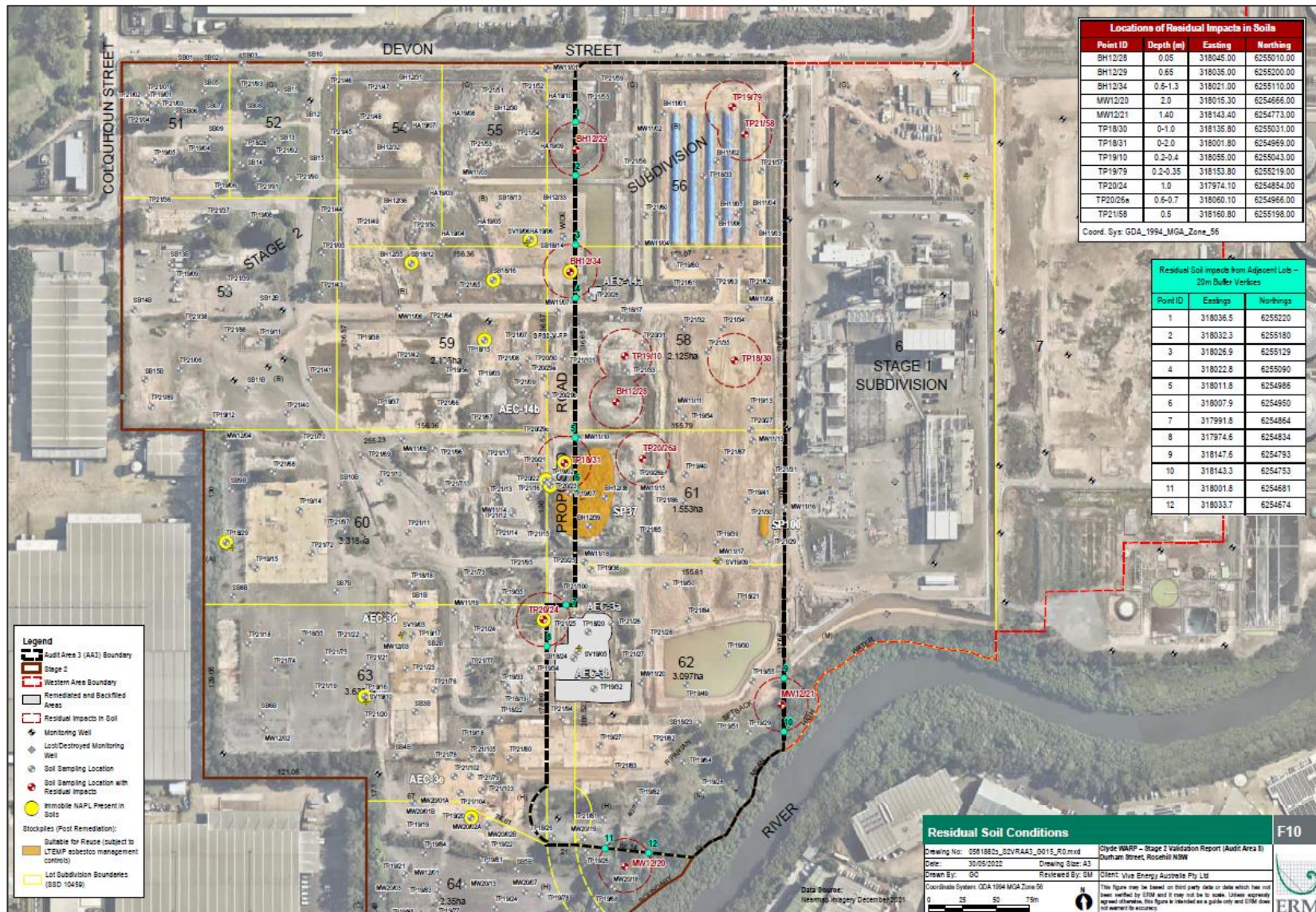


Figure 6 – Stage 2 AA3 remediated areas

2 Works undertaken

This Section describes the works undertaken in accordance with Development Consent SSD 9302 during the period 1 July 2021 to 30 June 2022.

2.1 Remediation works

Stage 2 remediation activities commenced September 2021. Excavation of an in-situ volume of 7,559 m³ of material was undertaken in accordance with the Stage 2 Remediation Action Plan (RAP) to remove contaminated soil materials and Light Non-Aqueous Phase Liquids (LNAPL) in shallow soils. Validation of the walls and base of the excavations was undertaken prior to backfilling with imported Virgin Excavated Natural Material (VENM).

Off-Site disposal of 1,999.36 tonnes of asbestos contaminated material from pre-existing stockpiles (SP29, SP30 and SP99) and excavations AEC-1 and AEC-3B. All materials were disposed of to an appropriately licenced waste facility.

Of the excavated material, an estimated 6,541 m³ was classified as requiring remediation. This material was screened and then formed into five large biopiles in the same location within the Stage 2 area established for the previous Stage 1 biopiling activities. The active biopile remediation process was successfully completed on 09 May 2022 with validation sample results demonstrating that remediation criteria had been met.

Full details of the Stage 2 remediation works are detailed in the following Clyde WARP Validation Reports;

Stage 2 Validation Report - Proposed Lots 51-55 (Audit Area 1), prepared by ERM and dated 3 December 2021;

Stage 2 Validation Report - Proposed Lots 59, 60 and 63 (Audit Area 2), prepared by ERM and dated 4 April 2022; and

Stage 2 Validation Report - Proposed Lots 56, 58, 61 and 62 (Audit Area 3), prepared by ERM and dated 7 June 2022.

2.2 Erosion and sediment control works

As a result of the remediation and subsequent development of the Stage 1 area, and the decommissioning of the former refinery's subgrade drainage system, surface water runoff from the Stage 2 area no longer drains to the Clyde Terminal waste water treatment plant.

To ensure adequate surface water management across the Stage 2 area, an erosion and sediment control plan (ESCP) including the construction of a sediment basin, was submitted to DPE as part of an update to the Stage 1 REMP and Soil and Water Management Plan. These plans were approved by the Planning Secretary on 9 April 2021.

Following approval of these plans, a sediment basin was constructed in the southern part of the Stage 2 area during May and June 2021. The sediment basin was designed and constructed in general accordance with the requirements from 'Managing Urban Stormwater: Soils and Construction – Volume 1: Blue Book (Landcom 2004)'.

3 Environmental performance

3.1 Air

During the reporting period, air quality was monitored and managed in accordance with the Remediation Environmental Management Plan (REMP), the Air Quality Management Plan (AQMP) and the Air Emissions Verification Report (AEVR), in addition to the Clyde Terminal Environment Protection Licence 570 (EPL570).

A description of the monitoring undertaken and a summary of results is provided in **Appendix A.1**

3.2 Water

Minimal groundwater was encountered during excavation works or accumulated in excavations from rainfall. Consequently, no water was required to be discharged from the Site.

3.3 Groundwater

During the reporting period, groundwater was monitored in accordance with the Remediation Environmental Management Plan (REMP), the Groundwater Monitoring and Management Plan (GMP) and EPL570.

A description of the monitoring undertaken and a summary of results is provided in **Appendix A.2**

3.4 Community consultation

Prior to the commencement of the Stage 2 remediation activities, a Community Update newsletter/flyer was prepared and physically distributed to approximately 2330 residents and businesses within a 2km (approx.) radius of the Site.

The Community Update (dated August 2021) was also loaded onto the Viva Energy website at the following location: <https://www.vivaenergy.com.au/operations/clyde>

No concerns in relation to the remediation works were raised by any members of the community. Accordingly, no alterations to works or implementation of mitigation measures were required as a result of any issue raised by the community.

4 Non-compliances

No reportable incidents or non-compliances occurred relating to consent conditions during this reporting period.

No non-compliances with the Clyde Terminal (EPL570 conditions occurred during the reporting period.

5 Contingency measures

Environmental performance for Stage 2 of the Clyde WARP (this reporting period) has been compliant and consistent with the statutory requirements and limits.

There were no issues identified with the effectiveness of the remediation works that warranted the consideration or implementation of any contingency measures.

Appendix A

- A.1 Summary of air quality monitoring results
- A.2 Summary of groundwater monitoring results

A.1 Summary of air quality monitoring results

Environmental Resources Management Australia Pty Ltd (ERM) conducted air quality monitoring on behalf of Viva Energy throughout the execution of Stage 2 remediation works for the project.

This section provides an overview of air quality monitoring undertaken in accordance with the Stage 2 Air Emissions Verification Report (AEVR) during the remediation works and includes the following:

- **Photo-ionisation Detector (PID) Area monitoring:** which was used to provide real-time information on the intensity of VOC emissions (measured in parts per million by volume [ppmv]) during soil handling works, and implement response measures as required;
- **Boundary VOC monitoring:** undertaken during the Stage 2 remediation works in order to provide assurance of the efficacy of PID area monitoring in managing potential off-Site VOC impacts; and
- **Biopile Soil Vapour Extraction (SVE) system monitoring:** undertaken in accordance with the AEVR and Environment Protection Licence (EPL) requirements, including daily monitoring of exhaust concentrations (Monday – Friday) and weekly reporting of monitoring and operational data.

Data related to the above has been reported in detail within Weekly Air Quality Performance Reports provided to the NSW EPA in accordance with the relevant conditions of EPL 570.

1.1 PID Area Monitoring

PID area monitoring was undertaken during soil handling operations in order to provide real-time assessment of total volatile organic compound (TVOC) concentrations and to inform Level 1 and Level 2 responses, as nominated within Section 6.5.2 of the Stage 2 AEVR. The results of these monitoring events are provided in the Stage 2 Remediation – Ambient Air Quality Summary (AAQS) Report. Level 1 and Level 2 exceedances are summarised in Table A1-1 below.

Table A1-1: Summary of PID area monitoring trigger level 1 (5 ppmv) and level 2 (10 ppmv) exceedances

Date	Monitoring Location	Level Reached	Comment / Management Actions Implemented
29/09/2021	3A-NW	Level 1	<ul style="list-style-type: none">■ Notified equipment operator of elevated VOC readings during loading of material■ Reduced volume of material being transferred. Concentrations reduce to below level 1 trigger
30/09/2021	3A-NW	Level 1	<ul style="list-style-type: none">■ Notified equipment operator of elevated VOC readings during loading of material;■ Conduct monitoring of boundary during works execution.
1/10/2021	3A-NW	Level 1	<ul style="list-style-type: none">■ Notified equipment operator of elevated VOC readings.
5/10/2021	3A-NW	Level 1	<ul style="list-style-type: none">■ Notified equipment operator of elevated VOC readings during loading of material;■ Reduced volume of material being transferred.
6/10/2021	3A-NW	Level 2	<ul style="list-style-type: none">■ Level 2 trigger reached over isolated 60 second peak.■ Notified equipment operator of elevated VOC reading;■ Subsequent measurements were below Level 1 trigger.
7/10/2021	SSA-CW	Level 2	<ul style="list-style-type: none">■ Notified equipment operator of elevated VOC readings during loading of material;■ Cessation of soil handling operations until PID measurements were below level 1 trigger level;■ Activated anotec odour misting system.
8/10/2021	3A-NW	Level 2	<ul style="list-style-type: none">■ Notified equipment operator of elevated VOC readings during loading of material;

Date	Monitoring Location	Level Reached	Comment / Management Actions Implemented
			<ul style="list-style-type: none"> ■ Cessation of soil handling operations until PID measurements were below level 1 trigger level; ■ Modification of excavation methods to exclude stockpiling of freed material outside of the excavation. ■ Reduction of material drop heights. ■ Reduction of excavation rates.
19/10/2021	SSA-CW	Level 1	<ul style="list-style-type: none"> ■ Notified equipment operator of elevated VOC readings during loading of material; ■ Reduced volume of material being transferred.

1.2 Boundary VOC Monitoring

Ambient VOC monitoring was undertaken during the Stage 2 remediation works in order to provide assurance of the efficacy of PID area monitoring in managing potential off-Site VOC impacts.

The sampling was conducted using evacuated canisters in accordance with the USEPA TO-15 methodology, as specified within *Compendium Method TO-15 - Determination of volatile organic compounds in air collected in specially-prepared canisters and analysed by gas chromatography / mass spectrometry* (US EPA, 1999). As context, this method has also been applied by state jurisdictions under the National Environment Protection (Air Toxics) Measure (NEPC, 2011), for the evaluation of VOC concentrations within populated airsheds around Australia.

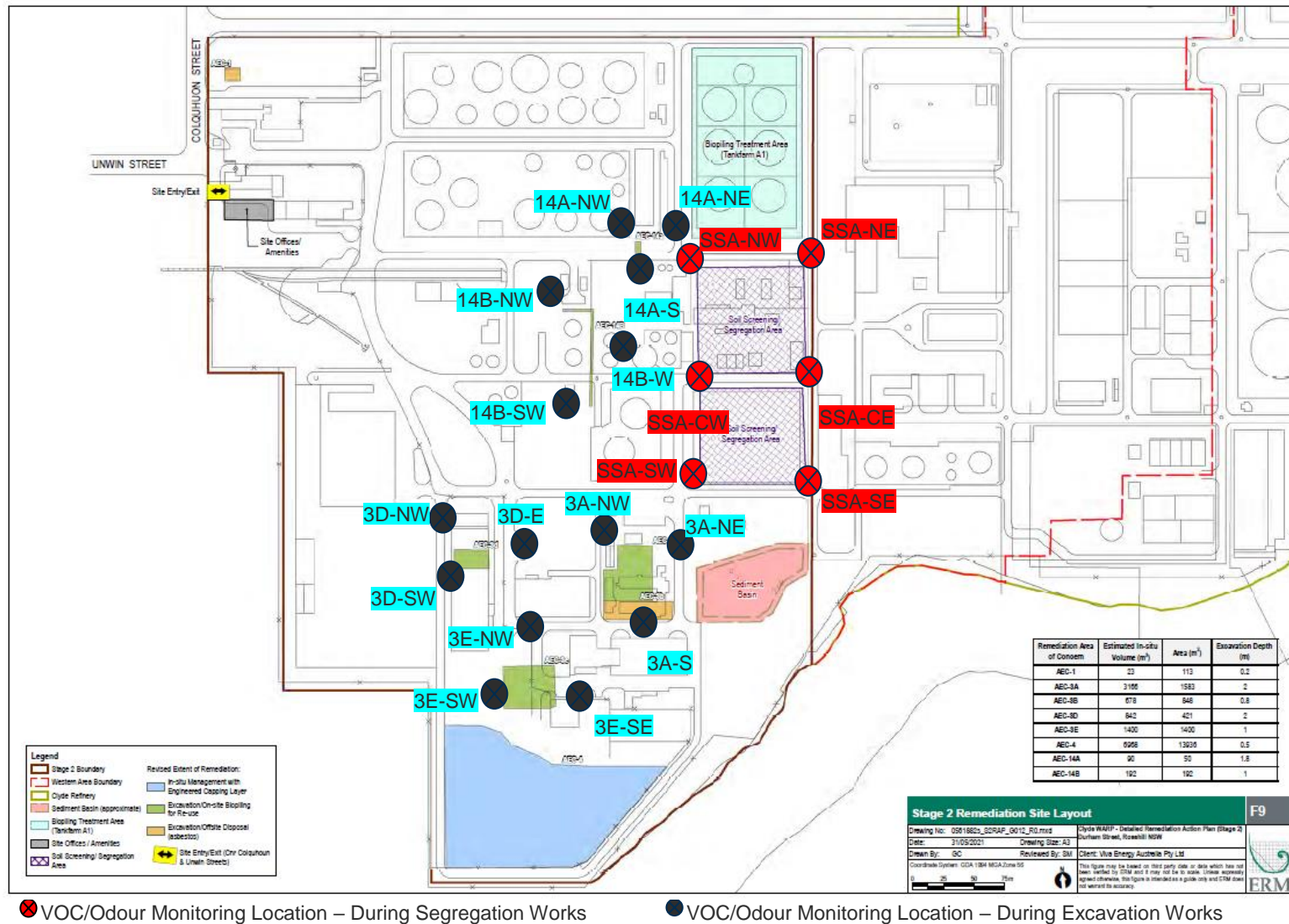
1.2.1 Monitoring Program

Monitoring was conducted near to the northern boundary (EC01), southern boundary (EC02), western boundary (EC03) and eastern boundary (EC04) of the Western Area. In addition, an 'at-source' location (EC00) was included to allow assessment of the contribution of the remediation works relative to other local and regional VOC emission sources.

Three rounds of monitoring were included, targeted to the intensive phases of remediation works. These include:

- Round 1: Excavation and stockpiling (AEC-3A) (7/10/2021 – 8/10/2021);
- Round 2: Excavation and stockpiling (AEC-3D) (20/10/2021 – 21/10/2021);
- Round 3: Excavation, stockpiling and screening (AEC-3E) (28/10/2021 – 29/10/2021); and
- Round 4: Stockpiling and screening operations (16/11/2021 – 17/11/2021).

Figure A1-1 illustrates the monitoring locations relative to the Stage 2 remediation works. Figure A1-2 illustrates the air sampling locations relative to the Stage 2 remediation works.



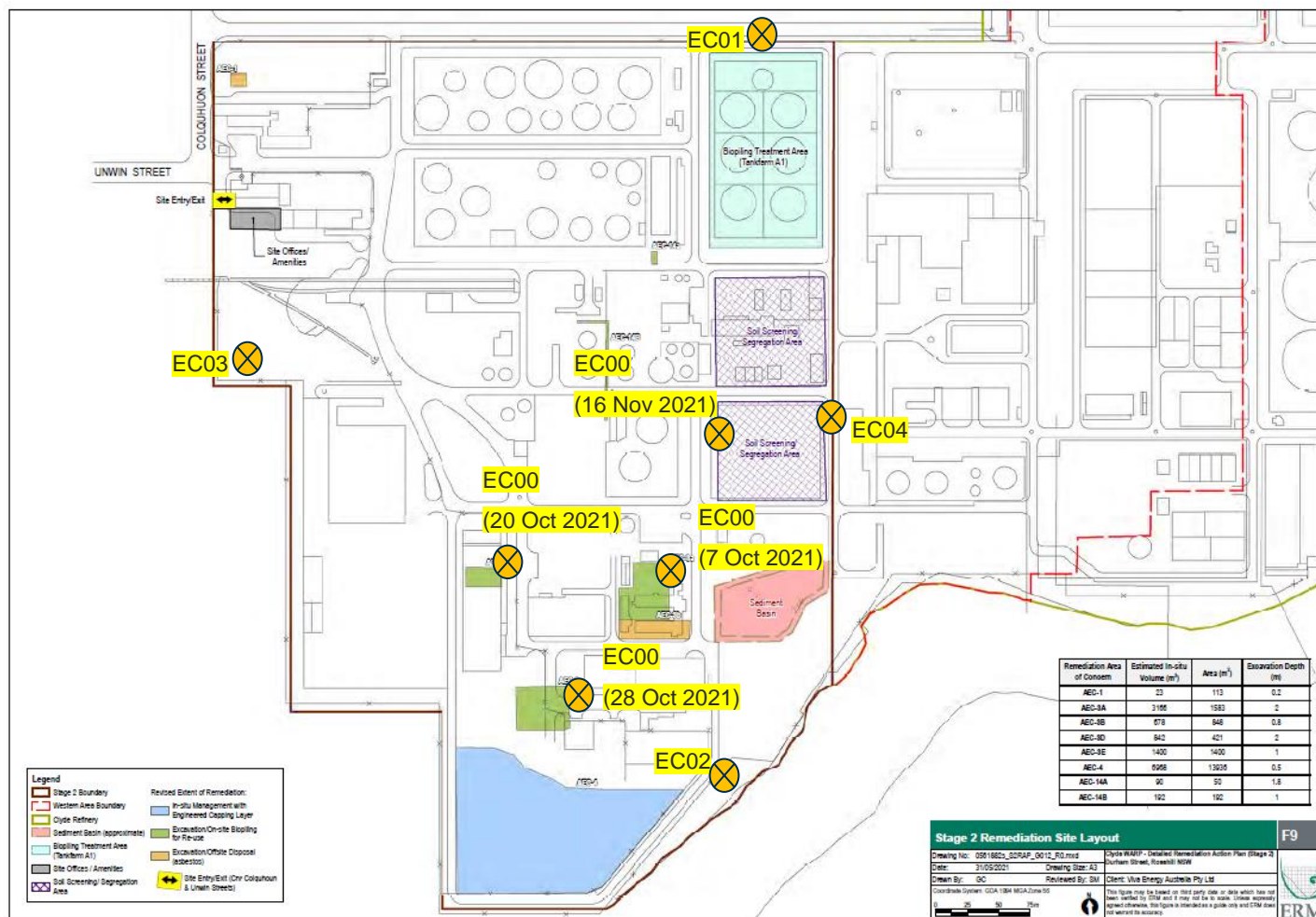


Figure A1-2: Air sampling locations

1.2.2 Results

Table A1-2 through **Table A1-5** present a summary of the Stage 2 ambient VOC monitoring results for analytes presented within the Stage 2 AEVR. It is noted that speciated VOC results above the Limit of Reporting (LOR) were limited to ethylbenzene, toluene, xylenes, 1,2,4-trimethylbenzene and cyclohexane, which are shown within the tables in bold font.

Table A1-2: Summary of Stage 2 ambient VOC monitoring results: Round 1 (7-8/10/2021)

Substance	Measured Concentration (µg/m³)				
	EC00	EC01	EC02	EC03	EC04
	At source (AEC-3A)	~500m NE	~130m SE	~360m NW	~190m NE
Benzene	< 3	< 3	< 3	< 3	< 3
Toluene	< 7.5	< 7.5	< 7.5	< 7.5	< 7.5
Ethylbenzene	11	< 4	< 4	< 4	< 4
Xylenes - Total	19	< 12	< 13	< 13	< 12
1.2.4-Trimethylbenzene	< 5	< 4	< 5	< 5	< 5
1.3.5-Trimethylbenzene	< 5	< 4	< 5	< 5	< 5
Hexane	< 3.5	< 3.5	< 3.5	< 3.5	< 3.5
Naphthalene	< 20	< 20	< 21	< 20	< 20
Cyclohexane	81	< 3	< 3	< 3	< 3

Notes: Detections above the LOR shown in **bold font**. "<" – Less than LOR.

Table A1-3: Summary of Stage 2 ambient VOC monitoring results: Round 2 (20-21/10/2021)

Substance	Measured Concentration (µg/m³)				
	EC00	EC01	EC02	EC03	EC04
	At source (AEC-3D)	~570m NE	~200m SE	~290m NW	~260m NE
Benzene	< 3	< 3	< 3	< 2	< 3
Toluene	10	< 7.5	< 7.5	< 7.5	12
Ethylbenzene	< 3	< 4	< 4	< 3	< 4
Xylenes - Total	< 10	< 12	< 12	< 10	< 11
1.2.4-Trimethylbenzene	6.5	< 4	< 5	< 4	< 4
1.3.5-Trimethylbenzene	< 4	< 4	< 5	< 4	< 4
Hexane	< 3	< 3	< 3	< 3	< 3
Naphthalene	< 17	< 19	< 20	< 16	< 18
Cyclohexane	< 3	< 3	< 3	< 3	< 3

Notes: Detections above the LOR shown in **bold font**. "<" – Less than LOR.

Table A1-4: Summary of Stage 2 ambient VOC monitoring results: Round 3 (28-29/10/2021)

Substance	Measured Concentration (µg/m³)				
	EC00	EC01	EC02	EC03	EC04
	At source (AEC-3E)	~590m NE	~150m SE	~350m NW	~280m NE
Benzene	< 3	< 3	< 3	< 3	< 3
Toluene	11	13	11	9.8	19
Ethylbenzene	< 4	< 4	< 4	< 4	< 4
Xylenes - Total	< 13	< 12	< 13	< 12	< 13
1.2.4-Trimethylbenzene	< 5	< 5	< 5	< 5	< 5
1.3.5-Trimethylbenzene	< 5	< 5	< 5	< 5	< 5
Hexane	< 5	< 5	< 5	< 5	< 5
Naphthalene	< 22	< 20	< 20	< 20	< 22
Cyclohexane	< 3.5	< 3.5	< 3.5	< 3.5	< 3.5

Notes: Detections above the LOR shown in **bold font**. "<" – Less than LOR

Table A1-5: Summary of Stage 2 ambient VOC monitoring results: Round 4 (16-17/11/2021)

Substance	Measured Concentration (µg/m³)				
	EC00	EC01	EC02	EC03	EC04
	At source (screening area)	~360m NNE	~250m SE	~370m W	~90m E
Benzene	< 3	No data	< 3	< 3	< 3
Toluene	< 7.5		< 7.5	< 7.5	< 7.5
Ethylbenzene	< 4		< 4	< 4	< 4
Xylenes - Total	< 11		< 11	< 12	< 12
1.2.4-Trimethylbenzene	< 4		< 4	< 4	< 4
1.3.5-Trimethylbenzene	< 4		< 4	< 4	< 4
Hexane	< 5		< 5	< 5	< 5
Naphthalene	< 18		< 19	< 20	< 19
Cyclohexane	< 3.5		< 3.5	< 3.5	< 3.5

Notes: Detections above the LOR shown in **bold font**. "<" – Less than LOR. 'No data' – sample discarded due to regulator blockage.

2.1.1 Screening of Monitoring Results

Screening criteria have been compiled to provide a means of assessing whether ambient air quality monitoring results are elevated so as to warrant additional investigation. 24 hour average have been collated for direct screening of maximum monitoring results, whilst annual average (chronic) criteria have been also been presented for contextual purposes.

With this objective, the following sources of screening criteria were adopted in order of priority:

- NEPM Air Toxics Monitoring Investigation Levels (MILs), (NEPC, 2011);
- US Agency for Toxic Substances and Disease Registry (ATSDR) Minimal Risk Levels (MRLs), (ATSDR, 2021);
- Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (NSW EPA, 2016); and
- Texas Commission of Environmental Quality (TCEQ) TAMIS Database (TCEQ, 2021).

MILs provided within NEPC (2011) have been adopted as a priority, given their endorsement in a local context as part of the NEPM Air Toxics program. In this role, the MILs are applied by each state government in screening whether ambient VOC monitoring results are indicative of the need for further investigation.

ATSDR MRLs have been adopted as screening criteria for VOC/averaging period combinations for which MILs are not available. This approach has been adopted given the compatibility in the intended application of the MRLs, which are also provided as a screening tool for assessing where potential health effects should be considered in more detail. As further context, it is also noted the ATSDR MRLs are considered extensively in the derivation of MILs (NEPC, 2004), and are in some cases identical to the corresponding MILs (e.g. benzene annual average). It is also noted that exceedances of either MILs or MRLs do not mean that adverse health effects will occur, but indicate a situation in which further investigation should be undertaken.

In addition, for substances for which MILs nor MRLs are available, 1 hour criteria provided in NSW EPA (2016) and TCEQ (2021) have been adapted to 24 hour criteria simply by dividing by 24, thus representing the theoretical lower bound of concentrations against which compliance with the 1 hour criterion is demonstrated¹. Annual average criteria for these substances have been sourced from TCEQ (2021). **Table A1-6** presents the results of this screening process.

Table A1-6 Screening of boundary monitoring results (maximum by location)

Substance	Maximum 24 hour Concentration: Rounds 1 – 4 (µg/m ³)				Screening Criteria	
	EC01	EC02	EC03	EC04	24 hour	Chronic / Annual
	Northern Boundary	Southern Boundary	Western Boundary	Eastern Boundary		
Benzene	< 3	< 3	< 3	< 3	29 ^(a)	9 ^(b)
Toluene	13	11	9.8	19	3,770 ^(b)	377 ^(b)
Ethylbenzene	< 4	< 4	< 4	< 4	21,700 ^(a)	260 ^(a)
Xylenes - Total	< 12	< 13	< 13	< 12	1,085 ^(b)	868 ^(b)
1,2,4-Trimethylbenzene	< 4	< 5	< 5	< 5	92 ^(c*)	54 ^(d)
1,3,5-Trimethylbenzene	< 5	< 5	< 5	< 5	92 ^(c*)	54 ^(d)
Hexane	< 5	< 5	< 5	< 5	133 ^(c*)	200 ^(d)
Naphthalene	< 20	< 21	< 20	< 22	18 ^(d*)	50 ^(d)
Cyclohexane	< 3.5	< 3.5	< 3.5	< 3.5	792 ^(c*)	340

Notes:

^(a) ATSDR (2021)

^(b) NEPC (2011)

^(c) NSW EPA (2016)

^(d) TCEQ (2021)

* 1 hour average criterion divided by 24 to obtain the theoretical lower bound 24 hour average concentration indicative of compliance.

¹ Based on these assumptions, exceedances of the adapted 24 hour criteria do not necessarily indicate an exceedance of the 1 hour criteria, however compliance with the adapted 24 hour criteria indicates compliance with the 1 hour criteria.

“<” Maximum result less than LOR.

As shown in these data, detections above the limit of reporting are limited to toluene, with maximum measured concentrations being less than an order of magnitude below respective screening criteria.

2.1.2 Comparison against Urban Background Datasets

Table A1-7 provides additional context on the scale of monitoring results, with comparison to average and maximum concentrations measured by the NSW Department of Environment and Conservation (DEC) in Sydney as part of the NSW Ambient Air Quality Research Project (1996 – 2001) (DEC, 2004) and the NSW NEPM air toxics monitoring campaign (NEPC, 2010). Comparison against screening criteria is also provided.

Table A1-7: Comparison of boundary monitoring results with historical monitoring within Sydney

Substance	WARP Stage 2 Boundary	Urban Air				24 hour Screening Criteria
		(Sydney 1996 – 2001):		(Sydney 2009 – 2010):		
		Average (Maximum)		Average (Maximum)		
		EC01 - 04	Rozelle	Sydney CBD	Rozelle	
Toluene	<7.5 (19)	8.3 (60.3)	15.8 (37.7)	3.4 (14.3)	6.8 (24.1)	3,770

Note: All values converted from volumetric to mass-based units at conditions of 25°C and 1 atmosphere.

As shown in these data, concentrations of detected VOCs are during Stage 2 are within the range of those observed in ambient air within Sydney as documented in DEC (2004) and NEPC (2010).

2.2 Biopile Area Monitoring and Soil Vapour Extraction (SVE) System

Biopile monitoring was undertaken in accordance with the AEVR and a number of supplementary Environment Protection Licence (EPL) requirements, including daily monitoring of exhaust concentrations (Monday – Friday) and weekly reporting of monitoring data and operational data.

Biopile monitoring of the SVE system was documented within the weekly Air Quality Performance Reports that were submitted to the NSW EPA between 25 February 2022 and 03 June 2022. A total of 12 weekly reports were prepared. The SVE systems were decommissioned on 9 May 2022; therefore, only one report was submitted after this date (03 June 2022) as monitoring was only required on a single working day (9 May 2022).

2.2.1 Carbon Breakthrough Times

As per the carbon breakthrough management procedure (Enviropacific Services, 2021), the SVE system was arranged in a parallel configuration, consisting of a lead and lag drum in parallel for each of the seven SVE systems, resulting in initial lead vessel adsorption capacity estimates ranging from 21 days (SVE-04) to 402 days (SVE-02), which progressively increased during the remediation, as inlet loadings decreased. The configuration of the parallel SVE system is shown below in Figure A1-3.

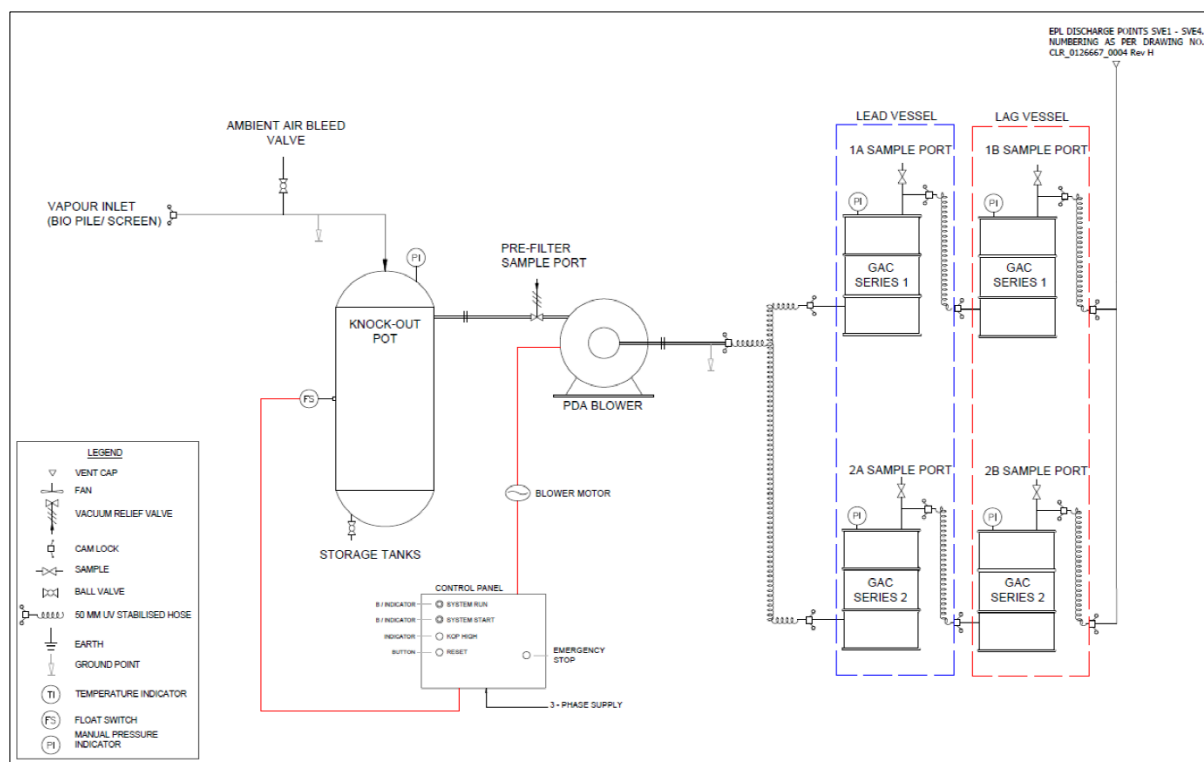


Figure A1-3: Stage 2 SVE System Process Diagram (Enviropacific Services, 2021)

In addition to process monitoring, detailed evaluations of remaining lead vessel adsorption capacity were made on a weekly basis and reported within weekly Air Quality Performance Reports provided to the EPA throughout the duration of soil treatment process. Table A1-8 summarises this data.

Table A1-8 Summary of lead vessel remaining adsorption capacity during Stage 2 soil treatment

Day of Week	Date	Evaluation of Remaining Adsorption Capacity - lead vessel only (days)							
		SVE-01	SVE-02	SVE-03	SVE-04	SVE-05	SVE-06	SVE-07	SVE-08
Friday	25/02/2022	~259	~402	~212	~21	~35	~57	~35	OOS
Friday	4/03/2022	~546	~970	~401	~21	~37	~70	~37	OOS
Friday	11/03/2022	~565	~482	~372	~28	~64	~90	~33	OOS
Friday	18/03/2022	366	250	160	50	212	94	194	OOS
Friday	25/03/2022	1009	842	571	31	32	31	40	OOS
Friday	01/04/2022	1822	1785	1420	53	100	129	329	OOS
Friday	08/04/2022	7716	11112	4327	64	106	106	153	OOS
Thursday	14/04/2022	5303	4232	3667	43	157	110	134	OOS
Friday	22/04/2022	5295	10440	6806	8	72	29	104	OOS
Friday	29/04/2022	5288	7073	5028	33	23	22	73	OOS
Friday	06/05/2022	7066	10426	7066	73	119	110	161	OOS

Note: OOS – Out of Service

2.2.2 Monitoring of SVE Inlet, Lead-lag Interface and Discharge Points

During Stage 2, SVE system monitoring was undertaken on a daily basis during weekdays, in accordance with EPL requirements. During this time, the SVE treatment system operated in a consistent and predictable manner, with effective control of VOCs for the duration of the biopiling operations (limiting fugitive emissions and breakthrough of contaminants). Figures A1-4 and A1-5 present this data.

The following is noted with regard to the system operation undertaken over a period of 75 days between 21 February and 6 May 2022:

- Inlet concentrations were observed to decrease rapidly throughout the first week of treatment, prior to a more gradual decrease across the duration of the biopile treatment;
- Treatment capacity was observed to be consistent with breakthrough estimates, and change out of carbon filter media in the lead vessel was not required, nor was implementation of a contingency vessel;
- VOC concentrations at the outlet of lead vessel were less than or equal to 3.7 ppm v for the duration of the biopile treatment, indicative of no breakthrough of VOCs from the lead to the lag vessel;
- VOC concentrations at the EPL discharge points were less than or equal to 2.0 ppm v for the duration of the biopile treatment; and
- Ambient VOC concentrations in close proximity to the biopile covers were indicative of negligible fugitive VOC emissions from the covered biopiles. This condition was observed irrespective of the operating condition of the SVE system.

Figure presents a summary of SVE inlet monitoring results and Figure A1-5 presents EPL discharge point monitoring results across the biopile treatment period.

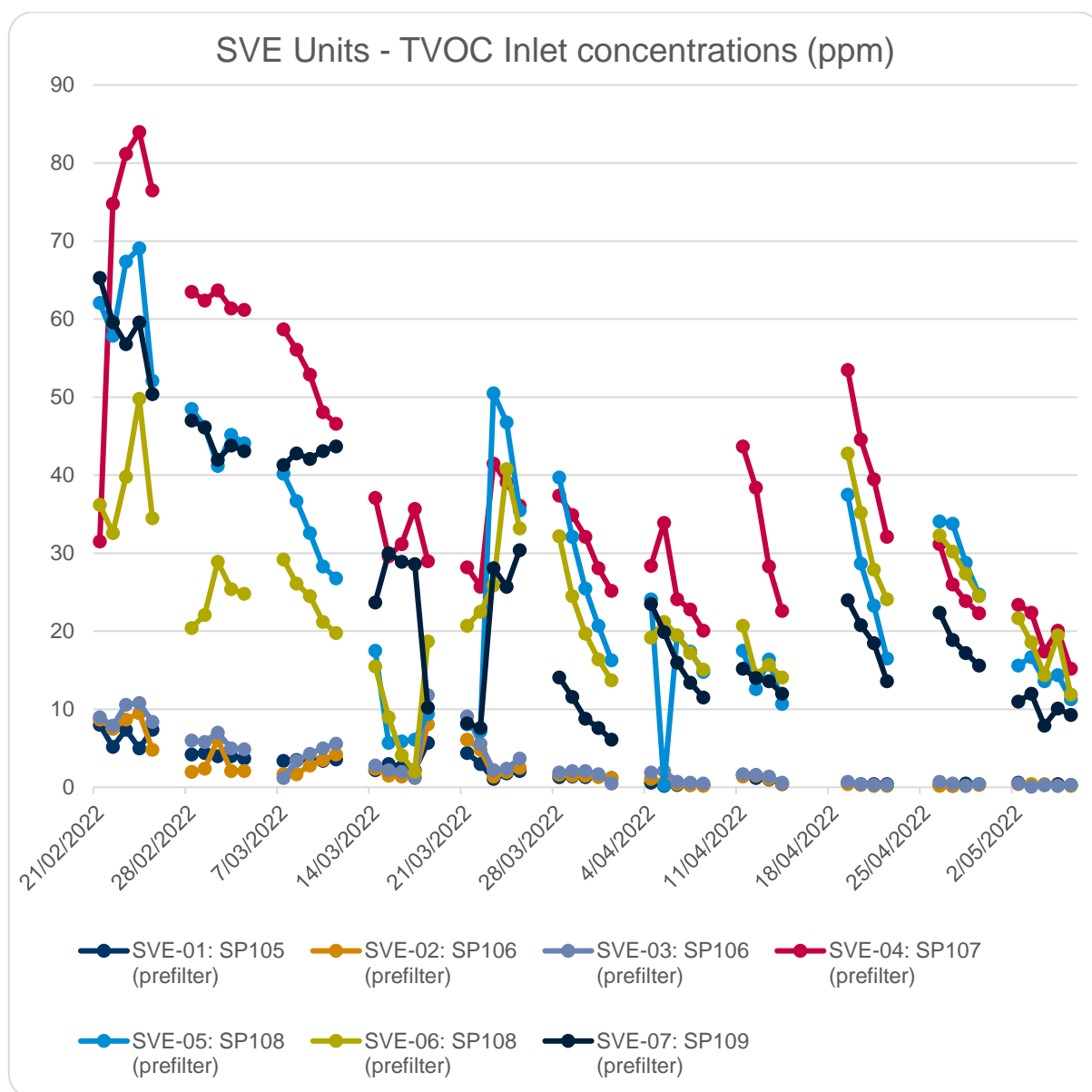


Figure A1-4: Summary of SVE System Inlet VOC concentration data across the duration of soil treatment

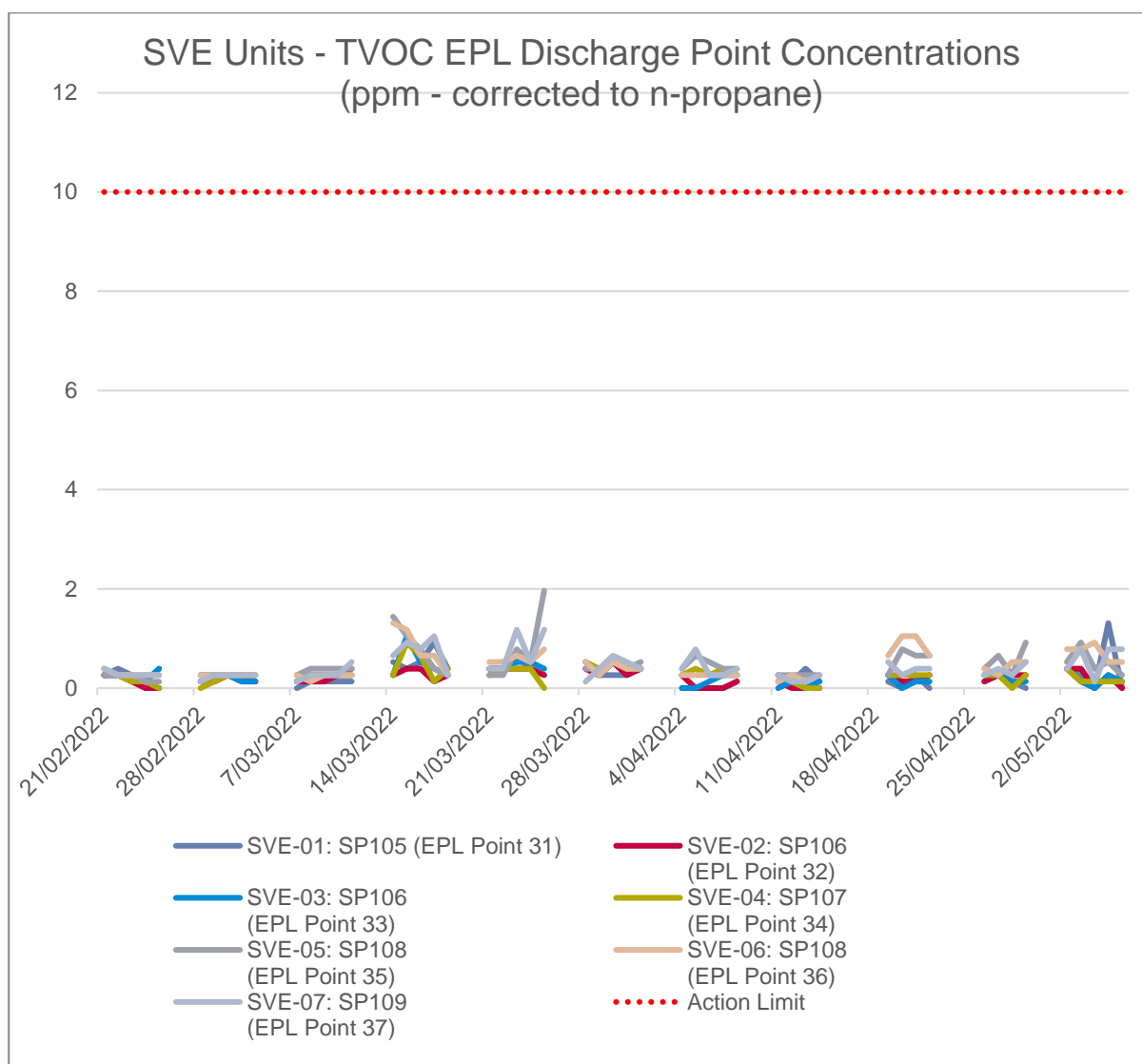


Figure A1-5: Summary of SVE System Outlet VOC concentration data across the duration of soil treatment

A.2 Summary of groundwater monitoring results

ERM was engaged by Viva Energy to complete groundwater monitoring requirements in accordance with the approved Groundwater Monitoring and Management Plan (GMP) and the associated Groundwater Monitoring Program (GWMP) for Stage 2 (ERM, 2021²). The groundwater monitoring program included the following:

Existing groundwater monitoring wells were selected for gauging and sampling based on the following objectives:

- **Monitoring during remediation** – to demonstrate remediation works do not have short-term adverse effects on localised groundwater quality or the Duck River and implement contingency actions (if required); and
- **Monitoring post-remediation** – to demonstrate that stable to decreasing groundwater concentrations continue to be observed as a result of natural attenuation processes and removal of key source areas.

Stage 2 – Monitoring During Remediation

During the active remediation period from September – November 2021, ERM conducted the following compliance monitoring activities related to groundwater management during the Stage 2 remediation works in accordance with the Groundwater Monitoring Program (GWMP) (ERM, 2021):

- Weekly groundwater gauging of the near-excavation monitoring wells to the Stage 2 Excavation Areas. MW11/18 was inaccessible due to being clogged with mud and MW18/23 was not sampled as the hydrasleeve could not be removed from the well.
- Pre and post works (within three months following completion of remediation works) sampling event of these wells to assess potential for adverse changes to groundwater conditions from excavation works; and
- Monthly groundwater gauging and sampling of downgradient monitoring wells to monitor for potential LNAPL mobilisation from remediation works.

Based on groundwater monitoring undertaken throughout the execution of remedial works in the Stage 2 Area, the following was noted:

- Fluctuations in the groundwater levels of near-excavation monitoring wells is considered likely due to the inconsistent weather conditions (including significant rainfall) leading up to and during the monitoring period. Minor variations in groundwater level were observed, with the exception of MW11/20. The groundwater level within MW11/20 is observed to have increased significantly and is presumed due to seepage of rainwater and water trucks, as it was observed the well cap was not properly sealed.
- Groundwater flow appears to have slightly altered from a pre-remediation south eastern direction to a southerly direction during the two month remediation. The minor change in groundwater flow direction is considered likely due to the large variation in rainfall events throughout the two month monitoring schedule.
- No evidence of contaminant mobilisation or migration of Light Non-Aqueous Phase Liquids (LNAPL) into key indicator wells were noted during gauging or sampling events conducted pre, during or post remediation works.
- No significant changes were observed in groundwater pH measurements taken pre- and post-remediation. As such, no acidification of groundwater conditions is considered to have occurred and is consistent with the low risk of acid sulfate soils and the fact that no dewatering was undertaken.
- Contaminant concentrations of TRH/BTEXN reported by the laboratory were comparable pre- and post-remediation works and consistent with historical data from the Site.
- Concentrations of contaminants of concern were reported below the laboratory limit of reporting at down-gradient boundary wells when silica gel clean-up was undertaken on TRH C10-C40 fractions. As such, no evidence of contaminant migration or impacts to the Duck River are considered to have occurred as a result of the Stage 2 remediation works.

On the basis of the above assessment, the implementation of contingency measures for groundwater (as per the GWMP) were not required to be implemented during remediation works.

All groundwater data obtained during the remediation works is detailed within the following reports:

² ERM (2021) Clyde Western Area Remediation Project – Groundwater Monitoring Program – Stage 2. Final, Revision 3, dated 14 July 2021.

- “Stage 2 Monthly GME 1 Report”, prepared by ERM and dated 8 November 2021;
- “Stage 2 Monthly GME 2 Report”, prepared by ERM and dated 20 December 2021.
- “Clyde Western Area Remediation Project Stage 2 Groundwater Monitoring Report (2021)”, prepared by ERM and dated 4 May 2022.

Stage 2 – Monitoring Post Remediation

Two post remediation Groundwater Monitoring Events (GME) have been completed within the Stage 2 Area during the reporting period to satisfy Condition B22 of the conditions of Consent for the Project:

- GME 1 (July 2021); and
- GME 2 (December 2021).

Monitoring of groundwater conditions for concentrations of petroleum hydrocarbon based contaminants of concern has identified the following conclusions in relation to the Stage 2 Area:

- Ongoing monitoring was undertaken in general accordance with the Site Auditor Approved GWMP and met the requirements of B22 of the Conditions of Consent for the Project.
- No exceedances of Site Specific Target Levels (SSTLs) were reported for on-Site receptors in any groundwater monitoring wells sampled.
- Evidence of stable groundwater conditions and natural attenuation processes continue to be identified as per previous monitoring, including:
 - No evidence of mobilisation or migration of LNAPL in key indicator wells was noted during gauging or sampling events conducted.
 - No statistically significant increasing trends of key contaminants of concern (Benzene, TRH C₆-C₉ fractions, TRH C₁₀-C₃₆ fractions following silica gel clean-up) identified during GMEs 1 and 2; and
 - The presence of a high proportion of polar compounds in groundwater samples, as indicated by widespread detections of TRH C₁₀-C₄₀ fractions versus non-detect following silica gel clean-up analysis. Polar metabolites are formed via microbial degradation of petroleum hydrocarbon source areas.

The above findings are consistent with groundwater monitoring events undertaken in the subject wells in recent years.

Detailed interpretation and presentation of groundwater data obtained post the Stage 2 remediation works is detailed within the following report:

- “Clyde Western Area Remediation Project Stage 2 Groundwater Monitoring Report (2021)”, prepared by ERM and dated 4 May 2022.

Contingency Actions

The implementation of contingency items (as per Section 3.7 of the GWMP) were not warranted as no adverse changes to environmental conditions or risk to off-Site receptors were identified.