



Site Audit Report (073-2127799) - Stage 1 Area

Clyde Western Area Remediation Project

Viva Energy Australia Pty Ltd

2 May 2022

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Status Code	Revision	Author	Reviewer		Approved for issue		
			Name	Signature	Name	Signature	Date
[Status code]	A	D.Balbachevsky	A. Kohlrusch		A. Kohlrusch		2 May 2022
[Status code]							
[Status code]							
[Status code]							
[Status code]							

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Glossary

Acronym	Description
ACM	Asbestos Containing Material
AEC	Areas of Environmental Concern
AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment and Conservation Council
ANZG	Australian and New Zealand Guidelines.
AOC	Accidentally Oil Contaminated
AQIA	Air Quality Impact Assessment
AQMP	Air Quality Management Plan
AS	Australian Standard
ASC	Assessment of Site Contamination
ASS	Acid Sulphate Soil
BGL	Below Ground Level
BH	Borehole
BTEX	Benzene, Toluene, Ethylbenzene and Xylenes
CLM	Contaminated Land Management
COC	Chain of Custody
CoPC	Contaminant of Potential Concern
CRC CARE	Cooperative Research Centre for Contamination Assessment and Remediation of the Environment
CSM	Conceptual Site Model
CTCP	Clyde Terminal Conversion Project
DO	Dissolved Oxygen
DPIE	Department of Planning, Industry, and Environment
DQIs	Data Quality Indicators
DQOs	Data Quality Objectives
EC	Electrical Conductivity
EIL	Ecologically Based Investigation Level
EIS	Environmental Impact Statement
ENM	Excavated Natural Material
EPA	NSW Environment Protection Authority
EPL	Environment Protection Licence
ERM	Environmental Resources Management
ESA	Environmental Site Assessment
ESL	Ecological Screening Level
eV	Electron Volt
FA	Fibrous Asbestos
GME	Groundwater Monitoring Event
GMP	Groundwater Management Plan
GWMP	Groundwater Monitoring Plan
Ha	Hectares

Acronym	Description
HHERA	Human Health and Ecological Risk Assessment
HIL	Health-Based Investigation Level
HSL	Health Screening Level
IMW	Intrusive Maintenance Workers
km	Kilometre
LCS	Laboratory Control Samples
LEP	Local Environment Plan
LFG	Landfill Gas
LGA	Local Government Area
LNAPL	Light Non-Aqueous Phase Liquid
LOR	Limit of Reporting
LTEMP	Long Term Environmental Management Plan
m	metre
m AHD	Metres Australian Height Datum
m bgl	Metres Below Ground Level
m btoc	Metres Below Top of Casing
m ³	Cubic metres
mg/kg	Milligrams per Kilogram
mg/L	Milligrams per Litre
MW	Monitoring Well
NATA	National Association of Testing Authorities
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NHMRC	National Health and Medical Research Council
NSW	New South Wales
OCP	Organochlorine Pesticides
OEH	Office of Environment and Heritage
OPP	Organophosphorus Pesticides
PAH	Polycyclic Aromatic Hydrocarbons
PASS	Potential Acid Sulfate Soils
PCB	Polychlorinated Biphenyls
PFAS	Per and Polyfluoroalkyl Substances
PFHxS	Perfluorohexanesulfonate
PFOS	Perfluorooctanesulfonic acid
PID	Photo-Ionisation Detector
POEO	Protection of the Environment Operations
PPE	Personal Protective Equipment
PPM	Parts per Million
PSI	Preliminary Site Investigation
QA	Quality Assurance
QC	Quality Control
RAP	Remedial Action Plan

Acronym	Description
EMP	Environmental Management Plan
RLs	Relative Levels
RPD	Relative Percentage Difference
RSI	Remediation Site Investigation
RSW	Restricted Solid Waste
SAQP	Sampling and Analytical Quality Plan
SPOCAS	Suspension Peroxide Oxidation – Combined Acidity and Sulphate
SSD	State Significant Development.
SSTLs	Site Specific Target Levels
SVOC	Semi-Volatile Organic Compound
SWL	Standing Water Level
SWMP	Soil and Water Management Plan
TP	Test Pit
TRH	Total Recoverable Hydrocarbons
UCS	Unconfined Compressive Strength
µg/kg	Micrograms per Kilogram
µg/L	Micrograms per Litre
VENM	Virgin Excavated Natural Material
VOC	Volatile Organic Compound
WARP	Western Area Remediation Project
WWTP	Wastewater Treatment Plant

1. Introduction

Andrew Kohlrusch of GHD Pty Ltd (the auditor) was commissioned by Viva Energy Australia Pty Ltd (Viva Energy) to conduct the environmental site audit within Stage 1 Area of the Western Area Remediation Project (WARP) of the Clyde Terminal at Durham Street, Rosehill NSW.

Viva Energy currently operates the Clyde Terminal on part of the former refinery. However, a large part in the south-western portion is no longer required for operational purposes. Therefore, Viva Energy has commenced remediation of approximately 40 hectares to facilitate sale and redevelopment for commercial/industrial. This portion of the land that is no longer required is herein referenced as the 'Western Area' or 'WARP'.

Given the scale of remedial works, the Western Area was declared State Significant Development (SSD) and as such to assess the potential environmental impacts from remediation, an Environmental Impact Statement (EIS) containing a Conceptual Remedial Action Plan (RAP) was submitted to Department of Planning, Industry, and Environment (DPIE) in late 2019.

The Consent Conditions for SSD N° 9302 were issued on 7 May 2020. Staging of the remediation of the Western Area is being completed as per Consent Condition A9 of SSD N° 9302. Viva Energy is staging the remediation of the Western Area as follows:

- Stage 1 – Former Process West – Completed in 2020 with a long term environmental management plan.
- Stage 2 – Former Utilities and Movements – Being conducted in three sub-stages (Audit Areas AA1, AA2 and AA3) currently under remediation and validation; and
- Stage 3 – Former Process East – (projected for completion in 2022/23).

The Stage 1 Area (the site) location is shown on Figure F1 in **Appendix A**.

1.1 Stage 1 audit chronology

This audit is statutory as per Consent Condition B3 for SSD N° 9302. The site has also been notified to the NSW Environment Protection Authority (EPA) under *Section 60 of the Contaminated Land Management Act 1997*.

Remediation of the Stage 1 Area had been completed in 2020. The auditor issued Site Audit Statement (SAS) N° 055-2127799A on 18 February 2021, stating that the site was suitable for commercial/industrial land use subject to implementation of a long term environmental management plan (LTEMP). The LTEMP identified the presence of residual contaminated soil that needed to be managed (owing to the presence of soils that exceeded TRH management limits) and included a groundwater monitoring program to assess groundwater quality post-remediation.

Following completion of the remedial groundwater assessment required under the Condition Consent B22 of SSD N° 9302 and the results of the 2021 groundwater monitoring events (GMEs) (further discussed in **Sections 7.1** and **7.2**), the auditor agreed with ERM's recommendation that monitoring of residual impacts in groundwater could be removed from the Stage 1 LTEMP. Thus, the LTEMP issued in February 2021 was updated to remove groundwater monitoring requirements.

The auditor, in November 2021, issued SAS 065-2127799 attesting the appropriateness of the GME reports and the updated LTEMP prepared by ERM for the Stage 1 Area. The auditor concurred with ERM's opinion that the objective of Condition Consent B22 was met and that groundwater monitoring within Stage 1 Area was no longer necessary. Consequently, this SAS and supporting Site Audit Report (SAR) supersedes the previous SAS 055-2127799A issued in February 2021. A summary of the previous SAS is presented in **Table 1**. The objective of this audit is further discussed in **Section 1.4**.

The purpose of this current audit is discussed in **Section 1.4**. A list of previous site audit statements issued by the auditor in relation to the Stage 1 Area is shown **Table 1**.

Table 1 Previous audit reports – Stage 1 Area

Audit scope	Objectives	SAS N°	SAS date
Review of Stage 1 RAP	Comprising an audit of the detailed RAP prepared for Stage 1. Outcome of the audit was that the site could be made suitable through implementation of the RAP.	043-2127799	22/06/2020
Review of Stage 1 Remediation and Validation	Prepared following remedial works completed in implementing the RAP (for which SAS N° 043-2127799 was issued). Outcome of the audit was that the site was suitable for commercial/industrial land use with an LTEMP.	055-2127799A	18/02/2021
Stage 1 LTEMP Ongoing Groundwater Monitoring	Produced following review of reports related to the ongoing groundwater monitoring program for the Stage 1 Area, required under Consent Condition B22 of SSD N° 9302. Outcome of the audit was that groundwater monitoring was no longer required (as listed in the relevant conditions of consent for SSD 9302).	065-2127799	29/11/2021

1.2 Site audit details

This SAR and associated SAS have been produced following review of reports related to the ongoing groundwater monitoring program for the Stage 1 Area, required under Consent Condition B22 of SSD N° 9302. Details of Consent Condition B22. Of note is that the culmination of the ongoing groundwater monitoring program was a recommendation that groundwater monitoring is no longer warranted in Stage 1 and could be removed as a requirement of the LTEMP. The LTEMP (ERM (2021e)) has been updated and only includes the requirement to manage soils that may be disturbed during intrusive maintenance or earthworks.

The reports reviewed as part of this audit are listed in **Section 1.5** and the relevant background documentation is listed **Section 1.6**. The site audit details are presented in **Table 2**.

Table 2 Site audit details

Information	Details
Site auditor	Mr. Andrew Kohlrusch
NSW EPA site auditor accreditation n°.	0403
NSW EPA site audit statement n°.	073-2127799
Audit category	Statutory
Legal property description	Part Lot 100 in DP 1168951
Council	City of Parramatta Council
Site area	6.998 hectares
Site owner	Viva Energy
Current land use	Industrial
Site occupier	Downer EDI Works Pty Ltd ('Downer')

This site audit has been conducted in accordance with the requirements of the *Contaminated Land Management Act 1997* (the 'Act'). The Act defines the site audit as follows:

"site audit" means a review:

- a. *that relates to management (whether under this Act or otherwise) of the actual or possible contamination of land; and*
- b. *that is conducted for the purpose of determining any one or more of the following matters:*
 - (i) *the nature and extent of any contamination of the land;*
 - (ii) *the nature and extent of any management of actual or possible contamination of the land;*

- (iii) *whether the land is suitable for any specified use or range of uses;*
- (iv) *what management remains necessary before the land is suitable for any specified use or range of uses;*
- (v) *the suitability and appropriateness of a plan of management, long-term management plan or a voluntary management proposal.*

Furthermore, the Act provides the following definitions:

- *"Site Audit Report" means a site audit report prepared by a site auditor in accordance with Part 4 [of the Act].*
- *"Site Audit Statement" means a site audit statement prepared by a site auditor in accordance with Part 4 [of the Act].*

1.3 Audit triggers

Following the announcement of the closure of the former Clyde Refinery, on 22 June 2012, the NSW EPA issued a Preliminary Investigation Order to Viva Energy under the CLM Act requesting reports on environmental contamination.

Following receipt of a number of reports, in June 2016, the NSW EPA declared Lot 398 in DP 41324, Lot 2 in DP224288, Lot 1 in DP383675, Lot 101 in DP809340 and, Lot 100 in DP1168951 (which includes the Western Area) as contaminated land under the CLM Act (Declaration No. 20131110).

1.3.1 Consent Conditions for SSD N° 9302

The NSW DPIE on 7 May 2020 issued the Consent of Conditions for the remediation of contaminated soils and management of contaminated groundwater to enable future commercial and industrial land uses. Consent Conditions for SSD No. 9302 (from the audit perspective) require the following:

The development may only be carried out:

- (a) in compliance with the conditions of this consent;*
- (b) in accordance with all written directions of the Planning Secretary;*
- (c) in accordance with the EIS and RtS;*
- (d) in accordance with the Detailed RAP;*
- (e) in accordance with the Development Layout in Appendix 1. and*
- (f) in accordance with the management and mitigation measures in Appendix 2.*

Part B of the Conditions of Consent SSD No. 9302 specified the environmental conditions for the remediation, which included the following:

Prior to the commencement of preparation works, the Applicant must prepare a Detailed RAP for the development, in consultation with the EPA and to the satisfaction of the Site Auditor and the Planning Secretary. The Detailed RAP must:

- be prepared by a suitably qualified and experienced person in accordance with Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites (OEH, 2011). (The auditor notes that these Guidelines were updated in April 2020 and are currently referenced as EPA (2020) Guidelines for Consultants Reporting on Contaminated Sites);
- be reviewed by the Site Auditor in accordance with the requirements of Condition B3;
- be approved by the Site Auditor and Planning Secretary, prior to the commencement of preparation works;
- be submitted to the EPA for reference once approved and prior to the commencement of preparation works;
- detail all final remediation methods and technologies including layouts and design;
- detail the decision protocol for determining which remediation method applies to different materials;

- incorporate the recommendations of the Air Emissions Verification Report approved in accordance with condition B15;
- include triggers for contingency actions and alternate treatment methods to ensure the remediation objectives are achieved;
- detail all procedures and plans to be implemented to reduce risks to an acceptable level for the proposed final land use;
- the Validation report should be submitted within six months of the completion of demobilisation, or as otherwise agreed with the Planning Secretary, the auditor must submit a Validation Report to the EPA, Council and the Planning Secretary;
- the SAR and SAS should be submitted within 12 months of the completion of demobilisation, or as otherwise agreed with the Planning Secretary, the auditor must submit a SAR and Section A, SAS to the EPA, Council and the Planning Secretary. The reports must confirm that the remedial works approved under this consent have been completed in accordance with the remediation objectives listed in the Detailed RAP and the risks to human health and the environment have been addressed in accordance with the objectives of the Detailed RAP; and
- the Conditions of Consent requires that prior to the finalisation of the SAS and SAR, a Long Term Environmental Management Plan (LTEMP) should be prepared to the satisfaction of the auditor and the Planning Secretary.

In addition to the technical aspects needed to meet the SSD N° 9302 Conditions of Consent, there was also a provision to stage remediation of the site. Stage 1 Area – Groundwater Consent Conditions. The Consent Conditions required in SSD N° 9302 in relation to groundwater are as follows:

- *B22(b) include a program to monitor groundwater levels and quality during remediation works and following demobilisation.*
- *B22(d) detail ongoing monitoring following demobilisation, to verify that natural attenuation of groundwater contamination is occurring over time.*
- *B22(e) include trigger levels for investigating potential adverse impacts to the Duck River, including triggers for indicating if further remediation of groundwater is required.*
- *B22(f) outline contingency actions to be implemented if monitoring indicates that natural attenuation is not occurring, or groundwater is having an adverse impact on the Duck River.*
- *B22(g) monitor the effectiveness of management measures and contingency actions for reducing impacts.*
- *B22(h) procedures for reporting changes to groundwater conditions that have the potential to create unacceptable risks to the Duck River.*

To meet Consent Condition B22 a Groundwater Management Plan (GMP) (AECOM, 2020) was prepared and approved by the auditor on 4 June 2020, as discussed in IAA08. A copy of IAA18 is presented in **Appendix B**.

A Groundwater Monitoring Plan (GWMP) detailing the groundwater monitoring program required by Condition B22 was prepared by ERM, and it was included in Appendix A of the GMP, as well as in the Stage 1 LTEMP (ERM, 2021a).

The GWMP was required to:

- *Present trigger levels for investigating potential adverse impacts to the Duck River, including triggers for indicating if further remediation of groundwater is required.*
- *Present contingency actions to be implemented in case the monitoring events indicates that natural attenuation is not occurring, or groundwater is having an adverse impact on the Duck River.*
- *Monitor the effectiveness of management measures and contingency actions for reducing impacts.*
- *Document procedures for reporting changes to groundwater conditions that have the potential to create unacceptable risks to the Duck River.*

The auditor noted that IAA19 issued on 15 October 2021 endorsed the findings of the groundwater monitoring events reports outlined in **Section 1.5**. A copy of IAA19 is presented in **Appendix B**.

1.4 Site audit purpose

The auditor issued a Section A2 SAS (055-2127799A) in February 2021 stating that the site was suitable with implementation of a Long-Term Environmental Management Plan (LTEMP) that incorporated groundwater monitoring. A Section B2 SAS (065-2127799) was issued in November 2021 stating that there was no longer a need to monitor groundwater in the Stage 1 area (**Appendix B – excluding the EMP that has subsequently been revised**).

The purpose of this site audit report is to comment on the suitability of the Stage 1 Area for its commercial/industrial intended uses, subject to compliance with the revised passive LTEMP prepared by ERM (ERM (2021e)) – that was amended by omitting the need to conduct groundwater monitoring. The key focus of the revised LTEMP is to manage the residual petroleum aesthetic issues present in shallow fill. The LTEMP also provided instructions for the management of potential unexpected finds such as asbestos.

Remediation of the site had already been documented in a Section A2 SAS (055-2127799A) and accompanying site audit report (*Viva Energy, Clyde Western Area Remediation Project – Stage 1 Remedial and Validation Works* – GHD, February 2021).

Similarly, a comprehensive assessment of the works completed as part of the groundwater monitoring that led to the issue of SAS 065-2127799 was presented in the accompanying site audit report (*Site Audit Report – Stage 1 Area Ongoing Groundwater Monitoring, Clyde Western Area Remediation Project* – GHD, November 2021).

This site audit report has therefore presented a summary of works that were audited as part of the SAS 055-2127799A and SAS 065-2127799.

1.5 Audited documentation

This SAR has been prepared following review of information presented in the following documents associated with the ongoing groundwater monitoring events:

- ERM (2021c). *Clyde Western Area Remediation Project - Quarter 4 (2020) Groundwater Monitoring Report*, dated 24 March 2021 (the Q4 2020 GME);
- ERM (2021d). *Clyde Western Area Remediation Project Stage 1 – Ongoing Groundwater Monitoring Event 2 and Annual Summary Report*, dated 12 October 2021 (the Ongoing GME 2); and
- ERM (2021e). *Clyde Western Area Remediation Project, Stage 1 Long Term Environmental Management Plan*, dated 8 November 2021 (the updated LTEMP).

The outcome of the reviews of these documents was presented in interim audit advice letters (IAA) or tracked in an audit commentary spreadsheet. Copies of IAAs and/or audit spreadsheet, as well as the consultant's responses (where relevant) are presented in **Appendix B**.

1.6 Background reports

Given the nature of the works completed at the WARP, the auditor also considered the following documents as background information, much of which had been considered in preparing the SAS and SAR related to the Stage 1 remedial and validation works (summarised in Section A2 SAS 055-2127799A, suitable with implementation of an LTEMP) and Section B2 SAS 065-2127799, that groundwater monitoring was no longer required in Stage 1.

- AECOM (2019). *Viva Energy Clyde Western Area Remediation Project – Appendix C: Conceptual Remedial Action Plan*, dated 21 January 2019 (the Conceptual RAP);
- ERM (2020a). *Clyde Western Remediation Project, Remediation Site Investigation*, dated 7 February 2020 (the RSI);

- ERM (2020b). *Clyde Western Area Remediation Project, Human Health and Ecological Risk Assessment*, dated 16 February 2020 (the HHERA);
- ERM (2020c). *Clyde Western Area Remediation Project, Stage 1 - Detailed Remediation Action Plan*, dated 4 June 2020 (the Stage 1 RAP);
- ERM (2020d). *Clyde Western Area Remediation Project, Stage 1 – Validation Report*, dated 10 December 2020 (the Stage 1 Validation);
- AECOM (2020). *Clyde Western Area Remediation Project – Stage 1 Remediation Environmental Management Plan Groundwater Monitoring and Management Plan*, June 2020 (the GMP);
- ERM (2021a). *Clyde Western Area Remediation Project, Stage 1 Long Term Environmental Management Plan*, dated 29 January 2021 (the LTEMP); and
- ERM (2021b). *Clyde Western Area Remediation Project - Groundwater Monitoring Program*, dated 29 January 2021, Revision 4 (the GWMP – included as Attachment A of the GMP).

1.7 Regulatory guidelines

This SAR was prepared with reference to the following NSW EPA made or endorsed guidelines:

- NSW EPA (2020). *Contaminated sites: Guidelines for Consultants Reporting on Contaminated sites* (the Consultant Guidelines);
- NSW EPA (2020). *Assessment and Management of Hazardous Ground Gases* (the Ground Gas Guidelines);
- ANZAST (2018). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*;
- NSW EPA (2017). *Contaminated Land Management: Guidelines for the New South Wales Site Auditor 3rd Scheme (edition)* (the Auditor Guidelines);
- CRC Care (2015). *A Practitioner's guide for the analysis, management and remediation of LNAPL. Technical Report N° 34*;
- NEPC (2013). *National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended by the National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (N° 1), National Environment Protection Council, May 2013* (the ASC NEPM);
- NHMRC & NRMMC (2004). *Guidelines for Drinking Water Quality in Australia, National Health and Medical Research Council and Natural Resource Management Ministerial Council, Canberra*;
- NSW DEC (2007). *Guidelines for the Assessment and Management of Groundwater Contamination* (the Groundwater Guidelines); and
- NSW EPA (1995). *Sampling Design Guidelines* (the Sampling Guidelines).

1.8 Permitted land uses

The Stage 1 is zoned as IN3 – Heavy Industrial under the Parramatta Council Local Environmental Plan 2011. Permissible uses allowed under this zoning (with consent), include:

Agricultural produce industries; Building identification signs; Business identification signs; Depots; Freight transport facilities; General industries; Hardware and building supplies; Hazardous storage establishments; Heavy industries; Horticulture; Kiosks; Medical centres; Offensive storage establishments; Pubs; Roads; Rural supplies; Sawmill or log processing works; Take away food and drink premises; Timber yards; Warehouse or distribution centres; Water storage facilities

1.9 Site audit report structure

This SAR documents the audit of the reports referenced in **Section 1.5**. Where the auditor has provided comments on the work, these are highlighted in blue shaded dialogue boxes. The remainder of this report is organised as follows:

- Section 2 Site conditions and environmental setting
- Section 3 Historical land uses

Section 4	Previous characterisation report – Stage 1 Area
Section 5	Groundwater assessment criteria
Section 6	Data quality objectives
Section 7	Consent Condition B22 - Groundwater monitoring events
Section 8	Evaluation of quality assurance and quality control
Section 9	Post remediation conceptual site model
Section 10	Other considerations
Section 11	Updated long-term environmental management plan
Section 12	Auditor conclusion
Section 13	Disclaimer

1.10 Limitations of this report

The information and opinions given in this SAR are based on reviewing information presented in the documentation referenced in **Section 1.5** and other supporting information provided by Viva Energy and the consultant.

The auditor has not carried out any independent investigations in relation to the condition of the site. This audit is subject to the limitations presented in **Section 13** of this report.

The auditor assumes no responsibility or liability for any errors or omissions in the information provided in the reports reviewed or that the consultant did not confer any reliance on the reports to the auditor.

The auditor issued in 2021 Section B2 SAS 065-2127799 declaring that groundwater monitoring was no longer necessary for the Stage 1 area and ERM subsequently issued a revised LTEMP (that no longer had a requirement to monitoring groundwater quality). It was therefore necessary to issue an updated Section A2 SAS that reflected the amended conditions for the site use. The purpose of this site audit was therefore to assess land use suitability of the Stage 1 Area for its commercial/industrial intend uses of the land, subject to compliance with the amended passive Long-Term Environmental Plan. No other warranties, expressed or implied, are made.

This SAR relates only to the subsurface to define the nature and extent of contamination at the site, and related identified off-site impacts from surface water, groundwater or soil vapour. It does not comment on the evaluation of geotechnical issues, or any other issues associated with the site.

2. Site conditions and environmental setting

A summary of the site conditions and environmental settings discussed by ERM in the reports referenced to in **Sections 1.5** and **1.6**.

2.1 Site identification

The Stage 1 Area is located within the former Process West Area and extends from Devon Street in the north to the Duck River that constitutes the southern boundary of the Western Area. The site location plan and layout are shown on Figures F1 and F2 in **Appendix A**. The site identification information is summarised in **Table 3**.

Table 3 Site identification summary

Site identification:	Stage 1 Area
Site area:	6.998 hectares
Local Government Authority	City of Parramatta Council
Lot and Deposit Plan (DP):	Part Lot 100 in DP 1168951
Current land use:	Industrial (under development)
Land use zoning:	IN3 – Heavy Industrial under the Parramatta Local Environmental Plan 2011

2.2 Stage 1 Area description (former)

The Stage 1 Area comprised the former Process West Area. The following description was noted by ERM in January 2020 prior to commencement of remediation:

- Concrete and bitumen hard standing were present across most of the Stage 1 Area;
- Aboveground pipework remained within the pipe tracks bordering the west and northern extent of the former Process West footprint;
- Corrugated Plate Interceptor units remain at the ground surface;
- The Central Control Room building had been demolished, leaving an open void with concrete walls and base within the former basement area of approximately 50 metres x 18 metres which extended approximately three metres below the surrounding surface level; and
- A large stockpile of building and demolition waste situated in the Western portion of the Site. This stockpile occupied an approximate footprint of 1,100 m² with an average height of two metres (approximately 2,200 m³).

2.3 Stage 1 Area description (current)

During a site visit conducted on 4 November 2021, the auditor noted that the Stage 1 Area was under development, including the pouring of concrete slabs, construction of buildings and installation of underground services.

The auditor noted that the residual hydrocarbon impacted shallow soils within the Stage 1 Area were being managed through an LTEMP (as per the Consent Conditions and included as part of SAS N° 055-2127799A). Photographs taken during the November 2021 site visit showing the development of the Stage 1 area are presented in Figure 1, Figure 2, and Figure 3.



Figure 1 *Boundary between Stage 2 Area and east of Stage 1 Area*



Figure 2 *View of Stage 1 Area from the biopiles within Stage 2 Area*



Figure 3 *View of infrastructure being constructed within Stage 1 Area*

2.4 Environmental setting

A summary of the environmental setting relevant to the Stage 1 Area is presented in **Table 4**.

Table 4 Summary of environmental setting – Stage 1 Area

Information	Key information
Water bodies	The nearest water body is the Duck River located immediately to the south of the Stage 1 Area. The Duck River is lined with mangroves adjacent to the Western Area. However, it is considered a moderately disturbed catchment. As reported by ERM in the Remediation Site Investigation (RSI) the tidal limit of the Duck River extends approximately one-kilometre upstream of the Stage 1 Area to the Clyde Railway culvert (Cardno Lawson-Treloar, 2008). The upper reaches of the Duck River extend approximately 10 kilometres south to Condell Park, within the Bankstown LGA where stormwater flows within a series of storm water pipes and open concrete drains. The downstream extent of the Duck River converges with the Parramatta River at the north-east boundary of the refinery. Parramatta River is the major tributary of Sydney Harbour located approximately 15 kilometres downstream of the refinery which, in turn discharges into the Pacific Ocean.
Geology	Based on historical intrusive works, the average thickness of fill material within the Site is 0.6 metre underlined by high plasticity clay (alluvial sediments). Localised areas of backfill sand had been identified surrounding subsurface footings and structures to a depth of 2 metres below ground level (mbgl). The Acid Sulfate Soil (ASS) Risk Map for Parramatta/Prospect (scale 1:25,000) produced by the Department of Land and Water Conservation (1997) identified the Western Area as having a high probability of ASS in estuarine sediments adjacent to the Duck River. However, intrusive works carried out by ERM reported that no estuarine sediments had been identified within soils within the site. ERM in the Stage 1 RAP concluded that given the absence of such sediments across the Stage 1 area, the probability of encountering ASS or Potential Acid Sulfate Soils (PASS) was low.
Groundwater depth	The groundwater is represented as a shallow unconfined water bearing zone within the fill material at depths between 1 metre below ground level (mbgl) to 3 mbgl. No groundwater was encountered during the remedial works apart from inflow at a depth of approximately 1.5 mbgl to 2 mbgl.
Groundwater flow direction	The inferred groundwater flow direction based upon the numerous gauging activities that have taken place is towards the Duck River to the south and south-east. The groundwater flow direction map is shown on Figure F2 in Appendix A.
Hydraulic gradient	The average hydraulic gradients calculated ranged between 0.003 along the up-gradient portion of the Western Area to 0.011 across the southern portions of the Western Area.
Hydraulic conductivity	The RSI reported that the hydraulic conductivity has been established to be low across the large majority of the Western Area, with estimated hydraulic conductivity values for wells that were screened across clay, sandy clay and gravelly clay typically ranging from 5×10^{-5} m / day to 4×10^{-2} m/day (close to the Duck River). Historical data demonstrates that the laterally continuous higher hydraulic conductivity lithological units are not expected to be encountered within the Site.

2.5 Auditor discussion - Site conditions and environmental setting

The auditor noted that although ERM did not include a discussion regarding the local environmental setting in the ongoing groundwater reports. However the auditor notes that a detailed description of Stage 1 had been provided in other considered in preparing this site audit report. The auditor also had reviewed in 2020 a number of reports as outlined in **Section 1.6** in which a detailed description of the Stage 1 Area as well as the immediate site environmental setting were discussed.

The auditor considered that the site description of the immediate surrounding land documented in the previously reports were consistent with the auditor's observations made during the site inspection undertaken on 4 November 2021.

As noted by the auditor in **Section 2.3**, the Stage 1 Area was under development with the residual soil impacts (associated with aesthetic issues) being managed via the LTEMP that formed part of the SAS055-2127799A.

The site is zoned as IN3 under the Parramatta LEP 2011 as discussion presented in **Section 1.8**. The auditor noted that the proposed future commercial/industrial land uses are consistent with the Parramatta Council zoning.

The nearest water body is the Duck River which is located immediately off-site to the south of the Stage 1 Area. The auditor noted regarding the hydrogeological characterisation of the site, the following the key information:

- Vertical migration of groundwater is limited by the soil profile which comprises a thin layer of unconsolidated fill underlain by low permeability clay.
- Lateral migration of contaminants of potential concern (CoPC) in groundwater is limited by the low permeability of the lithology and relatively flat hydraulic gradient. ERM reported in the RSI that this conclusion was supported by the limited lateral extent of impacted groundwater, indicating that where present areas of impacted groundwater are stable and do not appear to be migrating.

It is the auditor's opinion that the site conditions and environmental setting information provided by ERM in the reports listed in **Sections 1.4** and **1.6** reviewed as part of this audit contained relevant information as recommended in Schedule B2 of the ASC NEPM (NEPC, 2013) and the Consultant Guidelines (NSW EPA, 2020).

3. Historical land uses

The summary of the historical land use provided below was developed by ERM based on desktop reviews, interviews and aerial photograph reviews undertaken during the previous investigations, further outlined in **Section 4**.

3.1 Former Clyde Refinery

AECOM in the Conceptual RAP described that the former Clyde Refinery was originally included as part of an 850-acre land grant by the Crown to John Macarthur. In 1908, a parcel of 140 acres of land was transferred to the Commonwealth Oil Corporation (COC). The COC struck financial difficulties and went into receivership. In 1913 the land was then acquired from COC by John Fell and Co.

The new owner began purchasing crude oil to refine at Clyde and refining commenced in 1926. In 1928, Shell Refining Pty Ltd took over as owner and operator of the site. Shell purchased an additional seven acres of land and a further 150 acres in June 1930. The duration of the first stage of expansion of the site was from 1929 to 1939 with the purchase and construction of new equipment and buildings, increasing the crude product intake to approximately 250 tonnes/day by 1934.

The former Clyde Refinery operations primarily comprised the receipt and refining of crude oil and finishing product piped from the Gore Bay Terminal until cessation of refining activities in 2012. Since the completion of refining operations, the former Clyde Refinery has been partially utilised as a terminal, which primarily involves the receipt, storage, and distribution of finished petroleum products.

Since the cessation of refining operations in 2012, the Clyde Terminal continues to receive finished petroleum products from the Gore Bay Terminal via an existing product transfer pipeline and distributes the products by separate pipelines from the Clyde Terminal to the adjacent Parramatta Terminal.

3.2 The Western Area

Following completion of the Clyde Terminal Conversion Project (SSD N° 5147), the Western Area was no longer required for operational purposes. Given the identified presence of contaminated soil in the Western Area, remediation as per conditions listed in SSD N° 9302, is taking place to enable future commercial and/or industrial land uses.

A figure showing the location of the Western Area is presented on Figure F1 in **Appendix A**.

3.3 The Stage 1 Area (the Site)

The plant decommissioning, decontamination and above grade demolition activities of the majority of above-ground infrastructure within the Western Area was completed between 2012 and 2016.

Demolition of the final remaining above ground infrastructure (Western Tank farm, Tank farm C and remaining pipe track areas) was completed in early 2020 prior to commencement of the remedial works in the Stage 1 Area.

Within the boundaries of the Stage 1 Area, the following features associated with former refining operations existed and operated since approximately 1960 prior to demolition:

- Former Process West – Aboveground fuel processing infrastructure including a Distillate splitter unit, crude oil distillate units, Central Control Room;
- Tank Farm H – formerly containing Aboveground Storage Tanks (ASTs) 501 – 505, formerly storing various grades of bitumen and wash oil; and
- Drainage infrastructure and associated oil-water interceptor units.

The Stage 1 Area showing the former key features is presented on **Appendix A** (Figure F5 from the Stage 1 RAP), while the drainage infrastructure is shown on **Appendix A** (Figure F4 from the Stage 1 RAP).

3.4 Auditor discussion – Historical land use

The auditor considered that although the groundwater monitoring reports did not include a summary of the historical land uses, a detailed description of past land uses had been discussed in the previous reports outlined in **Section 1.6**. The auditor has reviewed those reports and considered that the site's primary historical usage which had resulted in the soil contamination was the storage and processing of petroleum hydrocarbons and the local drainage and associated oil-water interceptor units.

The auditor noted that most of the former infrastructure within Stage 1 Area was aboveground, including the drainage infrastructure, Tank farm H and Former Process West. Further, as noted by the auditor in SAS 055-2127799A, issued in February 2021, the Stage 1 Area had been satisfactory remediated and the potential human health risks to on-site commercial/industrial receptors are low and acceptable.

The identified residual hydrocarbons impacts associated with shallow fill (aesthetic issues) are to be managed under the LTEMP further discussed in **Section 11**.

4. Characterisation and validation reports

This section presents a summary of historical site investigations reports associated with the Stage 1 Area. A comprehensive evaluation of data (including quality control assessments) presented in these reports had been prepared in the site audit report that accompanied the Section A2 SAS 055-2127799A issued on 18 February 2021, a copy of which is presented in **Appendix B**.

Investigations across the Clyde Refinery have been conducted since 1991. Based on the historical reports finding including the historical and uses, ERM identified that the primary sources of soil and groundwater contamination were associated with the refinery processing infrastructure. The mechanism of release from these former primary sources was at the ground surface due to storage and transfer of petroleum manufacturing product primarily within aboveground infrastructure.

The Stage 1 RAP identified the following CoPC:

- Total recoverable hydrocarbons (TRH) C₈-C₁₂ aliphatic fractions;
- TRH C₁₀-C₁₆ aromatic fractions; and
- BTEXN and TRH C₁₆-C₄₀ (these chemicals have been selected as a precaution as their presence at levels greater than nominated screening levels has not been detected in Stage 1 Area soils).

Remedial works in Stage 1 were completed in 2020. The site Validation report (ERM, 2020d) was reviewed by the auditor, the results of which were presented in a site audit report and summarised in SAS 055-2127799. The auditor concluded in SAS 055-2127799A that:

- *It is the auditor's opinion that based on the remedial and validation works results discussed in this SAR, the Stage 1 Area is suitable (subject to implementation of the updated LTEMP) for the commercial/industrial land uses.*
- *The SAR also confirmed, as required by condition B7 of the Development Consent, that:*
 - *the remedial works approved under the Development Consent have been completed in accordance with the remediation objectives listed in the Stage 1 RAP; and*
 - *risks to human health and the environment have been addressed in accordance with the objectives of the Stage 1 RAP.*

The key elements of the LTEMP for Stage 1 were the identification of soils that contained hydrocarbons or asbestos (but did not present an unacceptable risk of exposure if undisturbed) and an ongoing groundwater monitoring program (to comply with Consent Condition 22 of SSD N° 9302).

A summary of the relevant background reports listed in **Section 1.6** followed by the auditor discussion, already presented in the previously SAS N° 043-2127799 and SAS N° 055/2127799A are summarised in **Table 5**.

Table 5 Summary of characterisation and validation reports relevant to Stage 1 Area and auditor comments

Reports	Objectives/Scope of works	Key findings	Auditor discussion
RSI (ERM, 2020a)	The objective of the RSI was to collect data to assess the risk of contamination to sensitive on-site and off-site human and ecological receptors resulting from the Areas of Environmental Concern (AECs). The scope of works comprised the drilling of 80 test pits to a maximum depth of 4.8 mbgl to characterise soils in specific areas where data gaps were identified, as outlined in the RSI SAQP.	ERM concluded that there were 15 AECs along to the Western Area, based on the historical land uses. Regarding the Stage 1 Area the following AECs were identified: – AEC-9 and portions of AEC-7, AEC-13, AEC-14 and AEC-15 impacted by residual hydrocarbon impacts. Based on the nature of the drainage network (refer to Figure F4 in Appendix A), ERM recommended an unexpected finds protocol to be implemented during the excavation and removal of the subsurface drainage network, which would allow appropriate management and assessment of isolated areas of soil impacts during remediation and sub-grade infrastructure removal. ERM considered the RSI together with the historical assessments provided sufficient information to better characterise the site and collect data in and around the AECs. In addition, the RSI results were considered for the purposes of developing a HHERA to refine the potential risks to human and ecological receptors, the development of site-specific target levels (SSTLs) and remedial end points.	It was the auditor's opinion that the RSI followed the endorsed Sampling and Analytical Quality Plan (SAQP) and the relevant guidelines made or endorsed by EPA, providing sufficient information to portray the characterisation of the Western Area (which includes the Stage 1 Area), assisting in the preparation of the HHERA and the Detailed RAP. The auditor acknowledged that the distribution of the sampling locations used to define the extent of contamination within the Western Area and the Stage 1 Area was sufficient to identify and characterise the extent of the AECs.
HHERA (ERM, 2020b)	The HHERA was developed to evaluate the significance of potential risks where Tier 1 screening levels were exceeded. SSTLs were derived based on the updated CSM from the RSI and historical relevant reports.	Regarding the Stage 1 Area, the HHERA developed further exposure derived SSTLs for the following exposure scenarios: – Inhalation of hydrocarbons vapours by future on-site workers in indoor areas within AEC-09. – Direct contact or ingestion of impacted soils by future on-site intrusive maintenance workers (IMW) or construction workers within part of AECs 7, 14 and 15. ERM concluded that groundwater did not require remediation, given the residual LNAPL characteristics and low mobility, and dissolved phase petroleum plumes were stable or decreasing. In addition, the extents of the petroleum hydrocarbons plumes were sufficiently delineated. Therefore, the potential risks to off-site ecological receptors were deemed by ERM to be low and acceptable. There was potential for asbestos to be present in AECs 13 and 15. ERM concluded that this matter should be managed via an LTEMP.	Regarding potential risks associated with the Stage 1 Area, the auditor noted that the risk driver was vapour intrusion for future commercial works related with exceedances of naphthalene, TRH C₈-C₁₂ (aliphatic and aromatic) and TRH C₁₀ - C₁₆ (aromatic) within AEC 9. AEC-9 was subsequently remediated (as outlined in the Stage RAP and Stage 1 Area Remediation and Validation report). Potential for asbestos occurrence was noted within AEC 13 and AEC 15. The auditor concurred with the HHERA that asbestos occurrence and LNAPL does not pose a potential risk to future commercial receptors, thus both should be managed through an LTEMP. The auditor concluded ERM adequately demonstrated that the residual LNAPL, as well as the dissolved phase hydrocarbon plumes do not pose an unacceptable human and ecological risk to the current and future on and off-site receptors. Further assessment of the natural attenuation of hydrocarbons plumes could be assessed via an LTEMP, incorporating a groundwater monitoring program.
Stage 1 RAP (ERM, 2020c)	The driver for remediation within the Stage 1 Area was the potential for indoor inhalation of vapours by future on-site commercial workers from hydrocarbon impacted soil and within the AEC-9.	The nominated remedial methodology was as follows: 1. Excavation and on-site bioremediation (biopiling). 2. Excavation and off-site disposal of soils (as a contingency measure). The estimated in-situ soil remediation volume was 4.172 m³, considering a maximum depth of excavation of 1.5 mbgl. Excavated material would be stockpiled in small piles adjacent to the excavation, prior to screening and loading into trucks to be transported to the biopile treatment area for classification and treatment (as required). Biopiling was to take place in a designated biopile treatment area, formerly known as Tank Farm A2. Oversize material would be crushed and mixed with validated soils for re-use on the project as backfill. Upon validation, excavations would be progressively backfilled with Virgin Excavated Natural Material (VENM) or other suitable material, with restoration of the surface to the local grade. The validation program presented the following program: – Excavation: 1 sample per 100 m² from floors of excavations and 1 sample per 10 linear metres of excavation walls. – Biopile re-use: Initial sampling will be undertaken to determine the requirement for biopiling for less impacted materials.	The auditor considered that the Stage 1 RAP was prepared in accordance with guidelines made or approved by NSW EPA under the <i>CLM Act 1997</i>. The Stage 1 RAP outlined a clear rationale for the selection and implementation of on-site biopiling as the preferred remedial technology to address the presence of the contaminated soils on-site and to remove the potential human health risk to render the Stage 1 Area suitable for the future commercial/industrial use. The auditor considered that the validation program was sufficient to meet the remediation objectives in the Stage 1 RAP. The auditor was satisfied that the Stage 1 RAP adequately demonstrates in detail all procedures and plans to be implemented to reduce risks to human health or environment, and establishes the environmental safeguards required to complete the remediation in an environmentally acceptable manner. The RSI, the HEERA, the other supportive reports, including but not limited to the Remedial Option Analysis (ROA), the Air Emission Validation Report (AEVR) and the Stage 1 RAP were discussed in the SAS No. 043/212799 issued on 22 June 2020.

Reports	Objectives/Scope of works	Key findings	Auditor discussion
Stage 1 Area Remediation and Validation (ERM, 2020d)	The remediation and validation program for the Stage 1 Area, was undertaken largely in accordance with the approved Stage 1 RAP and took place between 6 October and 3 December 2020. The main objective of the remediation was rendering the Stage 1 Area suitable for the proposed industrial use in accordance. As previously discussed in the HHERA an LTEMP was required to manage natural attenuation, control further exposure to aesthetic issues and provide protocol to unexpected findings.	The key aspects of the Stage 1 remediation and validation works included the following activities: – Remediation excavation: Excavation of an in-situ volume of 4,673 m³ of soil from AEC-9 aim to remove contaminated soil materials and LNAPL in shallow soils. The validation of the walls and base of the excavation was undertaken prior to backfilling with imported VENM. – Stockpiled material validation: Stockpiled material from the AEC-9 excavation was characterised for either on-site re-use or on-site soil treatment via biopiling undertaken on the adjacent Stage 2 Area. Excavated materials validated as suitable for re-use remain on the Stage 1 Area for use during future land-forming works. – Material importation and backfill: An estimated total of 12,022 tonnes of VENM was imported prior to backfill and compaction within the AEC-9 excavation.	Based on the long-term use of the site as a petroleum refinery, it was the auditor's opinion that the suite of analytes (and the area) selected to be remediated was appropriate. As concluded by the auditor in the SAR issued on February 2021 (SAS No. 055/2127799A) the remedial works and subsequent validation program were completed largely in accordance with the approved Stage 1 RAP. The auditor was satisfied with the level and detailed information presented in the Validation report prepared by ERM. It was the auditor's opinion that the Stage 1 Area was sufficiently remediated and the potential human health risks to commercial/industrial receptors were low and acceptable, with the application of approved passive LTEMP necessary to manage the residual aesthetic impacts and unexpected findings within Stage 1 Area. Therefore, the auditor also concluded that the Consent Condition B7 were appropriately met, as discussed in the SAR/SAS No. 055-2127799A issued in February 2021.

5. Groundwater characterisation

5.1 Chemicals of concern

The chemicals of concern that were listed in the GWMP included:

- benzene, toluene, ethylbenzene, xylene and naphthalene (BTEXN) and total recoverable hydrocarbons (TRH) C6-C40.

5.2 Groundwater criteria

An ongoing groundwater monitoring program was implemented as part of the LTEMP for Stage 1. ERM stated in the ongoing groundwater monitoring reports that the adopted assessment criteria had been sourced from guidelines made or approved under the *CLM Act 1997*, including the ASC NEPM. Where alternative sources had been utilised, appropriate justification has been provided.

ERM noted that SSTLs were developed based on a targeted analytical approach and Tier 2 Assessment of the dataset, as part of HHERA completed by ERM in 2020. The HHERA was assessed by auditor, as part of the site audit completed in June 2020 (SAS No. 043-2127799).

A summary of the key findings of the HHERA, and the auditor's commentary are presented in **Section 4**. A copy of the SSTLs is presented in **Appendix C**.

ERM adopted groundwater investigation criteria to assess the potential risks to on-site receptors (commercial, construction and intrusive maintenance workers) and off-site receptors (human health and ecological). These criteria are summarised in the following sections.

5.2.1 On-site receptors

The criteria to assess exposure to on-site receptors were adopted from the HHERA. The key exposure pathway was vapour intrusion. The following SSTLs were developed to assess potential human health risks via inhalation of vapours from groundwater:

- Groundwater SSTLs for future commercial workers in indoor air environments;
- Groundwater SSTLs for construction workers conducting intrusive works; and
- Construction intrusive maintenance workers conducting intrusive works.

The following information was noted by ERM in the ongoing groundwater monitoring event reports:

- Human health SSTLs assumed no future beneficial groundwater use; and
- Ecological receptors were not considered due to the current and proposed future land-use zoning (heavy industrial).

5.2.2 Off-site receptors

Groundwater risks to off-site, ecological and human receptors were compared to Tier 1 assessment criteria. Ecological receptors, namely the Duck River, were assessed using the following criteria:

- ANZG (2018). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality – Toxicant Default Guideline Values* (Marine Water - 95% Species Protection); and
- NEPC 2013. *Marine Groundwater Investigation Levels* (the GILs).

Off-site human receptors including recreational users of the Duck River and Upper Parramatta River were assessed using the following criteria:

- NHMRC (2008). *Guidelines for Managing Risks in Recreational Waters, Commonwealth of Australia*, Canberra.

5.3 Auditor discussion – Groundwater assessment criteria

The auditor considered that the groundwater criteria adopted by ERM allowed an appropriate assessment of risks to the on-site receptors of Stage 1 and off-site human and ecological receptors to be made.

Given the nature of the land use of Stage 1 Area (industrial) that will be largely covered in hardstand surface, ERM did not consider there to be potential exposure risks to on-site ecological receptors. The auditor agreed with this evaluation.

The auditor considered that the groundwater monitoring reports nominated appropriate target levels based on Schedule B1 and B7 of the ASC NEPM and considered the land use scenarios/activities during and after remediation.

6. Data quality objectives

ERM documented in the Q4 2020 GME and the Ongoing GME 2 reports that the Data Quality Objectives (DQOs) for the groundwater monitoring program had been developed as per recommendations in the ASC NEPM. A summary of the DQOs presented by ERM in the Q4 2020 GME and Ongoing GME 2 reports is presented in **Table 6**.

Table 6 Data quality objectives

Step	Description	Outcomes for Q4 2020 GME and Ongoing GME 2
1	State the problem	ERM stated that the objective for the ongoing groundwater monitoring events was to collect groundwater data in accordance with the approved GWMP to meet the Consent Condition B22 listed in SSD No. 9302. ERM stated that the groundwater monitoring plan presented in the GWMP was required to: – Present trigger levels for assessing potential adverse impacts to the Duck River, caused by the remediation, including triggers for indicating if further remediation of groundwater is required. – Outline contingency actions to be implemented if monitoring indicates that natural attenuation is not occurring, or groundwater is having an adverse impact on the Duck River. – Monitor the effectiveness of management measures and contingency actions for reducing impacts. – Document procedures for reporting changes to groundwater conditions that have the potential to create unacceptable risks to the Duck River.
2	Identify the decisions	ERM stated that the data to be collected in the ongoing groundwater monitoring events were required to make decisions to demonstrate that: – Mitigation measures for protection of groundwater during remediation are effective in preventing adverse effects to groundwater. – Concentrations of CoPC continue to not represent a risk to human health or ecological receptors. – Concentrations of CoPC continue to not represent unacceptable risks to sensitive receptors following remediation. – Ongoing management of groundwater via natural attenuation remains an appropriate long-term strategy, such that contingency measures, including groundwater remediation are not more required.
3	Identify the information inputs	ERM stated that the inputs to make the above decisions included: – Appropriate groundwater gauging data including water levels and thickness of LNAPL (if identified). – Appropriate groundwater analytical data (including obtaining data from appropriate monitoring wells and appropriate analysis). – Concentration trend analysis (Mann-Kendall) for relevant CoPC. – Analytical results assessed against the adopted assessment criteria (discussed in Section 5 of this SAR). – Establishment of a monitoring and assessment schedule as per the approved GWMP. – Information, comments or advice provided by the relevant stakeholders, including Viva Energy, the Site Auditor, and the Planning Secretary.
4	Defining the study boundaries	ERM stated that the site boundary is the Stage 1 Area as shown on Figure F2 in Appendix A. The vertical extent of groundwater monitoring is the shallow water bearing unit. The temporal limits include the period in which remediation works were undertaken, and biannual ongoing sampling events completed post-remediation.
5	Develop a decision rule	ERM developed the following decision rules:

Step	Description	Outcomes for Q4 2020 GME and Ongoing GME 2
		– Biannual groundwater monitoring events of target monitoring wells as per the GWMP for the Stage 1 Area CoPC (discussed in Section 5.1). Following completion of two rounds of groundwater data collection, the analytical program should be reviewed. – Monitoring of representative wells surrounding areas where source removal has been undertaken. – Groundwater quality during and following remediation should be evaluated via comparison of groundwater analytical data with the relevant assessment criteria to assess potential for ongoing risk to receptors. In addition, the occurrence of visible or measurable LNAPL in wells where not previously identified would trigger the implementation of contingency actions as per the GWMP. – Demonstration of continued natural attenuation and stability of dissolved phase groundwater impacts is occurring over time will include evaluation of primary and secondary lines of evidence presented within CRC Care Technical Report 15. – Statistical Trend Analysis (Mann Kendall) should be utilised to evaluate spatial and temporal trends of CoPC concentrations over time. – Collection of natural attenuation indicators at selected up gradient, plume centre and plume edge locations will enable a secondary line of evidence of the occurrence of natural attenuation. – In order to assess the reduction or cessation of groundwater monitoring program, concentrations within individual wells (or based on flux assessment) must be compliant with assessment criteria at the boundary with the Duck River and not exceed SSTLs. If rebound is recorded during post-remediation monitoring rounds, it may be necessary to extend the duration of post-remediation monitoring.
6	Specify limits on decision errors	ERM stated that the acceptable limits on decision errors applied during the review of the results were to be based on the DQIs of precision, accuracy, representativeness, comparability and completeness in accordance with the ASC NEPM.
7	Optimisation of the design for obtaining data	The following was reported by ERM regarding the optimisation of design to obtain data: – <i>Review of the data set and concentration trends, and consideration of the appropriateness of the monitoring schedule will be undertaken annually. Revisions to the monitoring schedule (if required) should be made on the basis of the interpretation of the results. Outliers should be identified, and contingency measures implemented if needed.</i>

6.1 Auditor discussion – Data quality objectives

The auditor considered that the DQOs presented by ERM in the Q4 2020 GME and Ongoing GME 2 reports were appropriate for the purposes of collecting data of acceptable quality to assess groundwater quality during and following remedial works, and to evaluate whether natural attenuation of groundwater contamination is occurring.

It is the auditor's opinion that the DQOs prepared by ERM took into consideration the objectives of the GWMP that was prepared to meet the Condition of Consent B22 for SSD N° 9302.

7. Consent Condition B22 - Groundwater monitoring events

The Q4 2020 GME and the subsequent Ongoing GME 2 report, developed to meet the requirements of Consent Condition B22, included the following scope of work related to groundwater assessment:

- Gauging and sampling of three groundwater monitoring wells, MW11/24, MW12/17 and MW18/06, located near the remedial excavation (AEC-9 in Stage 1) and two wells, MW11/41 and MW11/42, located down-gradient of the remediated area;
- Groundwater sampling using HydraSleeve™ no-purge samplers and measurement of field parameters, comprising dissolved oxygen (DO), electrical conductivity (EC), redox potential (Eh), temperature (T) and pH; and
- Analysis of groundwater samples for BTEXN, TRH (before and following silica gel clean-up) and natural attenuation parameters (ferrous Iron - Fe²⁺, methane, nitrate (as N) and sulfate).

The locations of the five groundwater monitoring wells are presented on Figure F2 in **Appendix A**.

7.1 Q4 2020 GME report

ERM reported that the objectives of the Q4 2020 GME were to:

- Meet the requirements of the GWMP and Consent Condition B22 of SSD N° 9302; and
- Present groundwater monitoring data collected during and after (ongoing) remedial works and assess whether remediation works had short-term adverse effects of groundwater quality or on the Duck River.

A summary of the tasks required under the GWMP, followed by the auditor discussion is presented in **Table 7**. The analytical results are presented in **Appendix C**.

Table 7 Summary of Q4 2020 GME and auditor discussion

Monitoring Area	Rationale	Frequency	Data Collected	Key Results	Auditor Discussion
Excavation areas (MW11/24, MW12/17 and MW18/06)	Assess changes in dissolved phase of CoPC from remediation. Assess potential ASS issues associated with the remediation.	Baseline sampling prior to commencement of remedial works. Within three months following completion of remedial works.	Groundwater samples for laboratory analysis of CoPC. Groundwater samples for analysis of field parameters, including pH.	Groundwater monitoring sampling events were undertaken on 06/10/20 (baseline) and 03/12/20 (post-remediation). <u>CoPC analytical results</u> BTEXN concentrations in groundwater were below limit of reporting (LOR) in both sampling events. MW11/24 –TRH C₁₀-C₃₆ concentrations post-silica gel clean-up analysis were observed in October 2020. However, TRH results post-silica gel analysis were below LOR in December 2020. MW12/17 and MW18/06 – TRH C₁₀-C₃₆ concentrations post-silica gel clean-up analysis were below LOR in both sampling events. Since Q2 2018 GME silica gel clean-up analysis of groundwater samples has indicated that reported concentrations of TRH comprise mostly polar (non-petroleum hydrocarbon) by-products generated by the biodegradation of hydrocarbons via microbial activity. <u>pH measurements</u> The historical pH measurements and the post-remediation ranged as follows, respectively: MW18/06: 4.9 and 5.06 MW11/24: 5.03 and 4.50 MW12/17: 6.98 and 7.23	Based on the data collected by ERM during the remedial works, the auditor considered the following: The remediation within the Stage 1 Area had not caused any immediate changes in the groundwater quality conditions around the excavation area, such as mobilisation of residual LNAPL trapped in soils or increase of dissolved phase CoPC – as BTEXN results remained below LOR, a trend consistent with the past eight years of historical data and LNAPL was not observed during the groundwater monitoring. The post-silica gel TRH concentration that was recorded in October 2020 in groundwater collected from MW11/24 was not detected in December 2020. Likewise, TRH was not identified in post-silica gel analysis in groundwater collected from any other well in December 2020. Potential ASS associated with the remediation (excavations) was not observed based on field measurements, as expected. The auditor noted that the assessment of ASS in the Stage 1 Area was recommended as a precaution, as the presence of ASS was considered very unlikely based on historical data and desktop survey.
Excavation areas (MW11/24, MW12/17 and MW18/06)	Monitor potential alteration to groundwater levels/flow regime. Monitor potential for LNAPL mobilisation.	Weekly during excavation.	Gauging data (SWLs and LNAPL)	Gauging events were completed in 30/09/20 (Baseline), 13/10/20, 20/10/20, 29/10/20, 05/11/20, 12/11/20, 17/11/20 (Remediation) and 01/12/20 (Pos-remediation). Groundwater fluctuations recorded between the baseline and post-remediation events were: 0.31 m in MW11/24, 0.15 m in MW12/17 and 0.57 m in MW18/06. LNAPL was not observed in any well during the weekly monitoring events.	Based on the weekly gauging data the auditor considered the following: There was no mobilisation due to remediation of residual LNAPL trapped in soil pores within the capillary fringe to groundwater, as LNAPL was not observed in any of the three monitoring wells during the seven-week monitoring period. Groundwater levels were not affected by the remediation. The maximum increase of 0.57 m in groundwater levels was likely associated with the heavy rainfall period that occurred in October 2020.
Down-gradient boundary (MW11/41 and MW11/42)	Assess whether groundwater at the boundary of the site is not adversely impacted by remediation or causing environmental harm to the Duck River. Monitor potential for LNAPL mobilisation from remediation works.	Monthly during remediation.	Gauging data (SWLs and LNAPL) Groundwater samples for analysis of field parameters, including pH.	A gauging event was completed in December 2020 (post-remediation). The groundwater level at MW11/42 was 1.56 mBTOC while MW11/42 was dry. pH measurement in sample collected in December 2020 at MW11/42 was 5.03, which is in range with observed in samples collected near the remediated area.	The auditor noted that October and November groundwater monitoring was not included in the Q4 2020 GME report. However, the auditor considered that this deviation from the GWMP did not affect the required assessment of the potential effects caused by the remediation to Duck River, based on the following lines of evidence: – The remediation was completed in six weeks. During the preparation of the GWMP a longer time for the completion of the remedial works was contemplated. – Groundwater level gauging conducted during the six-week period of remediation showed that the remediation did not have any effect on the hydraulic conditions in the vicinity of the excavation area. Therefore, considering the low hydraulic gradient of the site and the local geology little if any changes were expected to the hydraulic conditions in wells within the southern boundaries of Stage 1 Area. – LNAPL was not observed in the gauging events in any of the three monitoring wells within the excavation area. The auditor considered that sufficient QA/QC was presented in the Ongoing GME 2. The data collected in March 2021 was consistent with the eight years historical data. Details about QA/QC evaluation were presented during the review of the Q4 2020 GME. Based on the data obtained in the three wells around the excavation area in December 2020 and from the down gradient well MW11/41 the auditor considers the following: – Groundwater down gradient of the excavated area was not impacted by remediation works or causing environmental harm to the Duck River. – Residual LNAPL trapped in the pores soil within the capillary fringe was not mobilised given the remediation works.

7.2 Ongoing GME 2 annual report

ERM reported that the objectives of the Ongoing GME 2 report were to:

- Comply with the requirements of the GWMP and development consent; and
- Meet GWMP requirement for post-remediation groundwater monitoring to demonstrate remedial works undertaken for Stage 1 have not had short-term adverse effects on localised groundwater quality or the Duck River and document contingency actions (if required).

A summary of the requirements under the GWMP, followed by auditor commentary is presented in **Table 8**. The analytical results are presented in **Appendix C**.

Table 8 Summary of Ongoing GME 2 results and auditor discussion

Monitoring Area	Rationale	Frequency	Data Collected	Key Results / Recommendation	Auditor Discussion
Excavation Areas (MW11/24, MW12/17 and MW18/06)	- Demonstrate that stable to decreasing groundwater concentrations continue to be observed as a result of natural attenuation processes and removal of key source areas; and - Monitor potential for alteration to groundwater levels/flow regime or LNAPL mobilisation.	- Biannually following completion of post remediation sampling event; and - Requirement for ongoing sampling is to be reviewed annually (i.e. every two GMEs) based on trend analysis and reported concentrations.	- Groundwater samples for laboratory analysis of CoPC, MNA parameters collection of field parameters; and - Gauging data (SWLs and LNAPL).	Groundwater monitoring was completed in March 2021. The following results were observed: – Groundwater ranged from 2.050 mAHD (MW11/42, located at the southern boundary of Stage 1) to 3.150 mAHD (MW12/17, located in the northern portion of the Stage 1 Area). BTEXN concentrations in groundwater were below LOR in both sampling events; – LNAPL was not observed in any of the five well during the ongoing monitoring events; and – TRH concentrations post-silica gel clean-up analysis were below LOR, in accordance with the historical results. Stable concentrations (mostly below LOR) of BTEXN have been observed in monitoring events conducted in the WARP since 2012. The data collected in March 2021 were consistent with groundwater monitoring events undertaken in the five subject wells in recent years. Potential for adverse changes in groundwater conditions are low given the removal of primary sources from the Stage 1. ERM considered that since concentrations of CoPC were mostly below the laboratory LOR, and no potential risks were identified to both on- and off-site receptors (human and ecological) from groundwater, the continuation of monitoring to demonstrate the ongoing occurrence of natural attenuation processes is not considered to be of any material environmental benefit. The updated CSM indicated that the only potentially complete Source-Pathway Receptor (SPR) linkage for the Stage 1 Area following completion of remediation activities is “<i>Release of residual sludge/ LNAPL to soil and/or groundwater during excavation of pipework or drainage infrastructure</i>”. However, this potentially complete SPR linkage is already managed by the LTEMP (i.e. controls and procedures will be administered by the landowner to mitigate potential for future releases should demolition of this infrastructure be undertaken in the future).	The auditor noted that as per the GWMP, groundwater sampling was to be conducted six months following the post remediation groundwater sampling event. However, the ongoing sampling event was completed only three months later. The auditor, considered that this departure from the GWMP did not affect ERM's conclusions and recommendation based on the following lines of evidence: – The primary source of hydrocarbon contamination was removed as part of the Stage 1 Area remedial works. The Human Health and Ecological Risk Assessment (HHERA) had earlier identified that groundwater impacts do not pose any potential risks to both on- and off-site receptors (ecological and human). Therefore, remediation of the groundwater was not deemed necessary; – The data collected during and following completion of remediation to meet the Condition Consent B22 indicated that the hydraulic conditions of the Stage 1 Area were not affected by remedial works; – The GWSDAT trend plots indicated that groundwater level fluctuations monitored since 2012 do not influence groundwater quality, as shown in Figure 4 (extracted from Ongoing GME 2 report); and – The residual LNAPL trapped within the soil pores in the capillary fringe as well as the dissolved phase CoPC were not mobilised as a consequence of the remedial activities. BTEXN concentrations in groundwater samples collected from the five monitoring wells included in the GWMP were less than the LOR before, during and after completion of remediation within Stage 1 Area. Reported concentrations of TRH fractions post silica gel clean-up analysis were below the laboratory LOR. The percent difference from TRH after silica gel clean-up analysis reported a decrease ranging between 58 % to 98 %, with an average of 89 %. The percentages of polar compounds removed through the silica gel clean-up analysis, supported the assertion that biodegradation of hydrocarbons has been occurring. Groundwater quality has been monitored within the Stage 1 Area since 2012. As concluded in the HHERA groundwater impacts do not pose unacceptable risks to future on- and off-site ecological or human receptors, considering that groundwater is not abstracted for any purposes. This scenario was confirmed with the results of Q4 2020 GME and Ongoing GME. The auditor considered that sufficient QA/QC was presented in the Ongoing GME 2. The data collected in March 2021 was consistent with the eight sets of historical data. Details about QA/QC evaluation will be discussed during the review of the Ongoing GME 2. The CSM was reviewed in the light of the data obtained during and after completion of the remediation works within the Stage 1 Area. The auditor concurred with ERM's opinion that the potential human and health risks to both on and off-site receptor were low and acceptable with the implementation of the endorsed LTEMP.
Down-gradient boundary (MW11/41 and MW11/42)	- Assess whether groundwater at the boundary of the site is not adversely impacted by remediation works or causing environmental harm to the Duck River; and - Monitor potential for LNAPL mobilisation from remediation works.	- Biannually (every six months) following completion of post remediation sampling event; and - Requirement for ongoing sampling is to be reviewed annually (i.e. every two GMEs) based on trend analysis and reported concentrations.	- Groundwater samples for laboratory analysis of CoPC, MNA parameters collection of field parameters; and - Gauging data (SWLs and LNAPL).		

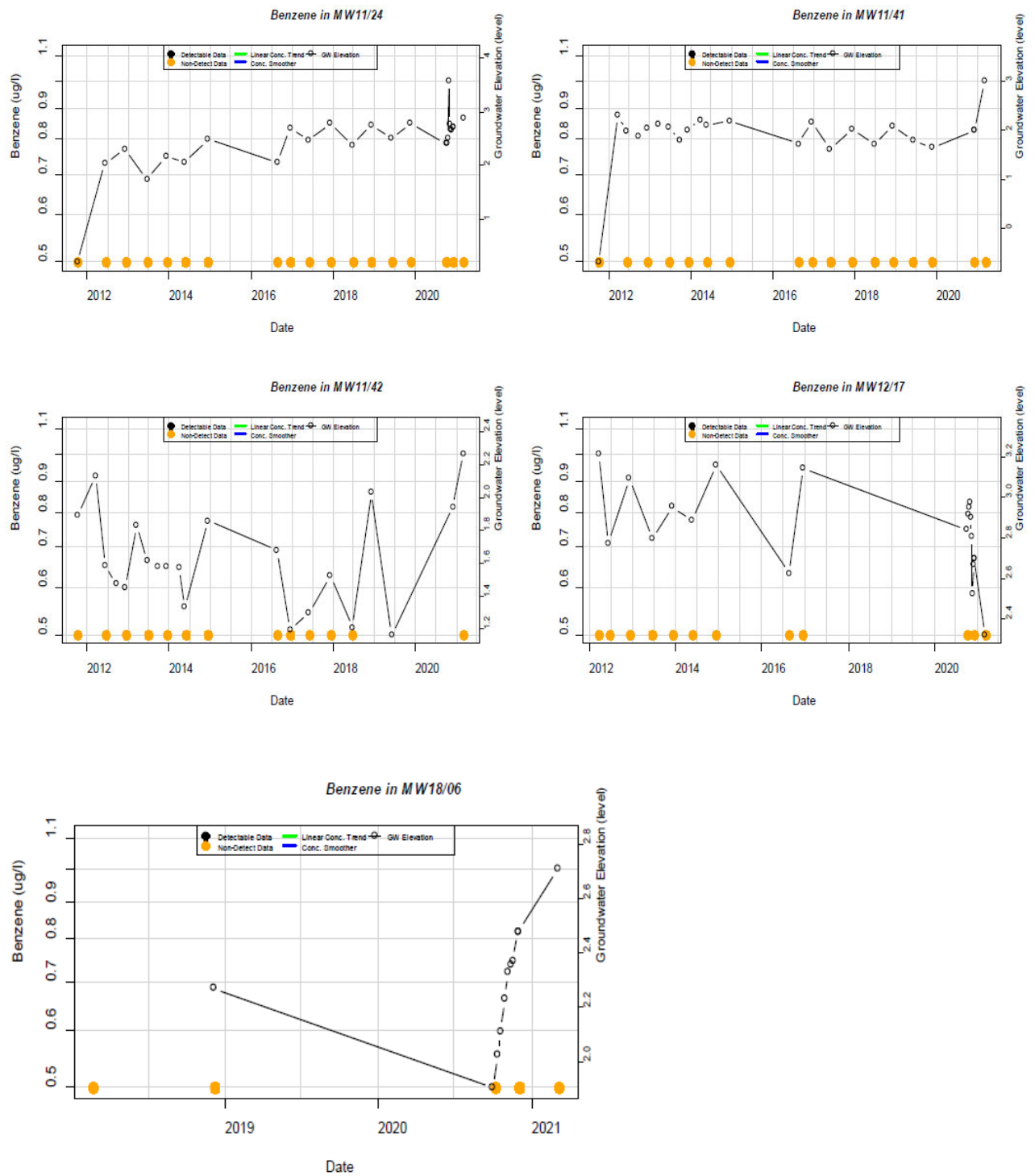


Figure 4 Groundwater level fluctuation and benzene trends

8. Evaluation of quality assurance and quality control

This section of the SAR provides an evaluation of the QA/QC procedures relevant to the Ongoing GME 2 report prepared by ERM with reference to the ASC NEPM and relevant NSW EPA guidelines. The auditor had made comments on ERM's QA/QC procedures in the Q4 2020 GME report which were taken into consideration in the Ongoing GME 2 and Annual Summary Report.

The field and laboratory QA/QC measures presented by ERM in the Ongoing GME 2 report have been compared to the requirements presented in the NSW EPA *Consultant Guidelines* to gauge the integrity of the data.

A copy of the auditor's assessment of QA/QC measures presented by ERM is provided within **Appendix D** of this SAR.

8.1 Auditor discussion – Data quality evaluation

The auditor considered that an adequate level of QA/QC has been adopted by ERM in the Ongoing GME 2 program (and by extension the Q4 2020 GME). Sampling locations and methodologies were appropriate and consistent with protocols listed in the GWMP.

No inter- and intra-laboratory duplicate samples, trip spike, trip blank or rinsate blanks were collected as part of the Ongoing GME 2 for Stage 1. Although this did not conform to the GWMP, the auditor considered that this did not affect the outcome of the GMEs and the resulting conclusions as:

- analytical results were consistent with previous sampling rounds and generally less than the laboratory LOR;
- field observations did not record the presence of odours or sheens;
- appropriate sampling and sample management methods were used and were consistent with those used in previous rounds; and
- the absence of volatile contaminants in groundwater samples.

The analyses of all groundwater samples had been conducted by laboratories certified by the NATA for the selected CoPC.

The auditor considers that the data presented in the Ongoing GME 2 and Annual Summary Report were sufficiently precise, accurate, representative, complete and comparable for the audit.

The auditor is of the opinion that the overall quality of data and their presentation were of an adequate standard to support ERM's conclusions.

9. Post remediation conceptual site model

Following completion of the groundwater monitoring events, ERM prepared a post remediation conceptual site model (CSM). The key components of a CSM (as defined in the NEPM) and the outcome by ERM of the assessment of the interactions between each are presented in the following sections.

9.1 Potential residual sources of impacts

The Ongoing GME 2 report stated that following completion of remedial works, the following potential residual ongoing sources of contamination could affect groundwater quality within the Stage 1 Area were:

- Residual soil impacts related to hydrocarbons that exceed management limits; and
- Residual hydrocarbon sludge remaining within the decommissioned drainage pipes/pits.

9.2 Receptors

The receptors that may be exposed to the identified residual sources of contamination included:

- Human receptors:
 - future on-site, short-term construction workers and intrusive workers;
 - future workers undertaking intrusive maintenance activities on-site; and
 - future on-site commercial / industrial workers.
- Ecological receptors:
 - Ecosystems associated with the Duck River, bordering the Stage 1 Area to the south, and the Parramatta River, into which the Duck River discharges to the north-east.

ERM noted that Duck and Parramatta Rivers are considered slightly to moderately disturbed marine ecosystems based on ANZG (2018) guidelines.

9.3 Risk characterisation

The Ongoing GME 2 report identified the following potentially complete Source-Pathway-Receptor (SPR) linkages relevant to the Stage 1 Area following completion of remedial and validation works.

- *Release of residual sludge or LNAPL to soil and/or groundwater during excavation of pipework or drainage infrastructure.*

The location and condition of sub-grade infrastructure, including the presence of residual sludges within the decommissioned and decontaminated (to the extent practical) drainage network has been highlighted in an updated LTEMP (**Section 11**). Controls and procedures will be administered by the landowner to mitigate potential for releases should demolition of this infrastructure be necessary.

On the basis that management of the pipework and infrastructure is implemented through future administrative controls in the updated LTEMP and that there had been no demonstrable impact to groundwater that could affect the identified receptors, the aforementioned potential source-pathway-receptor (SPR) linkages are considered incomplete.

The following notes were presented in the Ongoing GME 2 report:

- *Groundwater users (potable or non-potable) were not considered a potential receptor given the absence of registered extraction bores down gradient of the Stage 1 Area, poor background quality of groundwater and likely low yields.*
- *No on-site ecological receptors have been identified.*
- *Any development of the site is likely to comprise slab on grade commercial / industrial land use, resulting in the removal of any areas where ecological communities could establish.*

9.4 Auditor discussion – Post remediation conceptual site model

The auditor considered that the updated CSM developed by ERM for the Stage 1 Area post-remediation had appropriately evaluated whether the residual sources of hydrocarbons and receptors may be connected.

The auditor considers that the CSM developed by ERM was prepared as per the ASC NEPM (NEPC, 2013) method and contained many of the elements required in the *Consultant checklist* (NSW EPA, 2020).

The auditor noted that the key exposure routes to residual contamination would only occur if there were disturbance of the areas where the sub surface infrastructure is located. The locations and management of these areas are outlined in the updated LTEMP that is discussed further in **Section 11**.

10. Other considerations

10.1 Ecological considerations

The Stage 1 area has been remedied and is currently under development for industrial land use. Therefore, it is expected that given the nature of the development, the majority of the area will be covered by a hard surface. Therefore, plausible ecosystems within the Stage 1 Area are very unlikely.

ERM stated in the HHERA that off-site migration of LNAPL or dissolved phase petroleum hydrocarbons was not occurring at levels that could potentially cause risk to the identified environmental/ecological receptors, principally Duck River. In addition, previous groundwater monitoring data – that were assessed as part of the SAR/SAS issued by the auditor in February 2021 (SAS N° 055-2127799A) – along with the Q4 GME and Ongoing GME 2 data have presented information demonstrating that CoPC did not exceed relevant investigation levels in groundwater samples collected downgradient of the Stage 1 Area.

10.2 Aesthetic impacts

Following remediation and the soil validation program, the only identified aesthetic impacts were those associated with residual petroleum hydrocarbons in shallow soil within Stage 1 Area. The management/mitigation actions for these soils are detailed in the updated LTEMP discussed in **Section 11**.

A copy of the updated LTEMP is included in **Appendix E**. The auditor notes that the materials that have TRH concentrations in excess of the management limits are not at the surface and would only create a nuisance odour if disturbed.

10.3 Chemical mixtures

The ongoing groundwater monitoring reports did not specifically examine potential additive or synergistic effects of chemical mixtures. However, given the CoPC are principally petroleum hydrocarbons and the majority of the recorded concentrations were less than limit of reporting (LOR), impacts of chemical mixtures were very unlikely.

10.4 Auditor discussion – Other considerations

The auditor noted that the site was a process area associated with the petroleum refinery and had mostly been covered in hardstand. Additionally, the primary sources of contamination within the Stage 1 Area that could present a human health risk were removed as part of the remedial works. Furthermore, future land use of the Stage 1 will be commercial/industrial which will entail covering the site with hardstand.

The auditor noted that ERM reported in the GMEs that groundwater concentrations of CoPC were largely less than adopted trigger levels for ecological receptors at delineation wells down gradient of the Stage 1 Area. These results mirrored those of previous monitoring events. As such, the auditor agreed there is no complete SPR linkage between identified groundwater impacts on-site and off-site ecological receptors.

The auditor noted that following completion of remedial works, LNAPL in soils or groundwater is unlikely to be encountered during routine use of the Stage 1 Area. On-site intrusive maintenance works would need to be managed under the updated LTEMP (discussed in **Section 11**) and relevant workplace health and safety procedures. Odours may be encountered in some areas of the site if excavations are undertaken, but air quality monitoring conducted during the remedial works has shown there is little or any volatiles generated when disturbing the hydrocarbon affected materials.

Although not specifically discussed in the Stage 1 Validation and Ongoing GME 2 reports, potential chemical mixtures were not relevant in relation to human health risks as these were assessed as part of the HHERA used to inform the scope of the remedial works.

11. Updated long-term environmental management plan

Following the completion of the Q4 2020 GME and the Ongoing GME 2 sampling program, ERM concluded that ongoing groundwater monitoring as per the GWMP was no longer required, as discussed in **Section 7**.

Accordingly, the LTEMP issued as part of SAS(055-2127799A) was updated by omitting the need to conduct groundwater monitoring. Management of shallow hydrocarbon affected soils for aesthetic reasons is the key aspect of the updated LTEMP – included in **Appendix E**.

11.1 Purpose of updated LTEMP

The key aspects of the updated LTEMP included:

- Summary background environmental information conditions at the site, and provide a mechanism to inform the site owner/manager, workers and site users of the presence of the residual hydrocarbon contamination;
- Outline of methods and procedures that will avoid and / or mitigate adverse effects on human health and / or the environment;
- Provision of a methodology for the appropriate environmental management of excavation works that may encounter residual hydrocarbon contaminated soil;
- Provision of environmental requirements for the sourcing and placement of backfill material;
- Discussion of safety measures / considerations for dealing with potentially contaminated soil; and
- Outline of restrictions to potential future land uses.

11.2 Nature of the residual contamination

Following completion of remedial works within the Stage 1 Area, the following residual contamination may be present:

- Oily water / sludge associated with former underground drainage infrastructure;
- Asbestos associated with former underground building structures; and
- Hydrocarbon impacted soils.

The location and extent of residual contamination within the Stage 1 Area is illustrated on **Appendix A** (Figures F2 and F3).

11.3 LTEMP enforceability

All site management requirements are legally enforceable via condition B10(a) and (b) of the Development Consent (State Significant Development 9302), as issued under Section 4.38 of the Environmental Planning and Assessment Act 1979 (the 'EP&A Act'), as outlined below:

- *B10. Upon completion of the Site Audit Statement and Site Audit Report, the Applicant must: (a) Implement the approved LTEMP (b) Provide evidence to the Planning Secretary that the LTEMP is listed on the relevant planning certificate for the land, issued under section 10.7 of the EP&A Act.*

11.4 LTEMP public notification

As required by condition B10 (b) of the Development Consent, Parramatta Council will be requested to add a notation to the planning certificate for the Stage 1 Area under section 10.7(5) of the EP&A Act that the property is subject to the updated LTEMP.

11.5 Actions required under LTEMP

Based on the nature and extent of residual contamination identified within the Stage 1 Area the following management controls are required:

- Non-Intrusive works – No management controls are required;
- Intrusive Excavation Works – Implementation of environmental management controls as detailed in **Appendix E**.

11.6 Auditor discussion – Updated LTEMP

The revised Stage 1 LTEMP has been reviewed by the auditor who concluded in SAS N° 065-2127799 (**Table 1**), that the LTEMP had been prepared in a manner consistent with relevant NSW EPA made or approved guidelines. The auditor accepted that the LTEMP appropriately identified the residual contamination and provided an adequate description of the objectives, scope of works, roles and responsibilities of parties involved in its implementation and management. A copy of the LTEMP prepared by ERM is presented in **Appendix E**.

The auditor noted that the LTEMP is legally enforceable through condition B10(a) of the Development Consent (State Significant Development 9302).

The LTEMP will be noted on the planning certificate under section 10.7(5) of the EP&A Act as required by condition B10(b) of the Development Consent, notifying of the restrictions applying to the land to ensure that potential purchasers or other interested individuals are aware of the restrictions.

Both the EPA and Council were consulted as per the requirements of SSD No. 9302.

12. Conclusions

12.1 Consultant's conclusions

The Validation report prepared following remedial works at Stage 1 stated:

Based on the outcomes of validation activities undertaken and detailed within this report, the Stage 1 Area is considered suitable for commercial/industrial land use, subject to implementation of a legally enforceable Long-Term Environmental Management Plan.

Site audit statement 055-2127799A (and accompanying audit report) was issued confirming the suitability of the site with an LTEMP that incorporated groundwater monitoring.

The following information was reported by ERM in its Ongoing GME 2 report:

No adverse changes to groundwater conditions or potential harm to offsite receptors were identified to have occurred since the Q4 2020 GME as follows:

- *The direction of groundwater flow is generally consistent with previous GMEs and flows to the southeast towards the bounding Duck River.*
- *LNAPL was not observed within the subject wells and no history of LNAPL is noted within the subject wells.*
- *No exceedances of risk based SSTLs were reported for on-site receptors, and this is consistent with the existing CSM.*
- *Evidence of stable groundwater conditions and natural attenuation processes continue to be identified as per previous monitoring events.*

Potential for future risks to receptors from groundwater in the Stage 1 Area are considered unlikely given the removal of primary sources from the site, established low permeability and transmissivity of groundwater and evidence of ongoing conditions favourable to natural attenuation over time.

All relevant conditions for State Significant Development 9302 (Condition B22) have been met through groundwater monitoring works undertaken.

Ongoing groundwater monitoring as per the GWMP within Stage 1 is no longer considered to be required on the basis that no current or future risks have been identified to receptors and the removal or ongoing management of primary sources has been completed. Other relevant conditions outlined within the Stage 1 Long Term Environmental Management Plan will remain in place.

Site audit 065-2127799 (and accompanying audit report) was issued confirming that sufficient information had been provided that demonstrated groundwater monitoring was no longer required in Stage 1.

12.2 Auditor's conclusion

The auditor considered that the Q4 2020 GME and the Ongoing GME 2 reports were prepared in a manner consistent with the guidelines outlined in **Section 1.7**. The concentrations of CoPC, including benzene and TRH fractions following silica gel clean-up analysis have not indicated any increasing concentrations due to remediation activities. The auditor noted that the concentrations of CoPC recorded in groundwater in the last two rounds of monitoring are similar to those recorded in previous GMEs.

ERM provided sufficient lines of evidence to demonstrate that trends of and/or CoPC concentrations in groundwater have been stable over the last eight years with a large proportion of CoPC being less than the LOR. These data support ERM's assertion that potential risks to on- and off-site human and ecological receptors are low and acceptable.

The auditor supports ERM's recommendation of cessation of groundwater monitoring in the Stage 1 Area. The auditor's opinion is based on the discussion presented in **Section 7** and the evaluation of the data in relation to the relevant conditions of consent in **Table 7** and **Table 8**. Consequently, this SAS and supporting Site Audit Report (SAR) supersedes the previous SAS 055-2127799A issued in February 2021.

A summary of the conditions of SSD No 9302 (that were incorporated in the GWMP) and the auditor's assessment of compliance and risk to human health and the environment based on the data collected during the recent monitoring programs is presented in **Table 9**.

Table 9 Conditions of SSD N° 9302 and auditor's assessment

SSD Condition	Definition	Auditor comments
B22(b)	Include a program to monitor groundwater levels and quality during remediation works and following demobilisation	Groundwater monitoring was conducted by ERM during and following remedial works. The monitoring showed that there was a rise in the groundwater levels, and this was attributed to rainfall events.
B22(d)	Detail ongoing monitoring following demobilisation, to verify that natural attenuation of groundwater contamination is occurring over time	Groundwater samples were collected from the five wells associated with Stage 1 remediation and were subsequently analysed for MNA parameters. While the presence of some MNA compounds were detected (e.g. sulfate), there was no consistent demonstration that MNA is occurring. The TRH analysis following silica gel clean up however has shown that biodegradation of the hydrocarbons is occurring. The lack of MNA activity does not have a bearing on risk to human health and/or the environment as none of the CoPC were recorded at concentrations greater than the nominated trigger levels.
B22(e)	Include trigger levels for investigating potential adverse impacts to the Duck River, including triggers for indicating if further remediation of groundwater is required	Appropriate trigger levels were nominated for the evaluation of data collected during the groundwater monitoring program. The majority of CoPC were less than the level of reporting and all recorded concentrations were less than the trigger levels listed in the GWMP.
B22 (f)	Outline contingency actions to be implemented if monitoring indicates that natural attenuation is not occurring, or groundwater is having an adverse impact on the Duck River	Although MNA has not been demonstrated to be influencing the hydrocarbon concentrations, the majority are less than LOR and all are less than the nominated trigger levels. The silica gel cleans up analysis has shown that biodegradation of the hydrocarbons is occurring. The data that has been collected as part of the GWMP program, coupled with the data collected over the past eight years has shown that there is no unacceptable risk of exposure to human and health and the environment.
B22(g)	Monitor the effectiveness of management measures and contingency actions for reducing impacts	Groundwater monitoring was conducted during and after remediation: around excavation areas and along the down gradient site boundary. The data has shown that remediation has not affected groundwater quality and the risk to human health and the environment is low and acceptable.
B22(h)	Procedures for reporting changes to groundwater conditions that have the potential to create unacceptable risks to the Duck River.	The auditor noted that the most recent concentrations of CoPC detected in groundwater as well as the absence of LNAPL have demonstrated there to be no unacceptable risks to on and off-site receptors, as previously discussed in the HHERA (ERM, 2020b).

The groundwater data collected before, during and after the Stage 1 remedial works as part of condition of consent 22, demonstrated there was no longer any need to monitor groundwater quality in the Stage 1 Area. Consequently, it is the auditor's opinion that the Stage 1 Area is suitable for its intended use as commercial/industrial land uses subject to compliance with the passive LTEMP prepared by ERM to manage the aesthetic residual petroleum issues present in shallow fill/soils. The LTEMP also provided instructions for management of potential unexpected finds such as asbestos.

13. Disclaimer

This Site Audit Report (SAR) and accompanying site Audit Statement (SAS) have been prepared in accordance with relevant provisions of the *Contaminated Land Management Act 1997*. This Report:

- Has been prepared by the auditor and his support team as indicated in the appropriate sections of this SAR (“GHD”) for Viva Energy.
- May be used and relied on by Viva Energy.
- May be used by and provided to the NSW EPA and the relevant planning authority for the purpose of meeting statutory obligations in accordance with the relevant sections of the.
- May be provided to other third parties but such third parties use of or reliance on the SAR is at their sole risk, as this SAR must not be relied on by any person other than those listed above without the prior written consent of GHD.
- May only be used for the purpose as stated in **Section 1.4** of the SAR (and must not be used for any other purpose).
- GHD and its servants, employees and officers (including the auditor) otherwise expressly disclaim responsibility to any person other than Viva Energy arising from or in connection with this SAR.
- To the maximum extent permitted by law, all implied warranties and conditions in relation to the services provided by GHD and the SAR are excluded unless they are expressly stated to apply in this Report.

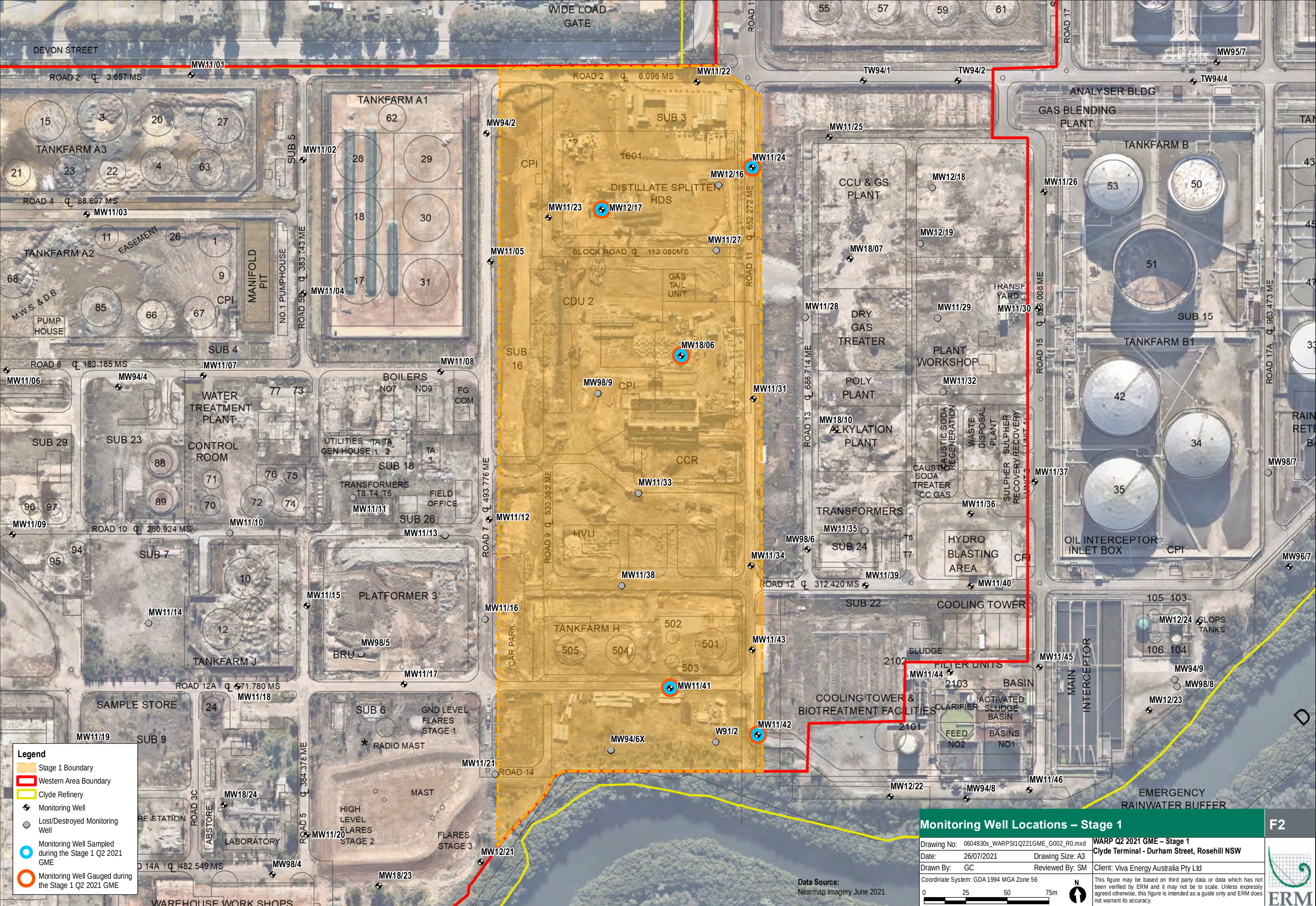
The services undertaken by the auditor, his team and GHD in connection with preparing this SAR:

- Were undertaken in accordance with current profession practice and by reference to relevant guidelines made or approved by the NSW EPA.
- The opinions, conclusions and any recommendations in this SAR are based on assumptions made by the auditor, his team and GHD when undertaking services and preparing the SAR (“Assumptions”), as specified throughout this SAR.
- GHD and the auditor expressly disclaim responsibility for any error in, or omission from, this SAR arising from or in connection with any of the Assumptions being incorrect.
- Subject to the paragraphs in this section of the SAR, the opinions, conclusions and any recommendations in this SAR are based on conditions encountered and information reviewed at the time of preparation of this SAR and are relevant until relevant legislations changes, at which time, GHD expressly disclaims responsibility for any error in, or omission from, this SAR arising from or in connection with those opinions, conclusions and any recommendations.
- The auditor and GHD have prepared this SAR on the basis of information provided by Viva Energy and others who provided information to GHD (including Government authorities), which the auditor and GHD have not independently verified or checked (“Unverified Information”) beyond the agreed scope of work.
- The auditor and GHD expressly disclaim responsibility in connection with the Unverified Information, including (but not limited to) errors in, or omissions from, the SAR, which were caused or contributed to by errors in, or omissions from, the Unverified Information.
- This SAR and SAS should be read in full, and no excerpts are taken to be representative of the findings of this SAR.
- The opinions, conclusions and any recommendations in this SAR are based on information obtained from, and testing (if undertaken as specified in this SAR) undertaken at or in connection with the Stage 1 Area.
- Although reasonable care has been used to assess the extent to which the data collected from site is representative of the overall site condition and its beneficial uses, investigations undertaken in respect of this SAR are constrained by the particular conditions as discussed in this SAR.
- Site conditions may change after the date of this SAR. The auditor and GHD expressly disclaim responsibility:
 1. Arising from, or in connection with, any change to the site conditions.
 2. To update this SAR if the site conditions change.
- These Disclaimers should be read in conjunction with the entire SAR and no excerpts are taken to be representative of the findings of this SAR.

Appendix A

Figures

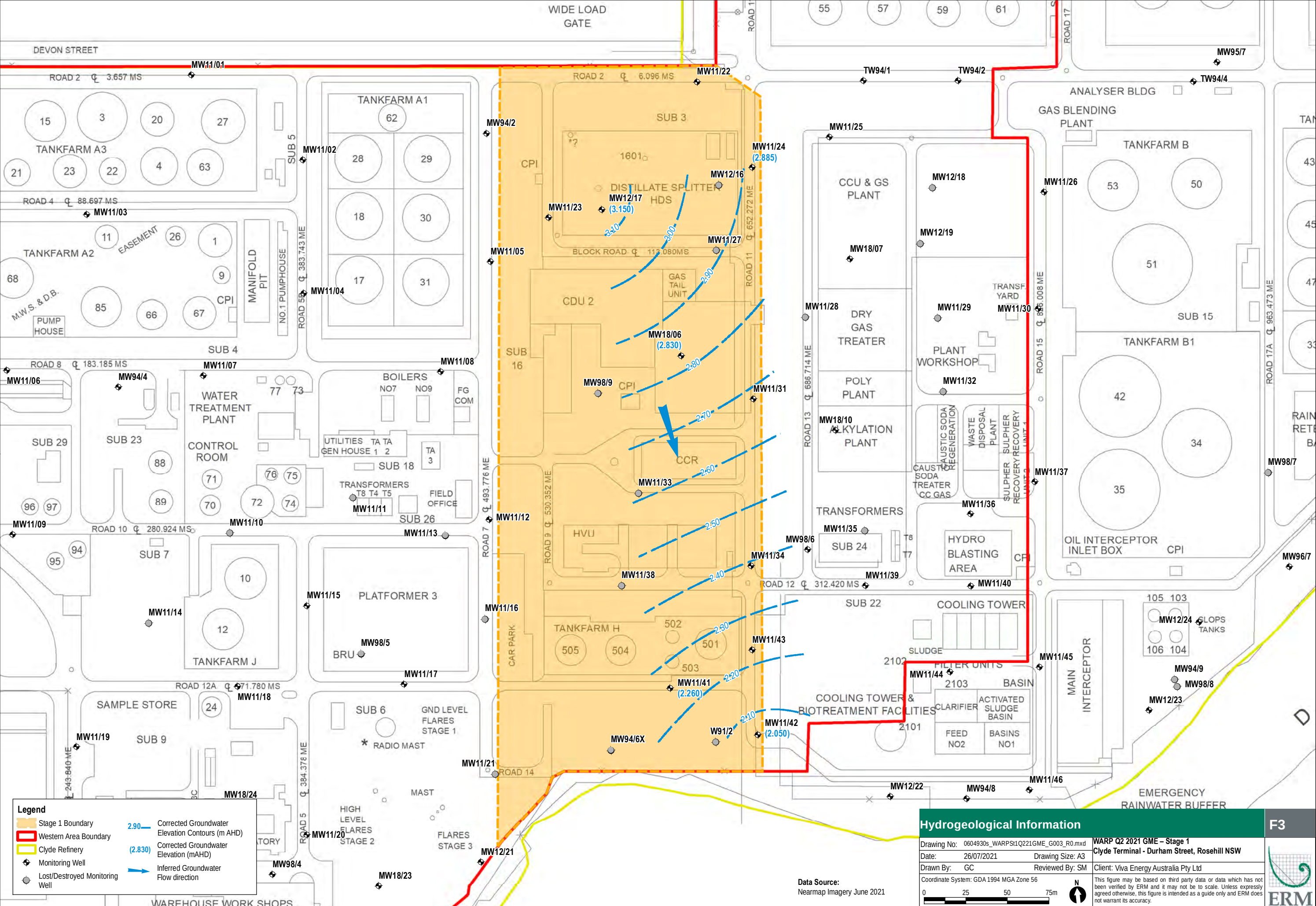
Figures - Ongoing GME 2



- Legend**
- Stage 1 Boundary
 - Western Area Boundary
 - Clyde Refinery
 - Monitoring Well
 - Lost/Destroyed Monitoring Well
 - Monitoring Well Sampled during the Stage 1 Q2 2021 GME
 - Monitoring Well Gauged during the Stage 1 Q2 2021 GME

Monitoring Well Locations – Stage 1

Drawing No: 0604930s_WARPS1Q221GME_G002_R0.mxd	WARP Q2 2021 GME – Stage 1	F2
Date: 26/07/2021	Clyde Terminal - Durham Street, Rosehill NSW	
Drawn By: GC	Reviewed By: SM	
Coordinate System: GDA1994 MGA Zone 56	Client: Viva Energy Australia Pty Ltd	
0 25 50 75m	This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.	ERM



Legend

Stage 1 Boundary

Western Area Boundary

Clyde Refinery

Monitoring Well

Lost/Destroyed Monitoring Well

2.90

(2.830)

Inferred Groundwater Flow direction

Hydrogeological Information

F3

Drawing No: 0604930s_WARPS1Q221GME_G003_R0.mxd

Date: 26/07/2021

Drawn By: GC

Coordinate System: GDA1994 MGA Zone 56

Drawing Size: A3

Reviewed By: SM

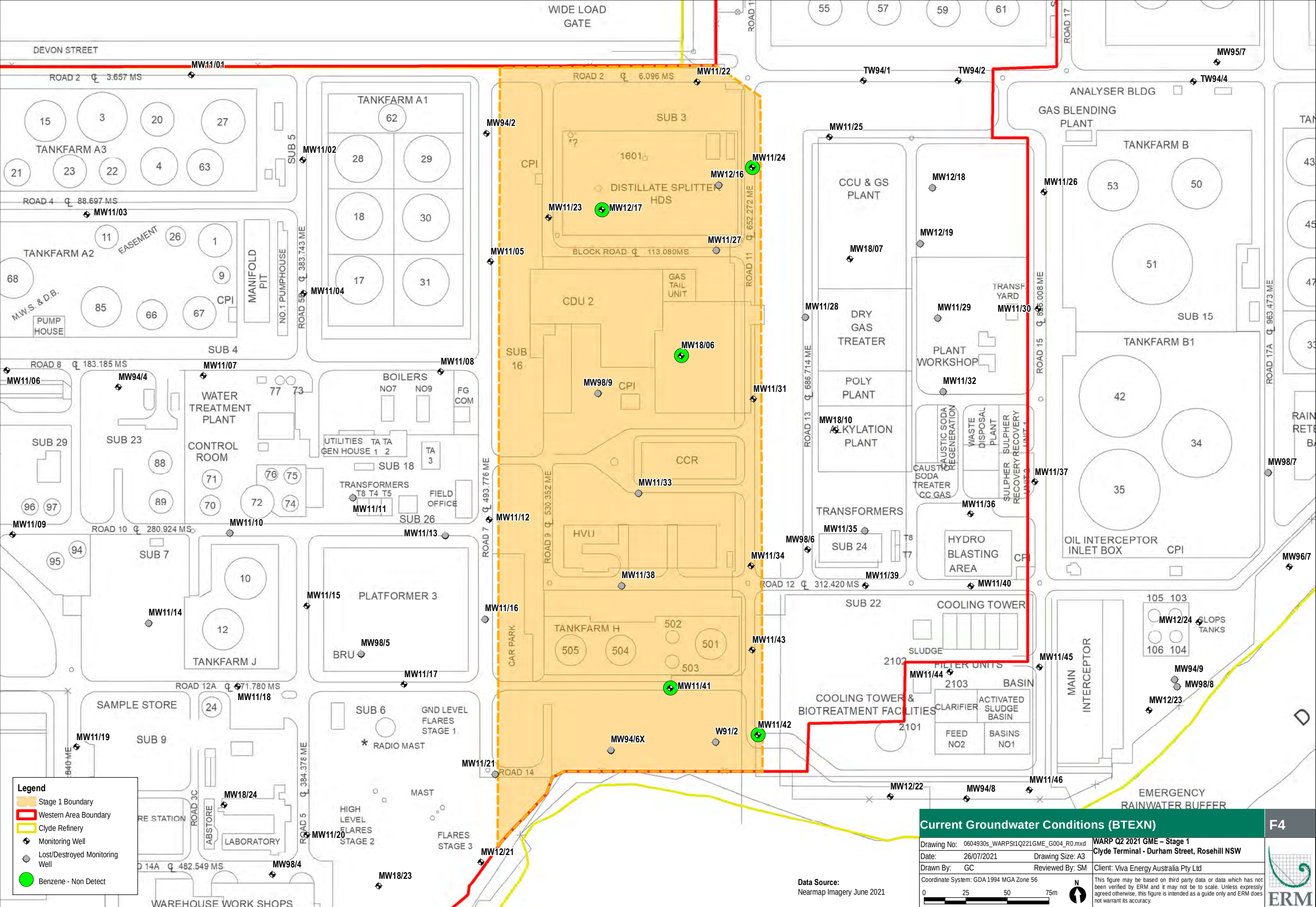
Client: Viva Energy Australia Pty Ltd

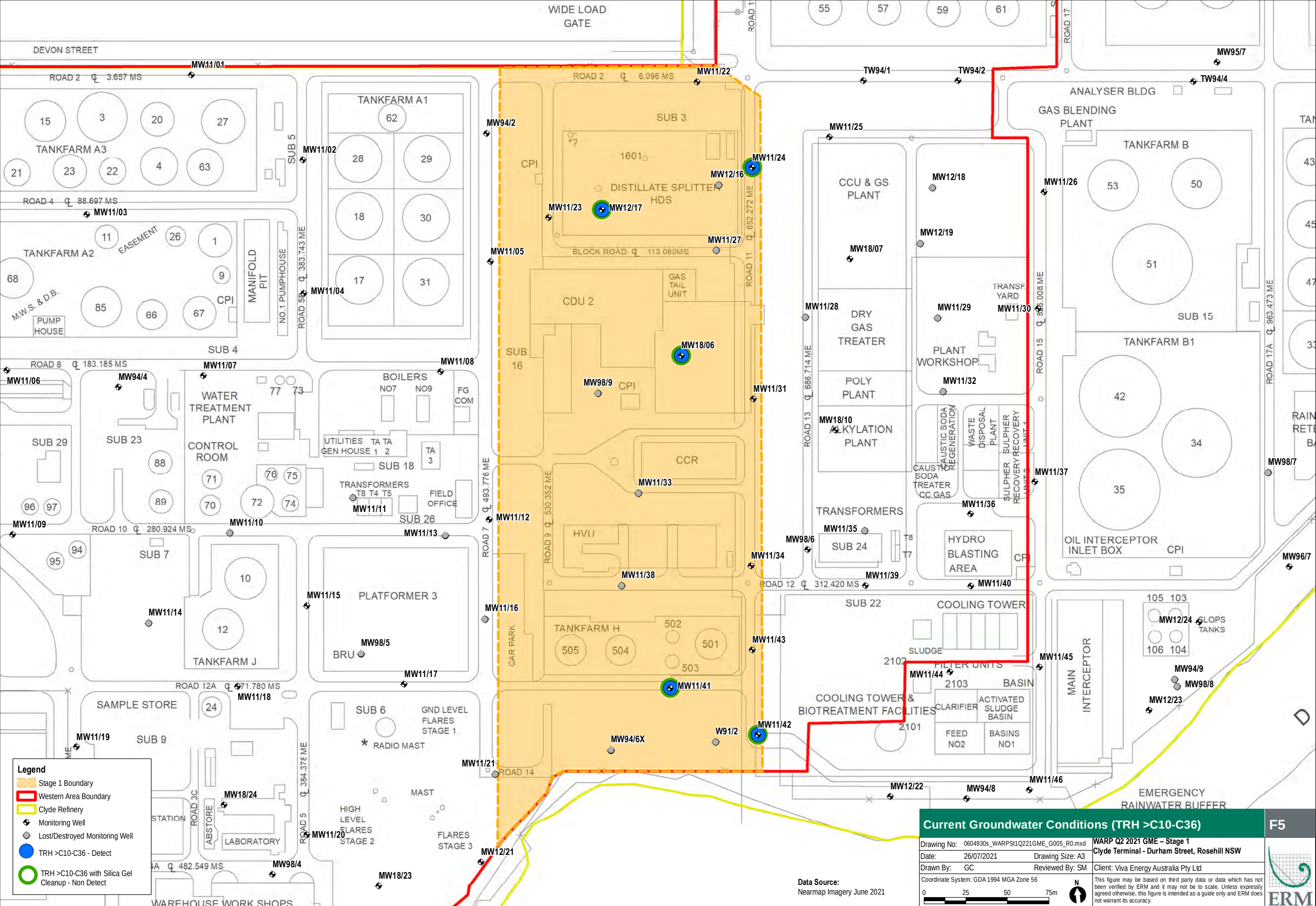
This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

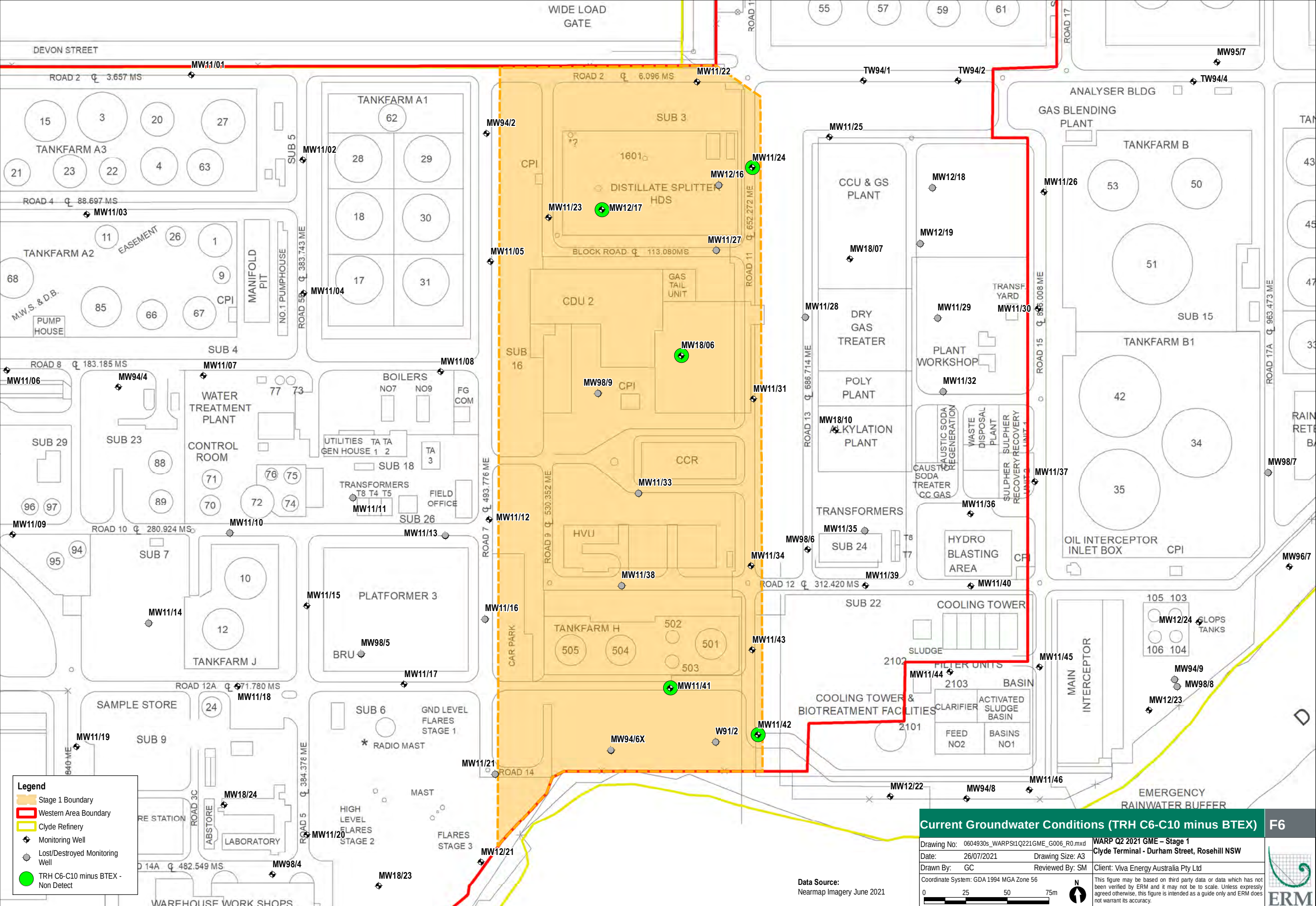
WARP Q2 2021 GME - Stage 1

Clyde Terminal - Durham Street, Rosehill NSW

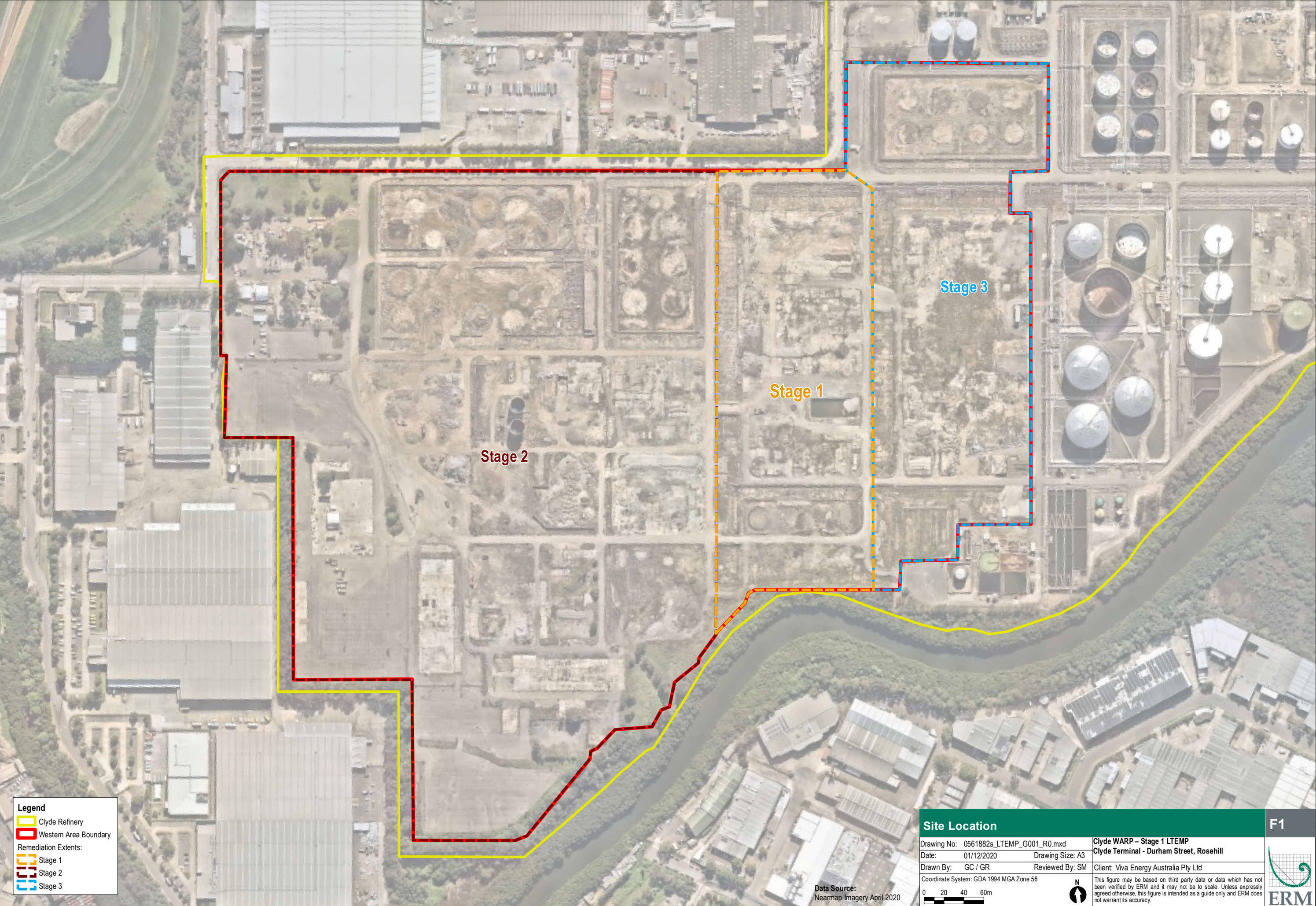
ERM







FIGURES - Updated LTEMP



Legend

Clyde Refinery

Western Area Boundary

Remediation Extents:

Stage 1

Stage 2

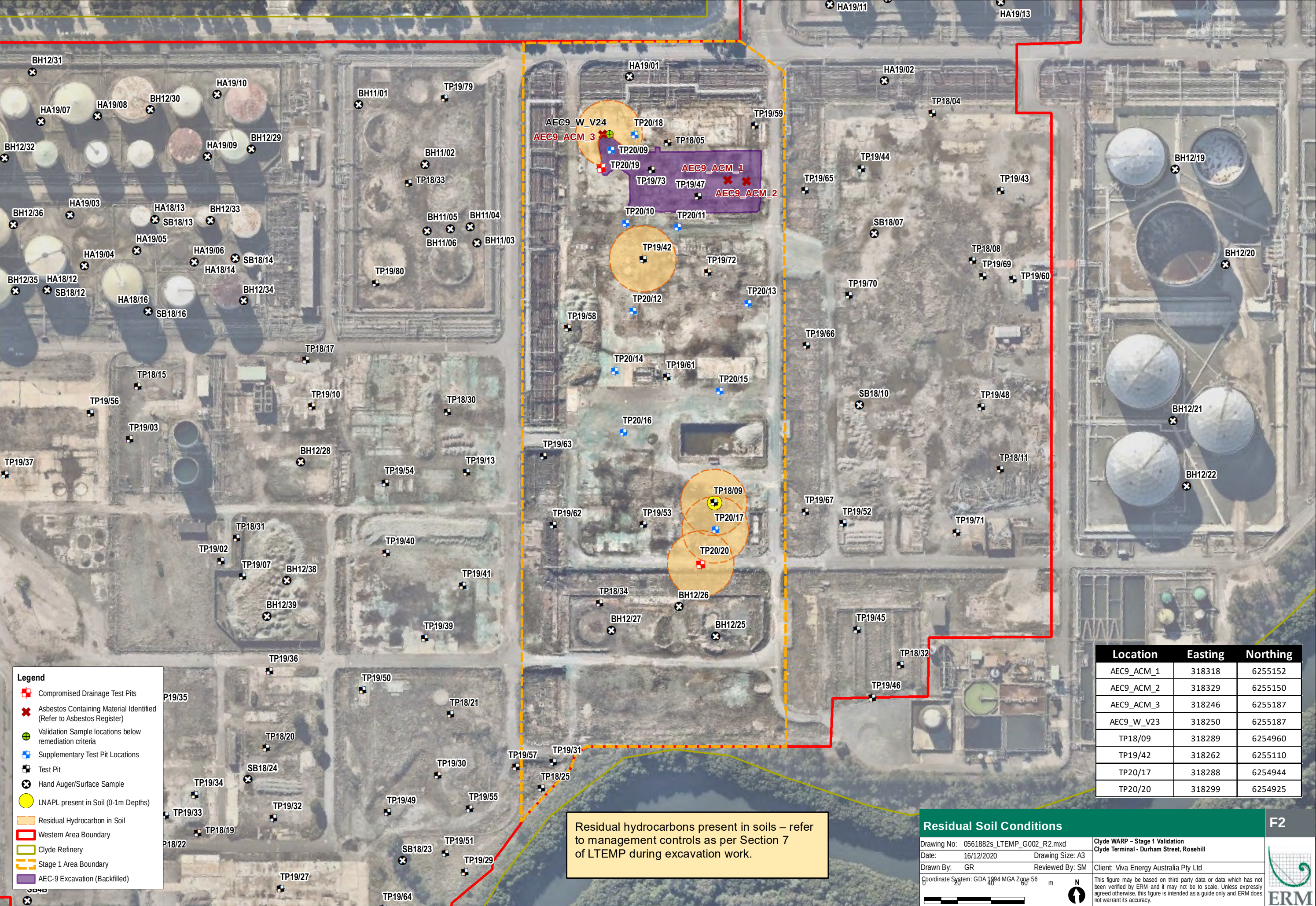
Stage 3

Site Location

Drawing No: 0561882s_LTEMP_G001_R0.mxd		Clyde WARP – Stage 1 LTEMP	
Date: 01/12/2020	Drawing Size: A3	Clyde Terminal - Durham Street, Rosehill	
Drawn By: GC / GR	Reviewed By: SM	Client: Viva Energy Australia Pty Ltd	
Coordinate System: GDA 1994 MGA Zone 56			

Data Source:
Nearmap Imagery April 2020





Legend

- Compromised Drainage Test Pits
- Asbestos Containing Material Identified (Refer to Asbestos Register)
- Validation Sample locations below remediation criteria
- Supplementary Test Pit Locations
- Test Pit
- Hand Auger/Surface Sample
- LNAPL present in Soil (0-1m Depths)
- Residual Hydrocarbon in Soil
- Western Area Boundary
- Clyde Refinery
- Stage 1 Area Boundary
- AEC-9 Excavation (Backfilled)

Location	Easting	Northing
AEC9_ACM_1	318318	6255152
AEC9_ACM_2	318329	6255150
AEC9_ACM_3	318246	6255187
AEC9_W_V23	318250	6255187
TP18/09	318289	6254960
TP19/42	318262	6255110
TP20/17	318288	6254944
TP20/20	318299	6254925

Residual hydrocarbons present in soils – refer to management controls as per Section 7 of LTEMP during excavation work.

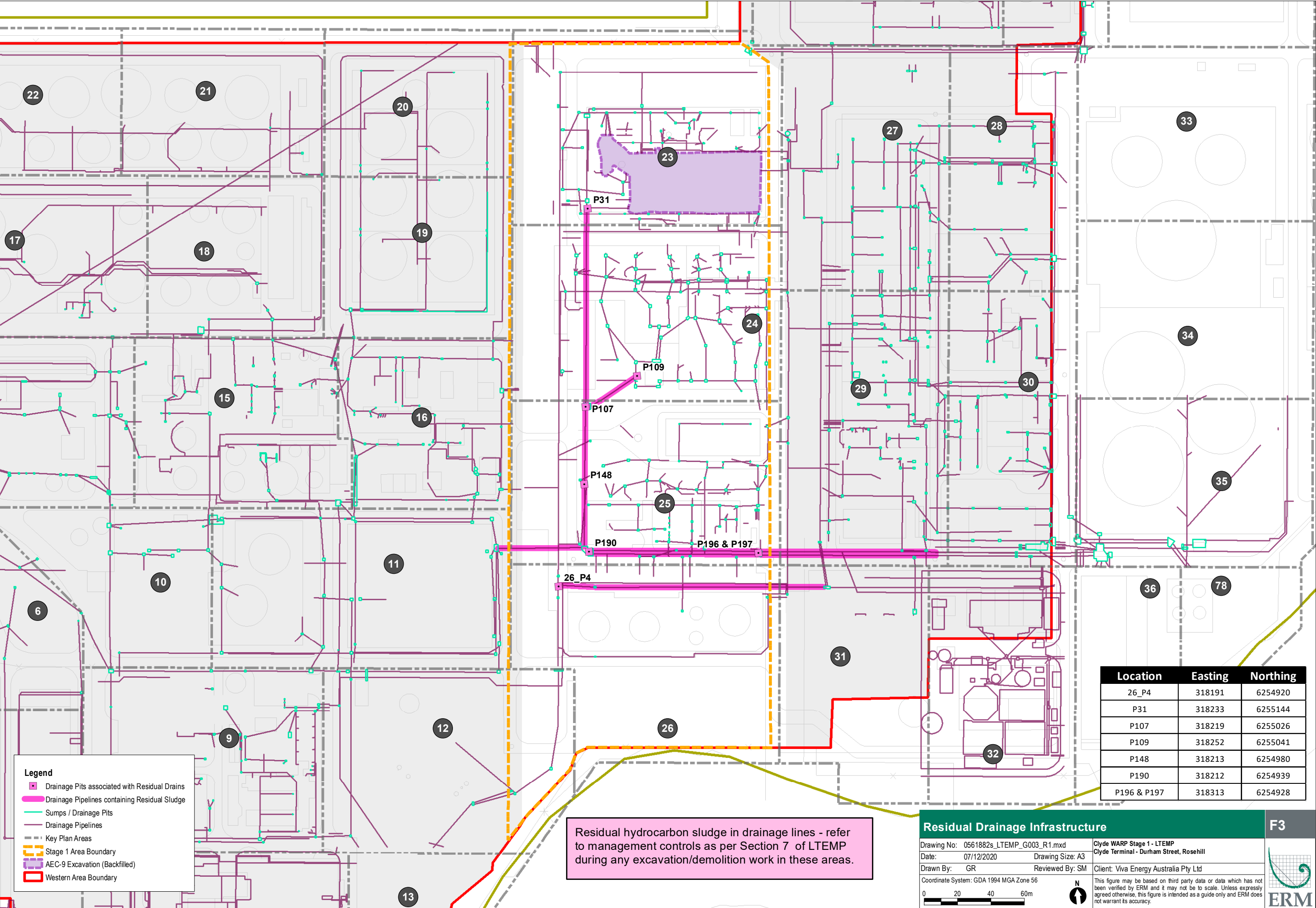
Residual Soil Conditions

Drawing No: 0561882s_LTEMP_G002_R2.mxd
Date: 16/12/2020
Drawing Size: A3
Drawn By: GR
Reviewed By: SM
Coordinate System: GDA 1994 MGA Zone 56

Clyde WARP – Stage 1 Validation
Clyde Terminal - Durham Street, Rosehill
Client: Viva Energy Australia Pty Ltd

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

F2



Appendix B

Interim Audit Advice Documentation

Our ref: 2127799/IAA18

23 September 2021

Viva Energy Australia Pty Ltd
Adam Speers
Level 31 (Suite 2), Governor Macquarie Tower, 1 Farrer Place
Sydney NSW 2000

Western Area Remediation Project - Interim Audit Advice 18 – Stage 1 - Review of Ongoing Groundwater Monitoring Event 2

Dear Adam,

1. Introduction

Andrew Kohlrusch of GHD Pty Ltd (the auditor) was commissioned by Viva Energy Australia Pty Ltd (Viva Energy) to conduct an environmental site audit of the Western Area of the former Clyde refinery (Western Area Remediation Project or WARP). The Western Area Remediation Project is located at Durham Street, Rosehill on the Camellia Peninsula.

As part of the audit, the auditor has reviewed the following document prepared by Environmental Resources Management (ERM):

- ERM (2021b). *Clyde Western Area Remediation Project Stage 1 – Ongoing Groundwater Monitoring Event 2 and Annual Summary Report*, dated 10 September 2021 (the **Ongoing GME 2**).

In preparing this Interim Audit Advice (IAA), the auditor considered the information presented in the following documents:

- ERM (2021a). *Clyde Western Area Remediation Project - Quarter 4 (2020) Groundwater Monitoring Report*, dated 24 March 2021 (the **2020 Q4 GME**).
- ERM (2020). *Clyde Western Area Remediation Project - Groundwater Monitoring Program*, dated 15 May 2020, revised draft 2 (the **GMP** – included as Attachment A of the GMP).
- AECOM (2020). *Clyde Western Area Remediation Project – Remediation Environmental Management Plan - Groundwater Monitoring and Management Plan*, dated 8 May 2020, Revision 3 (the **GMP**).

The purpose of this audit advice is to comment on whether the Ongoing GME 2 was prepared in a manner consistent with the requirements of Conditions of Consent B22 (further discussed in *Section 2*) and the NSW Environment Protection Authority (EPA) made or endorsed guidelines:

- NSW EPA (2020). *Guidelines for Consultants Reporting on Contaminated Sites 2020* (the Consultant Guidelines).
- NSW EPA (2017). *Guidelines for the NSW Site Auditor 3rd Scheme* (the Auditor Guidelines).
- NSW EPA (2015). *Guidelines for the Assessment and Management of Groundwater Contamination*.
- NEPC (2013) *National Environment Protection (Assessment of Site Contamination) Measure 1999* (the NEPM).

2. Regulatory requirements

Viva Energy is in the process of delivering the WARP to facilitate future commercial and/or industrial development. Given the scale of remedial works, the WARP was declared State Significant Development (SSD) and as such, to assess the potential environmental impacts from remediation, an Environmental Impact Statement (EIS) containing a Conceptual RAP (AECOM, 2019) was submitted to Department of Planning, Industry, and Environment (DPIE) in late 2019. Consent Conditions for SSD 9302 were issued on 7 May 2020.

The remediation will be completed in three different stages as follows:

- Stage 1 – Former Process West. The Stage 1 remedial works and subsequent validation program were carried out under ERM supervision between October 2020 and February 2021.
- Stage 2 – Former Utilities and Movements. The Stage 2 area is currently being remediated under supervision of ERM.
- Stage 3 – Former Process East.

Viva Energy had informed DPIE in accordance with Condition A9 of SSD of the stages. All conditions in the SSD must be followed for any stages.

The conditions imposed on the Development Consent (from the groundwater perspective) require the following:

- B22(b) include a program to monitor groundwater levels and quality during remediation works and following demobilisation.
- B22(d) detail ongoing monitoring following demobilisation, to verify that natural attenuation of groundwater contamination is occurring over time.
- B22(e) include trigger levels for investigating potential adverse impacts to the Duck River, including triggers for indicating if further remediation of groundwater is required.
- B22(f) outline contingency actions to be implemented if monitoring indicates that natural attenuation is not occurring, or groundwater is having an adverse impact on the Duck River.
- B22(g) monitor the effectiveness of management measures and contingency actions for reducing impacts.
- B22(h) procedures for reporting changes to groundwater conditions that have the potential to create unacceptable risks to the Duck River.

To meet Consent Condition B22 a GMP was prepared by AECOM (AECOM, 2020) and approved by the auditor on 4 June 2020 (IAA08). The GWMP (ERM, 2020) included as an attachment of the GMP detailed the groundwater monitoring program required by Condition B22.

The Ongoing GME 2 was carried out as per the GWMP. The groundwater monitoring program included tasks to be carried out during remedial works (to meet Condition B22 (b)) as per *Table 1* and tasks to be completed six months post-remediation (to meet Condition B22 (d)) as per *Table 2*.

Table 1 Groundwater Monitoring Program – During remediation

Monitoring Area	Rationale	Frequency	Data Collected
Excavation Areas (nearby wells)	Sampling for adverse changes in dissolved phase COPC concentrations from remediation activities. Although considered unlikely to occur, an indication of potential ASS issues created during remediation may be assessed via collection of field parameters.	Baseline sampling prior to commencement of remediation works. Within 3 months following completion of remediation works.	laboratory analysis for target CoPC (excavation specific), collection of field parameters (including pH).
Excavation Areas (nearby wells)	Gauging to monitor potential alteration to groundwater levels/ flow regime.	Gauging weekly during excavation and/or dewatering.	Gauging Data (water levels, LNAPL presence/ thickness).

Monitoring Area	Rationale	Frequency	Data Collected
	Monitor potential for LNAPL mobilisation.		
Down-gradient boundary	Demonstrate groundwater at the boundary is not adversely impacted by remediation works or causing environmental harm to the Duck River. Monitor potential for LNAPL mobilisation from remediation works.	monthly during active remediation conducted up- gradient.	Gauging data (water levels, LNAPL presence/ thickness). Grab sample for collection of field parameters (including pH).

Note – Extracted from ERM, 2021a.

Table 2 Groundwater Monitoring Program – Post Remediation

Monitoring Area	Rationale	Frequency	Data collected
Excavation Areas (nearby wells)	demonstrate that stable to decreasing groundwater concentrations continue to be observed as a result of natural attenuation processes and removal of key source areas. Gauging to monitor potential for alteration to groundwater levels/ flow regime or LNAPL mobilisation	Biannually (every 6 months) following completion of post remediation sampling event Requirement for ongoing sampling is to be reviewed annually (ie every two GMEs) based on trend analysis and reported concentrations	laboratory analysis for TRH, BTEXN and MNA parameters collection of field parameters Gauging Data (water levels, LNAPL presence/ thickness).
Downgradient boundary	Demonstrate groundwater at the boundary is not impacted by remediation works or causing environmental harm to the Duck River; Monitor potential for LNAPL mobilisation from remediation works	Biannually (every 6 months) following completion of post remediation sampling event Requirement for ongoing sampling is to be reviewed annually (ie every two GMEs) based on trend analysis and reported concentrations	laboratory analysis for TRH, BTEXN and MNA parameters collection of field parameters; Gauging Data (water levels, LNAPL presence/ thickness); collection of field parameters (including pH)

Note – Extracted from ERM, 2021a.

3. Auditor review and commentaries

The Ongoing GME 2 objective was to meet the GMP requirements (described in Tables 1 and 2).

The groundwater wells included in the post-remediation program for the Stage 1 Area were:

- MW11/24, MW12/17 and MW18/06 – three wells located near the remediation excavation.
- MW11/41 and MW11/42 – two down-gradient groundwater monitoring wells.

The groundwater monitoring program for the Ongoing GME 2 was completed between 4 and 8 March 2021. The auditor notes that the GME 1 was carried out in December 2020, following completion of remediation within the Stage 1 Area.

The auditor considered that overall, the Ongoing GME 2 had been prepared in accordance with the guidelines referred to in *Section 1* and has taken into consideration the approved GMP (AECOM, 2020). However, there are some items and other technical queries that should be addressed before finalisation of the Ongoing GME 2. The key points that need to be considered are:

- The report should clearly demonstrate that the relevant requirements of Condition B22 have been met, both during remediation and after remediation.

- Based on the reporting and data evaluation description presented in Section 3.6 of the GWMP, a *Completion of interpretive QA/QC assessment for the preceding year's dataset* should be included in the Ongoing GME 2 (not only the QA/QC assessment for the March 2021 GME).
- The technical discussion presented in Section 6.2 is unclear or insufficiently substantiated. The auditor noted that similar comments were made in the Q4 2020 GME review, which were not addressed in Ongoing GME 2.
- The report should only contain data relevant to sampling groundwater wells within Stage 1 to meet Condition B22 (as per the permissible staging of remediation). The auditor noted that data from the WARP monitoring wells were included in the tables in the appendix.
- In addition to the statements regarding polar organics, ERM should present a comparative assessment of TRH and silica gel clean up analyses to demonstrate that the non-polar metabolites are being transformed. Commentary should be provided on the toxicity of the polar metabolites.
- The rationale supporting the cessation of the groundwater program before the two approved events as per the GMP (Section 3.4.5 and Section 3.6) needs to be based on a more detailed discussion of the data that has been collected to date. The auditor noted that the Ongoing GME 2 was not completed six months after completion of the remediation, but three months (please note that the Ongoing GME 2 is not an annual report as required in table presented in Section 3.6 of the GWMP). Rationale should be presented supporting that the shorter period between monitoring does not affect the objectives of the monitoring program.

4. Conclusions

It is recommended that the comments provided in the comments table (attached via email) should be addressed, presented in a revised report, and endorsed by the auditor before submission of the report to NSW EPA and DPIE.

This report should be regarded as interim advice to the overall review and site audit process and should not be considered a Site Audit Statement under the CLM Act, 1997. This interim audit advice letter will subsequently be referred to and provided as an Annex to the final Site Audit Statement and Site Audit Report.

Sincerely,



GHD Pty Ltd

Andrew Kohlrusch

NSW EPA Accredited Auditor

Encl via email. Auditor commentary spreadsheet 2021-09-22

cc. Adam Speers – Viva Energy

Our ref: 2127799/IAA19

15 October 2021

Viva Energy Australia Pty Ltd
Adam Speers
Level 31 (Suite 2), Governor Macquarie Tower, 1 Farrer Place
Sydney NSW 2000

Interim Audit Advice 19 – Review of Ongoing Groundwater Monitoring Event 2 and Annual Report (Stage 1 Area)

Dear Adam,

1. Introduction

Andrew Kohlrusch of GHD Pty Ltd (the auditor) was commissioned by Viva Energy Australia Pty Ltd (Viva Energy) to conduct an environmental site audit in the Western Area of the former Clyde refinery (Western Area Remediation Project or WARP). The Western Area Remediation Project is located at Durham Street, Rosehill on the Camellia Peninsula NSW.

As part of the audit, the auditor has reviewed the following reports prepared by Environmental Resources Management (ERM):

- ERM (2021c). *Clyde Western Area Remediation Project - Quarter 4 (2020) Groundwater Monitoring Report*, dated 24 March 2021 (the **Q4 2020 GME**).
- ERM (2021d). *Clyde Western Area Remediation Project Stage 1 – Ongoing Groundwater Monitoring Event 2 and Annual Summary Report*, dated 12 October 2021 (the **Ongoing GME 2**).

In preparing this Interim Audit Advice (IAA), the auditor also considered information presented in the following documents:

- AECOM (2020). *Clyde Western Area Remediation Project – Remediation Environmental Management Plan - Groundwater Monitoring and Management Plan*, dated 8 May 2020, Revision 3 (the **GMP**).
- ERM (2021a). *Clyde Western Area Remediation Project - Groundwater Monitoring Program*, dated 29 January 2021, revision 4 (the **GWMP** – included as Attachment A of the GMP).
- ERM (2021b). *Clyde Western Area Remediation Project – Stage 1 Long Term Environmental Management Plan*, dated 29 January 2021 (the **LTEMP**).

The purpose of this IAA is to comment on whether the Ongoing GME 2 was prepared in a manner consistent with the endorsed GMP (further discussed in *Section 2*) and the NSW Environment Protection Authority (EPA) made or endorsed guidelines including:

- NSW EPA (2020). *Guidelines for Consultants Reporting on Contaminated Sites 2020* (the **Consultant Guidelines**).
- NSW EPA (2017). *Guidelines for the NSW Site Auditor 3rd Scheme* (the **Auditor Guidelines**).
- ANZG (2018). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, Australian and New Zealand Governments and Australian state and territory governments.

- NEPC (2013). National Environment Protection (Assessment of Site Contamination) Measure 1999 amended in 2013 (the **NEPM**).

2. Regulatory requirements

Viva Energy is in the process of delivering the WARP to facilitate future commercial and/or industrial development. Given the scale of remedial works, the WARP was declared State Significant Development (SSD) and as such, to assess the potential environmental impacts from remediation an Environmental Impact Statement (EIS) containing a Conceptual Remedial Action Plan (RAP) was submitted to the Department of Planning, Industry, and Environment (DPIE) in 2019. Consent Conditions for SSD n° 9302 were issued on 7 May 2020.

The remediation is being completed in three different stages as follows:

- Stage 1 – Former Process West (Completed in 2020).
- Stage 2 – Former Utilities and Movements (Currently under remediation).
- Stage 3 – Former Process East.

All Consent Conditions in the SSD 9302 must be followed for any of the three stages (Consent Condition A9). Therefore, Viva Energy had informed DPIE about the remedial works for Stages 1 and Stage 2.

The WARP, including the Stage 1 Area (relevant to the Q4 2020 GME and Ongoing GME 2 report) is presented **Figure 1**

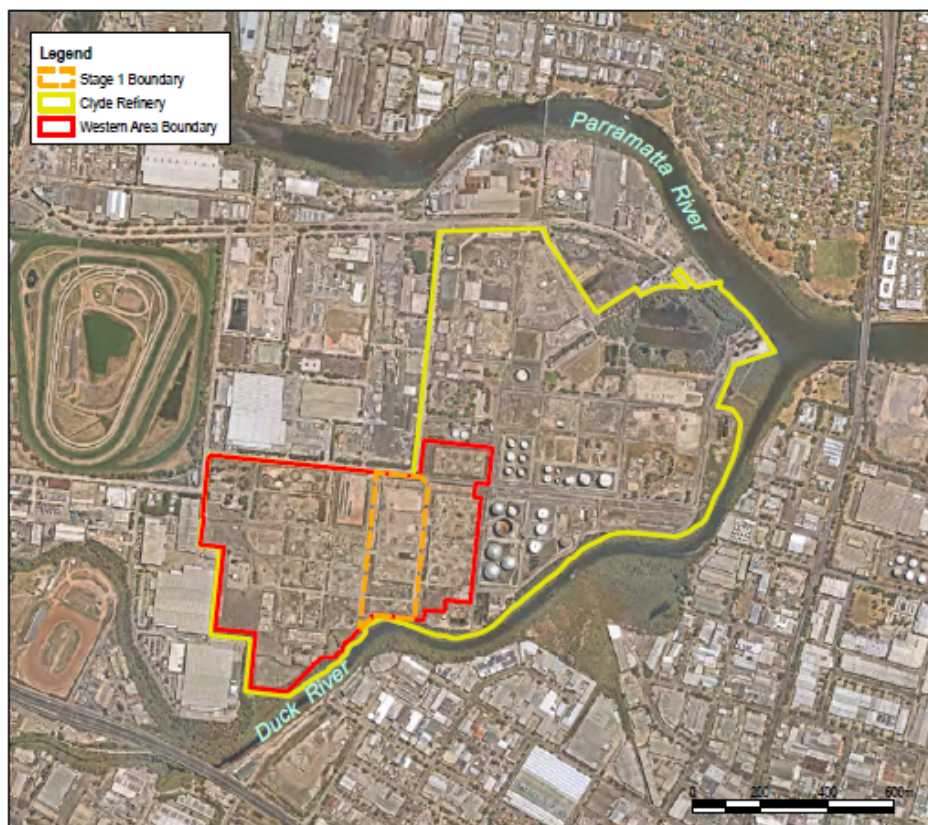


Figure 1 WARP and Stage 1 Area (extracted from ERM, 2021d)

The Consent Conditions of SSD 9302 related to groundwater monitoring and management are:

- *B22(b) include a program to monitor groundwater levels and quality during remediation works and following demobilisation.*
- *B22(d) detail ongoing monitoring following demobilisation, to verify that natural attenuation of groundwater contamination is occurring over time.*
- *B22(e) include trigger levels for investigating potential adverse impacts to the Duck River, including triggers for indicating if further remediation of groundwater is required.*
- *B22(f) outline contingency actions to be implemented if monitoring indicates that natural attenuation is not occurring, or groundwater is having an adverse impact on the Duck River.*
- *B22(g) monitor the effectiveness of management measures and contingency actions for reducing impacts.*
- *B22(h) procedures for reporting changes to groundwater conditions that have the potential to create unacceptable risks to the Duck River.*

2.1 Compliance with consent conditions

To comply with Consent Condition B22, the GWMP prepared by ERM. The GWMP detailing the groundwater monitoring program required by Condition B22 was prepared by ERM, and was included in Appendix A of the GMP and in the Stage 1 Long Term Environmental Management Plan (LTEMP) as Appendix D.

To comply with consent conditions relation to groundwater monitoring and management, the GWMP was required to:

- *Present trigger levels for investigating potential adverse impacts to the Duck River, including triggers for indicating if further remediation of groundwater is required.*
- *Present contingency actions to be implemented in case the monitoring events indicates that natural attenuation is not occurring, or groundwater is having an adverse impact on the Duck River.*
- *Monitor the effectiveness of management measures and contingency actions for reducing impacts.*
- *Document procedures for reporting changes to groundwater conditions that have the potential to create unacceptable risks to the Duck River.*

In IAA08, the auditor considered that the GWMP prepared by ERM contained many of the key elements as per the Consultant Guidelines (NSW EPA, 2020) and largely met Development Consent condition B22. However, there were some matters that required additional information and / or review before the document could be finalised. Following receipt of an updated GWMP, the auditor issued IAA11 that stated that matters raised in IAA08 had been resolved, including compliance with the conditions of consent related to groundwater monitoring and management.

3. Auditor review and commentary

The Q4 2020 GME and Ongoing GME 2 objective was to meet the GWMP requirements, thus complying with Consent Condition B22 of the SSD 9302. The groundwater monitoring wells included in the validation program for the Stage 1 Area are:

- MW11/24, MW12/17 and MW18/06 – located near the remediation excavation (AEC-9).
- MW11/41 and MW11/42 – located down-gradient near the Duck River.

Based on the HHERA, the CoPC for the Stage 1 Area are benzene, toluene, ethylbenzene, xylenes, naphthalene (BTEXN) and total recoverable hydrocarbon fractions (TRH).

The locations of these five groundwater monitoring wells are presented in **Figure 2**.

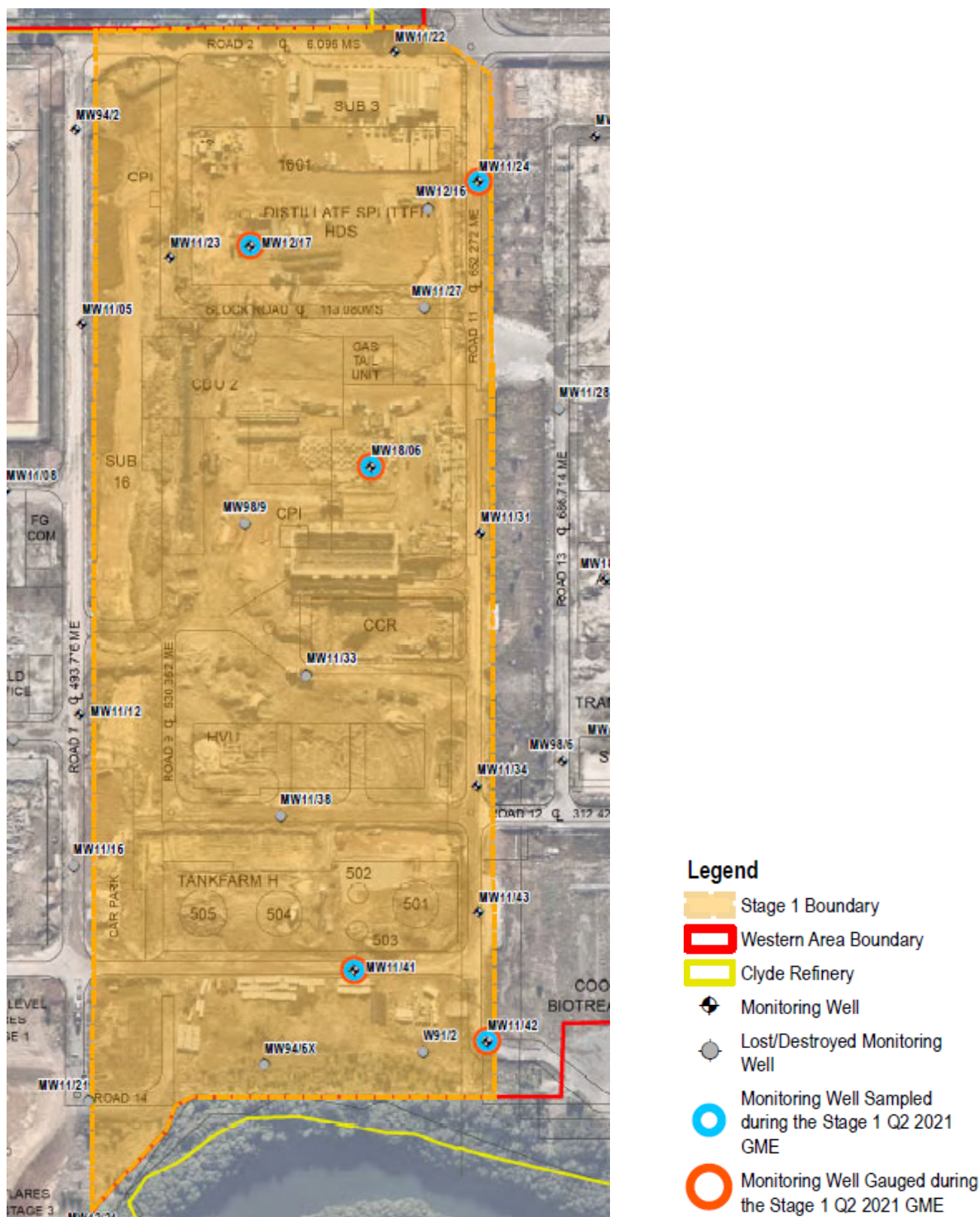


Figure 2 Stage 1 Area Monitoring Wells Location (extracted from ERM, 2021d)

3.1 Groundwater monitoring during remediation

ERM noted in the Q4 2020 GME report that monitoring well MW11/27 was destroyed during the remedial works. Therefore, the groundwater monitoring and gauging was carried out at the adjacent well MW18/06.

The groundwater monitoring program included activities to be completed during remediation works as listed in the GWMP. These requirements and the auditor's comments are presented in **Table 1**.

Table 1 Groundwater Monitoring Program – During remediation

Monitoring Area	Rationale	Frequency	Data Collected	Key Results	Auditor Comments
Excavation Areas (MW11/24, MW12/17 and MW18/06)	- Assess changes in dissolved phase of CoPC from remediation. - Assess potential Acid Sulphate Soil (ASS) issues associated with the remediation.	- Baseline sampling prior to commencement of remedial works. - Within three months following completion of remedial works.	- Groundwater samples for laboratory analysis of CoPC. - Groundwater samples for analysis of field parameters, including pH.	Groundwater monitoring sampling events were undertaken on 6/10/20 (baseline) and 3/12/20 (within three months following completion of remediation). <u>CoPC analytical results</u> - BTEXN concentrations in groundwater were below limit of reporting (LOR) in both sampling events. - MW11/24 –TRH C₁₀-C₃₆ was identified in post-silica gel clean-up analysis were observed in October 2020. However, TRH results post-silica gel analysis were below LOR in December 2020. - MW12/17 and MW18/06 – TRH C₁₀-C₃₆ concentrations post-silica gel clean-up analysis were below LOR in both sampling events. - Silica gel clean-up analysis in groundwater samples since Q2 2018 have shown that reported concentrations of TRH comprise mostly polar (non-petroleum hydrocarbon) by-products generated by the biodegradation of hydrocarbons via microbial activity. <u>pH measurements</u> - pH measurements post-remediation ranged between 4.5 (MW11/24) and 7.23 (MW12/17). These results were similar to the historical mean 4.48 (MW11/41) and 6.98 (MW12/24).	Based on the data collected by ERM during the remedial works, the auditor considers that: - Remediation within the Stage 1 Area had not caused any measurable changes in groundwater quality around the excavation area – such as mobilisation of residual LNAPL trapped in soils or an increase of dissolved phase CoPC. BTEXN results were less LOR, mirroring the eight years of historical data and, LNAPL was not observed during the groundwater monitoring. - The silica-gel TRH concentrations observed in October 2020 at MW11/24 was not detected in December 2020. Likewise, TRH concentration post-silica gel analysis were not observed in any other well in December 2020. - Potential ASS issues associated with the remediation (excavations) were not observed based on field measurements, as expected. The auditor notes that the assessment of ASS issues posed by the excavations within Stage 1 Area were recommended as a precaution, as this hypothesis was considered very unlikely based on historical data, desktop survey and the observations that soils at AEC-9 comprised residual clays (shale).
Excavation Areas (MW11/24, MW12/17 and MW18/06)	- Monitor potential alteration to groundwater levels/flow regime. - Monitor potential for LNAPL mobilisation.	Weekly during excavation.	Gauging data (SWLs and LNAPL)	Gauging events were completed in 30/09/20 (Baseline), 13/10/20, 20/10/20, 29/10/20, 5/11/20, 12/11/20, 17/11/20 (Remediation) and 1/12/20 (Pos-remediation). - Groundwater fluctuations recorded between the baseline and post-remediation events were: 0.31 m in MW11/24, 0.15 m in MW12/17 and 0.57 m in MW18/06. - LNAPL was not observed in any well during the weekly monitoring events.	Based on the weekly gauging data, the auditor considers that: - Residual LNAPL trapped in soil pores within the capillary fringe (if present) was not mobilised to groundwater due to remediation, as LNAPL was not observed in any of the three monitoring wells during the seven-week monitoring period. - Groundwater levels were not affected by the remedial works. The maximum rise of 0.57 m in groundwater levels was likely associated with the heavy rainfall period occurred in October 2020. - The auditor noted during an inspection of the remediation area that groundwater was not intersected, and that rainwater had pooled at the base of the excavation.
Down-gradient Boundary (MW11/41 and MW11/42)	- Assess whether groundwater at the boundary of the site is not adversely impacted by remediation or causing environmental harm to the Duck River. - Monitor potential for LNAPL mobilisation from remediation works.	Monthly during remediation.	- Gauging data (SWLs and LNAPL) - Groundwater samples for analysis of field parameters, including pH.	A gauging event was completed on 1/12/20. - The groundwater level at MW11/42 was 1.56 mBTOC while MW11/41 was dry. - The pH of groundwater at MW11/41 was 5.03, which was within the range measured in groundwater wells in the remediated area.	The auditor noted that October and November groundwater monitoring was not conducted as part of the Q4 2020 GME. The auditor considers that this deviation from the GWMP did not affect the required assessment of the potential effects caused by the remediation to Duck River, based on the following lines of evidence: The remediation was completed in six weeks. The GWMP anticipated a longer time for completion of the remediation. Given the short duration of the remedial works, the geology (low permeability residual clays) and the low groundwater gradient, it would not be expected that changes to groundwater quality would be measurable over this period.

Monitoring Area	Rationale	Frequency	Data Collected	Key Results	Auditor Comments
					- Gauging data collected during the six-week remediation period confirmed that the remediation did not have any effect on the hydraulic conditions in the vicinity of the excavation area. - LNAPL was not observed in any of the three monitoring wells within the excavation area, during the six weekly gauging events. The auditor considered that sufficient QA/QC was presented in the Q4 2020 GME. The data collected in March 2020 was consistent with the eight years historical data. Based on the data obtained in December 2020 from the three wells around the excavation area and from the down gradient well MW11/41, ERM demonstrated that: - Groundwater down gradient of the excavated area was not impacted by remedial works or causing environmental harm to the Duck River. - Residual LNAPL that may be trapped in the pores soil within the capillary fringe had not been mobilised as a result of remedial works.

3.2 Groundwater monitoring post-remediation

The groundwater monitoring program included activities to be completed during remediation works as listed in the GWMP. These requirements and the auditor's comments are in **Table 2**.

Table 2 Groundwater Monitoring Program – Post Remediation

Monitoring Area	Rationale	Frequency	Data Collected	Key Results / Recommendations	Auditor Comments
Excavation Areas (MW11/24, MW12/17 and MW18/06)	- Demonstrate that stable to decreasing groundwater concentrations continue to be observed as a result of natural attenuation processes and removal of key source areas. - Monitor potential for alteration to groundwater levels/flow regime or LNAPL mobilisation.	- Biannually (every six months) following completion of post remediation sampling event. - Requirement for ongoing sampling is to be reviewed annually (i.e. every two GMEs) based on trend analysis and reported concentrations	- Groundwater samples for laboratory analysis of CoPC, MNA parameters collection of field parameters. - Gauging data (SWLs and LNAPL).	Groundwater monitoring event was completed in March 2021. The following results were recorded: - Groundwater ranged from 2.050 mAHD (MW11/42, located at the southern boundary of Stage 1) to 3.150 mAHD (MW12/17, located in the northern portion of the Stage 1 Area). BTEXN concentrations in groundwater were below LOR. - LNAPL was not observed in any of the five wells. - Silica gel clean-up TRH concentrations were below LOR, mirroring historical results.	The auditor noted that the GWMP states that groundwater sampling should be collected six months following completion of the post remediation sampling event. However, the ongoing sampling event was completed three months after the post remediation sampling event. The auditor considered that this divergence from the GWMP will not affect ERM's conclusions and recommendation based on the following lines of evidence: The primary sources of potential impacts were removed during remediation of Stage 1 Area. As per the endorsed Human Health and Ecological Risk Assessment (HHERA) groundwater impacts does not pose any potential risks to both on- and off-site receptors (ecological and human), therefore remediation of the groundwater was deemed not necessary.
Down-gradient boundary (MW11/41 and MW11/42)	- Assess whether groundwater at the boundary of the site is not adversely impacted by remediation works or causing environmental harm to the Duck River. - Monitor potential for LNAPL mobilisation from remediation works.	- Biannually (every six months) following completion of post remediation sampling event. - Requirement for ongoing sampling is to be reviewed annually (i.e. every two GMEs) based on trend analysis and reported concentrations.	- Groundwater samples for laboratory analysis of CoPC, MNA parameters collection of field parameters. - Gauging data (SWLs and LNAPL).	- Stable concentrations (mostly below LOR) of BTEXN have been observed since most monitoring wells were installed across the WARP in 2012. - The data collected in March 2021 were consistent with groundwater monitoring events undertaken in the five subject wells in recent years. Potential for adverse changes in groundwater conditions are low given the removal of primary sources from the Stage 1. - ERM considered that since concentrations of CoPC were mostly below the LOR, and no potential risks were identified to both on- and off-site receptors (human and ecological) from groundwater, the continuation of monitoring to demonstrate the ongoing occurrence of natural attenuation processes is not considered to be of any material environmental benefit.	- The data collected during and following completion of remediation to meet the Condition Consent B22 indicated that the hydraulically conditions of Stage 1 Area were not affected by remedial works. - The GWSDAT trend plots indicated that groundwater levels fluctuation monitored since 2012 has not influenced groundwater quality, as shown in Figure 3. - The residual trapped LNAPL (if present) within the soil pores in the capillary fringe as well as the dissolved phase CoPC has not mobilised as a consequence of the remedial activities. - BTEXN concentrations in groundwater samples collected from the five monitoring wells as part of the GWMP recorded concentrations below LOR before, during and after completion of

Monitoring Area	Rationale	Frequency	Data Collected	Key Results / Recommendations	Auditor Comments
				The updated conceptual site model (CSM) indicated that the only potentially complete Source-Pathway Receptor (SPR) linkage for the Stage 1 Area following completion of remediation activities is “Release of residual sludge/ LNAPL to soil and/or groundwater during excavation of pipework or drainage infrastructure”. However, this potentially complete SPR linkage is already managed by the LTEMP (i.e. controls and procedures will be administered by the land-owner to mitigate potential for future releases should demolition of this infrastructure be undertaken in the future).	remediation within Stage 1 Area. These results are largely reflective of data collected over the past eight years from these wells in which little to no BTEX compounds have been recorded in groundwater. - Reported concentrations of TRH fractions post silica gel clean-up analysis were below the LOR. The percent difference from TRH after silica gel clean-up analysis reported a decrease ranging between 58 % to 98 %, with an average of 89 %. The percentages of polar compounds removed through the silica gel clean-up analysis, supported the assertion that biodegradation of hydrocarbons has been occurring. - No potential harm to the Duck River (off-site receptor) was identified to have occurred as a consequence of the excavations within Stage 1 Area. - Groundwater quality conditions have been monitored within the Stage 1 Area since 2012. As concluded in the human health risk assessment, hydrocarbons in groundwater do not pose unacceptable risks to future on- and off-site ecological or human receptors, considering that groundwater is not abstracted for any purpose. This scenario has been confirmed with the results of Q4 2020 GME and Ongoing GME. - The auditor considered that sufficient QA/QC was presented in the Ongoing GME 2. Details about QA/QC evaluation will be discussed in the updated SAR. - The CSM was reviewed in the light of the data obtained during and after completion of the remediation works within the Stage 1 Area. The auditor concurred with ERM's opinion that the potential human and health risks to both on – and off-site receptor are low and acceptable. An updated LTEMP will be issued in regards of the residual impacts in soils.

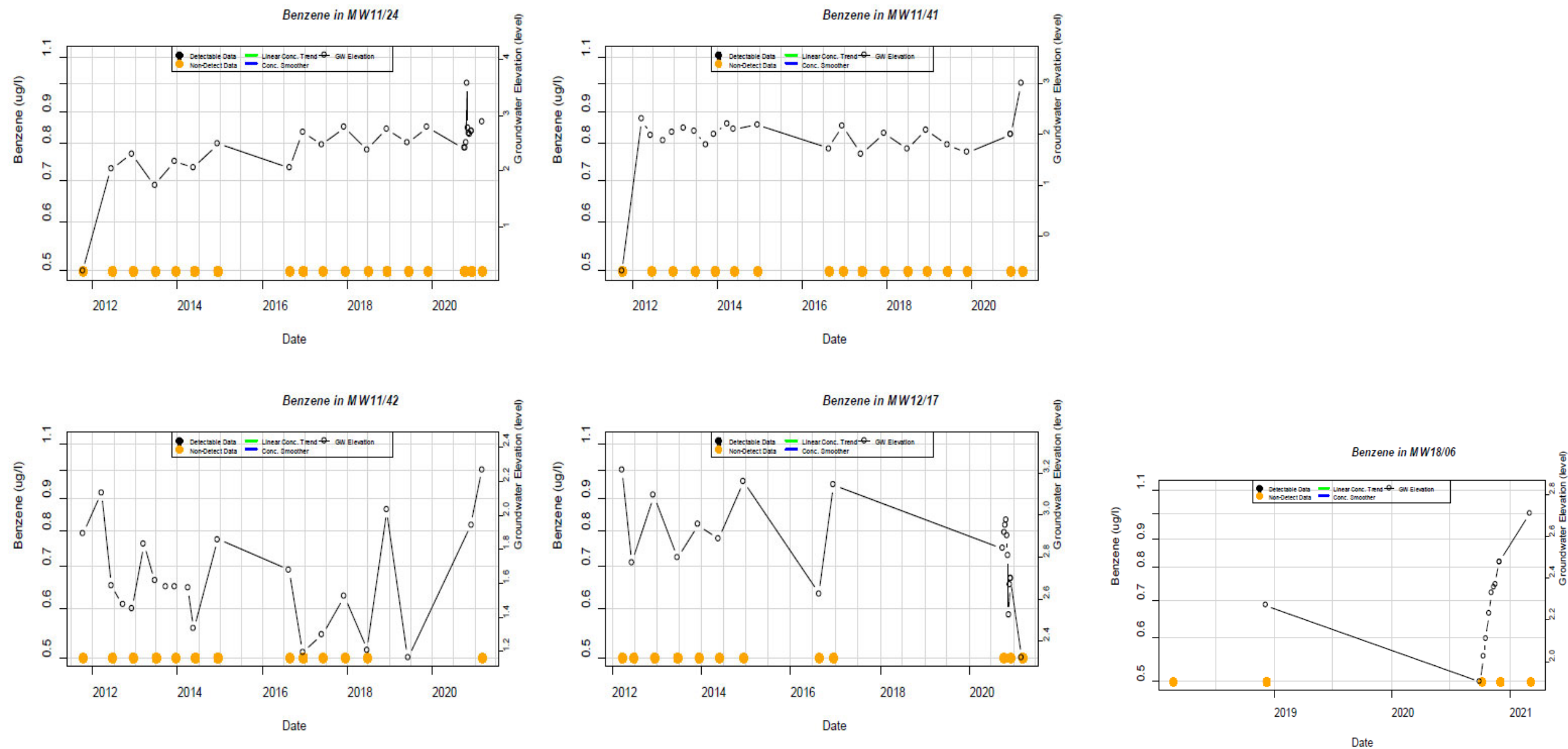


Figure 3 Groundwater level fluctuation and benzene trends (extracted from ERM, 2021c)

3.3 Summary of GME reports

Comparison of data pre-and post-remediation indicated that the remedial works did not affect local hydraulic conditions and did not result in mobilisation of residual LNAPL trapped within the soil pores or CoPC.

ERM concluded that the data collected to date (including eight years of historical data) demonstrated that trends and/or CoPC concentrations have been stable over the last eight years with a large proportion of CoPC being less than the LOR. The potential risks to on- and off-site human and ecological receptors was therefore deemed to be low and acceptable.

Since the recent GME reports (and considering groundwater data collected over the past eight years), ERM concluded that there is no demonstrable need to continue groundwater monitoring, ERM recommended that groundwater monitoring is no longer necessary at the Stage 1 area.

4. Conclusions

The auditor considered that the Q4 2020 GME report and the Ongoing GME 2 report were prepared in a manner consistent with the *Consultant Guidelines*. The concentrations of CoPC, including benzene and TRH fractions following silica gel clean-up analysis, have not indicated any increasing concentrations due to remediation activities.

ERM provided sufficient lines of evidence to demonstrate that trends and/or CoPC concentrations have been stable over the last eight years with a large proportion of CoPC being less than the LOR. These data support ERM's assertion that potential risks to on- and off-site human and ecological receptors are low and acceptable.

Table 3 presents a summary of the conditions of SSD9302 (that were incorporated in the GWMP) and the auditor's assessment of compliance and risk to human health and the environment based on the data collected during the recent monitoring programs.

Table 3 Summary of the conditions of SSD9302 and auditor's assessment

SSD Condition	Definition	Auditor comments
B22(b)	Include a program to monitor groundwater levels and quality during remediation works and following demobilisation	Groundwater monitoring was conducted by ERM during and following remedial works. The monitoring showed that there was a rise in the groundwater levels and this was attributed to rainfall events.
B22(d)	Detail ongoing monitoring following demobilisation, to verify that natural attenuation of groundwater contamination is occurring over time	Groundwater samples were collected from the five wells associated with Stage 1 remediation and were subsequently analysed for MNA parameters. While the presence of some MNA compounds were detected (e.g. sulfate), there was no consistent demonstration that MNA is occurring. The TRH analysis following silica gel clean up however has shown that biodegradation of the hydrocarbons is occurring. The lack of MNA activity does not have a bearing on risk to human health and/or the environment as none of the CoPC were recorded at concentrations greater than the nominated trigger levels.
B22(e)	Include trigger levels for investigating potential adverse impacts to the Duck River, including triggers for indicating if further remediation of groundwater is required	Appropriate trigger levels were nominated for the evaluation of data collected during the groundwater monitoring program. The majority of CoPC were less than the level of reporting and all recorded concentrations were less than the trigger levels listed in the GWMP.

SSD Condition	Definition	Auditor comments
B22 (f)	Outline contingency actions to be implemented if monitoring indicates that natural attenuation is not occurring, or groundwater is having an adverse impact on the Duck River	Although MNA has not been demonstrated to be influencing the hydrocarbon concentrations, the majority are less than LOR and all are less than the nominated trigger levels. The silica gel clean up analysis has shown that biodegradation of the hydrocarbons is occurring. The data that has been collected as part of the GWMP program, coupled with the data collected over the past eight years has shown that there is no unacceptable risk of exposure to human and health and the environment.
B22(g)	Monitor the effectiveness of management measures and contingency actions for reducing impacts	Groundwater monitoring was conducted during and after remediation: around excavation areas and along the down gradient site boundary. The data has shown that remediation has not affected groundwater quality and the risk to human health and the environment is low and acceptable.
B22(h)	Procedures for reporting changes to groundwater conditions that have the potential to create unacceptable risks to the Duck River.	The auditor noted that the most recent concentrations of CoPC detected in groundwater as well as the absence of LNAPL have demonstrated there to be no unacceptable risks to on and off-site receptors, as previously discussed in the HHERA (ERM, 2020b).

The auditor supports ERM's recommendation of cessation of groundwater monitoring events. The auditor's opinion is based on the discussion presented in **Section 3** and the evaluation of the data in relation to the relevant conditions of consent in **Table 3**.

The auditor notes that the Stage 1 Area will remain subject to the unexpected finds protocol and relevant conditions outlined within the Stage 1 LTEMP. As the LTEMP will need to be updated to remove the groundwater monitoring, this update will need to be reflected in an updated SAR/SAS.

This report should be regarded as interim advice to the overall review and site audit process and should not be considered a Site Audit Statement under the CLM Act, 1997. This interim audit advice letter will subsequently be referred to and provided as an Annex to the final Site Audit Statement and Site Audit Report.

Sincerely,



GHD Pty Ltd

Andrew Kohlusch

NSW EPA Accredited Auditor

Appendix C

Tables



Table 4. Groundwater Gauging Results
Clyde WARP
Stage 1 Ongoing GME 2 (2021)

Well ID	Gauging Date	TOC Elevation (mAHD)	Total Measured Depth (mbTOC)	Depth to LNAPL (mbTOC)	Depth to Water (mbTOC)	LNAPL Thickness (m)	Corrected Depth to Water (mbTOC)	Corrected Water Elevation (mAHD)	Well Condition/Comments
MW11/24	04-Mar-21	4.210	5.340	-	1.325	-	1.325	2.885	No Odour
MW11/41	04-Mar-21	3.550	-	-	1.290	-	1.290	2.260	No Odour
MW11/42	04-Mar-21	3.440	4.720	-	1.390	-	1.390	2.050	No Odour
MW12/17	04-Mar-21	3.710	5.370	-	0.560	-	0.560	3.150	No Odour
MW18/06	04-Mar-21	4.000	6.940	-	1.170	-	1.170	2.830	No Odour
Notes: TOC=Top of Casing BTOC=Below Top of Casing mAHD=Australian Height Datum m=Meters NA - Not Available									
			-	No Survey Data					



Well ID	Sample Date/Time	Purge Volume (L)	TEMP (°C)	pH	EC (µScm ⁻¹)	DO (mg/L)	Eh (mV)	Comments
MW11/24	8/03/2021 11:00	-	26.8	4.50	10,676	1.69	257.1	Clear, colourless, odourless
MW11/41	8/03/2021 12:30	-	26.5	4.21	11,506	2.85	266.8	Slightly turbid, light brown, odourless
MW11/42	8/03/2021 13:06	-	27.0	6.69	13,471	1.48	-80.4	Brown, turbid, odourless
MW12/17	8/03/2021 11:40	-	25.6	7.07	2,706	2.61	-70.4	Brown, turbid, odourless
MW18/06	8/03/2021 10:40	-	23.8	4.08	19,006	1.28	237.7	Clear, colourless, odourless

Notes:								
Pre	Pre Purging			Eh	Redox			
Post	Post Purging			mV	millivolts			
DO	Dissolved Oxygen			L	Litres			
mg/L	milligrams per litre						Field Staff:	
EC	Electrical Conductivity						Lincoln DeHaas	
µScm ⁻¹	microsiemens per centimetre							



Table 6 - Groundwater Analytical Results
Clyde WARP
Stage 1 Ongoing GME 2 (2021)

ERM

	MNA				TRH Silica Gel Cleanup							BTEX						TRH NEPM (1999)					TRH NEPM (2013)								
	Ferrous Iron - Fe2+	Methane	Nitrate (as N)	Sulphate	TRH >C10-C14 Silica Gel Cleanup	TRH >C10-C16 Silica Gel Cleanup	TRH >C10-C36 Silica Gel Cleanup	TRH >C15-C28 Silica Gel Cleanup	TRH >C16-C34 Silica Gel Cleanup	TRH >C29-C36	TRH >C34-C40 Silica Gel Cleanup	Benzene	Toluene	Ethylbenzene	Xylene (o)	Xylene (m & p)	Xylene Total	Naphthalene	TRH >C6-C9 Fraction	TRH >C10-C14 Fraction	TRH >C15-C28 Fraction	TRH >C29-C36 Fraction	TRH >C10-C36 Fraction	TRH C6-C10 Fraction	TRH C6-C10 less BTEX	TRH >C10-C16 Fraction	TRH >C10-C16 Fraction less N	TRH >C16-C34 Fraction	TRH >C10-C40 Fraction	TRH >C34-C40 Fraction	
EQL	0.05	0.05	0.02	5	50	50	100	100	100	100	100	1	1	1	1	2	3	10	20	50	100	100	100	20	20	50	50	100	100	100	
ANZG (2018) TV - Marine water (95%)												700 ^{#1}	180 ^{#2}	5 ^{#2}	350 ^{#2}	275 ^{#2}		70 ^{#1}													
Clyde - Site Specific HSL D (Sand) 0-<2 m												4800 ^{#3}	NL#3		NL#3			NL#3							6120 ^{#3}		NL#3				
Clyde WARP SSSL - GW VI - Commercial												5000						13000								6200		NL			
Clyde WARP SSSL - GW VI - Construction												NL						NL						-	NL	-	NL	-			-
Clyde WARP SSSL - GW VI - IMW												NL						NL						-	NL	-	NL	-			-
NEPM (1999) GIL - Marine Water												500 950	180	5	350	275		50													
NEPM (2013) - Marine Water												500						50													
NEPM (2013) - Recreational				5000								10	8000	3000			6000														
NHMRC (2019) HBGV - Recreational Water																															

Location_Code	Field_ID	Monitoring_Zone	Sampled_Date_Time	Lab_Report_Number	Sample_Type	8.7	<0.05	<0.02	790	<50	<50	<100	<100	<100	<100	<100	<1	<1	<1	<1	<2	<3	<10	<20	130	300	<100	430	<20	<20	150	150	300	450	<100
MW11/24	MW 11/24	9	8/03/2021	778891	Normal	8.7	<0.05	<0.02	790	<50	<50	<100	<100	<100	<100	<100	<1	<1	<1	<1	<2	<3	<10	<20	230	400	100	730	<20	<20	240	240	500	740	<100
MW11/41	MW 11/41	15	8/03/2021	778891	Normal	53	<0.05	0.04	420	<50	<50	<100	<100	<100	<100	<100	<1	<1	<1	<1	<2	<3	<10	<20	120	600	<100	720	<20	<20	210	210	600	810	<100
MW11/42	MW 11/42	15	8/03/2021	778891	Normal	0.21	2.1	<0.02	140	<50	<50	<100	<100	<100	<100	<100	<1	<1	<1	<1	<2	<3	<10	<20	80	500	<100	580	<20	<20	170	170	500	670	<100
MW12/17	MW 12/17	9	8/03/2021	778891	Normal	2.7	<0.05	0.03	440	<50	<50	<100	<100	<100	<100	<100	<1	<1	<1	<1	<2	<3	<10	<20	80	500	<100	580	<20	<20	170	170	500	670	<100
MW18/06	MW 18/06	9	8/03/2021	778891	Normal	8.8	<0.05	<0.02	840	<50	<50	<100	<100	<100	<100	<100	<1	<1	<1	<1	<2	<3	<10	<20	430	500	200	1130	<20	<20	450	450	600	1050	<100

Statistical Summary																																
Number of Results	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Number of Detects	5	1	2	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5	2	5	0	0	5	5	5	5	5	0
Minimum Concentration	0.21	<0.05	<0.02	140	<50	<50	<100	<100	<100	<100	<100	<1	<1	<1	<1	<2	<3	<10	<20	80	300	<100	430	<20	<20	150	150	300	450	<100		
Minimum Detect	0.21	2.1	0.03	140	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	80	300	100	430	ND	ND	150	150	300	450	ND		
Maximum Concentration	53	2.1	0.04	840	<50	<50	<100	<100	<100	<100	<100	<1	<1	<1	<1	<2	<3	<10	<20	430	600	200	1130	<20	<20	450	450	600	1050	<100		
Maximum Detect	53	2.1	0.04	840	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	430	600	200	1130	ND	ND	450	450	600	1050	ND		
Average Concentration	15	0.44	0.02	526	25	25	50	50	50	50	50	0.5	0.5	0.5	0.5	1	1.5	5	10	198	460	90	718	10	10	244	244	500	744	50		
Median Concentration	8.7	0.025	0.01	440	25	25	50	50	50	50	50	0.5	0.5	0.5	0.5	1	1.5	5	10	130	500	50	720	10	10	210	210	500	740	50		
Standard Deviation	22	0.93	0.014	290	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	141	114	65	261	0	0	120	120	122	218	0		
Number of Guideline Exceedances	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	5	0	5	0	5	0	5
Number of Guideline Exceedances(Detects Only)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	5	0	5	0	5	0	5

Env Stds Comments
#1:Moderate Reliability
#2:Unknown level of species protection; Unknown Reliability
#3:Site Specific - CRC Care Extension Model (2012)



Table 7 Groundwater Trend Analysis Summary
Clyde WARP
Stage 1 Ongoing GME 2 (2021)

Well ID	Benzene	TRH C10-C36 Silica Gel	TRH C6-C9 Fraction
MW11/24	ND	No trend #1	ND
MW11/41	ND	ND	ND
MW11/42	ND	ND	ND
MW12/17	ND	ND	ND
MW18/06	ND	ND	No trend #1
Notes			
#1	Concentrations of this analyte were not detected above the laboratory limit of reporting during Q2 2021 Stage 1 WARP GME		
ND	Concentrations have been consistently reported below the laboratory limit of reporting throughout the period of data collection		

HISTORICAL GROUNDWATER RESULTS TABLE

Well	Reference Elevation	Top Screen Depth	Bottom Screen Depth	Date & Time	Monitoring Round	Water Level	Water Depth bTOC	Water Depth bgl	Units	Comments
MW11/21	4.12	1	5	13/10/2011 0:00	Oct 2011	1.998	2.122	2.122	m	
MW11/21	4.12	1	5	18/06/2013 0:00	Q2 2013	2.17	1.95	1.95	m	No odour, silty bottom
MW11/21	4.12	1	5	24/09/2013 0:00	Q3 2013	1.985	2.135	2.135	m	Silty at base, no odour
MW11/21	4.12	1	5	3/12/2013 0:00	Q4 2013	2.221	1.899	1.899	m	No odour
MW11/21	4.12	1	5	28/03/2014 0:00	Q1 2014	2.225	1.895	1.895	m	No odour
MW11/21	4.12	1	5	19/05/2014 0:00	Q2 2014	2.035	2.085	2.085	m	No odour, silty base
MW11/21	4.12	1	5	9/12/2014 0:00	Q4 2014	2.337	1.783	1.783	m	No odour
MW11/22	4.13	1	5	4/10/2011 0:00	Oct 2011	-0.747	4.877	4.957	m	
MW11/22	4.13	1	5	3/12/2012 0:00	Q4 2012	2.077	2.053	2.133	m	No odour
MW11/22	4.13	1	5	9/12/2013 0:00	Q4 2013	2.481	1.649	1.729	m	No odour
MW11/22	4.13	1	5	11/12/2014 0:00	Q4 2014	2.282	1.848	1.928	m	No odour
MW11/22	4.13	1	5	16/08/2016 0:00	Q2 2016	2.255	1.875	1.955	m	No odour.
MW11/22	4.13	1	5	18/08/2016 0:00	Q2 2016	2.255	1.875	1.955	m	No odour.
MW11/22	4.13	1	5	13/12/2016 0:00		2.215	1.915	1.995	m	No odour.
MW11/23	4.1	1.5	6	6/10/2011 0:00	Oct 2011	1.13	2.97	3.06	m	
MW11/23	4.1	1.5	6	16/08/2016 0:00	Q2 2016	2.285	1.815	1.905	m	No odour.
MW11/23	4.1	1.5	6	17/08/2016 0:00	Q2 2016	2.285	1.815	1.905	m	No odour.
MW11/24	4.21	1	5.5	6/10/2011 0:00	Oct 2011	0.208	4.002	4.072	m	
MW11/24	4.21	1	5.5	6/06/2012 0:00	Q2 2012	2.05	2.16	2.23	m	No odour
MW11/24	4.21	1	5.5	3/12/2012 0:00	Q4 2012	2.3	1.91	1.98	m	No odour
MW11/24	4.21	1	5.5	18/06/2013 0:00	Q2 2013	1.753	2.457	2.527	m	No odour
MW11/24	4.21	1	5.5	3/12/2013 0:00	Q4 2013	2.17	2.04	2.11	m	No odour
MW11/24	4.21	1	5.5	19/05/2014 0:00	Q2 2014	2.06	2.15	2.22	m	No odour
MW11/24	4.21	1	5.5	29/10/2020 0:00		3.575	0.635	0.705	m	No odour
MW11/24	4.21	1	5.5	5/11/2020 0:00		2.779	1.431	1.501	m	No odour
MW11/24	4.21	1	5.5	12/11/2020 0:00		2.675	1.535	1.605	m	No odour
MW11/24	4.21	1	5.5	17/11/2020 0:00		2.655	1.555	1.625	m	No odour
MW11/24	4.21	1	5.5	1/12/2020 0:00		2.721	1.489	1.559	m	No odour
MW11/24	4.21	1	5.5	1/12/2020 0:00		2.721	1.489	1.559	m	No Odour
MW11/24	4.21	1	5.5	4/12/2018 0:00		2.758	1.452	1.522	m	No odour.
MW11/24	4.21	1	5.5	3/06/2019 0:00		2.51	1.7	1.77	m	Hydrocarbon Odour
MW11/24	4.21	1	5.5	19/11/2019 0:00		2.793	1.417	1.487	m	
MW11/24	4.21	1	5.5	30/09/2020 0:00		2.416	1.794	1.864	m	No odour
MW11/24	4.21	1	5.5	13/10/2020 0:00		2.427	1.783	1.853	m	No odour
MW11/24	4.21	1	5.5	20/10/2020 0:00		2.522	1.688	1.758	m	No odour
MW11/24	4.21	1	5.5	9/12/2014 0:00	Q4 2014	2.489	1.721	1.791	m	No odour
MW11/24	4.21	1	5.5	18/08/2016 0:00	Q2 2016	2.067	2.143	2.213	m	No odour.
MW11/24	4.21	1	5.5	13/12/2016 0:00		2.695	1.515	1.585	m	
MW11/24	4.21	1	5.5	23/05/2017 0:00	Q2 2017	2.475	1.735	1.805	m	No odour.
MW11/24	4.21	1	5.5	5/12/2017 0:00	Q4 2017	2.788	1.422	1.492	m	No odour.
MW11/24	4.21	1	5.5	20/06/2018 0:00	Q2 2018	2.385	1.825	1.895	m	Soil organic odour
MW11/27	4.08	1	5.5	6/10/2011 0:00	Oct 2011	-0.295	4.375	4.465	m	
MW11/27	4.08	1	5.5	6/06/2012 0:00	Q2 2012	2.855	1.225	1.315	m	No odour
MW11/27	4.08	1	5.5	3/12/2012 0:00	Q4 2012	2.905	1.175	1.265	m	No odour
MW11/27	4.08	1	5.5	18/06/2013 0:00	Q2 2013	2.598	1.482	1.572	m	Faint chemical odour (not hydrocarbon)
MW11/27	4.08	1	5.5	3/12/2013 0:00	Q4 2013	2.801	1.279	1.369	m	No odour
MW11/27	4.08	1	5.5	19/05/2014 0:00	Q2 2014	2.85	1.23	1.32	m	No odour
MW11/27	4.08	1	5.5	9/12/2014 0:00	Q4 2014	2.925	1.155	1.245	m	No odour
MW11/31	3.85	1	5	6/10/2011 0:00	Oct 2011	2.453	1.397	1.477	m	
MW11/31	3.85	1	5	16/08/2016 0:00	Q2 2016	2.53	1.32	1.4	m	No odour.
MW11/31	3.85	1	5	20/08/2016 0:00	Q2 2016	2.53	1.32	1.4	m	No odour.
MW11/31	3.85	1	5	13/12/2016 0:00		2.795	1.055	1.135	m	No odour.
MW11/31	3.85	1	5	23/05/2017 0:00	Q2 2017	2.824	1.026	1.106	m	No odour.
MW11/31	3.85	1	5	20/06/2018 0:00	Q2 2018	3.445	0.405	0.485	m	No odour
MW11/31	3.85	1	5	4/12/2018 0:00		3.07	0.78	0.86	m	No odour
MW11/31	3.85	1	5	5/06/2019 0:00		2.615	1.235	1.315	m	Hydrocarbon Odour
MW11/31	3.85	1	5	19/11/2019 0:00		3.139	0.711	0.791	m	
MW11/33	3.6	1	4.5	5/10/2011 0:00	Oct 2011	2.082	1.518	1.628	m	
MW11/34	3.58	1	5.5	5/10/2011 0:00	Oct 2011	1.837	1.743	1.813	m	
MW11/34	3.58	1	5.5	15/08/2016 0:00	Q2 2016	1.86	1.72	1.79	m	No odour.
MW11/38	3.54	1	5	6/10/2011 0:00	Oct 2011	1.556	1.984	2.054	m	
MW11/38	3.54	1	5	6/06/2012 0:00	Q2 2012	1.975	1.565	1.635	m	No odour
MW11/38	3.54	1	5	18/09/2012 0:00	Q3 2012	1.945	1.595	1.665	m	No odour
MW11/38	3.54	1	5	10/12/2012 0:00	Q4 2012	2.07	1.47	1.54	m	No odour

Well	Reference Elevation	Top Screen Depth	Bottom Screen Depth	Date & Time	Monitoring Round	Water Level	Water Depth bTOC	Water Depth bgl	Units	Comments
MW11/38	3.54	1	5	13/03/2013 0:00	Q1 2013	2.187	1.353	1.423	m	Hydrocarbon odour
MW11/38	3.54	1	5	18/06/2013 0:00	Q2 2013	1.862	1.678	1.748	m	No odour
MW11/38	3.54	1	5	24/09/2013 0:00	Q3 2013	1.951	1.589	1.659	m	No odour
MW11/38	3.54	1	5	3/12/2013 0:00	Q4 2013	2.116	1.424	1.494	m	No odour
MW11/38	3.54	1	5	28/03/2014 0:00	Q1 2014	2.146	1.394	1.464	m	No odour
MW11/38	3.54	1	5	19/05/2014 0:00	Q2 2014	1.92	1.62	1.69	m	No odour
MW11/38	3.54	1	5	9/12/2014 0:00	Q4 2014	2.168	1.372	1.442	m	No odour
MW11/41	3.55	1	4.5	4/10/2011 0:00	Oct 2011	-0.675	4.225	4.595	m	
MW11/41	3.55	1	4.5	19/03/2012 0:00	Q1 2012	2.301	1.249	1.619	m	
MW11/41	3.55	1	4.5	5/06/2012 0:00	Q2 2012	1.98	1.57	1.94	m	No odour
MW11/41	3.55	1	4.5	17/09/2012 0:00	Q3 2012	1.875	1.675	2.045	m	No odour
MW11/41	3.55	1	4.5	3/12/2012 0:00	Q4 2012	2.045	1.505	1.875	m	No odour
MW11/41	3.55	1	4.5	13/03/2013 0:00	Q1 2013	2.111	1.439	1.809	m	No odour
MW11/41	3.55	1	4.5	5/06/2019 0:00		1.79	1.76	2.13	m	Slight Hydrocarbon odour
MW11/41	3.55	1	4.5	20/11/2019 0:00		1.644	1.906	2.276	m	
MW11/41	3.55	1	4.5	2/12/2020 0:00		1.989	1.561	1.931	m	No odour
MW11/41	3.55	1	4.5	2/12/2020 0:00		1.989	1.561	1.931	m	No Odour
MW11/41	3.55	1	4.5	15/08/2016 0:00	Q2 2016	1.72	1.83	2.2	m	No odour.
MW11/41	3.55	1	4.5	13/12/2016 0:00		2.165	1.385	1.755	m	No odour.
MW11/41	3.55	1	4.5	23/05/2017 0:00	Q2 2017	1.618	1.932	2.302	m	No odour.
MW11/41	3.55	1	4.5	6/12/2017 0:00	Q4 2017	2.009	1.541	1.911	m	Hydrogen Sulfide odour.
MW11/41	3.55	1	4.5	21/06/2018 0:00	Q2 2018	1.705	1.845	2.215	m BTOC	No odour
MW11/41	3.55	1	4.5	4/12/2018 0:00		2.075	1.475	1.845	m	No odour
MW11/41	3.55	1	4.5	17/06/2013 0:00	Q2 2013	2.054	1.496	1.866	m	No odour
MW11/41	3.55	1	4.5	23/09/2013 0:00	Q3 2013	1.801	1.749	2.119	m	Surface water in gatic prior to gauging, slight hydrocarbon odour.
MW11/41	3.55	1	4.5	3/12/2013 0:00	Q4 2013	2.005	1.545	1.915	m	No odour
MW11/41	3.55	1	4.5	28/03/2014 0:00	Q1 2014	2.199	1.351	1.721	m	No odour
MW11/41	3.55	1	4.5	19/05/2014 0:00	Q2 2014	2.105	1.445	1.815	m	No odour
MW11/41	3.55	1	4.5	9/12/2014 0:00	Q4 2014	2.178	1.372	1.742	m	No odour
MW11/42	3.44	1	5	4/10/2011 0:00	Oct 2011	1.897	1.543	1.623	m	
MW11/42	3.44	1	5	19/03/2012 0:00	Q1 2012	2.133	1.307	1.387	m	
MW11/42	3.44	1	5	5/06/2012 0:00	Q2 2012	1.59	1.85	1.93	m	No odour
MW11/42	3.44	1	5	17/09/2012 0:00	Q3 2012	1.475	1.965	2.045	m	No odour
MW11/42	3.44	1	5	3/12/2012 0:00	Q4 2012	1.455	1.985	2.065	m	No odour
MW11/42	3.44	1	5	13/03/2013 0:00	Q1 2013	1.833	1.607	1.687	m	No odour
MW11/42	3.44	1	5	5/06/2019 0:00		1.165	2.275	2.355	m	Exisiting Hydrasleeve stuck in well. Unable to gauge total depth.
MW11/42	3.44	1	5	1/12/2020 0:00		1.946	1.494	1.574	m	HydroCarbon odour
MW11/42	3.44	1	5	16/08/2016 0:00	Q2 2016	1.68	1.76	1.84	m	No odour.
MW11/42	3.44	1	5	13/12/2016 0:00		1.195	2.245	2.325	m	No odour.
MW11/42	3.44	1	5	25/05/2017 0:00	Q2 2017	1.297	2.143	2.223	m	
MW11/42	3.44	1	5	6/12/2017 0:00	Q4 2017	1.525	1.915	1.995	m	Hydrocarbon odour.
MW11/42	3.44	1	5	21/06/2018 0:00	Q2 2018	1.206	2.234	2.314	m BTOC	Soil organic odour
MW11/42	3.44	1	5	4/12/2018 0:00		2.035	1.405	1.485	m	No odour, previous sleeve caught in well.
MW11/42	3.44	1	5	17/06/2013 0:00	Q2 2013	1.618	1.822	1.902	m	No odour
MW11/42	3.44	1	5	23/09/2013 0:00	Q3 2013	1.583	1.857	1.937	m	No odour
MW11/42	3.44	1	5	2/12/2013 0:00	Q4 2013	1.583	1.857	1.937	m	No odour
MW11/42	3.44	1	5	28/03/2014 0:00	Q1 2014	1.575	1.865	1.945	m	No odour
MW11/42	3.44	1	5	19/05/2014 0:00	Q2 2014	1.334	2.106	2.186	m	No odour
MW11/42	3.44	1	5	9/12/2014 0:00	Q4 2014	1.86	1.58	1.66	m	No odour
MW12/16	4	2	6	22/03/2012 0:00	Q1 2012	3.257	0.743	0.693	mAHD	
MW12/16	4	2	6	6/06/2012 0:00	Q2 2012	2.92	1.08	1.03	m	Chemical odour
MW12/16	4	2	6	18/09/2012 0:00	Q3 2012	2.29	1.71	1.66	m	Hydrocarbon odour
MW12/16	4	2	6	3/12/2012 0:00	Q4 2012	2.715	1.285	1.235	m	Strong hydrocarbon odour
MW12/16	4	2	6	13/03/2013 0:00	Q1 2013	3.144	0.86	0.81	m	LNAPL present
MW12/16	4	2	6	18/06/2013 0:00	Q2 2013	3.052	0.948	0.898	m	Strong odour (texta)
MW12/16	4	2	6	13/12/2016 0:00		2.96	1.04	0.99	m	No measureable LNAPL. Dark brown globules, strong hydrocarbon odour, hydrasleeve not installed.
MW12/16	4	2	6	23/05/2017 0:00	Q2 2017	3.26	0.74	0.69	m	LNAPL present. No sample taken.
MW12/16	4	2	6	4/12/2018 0:00		2.405	1.595	1.545	m	Strong hydrocarbon odour.
MW12/16	4	2	6	24/09/2013 0:00	Q3 2013	2.259	1.743	1.693	m	LNAPL present, light brown colour with solvent odour, confirmed with bailer
MW12/16	4	2	6	3/12/2013 0:00	Q4 2013	2.794	1.206	1.156	m	Strong chemical paint thinner odour. 1 mm of light brown LNAPL in bailer
MW12/16	4	2	6	28/03/2014 0:00	Q1 2014	3.144	0.856	0.806	m	Heavy sheen, solvent odour, light brown LNAPL globules in bailer.
MW12/16	4	2	6	19/05/2014 0:00	Q2 2014	3.058	0.942	0.892	m	Dark brown LNAPL, confirmed with bailer
MW12/16	4	2	6	10/12/2014 0:00	Q4 2014	2.8	1.2	1.15	m	LNAPL present in well when HydroSleeve retrieved. Not sampled.



Appendix D History GW Levels Stage 1

Well	Reference Elevation	Top Screen Depth	Bottom Screen Depth	Date & Time	Monitoring Round	Water Level	Water Depth bTOC	Water Depth bgl	Units	Comments
MW12/16	4	2	6	16/08/2016 0:00	Q2 2016	2.3	1.7	1.65		Strong hydrocarbon/chemical odour, 2cm of LNAPL present in bailer.
MW12/17	3.71	2.5	6	22/03/2012 0:00	Q1 2012	3.218	0.492	0.782	mAHD	
MW12/17	3.71	2.5	6	6/06/2012 0:00	Q2 2012	2.775	0.935	1.225	m	
MW12/17	3.71	2.5	6	3/12/2012 0:00	Q4 2012	3.095	0.615	0.905	m	Slight hydrocarbon odour
MW12/17	3.71	2.5	6	18/06/2013 0:00	Q2 2013	2.798	0.912	1.202	m	Odour (non-petroleum)
MW12/17	3.71	2.5	6	3/12/2013 0:00	Q4 2013	2.955	0.755	1.045	m	No odour
MW12/17	3.71	2.5	6	19/05/2014 0:00	Q2 2014	2.888	0.822	1.112	m	No odour
MW12/17	3.71	2.5	6	2/12/2020 0:00		2.696	1.014	1.304		No Odour
MW12/17	3.71	2.5	6	29/10/2020 0:00		2.975	0.735	1.025	m	No odour
MW12/17	3.71	2.5	6	5/11/2020 0:00		2.902	0.808	1.098	m	No odour
MW12/17	3.71	2.5	6	12/11/2020 0:00		2.81	0.9	1.19	m	No odour
MW12/17	3.71	2.5	6	17/11/2020 0:00		2.523	1.187	1.477	m	No odour
MW12/17	3.71	2.5	6	1/12/2020 0:00		2.667	1.043	1.333	m	No odour
MW12/17	3.71	2.5	6	2/12/2020 0:00		2.696	1.014	1.304	m	No odour
MW12/17	3.71	2.5	6	9/12/2014 0:00	Q4 2014	3.162	0.548	0.838		No odour
MW12/17	3.71	2.5	6	16/08/2016 0:00	Q2 2016	2.625	1.085	1.375		No odour.
MW12/17	3.71	2.5	6	13/12/2016 0:00		3.145	0.565	0.855		
MW12/17	3.71	2.5	6	30/09/2020 0:00		2.843	0.867	1.157	m	No odour
MW12/17	3.71	2.5	6	13/10/2020 0:00		2.916	0.794	1.084	m	No odour
MW12/17	3.71	2.5	6	20/10/2020 0:00		2.95	0.76	1.05	m	No odour
MW18/06	4			4/12/2018 0:00		2.27	1.73			Strong hydrocarbon odour.
MW18/06	4			30/09/2020 0:00		1.902	2.098		m	No odour
MW18/06	4			13/10/2020 0:00		2.023	1.977		m	No odour
MW18/06	4			20/10/2020 0:00		2.111	1.889		m	No odour
MW18/06	4			29/10/2020 0:00		2.23	1.77		m	No odour
MW18/06	4			5/11/2020 0:00		2.33	1.67		m	No odour
MW18/06	4			12/11/2020 0:00		2.355	1.645		m	No odour
MW18/06	4			17/11/2020 0:00		2.37	1.63		m	No odour
MW18/06	4			1/12/2020 0:00		2.479	1.521		m	No odour
MW18/06	4			1/12/2020 0:00		2.479	1.521			No Odour
MW94/GX	3.732			20/02/2008 0:00	Feb 2008	2.74	0.992	0.992	m	
MW94/GX	3.732			10/11/2008 0:00	Nov 2008	2.467	1.265	1.265	m	
MW94/GX	3.732			15/04/2009 0:00	Apr 2009	2.049	0.938	0.938	m	
MW94/GX	3.732			16/11/2009 0:00	Nov 2009	1.223	1.223	1.223	m	
MW94/GX	3.732			23/06/2010 0:00	Q2 2010	1.643	1.344	1.344	m	
MW94/GX	3.732			22/11/2010 0:00	Q4 2010	1.91	1.077	1.077	m	
MW94/GX	3.732			19/05/2014 0:00	Q2 2014	2.217	1.515	1.515	m	No odour
MW94/GX	3.732			6/06/2011 0:00	Q2 2011	1.934	1.053	1.053	m	
MW94/GX	3.732			6/10/2011 0:00	Q4 2011	1.88	1.107	1.107	m	
MW94/GX	3.732			6/06/2012 0:00	Q2 2012	1.727	1.26	1.26	m	No odour
MW94/GX	3.732			4/12/2012 0:00	Q4 2012	1.502	1.485	1.485	m	No odour
MW94/GX	3.732			17/06/2013 0:00	Q2 2013	1.772	1.215	1.215	m	No odour
MW94/GX	3.732			3/12/2013 0:00	Q4 2013	1.751	1.236	1.236	m	No odour
MW98/9	3.725	0.5	3.5	21/02/2008 0:00	Feb 2008	3.96	0.58	0.65	m	
MW98/9	3.725	0.5	3.5	11/11/2008 0:00	Nov 2008	4.004	0.536	0.606	m	
MW98/9	3.725	0.5	3.5	15/04/2009 0:00	Apr 2009	3.016	0.779	0.849	m	
MW98/9	3.725	0.5	3.5	16/11/2009 0:00	Nov 2009	0.327	0.327	0.397	m	
MW98/9	3.725	0.5	3.5	23/06/2010 0:00	Q2 2010	1.856	1.939	2.009	m	
MW98/9	3.725	0.5	3.5	22/11/2010 0:00	Q4 2010	3.297	0.498	0.568	m	
MW98/9	3.725	0.5	3.5	19/05/2014 0:00	Q2 2014	2.432	1.293	1.363	m	No odour
MW98/9	3.725	0.5	3.5	9/12/2014 0:00	Q4 2014	3.4	0.325	0.395		No odour
MW98/9	3.725	0.5	3.5	6/06/2011 0:00	Q2 2011	2.588	1.207	1.277	m	
MW98/9	3.725	0.5	3.5	6/10/2011 0:00	Q4 2011	3.003	0.792	0.862	m	
MW98/9	3.725	0.5	3.5	6/06/2012 0:00	Q2 2012	2.61	1.115	1.185	m	
MW98/9	3.725	0.5	3.5	3/12/2012 0:00	Q4 2012	3.27	0.455	0.525	m	No odour
MW98/9	3.725	0.5	3.5	18/06/2013 0:00	Q2 2013	2.377	1.348	1.418	m	No odour
MW98/9	3.725	0.5	3.5	3/12/2013 0:00	Q4 2013	3.067	0.658	0.728	m	No odour
W91/2	3.892	1.5	4.5	20/02/2008 0:00	Feb 2008	3.051	1.219	0.474	m	



Appendix D History LNAPL Stage 1

Well	TOC Elevation (m AHD)	Date Time	Monitoring Round	Top Depth	Water Depth	Product Depth	Base Depth	LNAPL Thickness	Product Corrected Water Level	LNAPL Rel Density
MW11/21	4.12	13/10/2011 0:00	Oct 2011						1.998	0.76
MW11/21	4.12	18/06/2013 0:00	Q2 2013	1.95	1.95				2.17	0.76
MW11/21	4.12	24/09/2013 0:00	Q3 2013	2.135	2.135				1.985	0.76
MW11/21	4.12	3/12/2013 0:00	Q4 2013	1.899	1.899				2.221	0.76
MW11/21	4.12	28/03/2014 0:00	Q1 2014	1.895	1.895				2.225	0.76
MW11/21	4.12	19/05/2014 0:00	Q2 2014	2.085	2.085				2.035	0.76
MW11/21	4.12	24/09/2014 0:00	Q3 2014							0.76
MW11/21	4.12	9/12/2014 0:00	Q4 2014	1.783	1.783				2.337	0.76
MW11/21	4.12	15/08/2016 0:00								0.76
MW11/22	4.13	4/10/2011 0:00	Oct 2011						-0.747	0.76
MW11/22	4.13	3/12/2012 0:00	Q4 2012	2.053	2.053				2.077	0.76
MW11/22	4.13	9/12/2013 0:00	Q4 2013	1.649	1.649				2.481	0.76
MW11/22	4.13	11/12/2014 0:00	Q4 2014	1.848	1.848				2.282	0.76
MW11/22	4.13	16/08/2016 0:00	Q2 2016	1.875	1.875				2.255	0.76
MW11/22	4.13	18/08/2016 0:00	Q2 2016	1.875	1.875				2.255	0.76
MW11/22	4.13	13/12/2016 0:00		1.915	1.915				2.215	0.76
MW11/23	4.1	6/10/2011 0:00	Oct 2011						1.13	0.76
MW11/23	4.1	16/08/2016 0:00	Q2 2016	1.815	1.815				2.285	0.76
MW11/23	4.1	17/08/2016 0:00	Q2 2016	1.815	1.815				2.285	0.76
MW11/24	4.21	6/10/2011 0:00	Oct 2011						0.208	0.76
MW11/24	4.21	6/06/2012 0:00	Q2 2012	2.16	2.16				2.05	0.76
MW11/24	4.21	3/12/2012 0:00	Q4 2012	1.91	1.91				2.3	0.76
MW11/24	4.21	18/06/2013 0:00	Q2 2013	2.457	2.457				1.753	0.76
MW11/24	4.21	3/12/2013 0:00	Q4 2013	2.04	2.04				2.17	0.76
MW11/24	4.21	19/05/2014 0:00	Q2 2014	2.15	2.15				2.06	0.76
MW11/24	4.21	29/10/2020 0:00		0.635	0.635				3.575	0.76
MW11/24	4.21	5/11/2020 0:00		1.431	1.431				2.779	0.76
MW11/24	4.21	12/11/2020 0:00		1.535	1.535				2.675	0.76
MW11/24	4.21	17/11/2020 0:00		1.555	1.555				2.655	0.76
MW11/24	4.21	1/12/2020 0:00		1.489	1.489				2.721	0.76
MW11/24	4.21	1/12/2020 0:00		1.489	1.489				2.721	0.76
MW11/24	4.21	4/12/2018 0:00		1.452	1.452				2.758	0.76
MW11/24	4.21	3/06/2019 0:00		1.7	1.7				2.51	0.76
MW11/24	4.21	19/11/2019 0:00		1.417	1.417				2.793	0.76
MW11/24	4.21	30/09/2020 0:00		1.794	1.794				2.416	0.76
MW11/24	4.21	13/10/2020 0:00		1.783	1.783				2.427	0.76
MW11/24	4.21	20/10/2020 0:00		1.688	1.688				2.522	0.76
MW11/24	4.21	9/12/2014 0:00	Q4 2014	1.721	1.721				2.489	0.76
MW11/24	4.21	18/08/2016 0:00	Q2 2016	2.143	2.143				2.067	0.76
MW11/24	4.21	13/12/2016 0:00		1.515	1.515				2.695	0.76
MW11/24	4.21	23/05/2017 0:00	Q2 2017	1.735	1.735				2.475	0.76
MW11/24	4.21	5/12/2017 0:00	Q4 2017	1.422	1.422				2.788	0.76
MW11/24	4.21	20/06/2018 0:00	Q2 2018	1.825	1.825				2.385	0.76
MW11/27	4.08	16/08/2016 0:00								0.76
MW11/27	4.08	6/06/2012 0:00	Q2 2012	1.225	1.225				2.855	0.76
MW11/27	4.08	3/12/2012 0:00	Q4 2012	1.175	1.175				2.905	0.76
MW11/27	4.08	18/06/2013 0:00	Q2 2013	1.482	1.482				2.598	0.76
MW11/27	4.08	3/12/2013 0:00	Q4 2013	1.279	1.279				2.801	0.76
MW11/27	4.08	19/05/2014 0:00	Q2 2014	1.23	1.23				2.85	0.76
MW11/27	4.08	9/12/2014 0:00	Q4 2014	1.155	1.155				2.925	0.76
MW11/27	4.08	6/10/2011 0:00	Oct 2011						-0.295	0.76
MW11/31	3.85	6/10/2011 0:00	Oct 2011						2.453	0.76
MW11/31	3.85	16/08/2016 0:00	Q2 2016	1.32	1.32				2.53	0.76



Appendix D History LNAPL Stage 1

Well	TOC Elevation (m AHD)	Date Time	Monitoring Round	Top Depth	Water Depth	Product Depth	Base Depth	LNAPL Thickness	Product Corrected Water Level	LNAPL Rel Density
MW11/31	3.85	20/08/2016 0:00	Q2 2016	1.32	1.32				2.53	0.76
MW11/31	3.85	13/12/2016 0:00		1.055	1.055				2.795	0.76
MW11/31	3.85	23/05/2017 0:00	Q2 2017	1.026	1.026				2.824	0.76
MW11/31	3.85	20/06/2018 0:00	Q2 2018	0.405	0.405				3.445	0.76
MW11/31	3.85	4/12/2018 0:00		0.78	0.78				3.07	0.76
MW11/31	3.85	5/06/2019 0:00		1.235	1.235				2.615	0.76
MW11/31	3.85	19/11/2019 0:00		0.711	0.711				3.139	0.76
MW11/32	3.68	14/10/2011 0:00	Oct 2011						0.242	0.76
MW11/33	3.6	5/10/2011 0:00	Oct 2011						2.082	0.76
MW11/33	3.6	15/08/2016 0:00								0.76
MW11/33	3.6	18/08/2016 0:00								0.76
MW11/34	3.58	5/10/2011 0:00	Oct 2011						1.837	0.76
MW11/34	3.58	15/08/2016 0:00	Q2 2016	1.72	1.72				1.86	0.76
MW11/38	3.54	6/10/2011 0:00	Oct 2011						1.556	0.76
MW11/38	3.54	6/06/2012 0:00	Q2 2012	1.565	1.565				1.975	0.76
MW11/38	3.54	18/09/2012 0:00	Q3 2012	1.595	1.595				1.945	0.76
MW11/38	3.54	10/12/2012 0:00	Q4 2012	1.47	1.47				2.07	0.76
MW11/38	3.54	13/03/2013 0:00	Q1 2013	1.353	1.353				2.187	0.76
MW11/38	3.54	18/06/2013 0:00	Q2 2013	1.678	1.678				1.862	0.76
MW11/38	3.54	16/08/2016 0:00								0.76
MW11/38	3.54	24/09/2013 0:00	Q3 2013	1.589	1.589				1.951	0.76
MW11/38	3.54	3/12/2013 0:00	Q4 2013	1.424	1.424				2.116	0.76
MW11/38	3.54	28/03/2014 0:00	Q1 2014	1.394	1.394				2.146	0.76
MW11/38	3.54	19/05/2014 0:00	Q2 2014	1.62	1.62				1.92	0.76
MW11/38	3.54	24/09/2014 0:00	Q3 2014							0.76
MW11/38	3.54	9/12/2014 0:00	Q4 2014	1.372	1.372				2.168	0.76
MW11/41	3.55	4/10/2011 0:00	Oct 2011						-0.675	0.76
MW11/41	3.55	19/03/2012 0:00	Q1 2012	1.249	1.249				2.301	0.76
MW11/41	3.55	5/06/2012 0:00	Q2 2012	1.57	1.57				1.98	0.76
MW11/41	3.55	17/09/2012 0:00	Q3 2012	1.675	1.675				1.875	0.76
MW11/41	3.55	3/12/2012 0:00	Q4 2012	1.505	1.505				2.045	0.76
MW11/41	3.55	13/03/2013 0:00	Q1 2013	1.439	1.439				2.111	0.76
MW11/41	3.55	4/12/2018 0:00		1.475	1.475				2.075	0.76
MW11/41	3.55	5/06/2019 0:00		1.76	1.76				1.79	0.76
MW11/41	3.55	20/11/2019 0:00		1.906	1.906				1.644	0.76
MW11/41	3.55	2/12/2020 0:00		1.561	1.561				1.989	0.76
MW11/41	3.55	2/12/2020 0:00		1.561	1.561				1.989	0.76
MW11/41	3.55	9/12/2014 0:00	Q4 2014	1.372	1.372				2.178	0.76
MW11/41	3.55	15/08/2016 0:00	Q2 2016	1.83	1.83				1.72	0.76
MW11/41	3.55	13/12/2016 0:00		1.385	1.385				2.165	0.76
MW11/41	3.55	23/05/2017 0:00	Q2 2017	1.932	1.932				1.618	0.76
MW11/41	3.55	6/12/2017 0:00	Q4 2017	1.541	1.541				2.009	0.76
MW11/41	3.55	21/06/2018 0:00	Q2 2018	1.845	1.845				1.705	0.76
MW11/41	3.55	17/06/2013 0:00	Q2 2013	1.496	1.496				2.054	0.76
MW11/41	3.55	23/09/2013 0:00	Q3 2013	1.749	1.749				1.801	0.76
MW11/41	3.55	3/12/2013 0:00	Q4 2013	1.545	1.545				2.005	0.76
MW11/41	3.55	28/03/2014 0:00	Q1 2014	1.351	1.351				2.199	0.76
MW11/41	3.55	19/05/2014 0:00	Q2 2014	1.445	1.445				2.105	0.76
MW11/41	3.55	24/09/2014 0:00	Q3 2014							0.76
MW11/42	3.44	4/10/2011 0:00	Oct 2011						1.897	0.76
MW11/42	3.44	19/03/2012 0:00	Q1 2012	1.307	1.307				2.133	0.76
MW11/42	3.44	5/06/2012 0:00	Q2 2012	1.85	1.85				1.59	0.76
MW11/42	3.44	17/09/2012 0:00	Q3 2012	1.965	1.965				1.475	0.76



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Well	TOC Elevation (m AHD)	Date Time	Monitoring Round	Top Depth	Water Depth	Product Depth	Base Depth	LNAPL Thickness	Product Corrected Water Level	LNAPL Rel Density
MW11/42	3.44	3/12/2012 0:00	Q4 2012	1.985	1.985				1.455	0.76
MW11/42	3.44	13/03/2013 0:00	Q1 2013	1.607	1.607				1.833	0.76
MW11/42	3.44	4/12/2018 0:00		1.405	1.405				2.035	0.76
MW11/42	3.44	5/06/2019 0:00		2.275	2.275				1.165	0.76
MW11/42	3.44	1/12/2020 0:00		1.494	1.494				1.946	0.76
MW11/42	3.44	1/12/2020 0:00								0.76
MW11/42	3.44	9/12/2014 0:00	Q4 2014	1.58	1.58				1.86	0.76
MW11/42	3.44	16/08/2016 0:00	Q2 2016	1.76	1.76				1.68	0.76
MW11/42	3.44	13/12/2016 0:00		2.245	2.245				1.195	0.76
MW11/42	3.44	25/05/2017 0:00	Q2 2017	2.143	2.143				1.297	0.76
MW11/42	3.44	6/12/2017 0:00	Q4 2017	1.915	1.915				1.525	0.76
MW11/42	3.44	21/06/2018 0:00	Q2 2018	2.234	2.234				1.206	0.76
MW11/42	3.44	17/06/2013 0:00	Q2 2013	1.822	1.822				1.618	0.76
MW11/42	3.44	23/09/2013 0:00	Q3 2013	1.857	1.857				1.583	0.76
MW11/42	3.44	2/12/2013 0:00	Q4 2013	1.857	1.857				1.583	0.76
MW11/42	3.44	28/03/2014 0:00	Q1 2014	1.865	1.865				1.575	0.76
MW11/42	3.44	19/05/2014 0:00	Q2 2014	2.106	2.106				1.334	0.76
MW11/42	3.44	24/09/2014 0:00	Q3 2014							0.76
MW12/16	4	16/08/2016 0:00	Q2 2016	1.675	1.7	1.675		0.025	2.319	0.76
MW12/16	4	13/12/2016 0:00		1.04	1.04				2.96	0.76
MW12/16	4	23/05/2017 0:00	Q2 2017	0.716	0.74	0.716		0.024	3.27824	0.76
MW12/16	4	4/12/2018 0:00		1.595	1.595				2.405	0.76
MW12/16	4	3/06/2019 0:00		0.87		0.87				0.76
MW12/16	4	24/09/2013 0:00	Q3 2013	1.74	1.743	1.74		0.003	2.26128	0.76
MW12/16	4	3/12/2013 0:00	Q4 2013	1.206	1.206				2.794	0.76
MW12/16	4	28/03/2014 0:00	Q1 2014	0.855	0.856	0.855		0.001	3.14476	0.76
MW12/16	4	19/05/2014 0:00	Q2 2014	0.922	0.942	0.922		0.02	3.0732	0.76
MW12/16	4	24/09/2014 0:00	Q3 2014							0.76
MW12/16	4	10/12/2014 0:00	Q4 2014	1.18	1.2	1.18		0.02	2.8152	0.76
MW12/16	4	22/03/2012 0:00	Q1 2012						3.257	0.76
MW12/16	4	6/06/2012 0:00	Q2 2012	1.08	1.08				2.92	0.76
MW12/16	4	18/09/2012 0:00	Q3 2012	1.71	1.71				2.29	0.76
MW12/16	4	3/12/2012 0:00	Q4 2012	1.285	1.285				2.715	0.76
MW12/16	4	13/03/2013 0:00	Q1 2013	0.855	0.86	0.855		0.005	3.1478	0.76
MW12/16	4	18/06/2013 0:00	Q2 2013	0.948	0.948				3.052	0.76
MW12/17	3.71	22/03/2012 0:00	Q1 2012						3.218	0.76
MW12/17	3.71	6/06/2012 0:00	Q2 2012	0.935	0.935				2.775	0.76
MW12/17	3.71	3/12/2012 0:00	Q4 2012	0.615	0.615				3.095	0.76
MW12/17	3.71	18/06/2013 0:00	Q2 2013	0.912	0.912				2.798	0.76
MW12/17	3.71	3/12/2013 0:00	Q4 2013	0.755	0.755				2.955	0.76
MW12/17	3.71	19/05/2014 0:00	Q2 2014	0.822	0.822				2.888	0.76
MW12/17	3.71	2/12/2020 0:00		1.014	1.014				2.696	0.76
MW12/17	3.71	2/12/2020 0:00		1.014	1.014				2.696	0.76
MW12/17	3.71	20/10/2020 0:00		0.76	0.76				2.95	0.76
MW12/17	3.71	29/10/2020 0:00		0.735	0.735				2.975	0.76
MW12/17	3.71	5/11/2020 0:00		0.808	0.808				2.902	0.76
MW12/17	3.71	12/11/2020 0:00		0.9	0.9				2.81	0.76
MW12/17	3.71	17/11/2020 0:00		1.187	1.187				2.523	0.76
MW12/17	3.71	1/12/2020 0:00		1.043	1.043				2.667	0.76
MW12/17	3.71	24/09/2014 0:00	Q3 2014							0.76
MW12/17	3.71	9/12/2014 0:00	Q4 2014	0.548	0.548				3.162	0.76
MW12/17	3.71	16/08/2016 0:00	Q2 2016	1.085	1.085				2.625	0.76
MW12/17	3.71	13/12/2016 0:00		0.565	0.565				3.145	0.76



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Well	TOC Elevation (m AHD)	Date Time	Monitoring Round	Top Depth	Water Depth	Product Depth	Base Depth	LNAPL Thickness	Product Corrected Water Level	LNAPL Rel Density
MW12/17	3.71	30/09/2020 0:00		0.867	0.867				2.843	0.76
MW12/17	3.71	13/10/2020 0:00		0.794	0.794				2.916	0.76
MW18/06		4/12/2018 0:00		1.73	1.73				2.27	0.76
MW18/06		30/09/2020 0:00		2.098	2.098				1.902	0.76
MW18/06		13/10/2020 0:00		1.977	1.977				2.023	0.76
MW18/06		1/12/2020 0:00		1.521	1.521				2.479	0.76
MW18/06		20/10/2020 0:00		1.889	1.889				2.111	0.76
MW18/06		29/10/2020 0:00		1.77	1.77				2.23	0.76
MW18/06		5/11/2020 0:00		1.67	1.67				2.33	0.76
MW18/06		12/11/2020 0:00		1.645	1.645				2.355	0.76
MW18/06		17/11/2020 0:00		1.63	1.63				2.37	0.76
MW18/06		1/12/2020 0:00		1.521	1.521				2.479	0.76
MW94/6X	3.732	20/02/2008 0:00	Feb 2008	0.992	0.992				2.74	0.76
MW94/6X	3.732	10/11/2008 0:00	Nov 2008	1.265	1.265				2.467	0.76
MW94/6X	3.732	15/04/2009 0:00	Apr 2009	0.938	0.938				2.049	0.76
MW94/6X	3.732	16/11/2009 0:00	Nov 2009	1.223	1.223				1.223	0.76
MW94/6X	3.732	23/06/2010 0:00	Q2 2010	1.344	1.344				1.643	0.76
MW94/6X	3.732	22/11/2010 0:00	Q4 2010	1.077	1.077				1.91	0.76
MW94/6X	3.732	19/05/2014 0:00	Q2 2014	1.515	1.515				2.217	0.76
MW94/6X	3.732	4/12/2014 0:00	Q4 2014							0.76
MW94/6X	3.732	6/06/2011 0:00	Q2 2011	1.053	1.053				1.934	0.76
MW94/6X	3.732	6/10/2011 0:00	Q4 2011	1.107	1.107				1.88	0.76
MW94/6X	3.732	6/06/2012 0:00	Q2 2012	1.26	1.26				1.727	0.76
MW94/6X	3.732	4/12/2012 0:00	Q4 2012	1.485	1.485				1.502	0.76
MW94/6X	3.732	17/06/2013 0:00	Q2 2013	1.215	1.215				1.772	0.76
MW94/6X	3.732	3/12/2013 0:00	Q4 2013	1.236	1.236				1.751	0.76
MW98/9	3.725	21/02/2008 0:00	Feb 2008	0.58	0.58				3.96	0.76
MW98/9	3.725	11/11/2008 0:00	Nov 2008	0.536	0.536				4.004	0.76
MW98/9	3.725	15/04/2009 0:00	Apr 2009	0.779	0.779				3.016	0.76
MW98/9	3.725	16/11/2009 0:00	Nov 2009	0.327	0.327				0.327	0.76
MW98/9	3.725	23/06/2010 0:00	Q2 2010	1.939	1.939				1.856	0.76
MW98/9	3.725	22/11/2010 0:00	Q4 2010	0.498	0.498				3.297	0.76
MW98/9	3.725	19/05/2014 0:00	Q2 2014	1.293	1.293				2.432	0.76
MW98/9	3.725	9/12/2014 0:00	Q4 2014	0.325	0.325				3.4	0.76
MW98/9	3.725	16/08/2016 0:00								0.76
MW98/9	3.725	6/06/2011 0:00	Q2 2011	1.207	1.207				2.588	0.76
MW98/9	3.725	6/10/2011 0:00	Q4 2011	0.792	0.792				3.003	0.76
MW98/9	3.725	6/06/2012 0:00	Q2 2012	1.115	1.115				2.61	0.76
MW98/9	3.725	3/12/2012 0:00	Q4 2012	0.455	0.455				3.27	0.76
MW98/9	3.725	18/06/2013 0:00	Q2 2013	1.348	1.348				2.377	0.76
MW98/9	3.725	3/12/2013 0:00	Q4 2013	0.658	0.658				3.067	0.76
W91/2	3.892	20/02/2008 0:00	Feb 2008	1.219	1.219				3.051	0.76
W91/2	3.892	10/11/2008 0:00	Nov 2008							0.76

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Acquisition	Field ID	Sampled Date	Sample Type	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840	841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880	881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949	950	951	952	953	954	955	956	957	958	959	960	961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	998	999	1000
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EQ1	0.05	0.1	1	0.05	0.05	100	0.05	0.05	0.05	2	0.05	1		0.5	0.05	30	10	100	0.2	0.1
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[illegible]

Appendix D

Data Quality Evaluation

Attachement E - Quality Assurance and Quality Control Review

Client: Viva Energy Australia Pty Ltd

Site: Clyde Western Area - Stage 1 Area (Part Lot 100 in DP 1168951)

Report: ERM (2021c). *Clyde Western Area Remediation Project Stage 1 – Ongoing Groundwater Monitoring Event 2 and Annual Summary Report*, dated 12 October 2021 (**the Ongoing GME 2**)

Item	Addressed (Y / N / NA)	Comments
Quality Assurance Program		
Statement of pre-determined DQOs for field and laboratory procedures, including quantitative DQOs	Y	Provided in Section 4, in line with GWMP.
DQOs state the problem, identify goals of the study, identify information inputs, define the boundaries of the study, develop an analytical approach, specify performance or acceptance criteria and outline the plan for obtaining data	Y	
Quality plan designed to achieve DQOs assessing accuracy, precision, comparability, representativeness and completeness of data	Y	
Procedures for assessing chemical data to determine if DQOs are met, including quantitative DQOs (e.g. standard deviation, % recovery, RPDs)	Y	ERM states that “ <i>the acceptable limits on decision errors applied during the review of the results are based on the Data Quality Indicators (DQIs) of precision, accuracy, representativeness, comparability and completeness (PARCC) in accordance with the ASC NEPM [...]</i> ”. Statistical procedures to assess data, such as standard deviation and 95% upper confidence levels, were not reported. Based on the analytical results which indicate low hydrocarbon contamination in groundwater, this omission is not considered to affect data quality.
Procedures that describe the actions if DQOs not met	Y	Provided in Section 4, in line with GWMP.
Sampling and Analytical Program		
Site investigation objectives and a brief background provided	Y	Reported in Sections 1 and 2.
Summary of CSM provided	Y	Section 9
Data gap analysis provided that reviews existing information	Y	The data have been reviewed in Section 8 (trend analysis) and Section 10 (Discussion).

Item	Addressed (Y / N / NA)	Comments
Preparation of a site specific health and safety plan and other necessary pre-mobilisation tasks	NA	Not applicable to the objective of this audit.
Assessment includes all relevant environmental media (e.g. soil, dust, surface water, groundwater, air, sediments and biota)	Y	The target media is groundwater.
Sampling is representative of the site, based on selection of appropriate sampling points stated in sampling plan. Included are details of analytes to be monitored, sampling pattern/frequency, and number of samples, location and depth of sampling points	Y	In line with the GWMP.
Acceptability of sample collection, handling and transportation in accordance with written procedures	Y	Described in Section 7.4.
Sample analyses use appropriate methodologies in NATA (or equivalent) accredited laboratories for each analyte & matrix	Y	The laboratories were accredited by NATA.
Appropriate sampling methods & procedures, field screening methods and analysis methods are outlined	Y	Described in the GWMP.
Detection limits for each chemical of potential concern are appropriate for use in assessment of risk	Y	LORs are lower than the adopted assessment criteria.
For dynamic/reactive sampling, methods for analysing and interpreting field data are outlined	NA	
Field QA/QC		
Use of standardised field sampling forms	Y	Provided in Appendix C
Sampling team	Y	Listed in field documentation.
Sampling methods including type of container used, labelling process, order and degree of filling, preservation, labelling, logging, custody	Y	Described in the GWMP.
Decontamination procedures between sampling	Y	Described in the GWMP.
Logs for each sample, including time, date, location, sampler, duplicate location & type, chemical analyses to be performed, sample preservation method, site observations & weather	Y	Groundwater sampling field notes are provided in Appendix C.
COC for each sample, including sampler, sample nature, collection date, analyses to be performed, preservation method, dispatch time, condition of samples at	Y	Provided in Appendix B

Item	Addressed (Y / N / NA)	Comments
dispatch and courier(s)		
Sample duplication/splitting techniques		
Quality control samples, including:		
— background samples	NA	Not required by GWMP.
— field duplicate samples	N	No inter- and intra-laboratory duplicate samples were collected as part of the Ongoing GME 2. This is noncompliant with the GWMP. However, based on the analytical data being consistent with previous sampling rounds, field observations (i.e., no odours or sheen), and appropriate sampling and sample management methods, the absence of duplicate samples is considered unlikely to have materially affected data quality.
— split samples	N	
— rinsate blanks	N	No rinsate blank samples were collected as part of the Ongoing GME 2. This is noncompliant with the GWMP. Based on appropriate sampling methods designed to reduce cross-contamination risks (e.g., use of Hydrasleeve™ and dedicated equipment), and the analytical results being consistent with previous sampling rounds, the absence of rinsate blank samples is considered unlikely to have materially affected data quality.
— field blanks	NA	Not required by GWMP.
— trip blanks	N	No trip blank samples were collected as part of the Ongoing GME 2. This is noncompliant with the GWMP. Based on the absence of volatile contaminants in groundwater samples, the absence of trip blanks is considered unlikely to have materially affected data quality.
— laboratory prepared trip spike samples	N	No trip spike samples were collected as part of the Ongoing GME 2. This is noncompliant with the GWMP. Based on the absence of volatile contaminants in groundwater samples, and the consistency of current results and historical data, the absence of trip spikes is considered unlikely to have materially affected data quality.
Background sample results	NA	Not required by GWMP.

Item	Addressed (Y / N / NA)	Comments
Results of QC samples eg field blanks, background, rinsates, trip blanks	N	QC samples not collected as discussed above.
Laboratory prepared trip spikes for volatile analytes and accompanying results	N	
Field instrument calibrations (when used)	Y	Appendix C
Tabulate field parameter measurements	Y	Provided in the appendix named “ <i>Tables</i> ”
Laboratory QA/QC		
Copy of completed COC including acknowledgment of receipt, conditions of samples on receipt and identity of samples included in shipments	Y	Appendix B
Record of holding times and compliance with methods	Y	Comments were provided by the laboratory.
Analytical methods used		
– Laboratory accreditation for methods used	Y	Eurofins Environmental Testing Australia Pty Ltd is accredited by NATA
– Performance in interlaboratory trials for methods used, where available	NA	Not supplied by analysing laboratory. Absence has no material effect as all laboratories are accredited by NATA.
Description & % recovery of surrogates & spikes	Y	
Instrument detection limits and MDLs	NA	Not supplied by analysing laboratory. Absence has no material effect. The laboratory provided limit of reporting which are relevant to the investigation.
Matrix or PQLs and limit of reporting for each analyte in each media	Y	
Quality control samples:		
– duplicates	Y	
– method blanks	Y	
– surrogates	Y	
– matrix spikes	Y	
Laboratory standard charts	NA	

Item	Addressed (Y / N / NA)	Comments
QA/QC Data Evaluation		
Evaluation of QA/QC with DQOs including: documentation completeness, data completeness, data comparability (see below), data representativeness	Y	Provided in Section 7.4
Precision & accuracy of sampling & analysis for each analyte in each matrix, advising reliability, unreliability or qualitative value of data	Y	
Data comparability including bias assessment, e.g. different personnel, methodologies, times, spatial and temporal changes etc	Y	The report states that sampling methods were consistent with previous sampling rounds.
Results of intra and interlaboratory QC checks	NA	Field QC samples were not collected as discussed above.
Names of laboratories and details of their accreditation	Y	Eurofins Environmental Testing Australia Pty Ltd
Discussion of appropriateness of non-standard test methods (incl. sample prep; method source and validation)	NA	All methods utilised are standard.
PQLs and MDLs for all relevant matrices	NA	
Acceptance limit(s) for each QC test (e.g. RPDs, recoveries) included	Y	Provided in laboratory reports
Acceptance limits for each calibration standard		
Results for all data tabulated according to each type of soil, fill, groundwaters, surface water and sediments, with appropriate statistical analysis.	Y	Appendix named “ <i>Tables</i> ”.
QC results relevant to the sample analyses	Y	
QA/QC ANALYTICAL METHODS		
Field Methods		
Applicability and appropriateness of field screening methods discussed.	Y	Water quality parameters were collected with a calibrated probe.
Adequacy of calibration of field monitoring equipment and validation of field measurements	Y	
Laboratory screening methods		
Applicability and limitations of analytical screening techniques appropriately discussed	NA	Standard methods were utilised.
Analytical screening method performance expressed, and based on acceptable	NA	Not reported by laboratories

Item	Addressed (Y / N / NA)	Comments
false negative rate		
Methods specific for contaminants		
Sensitivity of analytical methods appropriate for assessment of risk	Y	Standard analytical methods were used.
Precision and accuracy criteria in quality plan meet performance of 95% of laboratories in recognised inter-laboratory trials	NA	Not reported by the laboratory. This absence is unlikely to materially affect data quality.

Notes:

Y = Yes; N = No; NA = Not Applicable

Appendix E

Updated LTEMP



Clyde Western Area Remediation Project



Stage 1 – Long Term Environmental Management Plan

8th November 2021

Project No.: 0515132

Document details	
Document title	Clyde Western Area Remediation Project
Document subtitle	Stage 1 – Long Term Environmental Management Plan
Project No.	0515132
Date	8 th November 2021
Version	Final Rev 02
Author	Stephen Mulligan
Client Name	Viva Energy Australia Pty Ltd

Document history

Version	Revision	Author	Reviewed by	ERM approval to issue		Comments
				Name	Date	
Preliminary Draft	00	Ian Batterley	Peter Lavelle	Michael Gaggin	05.05.2020	Preliminary Draft for Viva Energy Review
Draft	01	Ian Batterley	Peter Lavelle	Michael Gaggin	12.05.2020	Draft
Draft	02	Ian Batterley	Peter Lavelle	Michael Gaggin	25.11.2020	Draft – incorporating residual conditions following remediation
Draft	03	Ian Batterley	Peter Lavelle	Michael Gaggin	1.12.2020	Draft – for Site Auditor Review
Draft	04	Ian Batterley	Stephen Mulligan	Michael Gaggin	2.12.2020	Amended Draft – for Site Auditor Review
Revised Draft	05	Ian Batterley	Stephen Mulligan	Michael Gaggin	7.12.2020	Revised Draft – based on Site Auditor Review
Final Draft	06	Ian Batterley	Stephen Mulligan	Michael Gaggin	16.12.2020	Final Draft
Final	00	Ian Batterley	Stephen Mulligan	Michael Gaggin	17.12.2020	Final
Final	01	Stephen Mulligan	Michael Gaggin	Michael Gaggin	29.01.2020	Final – Updated based on DPIE Review
Final	02	Stephen Mulligan	Peter Lavelle	Michael Gaggin	8.11.2021	Updated to remove groundwater monitoring requirements

Signature Page

8th November 2021

Clyde Western Area Remediation Project

Stage 1 – Long Term Environmental Management Plan



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EXECUTIVE SUMMARY

Introduction

Environmental Resources Management Australia Pty Ltd (ERM) was engaged by Viva Energy Australia Pty Ltd (Viva Energy) to prepare this Long-Term Environmental Management Plan (LTEMP) to outline required environmental management procedures and controls for intrusive works within the 'Stage 1' portion of the Clyde Western Area Remediation Project (WARP), herein referred to as 'The Stage 1 Area'

Background Information

The Stage 1 Area contained former refinery processing units, aboveground pipework for the transfer of product, electrical sub stations, the refinery Central Control Room (CCR), underground drainage pipe system and oil-water separator unit.

Remediation works completed within the Stage 1 Area were undertaken to reduce contaminant concentrations to enable future commercial / industrial land uses and mitigate potential risks to human health / ecological receptors.

Upon completion of remediation and validation works, ERM considered the site was suitable for commercial / industrial land uses including the proposed bitumen manufacturing plant with no basement structures or beneficial re-use of groundwater on site.

Application of this LTEMP

This LTEMP will be applied immediately upon the initiation of any works which involve intrusive excavation from the Site surface.

All works are to be undertaken in accordance with relevant licensing / permitting and regulatory requirements is outlined within **Section 2.0** and **Section 3.0**.

This LTEMP is considered to be 'passive' in the sense that there are no mechanical components incorporated into the plans and that the primary purpose of the plan is to document the residual contamination on-site and outline mechanisms for managing potential risk into the future.

Residual Contamination Following Remediation Works

Following completion of remediation works within the Stage 1 Area, the following residual contamination may be present within the Site:

- Oily water / sludge associated with former underground drainage infrastructure;
- Asbestos associated with former underground building structures; and
- Hydrocarbon impacted soils.

A description of residual contamination and the associated risks where intrusive excavation works are undertaken is presented within **Section 4.0** and **Section 5.0**. The location and extent of residual contamination within the Site is illustrated on **Figure 2** and **Figure 3** (Appendix A).

Required Environmental Management Controls

Based on the nature and extent of residual contamination identified within the Site the following management controls are required under various operational scenarios:

- No Intrusive Excavation (i.e. normal site operations) – No Management Controls Required
- Intrusive Excavation Works Required – Implementation of environmental management controls as detailed within **Section 7** and **Section 8** of this LTEMP.

GLOSSARY

Glossary Term	Definition
the Site	Viva Energy owned land on the Camellia Peninsula consisting of the following Lots: Lot 398 DP41324, Lots 100 and 101 of DP 1168951, Lot 101 DP809340, Lot 2 DP 224288, and Lot 1 DP 383675. It includes the Clyde Terminal, the Parramatta Terminal, the Wetland, the Western Area and other land that is currently vacant or leased to third parties
the Western Area	A largely vacant area of land, approximately 40 Ha in size, located in the south western part of the Site. The land previously contained a variety of refinery assets that have now been removed.
the Clyde Terminal	A part of the Site currently operating as an import, storage and distribution terminal for finished petroleum products including diesel, jet and gasoline fuels. The Clyde Terminal makes up the majority of the central part of Site and operates under SSD 5147 and NSW EPL 570
the Wetland	A large undeveloped wetland area in the north-eastern part of the Site close to the confluence of the Parramatta and Duck Rivers.
the Project	The proposal to remediate the contaminated soils in the Western Area to a commercial/industrial standard alongside associated infrastructure removal, waste management, soil and groundwater management, land forming and storm water management activities.
the Stage 1 Area	Stage 1 Area is situated within the eastern portion of the former Process West area and extends from Devon Street to the North to the Duck River at the southern boundary of the Western Area, the extent of which is shown on Figure 1.
The Land Custodian	The legal owner of the site identified as the Stage 1 Area

1. INTRODUCTION AND PURPOSE

Environmental Resources Management Australia Pty Ltd (ERM) was engaged by Viva Energy Australia Pty Ltd (Viva Energy) to prepare this Long-Term Environmental Management Plan (LTEMP) to outline required environmental management procedures and controls for intrusive works within the 'Stage 1' portion of the Clyde Western Area Remediation Project (WARP), herein referred to as 'The Stage 1 Area'.

- The site layout of the Stage 1 Area and portions of the Stage 1 Area, subject to this LTEMP identified to contain residual contamination, is illustrated within **Figure 1**.

ERM notes that this LTEMP is to be implemented following completion of remediation and validation works. All specific environmental management requirements during site development / construction should also be outlined within a Construction Environmental Management Plan (CEMP).

Prior to the commencement of any intrusive works, all site personnel / contractors are to be inducted into the requirements of this LTEMP and provide the Land Custodian with written confirmation that they acknowledge and understand the requirements and obligations outlined within the LTEMP.

Site specific biodiversity management measures for the Green and Golden Bell Frog, will be detailed within subsequent operational site management plans. Such plans are to be consistent with the *Revised Plan of Management: Restoration of Green and Gold Bell Frog Habitat, Clyde Terminal, January 2019 (where applicable), or its latest version*.

1.1 Purpose of the LTEMP

The specific objectives of this LTEMP are to:

- summarise background environmental information, known and likely conditions at the site, and provide a mechanism to inform the Land Custodian, workers and managers of the potential risks to human health and / or the environment arising from contact with residual contamination;
- outline methods and procedures that will avoid and / or mitigate adverse effects on human health and / or the environment;
- provide a recommended methodology for the appropriate environmental management of excavation works that may encounter residual contaminated soil and / or groundwater;
- provide environmental requirements for the sourcing and placement of backfill material;
- discuss safety measures / considerations for dealing with potentially contaminated soil; and
- outline restrictions to potential future land uses as detailed within Table 3.

All work related to excavation, movement, handling, importation and placement of fill and soil materials and / or groundwater within the site should be carried out in accordance with this LTEMP and in compliance with relevant legislation detailed within **Section 2.0**.

The requirements outlined within this LTEMP relating to residual soil / asbestos contamination will remain in place until residual contamination is appropriately removed and validated with no remaining potential risks to identified human health / ecological receptors. Any changes to the requirements outlined within this LTEMP will require review / endorsement by a NSW EPA accredited Site Auditor.

Where beneficial re-uses of groundwater are proposed, further assessment of the suitability of groundwater is to be completed by a suitably qualified environmental specialist with findings reviewed / endorsed by a NSW EPA accredited site auditor.

This LTEMP is considered to be 'passive' in the sense that there are no mechanical components incorporated into the plans and that the primary purpose of the plan is to document the residual contamination on-site and outline mechanisms for managing potential risk into the future.

1.2 LTEMP Revision

The Land Custodian of the Stage 1 Area are responsible for ensuring that all required stakeholders are provided with the current revision of this LTEMP.

The current revision of this LTEMP is detailed within the table below. Updates to this document must be undertaken in accordance with the requirements detailed within **Section 2.4**.

- Any subsequent revisions of this LTEMP must include a clear date / revision identifier to ensure the most current version of the LTEMP is implemented.

Table 1 – LTEMP Revision

Document Name	Document Revision Number	Date
Clyde Western Area Remediation Project: Stage 1 – Long Term Environmental Management Plan	■ Final Rev02	■ 28/10/2021

1.3 Limitations to this LTEMP

This LTEMP may not be applicable to potential future redevelopment that is not consistent with the current proposed use of the Stage 1 Area.

Where future land uses differ from the commercial / industrial land uses assumed within the ERM (2020) Human Health and Ecological Risk Assessment (HHERA), a review of the HHERA should be undertaken to assess the requirements for potential additional / modified site management provisions.

As the HHERA was based on a slab on grade commercial/ industrial land use, basement construction was not contemplated and is currently not permitted. Further specific assessment and review by a NSW EPA Accredited Site Auditor will be required prior to any such construction.

1.4 Related Documentation

The following documentation provides a summary of site conditions prior to the completion of remediation works within the Site and may be made available to the responsible entity upon request.

- ERM 2020a. Clyde Western Area Remediation Project – Remediation Site Investigation. Final V3. February 2020.
- ERM 2020b. Clyde Western Area Remediation Project – Human Health and Ecological Risk Assessment. Final V3. February 2020.

The following documentation relating to the environmental condition of the Stage 1 Area prior to and following the completion of remediation / validation works within the Site should be made available to the responsible entity for ongoing environmental management.

- ERM 2020c Clyde Western Area Remediation Project – Stage 1 – Detailed Remediation Action Plan V2. May 2020.
- ERM 2020d Clyde Western Area Remediation Project – Stage 1 - Validation Report. December 2020.
- ERM 2020e Clyde Western Area Remediation Project – Drainage Decommissioning Validation Report (Stage 1). December 2020.

2. STATUTORY REQUIREMENTS

2.1 Legal Enforceability and Public Notification of this EMP

Upon Site Auditor endorsement of this LTEMP all requirements are legally enforceable via existing Development Consent Condition B10(a) and (b) of the State Significant Development 9302, as issued under Section 4.38 of the Environmental Planning and Assessment Act 1979 (the 'EP&A Act'). This condition is outlined below:

B10. Upon completion of the Site Audit Statement and Site Audit Report, the Applicant must:

- (a) Implement the approved LTEMP***
- (b) Provide evidence to the Planning Secretary that the LTEMP is listed on the relevant planning certificate for the land, issued under section 10.7 of the EP&A Act***

As per condition B10 (b), Parramatta Council will be requested to add a notation under section 10.7(5) of the EP&A Act that the property is subject to this LTEMP.

2.2 Licence and Approval Requirements

The Land Custodian or its designated representative is responsible for obtaining all necessary / required environmental, safety and occupational hygiene approvals and licences prior to the commencement of any works that may impact underlying residual contamination.

- All required permits, approvals and notifications (e.g. SafeWork NSW notifications) required at the time of works must be complete, finalised and (where necessary) approved prior to works commencing;
- All site personnel, contractors, sub-contractors etc. must comply with the terms and conditions of all approvals and licences obtained; and
- Upon commencement of any intrusive works, all processes and procedures outlined in the LTEMP must be implemented immediately.

2.3 Regulatory Framework

During the course of any intrusive works within the Stage 1 Area, all operational personnel working within the site shall comply with the applicable environmental regulatory requirements in New South Wales (NSW) at the time of works.

Any works that require the handling, movement or disposal of contaminated soils / groundwater are to be undertaken in accordance with the operational site specific Environmental Protection Licence (EPL) and all relevant made / approved NSW EPA guidelines at the time of works.

2.4 Document Revision

This LTEMP may be reviewed and updated as necessary. Therefore, it is the responsibility of the reader of this document to ensure they have the current version of the LTEMP.

Where onsite works or inspections / audits identify that the LTEMP requires updating, the LTEMP should be updated as required. ERM notes that any updates to this LTEMP will require review and endorsement from a NSW EPA Accredited Site Auditor.

The master document, with the up-to-date version of the LTEMP will be available from the Land Custodian.

3. APPLICATION AND RESPONSIBILITIES

3.1 Implementation of this LTEMP

To ensure all site personnel / contractors are aware of the requirements detailed within this LTEMP, this LTEMP will be recorded on the Land Custodians site management / induction database (or any subsequent iterations / versions of the database).

Prior to the commencement of any intrusive works, site personnel / contractors will be required to complete all necessary access induction and works permitting which will include induction into the requirements of this LTEMP.

No works are to be undertaken until all relevant induction documentation has been received by the Land Custodian from onsite personnel / contractors including acknowledgement that they are aware and understand all requirements detailed within this LTEMP.

This LTEMP is to be implemented following completion of remediation and validation works. All specific environmental management requirements during site development / construction should also be outlined within a Construction Environmental Management Plan (CEMP)).

3.2 Area to which this LTEMP applies

The site is identified as Part Lot 100 in DP 1168951 and is located within the Stage 1 portion of the Clyde WARP.

- This LTEMP applies to the entire site, however specific management is required for areas within a 20 m buffer of where residual contamination (residual hydrocarbon impacted soil, residual asbestos formwork and residual site infrastructure) will remain in-situ following completion of remediation works. These locations requiring specific management are illustrated on Figure 1 and described within Section 5 of this LTEMP; and
- ERM notes that due to the historical land uses within the Site (i.e. former Refinery), all works must be undertaken in consideration of potential unexpected finds of contamination. Where unexpected finds are encountered during works, they too are to be managed in accordance with the requirements outlined within Section 7.1 of this LTEMP.

3.3 Application of LTEMP

This LTEMP will be applied immediately upon the initiation of any works which involve intrusive excavation from the Site surface, which may involve the following activities:

- excavation of fill and natural soil materials to facilitate removal, realignment or construction of any subsurface infrastructure;
- maintenance and / or upgrade of site utility services;
- temporary stockpiling of excavated material resulting from onsite intrusive works; and
- offsite disposal of any waste contaminated soil / groundwater (if required).

Controls outlined within this LTEMP are to be implemented where intrusive works / excavation works are undertaken. ERM further notes that additional controls including engagement of an environmental specialist, environmental monitoring and development of a task specific works plan (detailed within **Section 7.1**) are required for any works undertaken within 20 m of identified residual contamination (**Figure 2**).

- ERM notes that provided the site surface is not disturbed, including groundwater extraction, none of the controls in this LTEMP are necessary
- Where groundwater is proposed for future beneficial re-uses, an assessment of suitability must be undertaken by a suitably qualified environmental professional. The assessment and any recommendations for beneficial re-use. must be reviewed and endorsed by a NSW EPA Accredited Site Auditor.

3.4 Roles and Responsibilities

The following table summarises potential requirements to be implemented within the Stage 1 Area.

Table 2 – LTEMP Roles and Responsibilities

Position / Company	Responsibility
Stage 1 Area Land Custodian , Viva Energy and Site Auditor	■ Approve the LTEMP
Stage 1 Area Land Custodian (Downer)	■ Ensure all workers and contractors understand the nature and extent of residual contamination. ■ Require all contractors and sub-contractors comply with statutory and license requirements. ■ Maintain records of all works undertaken within the site as required within this LTEMP. ■
Stage 1 Area - Site Operational Staff, Contractors and Subcontractors	■ Implement the LTEMP at site level. ■ Provide adequate training for all employees and contractors during site induction, and as required on an ongoing basis during the works. ■ Comply with the relevant conditions of the consents and licenses (i.e. comply with all regulatory requirements). ■ Require any sub-contractors to comply with statutory and license requirements and conditions of the LTEMP. ■ Conduct monitoring as required in the LTEMP. ■ Complete all necessary registers, databases and records required in the LTEMP. ■ Meet all OH&S regulatory requirements. ■ Ensure that all environmental protection measures are in place and are functioning correctly. ■ During excavation works, assess any potentially contaminating unexpected finds in consideration of the sites use. ■ During intrusive excavation works, as required, undertake site inspections and monitoring of the site operations to ensure they are carried out in an environmentally responsible manner and meet the requirements of this LTEMP. ■ Complete, audits, non-conformance, incident, complaint and corrective action reports and follow up as required. ■ Ensure all non-conformance and/or complaints are reported to the appropriate responsible agent / authority. ■ Undertake corrective actions in response to requests made by the responsible agent regarding specific environmental or safety issues. ■ Notify the Land Custodian / nominated representative of any significant environmental issues. ■ Assess the requirement and (where necessary) engage an environmental specialist / scientist to undertake additional monitoring of excavations / unexpected finds.
Qualified Environmental Specialist	■ Where required, a suitably qualified environmental specialist is to be engaged to manage, monitor and evaluate environmental controls , demonstrate compliance with this LTEMP and assess specific requirements associated with excavation works within areas of known residual contamination and / or unexpected finds.

4. BACKGROUND INFORMATION

4.1 Site Details

The Western Area is an approximately 40 hectare (ha) parcel of land currently owned by Viva Energy within the footprint of the wider Clyde Terminal Site and is bordered to the south by the Duck River, to the east by current Clyde Terminal Operations and to the north and west by other Industrial zoned properties.

The Stage 1 Area extends from Devon Street to the North to the Duck River at the southern boundary of the Western Area. A Site Survey showing the Extent of the Stage 1 Area is provided as *Appendix C*.

The Stage 1 Area contained former refinery processing units, aboveground pipework for the transfer of product, electrical sub stations, the refinery Central Control Room (CCR), underground drainage pipe system and oil-water separator units.

Specific site identification details are summarised in *Table 3*, below.

Table 3 – Site Identification

Item	Description
Site Owner	■ Viva Energy Australia Pty Ltd (Viva)
Site Occupier	■ Downer EDI Works Pty Ltd (Downer) – anticipated early 2020
Site Address	■ Devon Street, Rosehill NSW
Legal Description	■ Part Lot 100 in DP 1168951
Local Government Authority	■ City of Parramatta Council
Current Zoning	■ IN3 – Heavy Industrial under the Parramatta Council Local Environmental Plan 2011
Current Land Uses	■ Vacant site
Future Proposed Land Use	■ Bitumen manufacturing plant (slab on grade commercial/ industrial) ■ Upon completion of remediation and validation works, the site is suitable for commercial / industrial land uses with no basement structures or beneficial re-use of groundwater.
Permissible Land Use(s)	Any permissible use allowed under the sites zoning (with consent), which includes: ■ Agricultural produce industries; Building identification signs; Business identification signs; Depots; Freight transport facilities; General industries; Hardware and building supplies; Hazardous storage establishments; Heavy industries; Horticulture; Kiosks; Medical centres; Offensive storage establishments; Pubs; Roads; Rural supplies; Sawmill or log processing works; Take away food and drink premises; Timber yards; Warehouse or distribution centres; Water storage facilities.
Area ¹	■ 7 hectares
Elevation	■ Between 3 and 4 metres Australian Height Datum (m AHD)

Source:

1. City of Parramatta Council LEP (2011)

5. RESIDUAL CONTAMINATION REQUIRING MANAGEMENT

Remediation works completed within the Stage 1 Area were undertaken to reduce contaminant concentrations to enable future commercial / industrial land uses and mitigate potential risks to human health / ecological receptors.

Based on field observations and results of validation sampling undertaken during completion of remediation and validation works, residual contamination is present within locations illustrated (including X and Y co-ordinates) on **Figure 2** and **Figure 3**.

A detailed description of residual contamination within the Stage 1 Area is provided below.

Table 4 –Stage 1 Area Residual Contamination

Potential Residual Contamination	Descriptions
Oily water / sludge associated with former underground drainage infrastructure	■ Due to the former operational history of the Site, there are 11 redundant underground pipes/drains throughout the Site that may require consideration during future potential intrusive excavation works which were decommissioned and decontaminated in-situ during site remediation works (to the extent practical due to access / structural considerations) (see Figure 2). ■ ERM notes that underground drainage lines were subject to cleaning, decontamination and were decommissioned in-situ via permanent disconnection from operational portions of Viva Energy's Clyde Terminal drainage network and backfilling pits and junctions with stabilised sand. ■ While drainage infrastructure within the Site is not considered to pose a risk to future site operations, residual hydrocarbon impacted sludge and sediment within pipes and pits shown on Figure 3 should be managed to avoid inadvertent release of LNAPL during future construction works and manage potential safety risks for workers (via dermal contact/inhalation) during and future excavation works undertaken to remove this infrastructure. Residual conditions are discussed in detail within the Drainage Decommissioning Validation Report (ERM 2020e). The location of drainage infrastructure is provided on Figure 3.
Asbestos associated with former underground building structures	■ Due to former site infrastructure located within the Site, there are three (3) redundant structures associated with former buildings located within the subsurface (redundant concrete footings etc.). During remedial works, asbestos formwork was noted to be present within a limited number of underground structures, which, due to structural reasons were not removed during site remediation. ■ Following completion of remedial works, several concrete structures containing asbestos formwork remain in-situ as illustrated on Figure 2. ■ ERM notes that based on site observations made during remedial works, asbestos is considered to be limited to isolated use as formwork for concrete footings and was not identified to be present within residual fill / soil material located within the Site. ■ While ERM notes that asbestos formwork within subsurface structures do not pose a risk to identified receptors under normal site operations/conditions, where intrusive excavation works are planned, additional controls such as health and safety planning, air / dust monitoring, spoil management and unexpected finds management may be required.

Potential Residual Contamination	Descriptions
Hydrocarbon impacted soil	■ Remediation works were focussed on the selective excavation and removal of contaminated soils. Following completion of remediation works within the Stage 1 Area, the potential exists for hydrocarbon impacted soils to be present within the Site boundary at known and unknown locations. ■ Following completion of remedial works, residual LNAPL or soil contamination exceeding TRH Management limits are present in a limited number of locations within the walls and base of the remediation excavation and within fill materials surrounding subsurface drainage infrastructure that has been decommissioned in-situ. ■ While ERM notes that results from the HHERA indicate that the presence of residual hydrocarbon impacted soils does not pose a risk to identified receptors under normal site operations and are limited to aesthetic considerations (presence of hydrocarbon staining and/or odours). Where intrusive excavation works are planned in identified areas, additional controls such as health and safety monitoring, gas testing, spoil management and unexpected finds management may be required.
Residual hydrocarbon impacted groundwater	■ Based on information obtained as part of previous investigations, groundwater is present within the Stage 1 Area at a depth of approximately 1 – 1.5 m bgl. ■ Remediation works within the site have removed the primary sources of impact (hydrocarbon impacted soils exceeding site suitability criteria). Previous investigations within the Stage 1 Area and broader Clyde Terminal site have identified degraded and non-volatile LNAPL within soil and groundwater at concentrations which do not pose a risk to human health or the environment. ■ ERM notes that results from previous investigations indicate that dissolved phase groundwater concentrations are stable or decreasing and do not pose a risk to identified receptors where intrusive excavation and / or contact with groundwater does not occur. ■ Where intrusive works are planned within the Site, additional controls such as health and safety monitoring, gas testing, excavation dewatering management and unexpected finds management may be required. ■

5.1 Location and Extent of Residual Contamination

As outlined in Section 3.2, this LTEMP applies to the whole site but more specifically to areas of the site where residual contaminated materials are retained under the site surface, as indicated in **Figure 2** and **Figure 3**. Following completion of remediation works, the following residual sources of contamination are known to exist within the Stage 1 Area:

- Residual soil impacts – limited to presence of LNAPL or hydrocarbon impacts exceeding TRH management limits:
 - Northern portion - AEC9_W_V24, TP19/42
 - Southern Portion - TP20/17, TP20/20 and TP18/09
- Asbestos associated with sub-grade footings and infrastructure (detailed within Appendix B):
 - AEC9_ACM_1
 - AEC9_ACM_2
 - AEC9_ACM_3
- Residual hydrocarbon sludge remaining within the decommissioned drainage pipes/pits (as per Figure 3).

ERM notes that due to the historical land uses within the Site, all future ground disturbance works or site redevelopment activity must be undertaken in consideration of potential unexpected finds of contamination.

Where unexpected finds are encountered during works, they too are to be managed in accordance with the requirements outlined within this LTEMP.

It should be noted the presence of stained or odorous material may be identified beneath the site during future intrusive works outside of those locations outlined in this LTEMP, however these conditions may not be representative of unacceptable exposure scenarios. Advice should be sought from an Environmental Consultant as per the roles and responsibility outlined in **Table 2**.

6. POTENTIAL RISKS TO HUMAN HEALTH AND THE ENVIRONMENT

6.1 Risks Where No Intrusive Excavation Works Are Undertaken

The following table outlines the potential risk to human health and the environment if residual contamination as illustrated within Figure 2 remains undisturbed (i.e no intrusive excavation works). As outlined previously.

Contaminant	Source	Management Controls	Human Health Risks	Environmental Risks	Exposure Pathways
Total Recoverable Hydrocarbons (C10-C16, C16-C34) and Light Non Aqueous Phase Liquids	Residual contamination within soils, groundwater and oily water / sludge	NA – no controls required	Negligible	Negligible	Negligible
Asbestos	Asbestos located within concrete formwork	NA – no controls required	Negligible	Negligible	Negligible

6.2 Potential Risks Where Intrusive Excavation Works Are Undertaken

The following table outlines the potential risk to human health and the environment if the material is disturbed without proper management controls. These risks may result from excavation works, installation of services, stockpiling of excavated materials and works that encounter residual contamination identified within Figure 2 or additional unexpected finds.

Contaminant	Source	Disturbed	Human Health Risks	Environmental Risks	Exposure Pathways
Total Recoverable Hydrocarbons (C10-C16, C16-C34) and Light Non Aqueous Phase Liquids	Residual contamination within soils, groundwater and oily water / sludge	Intrusive works such as excavation works, stockpiling of materials etc.	The effects on human health depend on a number of factors such as how long exposure occurs, concentrations in air, soil or water, and the health and age of the affected individual. ■ Potential for generation of odours during subsurface intrusive works resulting from degraded hydrocarbons within open excavations.	Risks associated with contamination transported to potentially sensitive receptors	Human Exposure Pathways: Limited to aesthetic considerations including potential for generation of odours during subsurface intrusive works Environmental Exposure pathways: Surface water / sediment run off to adjacent stormwater drains. Uncontrolled release of dust/ odours generated during excavation works.

Contaminant	Source	Disturbed	Human Health Risks	Environmental Risks	Exposure Pathways
Asbestos	Asbestos located within concrete formwork	Asbestos fibres can cause asbestosis, lung cancer and mesothelioma	Asbestos fibres can cause asbestosis, lung cancer and mesothelioma if inhaled	Asbestos is inert within the environment and therefore poses no known environmental risk	Human Exposure Pathways: Inhalation could occur through breathing in fibres in dust generated during soil disturbance activities. Environmental Exposure pathways: Nil

7. ENVIRONMENTAL MANAGEMENT

As outlined above the primary targets / goals of this LTEMP are to ensure that:

- the assessed risks to human health and the environment arising from contact with residual contamination is understood by all site workers and managers;
- prior to the commencement of any intrusive excavation works, appropriate systems and controls are put in place; and
- ensuring all ongoing operational, monitoring and maintenance requirements are adhered to by Site owners and/or managers.

7.1 Environmental Management Requirements

Prior to the commencement of works, it is the responsibility of Stage 1 Area Land Custodian and / or their nominated representative to determine if works within the Stage 1 Area will require intrusive excavation.

- Where any intrusive excavation works are undertaken within the Site the following controls must be implemented.

Table 5 – Stage 1 Area Environmental Management Requirements

Item	Requirements
All Intrusive Excavation Works Undertaken within the Stage 1 Area	
Training and Competence	The Land Custodian is to ensure that all site workers are suitably qualified to undertake required works and inducted into all relevant requirements stipulated within this LTEMP. ■ The induction will include outlining all requirements within the relevant documentation, training on the location of known residual contamination and in the identification of visual and olfactory indications of additional unexpected finds of contamination.
Health and Safety Plan	The contractor is to prepare a task specific health and safety plan that includes suitable protection measures for working with residual hydrocarbon contamination including but not limited to: ■ training requirements; ■ air / dust / odour monitoring action levels and monitoring procedures; ■ required respiratory protection; ■ minimum Personnel Protective Equipment (PPE) requirements; ■ site signage requirements; ■ site security; ■ required exposure route pathway mitigation measures (dust suppression etc.); ■ vehicle/machinery/plant safety; and ■ general site safety.

Item	Requirements
Excavation works and temporary stockpiling	To reduce and/or prevent the exposure of human receptors at the site to potential contamination within onsite soils, the following will be undertaken during any intrusive excavation works: ■ To reduce the area of disturbed material, the number of areas subject to excavation works at any one time should be minimised. ■ During excavation works, measures to reduce dust emissions such as spraying with water, addition of soil binding agents etc. should be undertaken. ■ Where works are undertaken within the vicinity of known asbestos materials, dust monitoring (as detailed below) is also to be undertaken to assess the suitability of controls for mitigating potential for fugitive airborne asbestos. ■ During excavation and materials handling sufficient odour control such as covers, tarps, odour control sprays etc. are to be implemented during works to minimise any disturbance to adjacent workers / receptors. ■ Where material requires offsite disposal, excavated material should be placed directly into a tipper truck and where possible material should not be placed into temporary stockpiles awaiting offsite disposal. ■ Where material requires stockpiling prior to offsite disposal, appropriate dust and sediment controls must be in place. Smaller volumes should be contained within an enclosed or covered skip. ■ All materials movement within the site must be recorded within an appropriate Materials Tracking Register.
Materials handling and disposal	■ Soil - Excavated materials are to be either re-instated within the same location (in accordance with relevant planning / DA conditions) or disposed offsite to a suitably licenced landfill / receiving facility in accordance with relevant NSW EPA waste disposal guidance at the time of works. ■ Concrete – Excavated concrete footings containing asbestos formwork are to be disposed offsite to a suitably licensed facility in accordance with NSW EPA waste classification requirements at the time of works. ■ Groundwater - Any groundwater extracted from excavation works is to be managed as per the site specific EPL or disposed in accordance with relevant NSW EPA made or endorsed waste disposal guidance at the time of works. ■ Residual Oily Water / Sludge – Oily water / sludge associated with redundant drainage infrastructure if encountered during excavation works should be classified and disposed offsite to a suitably licenced facility in accordance with relevant NSW EPA waste disposal guidance at the time of works.
Sediment and Stormwater Runoff Controls	During works, sediment and surface water runoff controls will be implemented to minimise generation and transport of potentially contaminated sediments and surface water within and off the Site. While ERM notes that controls will be developed based on the specific location / nature of works to be undertaken, controls may include (but not be limited to): ■ Sediment control; ■ Clean water diversions; and ■ Stormwater drain protection. Sediment control is required. Sediment control measures (i.e. silt fencing and hay bales) will be strategically placed at the following locations: ■ Down-gradient of temporary stockpiles or highly disturbed areas; ■ Up-gradient of temporary stockpiles to redirect water; and ■ Down-gradient of any surrounding stormwater channels that flow within/through the Site, as contingency against overflow into adjacent site areas. Clean water diversions are required to minimise ingress to excavations and soil erosion. Where necessary, clean water diversions (hay bales and gravel bags) will be strategically placed in the following locations: ■ Up-gradient of temporary stockpile or excavation areas to redirect water; and ■ Down-gradient of any surrounding stormwater channels that flow within/through the Site as contingency against overflow into bunded stockpile locations. Stormwater drain protection is required to prevent ingress of sediments to the stormwater infrastructure and will comprise: ■ Installation of sediment socks in any identified stormwater drains located down-gradient of any temporary stockpile areas.

Item	Requirements
	All sediment and surface water controls will be inspected by the Land Custodian's nominated representative during works, to inspect the controls in operation. Should any control measures be damaged or defective, the issue will be reported to the contractors project manager / representative, to arrange for repair or modification of the control systems in place.
Imported Fill Material	If imported fill is required at the site, only construction materials or certified Excavated Natural Material (ENM) or 'Virgin Excavated Natural Material' (VENM) materials are to be imported for use. If ENM / VENM is imported to the site accompanied by a VENM certificate, sampling will not be required. The ENM / VENM certificate should at a minimum: ■ state that the material has been classified as VENM (in accordance with relevant NSW EPA guidance) and is suitable for re-use within the site; and ■ include a summary of the site history of the source site, the findings of any environmental site investigations undertaken at that site and the results of any soil analysis undertaken. If the ENM / VENM certificate does not meet these requirements or fill material other than VENM (i.e. 'clean fill') is imported to the site, a site visit to the source site by an environmental consultant to enable collection and analysis of soil samples may be required. Samples are to be analysed for relevant contaminants of concern for the specific conditions of the source site. All VENM / imported material classification reports are to be provided to Land Custodian or their nominated representative and included within compliance reporting upon completion of works (Section 7.3).
Unexpected Finds Management	During excavation works there is the potential of encountering additional in-ground finds. Unexpected finds may include (but not be limited to): ■ asbestos containing materials; ■ additional LNAPL / hydrocarbon impact; ■ buried building rubble; ■ unusual soil staining and discoloration; and ■ odours emanating from the ground during earthworks. Where unexpected finds are uncovered: ■ Works are to cease immediately in the vicinity of the excavation; ■ the Land Custodian or their nominated representative is to be informed immediately; ■ the area surrounding the unexpected find is to be barricaded to ensure the area is not further disturbed; and ■ a suitably qualified environmental specialist is to visit the site, assess the discovery and undertake assessment / provide recommendations. The environmental consultant is to advise on the required course of action for the find, this may include: ■ Sample collection and analysis; ■ a detailed assessment (if required); and ■ preparation of an assessment report and remediation plan (if required). All reports are to be prepared in accordance with relevant NSW EPA guidance and provided to relevant regulatory / approval authority and Land Custodian for record keeping requirements. Where analysis of unexpected finds indicates a potential risk to either human health and or the environment necessary, a Task Specific Works Plan (as detailed below) may be prepared. The plan is to be developed to outline task specific procedures / processes to be adopted to minimise the risk to human health and / or the environment from any unexpected finds.

Item	Requirements
Vehicle and Equipment Cleaning and Operation	The following controls will be placed on operation and movement of equipment: ■ All equipment will be operated by suitably qualified operators. ■ Equipment working within any area containing contaminated materials will be washed inside the area. Wash water must be prevented from leaving the site / entering drains. ■ The surface of internal access roads carrying vehicular traffic will be kept clean. ■ All equipment will be maintained at optimum operating conditions and any servicing of equipment will be undertaken in areas specified by the Contractor. It is recommended that such activities be undertaken on concrete or bitumen surfaces to prevent impact to surface soils by oils, fuels or cleaning agents. ■ Any fuel stored onsite will be held in a designated area. The area will be appropriately bunded to contain any potential spillages and/or leaks. ■ Vehicles carrying spoil or rubble from the site (if required) will at all times be covered with an "enviro-tarp" or similar impervious material to prevent the escape of dust or other material. ■ All heavy vehicle access and egress to and from the site will be via the designated heavy vehicle route. ■ The wheels and wheel arches of all vehicles having had access the site will be inspected and if required, cleaned by the use of a broom or water spray to prevent mud and sediment from being deposited on local roadways. ■ After wheel and wheel arch cleaning, vehicles will be inspected for the presence of rocks between tyres and sediment within the undercarriage of the vehicle. Any material will be removed and placed at a designated point within the site.
Excavation Re-instatement	Upon completion of excavation works, the area must be re-instated with excavated material in the order in which it was excavated or with other approved imported fill materials.
Intrusive Excavation Works Within 20 m of Identified Residual Contamination (Figure 2)	
Engagement of Environmental Specialist	Where excavation works are undertaken within 20m of identified residual contamination (Figure 2) prior to the commencement of any intrusive works the Land Custodian or nominated representative is to engage a suitably qualified environmental specialist to undertake a review of health and safety management procedures, manage, monitor and evaluate environmental controls and demonstrate compliance with this LTEMP. ■ ERM notes that where unexpected finds of contamination are identified within other areas of the Site during excavation works, scientist suitably qualified environmental specialist should be engaged to manage, monitor and evaluate environmental controls, demonstrate compliance with this LTEMP and assess specific requirements for unexpected finds detailed above.
Environmental Monitoring	Environmental monitoring is to be undertaken for Volatile Organic Compounds in ambient air during all excavation and construction works within 20 m of identified residual hydrocarbon contamination to evaluate the effectiveness of control measures (Figure 2). Where works are to be undertaken within the vicinity of identified asbestos, dust monitoring should be undertaken to assess the effectiveness of environmental controls on preventing airborne releases of asbestos fibres. Air monitoring is to be undertaken by a suitably qualified occupational hygienist. ■ The specific monitoring methodology / regime should be developed by the environmental specialist / occupational hygienist and based on the specific tasks / construction mythology to be undertaken. ■ Action levels (vapour / dust / airbourne fibre levels where intrusive works are to cease and control measures are to be re-assessed / implemented) will be required to be developed within the health and safety plan and are to be based on relevant regulatory guidance at the time of works.

Item	Requirements
Task Specific Works Plan	Where intrusive excavation works are undertaken within 20 m of identified residual contamination illustrated on Figure 2, prior to undertaking works, the contractor is to ensure that a Task Specific Works Plan is prepared by a suitably qualified environmental professional to ensure all environmental risks are appropriately managed. ■ The Works Plan should be prepared for the specific works to be undertaken. ■ The Works Plan should be prepared in accordance with industry best practice standards at the time of works and must comply with all relevant NSW EPA regulatory guideline criteria relating to contaminated sites. The plans should include (but not be limited to) the following details: ■ Risks to human health and the environment – potential risks associated with the work should be highlighted. ■ General site management – Details of required inductions of employees or contractors. ■ Procedures and methodologies to be used for undertaking the works. ■ Specific details of ways to limit disturbance of impacted soils / groundwater / redundant site drainage infrastructure etc. (e.g. soil boring as opposed to open trenching). ■ Mitigation measures. ■ Air / dust monitoring action levels, including monitoring procedures for Lower Explosive Limit (LEL) and Volatile Organic Compounds (VOCs) around areas of residual hydrocarbon impacts; ■ Personal protective equipment. ■ Other protection measures (cabin ventilation, etc.). ■ Roles and responsibilities for implementing the mitigation measures. ■ Soil and groundwater management controls - As a minimum the following requirements should be detailed: ■ Any groundwater extracted during intrusive works is to be disposed in accordance with the site EPL and / or NSW EPA waste disposal guidance. ■ Excavated soils should be placed on within a bunded area to minimise potential run off. ■ Excavated concrete containing asbestos formwork should be covered following excavated to prevent wind-blown emissions of potential asbestos. ■ Soil / concrete material should be kept moist to limit dust. ■ Excavated materials, where possible, be replaced in the same location. Where this is not practicable, material must be disposed of in accordance with NSW EPA waste disposal regulations. ■ ERM notes that excavated concrete materials containing asbestos formwork are not to be replaced within the Site and are to be disposed offsite in accordance with NSW waste disposal requirements at the time of works. ■ Reinstatement of the site surface. ■ Waste management including waste disposal. ■ Record Keeping, audit and review.
Biodiversity Management Measures (Green and Golden Bell Frog)	
Green and Golden Bell Frog (GGBF)	Consistent with Viva Energy's existing GGBF management measures for the Clyde Terminal, to mitigate against potential impacts to the GGBF population, the following measures are to be included in an administered by the Stage 1 Land Custodian as part of an operational Environmental Management Plan: ■ Works inductions that focus on the potential occurrence of the species; ■ Pre-clearance surveys by an environmental representative as needed for stockpiles and excavations to check for the presence of GGBF; ■ Management of the site to minimise potential for creating habitat (i.e. no ponding of water); ■ Measures to minimise indirect impacts to GGBF through spread of Chytrid fungus; and ■ An unexpected find protocol which outlines the need to engage a suitably qualified ecologist to relocate any GGBF encountered.

7.2 Stage 1 Area Emergency Response

In the event of any incident, the first priority shall be the safety of all personnel and the community in the immediate vicinity.

In the event of a serious emergency at the site, the following procedure will be followed:

- Stop work;
- All personnel shall leave the work zone via established entry/exit routes;
- Leave the site and assemble at the emergency assembly area (as designated by the Site manager); and
- Await further instructions from the designated site manager. No project personnel or visitors are to leave the assembly area unless advised to do so by the site manager or their onsite representative to be nominated at a later stage.

The Site manager or their designated entity will notify the relevant service as to the details regarding any emergency.

Following emergency response, all practical steps should be taken to minimise the risk of further environmental damage as soon as possible after the event. The situation should be stabilised by following the appropriate incident management or contingency plan procedures. The appropriate staff should be notified and emergency procedures enacted.

Typical first response actions may include:

- Assessment of vapour concentrations / asbestos fibre counts from air monitoring in excavation areas and associated risk to human health;
- Temporary repair or isolation of failed plant / equipment component; and
- Sampling of impacted site media, be it soil, groundwater and / or surface water.

Follow-up action will include the development of a work plan to remediate or manage the impacted site media. The work plan would detail any sampling and analysis requirements to define the nature and extent of impact, methods for the recovery, handling, storage and treatment of impacted material, disposal and/or reuse options for impacted material and personal protective equipment requirements.

Records will be kept of any incidents, accidents, hazardous situations, unusual events and unsafe health exposures and the corrective action taken. Where necessary, the LTEMP should be updated based on findings of corrective actions / improvements etc.

7.3 Communication, Reporting and LTEMP Auditing Requirements

The table below outlines the reporting and auditing requirements to communicate information related to the Stage 1 Area LTEMP,

Table 6 –Stage 1 Area LTEMP Reporting and Auditing

Report	Requirement
Material Classification Reports	■ All reports relating to unexpected finds, offsite disposal of fill materials and importation of any materials used for construction / backfilling purposes are to be provided to the Land Custodian upon completion of works. ■ Reports are to include details laboratory analysis and subsequent classification information and materials tracking information detailing the total volume and final placement / disposal location.
Non-Conformance Reporting	■ Non-conformances will be recorded in a Non-Conformance and Corrective Action Report. Details of the non-conformance, including any immediate corrective actions undertaken, are to be recorded by the operational staff. ■ It is the responsibility of the site manager to immediately initiate corrective actions, if required. Once completed, the site foreman will provide details of the actions undertaken on the Non-Conformance Report and sign, date and file the report.
Incident Reporting	■ Records will be kept of any environmental incidents, accidents, hazardous situations, unusual events and unsafe health exposures and the corrective action taken. ■ The contractor / site superintendent will adequately investigate the cause of any incident so that necessary changes in work practices can be made to prevent the incident recurring.
Complaints Reporting	During intrusive works undertaken the Site, the contractor will maintain a register of complaints, which will include a record of any action taken with respect to the complaints. ■ If a complaint identifies a non-conformance, a Non-Conformance and Corrective Action Report must be initiated. ■ A copy of all complaint reports and subsequent investigations are to be provided to the Land Custodian or their nominated representative for filing and included within compliance reporting (detailed below).
LTEMP Compliance Reporting	Upon completion of any intrusive works, the contractor is to provide the Land Custodian or their nominated representative an Environmental Compliance Report detailing the following: ■ Details of the works undertaken including relevant photographs. ■ Details of management provisions in place to ensure compliance with this LTEMP, the HASP and SMP during the works. ■ Details of any non-conformances, complaints and corrective actions. ■ Details of any unexpected finds (nature, extent and results of testing / analysis undertaken, photographs). ■ Details of the appropriate classification, volume and disposal location of any material disposed offsite. ■ Details (including photographs) of any imported fill materials including volumes and confirmation of the suitability for use within the Site The report is to be provided to Land Custodian or their nominated representative within 21 days of completion of works.

Report	Requirement
LTEMP Performance Monitoring	This LTEMP should be reviewed by the Land Custodian or their nominated representative upon completion of all intrusive excavation activities and / or after incidents or reported findings, to ensure that: ■ information and environmental management strategies remain current; ■ any opportunities for improvement are identified; and ■ changes to legislation, licence and approval conditions are identified and complied with. The assessment should take into account all changes such as (but not limited to): ■ changes to site conditions; ■ work requirements; ■ legislation; and ■ environmental condition. If during the review process described above, areas for improvement are identified, or it be determined that the LTEMP requires revision, any changes to the document will require agreement by at least the following stakeholders: ■ Land Custodian (or nominated representative); ■ a suitable qualified environmental consultant; and ■ a NSW EPA accredited Site Auditor.
Record Keeping	All records related to implementation and ongoing auditing of the LTEMP should be maintained by the Land Custodian or their nominated representative in a consolidated and easily accessible location.

8. CONTINGENCY ACTIONS

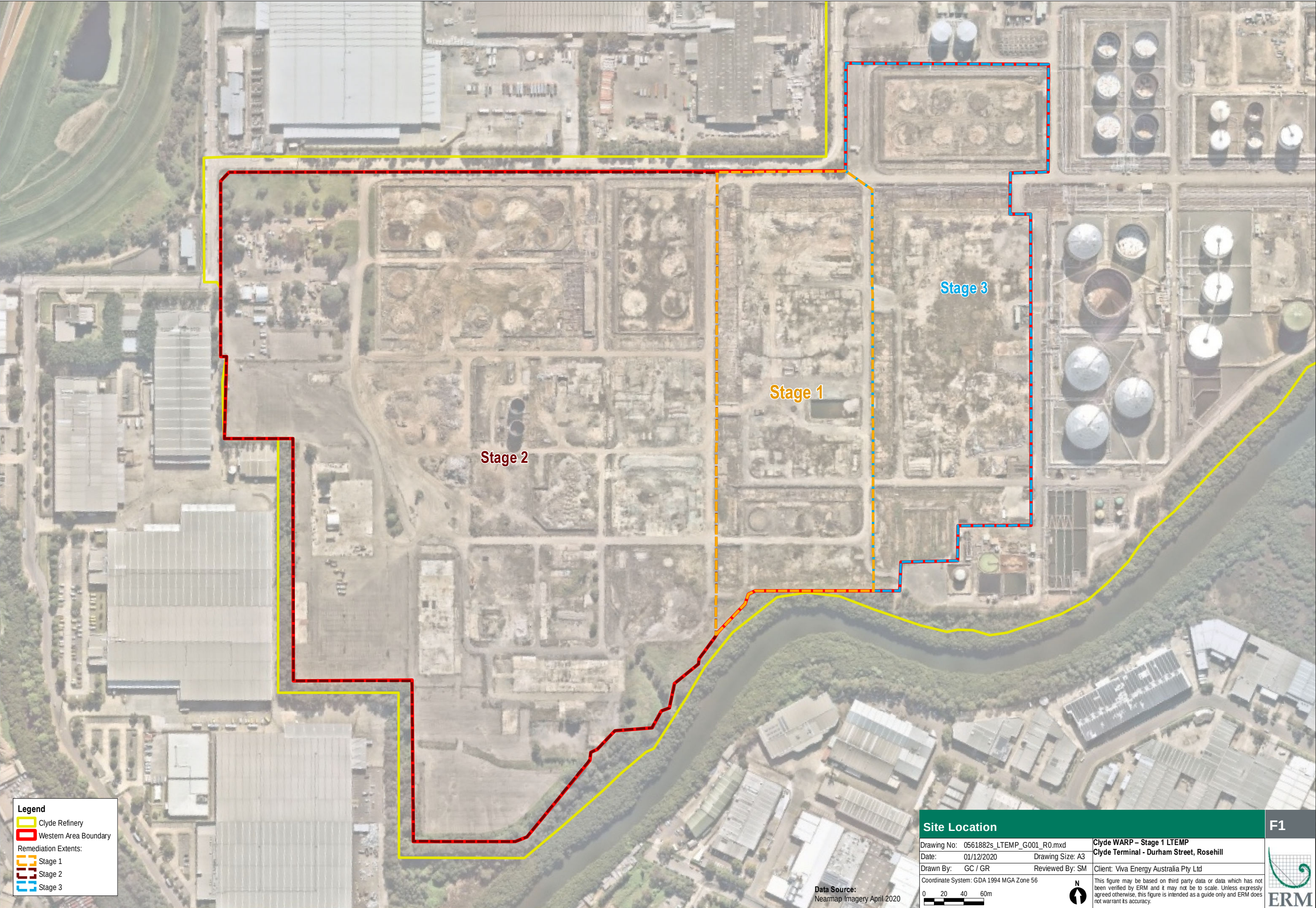
The purpose of the contingency plan is to identify unexpected situations that could occur, and specify procedures that can be implemented to manage such situations and prevent or minimise adverse impacts to the environment and human health.

Details of the procedures are defined in the table below:

Table 7 –Stage 1 Area Contingency Actions

Item	Contingency Action
	■
Asbestos Contamination	■ While asbestos has been identified within formworks associated with former site infrastructure, asbestos (fragments and / or fibres) in soils have not been identified within the Stage 1 Area. ■ While it is the opinion of ERM that the risk of significant and / or widespread asbestos contamination within the Stage 1 Area is unlikely, where asbestos contaminated soil is identified during development works, any finds should be investigated as per the unexpected finds methodology detailed within Section 7.1. ■ Identified asbestos remaining on site should be included on an updated version of the Asbestos Register (provided as Appendix B).
Additional/ unexpected LNAPL / Hydrocarbon Contamination resulting in Potential Vapour Risk	■ While it is the opinion of ERM that the likelihood of vapour risk from additional / unexpected finds of LNAPL / hydrocarbon impacted soil and / or groundwater is unlikely, during future development works, where a potential indicators of vapour risk is identified, the Land Custodian should engage an environmental specialist to undertake further assessment.

APPENDIX A FIGURES



Legend

Clyde Refinery

Western Area Boundary

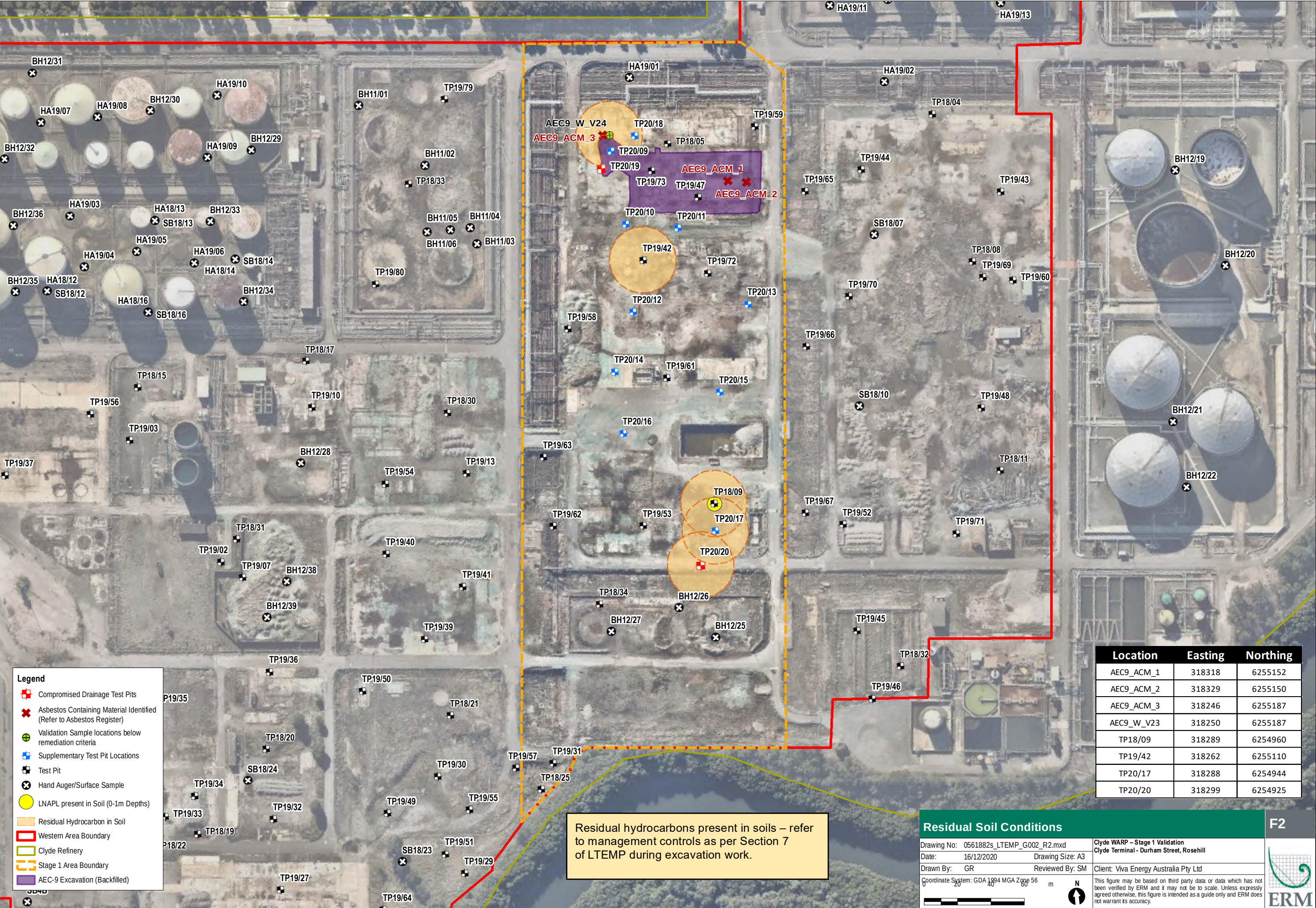
Remediation Extents:

Stage 1

Stage 2

Stage 3

Site Location			F1
Drawing No: 0561882s_LTEMP_G001_R0.mxd		Clyde WARP – Stage 1 LTEMP	
Date: 01/12/2020 Drawing Size: A3		Clyde Terminal - Durham Street, Rosehill	
Drawn By: GC / GR Reviewed By: SM		Client: Viva Energy Australia Pty Ltd	
Coordinate System: GDA 1994 MGA Zone 56		This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.	
0204060m N 			



Legend

- Compromised Drainage Test Pits
- Asbestos Containing Material Identified (Refer to Asbestos Register)
- Validation Sample locations below remediation criteria
- Supplementary Test Pit Locations
- Test Pit
- Hand Auger/Surface Sample
- LNAPL present in Soil (0-1m Depths)
- Residual Hydrocarbon in Soil
- Western Area Boundary
- Clyde Refinery
- Stage 1 Area Boundary
- AEC-9 Excavation (Backfilled)

Location	Easting	Northing
AEC9_ACM_1	318318	6255152
AEC9_ACM_2	318329	6255150
AEC9_ACM_3	318246	6255187
AEC9_W_V23	318250	6255187
TP18/09	318289	6254960
TP19/42	318262	6255110
TP20/17	318288	6254944
TP20/20	318299	6254925

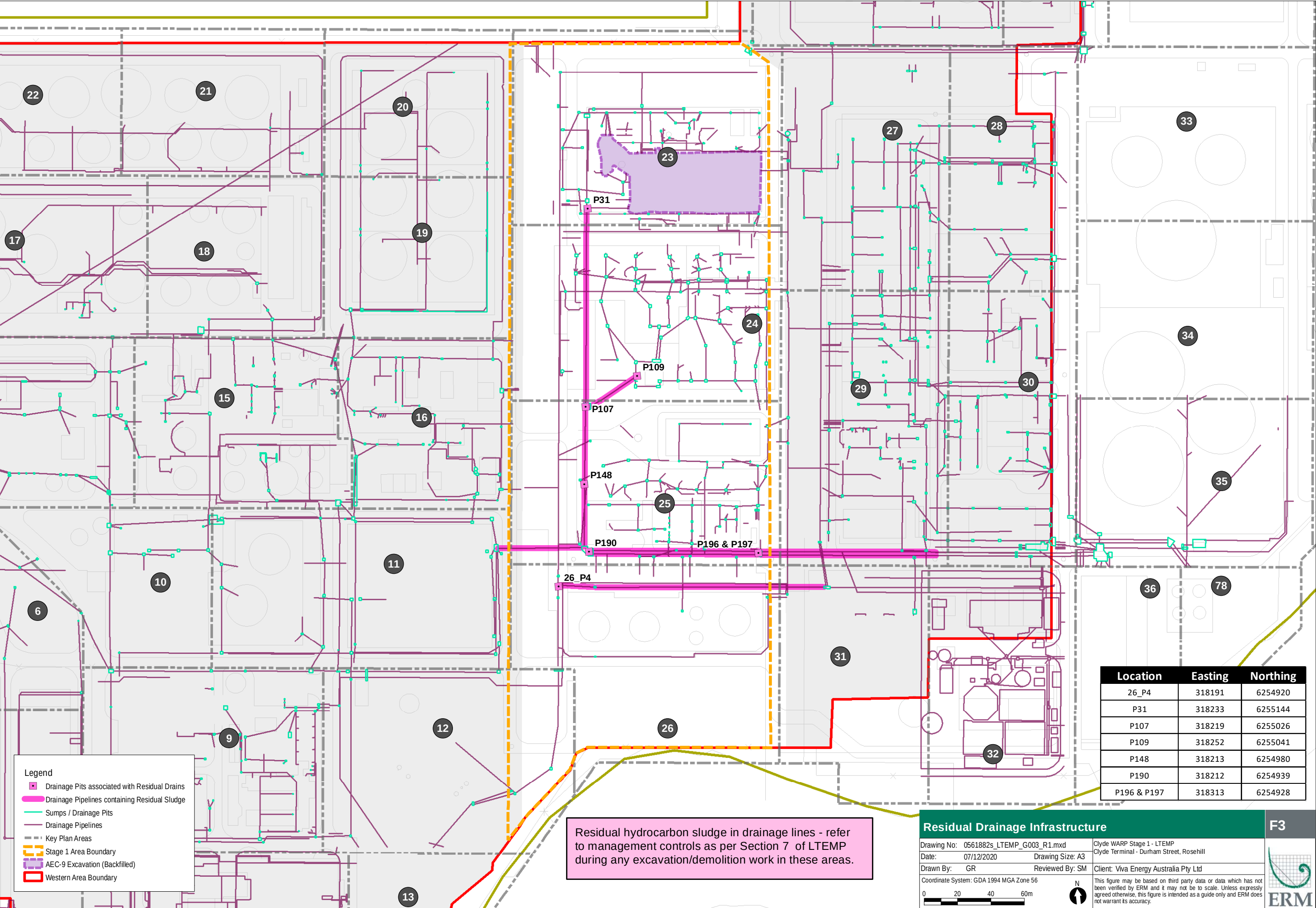
Residual hydrocarbons present in soils – refer to management controls as per Section 7 of LTEMP during excavation work.

Residual Soil Conditions

Drawing No: 0561882s_LTEMP_G002_R2.mxd
Date: 16/12/2020
Drawing Size: A3
Drawn By: GR
Reviewed By: SM
Coordinate System: GDA 1994 MGA Zone 56

Clyde WARP – Stage 1 Validation
Clyde Terminal - Durham Street, Rosehill
Client: Viva Energy Australia Pty Ltd

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.



APPENDIX B ASBESTOS REGISTER

Asbestos Register

As outlined within Section 5.0, residual asbestos formwork is present within subsurface redundant historical site infrastructure (footings etc). ERM notes that while no asbestos in soil has been identified, where works are to be undertaken within 20m of the below locations, asbestos management controls s outlined within Section 7.0 are to be implemented.

Date identified	ID	Eastings	Northings	Approximate Depth (m BGL)	Description	Friable or non-friable	Observed condition	Accessibility
19 October 2020	AEC9_ACM_1	318318	6255152	1.0m	■ Suspected ACM formwork (corrugated sheeting) attached to concrete foundation	Non-friable	■ Good – bonded corrugated sheeting attached to concrete foundation	Inaccessible under normal site conditions – only accessed via excavation
19 October 2020	AEC9_ACM_2	318329	6255150	1.3m	■ Suspected ACM formwork (corrugated sheeting) attached to concrete foundation	Non-friable	■ Good – bonded corrugated sheeting attached to concrete foundation	Inaccessible under normal site conditions – only accessed via excavation
11 November 2020	AEC9_ACM_3	318246	6255187	Approximately 2.5m	■ Suspected ACM formwork (corrugated sheeting) located on the northern excavation extent	Non-friable	■ Good – bonded corrugated sheeting attached to concrete foundation	Inaccessible under normal site conditions – only accessed via excavation

APPENDIX C SITE SURVEY

M.G.A

STAGE 1B

GRAND PARADE

101
DP 1168951

101
DP 809340

2
DP 224288

1 DP 383675
1 DP 1190873

DURHAM STREET

DEVON STREET

COLQUHOUN STREET

21
60.04ha
BY DED'N

6
6.998ha
(INCLUDING RIPARIAN
SETBACK)

5
28.07ha
(INCLUDING RIPARIAN
SETBACK)

2
DP 864567

DUCK

MEAN
RIVER

NOTES:
1. ALL DIMENSIONS SHOWN HEREON ARE APPROXIMATE
AND SUBJECT TO FINAL SURVEY
2. NO CADASTRAL SURVEY HAS BEEN UNDERTAKEN

(A) EASEMENT TO DRAIN WATER 10.2 & 13.4 WIDE (AC 424785)
(B) EASEMENT 6.095 WIDE (B309159) - SYDNEY WATER PIPELINE
(C) EASEMENT TO DRAIN WATER 13.4 WIDE (AC424784)
(G) PROPOSED EASEMENT FOR SERVICES 5 WIDE
(H) PIPELINE EASEMENT (V540637 & V540638)
(J) PIPELINE EASEMENT (V22813)
(K) PIPELINE EASEMENT WHOLE OF LOT (R297864)
(L) EASEMENT FOR OVERLAND FLOW 5 WIDE
(M) EASEMENT FOR PEDESTRIAN ACCESS 40 WIDE & VARIABLE
WIDTH

30 0 60 150 330m
SCALE 1:3000

CLIENT

VE PROPERTY
PTY LTD

PROJECT

PLAN OF
PROPOSED SUBDIVISION
OF
LOT 100 IN
DP 1168951
STAGE 1B

NOTES

The title boundaries shown hereon were not marked at the time of survey
and have been determined by plan dimensions only and not by field
survey.

Services shown hereon have been located where possible by field survey.
If not able to be so located, services have been plotted from the records of
relevant authorities where available and have been noted accordingly on
the plan. Where such records do not exist or are inadequate a notation
has been made hereon.

Prior to any demolition, excavation or construction on the site, the relevant
authority should be contacted for possible location of further underground
services and detailed locations of all services.

6	GKO	11/11/2020	AMEND RIPARIAN SETBACK
5B	GKO	02/11/2020	LANDSCAPE SETBACK REMOVED
4B	GKO	13/10/2020	SY074707.11.4 VER B
4	GKO	06/08/2020	APPROX AUSGRID LINE ADDED
3	GKO	23/07/2020	EASEMENTS ADDED
2	GKO	16/07/2020	LOT 6 DIMENSION AND AREA AMENDED
1	GKO	22/06/2020	INITIAL ISSUE

SYM	CODE	DESCRIPTION	SYM	CODE	DESCRIPTION
①	BIN	BIN	⊕	OFM	OPTICAL FIBRE MARKER
△	BM	BENCH MARK	=	OFP	OPTICAL FIBRE PIT
●	BO	BOLLARD	TM	TM	PALM TREE
■	DJM	DRAINAGE MANHOLE	SE	SE	SEAT
⬮	EFP	ELEC FUSE BOX	TS	TS	SHRUB
⊗	ELP	ELEC GARDEN LIGHT	TCA	TCA	TELSTRA PIT
EL	EL	ELEC GREEN PILLAR	SLH	SLH	SEWER LAMP HOLE
LP	LP	ELEC LIGHT POLE	SMH	SMH	SEWER MANHOLE
EP	EP	ELECT SINGLE PIT	SVP	SVP	SEWER VENT PIPE
SPL	SPL	ELEC STAY POLE	SI	SI	SIGN
PP	PP	ELEC POWER POLE	BS	BS	BUS STOP SIGN
ELP	ELP	ELEC POLE/LIGHT	T	T	TREE
TRANS	TRANS	ELE POLE/TRANSFORM	SGL	SGL	TRAFFIC LIGHT
FD	FD	FUEL DIP	SCL	SCL	TRAFFIC CONTROLLER
GM	GM	GAS MAIN	SJX	SJX	TRAFFIC JUNCTION BOX
GMR	GMR	GAS METER	US	US	UNKNOWN SERVICE
GAS	GAS	GAS VALVE	WAV	WAV	WATER AIR VALVE
AG	AG	GATE	WMR	WMR	WATER METER
GUL	GUL	GULLY PIT	WEP	WEP	WATER PUMP
HYD	HYD	HYDRANT	WSV	WSV	WATER STOP VALVE
⊕	BOR	BOREHOLE	WTP	WTP	WATER TAP

Symbols shown are indicative only. The symbol size and orientation does not
necessarily represent the real size or orientation of the feature.

DRAINAGE PIPE U/G	— IV — IV — IV — IV —
DRAIN	— I — I — I — I —
ELECT. CABLE A/G	— E — E — E — E —
ELEC. CABLE U/G	— e — e — e — e —
GAS PIPE	— GAS — GAS — GAS — GAS —
FENCE LINE	— F — F — F — F —
SEWERAGE PIPE	— S — S — S — S —
TELSTRA CABLE	— T — T — T — T —
WATER PIPE	— W — W — W — W —



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ISO 9001:2008
FS 53063

HEIGHT DATUM AHD	LOCAL AUTHORITY CITY OF PARRAMATTA
HEIGHT ORIGIN N/A	SCALE 1:3000(A1)
MERIDIAN 56	CONTOUR INTERVAL N/A
CO-ORD SYSTEM MGA	SURVEYOR N/A
DATE OF SURVEY -	DATE 11/11/2020
CCAD FILE 74707 ver 9 final subdivision	DRAWN SF/CLP
AUTOCAD FILE SY074707.000.11B.6	CHECKED GKO
ARCHIVE FILE SY074707.000.11.5B	APPROVED GKO
PLAN NUMBER SY074707.000.11B.6	SHEET 1 OF 1

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