

August 2007

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An environmental audit is an assessment of the condition of the environment, or the nature and extent of harm (or risk of harm) posed by an industrial process or activity, waste, substance or noise. Environmental audit reports are prepared by EPA-appointed environmental auditors who are highly qualified and skilled individuals.

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A certificate indicates that the auditor is of the opinion that the site is suitable for any beneficial use defined in the Act, whilst a statement indicates that there is some restriction on the use of the site.

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s53X Environmental Audit Report. 1136- 1138 Nepean Hwy, Highett. Stage 2A, CARMS Reference 37308-3

Department of Treasury and Finance

07 December 2021

→ **The Power of Commitment**



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ENVIRONMENT PROTECTION ACT 1970**Statement of Environmental Audit**

I, John Throssell of GHD Pty Ltd 180 Lonsdale Street, Melbourne, a person appointed by the Environment Protection Authority ('the Authority') under the *Environment Protection Act 1970* ('the Act') as an environmental auditor for the purposes of the Act, having:

1. been requested by Mr Adam Bradley of Victorian Department of Treasury and Finance to issue a certificate of environmental audit in relation to Stage 2A of the site located at 1136-1138 Nepean Highway, Highett 3190, located in the City of Kingston, comprising the land defined by the Certificate of Title Volume 9598 Folio 389, Allotment 2026, Parish of Moorabbin, owned by Department of Treasury and Finance and currently vacant.
2. had regard to, amongst other things,
 - i. guidelines issued by the Authority for the purposes of Part IXD of the Act,
 - ii. the beneficial uses that may be made of the site, and
 - iii. relevant State environment protection policies/industrial waste management policies, namely: State environment protection policy (Prevention and Management of Contamination of Land) 2002, State environment protection policy (Waters) 2018, Industrial Waste Management Policy (Prescribed Industrial Waste) 2000, Industrial Waste Management Policy (Waste Acid Sulphate Soils) 1999, State environment protection policy (Air Quality Management) 2001 and State environment protection policy (Ambient Air Quality) 1999.

in making a total assessment of the nature and extent of any harm or detriment caused to, or the risk of any possible harm or detriment that may be caused to, any beneficial use made of the site by any industrial processes or activity, waste or substance (including any chemical substance), and

3. completed an environmental audit report in accordance with section 53X of the Act, a copy of which has been sent to the Authority and the relevant planning and responsible authority.

HEREBY STATE that I am of the opinion that:

The site is suitable for the beneficial uses associated with

Sensitive use (High density: residential use, a childcare centre, pre-school or primary school);

Recreation/Open space;

Commercial;

Industrial);

use of the land,

subject to the following conditions attached thereto:

- Condition 1 This statement is directly referable to and based upon the layout and construction of the development shown and described in the attached *Masterplan: Apartment and Townhouse Scheme 1136-1147 Nepean Highway Highett Gasworks, 14/02/2020*. Any substantive change(s) i.e. coverage of paved area, building footprint, introduction of basements, must be verified by an environmental auditor appointed under Division 1 of Part 8.3 of the Environment Protection Act 2017, and this verification advised in writing to EPA and the planning authority.
- Condition 2 Groundwater at the site is polluted and is not suitable for the use of; water dependent ecosystems and species; potable water supply; agriculture and irrigation (irrigation and stock watering); water-based recreation (primary contact recreation); Traditional Owner cultural values; Cultural and spiritual values; buildings and structures. Groundwater must not be used for any precluded beneficial use without prior testing and review of results by a suitably qualified professional to confirm its suitability for the proposed use. It may be extracted for the purpose of environmental monitoring or remediation.
- Condition 3 There are no basements included in the proposed development plans for the site. The site is not suitable for a basement without further assessment and the potential design and installation of mitigation measures to manage vapour and odour risks. If a basement (single or multilevel) is incorporated in the development of the site, an environmental auditor Division 1 of Part 8.3 of the Environment Protection Act 2017 ("the Act") must be engaged to conduct an environmental audit under Division 3 of Part 8.3 of the of the Act, to consider this use.
- Condition 4 A Construction Environmental Management Plan must be developed for the site by a suitably qualified professional and verified by an environmental auditor appointed under Division 1 of Part 8.3 of the Environment Protection Act 2017, and this verification advised in writing to EPA and the planning authority.
- Condition 5 Prior to the commencement of site construction, the owner of the site must implement and maintain a Construction Environmental Management Plan required by condition 4 of this statement.
- Condition 6 The existing Site Environmental Management Plan (Stages 2 and 2A) must be revised by a suitably qualified professional to reflect current site conditions and verified by an environmental auditor appointed under Division 1 of Part 8.3 of the Environment Protection Act 2017, and this verification advised in writing to EPA and the planning authority.
- Condition 7 Prior to site occupation, the owner of the site must implement and maintain the revised Site Environmental Management Plan required by condition 6 of this statement.

The condition of the site is detrimental or potentially detrimental to any (one or more) beneficial uses of the site. Accordingly, I have not issued a Certificate of Environmental Audit for the site in its current condition, the reasons for which are presented in the environmental audit report. The terms and conditions that need to be complied with before a Certificate of Environmental Audit may be issued are set out as follows:

Removal of all residual soil impacts at the site

Restoration of all relevant beneficial uses of groundwater

Other related information:

The 2010 determination by EPA (CARMS 37308-2) that the former Highett Gasworks Site (Stages 2 and 2A) has been cleaned up to the extent practicable (CUTEP), and that Stages 2 and 2A are a groundwater quality restricted use zone (GQRUZ) remain valid.

Groundwater at the site is polluted with cyanide, ammonia, sulphate, metals, TRH, PAHs (including BTEX), phenols and MAHs and is not suitable for the beneficial uses of water dependent ecosystems and species; potable water supply; agriculture and irrigation (irrigation and stock watering); water-based recreation (primary contact recreation); Traditional Owner cultural values; Cultural and spiritual values; buildings and structures. The groundwater is suitable for the beneficial uses of industrial and commercial.

In accordance with clause 19(3) of SEPP (Groundwaters of Victoria), the Authority may require periodic reassessment of the practicability of groundwater clean up.

Groundwater at the site contains elevated concentrations of metals (arsenic, nickel and zinc) and nitrate. The concentrations are considered to be associated with off-site regional sources of pollution. The pollution is not sourced from the site.

Some soil and groundwater may contain odours at some locations on the site. This material is not considered to represent a health or ecological risk but may cause a noticeable odour if exposed during excavation works, development or occupation of the site.

No further groundwater monitoring across Stages 2 and 2A is considered necessary. The remaining groundwater impacts are considered to be stable or declining, and are adequately managed by the GQRUZ.

Groundwater monitoring bores present at the site and installed off-site should be decommissioned within 12 months of cessation of use in accordance with the requirements of "Minimum Construction Requirements for Water Bores in Australia", published by the Land and Water Biodiversity Committee (4th edition).

This statement of Environmental Audit (SoEA) supersedes the SoEA issued by John Throssell of Parsons Brinckerhoff which was provided in the Audit report titled Stages 2 and 2A 1136-1138 Nepean Highway Highett 3190 Victoria CARMS 37308-2. Ref 2125064A-A and dated 15 December 2011.

This Statement forms part of the Environmental Audit Report: 1136-1138 Nepean Hwy, Highett. Stage 2A, prepared for the Department of Treasury and Finance. *CARMS Reference 37308-3*, (December, 2021). Further details regarding the condition of the site may be found in the Environmental Audit Report.

DATED: 07 December 2021

SIGNED:



MR JOHN THROSSELL

ENVIRONMENTAL AUDITOR

(Appointed Pursuant to the *Environment Protection Act 1970*)

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CROWN FOLIO STATEMENT

Page 1 of 1

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CROWN FOLIO

LAND DESCRIPTION

Crown Allotment 2026 Parish of Moorabbin.
PARENT TITLE Volume 11703 Folio 299
Created by instrument MI156380G 06/08/2016

CROWN LAND ADMINISTRATOR

DEPARTMENT OF TREASURY AND FINANCE
MI156380G 06/08/2016

STATUS, ENCUMBRANCES AND NOTICES

DIAGRAM LOCATION

SEE CD061631C FOR FURTHER DETAILS AND BOUNDARIES

ACTIVITY IN THE LAST 125 DAYS

NIL

-----END OF CROWN FOLIO STATEMENT-----

Additional information: (not part of the Crown Folio Statement)

Street Address: VIEW STREET HIGHETT VIC 3190

DOCUMENT END



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CROWN DIAGRAM	CD061631C	
Location of Land Parish : MOORABBIN Allotment : 2026	This plan has been created to assist in locating a Crown Land parcel Warning - No warranty is given as to the accuracy or completeness of this plan Any derived dimensions are approximate	
Standard Parcel Identifier (SPI) : 2026\PP3163 Vicmap Parcel PFI : 219533681	Coordinate Position MGA : 328240, 5797660 (55) Melways Directory Reference : 77 F10 (ed. 38)	
		Compiled from VICMAP cadastral mapping data Date: 09/05/2012 QJ
0100200300400500 SCALE METRES		Sheet 1 of 1 Sheets

Executive summary

Table 1 *Summary of Audit Information*

Summary information required	
Auditor	Mr John Throssell
Auditor account number	75645
Auditor appointment end date	07/08/2024
Audit type	S53X
Date EPA notified of audit	25/03/2019
Audit service order number	8006101 (CARMS No. 37308-3)
Name of person requesting audit	Department of Treasury and Finance
Relationship of person requesting audit to site	Site manager
Name of premises owner	Development Victoria
Date of auditor engagement	18/03/2019
Completion date of the audit	07/12/2021
Reason for audit	Environmental audit overlay
Audit Categorisation	Risk
Environmental segments	Land, Groundwater, Air, Surface Water
If an audit was required by an EPA notice, licence or other, please provide EPA reference number	
Current land use zoning	Residential Growth Zone – Schedule 2 (RGZ2) under the Kingston City Council Planning Scheme
EPA region	Southern Metropolitan
Municipality	Kingston City Council
Dominant – Lot on plan	Certificate of Title Volume 9598 Folio 389. Plan of Consolidation No. 150995, Parish of Moorabbin.
Additional – Lot on plan	Crown Allotment 2026 Parish of Moorabbin. SPI:2026\PP3163
Site/premises name	Former Highett Gasworks
Building / complex sub-unit No.	
Street/Lot – Lower No.	1136
Street/Lot – Upper No.	1138
Street Name	Nepean
Street type (road, court, etc.)	Highway
Street suffix (North, South etc.)	
Suburb	Highett
Postcode	3190
GIS coordinate of site centroid	GDA94 – Longitude / Latitude in decimal degrees
Latitude (GDA94)	37.952067
Longitude (GDA94)	145.045068
Site area (m ²)	14,220
Plan of site/premises showing audit boundary attached	Refer to Figure 1

Summary information required		
Members and categories of support team utilised	Eric Friebe (human health risk assessment)	
Further works or requirements	Development and implementation of Construction Environmental Management Plan for site development works. Revision and implementation of the existing Site Environmental Management Plan (post construction and development).	
Nature and extent of continuing risk	Residual soil impacts require ongoing management. Groundwater not suitable for extractive uses. Further groundwater monitoring not required.	
Outcome of the audit	Statement of Environmental Audit	
Has EPA determined CUTEPA at the site?	Yes (2011)	
Has the Auditor determined CUTEPA at this site?	No	
Has a GQRUZ been identified at the site / beyond the site by EPA?	Yes, the site (Stage 2A) and Stage 2 is a GQRUZ	
Does NAPL remain at the site?	No	
Please indicate which of the protected beneficial of groundwater are precluded due to pollution	Protected Use Water dependent ecosystems and species Potable water supply (desirable) Potable mineral water supply Agriculture and irrigation (irrigation) Agriculture and irrigation (stock watering) Industrial and commercial water use Water-based recreation 3(primary contact recreation) Traditional Owner cultural values Cultural and spiritual values Buildings and structures Geothermal properties	Precluded? Yes Yes Not relevant Yes Yes No Yes Yes Yes Yes Not relevant

Table 2 Physical Site Information

Summary information required	
Historical land use	Gasworks, training centre
Current land use	Vacant land. A live gas main runs along the western boundary of the site.
Proposed future land use	Residential (medium and high density) and open space
Surrounding land use - north	Residential and commercial
Surrounding land use - south	Public park, recreation (Sir William Fry Reserve)
Surrounding land use - east	Vacant land (Stage 2), Moorabbin Magistrates Court, residential and commercial, Nepean Highway,
Surrounding land use - west	Frankston Railway Line, Lyle Anderson Reserve, Highett Bowls Club and residential
Proposed land use zoning	RG22 (Residential Growth)
Nearest surface water receptor - name	Port Phillip Bay
Nearest surface water receptor - direction	West
Likely point of groundwater discharge	Port Phillip Bay
Site aquifer formation	Brighton Group
Groundwater flow direction	West to southwest
Groundwater TDS range	172 to 4,796 mg/L in November 2018
Groundwater segment	A2

Summary information required	
Are multiple aquifers impacted by the pollution at the site?	No
Perched groundwater depth – upper (mbgl)	-
Perched groundwater depth – lower (mbgl)	-
Regional groundwater depth – upper (mbgl)	4.656
Regional groundwater depth – lower (mbgl)	10.335
Number of bores within 2km	368
Closest extractive use (distance in m)	300 m (115041, registered for irrigation use)
Zone of groundwater plume influence (m from site boundary)	Potential impacts below rail easement
Year groundwater was last monitored	November 2018
Have you attached electronic copies of current groundwater analytical results presented as a summary table?	Refer Appendix F

This Executive Summary presents a brief summary of information described in the environmental audit report. The Executive Summary should be read in conjunction with the full environmental audit report 1136-1138 Nepean Hwy, Highett. Stage 2A, prepared for the Department of Treasury and Finance. *CARMS Reference 37308-3*, (December, 2021), and interpreted in the context of the more detailed information presented in the body of the environmental audit report, the purpose and scope of the environmental audit and the disclaimers/limitations discussed in Section 1.6 of the environmental audit report.

Abbreviations

ABC	Ambient Background Concentration
ACL	Added Contaminant Limit
ACM	Asbestos Containing Material
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
BTEXN	Benzene, Toluene, Ethylbenzene, Xylene, Naphthalene
CEC	Cation Exchange Capacity
CUTEP	Clean Up to the Extent Practicable
DO	Dissolved Oxygen
EIL	Ecological Investigation Level
EPA	Environment Protection Authority
ESL	Ecological Screening Level
GME	Groundwater Monitoring Event
GQRUZ	Groundwater Quality Restricted Use Zone
HIL	Health Investigation Level
HSL	Health Screening Level
LNAPL	Light Non-aqueous Phase Liquid
LOR	Limit of Reporting
m	Metres
MAH	Monocyclic aromatic hydrocarbon
mg/kg	milligrams per kilogram
NAPL	Non-aqueous Phase Liquid
NATA	National Association of Testing Authorities
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NHMRC	National Health and Medical Research Council
OCP	Organochlorine Pesticide
OPP	Organophosphorus Pesticide
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PID	Photo-ionisation Detector
QA	Quality Assurance
QC	Quality Control
RAP	Remedial or Remediation Action Plan
RPD	Relative Percent Difference
SEPP	State Environment Protection Policy
SEPP Waters	State Environment Protection Policy (Waters) 2018
SMP	Site Management Plan
SVOC	Semi-volatile Organic Compound
TDS	Total Dissolved Solid
TIT	Triple Interceptor Trap

TPH	Total Petroleum Hydrocarbons
TRH	Total Recoverable Hydrocarbons (represents extracted biological and petroleum hydrocarbons (TPH) and is the normal laboratory analysis method)
UST	Underground Storage Tank
UCL	Upper Confidence Limit
UPSS	Underground Petroleum Storage Systems
VOC	Volatile Organic Compound
µg/L	micrograms per litre
µS/cm	micro Siemens per Centimetre

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Figure 1	Audit Boundary
Figure 2	GQRUZ Boundary

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1. Introduction

Mr John Throssell, an environmental auditor (contaminated land) appointed under Division 1 of Part 8.3 of the *Environment Protection Act 1970* ("the auditor") of GHD was engaged by Department of Treasury and Finance (DTF) to conduct a section 53X audit of the Stage 2A portion of the former Highett Gasworks site located at 1136 – 1138 Nepean Highway, Highett Victoria. The audit site is shown in Figure 1.

This environmental audit report sets out the results of an environmental audit conducted in accordance with Part IXD of the *Environment Protection Act 1970*. The report was completed in accordance with the guidelines issued by the EPA for environmental audits of contaminated sites.

The purpose of initiating the audit was to facilitate the proposed redevelopment of Stage 2A to residential and open space land uses.

1.1 Background

The former Highett Gasworks site was divided into Stages 1 and 2 circa 2005. A s53X audit of Stage 1 was completed in March 2006 (by David Adams of Parsons Brinckerhoff (PB)) resulting in a Statement of Environmental Audit. Stage 2 (Crown Allotment 2006, TP835477B), was further divided into Stages 2 (SPI:2027\PP3163) and 2A (SPI:2026\PP3163) in 2010 and are approximately 4.7 and 1.63 ha in area respectively.

A s53X audit of Stages 2 and 2A (herein referred to as the 2011 Audit) was completed in December 2011 (by John Throssell of PB) resulting in the issuing of Statements of Environmental Audit. Stage 2 was remediated and, subject to a range of conditions found to be suitable for sensitive (medium density), commercial, industrial and public open space land use.

High pressure gas lines were still active within Stage 2A and therefore the remediation of residual soil impacts could not be undertaken due to access and safety constraints. A Human Health Risk Assessment (HHRA) completed by Golder Associates (Golder) in February 2010 concluded that soil contamination near the gas main posed an unacceptable vapour risk to human health in a residential setting. Furthermore, the remediation of impacted soil along the western site boundary of Stage 2A was limited due to the proximity of the railway line, which runs parallel to the site boundary. Due to the residual soil impacts, the condition of Stage 2A was found to preclude all beneficial uses of the land as stated in the 2011 Statement of Environmental Audit.

Groundwater on-site and off-site was identified to be polluted and a Clean Up to the Extent Practicable (CUTEP) determination for both Stages 2 and 2A was made by EPA in November 2010 with a Groundwater Quality Restricted Use Zone (GQRUZ) placed over the two audit areas. A Groundwater Quality Management Plan (GQMP) was prepared in December 2011, which formed part of the Statement of Environmental Audits for Stage 2 and 2A. The GQMP required annual monitoring of 21 on-site and off-site groundwater compliance wells.

A condition of the Statement of Environmental Audit for Stage 2 and 2A was the preparation and implementation of an Environmental Management Plan (EMP). The EMP was prepared by Golder in June 2012 and it included the GQMP.

The high pressure gas lines in the 'old gas main easement' were decommissioned in 2018 and thereby allowing the completion of soil remediation on Stage 2A.

1.2 Auditor's support team

The environmental auditor's support team were involved with this environmental audit. The GHD staff that assisted with this audit are provided in Table 3:

Table 3 Auditor's team assisting with audit

Name	Qualification/Role/ Experience area	Contribution to audit
Effie Nikolis	Auditor's assistant / Project manager	Assisted with review of the assessor's reports and preparation of the draft environmental audit report.
Joshua Scandrett	Auditor's assistant / Project manager	Assisted with review of the assessor's reports.
Shin Yi Siew	Auditor's assistant / Project manager	Assisted with review of the assessor's reports.
Jane Leeder	Auditor's assistant	Assisted with review of the assessor's reports and with preparation of the draft environmental audit report.

1.3 Assessment Team

The following environmental consultants were engaged by DTF to undertake monitoring and reporting roles as listed in Table 4 below.

Table 4 Assessment Team

Company	Role	Description
Golder ¹	Former environmental consultant	Conducted environmental monitoring and prepared reports and documentation for the audit site (and wider former Hightett Gasworks site).
Leeder Consulting ¹	Former sub-consultant	Engaged by Golder to conduct soil vapour bore installation and monitoring.
Prensa Pty Ltd (Prensa)	Former environmental consultant	Conducted groundwater monitoring and prepared reports and documentation for the audit site.
EnviroLab	Laboratory	Engaged by Prensa to conduct laboratory analysis.
Senversa Pty Ltd (Senversa)	Environmental consultant (the 'assessor')	Conducted groundwater monitoring, environmental consultancy services for remediation and prepared reports and documentation for the audit site.
Ventia Pty Ltd (Ventia)	Remediation contractor	Engaged by DTF to implement the remediation design and coordinate the remediation and earthworks at the site.
Bureau Veritas	Hygienist	Engaged by Ventia to conduct air monitoring, supervise and validate asbestos removal works, and conduct asbestos testing and identification.
Asbestos Australia	Asbestos removal subcontractor	Licensed asbestos removalists engaged by Ventia to conduct asbestos removal works.
ALS	Laboratory	Engaged by Prensa and Senversa to conduct laboratory analysis.
Eurofins mgt (formerly mgt LabMark)	Laboratory	Engaged by Prensa and Senversa to conduct laboratory analysis.

1. Engaged by DTF in support of the Audit completed by PB in 2011

1.4 Issue of Certificates and Statements of Environmental Audit

The environmental audit system provides a mechanism of assuring planning and responsible authorities, prospective purchasers and others that potentially contaminated land is suitable for particular uses. If the contamination status of the site does not preclude any beneficial uses, then a Certificate of Environmental Audit (CoEA) will be issued. If the environmental auditor is of the opinion that contamination may render a site unsuitable for some beneficial uses, the auditor must issue a Statement of Environmental Audit (SoEA) to that effect.

The Statement of Environmental Audit (SoEA) will outline the specific uses that will not be compromised by the contamination present at the site, and any conditions or restrictions on activities at the site that may need to be observed.

A review of the Environment Protection Act 1970 has resulted in the passage of the Environment Protection Act 2017 (EP Act 2017) which came into effect in July 2021.

Part 16.4 of the New Act provides transitional provisions to address environmental audits where an auditor has notified EPA that they have been engaged to conduct an audit under section 53U of the Old Act, but the audit has not been completed by 1 July 2021.

Audits can be completed under the Old Act or the New Act. Section 478 of the New Act provides that an environmental auditor may conduct an environmental audit under the Old Act or the New Act (where an auditor has been engaged to conduct an audit prior to 1 July 2021 and the audit has not been completed at 1 July 2021). This Audit has been completed under the terms of the Old Act 1970.

1.5 Documents reviewed

The following documents have been reviewed for the purposes of this audit. Reports produced in the period from 2010 to 5 April 2019 were read by the auditor but were not the subject of independent and critical review. All subsequent key reports were critically reviewed by the auditor.

Table 5 Documents reviewed

Author	Date	Document Title	Included in appendices of this report
Golder	2 February 2010	Revised Human Health Risk Assessment, Highett Gasworks, 1136-1138 Nepean Highway Highett	No
Golder	5 December 2011	Groundwater Quality Management Plan – Stages 2 and 2A (Revision 2), Former Highett Gasworks 1138 Nepean Highway Highett Victoria	No
PB	15 December 2011	Environmental Audit Report Stages 2 and 2A 1136-1138 Nepean Highway Highett 3190 Victoria (CARMS #37308-2)	No
Golder	27 June 2012	Environmental Management Plan Stages 2 and 2A (Revision 2), Former Highett Gasworks, 1138 Nepean Highway Highett Victoria	No
Prensa Pty Ltd (Prensa)	February 2013	Groundwater Monitoring Events, 1136-1138 Nepean Highway Highett, Victoria	No (provided as Appendix E of Senversa 2021 Groundwater Monitoring Cessation Review).

Author	Date	Document Title	Included in appendices of this report
Prensa	October 2013	Groundwater Monitoring Event, 1136-1138 Nepean Highway Highett, Victoria	No (provided as Appendix E of Senversa 2021 Groundwater Monitoring Cessation Review).
Prensa	June 2014	Groundwater Monitoring Event, 1136-1138 Nepean Highway Highett, Victoria	No (provided as Appendix E of Senversa 2021 Groundwater Monitoring Cessation Review).
Prensa	July 2015	Groundwater Monitoring Event, 1136-1138 Nepean Highway Highett, Victoria	No (provided as Appendix E of Senversa 2021 Groundwater Monitoring Cessation Review).
Prensa	July 2016	Groundwater Monitoring Event, 1136-1138 Nepean Highway Highett, Victoria	No (provided as Appendix E of Senversa 2021 Groundwater Monitoring Cessation Review).
Prensa	August 2017	Groundwater Monitoring Event, 1136-1138 Nepean Highway Highett, Victoria	No (provided as Appendix E of Senversa 2021 Groundwater Monitoring Cessation Review).
Senversa	5 April 2019	Groundwater Monitoring Event, 1136-1138 Nepean Highway, Highett, Victoria ¹	No (provided as Appendix E of Senversa 2021 Groundwater Monitoring Cessation Review).
Senversa	10 April 2019	Data Gaps Review, 1136-1138 Nepean Highway, Highett, Victoria ²	Yes (Appendix C)
Senversa	4 September 2019	Remediation Work Plan, 1136-1138 Nepean Highway, Highett, Victoria ^{3, 7}	Yes (Appendix D)
Senversa	6 September 2019	Sampling and Analysis and Quality Plan, 1136-1138 Nepean Highway, Highett, Victoria ^{4, 7}	Yes (Appendix E)
Prensa	18 December 2019	Classification of Nominated In-Situ Soil at 95-7 Beach Road, Mentone, Victoria	No (provided as Appendix B of Senversa 2021 Remediation and Validation).
Compass Environmental	30 January 2020	Soil Classification Testing: 102 – 106 Burke Road & 2A/2B Nyora Street, Malvern East VIC	No (provided as Appendix B of Senversa 2021 Remediation and Validation).
Ventia Pty Ltd (Ventia)	27 May 2020	Highett Gasworks Stage 2A Remediation Project – 050061, Final Contractors Report	No (provided as Appendix B of Senversa 2021 Remediation and Validation).
Senversa Pty Ltd	14 July 2021	Groundwater Monitoring Cessation Review, Former Highett Gasworks – 1136-1138 Nepean Highway, Highett ^{5, 7}	Yes (Appendix F)

Author	Date	Document Title	Included in appendices of this report
Senversa Pty Ltd	16 July 2021	Remediation and Validation, 1136-1138 Nepean Highway, Highett, Victoria ^{6, 7}	Yes (Appendix F)
Notes: 1 Report referred to herein as Senversa (2019a) 2 Report referred to herein as Senversa (2019b) 3 Report referred to herein as Senversa (2019c) 4 Report referred to herein as Senversa (2019d) 5 Report referred to herein as Senversa (2021a) 6 Report referred to herein as Senversa (2021b) 7 Draft version(s) of report also reviewed by auditor			

1.6 Information about your environmental audit report

This statutory environmental audit report Environmental Audit Report, s53X Stage 2A, Former Highett Gasworks , Victoria, CARMS Reference 37308-3 ("Report") has been prepared in accordance with Part IXD of the Environment Protection Act 1970. The Report represents the Environmental Auditor's opinion of the condition of the site in relation to the presence and impact of contamination at the site and its suitability for beneficial uses stated in the Statement of Environmental Audit at the date the Statement of Environmental Audit is signed. This Report:

- 1. has been prepared by John Throssell of GHD Pty Ltd ("GHD") and his team as indicated in the appropriate sections of this Report for DTF;*
- 2. may be used and relied on by DTF;*
- 3. may be used by and provided to EPA for the purpose of meeting statutory obligations in accordance with the relevant sections of the Environment Protection Act 1970;*
- 4. may be provided to other third parties but such third parties' use of or reliance on the Report is at their sole risk because of, and subject to, the uncertainties associated with this audit as noted in the following paragraphs and in this Report; and*
- 5. may only be used for the purpose as stated in Section 1.1 of the Report (and must not be used for any other purpose).*

To the maximum extent permitted by law, all implied warranties and conditions in relation to the services provided by GHD and the Report are excluded unless they are expressly stated to apply in this Report.

The services undertaken by the Environmental Auditor and his team in connection with preparing this Report were undertaken in accordance with current profession practice and by reference to relevant environmental regulatory authority and industry standards in accordance with Part IXD of the Environment Protection Act 1970.

The opinions, conclusions and any recommendations in this Report are based on assumptions made by the Environmental Auditor when undertaking the audit and preparing the Report. The assumptions are specified throughout this Report.

In undertaking the audit and preparing this Report, the Environmental Auditor is required to make judgments regarding the completeness, reliability and accuracy of the information, and the potential for contamination to impact human health and the environment. The Environmental Auditor makes these judgments based on the information available, the potential impact of contaminants based on the current scientific understanding of the significance and behavior of contaminants, the specific characteristics of the contaminants matrices and current regulatory policy and legislation. The nature of contaminated site investigations is such that there is always some uncertainty in these matters; as new information can arise, the science underlying these matters can change, and regulatory policy and legislation can change. The Environmental Auditor and his team have formed their opinion based on the information available and their understanding of the current science and regulatory policy and legislation, applying processes and considerations in accordance with professional practice. It is possible that new information, a changed scientific understanding or changed regulatory policy and requirements will become available in the future that may lead to a different interpretation. The Environmental Auditor and GHD expressly disclaim responsibility for changes that arise because of any such new information, changed science or changed regulatory policy or legislation.

The Environmental Auditor and GHD have prepared this Report on the basis of information provided by DTF, assessment consultant and others who provided information to GHD (including Government authorities). The Environmental Auditor and GHD have verified the information received to the extent practicable and within the scope specified in the Environmental Auditor (Contaminated Land): Guidelines for Issue of Certificates and Statements of Environmental Audit (EPA Victoria, December 2015). There is some information which it has not been practicable to verify or check, and the Environmental Auditor and GHD are not responsible for this information, including (but not limited to) errors in, or omissions from, the Report, which were caused or contributed to by errors in, or omissions from, this unverified information.

The Environmental Auditor and GHD are not responsible for the Unverified Information, including (but not limited to) errors in, or omissions from, the Report, which were caused or contributed to by errors in, or omissions from, the Unverified Information.

This Report should be read in full and no excerpts are taken to be representative of the findings of this Report.

2. Assessment guidelines

Environmental protection in Victoria is legislated under the *Environment Protection Act 1970* (EP Act). Sub-ordinate legislation within the EP Act includes State Environment Protection Policies (SEPPs) that prescribe beneficial uses and objectives that are to be met to protect the various segments of the environment.

The policies considered for the audit included:

- *State environment protection policy (Prevention and Management of Contamination of Land), 2002 and its variation*
- *State Environment Protection Policy (Waters), 2018, herein referred to as ‘SEPP Waters’.*
- *State environment protection policy (Air Quality Management), 2001*

The SEPPs nominate the investigation levels required to protect beneficial uses.

The auditor considers that the beneficial uses and assessment guidelines adopted by the Assessor were consistent with the objectives of the SEPPs for soil and groundwater.

The guidelines and criteria for assessing soil and groundwater adopted by the auditor are discussed in Appendix B.

2.1 Soil beneficial use objectives

The 2011 Audit (PB, 2011) endorsed the use of “Adopted Clean Up Targets” (ACUT) for site remediation and these were carried through into the EMP developed by Golder (2012) for the ongoing management of residual soil impacts at Stage 2A. The ACUT were developed based on the proposed land uses of the site, being Sensitive Use – Other and / or Recreation/Open Space.

To facilitate a consistent approach to the remediation and re-Auditing of Stage 2A, and to ensure protection of future site users, the ACUT were reviewed by Senversa (2019a) considering changes to regulatory and technical guidance including the introduction of the National Environment Protection (Assessment of Site Contamination) Measure (‘the NEPM’; NEPC, 2013).

Soil acceptance criteria for volatile contaminants were also revised (Class V1 – V4) in order to address vapour intrusion into future residential buildings. These criteria are applicable for soils which may underlie a future building. Senversa adopted, with the auditor’s endorsement, the health screening level (HSL) A/B (for residential use) for a sand geology (the HSLs for this geology are the most conservative). The HSLs were developed in Friebe and Nadebaum, 2011, and are presented in the NEPM.

Of particular relevance to the redevelopment of Stage 2A where much of the site will be open space and roadways, the pathway of vapour intrusion is inactive. The vapour intrusion HSLs for open space in the NEPM are not limiting, indicating that vapour risks are low and acceptable in open space areas, regardless of concentration.

For these areas, screening levels protective of direct contact pathways from volatile contaminants (Class 1 and Class 2) have been presented (Friebe and Nadebaum, 2011). For shallow soils in open space areas, the direct contact HSLs for open space (HSL-C) have been selected (Class 1). For deeper open space areas, and at all depths below proposed roads and pavement areas, the direct contact HSLs for commercial/industrial (HSL-D) have been selected (Class 2).

Details of the development and application of the ACUTs are provided in Senversa (2019a) and a summary is also provided in section 3.5.1 of the Remediation and Validation report (Senversa, 2021b).

3. Site definition

3.1 Site physical definition and description

The description and definition of the site are as follows:

Table 6 Site definition and description

Aspect	Comments
Site locality	The audit site is located at 1136 – 1138 Nepean Highway, Highett, approximately 17 km southeast of the Melbourne CBD. The assessor provided site locality plans as Figure 1 in their reports (Senversa, 2021a and Senversa, 2021b).
GIS coordinate of site centroid	GDA94 – Longitude / Latitude in decimal degrees
Latitude / Easting (GDA94)	37.952067
Longitude / Northing (GDA94)	145.045068
Title information	Current Certificate of Title: Volume 9598 Folio 389 (to be updated following sale of the site) Lot and Plan Number: Plan of Consolidation No. 150995, Parish of Moorabbin Crown Description: Allotment 2026 Parish of Moorabbin Address: 1136 – 1138 Nepean Highway, Highett, Victoria, 3190 Standard Parcel Identifier: 2026\PP3163 Council Property Number: 461941 (Part A) Local Government Area (Council): Kingston
Area	The site encompasses an area of approximately 1.63 ha and is irregular in shape, triangular in the north and rectangular in the south.
Zoning	Residential Growth Zone – Schedule 2 (RGZ2)
Current land use	Vacant land. Above ground structures demolished. A live gas main runs along the western boundary of the site.
Proposed land use	The site is proposed to be redeveloped into a residential development comprising of three to six level apartments and townhouses, including open space and easement areas. The development plans for the site are included in Appendix A of the Remediation and Validation report (Senversa, 2021b).
Surrounding Land Use	North: Residential dwellings and the Best Western Plus Buckingham International Hotel East: Vacant land (Stage 2), Moorabbin Magistrates Court, residential and commercial complexes, Nepean Highway Service Road, residential dwellings. South: Sir William Fry Reserve. West: Frankston railway line followed by Lyle Anderson Reserve, Highett Bowls Club and residential dwellings.
On-site surface water body	There are no natural surface water bodies present on the site. There are some ornamental water features in Sir William Fry Reserve, and water storages associated with local golf courses, however these are not directly fed by groundwater. The nearest artificial surface water body is a Melbourne Water flood retarding basin at Avoca Street located approximately 1.2 km to the west of the site.

Aspect	Comments
Nearest surface water body and direction	Port Phillip Bay is located approximately 3.7 km west of the site.
Topography/drainage	The topography of the local area generally slopes gently to the southwest.
Vegetation	Several mature trees are located across the site, otherwise the site has been cleared.
Landfill within 500 m radius	The site history review has not identified any current or historical landfill located within a 500 m radius of the site.

The information in Section 1.1 and this section satisfactorily defines the site for the purposes of the audit.

3.2 Site physical status at audit commencement

At the commencement of the audit, Stage 2A was vacant with all above ground structures removed from the site (a heritage-protected brick chimney is located in Stage 2). Redundant high pressure gas lines in the 'old gas main easement' (decommissioned in 2018) and live high pressure gas lines in the 'new gas main easement' were present within Stage 2A.

A plan showing the location of the high-pressure gas lines associated with the 'old gas main easement' and 'new gas main easements' is provided as Figure 3A of the Remediation and Validation report (Senversa, 2021b).

3.3 Site physical status at audit completion

At the completion of the audit, Stage 2A is vacant with all above ground structures removed from the site. The high pressure gas lines in the 'old gas main easement' have largely been removed from the site. The live high pressure gas lines in the 'new gas main easement' run along the western boundary of the site.

3.4 History of use

The Stage 2A site formed the western margin of the former Highett gasworks which operated for 30 years between 1939 and 1969. The site was developed by the Brighton Gas Company and was the last gasworks site to be built in Victoria.

Gas manufacturing activities that occurred within and in close proximity to the Stage 2A area included: the No1 Purifier, Retort House, Coal Store and Coke Plant; Tar Separator; Carburetted Water Gas (CWG) Plant; a Relief Holder; Oil tanks, workshop and oil pump room and various liquor and effluent tanks and ponds. See Figure 5 of the 2011 Audit (PB, 2011) for the former Highett Gasworks site layout.

During the 1970s, the gasworks was largely demolished. In the late 1970s and early 1980s the site was redeveloped as the Scientific Services Department and Training Centre for the Gas and Fuel Corporation. Partial soil remediation was undertaken during this time of redevelopment and approximately 28,000 m³ of soil was remediated (removed from the site).

The Scientific Services Laboratory was located on the southern portion of the gasworks site and included: Chemistry and Physics Laboratories (including cooling towers which used chromium as an anti-corrosive); Administration area; Laboratory Services building, building for testing of coal tar enamels (the former Oil Gas Plant); general stores building with wind tunnel for appliance testing (the former No 1 Coal Store); maintenance equipment store and small incinerator; Amenities Block (the former Amenities Block); Solar Hut used for research into solar power; and General Office. The Scientific Services Laboratory provided research and testing facilities for gas appliances, materials used in the gas industry (including pipes and metal components), chemical testing and quality control of natural gas and LPG as well as miscellaneous services such as meter calibration and noise/vibration studies (Gas & Fuel, 01-May-96).

The Training Centre was located on the north portion of the site and included a number of buildings and a project department. Of the original gasworks structures in this area only the northern Store building remained. The training Centre provided facilities for training of plumbers and gasfitters (Gas & Fuel, 01-May-96).

In the 1980-1990s, the majority of buildings were demolished with the exception of the chimney of the Boiler/Town Gas Compressor complex.

The contaminants of concern that remained in soil and groundwater at the completion of the 2011 Audit (PB, 2011) are summarised below.

- **Soil:** Residual hydrocarbons (including polycyclic aromatic hydrocarbons (PAHs) and inorganics (including metals (lead and arsenic) and sulphates) in soils at depths of less than 1 metre and below the water table.
- **Groundwater:** Elevated petroleum hydrocarbons (including total petroleum hydrocarbons (TPH), benzene, toluene ethylbenzene, and xylene (BTEX), PAHs, total phenols, metals, ammonia, sulphate and free cyanide.

3.5 Audits undertaken nearby

The table below summarises the completed statutory audits completed in the vicinity (approximately 500 m radius) of the site.

Table 7 Audits recently completed on nearby sites

Location	EPA CARMS No.	Approximate distance and direction from subject site	Comments
Southland Development Project – Stage 1 Corner of Nepean Highway and Bay Road, Cheltenham, Victoria	34201-1	795 m southeast Likely to be across or down hydraulic gradient, therefore unlikely to impact the audit site.	Statement of Environmental Audit issued in 1998. Suitable for residential, children's-day care centres, preschools, primary schools and other commercial purposes. Past land uses include: Cheltenham Community Market, Lucas Industries Pty Ltd (manufacturing automotive and electrical components as well as substation) and former antique shop (containing asbestos). Levels of contaminants (nickel, chromium, manganese, copper, zinc, arsenic) plus soil pH exceed the adopted ecosystem protection criteria but are not above National Environmental Health Forum (NEHF), 1996, Setting 'A' (which includes residential, children's-day care centres, preschools, primary schools and other commercial purposes). Groundwater assessment not undertaken
7-13 Graham Road Highett, Victoria – Stage 1	36024-1	350 m southwest Located down hydraulic gradient, therefore unlikely to impact the audit site.	Certificate of Environmental Audit issued in 1999. Past land uses included: vehicle detailing by Ken Morgan Toyota (including USTs and TIT), All Good Interiors (office refurbishers, including a warehouse storing furniture and whitegoods). Groundwater assessment not undertaken
7-13 Graham Road Highett, Victoria – Stage 2	36024-2	400 m southwest Located down hydraulic gradient, therefore unlikely to impact the audit site.	Statement of Environmental Audit issued in 1999. Past land uses included: Screen printing (Creanova Pty Ltd) and electronic circuit board manufacture (Farrow McRae Pty Ltd). Localised areas contain low pH soils and concentrations of copper (and to a lesser extent chromium, arsenic and zinc) above environmental (ANZECC B) thresholds of potential concern but not above human health investigation levels NEHF (1998) 'A' guidelines for low density residential use. Groundwater assessment not undertaken
Southland Development Site 1156 Nepean Highway, Cheltenham, Victoria (corner of Bay Rd and Nepean Hwy)	34201-2	565 m south east Likely to be across or down hydraulic gradient, therefore unlikely to impact the audit site.	Statement of Environmental Audit issued in 2000. The groundwater at the site shall not be used for any purpose including drinking, garden watering and swimming pool make up. The groundwater at this site is polluted by trichloroethylene (TCE) to the extent that several beneficial uses of the groundwater are precluded. The soil contains contamination that exceeds the ANZECC-B (ecological) criteria in some locations. This groundwater and soil contamination does not pose any significant risk to the environment or human health.

Location	EPA CARMs No.	Approximate distance and direction from subject site	Comments
284 Highett Road, Highett, Victoria	44791-1	350 m northwest Located down hydraulic gradient, therefore unlikely to impact the audit site.	Certificate of Environmental Audit issued in 2001. Past land uses included: Former Air Force Aeronautical Engineering Support Facility (Department of Defence). Potential contaminants of concern: asbestos and lead dust.
284 Highett Road, Highett, Victoria	60341-1	320 m northwest Located down hydraulic gradient, therefore unlikely to impact the audit site.	Certificate of Environmental Audit issued in 2007. Past land uses include: Commonwealth Aircraft Corporation Ltd Factory, Lincoln Mills (Australia) Ltd factory (possible textile factory). Potential corrosive soil and/or groundwater conditions: elevated sulphate and low pH.
1142 Nepean Highway, Highett, Victoria.	67683-1	145 m east (adjacent to the eastern boundary of Stage 2 Audit Boundary). Up hydraulic gradient and therefore has potential to impact upon the audit site.	Statement of Environmental Audit completed on 2011. Former Fleet Marine boat retailer. Potential contaminants of concern: Groundwater: heavy metals, cyanide, nitrate, ammonia, 1,1 DCA and 1,1 DCE Soil: heavy metals, hydrocarbons, cyanide.
1144 – 1148 Nepean Highway, Highett, Victoria	69746-1	190 m east Up hydraulic gradient and therefore has potential to impact upon the audit site.	Statement of Environmental Audit completed in 2012. Past land uses include tennis courts, poultry farming, raincoat manufacturing, commercial printing facility. Aldrin and dieldrin impacted soil remains onsite. Elevated concentrations of ammonia and nitrate in groundwater considered to be associated with a regional contaminant plume. Elevated chloride concentrations in groundwater considered to be representative of natural groundwater salinity. Elevated concentrations of cadmium cobalt, copper, iron, lead, nickel and zinc in groundwater considered to be naturally occurring. Groundwater at the site precludes the beneficial uses of Maintenance of Ecosystems and Primary Contact Recreation.
Stage 2, 1144 Nepean Highway, Highett, Victoria	69746-4	80 m east (adjacent to eastern boundary of Stage 3 audit Boundary) Up hydraulic gradient and therefore has potential to impact upon the audit site.	Statement of Environmental Audit completed in 2018. Past land uses include poultry farming and printing. Remediation undertaken at the site including remediation of fill material including polychlorinated biphenyl (PCB) soil hotspots. Elevated concentrations of manganese and nickel considered to be regionally occurring. Elevated concentrations of PFAS considered to be associated with an offsite source. Elevated concentrations of nitrate and nitrite considered to be a co-contributing source. Groundwater at the site precludes the beneficial uses of Potable Water Supply, Potable Mineral Water Supply, Agriculture Parks and Gardens, Stock Watering and Primary Contact Recreation. The auditor determined CUTEF has been achieved and the site was declared a QGRUZ.

Location	EPA CARMS No.	Approximate distance and direction from subject site	Comments
32 – 34 Graham Road, Highett, Victoria	75232-1	220 m west Located down hydraulic gradient, therefore unlikely to impact the audit site.	Certificate of Environmental Audit completed in 2018. Past land uses include agriculture (grazing), engineers and manufacturing. Minor bonded asbestos containing material (ACM) was observed at the site and removed as far as practicable. Elevated concentrations of copper, nickel, vanadium and zinc in groundwater considered to be representative of background groundwater conditions. Elevated concentrations of TDS, pH and sodium in groundwater considered to be naturally occurring.
CSIRO Highett North, 37 Graham Road, Highett, Victoria	68549-1	245 m west Located down hydraulic gradient, therefore unlikely to impact the audit site.	Certificate of Environmental Audit completed in 2020. Past land uses include CSIRO research and education facility. Minor inert waste and bonded asbestos containing material (ACM) was observed in fill material at the site and removed as far as practicable. Elevated concentrations of lead, copper, nickel and zinc in groundwater considered to be associated with offsite sources of pollution and regional groundwater conditions.
CSIRO Highett South, 37 Graham Road, Highett, Victoria	68549-2	300 m west Located down hydraulic gradient, therefore unlikely to impact the audit site.	Certificate of Environmental Audit completed in 2020. Past land uses include CSIRO research and education facility. Minor inert waste and bonded ACM was observed in fill material at the site and removed as far as practicable. Elevated concentrations of lead, silver, copper, mercury and zinc in groundwater considered to be associated with offsite sources of pollution and regional groundwater conditions.
328 Bay Road, Cheltenham Victoria	74971-5	465 m south to southwest	Audit report not available.
36 – 40 Graham Road Highett, Victoria	75573-1	90 m west Located down hydraulic gradient, therefore unlikely to impact the audit site.	Statement of Environment Audit completed in 2020. Past land uses include tool making/engineering purposes (1951 – 1969), fabric manufacturing and processing (1969 – 2009) and manufacture of industrial filtration products and filter media (2009 – 2018) Asbestos remains off-site along the northern and north-western site boundaries. Elevated concentrations of copper, nickel, zinc, sodium, chloride and sulphate in groundwater considered to be naturally occurring. Elevated concentrations of beryllium, cobalt, lead, nitrate, nitrite, total nitrogen and 1,4 dichlorobenzene in groundwater considered to be regionally occurring. Elevated concentrations of nitrate, total nitrogen and vinyl chloride considered to be site sourced pollution Groundwater at the site precludes the beneficial uses of Potable Water Supply, Agriculture and Irrigation (Irrigation), Agriculture and Irrigation (Stock Watering), Industrial and Commercial, Water Based Recreation (Primary Contact Recreation), Traditional Owner Cultural Values and Cultural and Spiritual Values. The site was declared a GQRUZ and a GQMP must be implemented.

3.6 Review of EPA Notices, Register, Licences and / or Trade Waste Agreements

There were no EPA licences or trade waste agreements relevant to the site.

The site is subject to an overlay related to contaminated land (Environmental Audit Overlay), is not on the EPA Priority Sites Register and is/is not subject to an EPA clean-up or pollution abatement notice.

The site and the Stage 2 Audit area are subject to a GQRUZ. Additionally, a GQRUZ is located approximately 80 m to the east of the southern portion of the site (located to the immediate east of the Stage 2 Audit Area) at 1144 Nepean Highway, Highett.

3.7 Geology and hydrogeology

The soil lithology recorded at the site is summarised in Sections 5.2.3 and 5.2.3 of the Remediation and Validation report (Senversa, 2021b).

Additional information is provided in the 2011 Audit (PB, 2011).

3.7.1 Regional geology

The 1:63, 360 Ringwood Geological Map (Geological Survey of Victoria) indicates that the site is located on the Quaternary aged sand ridge sediments and Tertiary aged Red Bluff Sands of the Brighton Group Formation. The Brighton Group Formation is underlain by the Tertiary aged Fyansford Formation, which is subsequently underlain by Silurian aged Bedrock (Melbourne Mudstone).

3.7.2 Site specific soil

The geology at the site as characterised by the drilling and installation of groundwater monitoring wells at the site is summarised in Table 8.

Table 8 Summary of site lithology encountered during site investigations

Approximate depth (mbgl)	Description
0 to 3.0	FILL: sands, silty clays, clayey sand and gravels, crusted rock, some building materials/wastes (brick, concrete, slag and ash) Fill containing solid inert waste was largely removed during site remedial works in 2009/2010. Contaminated soil was treated by thermal desorption and then used to back fill remedial excavations. There were also observations of reworked natural material in some remedial excavations..
3.0 to 20.0	Natural fine to medium Sandy CLAYS and clayey SANDS grading to coarse sands and gravels at depth (Brighton Group) Generally becoming coarser with depth and more clay rich to the west
21.0	Sandy SILT, brown Potential top of Fyansford Formation or Silurian aged bedrock

The soil lithology descriptions for soil excavated during the remediation works at the site as described by the assessor are generally consistent with the summary of site lithology above. The assessor described the soils in excavations within the audit site as clays and sands comprising of varying amounts of clay, silt, sand and gravels.

3.7.3 Regional hydrogeology

Groundwater is present within the Brighton Group Formation which extends to approximately 25 m below surface. Groundwater wells at the site are screened predominately across the water table in the upper Brighton Group Aquifer, with three groundwater wells screened within the deeper Brighton Group Aquifer. The Brighton Group Formation is underlain by the Fyansford Formation from approximately 25 m to 40 m below surface, which is subsequently underlain by Melbourne Mudstone from approximately 40 m below surface. This site is in a Groundwater Management Unit; all groundwater layers at the site are located within the Moorabbin Groundwater Management Area.

3.7.4 Site hydrogeology

21 groundwater monitoring wells are installed at the site. 18 groundwater monitoring wells are installed in the upper Brighton Group Aquifer (and herein referred to as shallow wells) and three groundwater monitoring wells are installed in the deeper Brighton Group Aquifer (and herein referred to as deep wells). The results from the latest groundwater monitoring event undertaken at the site in November 2018 is summarised in Table 9.

Table 9 Summary of site hydrogeology

Aspects	Description
Brighton Group Formation	
Depth to groundwater (mbgl) (November 2018)	Shallow wells: 4.656 to 10.335 Deep wells: 8.491 to 8.689
Measured TDS (mg/L) (November 2018 – based on field EC in $\mu\text{S}/\text{cm}$ multiplied by 0.65)	Shallow wells: 172 to 4,796 mg/L Deep wells: 1,446 to 3,256 mg/L
Inferred flow direction	West to southwest
Gradient/Velocity/Bore yield?	Regional groundwater flow toward the west is estimated to be 0.37 – 3.7 m/year. The localised groundwater flow to the north in the vicinity of the southern groundwater mound is estimated to be occurring at a rate of approximately (1.28 – 12.8 m/year). The 2011 Audit (PB, 2011) concluded that the groundwater mound in the southern part of the site was likely to be associated with leaking water infrastructure.
Distance and direction to nearest surface water body	Permanent: Port Phillip Bay located approximately 3.7 km to the west of the site. Ornamental: Water features in Sir William Fry reserve approximately 50 m south of the site. These water features are not connected to the water table.

3.7.5 Registered groundwater bore database

A review of the registered groundwater bore database by the assessor conducted in 2020 showed 368 groundwater bores within a 2 km radius of the site. Of the 368 registered bores identified:

- 26 bores for domestic and stock use
- 94 bores for groundwater investigation
- 1 bore for industrial use
- 6 bores for irrigation use
- 1 bore for miscellaneous uses
- 240 bores did not have a listed/known use

One bore listed for unknown use and five for groundwater investigation are located within the Stage 2 and 2A audit boundaries. The nearest registered bore listed for an extractive use is 115041 registered for irrigation purposes and located approximately 300 m to the southeast of the site. The bore is screened from 36.50 to 40.0 mbgl and as such will be screened in a aquifer deeper than the superficial aquifer being investigated at the site.

4. Site investigation activities

4.1 Chronology of site activities relevant to the environmental audit

The chronology of site activities relevant to the environmental audit is presented in Table 10 below:

Table 10 *Sequence of site activities*

Date	Site Activity
November 2010	CUTEP determination for Stages 2 and 2A made by the EPA. A GQRUZ was placed over Stages 2 and 2A.
December 2011	SoEA issued for each of Stages 2 and 2A.
July 2012 to June 2017	Prensa Pty Ltd undertook nine groundwater monitoring events for Stages 2 and 2A.
2015	New gas main installed along the western boundary of Stage 2A
July 2018	Old gas main decommissioned by the asset owner.
November 2018	The assessor undertook a groundwater monitoring event for Stages 2 and 2A.
18 March 2019	John Throssell retained by DTF to undertake Environmental Audit.
25 March 2019	EPA notified of Environmental Audit.
14 May 2019	Site inspection by the auditor with the assessor and remediation contractor.
February to April 2020	The assessor and remediation contractor undertook remediation and validation works within Stage 2A. including removal of redundant gas main infrastructure.
7 December 2021	Completion date of the audit.

4.2 Field investigation summary

4.2.1 On-site investigation

A summary of site investigation works is presented in Table 11. It should be noted that groundwater investigations were undertaken for both Stage 2 and 2A audit areas.

Table 11 *Summary of site investigations*

Date	Reference	Scope of work completed
July to November 2012	Groundwater Monitoring Events, 1136-1138 Nepean Highway Highett, Victoria Prensa (2013a)	One round of groundwater monitoring conducted in July 2012 on 13 on-site and four off-site bores. Three rounds of groundwater monitoring conducted in September, October and November 2012 on 12 on-site and two off-site bores.
August 2013	Groundwater Monitoring Event, 1136-1138 Nepean Highway Highett, Victoria Prensa (2013b)	One round of groundwater monitoring conducted on 15 on-site and six off-site bores.
May to June 2014	Groundwater Monitoring Event, 1136-1138 Nepean Highway Highett, Victoria Prensa (2014)	One round of groundwater monitoring conducted on 15 on-site and six off-site bores.
June 2015	Groundwater Monitoring Event, 1136-1138 Nepean Highway Highett, Victoria Prensa (2015b)	One round of groundwater monitoring conducted on 15 on-site and six off-site bores.

Date	Reference	Scope of work completed
June 2016	Groundwater Monitoring Event, 1136-1138 Nepean Highway Highett, Victoria Prensa (2016)	One round of groundwater monitoring conducted on 15 on-site and six off-site bores.
June 2017	Groundwater Monitoring Event, 1136-1138 Nepean Highway Highett, Victoria Prensa (2017)	One round of groundwater monitoring conducted on 15 on-site and six off-site bores.
November 2018	Groundwater Monitoring Event, 1136-1138 Nepean Highway, Highett, Victoria Sensversa (2019a)	One round of groundwater monitoring conducted on 12 on-site and five off-site bores.
2021	Groundwater Monitoring Cessation Review, 1136-1138 Nepean Highway, Highett, Victoria Sensversa (2021a)	This report compiles the groundwater monitoring results for Stage 2 and Stage 2A undertaken between August 2013 and November 2018 and includes trend analysis.
2021	Remediation and Validation, 1136-1138 Nepean Highway, Highett, Victoria Sensversa (2021b)	This report outlines the remediation of Stage 2A undertaken including: Removal of 900 lineal metres of redundant gas pipework including approximately 30 lineal metres consisting of pipework coated with asbestos containing material; Validation of pipework removal trenches. Remediation of areas as defined in the EMP by excavation of soil including an additional area discovered to contain asbestos containing material. Validation sampling of remediation excavations.

4.2.2 Off-site investigation

With the exception groundwater investigations undertaken for Stage 2 and 2A audit areas as described in Section 4.2.1, no other off-site investigations were undertaken by the assessor.

4.3 Assessor's site assessment information

The scope of the assessments undertaken by the assessor and former environmental consultants are summarised in Section 4.2.1 and copies of the assessor's report and former environmental consultant's reports, are provided in this report.

The key reports relevant to the final condition of the audit site are:

- Groundwater Monitoring Cessation Review, 1136-1138 Nepean Highway, Highett, Victoria (Sensversa, 2021a) (provided in Appendix F)
- Remediation and Validation, 1136-1138 Nepean Highway, Highett, Victoria (Sensversa, 2021b) (provided in Appendix G)

The relevant environmental sampling information presented in the key assessor's reports is listed in Table 12 below.

Additional information regarding the history of the site is provided in the 2011 Audit (PB, 2011). Well installation logs are provided in the GQMP for Stages 2 and 2A (Golder, 2011) which is also provided in the 2011 Audit (PB, 2011).

Table 12 Assessor's site assessment information

Assessment Details	Groundwater Monitoring Cessation Review (Senversa, 2021a)	Remediation and Validation report (Senversa, 2021b)
Site history	A brief description of former site use is provided in Section 4.1.	A brief description of former site use is provided in Section 1.2.
Details of sampling and analysis	Section 2.2	Sections 5.2.4 to 5.2.7
Field observations	Provided within the individual groundwater monitoring event reports which are included in Appendix E.	Section 5.2.2 and 5.2.3
Bore logs	Refer; 2011 Audit (PB, 2011)	N/A
Field measurements	Provided within the individual groundwater monitoring event reports which are included in Appendix E.	N/A laboratory validation data used to define excavation limits.
Site plans	Figure 1	Figures 1 to 3
Table of analytical results	Table 1: GQMP Monitoring Data	Table 1: Remediation Area Validation Sample Results (No Exceedances) Table 2: Gas Pipeline validation samples Table 3: Remediation Area Validation Sample Results (With Exceedances) Table 4: Stockpile Soil Results Table 5: Stockpile Leachability Results
QA/QC discussions	Section 2.3.1 and provided within the individual groundwater monitoring event reports which are included in Appendix E.	Section 5.2.8 and Appendix E: Data Validation

4.4 Field sampling and laboratory testing program

The field sampling and laboratory testing program was designed by the assessor to characterise the natural soils and any fill material remaining on-site and as designed by the assessor and former environmental consultant (Prensa) to characterise groundwater for the Stage 2 and 2A audit areas. The testing was undertaken by the following laboratories:

- Primary laboratory: ALS
- Secondary laboratory: Eurofins | mgt (Senversa) and Envirolab (Prensa)
- Bureau Veritas: Asbestos testing and identification in soil samples for the work conducted by Ventia and reported in Appendix B of the Remediation and Validation report (Senversa, 2021b).

These laboratories are NATA accredited for the testing undertaken. The sampling and testing program undertaken by the assessor can be summarised as follows:

4.4.1 Soil

Stage 2 was previously assessed and remediated as a single stage alongside Stage 2A and was subject to a number of phases of investigation including:

- Site investigation works conducted from 1994 to approximately 2004 by various entities including Gas and Fuel, Gascor and Golder which involved combinations of gridded and targeted sampling. Additional investigations were undertaken related to the gas main easement in 2008 by Monarc Environmental and Golders.
- Site remediation and validation undertaken by Golder which included:
 - Baseworks (areas of known soil impacts to be removed/remediated)
 - Additional works (excavations) – chasing out services and contamination; and
 - Remediation and validation.

Details of these various soil investigation and remediation and validation works are provided in the 2011 Audit (PB, 2011).

Ten targeted soil samples were collected by Senversa to confirm the extent of the gas main pipework and were analysed for the total petroleum hydrocarbon criteria working group (TPHCWG) suite to better understand the composition of the total recoverable hydrocarbon (TRH) impacts beneath the site as part of preparation of the Remediation Work Plan (RWP). The samples were collected from areas where TRH impacts were previously identified. Limited TRH impacts were reported indicating that TRH impacts may be intermittent and localised. The results could not be used to adjust the acceptance criteria on site specific TRH composition basis. The sampling is discussed in the RWP (Senversa, 2019c), however no information regarding sample depths, sample locations, sampling methods was provided.

Senversa undertook remediation and validation works at the site in 2020, including the collection of validation soil samples and stockpile sampling for waste categorisation purposes. The relevant details are provided Section 6.

4.4.2 Groundwater

Groundwater assessment at the site of Stages 1, 2 and 2A, has been undertaken since the 1990's by various consultants including Land Remediation Department, Gas and Fuel Corporation of Victoria, Gas Services Business Land Remediation and Golder. In total, 40 wells were installed on the site and an additional twelve wells offsite were installed between 1997 and 2003 with a number of replacement wells installed in 2008. The majority of these wells were installed to monitor the water table aquifer within the Brighton Group. Three on site wells (9150001, 9150002 and 9150003) were installed to monitor groundwater in the deeper portion of the Brighton Group Aquifer.

Details of these various groundwater assessments are provided in the 2011 Audit (PB, 2011).

The current monitoring well network comprises of 21 groundwater monitoring wells. Two monitoring wells (9030002A and 9130011A) were re-installed in August 2013 by the former environmental consultant (Prensa) as the original groundwater monitoring wells (9030002 and 9130011) could not be located during the 2012 groundwater monitoring events. Groundwater monitoring was undertaken on an annual basis between 2012 and 2017 by Prensa and by Senversa in 2018. However, the groundwater monitoring frequency was increased to monthly following the July 2012 groundwater monitoring event in accordance with the GQMP and therefore an additional three groundwater monitoring events were undertaken in September, October and November 2012.

The groundwater monitoring wells were all purged and sampled using low flow monitoring techniques with the exception of one well during the November 2018 monitoring event which was bailed dry and sampled with a bailer the following day due to insufficient recovery. Table 13 lists the groundwater monitoring wells listed in Senversa (2019a), their total depth, screen interval and then they have been samples.

Table 13 Summary of groundwater monitoring well construction and sampling information

Well ID	Total Depth (m)	Screen interval (mbgl)	November 2018 SWL (mbTOC)	Groundwater Monitoring Event								
				Jul 2012	Sep 2012	Oct 2012	Aug 2013	May/Jun 2014	Jun 2015	Jun 2016	Jun 2017	Nov 2018
9010001	10.0	5.1 – 9.1	8.498	Y	Y	Y	Y	Y	Y	Y	Y	Y
9020001	10.1	5.5 – 10.1	8.605	Y	Y	Y	Y	Y	Y	Y	Y	Y
9050001	11.0	5.9 – 9.9	8.277	Y	N – omitted	N – omitted	N – omitted	Y	Y	Y	Y	Y
9120001	13.9	9.9 – 13.9	-	Y	Y	Y	Y	Y	Y	Y	N – blocked	N – blocked
9130003 ¹	10.0	6.0 – 10.0	6.853	N – not located	N – not located	N – not located	N – not located	Y	Y	Y	Y	Y
9130005 ¹	10.1	4.0 – 10.1	6.025	Y	Y	Y	Y	Y	Y	Y	Y	Y
9130006 ¹	10.2	4.2 – 10.2	-	Y	Y	Y	Y	Y	Y	Y	Y	N – not located
9130007 ¹	10.5	4.5 – 10.5	4.656	Y	N – omitted	N – omitted	N – omitted	Y	Y	Y	Y	Y
9130010 ¹	10.0	6.0 – 10.0	8.590	Y	N – omitted	N – omitted	N – omitted	Y	Y	Y	Y	Y
9140003	10.0	5.0 – 10.0	8.622	Y	Y	Y	Y	Y	Y	Y	Y	Y
9140005	11.0	5.2 – 8.2	8.447	Y	Y	Y	Y	Y	Y	Y	Y	Y
9140006	10.0	5.0 – 10.0	-	Y	Y	Y	Y	Y	Y	Y	N – not located	N – not located
9140007	12.0	6.0 – 11.0	10.335	N	N	N	N	Y	Y	Y	Y	Y
9140008	10.0	6.0 – 10.0	9.132	Y	Y	Y	Y	Y	Y	Y	Y	N – standpipe bent

Well ID	Total Depth (m)	Screen interval (mbgl)	November 2018 SWL (mbTOC)	Groundwater Monitoring Event								
				Jul 2012	Sep 2012	Oct 2012	Aug 2013	May/Jun 2014	Jun 2015	Jun 2016	Jun 2017	Nov 2018
9150001	17.8	14.8 – 17.8	8.689	Y	Y	Y	Y	Y	Y	Y	Y	Y
9150002	19.4	16.4 – 19.4	8.491	Y	Y	Y	Y	Y	Y	Y	Y	Y
9150003	20.5	17.5 – 20.5	8.599	Y	Y	Y	Y	Y	Y	Y	Y	Y
9030002A	10.5	7.5 – 10.5	8.704	N – 9030002 not located	N – 9030002 not located	N – 9030002 not located	N – 9030002 not located	Y	Y	Y	Y	Y
9130011A ¹	10.3	4.3 – 10.3	8.728	N – 9130011 not located	N – 9130011 not located	N – 9130011 not located	N – 9130011 not located	Y	Y	Y	Y	Y
BH6	10.0	5.0 – 10.0	8.700	Y	Y	Y	Y	Y	Y	Y	Y	Y
BHF35	10.5	4.5 – 10.5	7.264	Y	Y	Y	Y	Y	Y	Y	Y	Y
Notes: 1 Well located off-site												

Based on the June 2016 monitoring event where all bores were sampled, the field parameters of the groundwater were:

- Acidic to neutral (pH 4.22 to 7.3)
- Salinity ranging from 130 to 3,874 mg/L (based on electric conductivity of 200 $\mu\text{S}/\text{cm}$ to 5,960 $\mu\text{S}/\text{cm}$)
- Dissolved oxygen 1.57 to 10.16 ppm
- Redox -99.0 to 484.1 mV
- Temperature 15.4 to 17.7 °C

Measured salinity across the site has been generally consistent across the groundwater monitoring events (GMEs). Measured salinity (based on electric conductivity) across the site, however has ranged from 29.2 $\mu\text{S}/\text{cm}$ (9130011A in June 2015) to 7,379 $\mu\text{S}/\text{cm}$ (9130010 in November 2018).

For the GMEs conducted from 2012 to 2018, the groundwater samples were generally analysed for the following analytes:

- TPH
- Monocyclic aromatic hydrocarbons (MAH)
- PAH
- Total cyanide
- Metals (As, Cd, Cr, Cu, Pb, Hg, Ni and Zn)
- Ammonia
- Phenolic compounds
- Natural attenuation parameters (nitrate, sulphate, ferrous iron and methane)
- Major anions and cations (calcium, chloride, magnesium, potassium, sulphate and sodium).

A full summary of results of the laboratory testing program undertaken by the assessor and former environmental consultant (Prensa) is provided in the Groundwater Monitoring Cessation Review (Senversa, 2021a).

4.5 Adequacy of the assessor's investigation program

4.5.1 Soil

Senversa undertook remediation and validation works at the site in 2020, including the collection of validation soil samples and stockpile sampling for waste categorisation purposes. The scope of the remedial investigations as provided in RWP (Senversa, 2019c) was determined from the findings of the 2011 Audit (PB, 2011). This is discussed in more detail in Section 6.

Senversa also undertook limited soil sampling in the targeted remediation areas prior to remediation. The objective was to confirm the composition of TRH to facilitate comparison of soil data reported in the 2011 Audit (PB, 2011) with current criteria for volatiles (HSLs) which were not available at the time of the 2011 Audit. Analytical results were below laboratory reporting limits. These findings were reported in the RWP (Senversa, 2019c).

4.5.2 Groundwater

Based on available relevant guidelines and current industry practise, the auditor considers the assessor's groundwater investigation to be adequate.

The adequacy of the assessor's sampling program can be summarised as follows:

- 15 groundwater monitoring wells are present within the Stage 2 and 2A audit areas. A further six groundwater monitoring wells are located off-site to the west and south of the site (downgradient of the site). The on-site wells included one well (9120001) considered to be reflective of background conditions.
- Two monitoring wells (9030002A and 9130011A) were re-installed in August 2013 in the Brighton Group Aquifer to depths of 10.0 and 10.5 mbgl respectively with screen lengths of 6 and 5 m respectively. The water table was generally observed with the screen interval of each groundwater monitoring well during the nine GMEs conducted from 2012 to 2018, with the exception of the three deep wells (9150001, 9150002 and 9150003), one well (9130007) where the water table was recorded above the screen interval for six GME's and one well (9140005) where the water depth was recorded below the screen interval for three GME's.
- Each groundwater monitoring well has been sampled between five to nine times. Each groundwater monitoring well was purged and sampled using low flow monitoring techniques with the exception of one well during the November 2018 monitoring event which was bailed dry and sampled with a bailer the following day due to insufficient recovery. The low flow pump was generally within screen interval of each groundwater monitoring well during the nine GMEs conducted from 2012 to 2018, with the exception of three monitoring wells (9140007, 9150001 and 9150002) where the pump depth was recorded above the screen interval for one GME, one well (9150003) where the pump depth was recorded above the above the screen interval for two GME's, one well (9140005) where the pump depth was recorded below the screen interval for three GME's and one well (BH6) where the pump depth was recorded below the screen interval for one GME. The drawdown sustained during sampling was generally considered to be satisfactory. Groundwater samples have been analysed for an appropriate suite of contaminants commensurate with the historical use of the site.

5. Conceptual Site Model

Key aspects of the Conceptual Site Model (CSM) are discussed in Section 2 and Section 8 of the Remediation and Validation report (Senversa, 2021b). A CSM was also presented in the 2011 Audit (PB, 2011), which outlined the historical infrastructure and use of the site as the former Highett Gasworks facility over time. Key elements of the CSM are summarised in the sections below.

5.1 Site Characteristics

Key site characteristics including site description, environmental setting and hydrogeology are discussed in Section 2 of the Remediation and Validation report (Senversa, 2021b). Further details are also presented in Section 2 of the 2011 Audit (PB, 2011).

5.2 Sources of contamination

5.2.1 On-site

Historical on-site sources of contamination were outlined in Section 3.1 of the 2011 Audit (PB, 2011). Sources of contamination included former site infrastructure (primary sources) and surrounding soil (secondary sources). All primary sources and the majority of secondary sources of contamination have been removed from the site.

The sources of contamination are directly related to the historical activities associated with the former manufacture of coal gas on the site. This included storage of tar sludges, liquid chemicals/oils, ash and clinker. Chemicals of potential concern include hydrocarbons (PAH/MAH/TRH), cyanide, ammonia, sulphate and heavy metals. Further details can be found in Section 8 of the Remediation and Validation report (Senversa, 2021b).

5.2.2 Off-site

Historical off-site sources of contamination were outlined in Section 3.2 of the 2011 Audit (PB, 2011). Off-site sources of contamination included site historically used for boat retail and repair, screen printers and electronic circuit boards manufacture, Former Air Force Aeronautical Engineering Support Facility (Department of Defence), Commonwealth Aircraft Corporation Ltd Factory, Lincoln Mills (Australia) Ltd factory (possible textile factory).

5.3 Contaminant transport pathways and mechanisms

Both contaminated soil and groundwater remain on the site. Impacted soils are confined within the site boundaries, while groundwater impacts extend a short distance off-site to the west.

The key transport pathways and mechanisms for exposure to soil contamination are considered to be (i) direct exposure to the contaminated soil (through dermal exposure, accidental ingestion and inhalation of vapours) and (ii) potential accumulation and inhalation of vapours in closed spaces.

The key transport pathway and mechanism for groundwater contamination is lateral migration, with exposure through (i) direct exposure to the contaminated groundwater (by extraction and through dermal exposure, ingestion and inhalation of vapours), (ii) and potential accumulation and inhalation of vapours in closed spaces.

5.4 Potential receptors

Potential ecological receptors include site flora and fauna and the groundwater receiving environment (assumed to be Port Phillip Bay, approximately 3.7km west). Potential human health receptors include future residential and recreational site users, future construction workers and maintenance workers at the site.

5.5 Summary of Potential Pollutant Linkages

A summary of the potential source-pathway-receptor (pollutant) linkages with respect to ecological receptors and the environment is presented in Table 14.

Table 14 *Potential Pollutant Linkages - Ecological / Environmental Receptors*

Source	Pathway	Receptor	Status of Pollutant Link
Potential contaminants in soil	Direct exposure to impacted soil (dermal contact, ingestion)	On-site flora and fauna Surrounding formation, stormwater and groundwater	Complete / major pathway
Potential contaminants in groundwater	Direct exposure to impacted groundwater (dermal contact, ingestion)	On-site flora and fauna Surrounding formation Surface water body at point of groundwater discharge (Port Philip Bay)	Complete / major pathway
			Potentially complete / minor pathway
			Potentially complete / minor pathway

A summary of the potential source-pathway-receptor (pollutant) linkages with respect to human receptors is presented in Table 15.

Table 15 *Potential Pollutant Linkages - Human Receptors*

Sources	Pathways	Receptors	Status of Pollutant Link
Potential contaminants in soil	Direct exposure to impacted soil (dermal contact, accidental ingestion, vapour inhalation)	On-site workers	Complete / major pathway
		Off-site workers (in the vicinity of the site)	Incomplete / insignificant pathway
	Closed space accumulation and inhalation of vapours	Future residents and recreational users of the site	Potentially complete / minor pathway
Potential contaminants in groundwater	Direct exposure to impacted groundwater (dermal contact, ingestion, vapour inhalation)	On-site workers	Potentially complete / minor pathway
		Future residents and recreational users of the site	
	Closed space accumulation and inhalation of vapours	Off-site workers (in the vicinity of the site)	Incomplete / insignificant pathway
		Residents down hydraulic gradient of the site	Potentially complete / minor pathway
			Complete / major pathway

5.6 Auditors Review of CSM

The assessor conducted sufficient site characterisation to develop a robust and defensible conceptual site model that demonstrated:

- Understanding of the site's geomorphological and environmental setting
- Understanding of the geological, hydrogeological and hydrogeochemical conditions of the subsurface soils and groundwater systems that could be impacted by contaminants of concern
- Understanding of the location, nature and extent of the primary and secondary contaminant sources present on the site
- Understanding of the fate and transport of the contaminants of concern in the environment of the site and nearby surrounds
- Understanding of the likely human and environmental receptors that may be present on the site under the future developments that are permissible on the site
- Understanding of the nature of the exposure mechanisms of receptors to the contaminants of concern.

At the completion of the audit, the site had been remediated and all primary and secondary sources of contamination (except for residual impacted soils in some areas), had been removed and the majority of residual soils validated. Residual soil contamination remains in areas of the site which will require management in accordance with a soil contamination management plan to be developed for the site and verified by an Environmental Auditor.

Residual groundwater contamination is currently managed under a GQMP (Golder, 2011) and the site is part of a designated GQRUZ, determined by EPA on the 3 November 2010.

6. Remediation and validation

Soil investigations were undertaken as part of the 2011 Audit (PB, 2011) completed in December 2011. The audit resulted in a Statement of Environmental Audit being issued for Stage 2A due to residual soil contamination (cyanide, benzo(a)pyrene, total PAH and TRHs) which precluded all beneficial uses. The residual soil contamination could not be remediated due to the presence of a gas main and an EMP (Golder, 2012) was developed as a condition of the audit to document the soil contamination and specify the remediation areas and depths required following decommissioning of the gas main.

The high-pressure gas lines in the 'old gas main easement' were decommissioned in 2018.

A RWP (Senversa, 2019c) and Sampling Analysis and Quality Plan (SAQP) (Senversa, 2019d) were developed for the remediation of contaminated soil and removal of redundant gas pipes within Stage 2A, as specified in the EMP (Golder, 2012).

The RWP (Senversa, 2019c) and SAQP (Senversa, 2019d) were provided to the auditor for review prior to their implementation. These reports are included in Appendix D and Appendix E respectively.

The remediation approach adopted by Senversa and the timeline of remedial works are discussed in the sections below.

6.1 Remediation work plan

The objective of the RWP (Senversa, 2019c) was to provide a framework for remediation of contaminated soil and removal of redundant gas pipes within Stage 2A to achieve a Statement of Environmental Audit confirming that the site is suitable for residential and open space land uses.

An additional investigation was undertaken as part of the development of the RWP (Senversa, 2019c) to confirm the extent of the gas main pipework and refine the TRH acceptance criteria for the site. This additional investigation is discussed in Sections 4.4 and 4.5.

The remediation works outlined for Stage 2A in the RWP (Senversa, 2019c) included removal and validation of:

- 12 areas that contain Class 2 or Class 3 materials. The RWP (Senversa, 2019c) noted that two areas containing Class 3 material identified for removal in the EMP (Golder, 2012) are located across the live gas main and will remain in-situ.
- Six steel (plastic) pipes (of various diameters) located across four locations with a total trench length of 377 m.

6.2 Chronology of remediation activities

The chronology of remediation activities undertaken at the site is summarised below.

- **January to February 2020:**
 - Ventia undertook trenching and pipe removal works within five trenches (Trenches A – Live Gas Main, A, B, C and D (Node A) as referred to be Ventia in Appendix B of the Remediation and Validation report (Senversa, 2021b)). Asbestos removal works were undertaken at one trench (Trench C) by Asbestos Australia and cleared by Bureau Veritas. Works at two trenches (Trench B and Trench D (Node A)) were not fully completed during this period due to trees and concrete requiring removal.
 - Clean fill transported to site from 102-106 Burke Road, Malvern.

– **March to April 2020:**

- Ventia undertook excavation works and stockpiling of excavated material at 11 remediation areas (C2-RA01, C2-RA02, C3-RA01 to C3-RA06 and C3-RA08 to C3-RA10). Senversa collected validation samples from the excavation and samples from the stockpiled excavated material for each area. The excavation and sampling works were generally undertaken within the same day. These works also included the advancement of two test pits and excavation of additional material as a result of unexpected stained material at C3-RA08; and excavation of the two additional areas (ACM Dig and Non-ACM Dig) as a result of unexpected ACM impacted soil at C3-RA02 and end of Trench D (Node A)/Trench C and chemical contamination at ACM Dig. The ACM Dig was conducted by Asbestos Australia.
- Stockpiled material from the excavated areas within Stage 2A was disposed of at the appropriate licenced facilities (ResourceCo Langwarrin, Suez Ventia Joint Venture (SVJV) Soil Processing Facility and Hi-Quality Bulla).
- Clean fill transported to site by ResourceCo from 95-97 Beach Road, Mentone.
- Ventia completed trenching and pipe removal works within two trenches (Trench B and Trench D (Node A)) following tree and concrete removal works. Senversa collected validation samples from the trenches at the completion of removal works.

Additional information regarding the timing of the remediation activities undertaken by Ventia is outlined in Appendix B of the Remediation and Validation report (Senversa, 2021b). The auditor notes that the remediation activities undertaken by Ventia included the removal of redundant gas main pipework located within Stage 2, however this information has not been considered in this audit.

6.3 Remedial works

6.3.1 Removal of redundant gas main pipework

As outlined in Section 6.1, the RWP (Senversa, 2019c) identified six steel (plastic) pipes located across four locations in Stage 2A to be removed. However, in total ten steel (plastic) pipes (of varying diameters and equating to 863.02 lineal m) located across the five locations were removed during the remedial works undertaken by Ventia.

In addition, three asbestos coated (bituminous coating) pipes (of varying diameters and equating to 29.84 lineal m) were encountered during trenching undertaken at one location (Trench C). The occurrence of asbestos containing material (ACM) on site, is considered an unexpected find as it was not identified as a contaminant of concern in the RWP (Senversa, 2019c) and SAQP (Senversa, 2019d). As the asbestos was found in bonded material rather than friable material, the asbestos assessment undertaken was based on the visual presence of ACM rather than the analysis of asbestos fibres, in accordance with the NEPM.

Removal of the asbestos coated pipes was undertaken by a licenced contractor (Asbestos Australia) and airborne asbestos fibre monitoring was undertaken by an occupational hygienist (Bureau Veritas) with concentrations reported below the laboratory limit of reporting. The pipes were cut, wrapped and disposed of at a facility licenced to receive the waste (Hi-Quality Bulla). The area was cleared by Bureau Veritas and Asbestos Clearance Certificates and the results of airborne asbestos fibre monitoring are provided in Appendix B of the Remediation and Validation report (Senversa, 2021b).

Asbestos fragments were also encountered at the junction of Trench C and Trench D (Node A), resulted in excavation of an additional remediation area (ACM Dig) which is discussed in Section 6.3.2.

Additional information relating to the works undertaken to remove redundant gas main pipework from the site is described in Section 5.2.2, 5.2.7, 5.2.10 and Appendix B of the Remediation and Validation report (Senversa, 2021b). Trench locations are shown in Figures 3A to 3F and Appendix B of the Remediation and Validation report (Senversa, 2021b).

Validation sampling of the trenches was undertaken by Senversa and is discussed in Section 6.4.

6.3.2 Contaminated soil excavation

As outlined in Section 6.1, the RWP (Senversa, 2019c) identified 12 remediation areas that contain Class 2 or Class 3 materials. As identified in the RWP (Senversa, 2019c), remediation works were not completed at remediation area, C3-RA07 and not completed to the full extent to the west at remediation area, C3-RA03 due to location across the live gas main. In addition, excavations at the following locations were also limited by the live gas main; C2-RA02 (target depth not achieved due electrolysis line), C3-RA03 (full extent of remediation area not achieved to west), C3-RA06 (target depth not achieved) and C3-RA08 (excavation could not be extended to west (staining observed along western wall)).

Excavations at the following remediation areas were extended due to the presence of visual or olfactory signs of contamination; C3-RA01 (dark staining), C3-RA04 (naphthalene odours), C3-RA05 (dark staining), C3-RA06 (dark staining) and C3-RA08 (black staining and hydrocarbon odours). The excavation of contaminated soil at remediation areas was undertaken by Ventia in general accordance with the RWP (Senversa, 2019c).

6.3.3 ACM removal

As mentioned in Section 6.3.1, an unexpected find of ACM (asbestos cement sheeting fragments) during remedial works at C3-RA02 and the junction of Trench C and Trench D (Node A), resulted in excavation of an additional remediation area (ACM Dig). The occurrence of ACM on site, is considered an unexpected find as it was not identified as a contaminant of concern in the RWP (Senversa, 2019c) and SAQP (Senversa, 2019d).

As the asbestos was found in bonded material rather than friable material, the asbestos assessment undertaken was based on the visual presence of ACM rather than the analysis of asbestos fibres, in accordance with the NEPM.

The excavation was undertaken by a licenced contractor (Asbestos Australia) and airborne asbestos fibre monitoring was undertaken by an occupational hygienist (Bureau Veritas) with concentrations reported below the laboratory limit of reporting. Asbestos fragments were removed, filled with excavated soil which was placed in lined bins and disposed of at a facility licenced to receive the material (Hi-Quality Bulla) which was categorised as Fill with Asbestos. The area was cleared by Bureau Veritas and Asbestos Clearance Certificates and the results of airborne asbestos fibre monitoring are provided in Appendix B of the Remediation and Validation report (Senversa, 2021b).

During the excavation of the ACM Dig, chemical contamination was observed at the bottom of the excavation resulting in the excavation being extended. The part of the ACM Dig that has been extended is referred to as the Non-ACM Dig.

Volumes of soil excavated from the remediation areas are tabulated in Section 5.2.3 of the Remediation and Validation report (Senversa, 2021b). The auditor notes that inconsistencies relating to excavation and disposal volumes were recorded in the Remediation and Validation (Senversa, 2021b) report.

Additional information relating to the works undertaken to excavate contaminated soil from the identified remediation areas at the site are described in Section 5.2.3, 5.2.7 and Appendix B of the Remediation and Validation report (Senversa, 2021b).

Validation sampling of the remediation areas was undertaken by Senversa and is discussed in Section 6.4.

6.4 Validation works

Validation samples were collected by Senversa from pipework trenches and contaminated soil excavations. The RWP (Senversa, 2019c) and SAQP (Senversa, 2019d) outlined the required validation sampling frequencies based on the EMP (Golder, 2012):

- Remediation area excavations: one sample per 5 lineal metres along each wall (minimum of one per wall), one sample per 10m² on the base and additional samples as required based on visual or olfactory signs of contamination.
- Pipework trenches: one sample per 15 lineal m along each wall and additional samples as required based on visual or olfactory signs of contamination.

All samples were collected and analysed for potential contaminants in general accordance with the RWP (Senversa, 2019c) and SAQP (Senversa, 2019d).

Odours and staining remained in-situ along pipework trenches at sampling locations GE12 (green-grey staining and moderate organic odour) and GE18 (minor ash) and in remediation areas at C3-RA04 (naphthalene odours) and C3-RA08 (dark staining, organic and PAH odours).

Exceedances of adopted criteria were reported for some samples collected from remediation areas and these are discussed in Section 6.7. Validation sampling results for the remediation areas are provided in Tables 1 and 3 and results for the pipework trenches are provided in Table 2 of the Remediation and Validation report (Senversa, 2021b).

Additional information relating to validation sampling is described in Sections 5.2.3, 5.2.5, 5.2.6 and 5.2.7 of the Remediation and Validation report (Senversa, 2021b).

6.5 Off-site disposal of contaminated soil

Stockpiling of excavated soil was undertaken in general accordance with the RWP (Senversa, 2019c) as described in Section 5.2.4 of the Remediation and Validation report (Senversa, 2021b).

Each stockpile was sampled and categorised in general accordance with the RWP (Senversa, 2019c), SAQP (Senversa, 2019d) and EPA guidelines. The categorised waste was sent to appropriately licenced facilities as follows. Weighbridge Dockets and EPA Victoria Waste Transport Certificates are provided in Appendix B of the Remediation and Validation report (Senversa, 2021b).

- Fill material: Reused on site or ResourceCo Langwarrin
- Fill material with Asbestos and Category C: Hi-Quality Bulla
- Category A and B: SVJV Soil Processing Facility

Additional information relating to waste categorisation and the off-site disposal of contaminated soil is described in Sections 5.2.5, 5.2.7 and 5.2.10 of the Remediation and Validation report (Senversa, 2021b). Stockpile sample analytical results and leachability results are provided in Tables 4 and 5 of the Remediation and Validation report (Senversa, 2021b).

6.6 Backfilling of excavations

The backfilling of pipework trenches and contaminated soil excavations is described in Section 5.2.9 and Appendix B of the Remediation and Validation report (Senversa, 2021b).

Excavated material from the pipework trenches was used for backfilling. Contamination was not identified in the gas pipeline validation samples as mentioned in Section 6.4. Therefore in accordance with the RWP (Senversa, 2019c) the material excavated from the pipework trenches was used for backfilling unless there were visual or olfactory signs of contamination present. The auditor notes that material excavated from the pipework trenches was not sampled in accordance with the RWP (Senversa, 2019c).

Remediation excavation areas were generally backfilled with imported material with the exception of at C3-RA01 where excavated material from C2-RA01 (classified as fill material and considered as Class 2 material) was used to backfill the base of the C3-RA01 excavation in accordance with the RWP (Senversa, 2019c).

858 m³ of imported natural soil was sourced from 102-106 Burke Road, Malvern and 374 m³ from 95-97 Beach Road, Mentone. Prior to the material being transported to site, documentation for each site regarding soil type and analytical results were reviewed by Senversa. These documents are provided Appendix F of the Remediation and Validation report (Senversa, 2021b). The analytical results for the material sourced from both sites reported concentrations of metals and organics only above the laboratory limit of reporting. Metal and inorganic concentrations were considered to be below the relevant guidelines for the site. Additionally, Ventia visited the source sites prior to importation and the material was inspected by both Ventia and Senversa upon importation to site.

Additional information relating to the imported material is provided in Section 5.2.9 and Appendix B of the Remediation and Validation report (Senversa, 2021b).

6.7 Residual Contamination

Following completion of remediation works, residual soil contamination remains across the site, as depicted in Figures 5 and 6 of the Remediation and Validation report (Senversa, 2021b). In summary soil contamination remains in the following areas:

- To the east of the live gas main: at remediation areas C3-RA03 (benzo(a)pyrene and TRH impacts), C3-RA04 (naphthalene impacts), C3-RA06 (TRH impacts) and C3-RA08 (TRH and naphthalene impacts) as shown in Figure 4 and Table 3 of the Remediation and Validation report (Senversa, 2021b).
- Across the live gas main: at remediation area C3-RA07 and two other areas as outlined in the RWP (Senversa, 2019c) as shown in Figure 4 of the Remediation and Validation report (Senversa, 2021b) and Figure 3 of the RWP (Senversa, 2019c) respectively.
- Along the western site boundary: at various locations as identified in the 2011 Audit (PB, 2011).
- Residual chemical and aesthetic impacts remaining at the site are summarised in Figures 5 and 6 and Appendix I of the Remediation and Validation report (Senversa, 2021b).

The residual soil contamination remaining within Stage 2A is discussed further in Section 8.

6.8 Adequacy of the assessor's remediation program

The key driver for soil remediation within Stage 2A was the presence of residual soil contamination that could not be accessed while live gas infrastructure remained in situ. Soil remediation work was undertaken by Ventia and resulted in the removal of redundant gas mains within both Stage 2 and 2A, removal of residual soil contamination from areas identified in the works plan, and removal of asbestos impacted soil. Residual soil contamination within Stage 2A in areas located to the east of and across the live gas main and along the western site boundary will require on-going management in accordance with a site specific EMP.

Minor inconsistencies relating to excavation and disposal volumes were noted in the Remediation and Validation report (Senversa, 2021b), however, these are not considered significant.

In consideration of the above, the auditor considers that the remediation and validation program undertaken by Ventia and Senversa was appropriate.

7. Quality review of the site assessment and remediation and auditor verification

7.1 QA/QC review

The auditor has undertaken a review of the Quality Assurance and Quality Control (QA/QC) documentation presented by the assessor and reviewed their procedures to verify the integrity of the data presented. A QA/QC review was undertaken for the following key reports:

- Groundwater Monitoring Event, 1136-1138 Nepean Highway, Highett, Victoria, 5 April 2019 (Senversa, 2019a)
- Highett Gasworks Stage 2A Remediation Project- 050061, May 2020 (Ventia, 2020)
- Remediation and Validation, 1136-1138 Nepean Highway, Highett, Victoria (Senversa, 2021b)

The findings of the auditor's QA/QC review on the soil, groundwater and asbestos assessment are provided in Table H1 to H3 respectively in Appendix H.

The audit team also undertook a detailed review of the soil data presented by Senversa (2021b) as representing the final (post remediation) condition of the site. Documentation of the review is provided in Appendix J.

7.2 Auditor verification activities

7.2.1 Auditor verification sampling

Based on the scope of the soil and groundwater sampling program, the level of identified impacts, the robustness and defensibility of the data generated by the assessor, the auditor did not consider that there was a need for additional verification sampling by the auditor.

7.2.2 Site visits by auditor

The auditor visited the site on 14 May 2019, while a representative from Senversa and Ventia were still present on site during the completion of further assessment works. The following observations were made:

- A total of nine test pits were excavated along the alignment of Stage 2 and 2A
- New and old gas mains are concentrated towards the southern end of the western boundary of the site. This may restrict the extent of excavation around the old services, which appear to be buried deeper. A clearer separation between old and new pipes is visible in the northern part of the site.
- Newer pipes have warning tape and cream backfill sand surrounding the pipe. Pipes may not be consistent with old plans.
- Fill was noted to be variable, with some locations containing fill which was dark in colour with klinker and brick fragments.

The auditor also inspected the site, in August 2020, and again on 14 October 2020 prior to finalisation of the audit report.

7.2.3 Other verification activities

Other site verification activities included the following:

- Site photographs provided in Appendix I
- Inspection of borings / test pits during assessment and remediation activities and groundwater sampling activities.
- Interviews with the site owner and assessor on-site.

7.3 Conclusions on QA/QC

The auditor has undertaken a review of the QA/QC documentation for the field assessments conducted. The auditor's detailed review of the key site assessment reports is presented in Tables H1 to H3 provided in Appendix H of this report. Key points are summarised as follows:

- Overall the frequency and analytical suite of QC samples (field duplicate/split and rinsate/trip blanks) retrieved by Senversa was sufficient.
- The RPDs were generally acceptable, with the exception of a limited number of results that were above the recommended range for calculated RPDs for soil and groundwater results. The elevated RPDs were mainly reported for soil samples retrieved in fill, which is known to have a variable composition and contain anthropogenic materials. Elevated RPDs for cyanide and ammonia in groundwater were noted to be due to differences in laboratory methods.
- Sample holding times were generally acceptable, with the exception of some analyses for soil validation samples by the primary laboratory. Overall, these are not significant.
- Trip blank and rinsate blank sample results were generally reported to be below the laboratory limits of reporting (LOR).
- Calibration certificates were provided in the assessment reports and they indicate that the field equipment was adequately calibrated.
- Internal laboratory QAQC results were generally acceptable. Minor outliers were discussed by the assessor.
- Chains of custody (COC) were provided and were generally completed appropriately. Minor omissions in the chain of custody records were identified by the auditor, but these were not significant (refer QA/QC tables in Appendix H).

Based on current industry practice and relevant guidelines and standards, the auditor is satisfied that the quality of test results is adequate and therefore the results reported are representative of the composition of the soil and fill on the site.

8. Final condition of the site – soil

Soil remediation at the site was undertaken to the extent practicable and in general accordance with the RWP (Senversa, 2019c) and SAQP (Senversa, 2019d). Residual soil impacts remain at the site from both the remediation excavations undertaken by Senversa in 2020 and the works documented in the 2011 Audit (PB, 2011).

8.1 Residual impacts

Validation results that exceeded the ACUT are presented in Figure 4 and Table 3 and soil exceedances remaining at the site boundary and at the water table from the 2011 Audit (PB, 2011) are presented in Figures 5 and 6 and Appendix H of the Remediation and Validation report (Senversa, 2021b).

Senversa (2021b) have also provided a residual contamination summary table which includes consideration of management requirements in Appendix I and residual soil impacts considered to require management are presented in Figure 7 of the Remediation and Validation report.

8.1.1 Remediation and validation 2021

A summary of the completed remediation and validation works undertaken and residual chemical impacts for each remediation area is provided in Table 16.

Table 16 Summary of residual impacts remaining from remediation and validation works

Remediation Area	Summary of works
C2-RA01	Remediation was completed to target depth. The ACUT were achieved, and therefore no residual impacts remain within the remediation area that require management.
C2-RA02	Remediation could not be completed to target depth due to the live gas main and electrolysis line. However, the ACUT were achieved, and therefore no residual impacts remain within the remediation area that require management.
C3-RA01	Remediation was completed to target depth. The ACUT were achieved, and therefore no residual impacts remain within the remediation area that require management.
C3-RA02	Remediation was completed to target depth. The ACUT were achieved, and therefore no residual impacts remain within the remediation area that require management.
C3-RA03	Remediation could not be completed to target depth due to the proximity to the live gas main. Residual impacts remain within the remediation area at one sample location (C3-RA03_W2_0.7). The sample is considered Class 2 material based on elevated benzo(a)pyrene and total PAH concentrations and therefore is suitable under proposed building envelopes and in proposed roads and pavement areas and will require management if it is in a proposed open area. This sample is in the proposed footpath (pavement area) adjacent to the north western boundary, therefore the ACUT were achieved, and the residual impacts do not require management.
C3-RA04	Remediation was completed beyond the proposed excavation extent in all directions due to the observation of naphthalene odours at several locations. Residual impacts remain within the remediation area at one sample location (C3-RA04_W5_4.6). The sample is considered Class V3 (for volatile contaminants – vapour intrusion) and Class 1 (for volatile contaminants – direct contact) based on an elevated naphthalene concentration and therefore is suitable under proposed building envelopes (above ground buildings only) and in proposed open areas, roads and pavement areas and will require management if it is under proposed building envelopes (buildings which may have basements). This sample is in the proposed street adjacent to the north western boundary, therefore the ACUT were achieved, and the residual impact does not require management.
C3-RA05	Remediation was completed beyond the proposed excavation extent in all directions due to the observation of dark staining at several locations. However, the ACUT were achieved, and therefore no residual impacts remain within the remediation area that require management.

Remediation Area	Summary of works
C3-RA06	Remediation was completed beyond the proposed excavation extent in all directions due to the observation of dark staining in the southern part of the excavation but could not be completed to target depth due to the live gas main. Residual impacts remain within the remediation area at two sample locations (C3-RA06_W6_1.8 and C3-RA06_W7_1.8). The samples are considered Class V3 (volatile contaminants – vapour intrusion) and Class 1 (volatile contaminants – direct contact) based on elevated TRH (C10-C16 minus naphthalene) concentrations and therefore are suitable in proposed open areas, roads and pavement areas and will require management if under proposed buildings. These samples are in the proposed footpath adjacent to the north western boundary (pavement area), therefore the ACUT were achieved, and the residual impacts do not require management.
C3-RA07	Remediation to remove contaminated soil was not completed as remediation area located across the live gas main.
C3-RA08	Remediation was completed beyond the proposed excavation extent to the south and south east due to the observation of a layer of black staining along the western and southern walls and south east corner of the excavation but could not extended further to the west due to the live gas main. Residual impacts remain within the remediation area at one sample location (C3-RA08_W1_2.4). The sample is considered Class V4 (volatile contaminants – vapour intrusion) and Class 1 (volatile contaminants – direct contact) and therefore is suitable in proposed open areas, roads and pavement areas and will require management if under proposed buildings. The sample is in a proposed carpark area, therefore the ACUT were achieved, and the residual impacts do not require management.
C3-RA09	Remediation was completed to target depth. The ACUT were achieved, and therefore no residual impacts remain within the remediation area that require management.
C3-RA10	Remediation was completed to target depth. The ACUT were achieved, and therefore no residual impacts remain within the remediation area that require management.
ACM Dig (includes Non-ACM Dig)	Remediation was completed to remove fragments of cement sheeting and ACM impacted soil. A clearance certificate was issued for the area. Residual chemical impacts were reported in samples collected at the base of the ACM Dig excavation. Therefore, the impacted material (a further 8 m ³) was removed from all directions and the base of the excavation. Subsequently the ACUT were achieved, and no residual impacts remain within the remediation area that require management.

8.1.2 Remediation and validation 2011

Soil exceedances remained within Stage 2A following the soil investigations that supported the 2011 Audit (PB, 2011). These were also excluded from the recent remedial works due to their location at the boundary with the rail reserve or at the water table. These include samples:

- Remaining along the site boundary (railway boundary) and adjacent services easement to the north east. Based on current development plans, these areas are proposed open areas with the services easement likely to form a pedestrian link/landscaped bike path. Given that the live gas main is located within the service easement and the boundary samples are in proximity it is unlikely that excavation will be undertaken in this area, however work may be undertaken in this area as part of future gas main maintenance.
- Remaining at and below the groundwater table. However, given this it is unlikely that excavation will be undertaken to the depth of these samples during construction.
- That were not considered an issue by both the environmental consultant and former environmental consultant due to other reasons including apparent statistical outliers of the dataset.

The location of these exceedances, which will require ongoing management, are illustrated in Figures 5, 6 and 7 of the Remediation and Validation report (Senversa, 2021b).

Based on review of Appendix I of the Remediation and Validation report (Senversa, 2021a) samples remain on site of which the location of is not known (not shown on the figures provided by the assessor and the location has not been described by the assessor and former environmental consultant). Therefore, it cannot be determined whether these samples present a risk. Ongoing site management requirements will apply to the whole of Stage 2A to address any uncertainty on the location of unknown residual impacts.

8.1.3 Asbestos

All asbestos coated (bituminous coating) pipes were removed from the site during remedial works to remove redundant gas main pipework as discussed in Section 6.3.1.

Asbestos cement sheeting fragments and impacted soil encountered during trenching works at Trench C and the junction of Trench C and Trench D (Node A) were removed from the site and validated during remedial works as discussed in Section 6.3.2. However, given that few other instances of asbestos cement sheeting fragments have been encountered during site investigations and inspections undertaken as part of the previous 2011 Audit (PB, 2011) and remediation works at the site as discussed in Section 6, it is considered unlikely that this is a widespread issue at the site.

8.1.4 Off-site soil contamination

The 2011 Audit (PB, 2011) identified contaminated fill at the western and northern boundaries of the site which could not be removed due to the proximity of the rail easement (west) and a hotel building to the north. The likely source of the observed impacts was the historical use of gasworks waste as fill material. The management of these boundary impacts, in addition to other residual soil issues across the audit area, were outlined in an EMP (Golder, 2012), and this plan remains relevant to the ongoing management of the site.

8.2 Summary of site contamination and protected beneficial uses of the land

The consideration of the risk presented by residual soil impacts remaining at the site is based on the current development plans included in Appendix A of the Remediation and Validation report (Senversa, 2021b) and the ACUT discussed in Section 2.1 and Appendix B of this report.

8.2.1 Maintenance of highly modified ecosystems

Residual metals and hydrocarbon concentrations remain in soils at the site (TRH, PAH, Cyanide). However, although some of the analytical results exceed ecological criteria for both residential and commercial land use, these are either isolated (arsenic, zinc) or reflective of background levels (nickel) and unlikely to significantly impact vegetation growth on the site. The majority of the residual soil impacts are located along the western margin of the site which will comprise a gas easement with a bike path, roadway and public open space. The establishment and maintenance of vegetation in this part of the site will be addressed by a site environmental management plan (SEMP).

8.2.2 Human health

Residual concentrations of TRH(C10-C16), PAH and naphthalene that could not be removed due to the proximity of the site boundary and live gas infrastructure means that some controls will have to be introduced to minimise exposure to future site occupants and users.

Four of the remedial excavations undertaken by Senversa (2021b) contained validation samples exceeding the ACUT for volatile TRH(C10-C16) and naphthalene and non-volatile (BaP, Total PAH).

Residential and sensitive use is precluded by the residual soil impacts, however under the site development plan, all exceedances are located within a public open space along the western site boundary, which also includes a gas main easement. As such there will be no residences established in this part of the site.

The auditor evaluated whether the groundwater at the site can pose a vapour intrusion risk.

Benzene was reported in groundwater at BH6 during the most recent 2018 GME undertaken by Senversa (Senversa, 2019a), above the HSL A/B assessment criteria protective for low to high density residential land use (for sand). TRH Fraction F2 (>C10-C16 Fraction minus naphthalene) was reported in groundwater at 9150003, BH6 and BHF35 during the most recent 2018 GME undertaken by Senversa (Senversa, 2019a), above the HSL A/B assessment criteria protective for low to high density residential land use (for sand).

The depth to groundwater at the site is approximately 4.7 mbgl, and the presence of volatile contaminants in groundwater, indicates a potential risk of vapour intrusion from groundwater at the site.

Senversa (2021b) notes that Golder undertook a risk assessment in 2010 and given that maximum naphthalene and benzene concentrations in groundwater have not changed, the conclusion made by Golder with regards to the vapour risk from naphthalene and benzene in groundwater remains valid. Vapour risk was the key driver in the condition of the 2011 Audit (PB, 2011) requiring the development of the EMP for the site.

8.2.3 Buildings and structures

The 2011 Audit (PB, 2011) concluded that elevated sulphate and reduced pH levels in both soil and groundwater may result in a corrosive environment for below ground footings and other structures. No additional evaluation of soil corrosivity has been undertaken in the recent remedial works and therefore it is assumed that soil conditions remain unchanged. Under the proposed development plan, no substantial buried structures are planned for Stage 2A, with the exception of the existing gas mains.

8.2.4 Aesthetics

The beneficial uses associated with land include the protection of the visual and olfactory properties of soil and therefore not be offensive to the senses of human beings.

Senversa (2021b) noted fragments of ash and coke, dark staining, cyanide staining, odours (naphthalene and ammonia), slag fragments and solidified tar fragments. These occurrences have been summarised in Appendix H of the Remediation and Validation report (Senversa, 2021b) and the auditor agrees that the frequency of these impacts is minor and can be managed by a SMP, in a similar manner to ongoing management of Stage 2. Odorous or discoloured soils are generally located at the site boundary, in the vicinity of the live gas main, and at depth, where further excavation was not possible. These impacts are unlikely to be encountered except during intrusive works.

The auditor agrees with Senversa that these impacts are not considered to adversely impact the aesthetics beneficial use and can be appropriately managed.

8.2.5 Production of food, flora and fibre

The beneficial uses associated with land include the protection of the production and quality of food, flora and fibre that may be grown on the land (such as meat, dairy, fruits, vegetables and grains). The auditor notes that agricultural production of food on the site is considered unlikely given the proposed development of the site.

As the soil analytical results at the site included some exceedances of human health and maintenance of ecosystems criteria (PAH, cyanide and TRH), the site is also not suitable for the propagation of home-grown fruit and vegetables, without the placement of clean fill in garden.

9. Final condition of the site – groundwater

9.1 Beneficial uses of the groundwater

The assessor's groundwater field investigations indicated that the TDS of the groundwater tested at the site was between 172 mg/L and 4,796 mg/L for shallow wells and 1,446 mg/L to 3,256 mg/L for deep wells (based on field measurements in November 2018).

Segment A2 (SEPP *Waters*) is considered most appropriate classification for groundwater at the site. This is consistent with the Groundwater Monitoring Cessation Review (Senversa, 2021a) provided Appendix F, and the previous 2011 Audit (PB, 2011) and is based on the TDS concentrations reported in background/up-gradient monitoring wells during previous investigations.

The beneficial uses protected for Segment A2 under the SEPP *Waters* are:

- Water dependent ecosystems and species
- Potable water supply (acceptable)
- Potable mineral water supply
- Agriculture and irrigation (irrigation)
- Agricultural and irrigation (stock watering)
- Industrial and commercial
- Water-based recreation (primary contact recreation)
- Traditional Owner cultural values
- Cultural and spiritual values
- Buildings and Structures
- Geothermal properties

In addition to these beneficial uses, groundwater contamination should not be present at concentrations that would adversely affect the use of land at the site, such as may occur through the presence of volatiles (refer section 8.2.2).

9.2 Groundwater pollution and beneficial use assessment

The objectives of SEPP *Waters* are to:

- a. achieve the level of environmental quality required to protect the beneficial uses of waters
- b. ensure that pollution to waters from both diffuse and point sources is managed in an integrated way to deliver the best outcome for the community as a whole; and
- c. protect and improve environmental quality through consistent, equitable and proportionate regulatory decisions that focus on outcomes and use the best available information

The non-attainment of an environmental quality objective indicates that –

- (a) one or more beneficial uses may be at risk; and
- (b) an investigation is required to assess the level of risk to those beneficial uses and determine the actions needed to address those risks.

Consideration of the beneficial uses specified in Section 9.1, of this report, the SEPP *Waters* objective of protecting beneficial uses of waters, and the additional guidance outlined in EPA Publication 840.2 The Clean Up and Management of Polluted Groundwater (including the information provided in Section B1.3 of Appendix B of this report), the following sections provide discussion of pollution impacts of the protected beneficial uses, whether or not the beneficial use is likely to be realised and if the site is a source site.

9.3 Groundwater contamination status

Groundwater analytical results from the sampling events conducted in 2012, 2013, 2014, 2015, 2016, 2017 and 2018 since implementation of the GQMP, identified that groundwater at the site is contaminated with cyanide, ammonia, nitrate, sulphate, metals, TRH, PAHs (including BTEX), phenols and MAHs. The inorganic heavy metal concentrations (arsenic, nickel and zinc) and nitrate above the adopted criteria are considered likely to reflect regional ambient impacts and do not constitute pollution from the site. No NAPL has been identified at the site.

Contamination detected in groundwater is summarised in Section 4.1 and Table 1 of the Groundwater Monitoring Cessation Review (Senversa, 2021a) provided in Appendix F.

The condition of groundwater is discussed in the following sections.

9.3.1 Water dependent ecosystems and species

In the most recent 2018 GME undertaken by Senversa (Senversa, 2019a), cyanide, ammonia, nitrate, metals (arsenic, copper, lead, nickel and zinc in filtered samples), TRH (F2 and >C16 – C34 Fraction), PAHs (benzene, toluene, ethylbenzene, naphthalene, phenanthrene) and phenols (2,4-Dimethylphenol) concentrations measured in the groundwater beneath the site exceeded the adopted ecological criteria. Elevated metal concentrations (arsenic, cadmium, copper, lead, nickel and zinc) concentrations have been historically reported in some of the groundwater samples which were not filtered in the field, and the reported metal concentrations are likely attributed to the sediment load in the samples.

The assessor concluded that arsenic, nickel, zinc and nitrate concentrations were within the range of what is considered background conditions in the aquifer. Concentrations for these analytes were measured within the same range as off-site bores located at the audited sites:

- 284 Highbett Road, Highbett located approximately 320 m north west of the site (down hydraulic gradient); and
- 1142 Nepean Highway, Highbett located adjacent to the eastern boundary of Stage 2 Audit Boundary (up hydraulic gradient).

The beneficial use of water dependent ecosystems and species applies at the point of groundwater discharge, which is Port Phillip Bay. However, given that the bay is located approximately 3.7 km to the west of the site and regional groundwater flow toward the west is estimated to be 0.37 – 3.7 m/year, it is not a plausible receptor for groundwater impacts from the site.

The nearest artificial (ornamental) surface water body are water features located in Sir William Fry Reserve located approximately 50 m south of the site (inferred to be down hydraulic gradient). However, given that groundwater beneath the site is located at approximately 4.7 m depth, it is considered unlikely that groundwater originating from the audit site would intercept the water features.

As results for certain analytes were reported above the adopted criteria for water dependent ecosystems and species, this beneficial use is considered to be precluded by the condition of groundwater beneath the site.

9.3.2 Potable water supply

In the most recent 2018 GME undertaken by Senversa (Senversa, 2019a), cyanide, ammonia, nitrate, chloride, sodium, sulphate, metals (arsenic, lead and nickel in filtered samples), TRH (F1, F2, >C16 – C34 and >C34-C40 Fraction), PAHs (benzene, toluene, ethylbenzene, total xylene and naphthalene), phenols (2,4-Dimethylphenol) and MAH (styrene) concentrations measured in the groundwater beneath the site exceeded the adopted drinking water criteria.

Elevated metal concentrations (arsenic, lead and nickel) concentrations have been historically reported in some of the groundwater samples which were not filtered in the field, and the reported metal concentrations are likely attributed to the sediment load in the samples.

The assessor concluded that arsenic, nickel and nitrate concentrations were within the range of what is considered background conditions in the aquifer. Concentrations for these analytes were measured within the same range as off-site bores located at nearby audited sites.

Given the ready access to a mains water supply, the urban setting of the land and the proposed development of the site for a residential development comprising of three to six level apartments and townhouses, including open space and easement areas, it is considered unlikely that groundwater beneath the site would be used for potable water supply. It is also noted that no bores within 2 km of the site are registered for potable extraction purposes.

As results were reported above the adopted criteria for potable water supply, this beneficial use is precluded by the condition of groundwater beneath the site.

9.3.3 Potable mineral water supply

The natural quality of the groundwater at the site is not effervescent and is not within an area identified as a mineral spring. Therefore, in accordance with SEPP Waters and EPA guidelines, this beneficial use is not relevant and is not a protected beneficial use of groundwater at the site.

9.3.4 Agriculture and irrigation (irrigation)

Use of groundwater for agricultural activities includes for commercial irrigation, irrigation of domestic gardens, parks and golf courses. Assessment criteria were adopted for both short term and long term irrigation, as outlined in Section 4.1 of the Groundwater Monitoring Cessation Review (Senversa, 2021a).

In the most recent 2018 GME undertaken by Senversa (Senversa, 2019a), chloride, sodium, metals (nickel in filtered samples), and phenols (2,4-Dimethylphenol) concentrations measured in the groundwater beneath the site exceeded the adopted irrigation criteria.

The assessor concluded that nickel concentrations were within the range of what is considered background conditions in the aquifer. Concentrations for nickel were measured within the same range as off-site bores located at nearby audited sites.

Given the proposed development of the site, it is considered unlikely that groundwater beneath the site would be used for irrigation of domestic gardens but possible that groundwater beneath the site would be used for irrigation of landscaped (open space) areas at the site.

Sir William Fry Reserve is located to the immediate south of the site, Lyle Anderson Reserve is located west of the site to the west of the Frankston Railway line and local golf courses are located in the vicinity of the site (to the south west). It is also noted that of 32 groundwater bores are registered for irrigation and domestic and stock purposes within a 2 km radius of the site (the closest bore being located approximately 297 m from the site); 20 groundwater bores registered for domestic and stock purposes are screened in the same aquifer, 10 groundwater bores are screened against the same aquifer and or deeper formations and the screened aquifer/formation for the remaining two bores is unknown. Therefore, use of groundwater for irrigation (i.e. domestic gardens, parks and golf courses) exists off-site and is a relevant beneficial use.

As results were reported above the adopted criteria for irrigation, this beneficial use is precluded by the condition of groundwater beneath the site.

9.3.5 Agriculture and irrigation (stock watering)

Use of groundwater agricultural activities includes for stock watering. Assessment criteria for stock watering are outlined in Section 4.1 of the Groundwater Monitoring Cessation Review (Senversa, 2021a).

In the most recent 2018 GME undertaken by Senversa (Senversa, 2019a), cyanide, sulphate, PAHs (benzene and naphthalene), TRH (F2 and >C16 – C34 Fraction), phenols (2,4-Dimethylphenol) and MAH (styrene) concentrations measured in the groundwater beneath the site exceeded the adopted stock watering criteria.

Given the urban setting of the land and the proposed development of the site for a residential development, it is considered unlikely that groundwater beneath the site would be used to water stock. It is noted however that of 26 groundwater bores are registered for domestic and stock purposes within a 2 km radius of the site; 20 groundwater bores registered for domestic and stock purposes are screened in the same aquifer, five groundwater bores are screened against the same aquifer and or deeper formations and the screened aquifer/formation for the remaining bore is unknown. Despite the registered purposes for groundwater abstraction, the use of groundwater for stock watering in the general vicinity of the site is considered unlikely.

As results were reported above the adopted criteria for stock watering, this beneficial use precluded by the condition of groundwater beneath the site.

9.3.6 Industrial and commercial

Use of groundwater for commercial or industrial use, would need to meet water quality requirements specific to the industrial use considered. Given the wide range of potential industrial uses, there are no specific industrial / commercial water quality screening criteria and therefore, a site specific risk assessment would be required to confirm the suitability of water for this beneficial use. As a general note, the groundwater would need to be free of any nonaqueous phase liquids (such as separate phase hydrocarbons or chlorinated solvents) and be free of naturally occurring chemicals or contaminants so treatment would not be required.

Given the ready access to a mains water supply, the urban setting of the land and the proposed development of the site, it is considered unlikely that groundwater beneath the site would be used for industrial or commercial use. It is noted however that one bore within 2km of the site is registered for industrial use, although this bore is screened against deeper formations.

9.3.7 Water-based recreation (primary contact recreation)

The ANZECC 1992 and 2000 guidelines state that "Recreational water should contain no chemicals that can irritate the skin of the human body. Swimmers must also be protected from harmful effects through ingestion, absorption through the skin, and inhalation of volatile compounds. The guidelines from tables 5.2.3 and 5.2.4 should be applied for other toxicants. Special care must be taken to check for substances that can enter the body by absorption through the skin. Higher concentrations of toxicants may be tolerated occasionally if it is assumed that no person will ingest more than a maximum of 100 mL water during a normal swimming session (NHMRC 1990) compared with 2 L/d for potable water."

Therefore, primary contact recreation criteria can be taken as 10 times the drinking water criteria, where contaminants are not volatile, and therefore do not represent an inhalation risk, and the dermal contact risk is assumed to be minimal.

In the most recent 2018 GME undertaken by Senversa (Senversa, 2019a), cyanide, ammonia, nitrate, chloride, sodium, sulphate, metals (lead and nickel), PAHs (benzene, toluene, ethylbenzene, total xylene and naphthalene), TRH (F1, F2, >C16 – C34 and >C34-C40 Fraction) and MAH (styrene) concentrations measured in the groundwater beneath the site exceeded the adopted primary contact recreation criteria. Elevated metal concentrations (arsenic, lead and nickel) concentrations have been historically reported in some of the groundwater samples which were not filtered in the field, and the reported metal concentrations are likely attributed to the sediment load in the samples.

The assessor concluded that nickel and nitrate concentrations were within the range of what is considered background conditions in the aquifer. Concentrations for these analytes were measured within the same range as off-site bores located at nearby audited sites:

It is possible that groundwater may be used to fill swimming pools in the vicinity of the site, therefore primary contact recreation is a relevant beneficial use. However given the ready access to a mains water supply, this scenario is considered unlikely. It is noted however that of 26 groundwater bores are registered for domestic and stock purposes within a 2 km radius of the site; 20 groundwater bores registered for domestic and stock purposes are screened in the same aquifer, five groundwater bores are screened against the same aquifer and or deeper formations and the screened aquifer/formation for the remaining bore is unknown.

As results were reported above the adopted criteria for primary contact recreation, this beneficial use is precluded by the condition of groundwater beneath the site.

9.3.8 Traditional Owner cultural values

Water quality that protects the cultural values of Traditional Owners, ensures that these practices can continue. Traditional Owners cultural values may include traditional aquaculture, fishing, harvesting, cultivation of fresh and marine foods, fish, grasses and medicines (SEPP Waters). This beneficial use is assessed with respect to criteria for water dependent ecosystems and species and water based recreation (primary contact recreation). As such, the impact upon traditional owner and cultural values is applied at the point of groundwater discharge, which in this case is Port Phillip Bay.

As outlined in Sections 9.3.1 and 9.3.7 above, for the most recent 2018 GME undertaken by Senversa (Senversa, 2019a) concentrations of:

- Cyanide, ammonia, nitrate, metals (lead and nickel), TRH (F2 and >C16 – C34 Fraction), PAHs (benzene, toluene, ethylbenzene and naphthalene) were reported above the adopted criteria for both water-based dependent ecosystems and species and water based recreation (primary contact recreation)
- Metals (arsenic, copper and zinc), PAHs (phenanthrene) and phenols (2,4-Dimethylphenol) were reported above the adopted criteria for both water-based dependent ecosystems and species
- Chloride, sodium, sulphate, TRH (F1 and >C34-C40 Fraction) PAHs (total xylene) and MAH (styrene) were reported above the adopted criteria for water based recreation (primary contact recreation).

The assessor concluded that arsenic, nickel, zinc and nitrate concentrations were within the range of what is considered background conditions in the aquifer. Concentrations for these analytes were measured within the same range as off-site bores located on nearby audited sites.

As results were reported above the adopted criteria for water dependent ecosystems and species and water based recreation (primary contact recreation), this beneficial use is precluded by the condition of groundwater beneath the site.

However, as discussed in Section 9.3.1 and 9.3.7, given that the bay is located approximately 3.7 km to the west of the site and regional groundwater flow toward the west is estimated to be 0.37 – 3.7 m/year, it is not a plausible receptor for groundwater impacts from the site.

9.3.9 Cultural and spiritual values

Water quality that protects the cultural and spiritual needs of a community, ensures that spiritual and ceremonial practices can continue. These can include baptisms, water-based festivals and cultural celebrations (SEPP Waters).

This beneficial use was assessed with respect to criteria for water based recreation (primary contact recreation). As outlined in Sections 9.3.7 above, concentrations of cyanide, ammonia, nitrate, chloride, sodium, sulphate, metals (lead and nickel), PAHs (benzene, toluene, ethylbenzene, total xylene and naphthalene), TRH (F1, F2, >C16 – C34 and >C34-C40 Fraction) and MAH (styrene) were reported above the adopted criteria for primary contact recreation in the most recent 2018 GME undertaken by Senversa (Senversa, 2019a).

The assessor concluded that nickel and nitrate concentrations were within the range of what is considered background conditions in the aquifer. Concentrations for these analytes were measured within the same range as off-site bores located at nearby audited sites.

As results were reported above the adopted criteria for primary contact recreation, this beneficial use is precluded by the condition of groundwater beneath the site.

However, as discussed in Section 9.3.1, given that the bay is located approximately 3.7 km to the west of the site and regional groundwater flow toward the west is estimated to be 0.37 – 3.7 m/year, it is not a plausible receptor for groundwater impacts from the site.

9.3.10 Buildings and structures

The SEPP Waters states that introduced contaminants shall not cause groundwater to become corrosive to structures or building materials and particularly refers to pH, sulphate, chloride, redox potential and salinity. The measured chloride concentrations from the 2018 GME (Senversa, 2019a) were within the mild exposure classification for concrete and steel piles. However, the measured sulphate concentrations from the 2018 GME were within the moderate exposure classification for concrete piles. The majority of wells reported field pH from the 2018 GME within the mild and moderate exposure classifications for concrete and non-aggressive and mild exposure classifications for steel piles. However, well 9030002A reported a field pH value between 4 to 5 which would classify groundwater as having a severe exposure classification for concrete and wells 9050001 and 9130010 reported field pH values between 3 to 4 which would classify groundwater as having a very severe exposure classification for concrete piles and a severe exposure classification for steel piles.

The assessor stated in the Groundwater Monitoring Cessation Review (Senversa, 2021a) that as acidic on-site groundwater mixes with off-site (and more neutral) groundwater the pH would be expected to increase (acidity to decrease). However, groundwater acidity in addition to sulphate and chloride concentrations, should be taken into consideration in the design of building materials for any future development of the site.

The development plans for the site do not include basements or other deep structures although it is plausible that they could be installed in the future. The Remediation and Validation report (Senversa, 2021b) states that Development Victoria have advised that it is proposed that the buildings will not include basements.

9.3.11 Geothermal properties

Groundwater is not within the temperature range expected to be associated with geothermal activity.

9.4 Summary of groundwater pollution

Table 17 summarises the relevance of protected groundwater beneficial uses at the site.

Table 17 Summary of relevant beneficial uses, pollution and likelihood of being realised

Protected Segment A2 Beneficial Uses	Beneficial use precluded by pollution?	Pollutants	Likelihood of being realised		Comment
			On-site	Off-site	
Water dependent ecosystems and species	Yes	Cyanide, ammonia, nitrate, metals (arsenic, copper, lead, nickel and zinc), TRH (F2 and >C16 – C34 Fraction), PAHs (benzene, toluene, ethylbenzene, naphthalene, phenanthrene) and phenols (2,4-Dimethylphenol)	N/A	Unlikely	The groundwater is likely to discharge to Port Philip Bay located approximately 3.7 km to the west of the site. Nitrate, arsenic, nickel and zinc exceeded the adopted ecological criteria, however, these are considered to reflect ambient groundwater conditions and are not considered to constitute pollution.
Potable water supply (acceptable)	Yes	Cyanide, ammonia, nitrate, chloride, sodium, sulphate, metals (arsenic, lead and nickel), TRH (F1, F2, >C16 – C34 and >C34-C40 Fraction), PAHs (benzene, toluene, ethylbenzene, total xylene and naphthalene), phenols (2,4-Dimethylphenol) and MAH (styrene)	Unlikely	Unlikely	Given the availability of reticulated water on the site, this beneficial is unlikely to be realised. Nitrate, arsenic and nickel were reported above the adopted criteria; however these are considered to be reflect regional groundwater conditions and are not considered to constitute pollution.

Protected Segment A2 Beneficial Uses	Beneficial use precluded by pollution?	Pollutants	Likelihood of being realised		Comment
			On-site	Off-site	
Potable mineral water supply	No		Not Applicable	Not Applicable	The natural quality of the groundwater at the site is not effervescent and is not within an area identified as a mineral spring. Therefore, this beneficial use is not relevant at the site.
Agriculture and irrigation (irrigation)	Yes	Chloride, sodium, metals (nickel), and phenols (2,4-Dimethylphenol)	Possible	Existing	Potential use of groundwater for irrigation of landscaped (open space) areas at the site, and nearby parks and reserves. There are several registered bores for this purpose in the vicinity of the site, these are screened against the same and deeper formations. Nickel concentrations in groundwater beneath the site exceeded the adopted ecological criteria, However, these are considered to reflect ambient groundwater conditions and are not considered to constitute pollution.
Agriculture and irrigation (stock watering)	Yes	Cyanide, sulphate, PAHs (benzene and naphthalene), TRH (F2 and >C16 – C34 Fraction), phenols (2,4-Dimethylphenol) and MAH (styrene)	Unlikely	Unlikely	Unlikely even though there are several registered bores for this purpose in the vicinity of the site.
Industrial and commercial	No	None	Unlikely	Possible	There are several registered bores for this purpose in the vicinity of the site, these are screened against the same and or deeper formations. Industrial processes are more likely to utilise reticulated water.
Water-based recreation (primary contact recreation)	Yes	Cyanide, ammonia, nitrate, chloride, sodium, sulphate, metals (lead and nickel), TRH (F1, F2, >C16 – C34 and >C34-C40 Fraction), PAHs (benzene, toluene, ethylbenzene, total xylene and naphthalene), MAH (styrene)	Unlikely	Possible	Groundwater bores may be used to fill or top up swimming pools in this setting. The site is in an area of residential development (apartments, townhouses, open space and easement areas), and therefore given the availability of reticulated water this beneficial is unlikely to be realised. Nitrate and nickel concentrations in groundwater beneath the site exceeded the adopted ecological criteria, However, these are considered to reflect ambient groundwater conditions and are not considered to constitute pollution.

Protected Segment A2 Beneficial Uses	Beneficial use precluded by pollution?	Pollutants	Likelihood of being realised		Comment
			On-site	Off-site	
Traditional Owner cultural values	Yes	Cyanide, ammonia, nitrate, chloride, sodium, sulphate, metals (arsenic, copper, lead, nickel and zinc), TRH (F1, F2, >C16 – C34 Fraction and >C34-C40 Fraction), PAHs (benzene, toluene, ethylbenzene, total xylene, naphthalene and phenanthrene), MAH (styrene) and phenols (2,4-Dimethylphenol)	Unlikely	Unlikely	Groundwater at the site/area is considered unlikely to be extracted by traditional owners. The nearest location for groundwater discharge to the surface water environments is Port Philip Bay located approximately 3.7 km to the west of the site. Nitrate, arsenic, nickel and zinc concentrations exceeded the adopted ecological criteria, however, these are considered to reflect ambient groundwater conditions and are not considered to constitute pollution.
Cultural and spiritual values	Yes	Cyanide, ammonia, nitrate, chloride, sodium, sulphate, metals (lead and nickel), TRH (F1, F2, >C16 – C34 and >C34-C40 Fraction), PAHs (benzene, toluene, ethylbenzene, total xylene and naphthalene), MAH (styrene)	Unlikely	Unlikely	Groundwater at the site/area is considered unlikely to be used for ceremonial purposes. The nearest location for groundwater discharge to the surface water environments is Port Philip Bay located approximately 3.7 km to the west of the site. Nitrate and nickel concentrations in groundwater beneath the site exceeded the adopted ecological criteria, However, these are considered to reflect ambient groundwater conditions and are not considered to constitute pollution.
Buildings and structures	Yes	pH, sulphate	Possible	Possible	It is possible that deep foundations or structures could intersect the water table.
Geothermal properties	No	Not Applicable	Not Applicable	Not Applicable	The temperature of the groundwater (<30° C) and the relatively shallow depth of the water table at the site do not indicate that the groundwater has the natural thermal capacity.

9.5 Clean up to the extent practicable

An outcome of the previous Audit (PB, 2011) was that groundwater had been cleaned up to extent practicable (CUTEP). The site, incorporating stages 2 and 2A, was determined by EPA on the 3 November 2010 to be a GQRUZ. As residual groundwater contamination remained on the site, ongoing monitoring of groundwater was specified in a GQMP prepared for the site.

9.6 Cessation of groundwater quality management plan

The auditor was also engaged by DTF to consider the cessation or modification of the GQMP that has been implemented across Stages 2 and 2A since 2011.

The report titled Groundwater Monitoring Cessation Review was presented by Senversa on 14 July 2021 (Senvorsa, 2021a) following a critical review by the auditor. The findings of the auditor's review and a copy of the GQMP cessation checklist is contained in Appendix F. The auditor concurred with Senversa's conclusions that.

- Implementation of the GQMP monitoring should cease.
- The GQRUZ should be maintained in its current form given that groundwater contamination remains in the same areas as documented in the CUTEP submission and environmental audit and there is no evidence that extent will expand.
- The existing monitoring wells should be decommissioned in accordance with relevant guidelines.

9.7 Groundwater quality restricted use zone

The 2011 Audit (PB, 2011) identified off-site groundwater impacts beyond the western side of the rail easement comprising cyanide, ammonia and sulphate concentrations exceeding adopted protected beneficial use criteria. However as those groundwater beneficial uses were either not relevant, or unlikely to be realised, it was considered that the GQRUZ should only be limited to the site itself. Additionally, the rail easement along the western (down gradient) site margin provides an additional buffer to any potential future extractive uses of groundwater to the west of the site.

Given the extent of the groundwater monitoring record now available for the site it is considered unlikely that further off-site contamination will occur unless there is a substantial change in the local hydrogeological regime.

- Regional groundwater flow toward the west is estimated to be 0.37 – 3.7 m/year
- Primary sources of contamination for groundwater and some secondary sources have been removed from the site.
- Statistical analysis and assessment of contaminant concentrations undertaken by the assessor indicates that key contaminant concentrations show generally decreasing or stable trends.
- Assessment of key biodegradation parameters and contaminant concentrations undertaken by the assessor indicates that biodegradation of organic contaminants (BTEXN) is occurring

Based on the evidence provided in the Groundwater Monitoring Cessation Review (Senvorsa, 2021a) provided in Appendix F, the auditor considers that the GQRUZ should remain unchanged.

10. Auditor's assessment of risks at the site

10.1 Potential impacts of soil pollution on beneficial uses of the land

The final condition of soil at the site is discussed in detail in Section 8. The SEPP (Prevention and Management of Contamination of Land) 2002 stipulates the five beneficial uses of land that are to be protected in Victoria. Table 18 summarises risks associated with soils at the site in the context of the proposed development plan (included in the Remediation and Validation report (Senversa, 2021b), included in this report as Appendix G).

Table 18 *Evaluation of risk of contamination to beneficial uses of land*

Beneficial Use	Land use ⁽¹⁾	Contaminant Concentrations above criteria	Beneficial use precluded by pollution?
Maintenance of modified / highly modified ecosystems	All residential uses with garden accessible soil Recreation / open space Commercial / Industrial	PAH, cyanide TRH	Yes. Most exceedances are at the western site boundary or at depth beyond the root zone for landscape plantings. Can be managed with the implementation of a SEMP under the proposed development plan.
Human Health	Residential – single dwelling and medium density (including Childcare centre)	TRH, benzene, naphthalene, PAH	Yes Most exceedances are at the western site boundary. Can be managed with the implementation of a SEMP under the proposed development plan.
	High density residential	TRH, benzene	No Suitable for slab on-ground construction. Site not suitable for basement structures without management of ventilation.
	Recreation / open space	None	No Concentrations of volatile contaminants in soil and groundwater are not limiting
	Commercial / industrial	None	No Suitable for slab on-ground construction. Site not suitable for basement structures without management of ventilation.
Buildings and structures	All land beneficial uses	Sulphate, pH	No Elevated sulphate concentrations in soil may need to be considered in the design of below ground concrete structures.

Beneficial Use	Land use ⁽¹⁾	Contaminant Concentrations above criteria	Beneficial use precluded by pollution?
Aesthetics	Residential – single dwelling and medium density	Minor	No Placement of clean fill is recommended for garden beds and other landscaped areas.
	Childcare centre		
	High density residential		
	Recreation / open space		
Production of food flora and fibre	All residential uses with garden accessible soil	TRH, PAH, cyanide	Yes Placement of clean fill is recommended for garden beds.

Table Notes: (1) Residential land use descriptions in accordance with EPA Publication 759.3, Appendix 4

10.2 Evaluation of groundwater pollution

The final condition of groundwater at the site is discussed in detail in Section 9. Based on local and regional groundwater salinity, the SEPP (Waters) identifies groundwater as belonging to segment A2. Table 19 summarises the risk presented by site sourced groundwater contamination to the protected beneficial uses under Segment A2.

Table 19 Evaluation of risk of contamination to relevant beneficial uses of groundwater

Segment A2 Beneficial Use	Contaminant above criterion	Is the beneficial use precluded by pollution on-site?	Is the beneficial use precluded by pollution off-site?
Water dependent ecosystems and species	Metals, TRH, PAHs, cyanide, ammonia, phenol	Yes. Not relevant on-site.	No No plausible receptor is present in vicinity off-site
Potable water supply (desirable)	Metals, TRH, PAHs, MAH, cyanide, ammonia, phenol, sulphate hydrocarbon odour	Yes. The presence of hydrocarbon odours in the groundwater precludes the use of groundwater for potable use on the grounds of aesthetics.	No
Potable mineral water supply	Groundwater is not effervescent.	Not relevant.	Not relevant
Agriculture and irrigation (irrigation)	Metals, phenol	Yes. A site-specific assessment would be required to confirm that the groundwater is suitable for irrigation use.	Yes Unlikely to be realised under current zoning and land use
Agriculture and irrigation (stock watering)	TRH, PAH, MAH, cyanide, phenol, sulphate	Yes. The presence of hydrocarbon odours and sheens in the groundwater may also preclude the use of groundwater for stock watering on the grounds of aesthetics.	No
Industrial and commercial	None	No. A site-specific risk assessment would be required to confirm the suitability of water for this beneficial use.	No

Segment A2 Beneficial Use	Contaminant above criterion	Is the beneficial use precluded by pollution on-site?	Is the beneficial use precluded by pollution off-site?
Water-based recreation (primary contact recreation)	Metals, TRH, PAHs, MAH, cyanide, ammonia, sulphate hydrocarbon odour	Yes. The presence of hydrocarbon odours and sheens in the groundwater also precludes the use of groundwater for primary contact recreation on the grounds of aesthetics.	Yes Unlikely to be realised under current zoning and land use
Traditional Owner cultural values	Metals, TRH, PAHs, MAH, cyanide, ammonia, phenol, sulphate hydrocarbon odour	Yes Not relevant on-site.	Unlikely to be precluded at the point of discharge
Cultural and spiritual values	Metals, TRH, PAHs, MAH, cyanide, ammonia, sulphate hydrocarbon odour	Yes Not relevant on-site.	Unlikely to be precluded at the point of discharge
Buildings and structures	Sulphate, pH	Yes	Yes Unlikely to be realised
Geothermal properties	n/a	n/a	n/a
Table Notes: (1) considered to be reflective of ambient concentrations in regional groundwater and therefore not site sourced pollution. (2) exceeds trigger levels for long-term irrigation			

10.3 Consistency of the proposed development with the condition of the site

The proposed development of Stages 2 and 2A of the former Highett Gasworks site comprises mixed use (high density residential at levels above the ground floor, and commercial use with public open space areas). Development plans are included in the Remediation and Validation report (Senversa, 2021b), included in this report as Appendix G, and also form part of the Statement of Environmental Audit. The Stage 2A area will include a landscaped area, bike path and a roadway running along the western site boundary. This part of the site also forms the easement for the new gas main. Soil impacts remaining along the western fence line do not present a risk to future users of this area, and any potential risk to intrusive or maintenance workers will be managed under the guidance of the EMP.

The northern part of Stage 2A, facing View Street, will comprise 2 blocks of 3 level apartments, constructed on-ground with surrounding landscaping, roadways and carparking. This area is considered not to be suitable for any basement structures. All landscaped areas and garden beds will need to include 0.5 m of clean fill, as directed in the SEMP.

The proposed development, as described in Section 3.1 is considered to be suitable for the site in its current condition

11. Audit conclusions

Following completion of the environmental audit at “Stage 2A of the site located at 1136-1138 Nepean Highway, Highett 3190, located in the City of Kingston, comprising the land defined by the Certificate of Title Volume 9598 Folio 389, Allotment 2026, Parish of Moorabbin”, the following conclusions are provided:

The auditor is of the opinion that the site is suitable for the beneficial uses associated with; Sensitive use (High density: residential use, a childcare centre, pre-school or primary school); Recreation/Open space; Commercial; Industrial use of the land; subject to the following conditions:

- Condition 1 Groundwater at the site is polluted and is not suitable for the use of; water dependent ecosystems and species; potable water supply; agriculture and irrigation (irrigation and stock watering; water-based recreation (primary contact recreation); Traditional Owner cultural values; Cultural and spiritual values; buildings and structures. Groundwater must not be used for any precluded beneficial use without prior testing and review of results by a suitably qualified professional to confirm its suitability for the proposed use. It may be extracted for the purpose of environmental monitoring or remediation.
- Condition 2 There are no basements included in the proposed development plans for the site. The site is not suitable for a basement without further assessment and the potential design and installation of mitigation measures to manage vapour and odour risks. If a basement (single or multilevel) is incorporated in the development of the site, an environmental auditor Division 1 of Part 8.3 of the Environment Protection Act 2017 (“the Act”) must be engaged to conduct an environmental audit under Division 3 of Part 8.3 of the of the Act, to consider this use.
- Condition 3 A Construction Environmental Management Plan must be developed for the site by a suitably qualified professional and verified by an environmental auditor appointed under Division 1 of Part 8.3 of the Environment Protection Act 2017, and this verification advised in writing to EPA and the planning authority.
- Condition 4 Prior to the commencement of site construction, the owner of the site must implement and maintain a Construction Environmental Management Plan required by condition 3 of this statement.
- Condition 5 The existing Site Environmental Management Plan (Stages 2 and 2A) must be revised by a suitably qualified professional to reflect current site conditions and verified by an environmental auditor appointed under Division 1 of Part 8.3 of the Environment Protection Act 2017, and this verification advised in writing to EPA and the planning authority.
- Condition 6 Prior to site occupation, the owner of the site must implement and maintain the revised Site Environmental Management Plan required by condition 5 of this statement.
- Condition 7 This statement is directly referable to and based upon the layout and construction of the development shown and described in the attached *Masterplan: Apartment and Townhouse Scheme 1136-1147 Nepean Highway Highett Gasworks, 14/02/2020*. Any substantive change(s) i.e. coverage of paved area, building footprint, introduction of basements, must be verified by an environmental auditor appointed under Division 1 of Part 8.3 of the Environment Protection Act 2017, and this verification advised in writing to EPA and the planning authority.

The condition of the site is detrimental or potentially detrimental to any (one or more) beneficial uses of the site. Accordingly, I have not issued a Certificate of Environmental Audit for the site in its current condition, the reasons for which are presented in the environmental audit report. The terms and conditions that need to be complied with before a Certificate of Environmental Audit may be issued are set out as follows:

Removal of all residual soil impacts at the site

Restoration of all relevant beneficial uses of groundwater

Other related information:

The 2010 determination by EPA (CARMS 37308-2) that the former Highett Gasworks Site (Stages 2 and 2A) has been cleaned up to the extent practicable (CUTEP), and that Stages 2 and 2A are a groundwater quality restricted use zone (GQRUZ) remain valid.

Groundwater at the site is polluted with cyanide, ammonia, sulphate, metals, TRH, PAHs (including BTEX), phenols and MAHs and is not suitable for the beneficial uses of water dependent ecosystems and species; potable water supply; agriculture and irrigation (irrigation and stock watering); water-based recreation (primary contact recreation); Traditional Owner cultural values; Cultural and spiritual values; buildings and structures. The groundwater is suitable for the beneficial uses of industrial and commercial.

In accordance with clause 19(3) of SEPP (Groundwaters of Victoria), the Authority may require periodic reassessment of the practicability of groundwater clean up.

Groundwater at the site contains elevated concentrations of metals (arsenic, nickel and zinc) and nitrate. The concentrations are considered to be associated with off-site regional sources of pollution. The pollution is not sourced from the site.

Some soil and groundwater may contain odours at some locations on the site. This material is not considered to represent a health or ecological risk but may cause a noticeable odour if exposed during excavation works, development or occupation of the site.

No further groundwater monitoring across Stages 2 and 2A is considered necessary. The remaining groundwater impacts are considered to be stable or declining, and are adequately managed by the GQRUZ.

Groundwater monitoring bores present at the site and installed off-site should be decommissioned within 12 months of cessation of use in accordance with the requirements of "Minimum Construction Requirements for Water Bores in Australia", published by the Land and Water Biodiversity Committee (4th edition).

This statement of Environmental Audit (SoEA) supersedes the SoEA issued by John Throssell of Parsons Brinckerhoff which was provided in the Audit report titled Stages 2 and 2A 1136-1138 Nepean Highway Highett 3190 Victoria CARMS 37308-2. Ref 2125064A-A and dated 15 December 2011.

12. References

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Figures

Figure 1 Audit Boundary

Figure 2 GQRUZ Boundary



Address: Level 6, 15 William Street
Melbourne VIC 3000
Phone: (03) 9606 0070
Website: www.senversa.com.au

Legend

- Stage 2A Boundary
- Property Boundary

Notes:
Cadastral and road data sourced from land.vic.gov.au (DELWP)
Aerial imagery (28/01/2020) sourced from Nearmap Pty Ltd

Designed:	H. Lawrence	Date:	5/05/2020
Drawn:	M. Sari	Revision:	0
Checked:	D. Aheame	Scale:	1:2,000 (A3)
File:	M16889_014 F001_Site_Location		

0 25 50 100 150 Metres
Datum GDA 1994, Projection MGA Zone 55

Figure No: 1

Title: Site Location

Project: Soil Remediation

Location: 1136-1138 Nepean Highway, Highett

Client: Department of Treasury and Finance

Source: Reproduced Figure 1 of Senversa Remediation and Validation 2021



Department of Treasury and Finance
s53X Stage 2A
Former Highett Gasworks

Project No. 3137121
Revision No. A
Date 30 Nov 2021

Audit Boundary

FIGURE 1

Source: Senversa, Remediation and Validation, 16 July 2020 Whilst every care has been taken to prepare this map, GHD (and DATA CUSTODIAN) make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason. Data source: © OpenStreetMap (and) contributors, CC-BY-SA. Created by: sacevedo





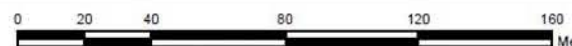
Address: Level 6, 15 William Street
Melbourne VIC 3000
Phone: (03) 9606 0070
Website: www.senversa.com.au

Legend

- Groundwater Monitoring Well - Sampled in 2018
- Groundwater Monitoring Well - Unable to be Sampled
- Site Boundary

Notes:
Cadastral and road data sourced from land.vic.gov.au (DELWP)
Aerial imagery sourced from Nearmap Pty Ltd

Designed:	K. Kijek	Date:	6/12/2018
Drawn:	M. Byrne	Revision:	0
Checked:		Scale:	1:2,000 (A3)
File:	M16889_02_F001_Site Location and GW Wells		



Datum GDA 1994, Projection MGA Zone 55

Figure No: 1

Title: Site Location and Groundwater Well Locations

Project: Groundwater Monitoring Event

Location: 1136 - 1138 Nepean Highway, Highett

Client: Department of Treasury and Finance

Source: Senversa, Groundwater Monitoring Cessation Review, 14 July 2021



Department of Treasury and Finance
s53X Stage 2A
Former Highett Gasworks
GQRUZ Boundary

Project No. 3137121
Revision No. A
Date 30 Nov 2021

FIGURE 2

