



INFORMATION REGARDING ENVIRONMENTAL AUDIT REPORTS

August 2007

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ENVIRONMENTAL AUDIT REPORT

FORMER MOBIL SERVICE STATION,
151-153 CHURCH STREET,
GEELONG WEST, VIC

AEC REF 5176

Vic EPA CARMS Ref 68842-2

Prepared for Mobil Oil Australia Pty Ltd

13 May 2011



AEC ENVIRONMENTAL PTY LTD

12 Greenhill Road
WAYVILLE SA 5034

P O Box 582
UNLEY SA 5061

Phone 08 8299 9955
Fax 08 8299 9954
Email: aec@aecaust.com.au
Web: www.aeclust.com.au

EXECUTIVE SUMMARY

This is an environmental audit report for the former Mobil Service Station site at 151-153 Church Street, Geelong West, Victoria (corner of Shannon Avenue and Church Street), which has been completed by Mr. Steven Kirsanovs of AEC Environmental Pty Ltd, in his capacity as an environmental auditor (contaminated land) appointed by the EPA pursuant to the *Environment Protection Act 1970*. The audit details and outcomes are summarised in Tables 1 and 2 on the following pages.

Table 1. Summary of audit information

EPA file reference no.	68842-2
Auditor	Steven Jon Kirsanovs
Auditor term of appointment	03/11/2009 to 02/11/2011
Name of person requesting certificate	Mr Stewart Frater (Mobil Oil Australia Pty Ltd)
Relationship to premises/location	Nominated representative for Mobil (site owner)
Date of request	15/02/2011
Date EPA notified of audit	22/02/2011
Completion date of the audit	13 May 2011
Reason for Audit	Clean up Notice N09017 dated 14 January 2011
Description of activity	Service Station Activities (storage, handling & distribution of petroleum hydrocarbons)
EPA Region	South West
Dominant – Lot on plan	Lot 1 on Title Plan 382065X, Volume 8666 Folio 665
Additional – Lot on plan(s)	
Site/Premises Name	Former Mobil Service Station (Geelong West)
o Building / complex sub-unit No	
o Street / Lot – Lower No	151
o Street / Lot – Upper No	153
o Street Name	Church
o Street type (road, court etc.)	Street
o Street suffix (North, south etc.)	
o Suburb	Geelong West
o Postcode	3218
GIS Coordinate of Site centroid	(from Vic Land Channel interactive mapping tool)
o Longitude / Northing (GDA 94)	5776299 N
o Latitude / Easting (GDA 94)	266730 E
Members and categories of support team utilised	Jackie Wright (Health Risk Assessment)
Outcome of the audit	Past leakage of petroleum products has resulted in contamination of land and groundwater in the vicinity of the site. There has been extensive investigation undertaken to characterise the nature and extent of impacts. The lateral extent of impacts has been delineated adequately, but the impacts have not been delineated vertically. The auditor is satisfied the scope of investigations to date has been commensurate with the scale and significance of the impacts. The hydrocarbon impacts are not likely to pose a significant current risk to the land and groundwater environment. However, there are

	limitations with some of the supporting data, particularly in relation to vapour intrusion risk. Further investigation is warranted to improve the confidence in the supporting data for exposures via vapour intrusion risk and indoor air quality impacts. The clean up measures carried out to date are reasonable and appropriate, and have been carried out with regard to the general requirements of EPA publication 840.
Further work or requirements	The auditor recommends the following additional investigation and management measures:- SHORT TERM MEASURES (WITHIN 3 MONTHS OF AUDIT COMPLETION) - o A site environmental management plan (SEMP) should be prepared for the management of contaminated soil and groundwater at the site. The plan should include provisions for ongoing groundwater monitoring, trigger levels, contingency plan, utility pit vapour monitoring, disposal or re-use of any waste soil or groundwater generated by site activities and retention and maintenance of the existing groundwater monitoring bore network. The SEMP must be prepared by an appropriately qualified professional practitioner and be subsequently approved by an Environmental Auditor (Contaminated Land) appointed pursuant to the Environment Protection Act 1970. - o EPA should consider declaring a Groundwater Quality Restricted Use Zone (GQRUZ) encompassing the site and affected off-site areas, or a similar regulatory mechanism that has the effect of prohibiting groundwater extraction and use unless it is for ongoing monitoring or remediation purposes. - o All owners and occupants of properties in the affected off-site areas should be informed of the risks posed by the groundwater impacts, including the risks if affected groundwater was extracted and utilised. As part of this consultation process, enquiries should be made to establish whether these properties have basements and/or cellars. MEDIUM TERM MEASURES (WITHIN 6 MONTHS OF AUDIT COMPLETION) - o An additional soil vapour monitoring event should be completed from the existing on site soil vapour monitoring bores, and the data used to upgrade the on site and off site health risk assessment. In addition to the scenarios of sub surface trenching and existing slab on ground structures, the risk assessment should consider the potential risk associated with subsurface structures such as basements and/or cellars both on site and off site.

	- o Further investigation should be conducted to vertically delineate dissolved phase impacts under the north eastern portion of the site. Delineation should be achieved to the lowest of the adopted groundwater clean-up criteria for each analyte of interest (eg. 1µg/L for benzene). - o A clean up and remediation plan should be prepared to address residual hydrocarbon impacted soil remaining on site. LONGER TERM MEASURES (WITHIN 2 YEARS OF AUDIT COMPLETION) - o If the environmental audit of the site currently being undertaken under Section 53X of the Environment Protection Act has not been completed and submitted within 2 years of the provision of this 53V audit (including a determination by EPA that clean up to extent practicable has been achieved), there should be a review conducted to assess the need for further investigation, remediation and/or other management measures. The form of this review should be an audit conducted in accordance with Section 53V of the Environment Protection Act 1970.
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Table 2. Physical Site Information

Groundwater segment	C
Surrounding land use	North:- Commercial (hair dresser directly opposite and fitness centre north west) East:- Residential South:- Residential West:- Caltex Service Station and residential property adjacent.

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LIST OF ABBREVIATIONS / TERMS

AEC	AEC Environmental Pty Ltd
AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
BGS	Below ground surface
Coffey	Coffey Environments
DPI	Department of Primary Industry
DSE	Department of Sustainability and Environment
EMP	Environmental Management Plan
EPA	Environment Protection Authority
ESA	Environmental Site Assessment
GQRUZ	Groundwater Quality Restricted Use Zone
IT	IT Environmental Pty Ltd
LEL	Lower Explosive Limit
LNAPL	Light non-aqueous phase liquid
MTBE	Methyl Tertiary-Butyl Ether
Mobil	Mobil Oil Australia Pty Ltd
MPEAT	Multiphase extraction and treatment
MPVE	Multi phase vapour extraction
NAPL	Non-aqueous phase liquid
NEPM	National Environment Protection Measure
PAH	Polycyclic Aromatic Hydrocarbons
PID	Photoionisation Detector
PPK	PPK Environments and Infrastructure
PSH	Phase separated hydrocarbon
SEPP	State Environment Protection Policy
SEPP (GoV)	State Environment Protection Policy (Groundwaters of Victoria)
SEPP (PMCL)	State Environment Protection Policy (Prevention and Management of Contamination of Land)
SWL	Standing Water Level
TEL	Tetraethyl lead
TIT	Triple interceptor trap
TML	Tetramethyl lead
TPH	Total Petroleum Hydrocarbons
UPSS	Underground petroleum storage system
UST	Underground storage tank
VCH	Volatile chlorinated hydrocarbons

AEC Document Control.

Report Title & Ref	Report Title:- Environmental Audit Report Former Mobil Service Station 151-153 Church Street, Geelong West Vic	Filename:- 68842-2 Audit Report Geelong West May 2011 Final
Approved By:-	13 May 2011 Steven Jon Kirsanovs Environmental Auditor (appointed pursuant to the Environment Protection Act 1970)	

Rev No	Status	Date	Author	Reviewer
0	Draft	13 May 2011	NW	SJK
1	Final	13 May 2011	SJK	SJK

Rev No	Copies	Recipient
0	1 x Electronic Copy	Mobil Oil Australia Pty Ltd
1	1 x Electronic Copy 1 x Hard Copy (text & figures only)	Environmental Audit Team (EPA)
1	1 x Electronic Copy 1 x Hard Copy (text & figures only)	EPA South West Region Office
1	1 x Electronic Copy 1 x Hard Copy (text & figures only)	Mobil Oil Australia Pty Ltd

1. INTRODUCTION

This is an environmental audit report carried out in relation to subsurface fuel impacts at the former Mobil service station site at 151-153 Church Street, Geelong West (corner of Shannon Avenue and Church Street). The audit has been completed by Mr. Steven Kirsanovs of AEC Environmental Pty Ltd (AEC) in his capacity as an environmental auditor (contaminated land) appointed by Environment Protection Authority (EPA) pursuant to the *Environment Protection Act 1970*.

The site address is 151-153 Church Street, Geelong West, and the legal description is Lot 1 on Title Plan 382065X – Certificate of Title Volume 8666 Folio 665. The site is located in a 'Residential 1' zone under the Greater Geelong Planning Scheme. The current site owner is listed as Mobil Oil Australia Ltd. The auditor notes that Mobil Oil Australia Ltd is the previous name of Mobil Oil Australia Pty Limited. The site owner is referred to as 'Mobil' throughout the remainder of the report.

There has been an extensive sequence of investigations and clean up work conducted at the site since 1997, by Handex, PPK Environment and Infrastructure (PPK), IT Environmental and more recently by Coffey Environments (Coffey). There are residual subsurface fuel related hydrocarbon impacts remaining at and in the vicinity of the site. Mobil was issued with a Clean Up Notice on 14 January 2011 (EPA Ref NO9017) pursuant to Section 62A of the Environment Protection Act 1970 ('the Act'). The Clean Up Notice contained specific requirements in relation to the completion of an environmental audit:-

- o By 14 March 2011, Mobil must have engaged an EPA-appointed environmental auditor and Mobil must submit to EPA for approval the auditor's proposed audit scope prepared in accordance with EPA Publication 952.2 (*Environmental Auditor Guidelines for the Preparation of Environmental Audit Reports on the Risk to the Environment*), detailing the proposed audit criteria, sampling and testing program, and quality control procedures, and specifying the expected completion date of the audit.
- o By 16 May 2011, Mobil must submit to EPA an environmental audit report, prepared in accordance with Section 53V of the Act. The specific objectives are detailed in the Clean Up Notice and reiterated in the audit scope.

The auditor was engaged on 15 February 2011 by Stewart Frater, the nominated representative of Mobil (the site owner at the time). The environmental audit was undertaken in accordance with Part IXD of the *Environment Protection Act 1970*, and specifically Section 53V which relates to an audit of the risk to a segment of the environment. The segment of the environment in this case is the land and groundwater at and in the vicinity of the site that may be affected by the subsurface fuel impacts. Further details of the audit objectives and scope are provided in Section 2. The relevant legislation, guidelines and standards current at the time of the audit are summarised in Section 9 of this audit report.

2 AUDIT DETAILS

2.1 Audit Objectives

The audit objectives as specified in AEC's letter to the EPA dated 7 April 2011 were as follows:-

- o to assess the adequacy of investigations to delineate the nature and extent of impacts arising from past or current activities at the site (including, but not limited to, determination of the extent of dissolved phase and non-aqueous phase liquid, and associated vapour impacts);
- o to assess the risks of any possible harm or detriment to the land, groundwater and surface water environment posed by the past or current activities;
- o to assess the adequacy of measures being planned and implemented to manage the risk;
- o to recommend any other investigation necessary to delineate the extent of impacts (if required), recommend any additional measures to determine risks (if required), and any additional clean up or management measures considered necessary to reduce the risk to an acceptable level (if required).

2.2 Audit Scope

The audit scope was specified in AEC's letter to the EPA dated 7 April 2011.

Activity Being Audited

The activity being audited is the past service station operations (including, but not limited to, storage and dispensing of petroleum products) at the Site ('the activity').

Segment

The segment for the audit is the land (includes consideration of vapours and liquids within interstitial space) at and in the vicinity of the Site that may be affected by the past activities at the Site; groundwater at and in the vicinity of the Site that may be affected by the past activities at the Site; and surface waters where groundwater monitoring data may indicate discharge from the Site to receiving waters.

Elements Considered

The elements considered included land, groundwater, air (odours and vapour emission), and surface water.

Beneficial Uses

The beneficial uses are those defined in relevant State Environment Protection Policies (SEPP's), including:-

- o Land. As defined in Table 1 of the SEPP Prevention and Management of Contamination of Land (PMCL). It is noted that the beneficial uses applicable to the site

are those associated with its current zoning, which is residential, however the beneficial uses associated with adjoining commercial and residential uses also needed to be considered.

- o Groundwater. As defined in Table 2 of the SEPP (Groundwaters of Victoria).
- o Air. As defined in Part III of the SEPP (Ambient Air Quality).
- o Surface Water. As defined in Table 1 of SEPP (Waters of Victoria).

Risk Assessment Conducted

The assessment considered risk to the land and groundwater environment including, but not limited to, assessment of potential vapour risk and risk posed by dissolved phase impacts and non aqueous phase liquid (NAPL). The assessment of risk was based on the quantitative on-site health risk assessment (PPK, Dec 1998), the off-site health risk assessment (Coffey, Dec 2008), the various assessment and monitoring reports provided for auditor review, and the auditor's own qualitative assessment of risk to relevant receptors. It is noted that as well as the land and groundwater environment, assessment of risk to the surface water environment was conducted based on a qualitative appraisal of the available data. Given the required timeframe for completion of the audit, there was insufficient time to complete further quantitative risk assessment.

Audit Timeframe

The audit report was completed and issued in final form on 13 May 2011, which was within the 16 May 2011 deadline stipulated by the Clean Up Notice (N09017).

2.3 Audit Criteria

The audit criteria include the Environment Protection Act 1970 ('The Act') (including, but not limited to, Section 53V), and relevant legislation and guidelines for environmental management. Other relevant documents used in the completion of this environmental audit included:

- o SEPP (PMCL) and related guidelines including the National Environment Protection (Assessment of Site Contamination) Measure, 1999.
- o SEPP (Groundwaters of Victoria) and related guidelines including ANZECC Water Quality and Monitoring Guidelines, 2000.
- o SEPP (Ambient Air Quality) and SEPP (Air Quality Management).
- o Environment Protection (Industrial Waste Resource) Regulations 2009.
- o Standards Australia (1999) Guide to the Sampling and Investigation of Potentially Contaminated Soil. Part 2: Volatile Substances. Australian Standard AS 4482.2-1999.
- o Standards Australia (2005) Guide to the investigation and sampling of sites with potentially contaminated soil, Part 1: Non-volatile and semi-volatile compounds. Australian Standard AS 4482.1-2005.
- o EPA Publication 668 (2006) Hydrogeological Assessment (Groundwater Quality) Guidelines.
- o EPA Publication 669 (2000) Groundwater Sampling Guidelines.

- o EPA Publication 840 (2002) The Clean Up and Management of Polluted Groundwater.
- o EPA Publication 888.1 (2009). Guidelines on the Design, Installation and Management Requirements for Underground Petroleum Storage systems (UPSS).

2.4 Audit Methodology

The audit was completed in stages in accordance with the following methodology:-

Stage 1. Project Start Up & Familiarisation

- o Initial site inspection followed by meeting with representatives of Mobil, and Mobil's appointed consultants (Coffey). This was completed on 1 February 2011.
- o Formal notification to the Victorian EPA in accordance with Appendix 1 of EPA Publication 952.2 & project initiation. This was completed on 22 February 2011.
- o Confirm scope of audit as per EPA Publication 952.2. The final scope was issued to EPA dated 7 April 2011.

Stage 2. Reviews and Data Gap Analysis

- o Review of previously completed reports made available in relation to assessment works completed to date. A full list of documents reviewed is provided in Section 2.6. The review assessed whether the extent of contamination both within the site and beyond the boundary of the site has been adequately delineated.
- o Review of previously completed reports made available in relation to the planning and conduct of clean up works completed to date. This included a review of the effectiveness of any remedial action completed to date.
- o It had been originally intended to consult with Mobil and their appointed consultant's in relation to any data gaps that might be able to addressed and reported within the audit timeframe. The audit was completed within a 2 month timeframe which did not allow for any such consultation or additional work to take place.
- o Review of the site's underground petroleum storage system (UPSS) against the elements outlined in EPA Publication 888 Guidelines on the Design, Installation and Management Requirements for Underground Petroleum Storage Systems in respect to UPSS removal/decommissioning.

Stage 3. Further Sampling & Testing

- o It had been originally intended to consult with Mobil and their appointed consultants regarding any additional sampling and testing work able to be practically completed by the consultants within the audit timeframe, and inspect any such sampling work carried out. No additional works were completed within the 2 month timeframe that the audit was completed in.
- o It had been intended to collect auditor verification samples from any sampling conducted by Mobil's appointed consultants between the time of the audit commencement and the end of April 2011. As no sampling was carried out in this timeframe, the audit relied entirely on the data as reported by Mobil's appointed consultants.

Stage 4. Assessment of Risk

- o Assessment of risks to the land and groundwater environment based on results of the investigation and clean up works completed at that stage. This included review of any

risk assessment work completed by Mobil's appointed consultants and remediation contractors at that stage.

Stage 5. Completion of Environmental Audit Report

- o A draft audit report was submitted for review and comment by Mobil on the 13 May 2011.
- o The audit report was completed and finalised on 13 May 2011.

Jackie Wright (a member of the auditor's approved expert support team in the field of human health risk assessment) was consulted and provided advice in relation to vapour intrusion issues and associated risks.

The following items were excluded from this audit scope:-

- o The UPSS review did not include review of the UPSS management system element of Publication 888.1.
- o Auditor verification samples were not collected as there was no sampling conducted by Mobil's appointed consultants between the time of the audit commencement and the end of April 2011. The audit is therefore entirely reliant on the data collected by Mobil's appointed assessors and remediation contractors.

2.5 Environmental Quality Criteria

Soil

The soil results have been compared with soil quality indicators as nominated in the SEPP Prevention and Management of Contamination of Land (PMCL) (2002). The SEPP (PMCL) specifies the principal objectives to be met in protection of beneficial uses of land are the 'investigation levels' for soil from Schedule B(1) of the National Environment Protection (Assessment of Site Contamination) Measure (NEPM). At the time of this audit the following investigation levels had been proposed in the NEPM:-

- o Interim urban ecological investigation levels (EIL's). The interim urban EIL's are based on considerations of phytotoxicity, soil survey data from four Australian capital cities, and values provided in the 1992 ANZECC Guidelines for the Assessment and Management of Contaminated Sites. The list of contaminants covered by the interim urban EIL's is limited to a few inorganic contaminants – including arsenic, barium, cadmium, chromium, copper, lead, manganese, mercury, and zinc.
- o Health investigation levels (HIL's). The health investigation levels (HIL's) listed in the current version of the NEPM include a limited range of metals/metalloids (including arsenic, beryllium, cadmium, cobalt, copper, lead, manganese, mercury, nickel, zinc) and organic compounds (including polycyclic aromatic hydrocarbons, polychlorinated biphenyls, total phenolics, selected organochlorine pesticides, and >C15 petroleum hydrocarbons considered as aliphatic and aromatic fractions).

The EIL's and HIL's in the current version of the NEPM do not cover the breadth of contaminants of interest at this site, and the assessment consultant and auditor have also used alternative sources for soil screening criteria including:-

- o ANZECC 'B' levels (ANZECC, 1992).

- o Typical background ranges of contaminants, as listed in ANZECC 1992 or the NEPM.
- o Dutch Target and Intervention Levels (MHSPE, 2000).
- o NSW EPA threshold concentrations for sensitive land use from the 'Guidelines for Assessment of Service Station Sites' (NSW EPA, 1994).
- o US EPA Region 9 Preliminary Remediation Goals.
- o Section 6 of the Australian Piling Code (AS2159-1995), for guidance in relation to potential adverse effects on buildings and structures.

The investigation levels are not intended to be interpreted strictly as "acceptance levels" or "maximum permissible levels". They are based on generic and conservative assumptions related to levels of exposure and potential adverse effects, and are simply intended to prompt further site specific investigation where they are exceeded. The SEPP (PMCL) also provides direction in relation to objectives for cleanup of land. Cleanup can be based on the relevant objectives specified in Table 2 of the SEPP (PMCL), for the protected beneficial uses defined in the SEPP (PMCL), or alternatively via clean up objectives derived via a site specific risk assessment undertaken in accordance with the NEPM.

Groundwater

The groundwater results were compared with the criteria specified in the *SEPP Waters of Victoria (as varied 2003)* and *SEPP Groundwaters of Victoria (1997)*. These are primarily derived from ANZECC and NHMRC documents, and are referenced below:-

- o Maintenance of ecosystems. ANZECC (2000) *Australian Water Quality Guidelines for Fresh and Marine Waters*. ANZECC 1992 criteria were used if no updated values were listed in ANZECC 2000.
- o Potable water. ANZECC (1992) *Australian Water Quality Guidelines for Fresh and Marine Waters*, criteria for raw water for drinking supply.
- o Potable mineral water supply. *Australian Food Standards Code (1987) – Standard 08 Mineral Water*, criteria for potable mineral water supply.
- o Stock watering. ANZECC (1992) *Australian Water Quality Guidelines for Fresh and Marine Waters*, criteria for livestock water. Criteria for raw drinking waters were used where no stock criteria were specified.
- o Agriculture, parks and gardens. ANZECC (1992) *Australian Water Quality Guidelines for Fresh and Marine Waters*, criteria for irrigation.
- o Industrial. ANZECC (1992) *Australian Water Quality Guidelines for Fresh and Marine Waters*, criteria for industrial water use.
- o Primary contact recreation. ANZECC (1992) *Australian Water Quality Guidelines for Fresh and Marine Waters*, criteria for raw drinking water.
- o Buildings and Structures. No specific criteria are listed in the SEPP, but results were considered with regard to Section 6 of the Australian Piling Code (AS2159-2009) for groundwater conditions and potential adverse effects on buildings and structures.

It is noted that some of the above guidelines have been superseded. The more recent guidelines include the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000), a revised edition of the Australian Drinking Water

Guidelines (NHMRC 2004), and Guidelines for Managing Risks in Recreational Water (NHMRC 2008). These have not yet been officially adopted by the EPA with the exception of the ANZECC/ARMCANZ 2000 criteria for 'maintenance of ecosystems'. However, EPA has advised auditors that the ANZECC/ARMCANZ 2000 guidelines or the other updated Australian guidelines can be used if they represent "better science".

Air

The environmental air quality criteria used for this audit are defined in the *SEPP Air Quality Management (SEPP AQM) Victoria*. The policy contributes to the protection of the beneficial uses of segments of the environment identified in other State environment protection policies which may be adversely affected by emissions to the air environment. Under Clause 10, the SEPP defines Air Quality Indicators for Class 1, 2 and 3 indicators and unclassified indicators (odour and total suspended particles or nuisance dust) for assessment of the design of new or expended sources of emissions such as industrial premises. The SEPP also provides Intervention Levels (Schedule B) for chemical or substances used for the assessment of local or neighbourhood monitoring data based on 1 or 24 hour averaging periods.

Reference has also been made to the National Environment Protection Measure (NEPM) Air Toxics (December 2004) and other reputable international sources (World Health Organisation and US EPA).

2.6 Documents / Reports Reviewed

A full list of the documents and reports reviewed as part of the audit is provided in Section 9 (References). Copies of all reports reviewed are attached in Appendix C.

3 REVIEW OF BACKGROUND INFORMATION

3.1 *Physical & Environmental Setting*

The former Mobil Geelong West Service Station site is located approximately 2.5km north west of the Geelong city centre, and approximately 1.5km inland (west) of Corio Bay. The land in the locality is essentially level. The Victorian Government Land Channel website indicates the site lies approximately 33 metres above sea level. There are no watercourses or surface water bodies in the immediate vicinity. The Moorabool River is approximately 2km to the south west. Adjoining land usage has been reported in various Coffey reports as follows:-

- o North. Church Street and residential and commercial properties.
- o East. Residential.
- o South. Residential.
- o South. Shannon Avenue and operating Caltex Service Station.

A regional setting map is presented as Figure 1.



Figure 1. Regional Setting

Auditor Comments:-

The physical and environmental setting, proximity to sensitive receptors, and surrounding land usage is adequately documented in the various background reports.

3.2 Geology & Hydrogeology

The regional and site specific geology and hydrogeology have been evaluated as part of the various phases of investigation carried out to date. The most recent conceptual model is documented in the Coffey report - *Summary Report, Former Mobil Service Station Geelong West (VO0993), 151 Church St, Geelong West (Coffey Environments, 4 May 2011)*. Regional geology was assessed with regard to Geological Survey of Victoria geological maps (1:63,360 scale Geelong Sheet, and 1:250,000 scale Queenscliff Sheet), *Geology of Victoria* (Douglas and Ferguson, 1988), and *Port Philip Region Groundwater Resources – Future Use and Management* (Leonard, 1992). The anticipated regional geology as reported by Coffey in depthwise sequence comprises:-

- o Quaternary age Newer Volcanics Formation. Comprising a sequence of basalt flows formed from various eruption points across the western plains of Victoria. The Geelong 1:63,360 map indicates the basalt flow ends to the immediate west and south of the site. Coffey anticipated possible encroachment of basalt flows onto the site given the close proximity of the inferred basalt flow boundary.
- o Upper Tertiary age sediments of the Moorabool Viaduct Formation (partial equivalent to Brighton Group). Comprising sand, ferruginous sand, calcareous sand, limestone, gravel, plant and marine fossils. Where present, this unit generally ranges from 5-25m in thickness, although in some areas in the region it is extremely thin and may even pinch out. This unit rests disconformably on the underlying Fyansford Formation and the contact zone is often indicated by a thin, discontinuous layer of phosphatic nodules and quartz pebbles. The geological map indicates this unit is exposed at the surface.
- o Middle Tertiary aged Batesford Limestone Formation. Comprising clay, calcareous sand, glauconic silt, sandy clay, skeletal limestone, marl, and richly fossiliferous limestone. This unit is not differentiated from the overlying Fyansford Formation in either the geological maps or the Leonard (1992) report. The Fyansford Formation reportedly comprises calcareous clay, interbedded with thin, more resistant, ferruginous and usually more calcareous layers. Coffey noted the upper section of the Fyansford Formation is sometimes confused with bedrock. Coffey also noted the unit contains high permeability sand lenses, such as those exposed on the beach at North Shore. Coffey inferred the upper sandy section at the Geelong West site is likely to be in the order of 5m to 20m thick.
- o Lower Tertiary aged sediments of the Werribee Formation. Comprising gravel, sand, clay, brown coal, and plant remains. Coffey inferred the Werribee Formation sediments are likely to be 10m to 30m thick in the area, and are probably between 50m and 100m below the natural surface.
- o Bedrock comprising either Ordo-Silurian mudstone/sandstone, Devonian dacite, granite or granodiorite, or Cretaceous age sandstone/mudstone/siltstone of the Otway Group.

Coffey has noted the site geology to be consistent with the expected regional geology – fine sands with varying silt and clay content (inferred Moorabool Viaduct Formation), overlying clays and calcarenite (inferred Fyansford Formation). There was also minor interbedded basalt (Newer Volcanics) in the western portion of the site. The typical profile at the site has comprised (in depthwise sequence):-

- o Fill to depths generally less than 0.2m (generally gravels, coarse sands and clays), with the exception of tank pits within the site where fill extends to depths of between 3 and 3.5m.
- o Gravelly sandy clay and clay to silty clay typically from 0.2 - 1.2m depth, dark brown with some calcareous material.
- o Fine sand with minor clay and silt typically from 1.2 – 9.5m depth. Interbedded basalt to 1.8m depth at the west and north west portion of site.
- o Clay to sandy silty clay typically from 9.5 – 10.8m depth, grey to brown with calcareous cementation.
- o Fine sandy silty clay typically from below 10.8m to the maximum depth of investigation of 15m. Light brown, saturated at 14.5m to 15m.

Groundwater has been intersected within a fine sand water bearing zone between 7m and 10m depth. Coffey have reported that two deeper wells screened in the underlying sandy silty clay sediments below 12m depth (MW27) and 13m (MW28) depth had standing water levels comparable to the wells screened in the upper water bearing zone. Coffey have interpreted these observations as indicating the groundwater in the 'shallow' and 'deeper' water bearing zones is part of an unconfined aquifer system that is interconnected to some degree. There has been a steady decline in groundwater levels in the gauging records since the late 1990's. Gauging records prior to 2003 used an arbitrary datum. The earliest available gauging data to Australian Height Datum (AHD) dates from May 2003 – standing water levels ranged from 20.732m AHD to 21.425m AHD (refer Handex 2003a). The most recent reported standing water levels (SWL's) are approximately 0.6m to 0.8m lower than the 2003 levels – results from January 2011 indicated SWL's from 19.958m AHD to 20.825m AHD (refer Coffey 2011c). Some of the 'shallow' monitoring wells have been dry in recent gauging events.

The groundwater flow direction over the investigation area has been consistently reported to be to the north-east, with a relatively flat hydraulic gradient of 0.005 (as reported in Coffey 2011d). Hydraulic conductivity has been estimated to range between 4.7 and 7.4 m/day. Based on the hydraulic gradient and conductivity as above, and an assumed effective porosity of 0.25 to 0.3 from the lithology, Coffey have estimated the groundwater velocity to range between 31 m/yr to 49 m/yr.

The groundwater beneficial maps series for Victoria (South Western Victoria Water Table Aquifers) indicates the salinity of the water table aquifer in the Geelong area is in the 3,501-13,000 mg/L range, which classifies the groundwater as Segment C under the SEPP Groundwaters of Victoria. Coffey have interpreted the groundwater at the site to be in Segment C based on field and laboratory TDS measurements, and consideration of background TDS values which they report have been generally in the range of 5,000 mg/L to 10,000 mg/L TDS.

Coffey carried out a search of registered groundwater bores within 1km of the site via the Department of Sustainability and Environment – Victorian Water Resources Data Warehouse (search conducted June 2009). The search identified 18 registered bores in this search radius – all are indicated to be for investigative purposes. Reported bore depths range from 6m to 12m. Coffey noted there was no information available on bore yield or standing water levels.

Auditor Comments:-

The various Coffey reports convey an adequate understanding of the regional and local geology. The auditor is satisfied the regional and site specific geology and hydrogeology is adequately documented in the various background reports.

The auditor notes although the bore search would suggest very limited (if any) groundwater usage in the locality, there is still the possibility (albeit highly unlikely) that groundwater is being utilised from unregistered bores in the locality.

EPA guidance to auditors is that the background salinity should be used to determine the relevant groundwater segment. The auditor agrees with Coffey's interpretation of the groundwater segment and considers the background salinity is within the range of 3,501-13,000 mg/L (ie. Segment C).

3.3 History of Site Operations and Product Storage

There is no formally documented site history review in any of the reports made available for review. Coffey's most recent summary report (Coffey 2011d) indicates that prior to 1947 the site comprised three separate properties, assumed to be residential. The western lot (closest to Shannon Avenue) may have been a store/workshop. A service station was established on the three lots sometime between 1967 and 1970. The service station was decommissioned in 1997, and the site has remained vacant since then. The former service station layout described in the various past reports comprised a workshop/sales building, six underground storage tanks (ranging up to 58,000L in capacity), two bowser islands, separate diesel bowser, lube bay and triple interceptor tank. The former site layout is shown on Figure 2 below.

Auditor Comments:-

The history of the site and surrounding properties has not been formally documented in the reports made available for review. It is acknowledged the former service station operations are likely to be the most significant historical source of contamination and that the former site layout was well documented. There is reasonable information provided on former fuel storage and dispensing infrastructure, and the former service station layout. A more comprehensive historical review would be useful to confirm there are no other historical sources of contamination on or off site.

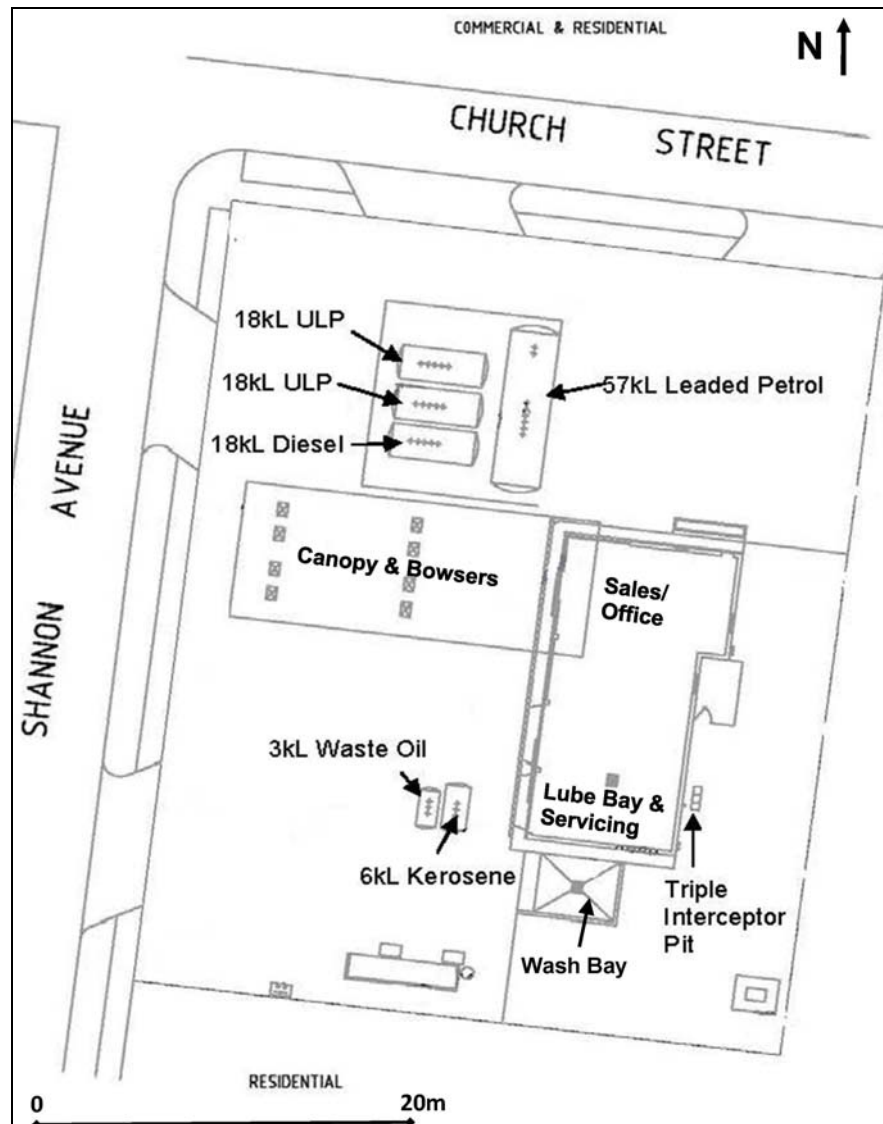


Figure 2. Former Site Layout (Pre Demolition - 1997) – adapted from Coffey 2011d

3.4 Soil and Groundwater Investigations

A number of phases of soil and groundwater investigations have been completed since 1997. A network of groundwater monitoring wells has been progressively established on-site, and off-site in adjoining properties and road reserves to delineate groundwater impacts and monitor conditions over time.

The initial investigations at the site were reportedly conducted by Handex in December 1997 and comprised drilling of 20 soil bores using a Geoprobe rig in a grid pattern across the site, coinciding with the removal of the underground storage tanks and associated infrastructure. The bores were extended to depths ranging from 3.0m to 4.3m below ground level. Sampling of tank excavation pits and spoil stockpiles was also conducted as part of this phase of works. Selected samples were analysed for TPH, BTEX and lead. All analytical results from the soil bores were below adopted investigation levels. Four stockpile soil samples results exceeded

adopted investigation levels (based on NSW EPA threshold levels for sensitive land use) for C6-C9 TPH, toluene, ethyl benzene and xylenes. A sample from the western wall of the triple interceptor tank pit wall also exceeded adopted investigation levels for C6-C9 TPH, toluene, ethyl benzene and xylenes.

Between May and October 1998, PPK installed 16 groundwater monitoring wells (MW1-MW3, MW5-MW10, MW12-MW18 inclusive, 11 on-site and 5 off-site), conducted a groundwater gauging and monitoring event, conducted further validation works of the existing excavations and stockpiled soils, and completed a quantitative health risk assessment. Elevated TPH and BTEX results were reported in groundwater samples analysed from a number of the bores drilled. Elevated TPH and BTEX results were also reported in a number of the groundwater monitoring locations. Phase separate hydrocarbons (PSH) were noted at two locations in the northern portion of the site (15mm at MW12, and 70mm at MW6). PSH was also noted in MW17, located in the Caltex service station site to the west (390mm thickness). Multiphase extraction (MPE) events were completed in October and December 1998, and are discussed in further detail later in this report.

PPK conducted groundwater monitoring events in March 1999, October 1999, July 2000, March 2001, July 2002, and May 2003. During this period, five new monitoring wells (MW19-MW23) were installed in July 2000, and four new monitoring wells (MW24-MW27) were installed in March 2001. During the March 2001 monitoring event, PSH was noted at 6 locations in the northern portion of the site (ranging from a sheen to 1,523mm thick), and in the 3 locations installed off site to the west, in and adjacent to the Caltex service station (ranging from 30mm to 330mm thick). During the May 2003 monitoring event, PSH was noted at 4 locations in the northern portion of the site (ranging from a sheen to 460mm thick). PSH was not noted in the 3 locations installed off site to the west in and adjacent to the Caltex service station, as passive skimmers had been installed in these wells.

In February 2004, IT Environmental completed a soil sampling program comprising drilling of 30 soil bores in an 8.5m spaced grid across the site using hand auger equipment, and installed seven additional groundwater monitoring wells (MW27 and MW28 to approx. 15m depth, and MW29-MW33 inclusive to depths between 10m and 11m). Additional trenching and validation sampling was completed across the boundaries of former tank pits. Results from the soil bores indicated no elevated TPH, BTEX, phenols or PAH in samples from the upper 1m of the soil profile across the site. Elevated TPH (C6-C9), xylenes and PAH's were reported in soils from 1.2m-2.4m depth at location MW33. Elevated TPH (C6-C9) results were also reported in samples from the north wall of the main tank pit (Pit B), and elevated TPH (C10-C36) results were reported in samples from the floor of the former triple interceptor pit excavation. The only result for metals above the adopted screening criteria was a single total chromium result from a wall sample in the former bowzers area (Pit A).

In October 2004, IT Environmental completed a groundwater monitoring event after completion of remediation trials including an aquifer pump test, drawdown/recovery tests, an in-situ soil vapour extraction (SVE) trial, a multiphase extraction (MPE) trial, and bioventing testing at the site. Elevated TPH and BTEX were reported in numerous on site wells, and PSH was reported in wells in the vicinity of the former main tank pit in the northern portion of the site (5mm at MW22 and 149mm at MW23).

In December 2004, IT Environmental conducted further tank pit excavation and validation work

in the vicinity of MW27 and MW33, in response to comments from an auditor engaged at the time to review the works.

In January 2005, IT Environmental installed two additional off site groundwater monitoring wells (MW39 and MW40).

Coffey Environments conducted groundwater monitoring events in April 2006, November 2007, and November 2008. The earlier monitoring events had focused on fuel related indicator analytes such as TPH, BTEX and lead. The analytical suites for the 2008 and 2009 events were broader and included TPH, BTEX, lead, PAH, phenols, natural attenuation parameters (nitrate, sulphate, iron species, methane) and also a broad suite of volatile organic compounds including halogenated volatiles. Elevated naphthalene and phenols results were reported in the hydrocarbon impacted zone but no other elevated VOCs were reported. PSH was still being reported in both on site wells in the northern portion of the site, and also in the wells installed on and adjacent to the Caltex service station across Shannon Avenue to the west. The November 2007 monitoring event included PSH fingerprint analysis at the specialist laboratory of Leeder Consulting from three monitoring wells (MW23 from on site, and off site wells MW25, and MW26 from the Caltex site). The fingerprint analysis concluded all three PSH samples were a degraded leaded petrol and had been in the environment for between ten and eighteen years.

In February 2009, Coffey Environments completed a Post Phase 2 Environmental Site Assessment which comprised drilling of twenty soil bores at targeted locations across the site (all to 4m depth), a groundwater monitoring event, and a ground penetrating radar survey across the site to confirm the absence of other underground petroleum related pipework or infrastructure. The results of the GPR are not discussed other than a note that a 0.5m section of remnant pipe was found and removed from one location. PSH was reported on site at MW6 (1mm), MW23 (1mm), MW38 (30mm), and off site adjacent the Caltex site at MW25 (110mm). This was the last assessment work prior to further remediation works, which were completed between September 2009 and November 2010. The remediation works and interim monitoring are discussed in further detail later in this audit report.

Auditor Comments:-

The Auditor is satisfied the soil and groundwater investigations have in general been documented adequately.

Drilling methods adopted (generally solid flight auger and/or hollow push tube) are considered appropriate for the contaminants of interest and depths/strata being targeted.

Bore logs and field records are documented adequately and indicate a good understanding of subsurface conditions in the area.

Soil sampling methods are considered appropriate. Adopted methods reportedly included pushtube, split spoon samplers, or hand augers. The method was dependent on the soil conditions and depths being targeted. All methods are considered appropriate for the contaminants being targeted.

The well logs indicate well construction methods and materials were appropriate. All wells were reportedly constructed from class 18 PVC (either 50mm or 100mm diameter). Screened intervals were indicated to be surrounded by sand and sealed with a bentonite seal at the top, and the portion of each well above the screen grouted to the surface.

The monitoring well network is considered comprehensive and wells are located adequately to allow delineation of the NAPL and dissolved phase impacts. This is discussed in further detail later in the audit report.

Groundwater gauging and sampling methods were appropriate. It is noted the majority of sampling was conducted using dedicated disposable Teflon bailers, and that gauging was carried out with an oil/water interface probe.

The analytical suites adopted in the more recent GMEs by Coffey have been comprehensive and have confirmed the impacts in the subsurface to be primarily due to fuel related sources. The absence of other impacts such as halogenated volatile compounds is noted.

Documented QA/QC protocols for the various phases of work generally were in accordance with current guidance, including the NEPM (Assessment of Site Contamination) and AS4482.1. The field QA/QC measures included formalised procedures for all aspects of fieldwork, standardised forms and records, chain of custody documentation completed for all phases of sampling, and collection of field samples for QA/QC purposes including blind duplicates (submitted to both the primary and secondary laboratories), trip and field blanks, and rinsate blanks. No obvious data quality issues were reported by Coffey in their evaluation of the field QA/QC data. The auditor is satisfied the quality of the field data is suitable for use in this audit report.

NATA accredited laboratories were used for all analyses. All laboratory reports submitted as attachments to the various assessment and monitoring reports indicated internal laboratory QA/QC was completed routinely for all batches of samples analysed. There were no obvious data quality inadequacies indicated by the internal laboratory QA/QC results including laboratory duplicates, matrix blanks, or surrogate spikes results. The auditor is satisfied with the overall quality of the laboratory data as indicated by the internal laboratory QA/QC reporting.

3.5 Soil Vapour Investigations and Monitoring

The May 2011 summary report by Coffey (Coffey 2011d) notes that in December 2003, IT Environmental conducted a petroleum vapour monitoring program (flux hood) at two locations on site. Results reported concentrations below the limit of reporting (0.2 mg/m^3) and no peaks were identified. The report also notes that in December 2004 and January 2005, IT Environmental conducted subfloor vapour monitoring on two occasions beneath the residential building on the adjoining lot to the east (149 Church Street). Results of this work are not discussed in the summary report or elsewhere in the reports provided for auditor review.

Soil vapour implants were installed by Coffey at four on-site locations in September 2008 (locations SVB1 to SVB8 inclusive). Two separate vapour sampling bores were installed at each location – a shallow implant (1.5m deep) and a deeper implant just above the water table (7.5m deep). Two of the locations were over the main impacted zone in the north eastern portion of the site, with the other two locations near the eastern boundary adjoining the residence.

The details of the soil vapour probe installations were not clear from the logs and report text in the Coffey On-site Health Risk Assessment Report (Coffey 2008b). The Auditor sought further clarification from Coffey and based on their advice it has been established that the vapour probes were installed as detailed below:-

- o The soil vapour sample implant is supplied and installed by Leeder, and comprises a perforated stainless steel tube attached to $\frac{1}{4}$ inch Teflon tubing. The screened interval and sand pack are approximately 40cm in height. The Teflon tubing runs up to the

surface.

- o There is a bentonite seal provided at the top of the sand pack section, and above this the borehole is grouted to the surface.
- o There is a flush mounted lockable gatic cover provided at the ground surface.

Soil vapour sampling was conducted by Leeder Consulting on 15 September 2008. Sampling methods adopted included sample collection in thermal desorption tubes and analysis via method TO-17 (USEPA, 1999), with backup sampling in carbon tubes and analysis via method MA-5 (Leeder Consulting, 2009). The MA-5 method was utilised where adsorbed concentrations on the thermal desorption tubes exceeded the reporting capacity of the detection device (GC-MS equipment). QA/QC measures adopted also included collection of blanks, including a helium tracer shroud being used to check for evidence of system leakage. Helium tracers were initially run through the system prior to sample collection and collected in a Tedlar bag. These were analysed via method ASTM D 1946-90 (ASTM, 1990).

The standard range of analytes included VOC's (including BTEX), naphthalene, and TPH aromatics/ aliphatics fractions. Gas samples were also collected and analysed for natural attenuation indicators (oxygen, carbon dioxide, and methane). Elevated results were reported in the deeper (7.5m deep) sampling points, with significantly lower results in the shallow (1.5m deep) sampling points. Results are discussed in detail later in this audit report.

Auditor Comments:-

The auditor was provided with the following advice by Jackie Wright (member of the auditor's approved expert support team for human health risk assessment) in relation to the soil vapour investigations carried out to date:-

- o The vapour bores were installed to appropriate depths.
- o The locations and sampling methods documented are appropriate.
- o The soil gas data is considered to be reliable and suitable for the assessment.
- o The network of bores was adequate in terms of number of locations and spatial coverage within the affected area.

3.6 Utility Pit Vapour Monitoring

Vapour monitoring of thirteen selected utility pits located within 30m of the site was conducted in February 2009 as part of Coffey's Post Phase II ESA (refer Coffey 2009a). Utility pits were continually screened using a photoionisation detector (PID) for five minutes with the PID set 0.5m depth inside each pit. No elevated results were reported, and no hydrocarbon or other odours were noted by the operator.

Auditor Comments:-

The utility pit monitoring was an appropriate means of gathering evidence for potential accumulation of hazardous levels of vapours in utility pits. It is noted that only a single round of monitoring has been conducted, and it would be useful to conduct additional monitoring to provide further confidence there are no significant vapour impacts in utility pits in the vicinity of the site.

4 NATURE AND EXTENT OF IMPACTS

4.1 *Subsurface Behaviour of Petroleum Hydrocarbon Releases*

Petroleum products such as petrol, diesel, kerosene, jet fuel lubricating oil and fuel oil are all types of light non aqueous phase liquids (LNAPL's). The behavior of LNAPL's released into the subsurface is complex, and relates to their partitioning into multiple phases, leading to their relatively high mobility and persistence in the subsurface after release. The following discussion of LNAPL behavior is reproduced from CRC CARE Technical Report No.11 (*Characterisation of Sites Impacted by Petroleum Hydrocarbons; National Guideline Document*). Petroleum hydrocarbons released into the subsurface can exist in multiple phases including:-

- o Immiscible liquid product moving down through the unsaturated zone and/or pooling at the capillary fringe or low permeability zones, residual product in the unsaturated zone, or trapped residual product in the saturated zone;
- o Adsorbed to soil particles in the solid phase;
- o Dissolved phase in groundwater; and/or
- o Vapour phase in the air filled pores of the soil matrix.

All 4 phases can be present in the unsaturated zone above the water table and capillary fringe. Within the saturated zone water has completely displaced air from the soil pores and there is no opportunity for vapours to be present.

It is noted the terms phase separated hydrocarbon (PSH), non aqueous phase liquid (NAPL) and light non aqueous phase liquid (LNAPL) are all equally valid for describing the component existing as the residual or mobile hydrocarbon product. The reports by Coffey detailing the assessment, monitoring and remediation works have generally used the term PSH, however this audit report has used the term NAPL or LNAPL in order to be consistent with SEPP (Groundwaters of Victoria).

A fuel product release into the subsurface that results in NAPL being present will have a mobile and a residual / immobile component. The residual component is comprised of the disconnected films and droplets left behind by migrating NAPL in the unsaturated zone, and disconnected 'blobs' of NAPL that have been cut off by water in the saturated zone. Mobile NAPL refers to connected portions of product that are able to coalesce and migrate. As mobile NAPL migrates in the subsurface more of it is trapped in soil pores and becomes immobile NAPL. The quantity left trapped in the soil pores is referred to as the 'residual saturation'. This results in LNAPL plumes being spatially 'self limiting', unless there is an ongoing source.

It is important to note the thickness of NAPL measured in a monitoring well rarely represents the actual thickness of NAPL present in the subsurface. The apparent thickness is usually several times greater than the actual thickness. The fact there is no measurable NAPL in a monitoring well does not necessarily mean there is no NAPL present, but only indicates that there is no mobile NAPL present at that location that has accumulated in the monitoring well. There is still the possibility of residual / immobile NAPL being present. Whilst measurements of NAPL

thickness are useful for ongoing monitoring purposes and general delineation of impacts, this is just one of a number of possible lines of evidence to assess presence of NAPL.

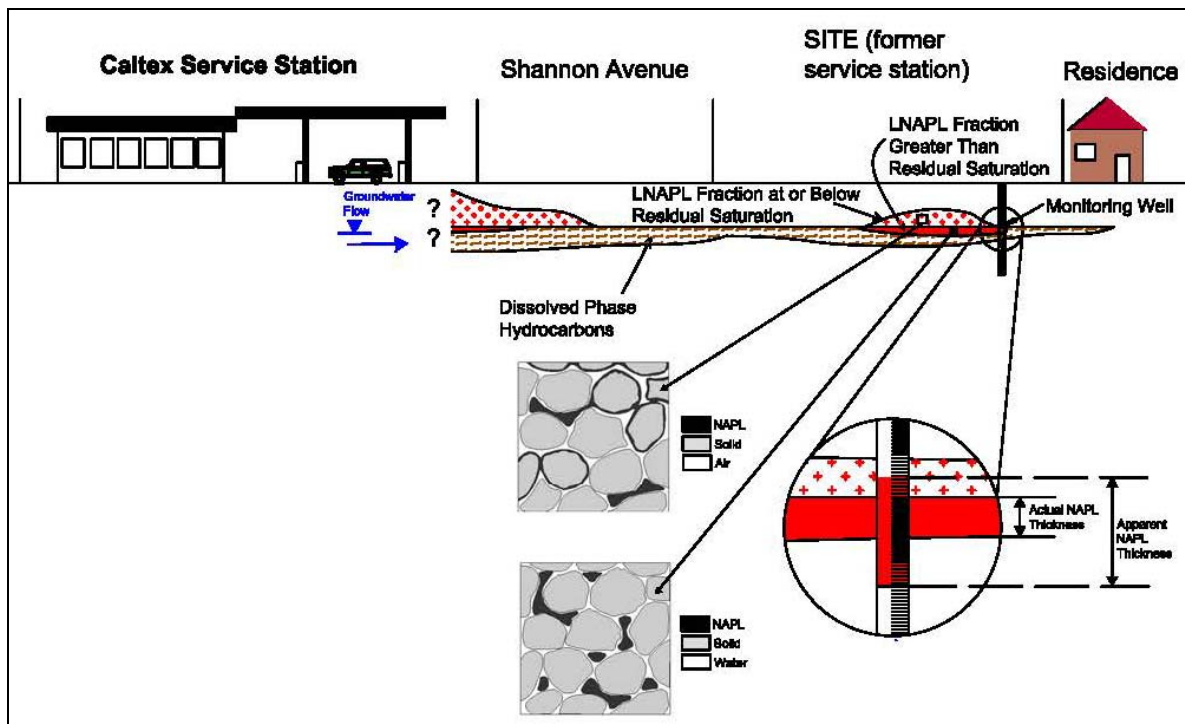


Figure 3. Conceptual Model of NAPL Occurrence

The presence of mobile and immobile components is also important in understanding the potential for NAPL recovery and remediation efforts. In finer grained soils, LNAPL saturations will generally be lower and LNAPL mobility and recoverability will be limited to a small percentage of the total LNAPL present. In coarser soils, LNAPL saturation will generally be higher, and mobility and recoverability of LNAPL will be higher. In many aquifers, regardless of the level of remedial effort, it will rarely be possible to achieve total removal of LNAPL. There is a detailed discussion on NAPL recoverability provided in CRC CARE Technical Report No. 6 (Lam, D & Moritz, P 2007), *Technical impracticability of further remediation for LNAPL-impacted soils and aquifers*.

4.2 Summary of Impacts

The nature and extent of impacts are summarised in the various Coffey reports discussed throughout this audit report. The impacts are primarily low molecular weight petroleum hydrocarbons, as indicated by elevated BTEX results, and also lower molecular weight TPH fractions. There have been no other volatile organic compounds detected, such as halogenated volatile compounds. Prior to the most recent phase of remediation works (which occurred between September 2009 and November 2010), Coffey interpreted that residual hydrocarbon impacted soils remained under the site, along with dissolved phase hydrocarbons and NAPL. Coffey also noted elevated concentrations of hydrocarbon vapours are present in the subsurface in the area of the dissolved phase and NAPL plume. It is also noted there is a separate NAPL and dissolved phase hydrocarbon plume to the west of the subject site under

the service station site on the west side of Shannon Avenue. The NAPL extends some distance under the road reserve eastwards towards the subject site, whilst the dissolved phase hydrocarbon plume extends under the road reserve and encroaches under the western boundary of the 151-153 Church Street site.

Gauging data indicates NAPL impacts have historically been limited to the northern portion of the site, although it is possible there has been some encroachment under the adjoining residential lot to the east and road reserve to the north. Prior to multiphase extraction events conducted by Handex in October and December 1998, measurable NAPL had been identified in three on-site wells ranging from 15mm to 390 mm. Following these MPE events, there was a reduction in measured NAPL thickness to 1mm in the March 1999 gauging event. The maximum historical NAPL thickness measured in on-site wells has been 1,534mm (MW23). Coffey have noted that since 2004, the number of wells and apparent thickness of NAPL showed a decreasing trend over time.

Historical monitoring data indicates dissolved phase hydrocarbons extend off site to the north and east, as well as hydrocarbon vapours in the areas of the dissolved phase and NAPL impacts. The historical monitoring data indicates the dissolved phase impacts have extended under the adjoining residential lot to the east, and also under the adjoining road reserve to the north of the site. Impacts have not been detected in the residential and commercial properties on the north side of Church Street. Summary plans showing the historical NAPL plumes and dissolved benzene plumes are provided in the audit report attachments (refer Figures D, E, G, H and I).

The extent of soil impacts essentially mirrors the extent of NAPL and dissolved phase impacts. Coffey have interpreted the petroleum hydrocarbon impact is predominantly sorbed at the smear zone which has a vertical extent of approximately 2m (between approximately 7m and 9m below the ground surface), following a sustained decreasing trend in standing groundwater levels since monitoring began in 1998. Coffey have also noted the hydrocarbon mass 'hung up' in soil within the smear zone remains a potential ongoing source of contamination to groundwater. There are also more shallow residual soil impacts remaining in two areas – near the former bowzers in the central to western portion of the site, and also in the vicinity of a former drain pit under the old lube bay area in the south eastern portion of the site which drained to the former triple interceptor trap. The nature and extent of the impacts in these areas can be summarised as follows:-

- o Northern and central portion of site, including former bowser and underground storage tank areas. These impacts are likely to be extensive under these parts of the site, corresponding to NAPL and dissolved phase impacts. Approximate depth 7m to 9m. Maximum results reported in this zone for benzene of 19 mg/kg (SB12, 7.0m), C6-C9 TPH 1,570 mg/kg (SB12, 7.0m), and C10-C36 TPH 1,090 mg/kg (MW54, 7.0m).
- o Former bowser area. Localised Impacts from approximately 3-7m depth. Maximum results reported in this zone for benzene of 33 mg/kg (SB12, 3.0m), C6-C9 TPH 2,919 mg/kg (SB12, 3.0m), and C10-C36 TPH 1,170 mg/kg (SB12, 3.0m).
- o Former drain pit area under old lube bay. Localised Impacts from approximately 2-3m depth. No elevated benzene impacts in this area. Maximum results reported in this zone for BTEX 448 mg/kg (MW33, 2.4m), C6-C9 TPH 1,300 mg/kg (MW33, 2.4m), and C10-C36 TPH 16,300 mg/kg (MW33, 2.4m).

The maximum reported soil vapour results from the September 2008 sampling event were as follows:-

- o Benzene. 1.3 milligrams per cubic metre (mg/m^3) for 1.5m depth samples, and 5,400 mg/m^3 for 7.5m depth samples.
- o Toluene. 2.6 mg/m^3 for 1.5m depth samples and 8,200 mg/m^3 for 7.5m depth samples.
- o Ethyl benzene. 0.16 mg/m^3 for 1.5m depth samples and 280 mg/m^3 for 7.5m depth samples.
- o Xylenes. 2.2 mg/m^3 for 1.5m depth samples and 2,300 mg/m^3 for 7.5m depth samples.
- o Naphthalene. 0.012 mg/m^3 for 1.5m depth samples and 0.65 mg/m^3 for 7.5m depth samples.

Auditor Comments:-

The Coffey reports provide an adequate overview of the nature and extent of fuel related hydrocarbon impacts associated with the site and provide sufficient evidence that fuel products are the primary source of subsurface impacts at the site.

There are two distinct NAPL and dissolved phase hydrocarbon plumes in the vicinity of the 151-153 Church Street site. There is one plume under the northern portion of the site. This is inferred to be associated with past on-site service station operations and is the focus of this environmental audit. The other plume to the west of the site is likely to be associated with operations at the service station site on the west side of Shannon Avenue. Consideration of impacts and risks associated with this plume is beyond the scope of this environmental audit.

Results in well monitoring measurements suggest the dissolved phase impacts arising from the on-site NAPL plume are only marginally more extensive than the NAPL impacts. This is not surprising considering the low permeability formations underlying the site and the relatively flat hydraulic gradient. The impacts extend under the adjoining residential lot to the east, and probably also under the Church Street road reserve to the north. The impacts do not appear to extend under the commercial and residential properties on the north side of Church Street.

The lateral extent of the dissolved phase and NAPL impacts arising from the on-site source/s has been adequately delineated. The groundwater monitoring well network has focused on the upper portions of the groundwater system, with the majority of wells installed in the shallow portion of the aquifer (with wells screened typically from 6-9m depth or 7-10m depth). There were also 2 deeper wells installed (up to 15m depth). The Auditor notes these deeper wells (MW27 and MW28) were both located hydraulically upgradient of the on-site sources.

The dissolved phase impacts from the on-site source/s have not been adequately delineated vertically. It is acknowledged the observed site geology suggests there is limited potential for vertical migration of the fuel related NAPL and dissolved phase impacts. However, further investigation is warranted to confirm the depth of groundwater impacts in the northern portion of the site.

The auditor notes the on-site soil vapour data is limited and based on a single monitoring event. It is acknowledged the sampling was conducted over the most heavily impacted zones of the site, and most likely represents worst case conditions, however further periodic monitoring would provide additional confidence in the vapour data.

4.3 NAPL Composition

There has been fingerprinting analysis undertaken to confirm the age/nature of the fuel product, and also to establish whether or not there are other additives present that may need to be considered as chemicals/substances of interest in addition to the usual TPH/BTEX/lead suite. Historically these may have included octane boosters such as tetraethyl lead (TEL), tetramethyl lead (TML), methyl tert-butyl ether (MTBE), and the organomanganese compound, MMT.

Coffey submitted three samples of NAPL to Leeder Consulting for fingerprinting as part of their November 2007 groundwater monitoring event. Two samples were from the on-site NAPL plume (MW23 and MW38), and the third sample was from the off-site NAPL plume (MW25). The Leeder Consulting report has been provided as part of this review and a copy is provided in the audit report attachments (Refer Leeder 2007a). The report concluded all three samples were found to have the same chromatographic profile, typical of a weathered leaded petrol product, aged between 10 and 18 years (refer to Leeder report M071760 in audit report attachments). The octane booster TEL was detected in all three samples, whilst other octane boosters such as TML, MTBE and the organomanganese compound MMT were not detected in the samples.

Auditor Comments:-

The auditor is satisfied that the composition/age/nature of the NAPL in the on-site and off-site plumes has been adequately characterised. It is noted the fingerprinting analyses indicate that other than tetraethyl lead (TEL), there are no other fuel related additives such as TML, MTBE, or MMT in the product.

The similarity of the inferred age of the product in the on-site NAPL plume and the off-site NAPL plume area located to the west of the site is noted. Although the two plumes are of similar age and product type, based on the understanding of the groundwater flow regime under the site and locality, it is considered highly unlikely the two plumes are from the same source. There is enough evidence to suggest the on-site NAPL plume is associated with a separate source to the off-site NAPL plume, which appears likely to be associated with the service station on the west side of Shannon Avenue.

4.4 NAPL and Plume Stability

A selection of summary plans showing the historical NAPL plumes and dissolved benzene plumes are provided in the audit report attachments (refer Figures D, E, G, H and I). Coffey's May 2011 summary report (Coffey 2011d) has noted a decreasing trend in the number of wells with measurable NAPL, apparent NAPL thickness in on-site wells, as well as a decreasing trend in dissolved phase concentrations in on-site monitoring wells and also up gradient monitoring wells. Coffey noted the trend was apparent even before the most recent phase of intensive remediation works from September 2009 to November 2010. It is noted there has been no measurable NAPL noted in any on-site monitoring wells since the May 2010 gauging event. There have been 2 reported gauging events since then – August 2010 and January 2011.

Coffey's May 2011 summary report includes an assessment of the evidence for natural attenuation processes are acting to assist in limiting the migration of the hydrocarbon plume in groundwater. Coffey noted that whilst petroleum hydrocarbon concentrations show a

decreasing trend in most monitoring wells, it is unclear as to how much of the decrease can be attributed to natural processes or the recent remediation works (including injection of oxidants). Coffey also examined secondary lines of evidence for natural attenuation processes via geochemical indicators, and concluded there is significant potential for aerobic degradation to be occurring on-site, and evidence that anaerobic degradative processes (such as nitrate, sulfate and iron reduction) are occurring downgradient of the injection area.

Auditor Comments:-

The Auditor considers further monitoring is warranted to determine the extent to which natural processes or the remediation activities are responsible for the observed decreases in dissolved phase and NAPL impacts both under the site and downgradient of the site. There is also uncertainty regarding the influence of the sustained period of decreasing standing water levels since monitoring commenced in 1998. Dissolved benzene concentrations in well MW31 on the adjoining residential lot to the east reduced from 13,000 µg/L in April 2004 to 280 µg/L in February 2009. It is unlikely the observed decrease is solely due to the on-site remediation works, as this period predates most of the MPE events completed in 2008 and 2009, and the intensive remediation efforts that commenced in September 2009 and were completed in November 2010. Concentrations decreased even further during and after the remediation works, with the benzene concentration in the most recent monitoring round (January 2011) reported below the 1µg/L reporting limit. It remains to be seen the extent which these decreases can be attributed to natural attenuation, enhancement by the recent in-situ oxidation remediation works, or simply reductions in groundwater levels removing the source soils in the smear zone from being in contact with groundwater. Ongoing groundwater monitoring is warranted to assess the longer term effectiveness of the remediation efforts to date, and to monitor temporal changes in the NAPL and dissolved phase plume at and in the vicinity of the site.

5 UPSS MANAGEMENT REVIEW

5.1 *Guidelines for UPSS Management*

This section assesses compliance with the requirements of EPA Publication 888.1 Guidelines in the Design, Installation and Management Requirements for Underground Petroleum Storage Systems (January 2009). The agreed scope of the audit was limited to consideration of the site's UPSS management relating to removal and/or decommissioning of UPSS.

5.2 *UPSS Removal/Decommissioning*

Publication 888.1 requires disused UPSS to be removed, where practicable and associated pollution cleaned up to the extent practicable. Where removal is not practicable, the UPSS should be emptied and decommissioned. UPSS decommissioning must be carried out in accordance with the relevant guidelines. Records of UPSS removal/decommissioning must be kept for up to five years, in accordance with the UPSS Management System.

Information relating to the UPSS removal and decommissioning has been provided in the Handex (2003b) report. This report summarises the UPSS removal and decommissioning works conducted by Handex in 1997 following site demolition.

Auditor Comments:-

The reporting and documentation of the upgrade works (including the records of UPSS removal / decommissioning) satisfies this aspect of the requirements of Publication 888.1.

6 REMEDIATION PLANNING AND IMPLEMENTATION

The following remediation activities have reportedly been completed to date: -

- o October and December 1998. MPE Events completed by Handex.
- o June 2002. Total Fluids Extraction Pilot Trial completed by PPK Environment and Infrastructure.
- o October 2004. IT Environmental completed an aquifer pump test, drawdown/recovery tests, in-situ vapour extraction (SVE) test, multiphase extraction (MPE) trial, and bioventing trial.
- o August 2008 to July 2009. JFTA completed five separate multi-phase vacuum extraction (MPVE) and air treatment events.
- o October 2009 to November 2010. Combination of MPVE and oxygen release compound (ORC) injection (into either groundwater wells or into soils by push tube) along with the establishment of hydraulic barrier controls. Eight separate events were completed during the period. JFTA completed the MPVE aspect of these remediation works, while Coffey completed the ORC injection and hydraulic barrier controls.

The following section summarises the auditor's review of the works to date. In addition to a general review of the overall technical and QA/QC aspects of the remediation works, the review has also assessed whether the clean up works address the elements required for clean up and management of polluted groundwater, specifically items 3 to 8 in EPA Publication 840 (Clean Up and Management of Polluted Groundwater). Further comments on specific aspects of the remediation planning and implementation are provided in the following sections.

6.1 *Characterisation of the Groundwater and Aquifers*

Publication 840 requires the nature, extent and degree of pollution in groundwater to be assessed prior to clean up. Where an imminent hazard is identified, some immediate clean up action will be necessary. Numerous phases of investigation and monitoring have been completed since 1998 to characterise the groundwater and aquifers at the site. These have been reviewed in detail earlier in this audit report.

Auditor Comments:-

The characterisation of the groundwater and aquifers (including assessment of the nature and extent of pollution) has been reviewed earlier in this audit report and is considered sufficient for the purposes of planning and implementing clean up works.

6.2 *Source Removal and Control*

Publication 840 notes that the removal or control of the source is a necessary first step in the clean up or management of polluted groundwater. Where complete source removal is not practicable, the source must be removed to the extent practicable, and treatment/control measures must be implemented. The primary sources (ie. underground fuel storage tanks, pipework and bowzers) were removed in 1997, along with a quantity of surrounding

contaminated soils. A ground penetrating radar survey has been completed to confirm the absence of any other underground petroleum related infrastructure. There are residual shallow soil impacts remaining in localised parts of the site (former bowser area and a former drain pit under the former lube bay), and it is also likely there are residual hydrocarbon impacted soils 'hung up' in an approximately 1-2m thick 'smear zone' above the water table, following a sustained decreasing trend in standing groundwater levels since monitoring began in 1998. Subsequent source control measures have been implemented including various methods in removing hydrocarbon mass from the system via MPVE events, or in-situ destruction (via in-situ chemical oxidation). These measures are discussed in detail later in this section.

Auditor Comments:-

The source removal and source control measures completed to date are considered reasonable and have been completed in a manner consistent with the intent of Publication 840. It is noted that further removal of the localised areas of shallow impacted soils (ie. in the 2-3.5m depth range) is likely to be practicable, and should be completed in due course. The effectiveness of the other source control measures will need to be confirmed via further ongoing monitoring.

6.3 Risk Assessment

Publication 840 notes the nature and timing of clean up activities may be influenced by the risk posed by the pollution. Assessment of risk using methods acceptable to EPA therefore may play an important role in the clean up and management of polluted groundwater. The assessment of risk posed by the groundwater impacts at the Geelong West site has been based on an on-site risk assessment completed in 1998 (PPK) and an off-site risk assessment completed in 2008 (Coffey Environments). These have been reviewed in detail earlier in this audit report.

Auditor Comments:-

The risk assessment work completed in relation to the hydrocarbon impacts at and in the vicinity of the Geelong West site has been reviewed in detail in Section 7 of this audit report. The risk assessment work to date is incomplete and requires upgrading to allow assessment of risk to all protected beneficial uses of land (including groundwater) at and in the vicinity of the site. The 1998 on-site risk assessment work is based on outdated methodologies, whilst the off-site risk assessment completed by Coffey in 2008 used on-site data and assessed a limited number of receptors and exposure scenarios. Overall, further risk assessment is warranted to adequately define the level of risk posed by the hydrocarbon impacts arising from the Geelong West site. This includes, collection of further soil vapour vapour monitoring data, assessment of the data in relation to on-site receptors consistent with permissible uses under the site's zoning, and revisiting the assessment of risks to residents in the adjoining property taking into account the house has a crawl space rather than a slab on ground flooring.

6.4 Remediation Objectives

Coffey have nominated clean up objectives in their Remediation Technology Screening Reviews (original version July 2009 and revised October 2009 – copies provided in Appendix C). The broad clean up objective for the site (as nominated by Coffey) is to achieve, to the extent practicable, the prevention of detriment to relevant beneficial uses on-site or off-site in accordance with the Environment Protection Act and associated policies and other related publications. Specifically, the remedial objective is to implement a cost effective remedial strategy that addresses recovery of NAPL fluids to the extent practicable, and remediation of dissolved phase impacts to groundwater to prevent further off-site migration and to protect or restore protected beneficial uses of groundwater to the extent practicable.

Auditor Comments:-

The remediation goals and objectives are considered appropriate and consistent with SEPP (Groundwaters of Victoria) and EPA Publication 840. The objectives nominated by Coffey acknowledge the framework for clean up and management of contaminated groundwater and process for determining the practicable limit of groundwater clean up, as outlined in EPA Publication 840 (The Clean Up and Management of Polluted Groundwater). Coffey have noted that removal of LNAPL to the extent practicable is of primary importance (as per the requirements of the SEPP (Groundwaters of Victoria)).

The auditor notes that David Lam (a member of the auditor's approved expert support team in the field of 'remedial technologies') was involved in the development of the remediation goals and objectives in a review capacity for Coffey Environments, which provides the auditor with additional confidence in the adequacy of this aspect of the remediation work.

6.5 Pilot Trials

PPK carried out field trials in 2002 with the aim of assessing site specific responses to soil vapour extraction and total fluid extraction, and to assess their applicability to remediate the site. PPK also carried out slug tests to estimate aquifer parameters and collected air samples in the effluent stream to assess stack emissions. The main outcomes of the works were as follows: -

- o The slug test results indicated the hydraulic conductivity of the impacted aquifer is approximately 5×10^{-4} m/min.
- o Based on the trial results, vacuum extraction alone was not considered to be a suitable option to remediate the PSH on site, and dewatering of the aquifer would be required to allow connection between wells.
- o A total fluids extraction system incorporating groundwater and vapour extraction was considered an appropriate remediation technology to remediate the site.
- o The radius of influence for the extraction well design parameters was 2.5 - 3m, and extraction wells were recommended to be installed at 5 – 6m centres in the immediate vicinity of the plume.

IT Environmental reportedly conducted an aquifer pump test, drawdown/recovery tests, in-situ vapour extraction (SVE) test, multiphase extraction (MPE) trial, and bioventing trial in October

2004. Details relating to these works were not provided for review; however the findings were summarised in the Coffey Remediation Technology Screening Review (July 2009). Results of the 2004 pilot trials were summarised in the Coffey review as follows: -

- o The 2004 works concluded that transmissivity ranged between 7.8 and 12.4 m²/day, equating to a hydraulic conductivity of 4.7 to 7.4 m/day.
- o The effective radius of influence for a soil vapour extraction (SVE) system was estimated to be 3.25m for the range of wellhead vacuums trialled.
- o The effective radius of influence for a multi phase extraction system was estimated to be at least 9m. This was based on a vacuum of 47kPa, which was calculated to extract up to 77.85m²/hr of soil air.
- o The overall results of the pilot trial suggested that it was unlikely that combined total fluid extraction and SVE technologies would be an effective remediation option for the site; however multi phase extraction would be an effective remediation option.

Auditor Comments:-

The pilot trials as documented by IT Environmental/Coffey provide an appropriate basis for technology selection and detailed design of a groundwater remediation system for the site. Further comments re technology screening are provided in the following section.

6.6 Technology Screening

Coffey documented a review of potential remedial technologies in a letter reported prepared in July 2009 (Coffey 2009b) and updated the review in October 2009 (Coffey 2009d) after additional site data was obtained. A remediation technology screening matrix is provided in both of these documents, and included a review of the applicability/effectiveness of each technology, the permissibility of each option (meeting logistical and regulatory requirements), the relative cost of each option and the treatment time of each option. The following technologies were reviewed in July 2009 as potentially applicable for the impacts at the Mobil Geelong West site: -

Option 1:

Injection of Oxygen Releasing Compounds (ORC) and nutrients. This option involved increasing the oxygen and nutrient supply to the groundwater by injecting a slurry into soil and groundwater. The aim of this technology is to enhance bioremediation by ensuring aerobic conditions remain in the aquifer. Advantages of this system are that minimal infrastructure is required and there is no need to dispose/manage any fluids or vapours collected. It was noted this technology requires favourable geological conditions to be effective and to avoid the mobilization of contamination when the ORC is injected.

Option 2:

Nitrate and nutrient addition. This option involves enhancing anaerobic bioremediation by injecting nutrients only (and not oxygen releasing compounds). Whilst Coffey listed some advantages to this technology (ease of distribution of injecting compounds, low biomass production) there were several disadvantages listed by Coffey, including a relatively slow hydrocarbon destruction rate, the reliance of competent bacterial species existing at the site and regulatory concerns over nitrate injection.

Option 3:

In-situ Chemical Oxidation. This involves injection of oxidants into the affected aquifer. This technology works well where there are lower contaminant concentrations present, however can leave residues in the groundwater and can lower the pH of groundwater. This technology was rated as the most applicable to the site, however was rated as having the lowest treatment time acceptability.

Option 4:

Permanent Multi-Phase Vacuum Extraction (MPVE) system. A high vacuum system is installed and used to remove various combinations of contaminated groundwater, PSH and VOC's from the subsurface. Coffey suggested this technology may require continued extraction over a long period due to the relatively low permeability of the aquifer at the site.

Option 5:

Portable MPVE by vacuum truck. This approach involved MPVE being applied to selected wells in impacted zones via a truck, and subsequent off site treatment and disposal of recovered fluids and NAPL. This would eliminate the need for an on-site treatment plant. This technology is best applied where the bulk of the contaminant mass is contained in a relatively high-permeability zone (such as within tank pit sands), however is not as effective where LNAPL is largely within a low permeability aquifer or across an extensive area. Coffey suggested this technology may require continued extraction over a long period due to the relatively low permeability of the aquifer at the site.

Option 6:

Air sparging with SVE. This involves injection of air into the impaction portion of the aquifer, and recovery of VOC's via an SVE system. Coffey considered this option was not applicable given the site's relatively complex (and unsuitable) geology, in particular the distribution of clay lenses.

Option 7:

Monitored natural attenuation. This involves periodic monitoring of groundwater conditions and impacts, with a reliance on natural processes including dilution, dispersion, adsorption, chemical transformations and biodegradation which act in combination to limit the migration of a dissolved hydrocarbon and LNAPL plume. Coffey noted that based on the geochemical parameters measured in the field and natural attenuation indicators, both aerobic and anaerobic degradation of hydrocarbons was occurring at the site, but the rate of hydrocarbon destruction is slow and unlikely to achieve the remediation objectives in a timely manner.

The July 2009 review identified ORC injection and direct chemical oxidation (Options 1 or 3) as the most appropriate technology for remediation of the site, based on previous trials, the geology, hydrogeology and the nature and extent of the contamination. The main limitation was identified as being potential difficulties in effectively distributing the injected media, and that these options were considered more appropriate for low contaminant concentrations. It was recommended that an initial aggressive MPVE campaign using a vac truck be initially conducted to target LNAPL removal.

The remediation technology screening review was revisited by Coffey in October 2009 after receipt of additional site data. The October 2009 review addressed the same technologies as the July 2009 review and had similar conclusions. Field investigations completed subsequent to the July 2009 review noted significant volumes of hydrocarbons in the soil profile above the

aquifer. The October 2009 review noted that SVE was the superior option to target these hydrocarbons and SVE should be implemented in the first instance, prior to any MPVE or ORC injection events.

Auditor Comments:-

The consideration of various potential remediation technologies was consistent with the approach advocated in EPA Publication 840, including the merits of the various options in terms of technical, logistical and financial constraints. The auditor notes that David Lam (a member of the auditor's approved expert support team in the field of 'remedial technologies') was involved in the technology screening in a review capacity for Coffey Environments, which provides the auditor with additional confidence in the adequacy of this aspect of the remediation work.

6.7 Trigger Levels and Contingency Plan

Vic EPA Publication 840 *The Clean Up and Management of Polluted Groundwater (April 2002)* notes that the management of polluted groundwater should include specified trigger levels and a contingency plan. There are no trigger levels or contingency plans specified in any of the clean up documentation provided for review.

Auditor Comments:-

The absence of a management plan for groundwater including trigger levels and a contingency plan does not meet Vic EPA requirements in relation to ongoing management of polluted groundwater. A Groundwater Quality Management Plan (GQMP) or equivalent document that is consistent with EPA requirements outlined in Publication 840 (including trigger levels and a contingency plan) should be prepared for the site.

6.8 Interim Groundwater Remediation Efforts (1998 to 2009)

Multiphase extraction (MPE) events via portable vacuum truck were utilised by Mobil as an interim measure to remove LNAPL and impacted groundwater from key areas of concern within the site.

Initial MPE events were completed by Handex in October 1998 and December 1998. These two events reportedly extracted a total of 12,220 litres of impacted groundwater from beneath the site. Handex calculated a total of approximately 26.4kg of vapour phase hydrocarbons were also recovered (equivalent to 37 litres of petrol).

A further four Multiphase extraction and air treatment (MPEAT) events were completed by JFTA between August 2008 and July 2009. These events extracted a total of 16,900 litres of impacted groundwater and removed vapour phase hydrocarbons equivalent to approximately 120 litres of petrol.

6.9 In-Situ ORC injection and MPE Events (2009-2010)

Remediation activities between September 2009 and November 2010 can be summarised as follows: -

- o Multi Phase Extraction and Treatment (MPEAT) and Soil Vapour Extraction. Two events (September/October 2009 and March 2010) involved the injection of water and oxygen releasing compound into two wells located on the upgradient boundary to create a hydraulic barrier from an upgradient hydrocarbon plume. Once the hydraulic barrier was established, the MPEAT and SVE were completed from wells located above the most impacted areas of the site.
- o Oxygen Releasing Compound (ORC) injection into soil. This was conducted on three occasions (March 2010, June 2010 and October 2010). These events comprised the injection of Regenox solution into the worst impacted soil identified on the site. Following these events, groundwater quality parameters were monitored to assess any changes in groundwater flow direction or groundwater quality parameters.
- o MPEAT and ORC injection into impacted groundwater wells. This was conducted on three occasions (April 2010, July 2010 and November 2010). These events comprised the injection of Regenox solution into wells situated in the most impacted areas at the site. MPEAT was conducted after a hydraulic barrier was created in the upgradient boundary, to prevent an offsite upgradient hydrocarbon plume from entering the site.

A summary of the remediation activities is presented in Table 3 below.

Table 3 – Summary of on-site remediation works (2009-2010)

Date(s)	Remediation Method	Total groundwater extracted (L)	Estimate of hydrocarbon liquid extracted as vapour (L)	Volume of ORC injected	Comments
29/9/09-1/10/09	MPEAT/ ORC-W* / SVE**	4900	19.7	4750 (2750 ORC & 2000 water)	*ORC was injected into upgradient wells only to test potential for creation of a hydraulic barrier in future events **Coffey conducted SVE trials on 1/10/09
22/3/10-24/3/10	MPEAT / ORC-W* / SVE	6500	22.9	10495 (5970 ORC & 4525 water)	*ORC was injected into upgradient wells only to create a hydraulic barrier.
1/3/10-5/3/10	ORC-S	-	-	19570	ORC injected into soil at depths between 2 and 7m bgl
12/4/10-16/4/10	MPEAT / ORC-W	7000	42.6	11935	ORC injected into 11 on site wells.
21/6/10-25/6/10	ORC-S	-	-	19210	ORC injected into soil at depths between 4 and 6m bgl.

Date(s)	Remediation Method	Total groundwater extracted (L)	Estimate of hydrocarbon liquid extracted as vapour (L)	Volume of ORC injected	Comments
26/7/10-30/7/10	MPEAT / ORC-W	6500	13.4	16010	ORC injected into 12 on site wells.
18/10/10-22/10/10	ORC-S	-	-	10132	ORC injected into soil at depths between 3 and 7m bgl.
15/11/10-19/11/10	MPEAT / ORC-W	5500	2.1	19911	ORC injected into 12 on site wells.
TOTAL		30,400 litres	100.7 litres	48,912 litres (ORC into soil) 56,576 litres (ORC into gw wells) 6,525 litres (water into gw wells) (112,013 litres total fluids)	

Notes:

MPEAT – Multi Phase Extraction and Treatment (with hydraulic barrier control on each occasion to minimize upgradient plume entering the site during works)

ORC-S – Injection of Oxygen Releasing Compound into soil

ORC-W – Injection of Oxygen Releasing Compound into monitoring wells

SVE – Soil Vapour Extraction

Auditor Comments:-

Monitoring data between remediation events show the remediation has potentially been highly effective in removing NAPL and reducing dissolved phase hydrocarbon concentrations under the site.

It is noted there was no NAPL reported in any on-site wells during the January 2011 groundwater monitoring and gauging event. Although these results are encouraging, further gauging and monitoring is warranted to assess LNAPL and dissolved phase plume behaviour as groundwater levels recover after a prolonged period of below average rainfall.

7 RISKS TO THE LAND, AIR AND WATER ENVIRONMENT

The following section details the auditor's assessment of risks to the land, air and water environment posed by the subsurface hydrocarbon impacts from the former Mobil Geelong West Service Station site. The main hazards associated with the release of hydrocarbon products into the environment include (CCME, 2008):-

- o Fire and / or explosion hazard.
- o Asphyxiation hazard.
- o Toxicity to humans.
- o Toxicity to flora, fauna, and aquatic ecosystems.
- o Aesthetic impacts (odours, staining).

It is important to distinguish between the definition of a hazard (ie. a possible adverse event), and risk (ie. the probability of the adverse event occurring). The purpose of a risk assessment is to evaluate the probability of any one or combination of the above hazards eventuating and resulting in adverse effects on the environment.

The ability to accurately and confidently predict the probability of any one particular adverse event is limited in cases such as this where there are multiple exposure pathways and receptors involved. This particular risk assessment is based on identification of plausible source-pathway-receptor linkages and then a qualitative assessment of the risk.

7.1 Conceptual Site Model

The conceptual site model is central to the risk assessment, as it provides the means for identification of the various source-pathway-receptor linkages that require further evaluation in terms of their significance (ie. the risk).

The nature and extent of the fuel related impacts arising from the Mobil Geelong West site (ie. the sources of the impacts) can be summarised as follows:-

- o Residual hydrocarbon impacted soils remain under the site, along with dissolved phase hydrocarbons and non aqueous phase liquid (NAPL). It is acknowledged that no NAPL was identified in the most recent gauging event; however NAPL may still exist at the site. The NAPL (if any) and dissolved phase are present at approximately water table level (ie. approximately 7-9m depth).
- o Dissolved phase hydrocarbons have historically been identified to extend off site to the north and east. The dissolved phase is more extensive than the NAPL impacts. The impacts extended under a residence to the east of the site and under part of the road reserve of Church Street to the north.

The following migration and exposure pathways are acting (or potentially acting) to influence the distribution of the hydrocarbon impacts in the subsurface:-

- o Groundwater flow system. Groundwater appears to be the prime vehicle for migration of the dissolved phase. Flow is in a generally north easterly direction.
- o Volatilisation. Vapours generated from the subsurface soil, NAPL and dissolved phases are a likely secondary migration mechanism as evidenced by elevated soil vapour concentrations measured on site.
- o Surface water runoff into underground utility trenches. Utility trenches exist both within the site and in the near vicinity of the site. These could in theory collect and distribute impacted surface water runoff to downstream receiving water bodies.
- o Utility trenches acting as preferential pathways. The utility trenches are also potential preferential pathways for migration of impacted groundwater, NAPL, and vapours. There does not appear to be any influence from service utility trenches on the extent of the hydrocarbon plume.

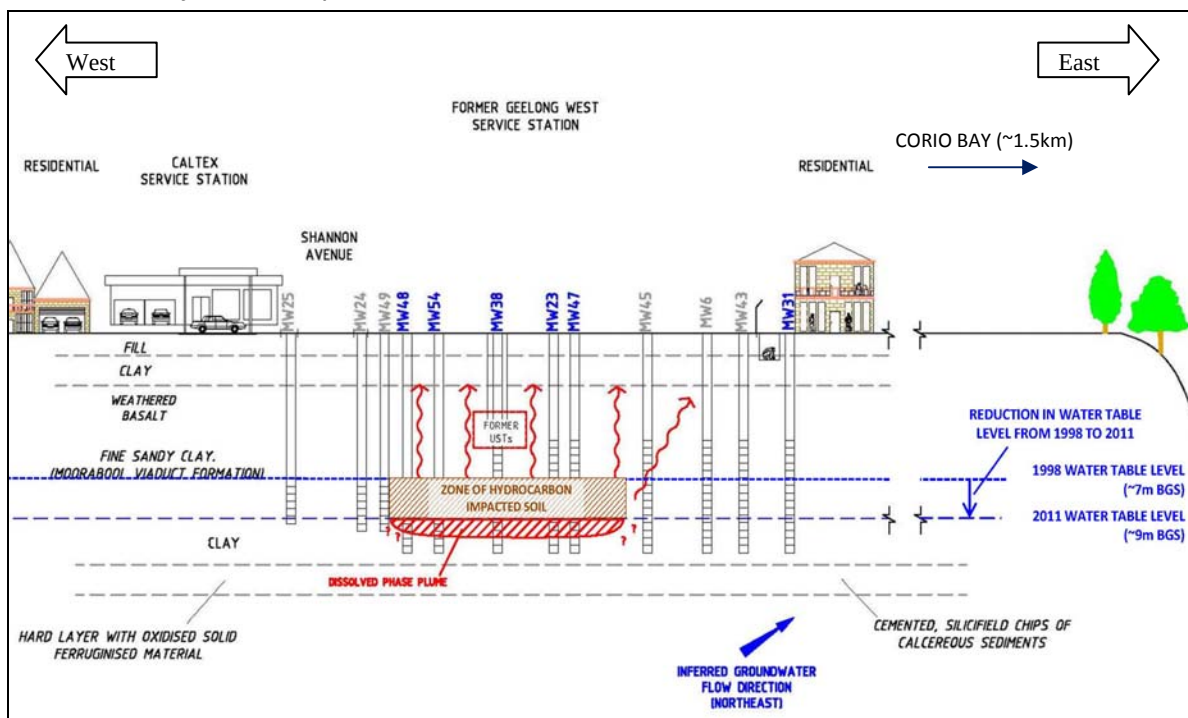


Figure 4. Conceptual Site Model (adapted from Coffey (May 2011) Summary Report)

The following receptor populations have been identified that could be affected by the fuel related hydrocarbon impacts arising from the Mobil Geelong West service station site:-

On-Site Receptors

- o Future workers involved in excavation or subsurface maintenance works.
- o Future residents

Off-Site Receptors

- o Occupants of residential premises in affected areas.
- o Future maintenance workers in existing subsurface utilities.
- o Future maintenance workers involved in excavation works in affected areas. This includes all affected road reserve areas and affected off-site properties.

The following ecological receptors have been identified that could be affected by the fuel related hydrocarbon impacts arising from the Mobil Geelong West service station site:-

On-Site Receptors

- o Plants and grasses in landscaped areas.
- o Terrestrial ecosystems and soil fauna.

Off-Site Receptors

- o Trees, plants and grasses in landscaped areas, recreational areas, residential areas, and commercial premises.
- o Terrestrial ecosystems and soil fauna.
- o Surface water bodies or waterways receiving groundwater discharge.
- o Surface water bodies receiving stormwater runoff sourced from the site.

Auditor Comments:-

The conceptual site model detailed in this section was based on information provided in various Coffey Environments referenced elsewhere in this audit report. The background information enabled an appropriate conceptual site model to be developed which details the various sources, pathways and receptors of interest at the site and affected areas off site.

7.2 Detailed Site Specific Health Risk Assessment

Mobil has commissioned two health risk assessments for the site - *Quantitative Health Risk Assessment of Former Service Station, Geelong West* (PPK, December 1998) and *Off-site Health Risk Assessment Mobil Geelong West Service Station* (Coffey, December 2008).

The PPK (1998) report documents an RBCA Tier 2 risk assessment which derived site specific threshold levels (SSTL's) for groundwater for a residence overlying the impacted zone (which included phase separated hydrocarbon). The report found the concentrations of benzene and C6-C9 TPH (aromatics) present were above the SSTL's. PPK accounted for the PSH by assuming the groundwater concentrations were at the maximum theoretical solubility limits for the various chemicals in a petroleum mixture. The report concluded that there was an unacceptable level of risk for a residential scenario via inhalation of volatiles (benzene and C6-C9 TPH aromatics) arising from the subsurface impacts. It also found there would be an unacceptable level of risk to health if affected groundwater was extracted and ingested. The report concluded health effects due to other uses of groundwater would need further assessment. The report also found that health risks are acceptable whilst there is no extraction of groundwater and the site does not have any (enclosed) residences on it.

The Coffey (2008) report documents a risk assessment based on a single round of soil vapour measurements in the vicinity of the PSH plume within the service station site. Vapour samples were collected from 4 locations within the service station site – each location had a sampling point installed at 7.5m depth (just above the water table), and also at 1.5m depth (shallow soils). One of the sampling locations was located on the eastern boundary adjacent to an adjoining residence.

Various exposure scenarios were evaluated on a qualitative basis which ruled out many potential exposure pathways. Direct contact exposures were ruled out for the majority of receptor groups with the exception of maintenance workers on-site as excavations on site could

conceivably intersect with impacted soils. The remainder of exposures deemed worthy of further quantitative assessment were limited to indirect exposures via vapour inhalation.

Coffey used the vapour intrusion models provided in the Risk Integrated Software for Clean-Ups (RISC) V4.03 for estimating vapour concentrations in a slab on ground residence and a 1m deep trenches overlying the impacted areas. RISC provides a number of alternative vapour models but in this case the Johnson and Ettinger Model (1991) was used. This is a steady state, one dimensional model, which considers vapour migration via diffusion from an infinite subsurface source in the unsaturated zone, and subsequent pressure driven flow into a below ground basement structure. In this case the source modeled was the measured soil vapour concentrations within the affected area.

Results indicated vapour concentrations at the 7.5m depth were above adopted health screening criteria, whilst the results from 1.5m depth were below adopted health screening criteria. Coffey specifically noted the assessment of risk was for a specific assumed receptor, being the off-site residents adjoining the service station site.

The following tables summarise Coffey's risk characterisation in terms of both non carcinogenic effects (via a hazard index) and carcinogenic effects (via an estimate of excess lifetime cancer risk). Table 4 shows estimates based on soil vapour measurements from shallow soil vapour bores (ie 1.5m depth). Table 5 shows estimates from deeper soil vapour bores, located just above the water table (ie. 7.5m depth). Shading indicates potentially unacceptable risks predicted for the particular scenario.

Table 4. Predicted Vapour Intrusion risks (Based on Shallow Soil Gas Data)

Exposure Scenario	Estimated Hazard Quotient	Estimated incremental excess lifetime cancer risk
Off-site Maintenance Worker - 1m deep sub-surface maintenance trench	0.0001	1.1×10^{-9}
Off-site Residential Occupant – Slab on-ground residential dwelling	0.008	6.2×10^{-8}
Adopted Criteria used in Coffey HRA (Sept 2010)	1	1×10^{-5}

Table 5. Predicted Vapour Intrusion Risks (Based on Deeper Soil Gas Data)

Exposure Scenario	Estimated Hazard Quotient	Estimated incremental excess lifetime cancer risk
Off-site Maintenance Worker - 1m deep sub-surface maintenance trench	0.11	1.5×10^{-6}
Off-site Residential Occupant – Slab on-ground residential dwelling	16	1.7×10^{-4}
Adopted Criteria used in Coffey HRA (Sept 2010)	1	1×10^{-5}

Auditor Comments:-

The auditor has been provided with the following advice in relation to the PPK (1998) and Coffey (2008) health risk assessments by Jackie Wright (a member of the auditor's approved expert support team for 'human health risk assessment'):-

In relation to the PPK (1998) Quantitative Health Risk Assessment (HRA), the following can be noted:

- o The HRA was conducted in accordance with ASTM Standard E1739-95. While limited Australian guidance was available in 1998, guidance from ANZECC (1992) and from the South Australian Health Commission (various documents) was available and would have been appropriate to adopt as guidance on the conduct of HRA in Australia. The ASTM approach is generally reasonable for the assessment of petroleum hydrocarbons, however there are aspects of the guidance, adopted by PPK, that are not appropriate (noted below where relevant).
- o Following the removal of USTs and associated infrastructure soil was excavated and remediated. Validation sampling (including an approximate grid of 8.5m) showed no remaining impacts in soil (in the unsaturated zone). Hence no soil impacts were assessed in the HRA. This is appropriate on the basis of the data provided.
- o PSH was identified in groundwater beneath the site. Risk issues were modeled for onsite exposures (residential use) on the basis of the maximum theoretical limit of solubility for TPH and BTEX. This is a reasonable approach for BTEX however for TPH the theoretical limit of solubility is often significantly lower than the solubility limit reported at site. This will have resulted in an underestimation of risks from TPH impacts in groundwater. In addition there is no assessment of other volatiles such as naphthalene.
- o The modeling of vapour migration has not considered advective (pressure driven) vapour migration into future homes. In addition, for onsite areas the modeling has assumed a 1m thick clean capillary fringe. Given the likely pathway of contaminant migration from former sources to groundwater, and the fluctuation of the groundwater table the capillary fringe is unlikely to be clean. PB note that in relation to soil contamination the only impacts identified were in the capillary fringe and saturated zone. Hence it is not appropriate for the capillary fringe to be considered clean on the site. Both these aspects will have underestimated the risk.
- o In general the receptors identified and exposure parameters adopted are reasonable.
- o In relation to toxicity, most of the values adopted, while dated, are reasonable (with the exception of the further note following). No intakes from other sources (background) have been addressed in the HRA. The major issue with the approach adopted by PPK is in the derivation of trigger levels. For this aspect of the work PPK has adopted occupational inhalation exposure guideline levels (termed by PPK as “permitted exposure limits based on epidemiological data” – which is incorrect) for the key drivers of vapour risk, namely benzene and toluene. This is an approach advocated by the outdated ASTM guidance and is not appropriate for the assessment of environmental exposures by any receptor. The outcomes of this approach are very high trigger levels for risk (based on vapour inhalation).
- o It is reasonable that the assessment of risks associated with the extraction and use of groundwater that is impacted by PSH shows an unacceptable risk. Even without the PPK HRA, these exposures would be considered unacceptable on the basis of the level of groundwater impacts identified beneath the site.
- o In relation to vapour risk issues, the approach adopted by PPK in the HRA presented is not considered appropriate or robust, however the conclusion that unacceptable vapour risks are present for future residential uses on the site above PSH is appropriate for the

screening level assessment presented. Such conclusions would be confirmed if a screening level assessment were conducted today.

In relation to the Coffey (2008) Off-Site Health Risk Assessment (HRA) the following is noted:

- o The HRA has been conducted in accordance with current and relevant Australian guidance, referencing enHealth (2004) and NEPM (1999) guidance.
- o The focus of the assessment is on the off-site residential areas where only vapour risk issues have been quantified in the assessment presented.
- o Soil gas data was collected from on-site locations above PSH and high level dissolved phase impacts, including locations on the site boundary adjacent to the off-site residential premises. The locations and sampling methods are appropriate. The soil gas data is considered to be reliable and suitable for the assessment.
- o Soil gas data was collected from 7.5m and 1.5m depth at 4 locations. The data collected from 7.5m is consistent with soil gas data directly above PSH or within the smear zone. Coffey notes that the groundwater table dropped 2m from 1998 to 2008 hence the 7.5m data is consistent with this scenario. The oxygen and carbon dioxide data, along with the observed significant attenuation of vapour concentrations from 7.5m to 1.5m supports that aerobic degradation is occurring and is the dominant factor in the attenuation of petroleum hydrocarbon vapours above the groundwater plume. The data from 1.5m depth is appropriate for the assessment of existing residential homes or homes constructed on a slab.
- o The toxicity data used in the assessment is generally appropriate. Some data are dated, however revision to these values does not change the assessment presented. The approach adopted by Coffey to the inclusion of exposures from other sources (other than site contamination) is highly conservative, allowing only 20% of the tolerable intake from the site contamination. Existing data from Melbourne and other Australian cities suggests this is a highly conservative approach and is expected to result in a conservative risk assessment.
- o Receptors identified and exposure parameters adopted are reasonable.
- o Parameters adopted in the modeling of vapour migration from soil gas to air are generally reasonable. Some parameters are inconsistent with geology types adopted. In addition no advection (pressure driven) vapour migration has been modeled. In relation to these aspects, if revised/included they do not change the outcome of the HRA presented. It is noted that the off-site residential home directly adjacent to the site is constructed on piers with a crawl-space. The modeling presented by Coffey is based on a slab-on-grade home, with the conclusions assumed to also be relevant to the existing crawl-space home. While the behavior of vapours migrating into these homes will differ, the approach adopted provides a reasonable estimation of risks on the crawl-space home.
- o Overall, for the assessment of existing off-site residential homes, the conclusions presented by Coffey are appropriate. Risks to residents in existing homes are not considered unacceptable on the basis of the 1.5m soil gas data collected.
- o The conclusions presented by Coffey can be used to address future exposures by residents in homes constructed on the site, or new homes constructed off-site, provided they are constructed as slab-on grade, and they comply with the current Building Code of Australia.

- o The assessment however has not considered future developments that may include the construction of basement levels. If these were constructed on or off the site, conclusions presented by Coffey on the basis of the 7.5m data may be relevant, however as advection has not been modeled (and is particularly relevant to buildings with basement levels), the risk values presented may be an underestimation of actual risks. Hence these developments have the potential for unacceptable risks.

7.3 Auditor's Assessment of Risks

This audit report has used a risk ranking system for each identified source-pathway-receptor linkage considered worthy of further assessment. The methodology is based on AS/NZS ISO 31000:2009 *Principles and Guidelines on Implementation* and AS/NZS ISO 31010:2009 *Risk Management – Risk Assessment Techniques*. The process is qualitative, and relies to a large degree on expert judgement. Each source-pathway-receptor linkage is assigned a risk ranking (low, medium, high, extreme) based on subjective ratings in terms of “likelihood” and “consequence”.

The first stage involves estimation of the nature and extent of the impacts, and the likelihood of adverse health effects or environmental impacts. The adopted descriptors for the ‘likelihood’ component of the risk ranking are summarised in the table below.

Table 6. Likelihood Descriptor Matrix

Level	Descriptor	Comments
A	Almost certain	Almost certain to result in unacceptable health or environmental impacts.
B	Probable	Will probably result in unacceptable health or environmental impacts.
C	Possible	Possible unacceptable health or environmental impacts at some time.
D	Unlikely	Unlikely there will be unacceptable health or environmental impacts.
E	Rare	Unacceptable health or environmental impacts may only arise in exceptional circumstances.

The second stage involves a qualitative ranking of the consequence or significance of the petroleum hydrocarbon impacts. The ranking system is outlined below.

Table 7. Consequence Descriptor Matrix

Level	Descriptor	Consequence
1	Catastrophic	Short term or acute risk of death or serious harm to persons, or of a major environmental incident. This may include an explosion in a building or confined space, asphyxiation of persons working in a confined space, or exposure to toxic fumes resulting in a fatality. The resulting fatality/fatalities overrides any financial implications.
2	Significant	Chronic exposures resulting in long term human health impacts, or significant environmental impacts, with major financial implications expected in addressing the issues (rectification costs in excess of \$100,000).
3	Moderate	Short term and reversible health effects or environmental impacts, with moderate financial implications expected in addressing the concerns (rectification costs between (\$10,000 and \$100,000).
4	Minor	Short term and minor adverse health effects or environmental impacts, with minor financial implications expected in addressing the concerns (rectification costs less than \$10,000).
5	Negligible	No adverse health effects or environmental impacts, public concerns, or financial implications.

The third stage involves multiplying the “likelihood” and “consequence” rankings to arrive at an overall risk ranking for the particular source-pathway-receptor linkage. The relative risks for each exposure scenario are ranked as Extreme, High, Medium, or Low. The scoring system is outlined in the risk ranking matrix below, and the table after provides descriptions of the rankings.

Table 8. Risk Rating Matrix

		Consequence				
		1	2	3	4	5
Likelihood	A	E	E	H	H	M
	B	E	H	H	M	M
	C	H	H	M	M	L
	D	H	M	M	L	L
	E	M	M	L	L	L

Table 9. Risk Ranking Descriptions

Rating	Description
E	Extreme risk – urgent response and management warranted.
H	High risk – further action and management warranted in short term (within 3 months) to medium term (within 12 months). Further investigation warranted to improve confidence in assessment and risk.
M	Medium risk – action and management warranted in longer term (within 2 years)
L	Low risk – risk does not warrant any specific management or action

The following table summarises the risk rankings assigned to the various source-pathway-receptor linkages identified in the conceptual model for the site and surrounds. The risk assessment has identified the most significant risk issue posed by the fuel related hydrocarbon

impacts to be vapour intrusion into on-site buildings and off-site residences and commercial buildings. The 'high' risk ranking could be downgraded pending review of further soil gas data. Other scenarios have been assigned either a 'medium' or 'low' risk ranking, as the associated risks have been assessed as adequately defined and/or adequately managed.

Table 10. Risk Assessment Rankings

Risk Rankings	On-Site Receptors	Off-Site Receptors
Extreme	No exposure scenarios were rated in this category.	No exposure scenarios were rated in this category.
High	Exposure via subsurface vapour migration into buildings, services and other confined spaces:- None currently, but this may be a consideration for residents or occupants of other sensitive land uses (eg child care centre) in potential future land use scenarios.	Exposure via subsurface vapour migration into buildings, services and other confined spaces:- Residents in adjoining properties to the east.
Medium	Exposures Via Direct Contact with NAPL or impacted soil, groundwater:- Terrestrial ecosystems	Exposure via subsurface vapour migration into buildings, services and other confined spaces:- Workers involved in maintenance of existing subsurface utilities, excavation works, or working in confined spaces.
Low	Emissions to Outdoor air:- Site visitors. Plants and grasses in landscaped areas. Exposures Via Direct Contact with NAPL or impacted soil, groundwater:- Site Visitors Plants and grasses in landscaped areas.	Emissions to outdoor air:- Pedestrians and users of affected residential properties. Plants and grasses in landscaped areas. Exposures Via Direct Contact with NAPL or impacted soil, groundwater:- Residents in affected off-site properties. Workers involved in excavation works. Plants and grasses in landscaped areas. Terrestrial ecosystems Emissions to surface waters:- Impacted surface water runoff from site entering stormwater system and ultimately discharging to receiving waters. Impacted groundwater discharging to surface waters.

7.4 Impacts on Beneficial Uses of Land

This section assesses the risk of harm or detriment to beneficial uses of land posed by the fuel related hydrocarbon impacts from the former Mobil Geelong West Service Station site. The SEPP Prevention and Management of Contamination of Land (2002) specifies the beneficial uses associated with various land uses, and indicators and objectives to be applied in

assessment of land contamination. The site is zoned Residential and the intended future use of the site is likely to be for residential purposes. The land usage in the affected areas off-site is residential.

The beneficial uses of land protected under the SEPP (PMCL) for residential land usage are:-

- o Maintenance of ecosystems (modified and highly modified);
- o Human health;
- o Buildings and structures;
- o Aesthetics; and
- o Production of food, flora and fibre.

Maintenance of Ecosystems

The affected area is within an older residential area, and may be considered to be a highly modified ecosystem, typical of an urban area. It would be reasonable to expect the soils within the affected area to sustain “modified ecosystems” and “highly modified ecosystems” found in urban environments. The soils in the area should be able to support vegetation typical of an urban area, which may include lawns, shrubs and other domestic plants, as well as small to medium sized trees. Petroleum hydrocarbon results (TPH and BTEX) on-site in the affected area exceed the adopted ecological soil assessment criteria. However, it is noted the majority of the residual impacts in soil under the site are located at significant depth near water table level (generally greater than 6m depth). Two shallower ‘hot-spot’ contamination areas are noted to remain in the vicinity of the former bowser area and a former TIT (near MW3).

The fuel related hydrocarbon contamination is not likely to currently pose a detriment to this beneficial use either on-site or off-site within the affected area.

Human Health

The main potential human health risk posed by the residual hydrocarbon impacts is indirect exposures via vapour intrusion into buildings or confined spaces such as trenches or excavations. Direct exposure to hydrocarbon impacted soils is also possible for on-site workers involved in trenching or excavation works. Based on current conditions potentially exposed persons include excavation workers on site, the occupants of the two adjoining residential properties to the east where historical impacts have been noted, and also for workers in the road reserve areas to the north.

The current available information indicates there is not likely to be an unacceptable risk to these persons. It is noted the risks associated with a basement or cellar structure have not been adequately evaluated. This has potential implications for future redevelopment on the site, and requires further evaluation. In addition, the adjoining residences to the east do not appear to have cellars or basement areas, but this has not been confirmed in the available reports. Further enquiries should be made to address this uncertainty.

Overall, the hydrocarbon impacts are not likely to pose any significant current risks to the land and groundwater environment. However, there are limitations with some of the supporting data, particularly in relation to vapour intrusion risk, and further investigation and monitoring is warranted to improve the confidence in the supporting data, particularly in regard to vapour intrusion risk and indoor air quality impacts.

Coffey notes that the site and surrounding areas are zoned residential and supplied by reticulated water and the likelihood of groundwater being used for industrial, agriculture, parks and gardens and stock watering is low. Coffey also notes that while primary contact recreation (ie filling of swimming pools/spas etc) could potentially occur, all registered groundwater bores within 1km are listed as investigation bores only.

Based on the absence of any evidence of current groundwater extraction or usage, the risk of adverse human health effects arising from extraction and use of groundwater is considered low. Any extraction from the affected areas should be restricted until groundwater quality is restored to acceptable levels.

Although it was not specifically mentioned in the health risk assessment, the auditor notes the utility monitoring conducted to date suggests there is not likely to be a significant risk of an explosive mixture accumulating in a subsurface utility pit or trench either on site or off site in the affected area. The monitoring was a once-off event however, and additional utility pit monitoring should be conducted to confirm the initial data.

The fuel related hydrocarbon contamination is not likely to pose a detriment to human health either on-site or off-site within the affected area. However, further investigation and monitoring is warranted to improve the confidence in the supporting data, particularly in regard to vapour intrusion risk.

Buildings and Structures

The fuel related impacts are in general present at depths below any current or likely services or buildings, and there are no indications the fuel related impacts pose a significant risk to the integrity of buildings or underground services. This includes the risk of explosive mixtures accumulating in subsurface utilities or other confined spaces.

Certain building materials or structures could be adversely affected if they were in direct contact with residual fuel product, for example PVC pipework or certain glues used in pipe joints. However, there is no evidence to suggest this situation currently exists.

The fuel related hydrocarbon contamination is not likely to currently pose a detriment to buildings and structures either on-site or off-site within the affected area.

Aesthetics

Hydrocarbon impacted land is typically associated with staining and odours that would be unacceptable from an aesthetic viewpoint in certain circumstances. This would include where the impacted soils are easily accessible or visible, or shallow enough for vapours and odours to be detectable. The impacts do not pose an aesthetic limitation in the context of ongoing use of the site as a retail fuel outlet. Considering the significant depth of the impacts in off-site areas (>6m depth), they also do not pose a limitation from an aesthetic viewpoint to off-site uses including the road reserve areas, or other properties in the affected area.

The fuel related hydrocarbon contamination does not currently pose a detriment to aesthetics either on-site or off-site within the affected area.

Production of Food, Flora and Fibre

The presence of fuel related hydrocarbon impacts in garden areas or cropping land may pose a limitation on production of food, flora and fibre, due to possible impediments to plant growth. This does not pose a significant limitation in the context of the existing land use patterns in the affected area. The depth of the impacts within the affected area (>6m depth) are well below those likely to affect cropping or plant growth.

The fuel related hydrocarbon contamination does not currently pose a detriment to production of food, flora and fibre either on-site or off-site within the affected area.

7.5 Impacts on Beneficial Uses of Groundwater

This section provides an assessment of the risk of harm or detriment to beneficial uses of groundwater posed by the fuel related hydrocarbon impacts from the former Mobil Geelong West Service Station site. It is noted that the presence of NAPL is in non-compliance with the SEPP (Groundwaters of Victoria) and by definition constitutes pollution of groundwater. Clause 18 of the SEPP requires that NAPL must be removed from an aquifer unless the EPA is satisfied the NAPL does not pose an unacceptable risk to any beneficial use. It is noted that the most recent gauging event has not detected any NAPL, however additional gauging events are recommended to confirm NAPL has been removed from the site.

The SEPP (Groundwaters of Victoria) specifies the beneficial uses of groundwater for various segments, based on groundwater salinity, and specifies indicators and objectives to be applied in assessment of groundwater quality. Coffey's interpretation of the groundwater salinity results from the site and vicinity indicates groundwater to be within Segment C (ie. salinity range 3,501 – 13,000 mg/L), and the auditor agrees with this interpretation.

The beneficial uses of groundwater protected in Segment C as specified in the SEPP (Groundwaters of Victoria) include:-

- o Maintenance of ecosystems
- o Stock watering
- o Industrial water use
- o Primary contact recreation (eg. bathing, swimming)
- o Buildings and structures

Maintenance of Ecosystems

This beneficial use would be precluded if polluted groundwater was impacting or had the potential to impact the water quality and ecosystems in Corio Bay approximately 1.5km east. The fuel related hydrocarbon impacts do not pose a detriment to this beneficial use as the current extent of the dissolved phase plume is not within close proximity to any surface water bodies or potential discharge points that would eventually reach Corio Bay. The historical data also does not suggest the impacts are likely to reach these receptors in the future.

Stock Watering

The fuel related impacts preclude the use of groundwater for this purpose within the affected area. It is noted this beneficial use is not relevant at this site or in the area as it is not compatible with existing or likely future land usage.

Industrial Water Use

The fuel related impacts preclude the use of groundwater for this purpose within the affected area. It is noted this beneficial use is not relevant at this site or in the area as it is not compatible with existing or likely future land usage. It is noted there is no identified current industrial use of groundwater in the locality, and future use is also considered unlikely as it is incompatible with the future land use and zoning; the salinity of the groundwater; the variable (generally low) yields of the water table aquifer; the relatively high cost of installing a bore and pump system; and the presence of a reliable reticulated supply.

Primary Contact Recreation

The fuel related impacts preclude the use of groundwater for this purpose within the affected area. There is no current groundwater use for this purpose identified in the locality. Future use for this purpose on site or in the locality is also considered unlikely given the presence of a reliable reticulated supply, the variable (generally low) yields of the water table aquifer, and the relatively high cost of installing a bore and pump system. However, it is noted that issues of water supply have become more prominent with climate change and recent long term drought conditions, which may increase consideration of groundwater use for this purpose in the future.

Buildings and Structures

Any residual NAPL remaining on the site may have an adverse effect on plastic pipework and fittings, but there is no evidence to suggest there is any existing pipework either on site or offsite in contact with the NAPL given the NAPL is present below 6m depth. The general groundwater quality is also not likely to be corrosive to buildings and structures. The fuel related hydrocarbon impacts do not currently pose a detriment to this beneficial use within the affected area.

7.6 Impacts on Beneficial Uses of Surface Waters

This section assesses the risk of harm or detriment to beneficial uses of surface waters posed by the fuel related hydrocarbon impacts from the former Mobil Geelong West Service Station site. The SEPP Waters of Victoria (2003) specifies the beneficial uses to be protected for various surface water segments across Victoria.

The SEPP (Waters of Victoria) specifies the following beneficial uses of surface waters:-

- o Maintenance of aquatic ecosystems;
- o Water based recreation;
- o Production of mollusks for human consumption;
- o Commercial and recreational use of edible fish and crustaceans;
- o Navigation and shipping; and

- o Industrial water use.

It is expected that stormwater from the area ultimately discharges to Corio Bay various drains. Stormwater drains are not considered waterbodies, however they are relevant in the context that they provide conduits and ultimately discharge to receiving waters. The environmental quality objectives and indicators apply at the point of discharge into the receiving water body.

There have not been any impacts identified in near surface soils and there are no structures or infrastructure present on the site that have the potential to impact on stormwater discharging from the site.

7.7 Impacts on Air Quality and Beneficial Uses

This section assesses the risk of harm or detriment to the air environment associated beneficial uses posed by the fuel related hydrocarbon impacts from the former Mobil Geelong West Service Station site. The SEPP Air Quality Management specifies the beneficial uses to be protected in terms of air quality in Victoria:-

- o Life, health and well being of humans;
- o Life, health and well being of other forms of life, including the protection of ecosystems and biodiversity;
- o Local amenity and aesthetic enjoyment;
- o Visibility;
- o The useful life and aesthetic appearance of buildings, structures, property and materials; and
- o Climate systems that are consistent with human development, the life, health and well being of humans, and the protection of ecosystems and biodiversity.

The air concentrations as predicted by the health risk assessment for fuel related hydrocarbons in various buildings located within the affected areas are well below relevant air quality objectives and indicators, as well as other adopted screening criteria in the absence of criteria nominated in the SEPP for certain fuel related air contaminants. The outdoor air quality would be expected to be significantly better due to dilution effects and greater air circulation. As noted previously, these conclusions are based on use of soil gas data from wells installed in shallow soil bores (1.5m depth). Use of the deeper soil gas data results in predicted indoor air concentrations above air quality criteria for some scenarios. The following tables show predicted air concentrations based on soil gas data from shallow bores (1.5m depth) and deeper bores (7.5m depth). Shading indicates scenarios where predicted indoor air concentrations exceed adopted air quality criteria.

The auditor's expert support team member in health risk assessment has advised that the use of the shallow soil gas data was appropriate as it takes into account attenuation of vapour concentrations through the soil profile. On this basis it is concluded the fuel related hydrocarbon contamination is not likely to pose a detriment to the beneficial uses associated with air quality within the affected area. However, further investigation and monitoring is warranted to improve the confidence in the supporting data, particularly in regard to indoor air quality in buildings within the affected area.

Table 11. Predicted Air Concentrations (based on shallow soil gas data @ 1.5m)

Exposure Scenario	Predicted Vapour Concentrations ($\mu\text{g}/\text{m}^3$)			
	Benzene	Toluene	Ethyl benzene	Xylenes
Slab-on-ground Residential Dwelling	0.0076	0.014	0.0007	0.011
1m Deep sub-surface Maintenance Trench	0.021	0.035	0.0018	0.028

Victorian EPA State Environment Protection Policy (SEPP) (Air Quality Management), 2001 ($\mu\text{g}/\text{m}^3$)

Intervention Levels (1)	75 (2)	1880 (2)	-	2080 (2)
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NEPM (Air Toxics), 2004 ($\mu\text{g}/\text{m}^3$)

Monitoring Investigation Level	96 (4)	3770 (3)	-	254 (3)
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Notes on adopted air quality criteria:-

- (1) Used for the assessment of local or neighbourhood monitoring data based on 1 or 24 hour averaging periods.
- (2) 1hr averaging time
- (3) 24hr averaging time
- (4) Annual averaging time

Table 12. Predicted Air Concentrations (based on deeper soil gas data @ 7.5m)

Exposure Scenario	Predicted Vapour Concentrations ($\mu\text{g}/\text{m}^3$)			
	Benzene	Toluene	Ethyl benzene	Xylenes
Slab-on-ground Residential Dwelling	21	29	0.85	7.4
1m Deep Sub-surface Maintenance Trench	29	40	1.2	10

Victorian EPA State Environment Protection Policy (SEPP) (Air Quality Management), 2001 ($\mu\text{g}/\text{m}^3$)

Intervention Levels (1)	75 (2)	1880 (2)	-	2080 (2)
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NEPM (Air Toxics), 2004 ($\mu\text{g}/\text{m}^3$)

Monitoring Investigation Level	96 (4)	3770 (3)	-	254 (3)
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Notes on adopted air quality criteria:-

- (1) Used for the assessment of local or neighbourhood monitoring data based on 1 or 24 hour averaging periods.
- (2) 1hr averaging time
- (3) 24hr averaging time
- (4) Annual averaging time

8 CONCLUSIONS AND RECOMMENDATIONS

The environmental audit has been undertaken in accordance with Part IXD of the Environment Protection Act 1970 (the Act), and specifically Section 53V which relates to an audit of the risk to a segment of the environment. The segment of the environment in this case is the land and groundwater at and in the vicinity of the former Mobil Geelong West Service Station site ('the site') that may be affected by the subsurface fuel impacts arising from past operations at the site. Further details of the audit objectives and scope are provided in Section 2. The relevant legislation, guidelines and standards current at the time of the audit are summarised in Section 9 of this audit report. The following section summarises the outcomes of the audit.

Background and Product Release History

Past leakage of fuels has resulted in contamination of land and groundwater at and in the vicinity of the former Mobil Geelong West Service Station site. Prior to 1947 it is understood the site comprised three separate properties, assumed to be residential. The western lot may have been a store-workshop. A service station was established on the three lots sometime between 1967 and 1970. The service station was decommissioned in 1997, and the site has remained vacant since then.

Based on the review of product sampling results and fingerprinting, the source of hydrocarbon product the two plumes of NAPL (on-site and off-site) are of similar age and product type, however it is considered highly unlikely the two plumes are from the same source.

The PSH product obtained from under the site indicates that the product is a typical weathered leaded petrol product aged between 10 and 18 years. Other than the octane booster tetraethyl lead (TEL), there are no other fuel related additives such as TML, MTBE or MMT in the product.

Adequacy of Investigation and Delineation of Impacts

There has been extensive investigation undertaken to characterise the nature and extent of impacts. The auditor is satisfied the scope of investigations has been commensurate with the environmental significance of the contamination.

The geology and hydrogeology of the site have been well characterised. The subsurface geology in the area comprises basaltic clays and weathered basalts (Newer Volcanics), overlying silty sandy clays and silty clayey sands (Moorabool Viaduct Formation), and silty sandy clays with limestone bands (possibly Fyansford Formation). Groundwater has been intersected within the upper portion of the Moorabool Viaduct formation, generally at depths between approximately 7 to 10 m below ground level. The formation the groundwater is encountered within a relatively low permeability formation with hydraulic conductivity estimated to range between 4.7 to 7.4 m/day. The estimated conductivity values are consistent with the published values for a fine sand. The groundwater flow direction over the investigation area is north east, with a relatively flat hydraulic gradient. Groundwater velocity is estimated to range between 31 to 49m/yr.

NAPL impacts have historically been limited to the northern portion of the site, although it is possible there has been some encroachment under the adjoining residential lot to the east and road reserve to the north. Prior to multiphase extraction events conducted by Handex in October and December 1998 measurable NAPL had been identified in three on-site wells ranging from 15mm to 390 mm. Following these MPE events, there was a reduction in measured NAPL thickness to 1mm in the March 1999 gauging event. The maximum historical NAPL thickness measured in on-site wells has been 1,534mm (MW23). Coffey have noted that since 2004, the number of wells and apparent thickness of NAPL showed a decreasing trend over time.

Dissolved phase hydrocarbons extend off site to the north and east, as well as hydrocarbon vapours in the areas of the dissolved phase and NAPL impacts. The historical monitoring data indicates the dissolved phase impacts have extended under the adjoining residential lot to the east, and also under the adjoining road reserve to the north of the site. Impacts have not been detected in the residential and commercial properties on the north side of Church Street. Summary plans showing the historical NAPL plumes and dissolved benzene plumes are provided in the audit report attachments (refer Figures D, E, G, H and I).

The lateral extent of the dissolved phase and NAPL impacts arising from the on-site source/s has been adequately delineated. The groundwater monitoring well network has focused on the upper portions of the groundwater system, with the majority of wells installed in the shallow portion of the aquifer (with wells screened typically from 6-9m depth or 7-10m depth). There were also 2 deeper wells installed (up to 15m depth). The Auditor notes these deeper wells (MW27 and MW28) were both located hydraulically upgradient of the on-site sources.

The dissolved phase impacts from the on-site source/s have not been adequately delineated vertically. It is acknowledged the observed site geology suggests there is limited potential for vertical migration of the fuel related NAPL and dissolved phase impacts. However, further investigation is warranted to confirm the depth of groundwater impacts in the northern portion of the site.

The extent of soil impacts essentially mirrors the extent of NAPL and dissolved phase impacts. Coffey have interpreted the petroleum hydrocarbon impacts is predominantly sorbed at the smear zone which has a vertical extent of approximately 2m (between approximately 7m and 9m below the ground surface), following a sustained decreasing trend in standing groundwater levels since monitoring began in 1998. Coffey have also noted the hydrocarbon mass 'hung up' in soil within the smear zone remains a potential ongoing source of contamination to groundwater. There are also more shallow residual soil impacts remaining in two areas – near the former bowlers in the central to western portion of the site, and also in the vicinity of a former drain pit under the old lube bay area in the south eastern portion of the site which drained to the former triple interceptor trap.

It is noted that there is a separate NAPL and dissolved phase hydrocarbon plume to the west of the site. The likely source has been interpreted as the Service Station located to the west of Shannon Ave. These dissolved phase impacts may encroach under the western portion of the audit site. It is noted these impacts are not associated with past site operations and therefore are not part of the 53V audit scope and have not been considered further.

Risk of Harm or Detriment to the Land and Groundwater Environment

There are no sensitive environments in the vicinity of the site that might be at risk of harm from the hydrocarbon impacts. The existence of NAPL precludes all protected beneficial uses of groundwater within the affected area (including stock watering, industrial use, primary contact recreation, and buildings and structures). However there is no existing or likely future usage of the groundwater, so there no current risk of harm associated with extractive use of groundwater.

The main potential human health risk posed by the residual hydrocarbon impacts is indirect exposures via vapour intrusion into buildings or confined spaces such as trenches or excavations. Direct exposure to hydrocarbon impacted soils is also possible for on-site workers involved in trenching or excavation works. Based on current conditions potentially exposed persons include excavation workers on site, the occupants of the two adjoining residential properties to the east where historical impacts have been noted, and also for workers in the road reserve areas to the north.

The current available information indicates there is not likely to be an unacceptable risk to these persons. It is noted the risks associated with a basement or cellar structure have not been adequately evaluated. This has potential implications for future redevelopment on the site, and requires further evaluation. In addition, the adjoining residences to the east do not appear to have cellars or basement areas, but this has not been confirmed in the available reports. Further enquiries should be made to address this uncertainty.

Overall, the hydrocarbon impacts are not likely to pose any significant current risks to the land and groundwater environment. However, there are limitations with some of the supporting data, particularly in relation to vapour intrusion risk, and further investigation and monitoring is warranted to improve the confidence in the supporting data, particularly in regard to vapour intrusion risk and indoor air quality impacts.

Adequacy of Clean Up and Management

Remediation activities to date have included pilot trials, of SVE, pumping and bioventing, removal of underground petroleum storage and dispensing infrastructure, multi-phase vacuum extraction (MPVE) and treatment events, and insitu chemical oxidation via injection of Regenox (a proprietary brand of oxidants). The monitoring data indicates a decreasing trend in NAPL and dissolved phase concentrations in the affected area. However, there is uncertainty regarding the extent to which these decreases can be attributed to natural attenuation, enhancement by the recent in-situ oxidation remediation works, or simply reductions in groundwater levels removing the source soils in the smear zone from being in contact with groundwater.

Overall, the auditor is satisfied the cleanup measures carried out to date were reasonable and appropriate and have been completed with regard to the general requirements of the EPA publication 840 (The Clean up and Management of Polluted Groundwater), with the exception of a management plan for groundwater (including provisions for trigger levels and a contingency plan).

Recommendations for Further Investigation and/or Management

The auditor recommends the following additional investigation and management measures:-

SHORT TERM MEASURES (WITHIN 3 MONTHS OF AUDIT COMPLETION)

- o A site environmental management plan (SEMP) should be prepared for the management of contaminated soil and groundwater at the site. The plan should include provisions for ongoing groundwater monitoring, trigger levels, contingency plan, utility pit vapour monitoring, disposal or re-use of any waste soil or groundwater generated by site activities and retention and maintenance of the existing groundwater monitoring bore network. The SEMP must be prepared by an appropriately qualified professional practitioner and be subsequently approved by an Environmental Auditor (Contaminated Land) appointed pursuant to the Environment Protection Act 1970.
- o EPA should consider declaring a Groundwater Quality Restricted Use Zone (GQRUZ) encompassing the site and affected off-site areas, or a similar regulatory mechanism that has the effect of prohibiting groundwater extraction and use unless it is for ongoing monitoring or remediation purposes.
- o All owners and occupants of properties in the affected off-site areas should be informed of the risks posed by the groundwater impacts, including the risks if affected groundwater was extracted and utilised. As part of this consultation process, enquiries should be made to establish whether these properties have basements and/or cellars.

MEDIUM TERM MEASURES (WITHIN 6 MONTHS OF AUDIT COMPLETION)

- o An additional soil vapour monitoring event should be completed from the existing on site soil vapour monitoring bores, and the data used to upgrade the on site and off site health risk assessment. In addition to the scenarios of sub surface trenching and existing slab on ground structures, the risk assessment should consider the potential risk associated with subsurface structures such as basements and/or cellars both on site and off site.
- o Further investigation should be conducted to vertically delineate dissolved phase impacts under the north eastern portion of the site. Delineation should be achieved to the lowest of the adopted groundwater clean-up criteria for each analyte of interest (eg. 1µg/L for benzene).
- o A clean up and remediation plan should be prepared to address residual hydrocarbon impacted soil remaining on site.

LONGER TERM MEASURES (WITHIN 2 YEARS OF AUDIT COMPLETION)

- o If the environmental audit of the site currently being undertaken under Section 53X of the Environment Protection Act has not been completed and submitted within 2 years of the provision of this 53V audit (including a determination by EPA that clean up to extent practicable has been achieved), there should be a review conducted to assess the need for further investigation, remediation and/or other management measures. The form of this review should be an audit conducted in accordance with Section 53V of the Environment Protection Act 1970.

9 REFERENCES

Vic EPA Guidelines & Legislation

- o Environment Protection Act 1970
- o Planning and Environment Act 1987
- o State Environment Protection Policy (Prevention and Management of Contamination of Land), Victorian Government Gazette Publication No. S95, 2002
- o State Environment Protection Policy (Groundwaters of Victoria), Victorian Government Gazette Publication No. S160, 1997 (and variations dated June 1999 and June 2003)
- o State Environment Protection Policy (Ambient Air Quality), Victorian Government Gazette Publication No. S19, 1999
- o State Environment Protection Policy (Air Quality Management), Victorian Government Gazette Publication No. S240, 2001
- o State Environment Protection Policy (Waters of Victoria), Victorian Government Gazette Publication No. S13, 1988 (as varied on 3 June 2003 No. S107) and Schedule F6 (Waters of Port Philip Bay) as varied in S121, 2003
- o Environment Protection (Industrial Waste Resource) Regulations 2009
- o Environmental Auditor Guidelines for the Preparation of Environmental Audit Reports on Risk to the Environment (Vic EPA Publication 952.2, August 2007)
- o Guidelines for Issue of Certificates and Statements of Environmental Audit (Vic EPA Publication 759.1 Oct 2007)
- o Guidelines on the Design, Installation and Management Requirements for Underground Petroleum Storage Systems (UPSS) (Vic EPA Publication 888.1, January 2009)
- o Sampling and Analysis of Waters, Wastewaters, Soils and Wastes (IWRG701 – June 2009)
- o Hydrogeological Assessments (Water Quality) Guidelines, Vic EPA Publication 668, September 2006
- o Groundwater Sampling Guidelines. Vic EPA Publication 669, April 2000.
- o The Clean Up and Management of Polluted Groundwater, Vic EPA Publication 840, April 2002
- o Various guidance provided to auditors (unpublished) prior to the date of this audit report

Other National Documents

- o National Environment Protection (Assessment of Site Contamination) Measure (NEPC, 1999)
- o National Environment Protection (Air Toxics) Measure (NEPC, 2004)
- o Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites (ANZECC, 1992)
- o AS/NZS ISO 31000:2009 *Principles and Guidelines on Implementation*
- o AS/NZS ISO 31010:2009 *Risk Management – Risk Assessment Techniques*
- o Australian and New Zealand Water Quality Guidelines for Fresh and Marine Waters (Australian and New Zealand Environment and Conservation Council, ANZECC, 1992)

- o Australian Standard, Guide to the investigation and sampling of sites with potentially contaminated soil, Part 1: Non-volatile and semi-volatile compounds. AS4482.1-2005.
- o Australian Standard, Guide to the investigation and sampling of sites with potentially contaminated soil, Part 2: Volatile compounds. AS4482.2-1999.
- o Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia, ANZECC/ARMCANZ, 2000)
- o Australian Drinking Water Guidelines (National Health & Medical Research Council, and Natural Resource Management Ministerial Council, NHMRC/NRMMC, 2004)
- o Guidelines for Assessing Service Station Sites (NSW EPA Publication 94/119, 1994)

Reports / Supporting Data

- PPK Environment & Infrastructure Pty Ltd (PPK 1998) Quantitative Health Risk Assessment of Former Service Station, Geelong West, Victoria (VO0993) (December 1998);
- PPK Environment & Infrastructure Pty Ltd (PPK 1999a) March 1999 Groundwater Monitoring, MSS Geelong West (VO0993) (15 March 1999);
- PPK Environment & Infrastructure Pty Ltd (PPK 1999b) Groundwater Monitoring, October 1999 – Church Street, Geelong West (VO0993) (15 December 1999);
- PPK Environment & Infrastructure Pty Ltd (PPK 2002) Final Report Detailing Total Fluids Pilot Trial, Geelong West (VO0993) Victoria (25 June 2002);
- Handex (Handex 2003a) Groundwater Monitoring Report. Former Mobil Service Station Corner Shannon Avenue and Church Street, Geelong West, Victoria (July 2003);
- Handex (Handex 2003b) Summary Environmental Report. Former Mobil Service Station Corner Shannon Ave. and Church Street, Geelong West, Victoria (August 2003);
- Coffey Environments (Coffey 2007) Groundwater Monitoring Results – Monitoring Well MW31. 149 Church Street, Geelong West, Victoria (19 July 2007);
- Coffey Environments (Coffey 2008a) Annual Groundwater Monitoring Event Report. Former Mobil Service Station Geelong West (VO0993). 151 Church Street (Cnr Shannon Avenue) Geelong West, Victoria (17 November 2008);
- Coffey Environments (Coffey 2008b) Off-site Health Risk Assessment Mobil Geelong West Service Station (VO0993). Corner Shannon Avenue and Church Street Geelong West, Victoria (12 December 2008);
- JFTA Environmental Solutions (JFTA 2008) Groundwater Multiphase Extraction and Air Treatment Event (27th and 28th August 2008) – Ref 700358. Former Mobil Service Station Cnr Shannon Ave and Church St, Geelong West, Vic (13 January 2009);
- JFTA Environmental Solutions (JFTA 2009a) Groundwater Multiphase Extraction and Air Treatment Event (22nd and 23rd January 2009) – Ref 700418. Former Mobil Service Station Cnr Shannon Ave and Church St, Geelong West, Vic (6 April 2009);
- Coffey Environments (Coffey 2009a) Post Phase 2 Environmental Site Assessment Former Mobil Service Station Geelong West (VO0993) 151 Church Street (Cnr Shannon Avenue), Geelong West, Victoria (24 April 2009);

- JFTA Environmental Solutions (JFTA 2009b) Groundwater Multiphase Extraction and Air Treatment Event (19th and 20th March 2009) – Ref 700418. Former Mobil Service Station Cnr Shannon Ave and Church St, Geelong West, Vic (27 March 2009);
- JFTA Environmental Solutions (JFTA 2009c) Groundwater Multiphase Extraction and Air Treatment Event (4th and 6th July 2009) – Ref 700418. Former Mobil Service Station Cnr Shannon Ave and Church St, Geelong West, Vic (10 July 2009);
- Coffey Environments (Coffey 2009b) Remediation Technology Screening Review for Former Mobil Geelong West Service Station (VO0993) (20 July 2009);
- Coffey Environments (Coffey 2009c) Well Installation and Limited Environmental Investigation. Former Mobil Service Station Geelong West (VO0993). 151 Church Street (Cnr Shannon Ave), Geelong West, Victoria (22 September 2009);
- Coffey Environments (Coffey 2009d) Revised Remediation Technology Screening Review for Former Mobil Geelong West Service Station (VO0993) dated 20 July 2009 (2 October 2009);
- JFTA Environmental Solutions (JFTA 2009d) Groundwater Multiphase Extraction and Air Treatment Event (29th September to 1st October 2009) – Ref 700543. Former Mobil Service Station Cnr Shannon Ave and Church St, Geelong West, Vic (7 October 2009);
- Coffey Environments (Coffey 2009e) Oxygen Release Compound (ORC) Injection and Hydraulic Barrier Control During Multi Phase Extraction Event at Former Mobil Geelong West Service Station (VO0993), 151 Church Street, Geelong West, Vic (23 October 2009);
- Coffey Environments (Coffey 2009f) Soil Vapour Extraction Screening Event at Former Mobil Service Station Geelong West (VO0993). 151 Church Street, Geelong West, Victoria (28 October 2009);
- Coffey Environments (Coffey 2009g) Interim Groundwater Monitoring Event. Former Mobil Service Station Geelong West (VO0993). 151 Church Street (Cnr Shannon Avenue), Geelong West, Victoria (18 December 2009);
- Coffey Environments (Coffey 2010a) Oxygen Release Compound (ORC) Injection and Hydraulic Barrier Control During Multi Phase Extraction and Treatment (MPEAT) Event at Former Mobil Geelong West Service Station (VO0993), 151 Church Street, Geelong West, Vic (13 April 2010).
- Coffey Environments (Coffey 2010b) Soil Injection of RegenOx via Push Tube and Wavefront Technology at Former Mobil Geelong West Service Station (VO0993), 151 Church Street, Geelong West, Vic (13 April 2010).
- Coffey Environments (Coffey 2010c) Combined MPEAT and Injection of RegenOx in On-Site Remediation Wells Using Wavefront Technology at Former Mobil Geelong West Service Station (VO0993), 151 Church Street, Geelong West, Vic (17 June 2010);
- Coffey Environments (Coffey 2010d) Interim Groundwater Monitoring Event. Former Mobil Service Station Geelong West (VO0993). 151 Church Street (Cnr Shannon Avenue), Geelong West, Victoria (6 August 2010);
- Coffey Environments (Coffey 2010e) Soil Injection of RegenOx via Push Tube and Using Wavefront Technology (STEP 5), at Former Mobil Geelong West Service Station (VO0993), 151 Church Street, Geelong West, Vic (31 August 2010);
- Coffey Environments (Coffey 2010f) Combined MPEAT and Injection of RegenOx in On-Site Remediation Wells Using Wavefront Technology (STEP 6) at Former Mobil

Geelong West Service Station (VO0993), 151 Church Street, Geelong West, Vic (6 September 2010);

- Coffey Environments (Coffey 2010g) Interim Groundwater Monitoring Event. Former Mobil Service Station Geelong West (VO0993). 151 Church Street (Cnr Shannon Avenue), Geelong West, Victoria (8 October 2010);
- Coffey Environments (Coffey 2011a) Soil Injection of RegenOx via Push Tube and Using Wavefront Technology (STEP 8), and Data Gaps Filling at Former Mobil Geelong West Service Station (VO0993), 151 Church Street, Geelong West, Vic (12 January 2011); and
- Coffey Environments (Coffey 2011b) Combined MPVE and Injection of RegenOx in On-Site Remediation Wells Using Wavefront Technology (STEP 9) at Former Mobil Geelong West Service Station (VO0993), 151 Church Street, Geelong West, Vic (24 January 2011).
- Coffey Environments (Coffey 2011c) Post Injection Groundwater Monitoring Event. Former Mobil Service Station Geelong West (VO0993), 151 Church Street (Cnr Shannon Avenue), Geelong West, Victoria (4 May 2011).
- Coffey Environments (Coffey 2011d) Summary Report. Former Mobil Service Station Geelong West (VO0993), 151 Church Street, Geelong West. (4 May 2011).

Other References

- o Canadian Council of Ministers of the Environment (CCME). Canada Wide Standards for Petroleum Hydrocarbons in Soil. Table 1 – Revised 2008
- o Environmental Quality Objectives in the Netherlands, Ministry of Housing, Spatial Planning and Environment (MHSPE, 2000)
- o Geology of Victoria. Abele, C., Gloe, C.S., Hocking, J.B., Holdgate, G.R., Kenley P.R., Lawrence, C.R., Ripper, D., Threfall, W.E., & Bolger P.F. Douglas J.G, and Ferguson J.A. eds, p272-302. Geological Society of Australia, Victoria Division, Melbourne
- o CRC for Contamination Assessment and Remediation of the Environment (CRC CARE) Technical Report No. 6 (Lam, D & Moritz, P 2007), *Technical impracticability of further remediation for LNAPL-impacted soils and aquifers*
- o CRC for Contamination Assessment and Remediation of the Environment (CRC CARE) Technical Report No.11 (L Clements, T Palaia and J Davis) *Characterisation of Sites Impacted by Petroleum Hydrocarbons; National Guideline Document*

FIGURES

Figure A—Locality Plan

Figure B—Former Site Layout

Figure C—Monitoring Well Locations

Figure D—Pre remediation benzene impacts (Feb 2009)

Figure E—Post remediation benzene impacts (Jan 2011)

Figure F—Groundwater SWL historical trends

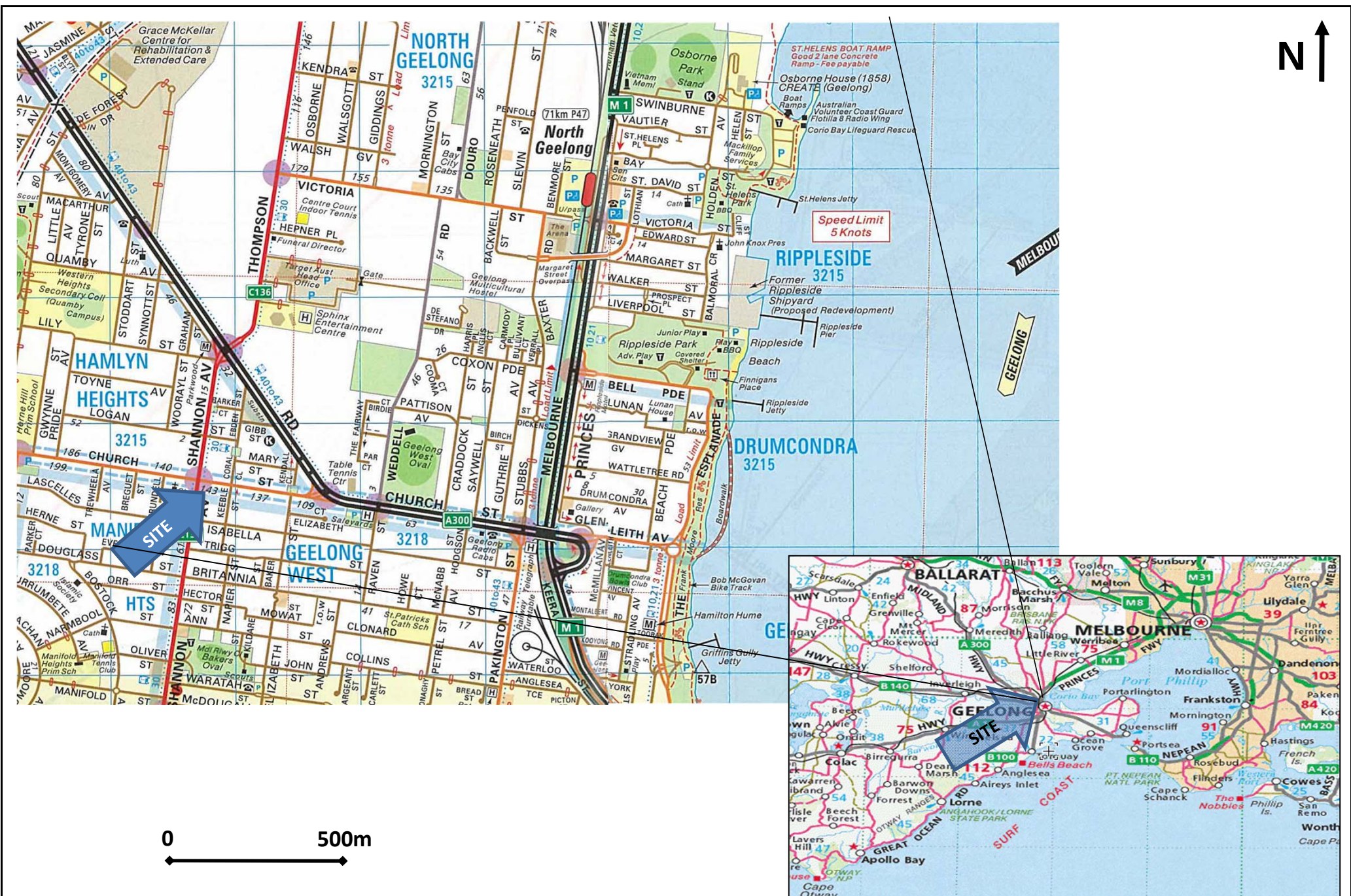
Figure G—Historical PSH Plume (June 1999 to June 2003)

Figure H—Historical PSH Plume (Apr 2006 to Feb 2009)

Figure I—Historical PSH Plume (Aug 2009 to Jan 2011)

Figure J—Conceptual Site Model





AEC Environmental Pty Ltd

Location: 151 Church Street, Geelong West

AEC Job Ref: 5176

Drawn: NW

Checked: SK

FIGURE A: LOCALITY PLAN

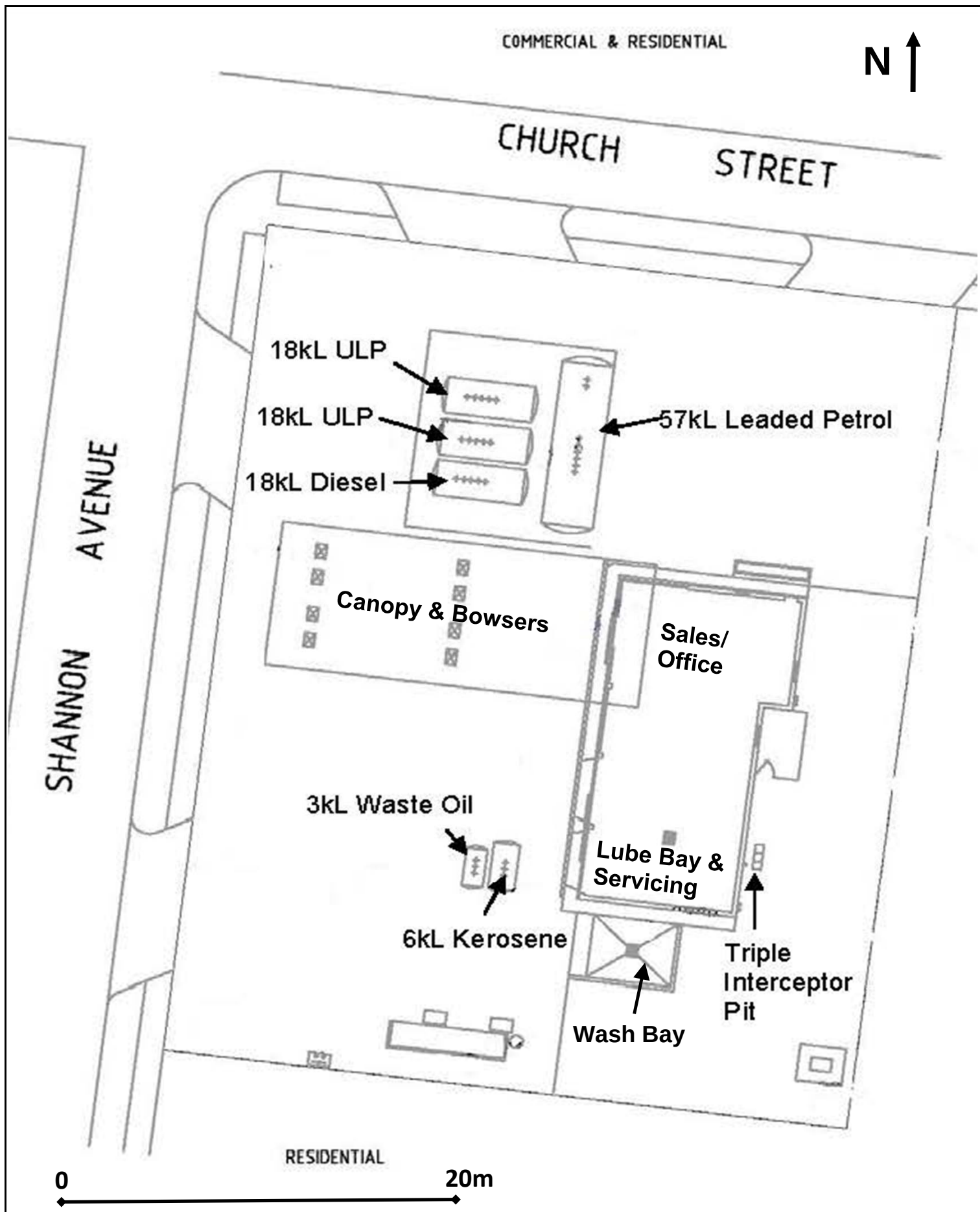
Date: May 2011

Scale: As shown

Source: Melway Publishing

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AEC Environmental Pty Ltd

Location: 151 Church Street, Geelong West

AEC Job Ref: 5176

Source: Adapted from Coffey

Drawn: NW

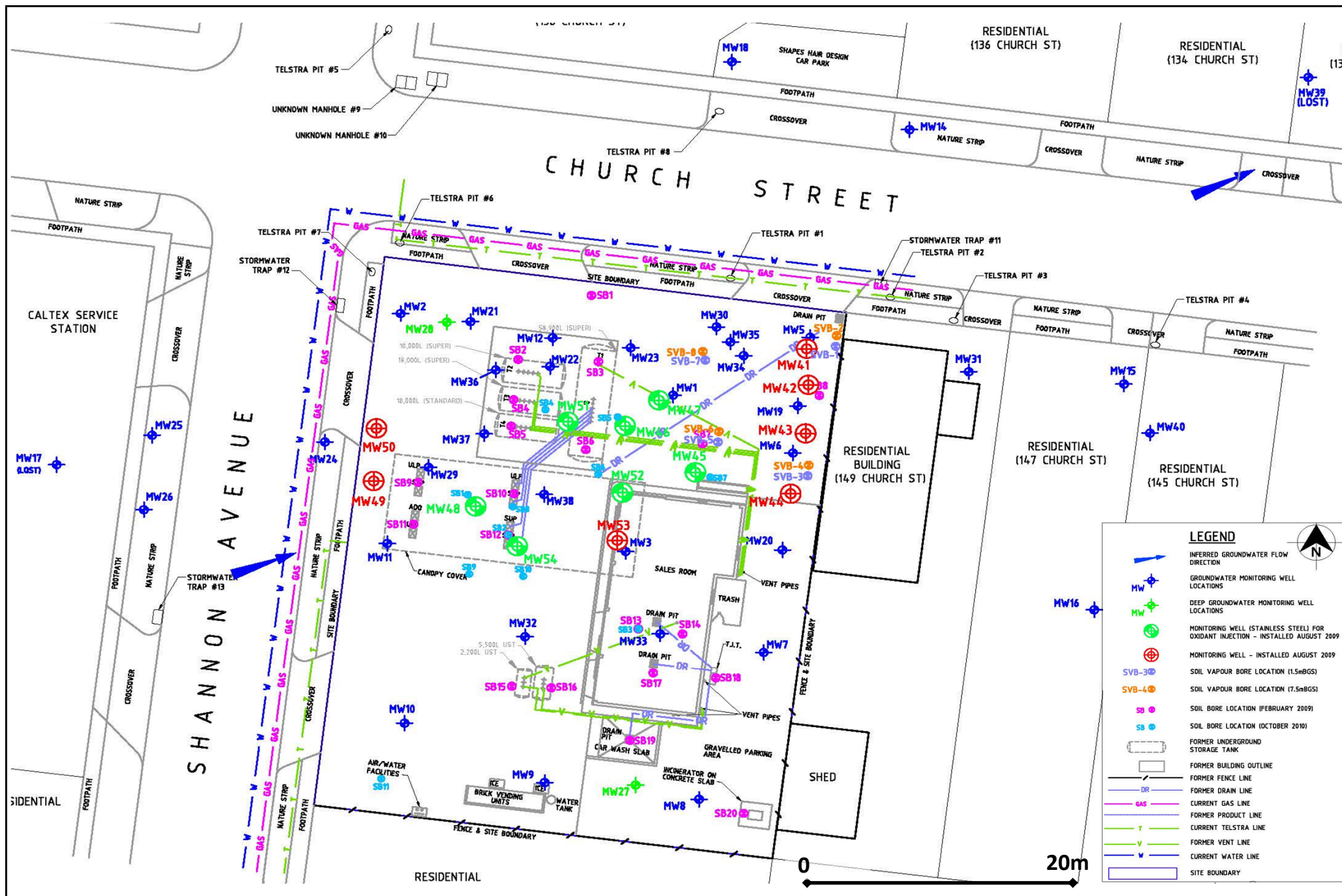
Date: May 11

(May 2011) Summary Report

Checked: SK

FIGURE B - FORMER SITE LAYOUT





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Location: 151 Church Street, Geelong West

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**FIGURE C: MONITORING
WELL LOCATIONS**

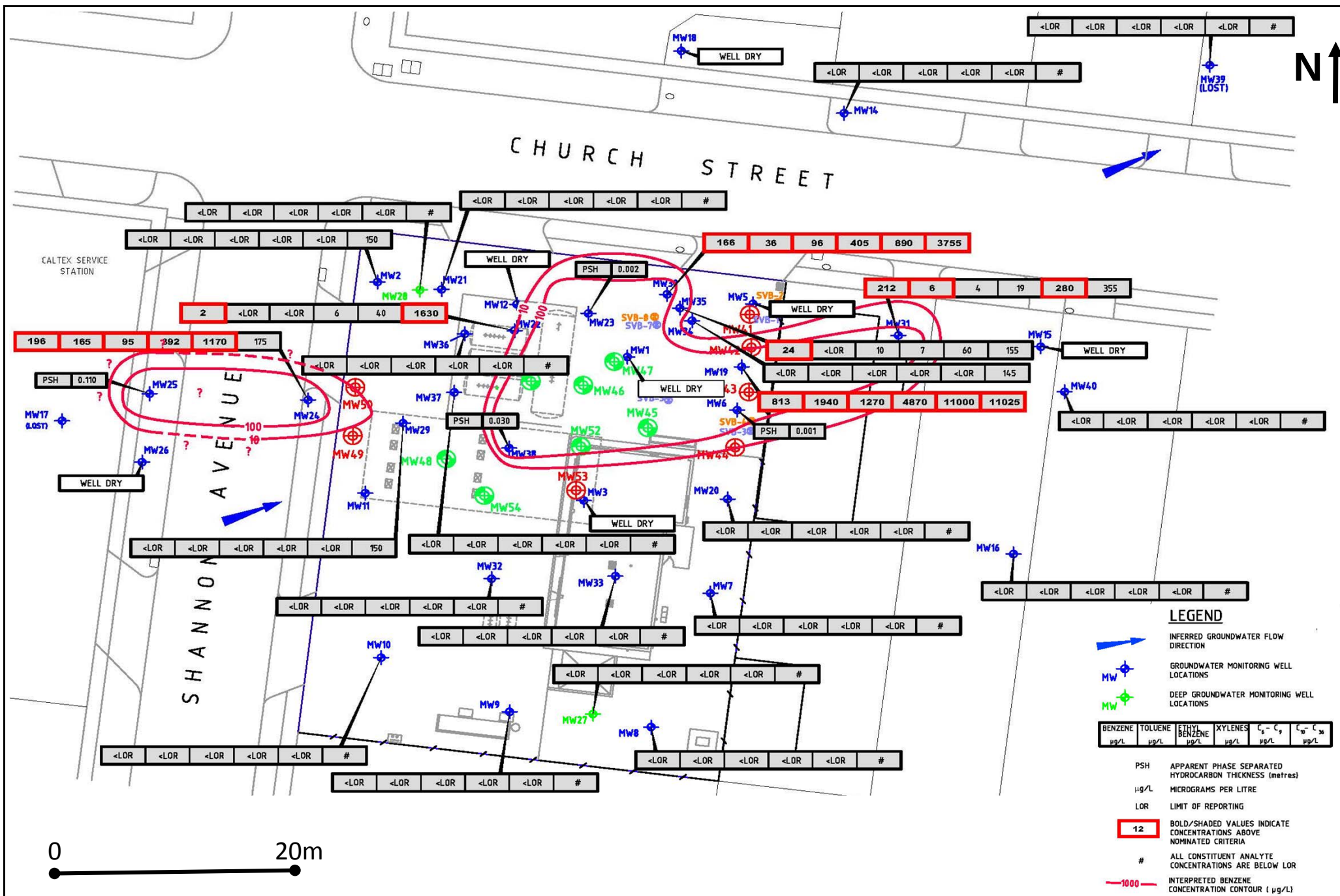
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Source: Adapted from Coffey (May 2011) Summary Report

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Location: 151 Church Street, Geelong West

AEC Job Ref: 5176

Drawn: NW

Checked: SK

**FIGURE D: PRE REMEDIATION
BENZENE IMPACTS - FEB 2009**

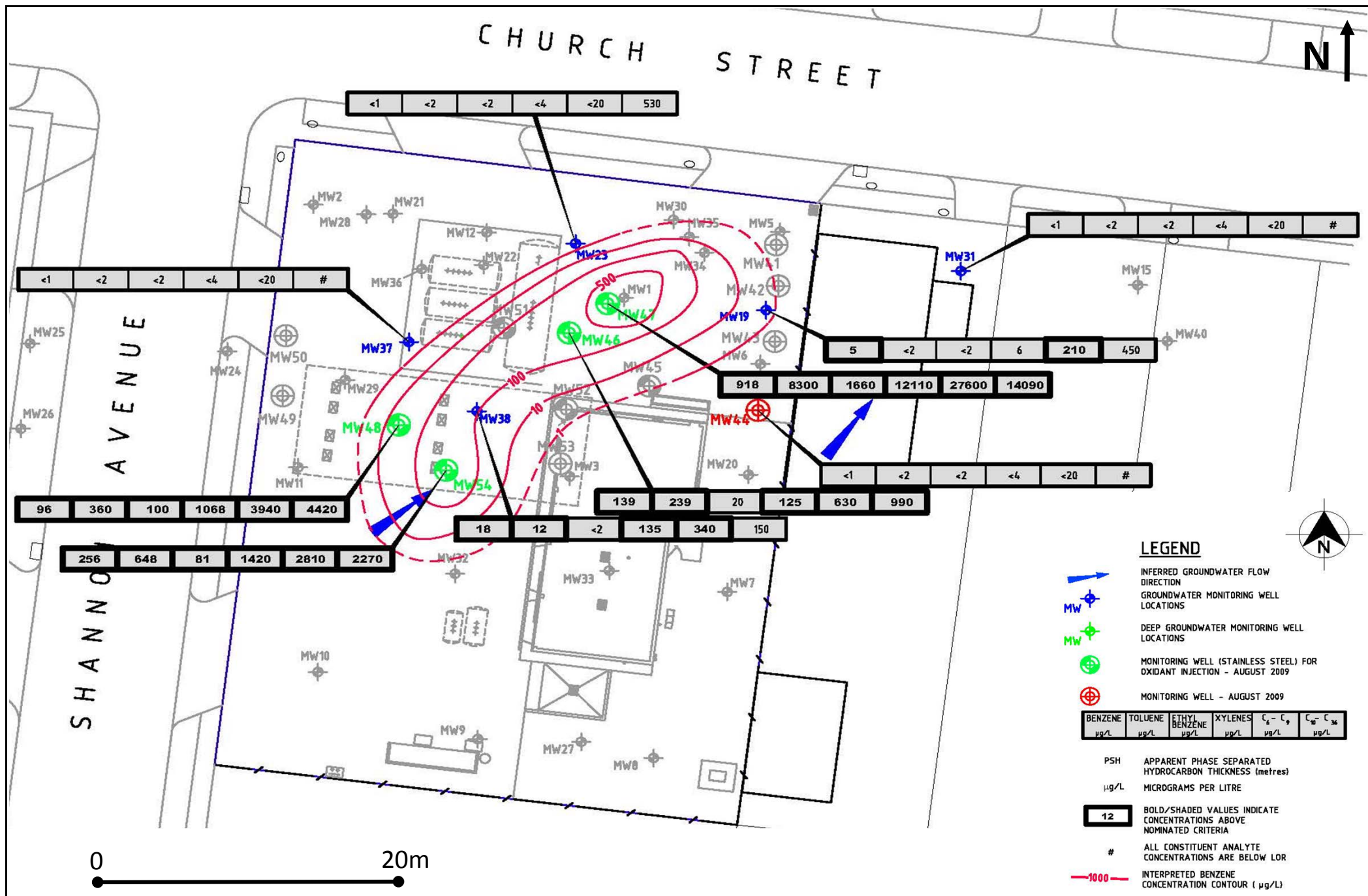
Date: May 2011

Scale: As shown

Source: Adapted from Coffey (May 2011) Summary Report

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Location: 151 Church Street, Geelong West

AEC Job Ref: 5176

Drawn: NW
Checked: SK

**FIGURE E: POST REMEDIATION
BENZENE IMPACTS - JAN 2011**

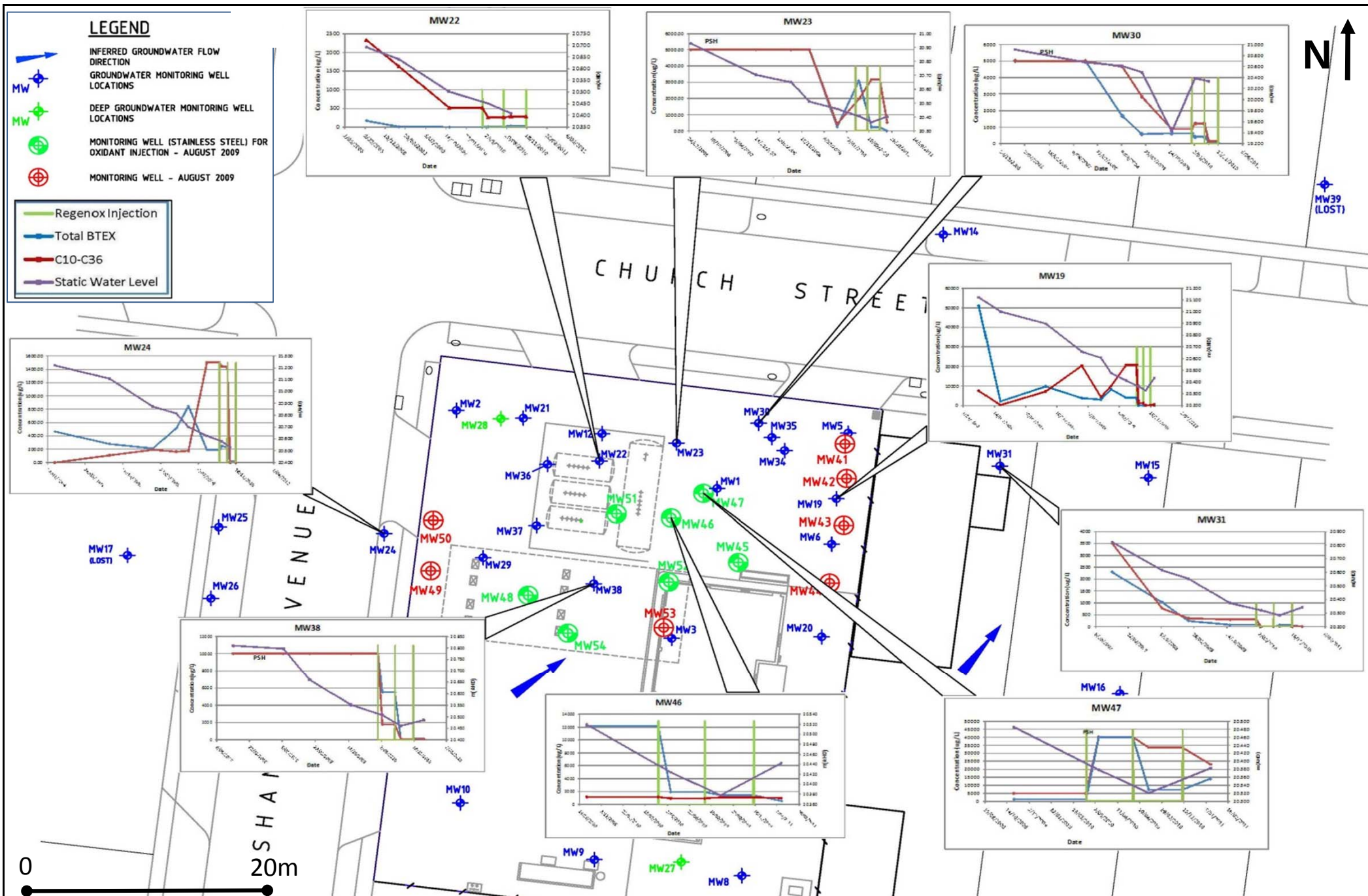
70 of 105



Date: May 2011

Scale: As shown

Source: Adapted from Coffey (May 2011) Summary Report



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Location: 151 Church Street, Geelong West

AEC Job Ref: 5176

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**FIGURE F: GROUNDWATER SWL
HISTORICAL TRENDS**

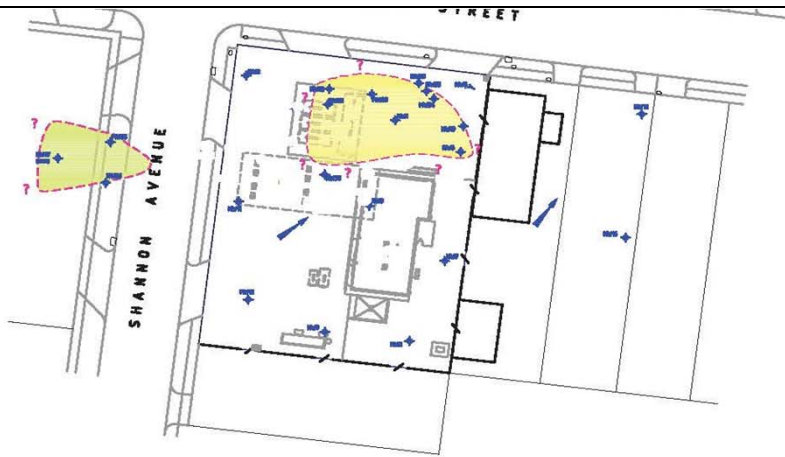
71 of 105



Date: May 2011

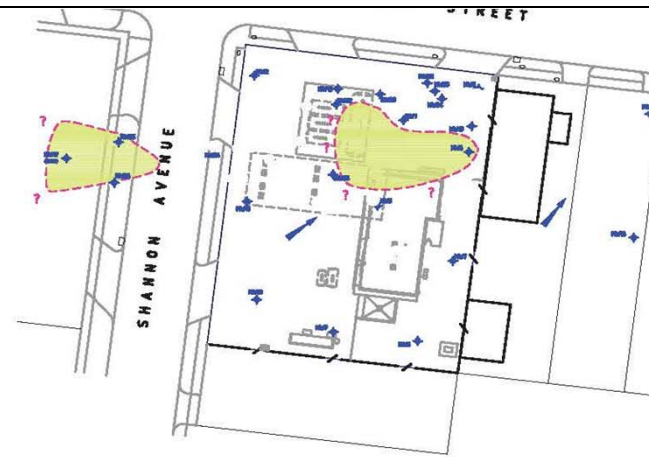
Scale: As shown

Source: Adapted from Coffey (May 2011) Summary Report



INFERRED PSH PLUME OCTOBER 1998

CONDUCTED BY HANDEX



INFERRED PSH PLUME JUNE 1999

CONDUCTED BY HANDEX



INFERRED PSH PLUME OCTOBER 1999

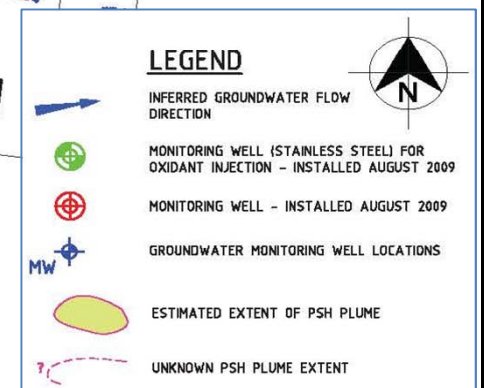
CONDUCTED BY PPK



INFERRED PSH PLUME JUNE 2003

CONDUCTED BY COFFEY (IT Environmental)

0 20m



AEC Environmental Pty Ltd

Location: 151 Church Street, Geelong West

AEC Job Ref: 5176

Drawn: NW

Checked: SK

**FIGURE G: HISTORICAL PSH
PLUME - JUNE 99 TO JUNE 03**

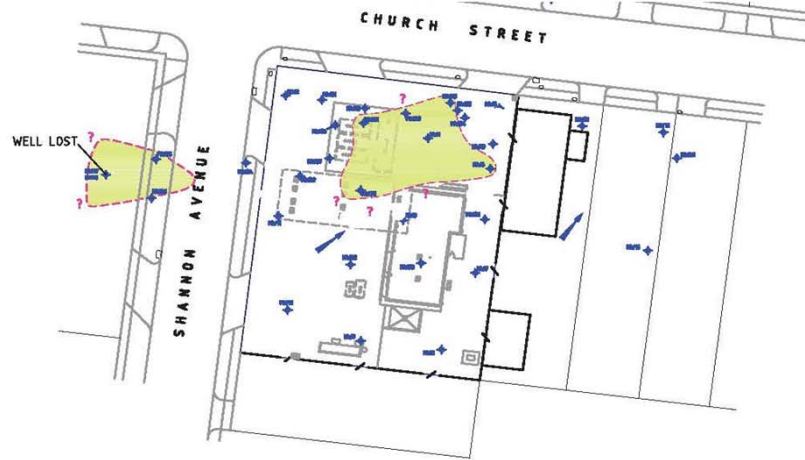
2 of 105



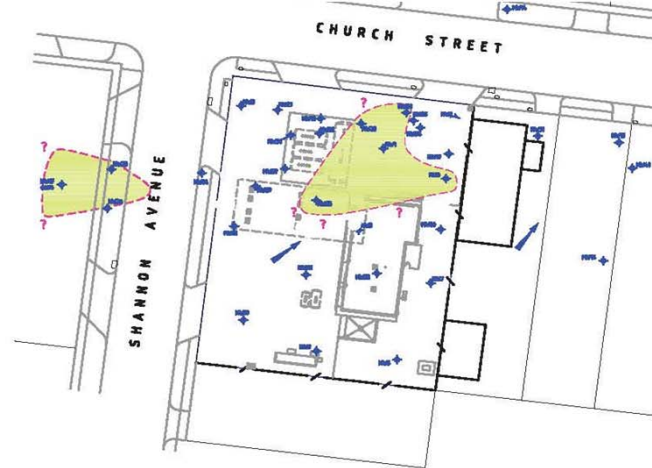
Date: May 2011

Scale: As shown

Source: Adapted from Coffey (May 2011) Summary Report



INFERRED PSH PLUME APRIL 2006



INFERRED PSH PLUME NOVEMBER 2007

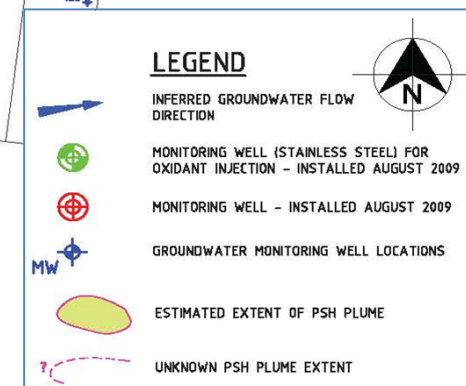


INFERRED PSH PLUME SEPTEMBER 2008



INFERRED PSH PLUME FEBRUARY 2009

0 20m



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Location: 151 Church Street, Geelong West

AEC Job Ref: 5176

Drawn: NW

Checked: SK

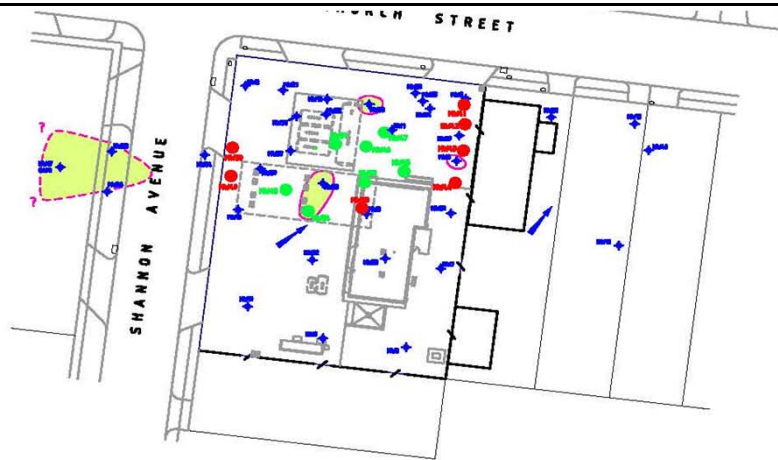
**FIGURE H: HISTORICAL PSH
PLUME - APR 06 TO FEB 09** 73 of 105



Date: May 2011

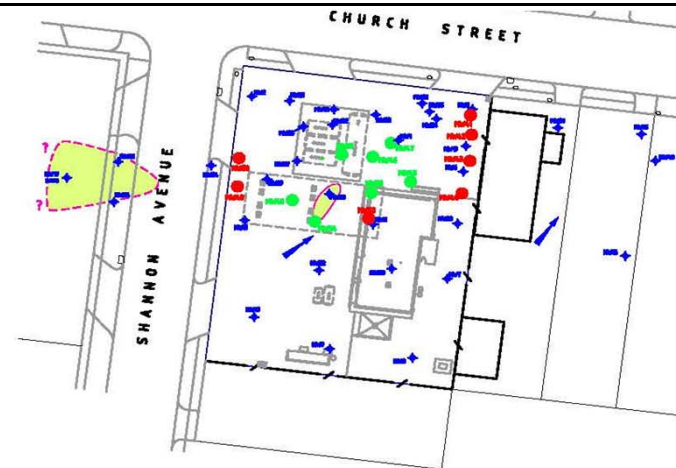
Scale: As shown

Source: Adapted from Coffey (May 2011) Summary Report



INFERRED PSH PLUME AUGUST 2009

● ● MONITORING WELLS INSTALLED

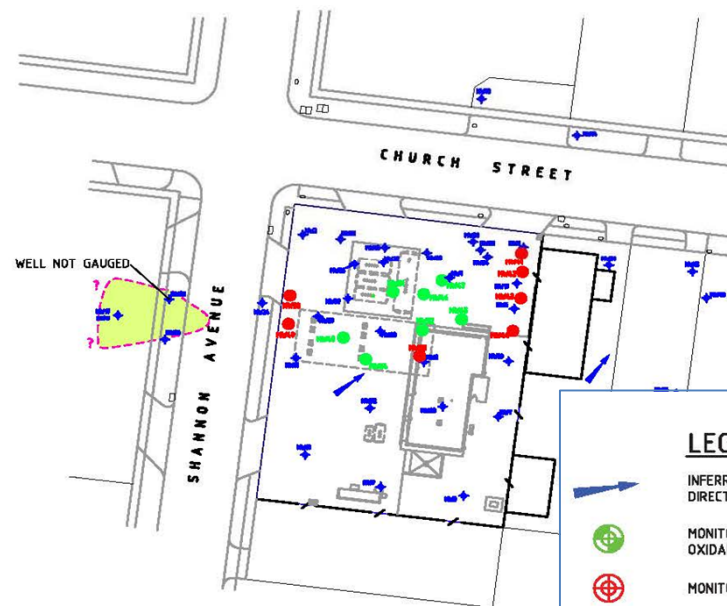


INFERRED PSH PLUME OCTOBER 2009

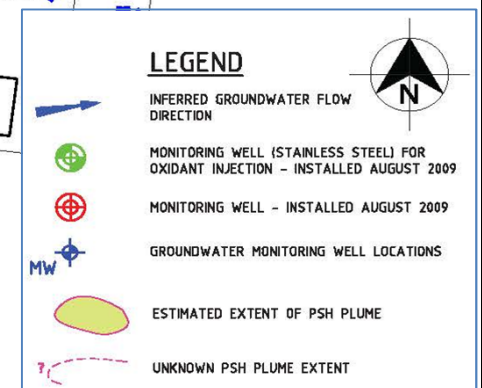


INFERRED PSH PLUME MAY 2010

0 20m



INFERRED PSH PLUME JANUARY 2011
NO MEASURABLE PSH



AEC Environmental Pty Ltd

Location: 151 Church Street, Geelong West

AEC Job Ref: 5176

Drawn: NW

Checked: SK

FIGURE I: HISTORICAL PSH

PLUME - AUG 09 TO JAN 11 74 of 105

Date: May 2011

Scale: As shown

Source: Adapted from Coffey (May 2011) Summary Report





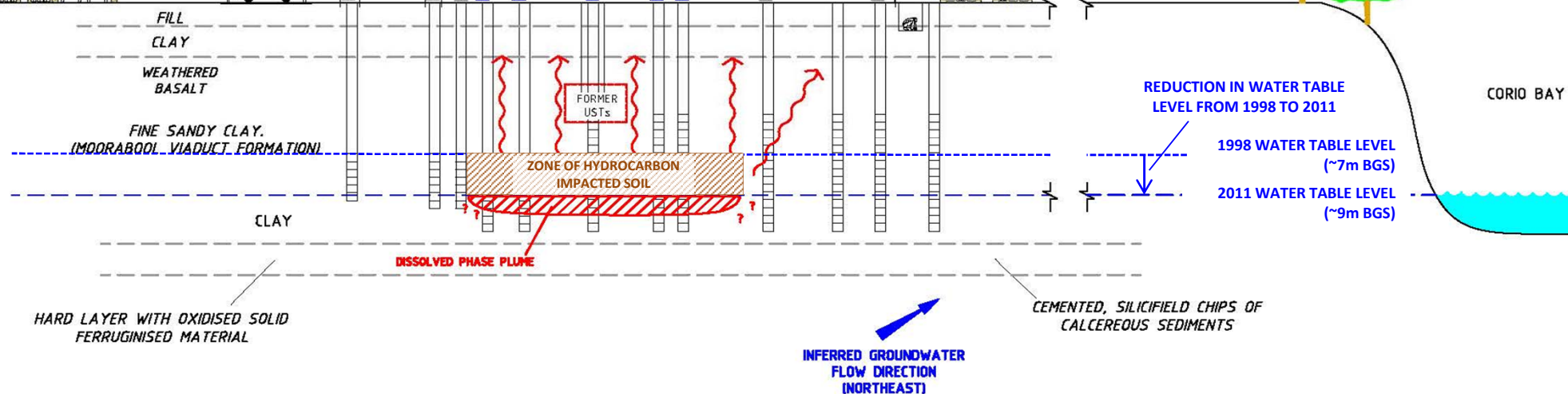
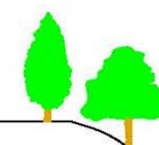
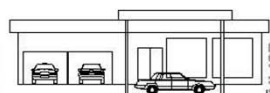
FORMER GEELONG WEST
SERVICE STATION

RESIDENTIAL

CALTEX
SERVICE STATION

RESIDENTIAL

SHANNON
AVENUE



AEC Environmental Pty Ltd

Location: 151 Church Street, Geelong West

AEC Job Ref: 5176

Drawn: NW

Checked: SK

**FIGURE J: CONCEPTUAL SITE
MODEL**

Date: May 2011

Scale: not to scale

Source: Adapted from Coffey (May 2011) Summary Report

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TABLES

- **Table 1— Removed Underground Storage Tank Details**
- **Table 2—Groundwater Monitoring Well Details**
- **Table 3—Historical Groundwater Gauging Results**
- **Table 4—Historical Groundwater Results (TPH, BTEX, Lead)**
- **Table 5—Historical Soil Vapour Analytical Results**



TABLE 1
REMOVED UNDERGROUND STORAGE TANK DETAILS
Former Mobil Geelong West Service Station (VO0993)

Tank ID	Type of Tank	Approximate Size (kL)	Product Type	Type of Construction	Status	Corrosion Protection	Condition of Tank if Exposed	Overfill Protection	Leak Detection Type	Date of Installation	Tank Bottom Invert (mBGS)	Date of Last Integrity Test	Removal or Abandonment Date	Origin of Information
T1	UST	57	Leaded Petrol	NK	Removed	NK	NA	NK	NK	NK	NK	NK	Approx 1997	PPK (1998)*
T2	UST	18	Unleaded Petrol	NK	Removed	NK	NA	NK	NK	NK	NK	NK	Approx 1997	PPK (1998)*
T3	UST	18	Unleaded Petrol	NK	Removed	NK	NA	NK	NK	NK	NK	NK	Approx 1997	PPK (1998)*
T4	UST	18	Diesel	NK	Removed	NK	NA	NK	NK	NK	NK	NK	Approx 1997	PPK (1998)*
T5	UST	6	Kerosene	NK	Removed	NK	NA	NK	NK	NK	NK	NK	Approx 1997	PPK (1998)*
T6	UST	3	Waste Oil	NK	Removed	NK	NA	NK	NK	NK	NK	NK	Approx 1997	PPK (1998)*

Notes:
 UST = Underground Storage Tank
 NA = Not Applicable
 NK = Not Known

* Origin of Information = PPK Environment and Infrastructure, *Quantitative Health Risk Assessment Of Former Service Station, Geelong West, Victoria (VO0993)*, December 1998

TABLE 2
GROUNDWATER MONITORING WELL DETAILS
FORMER MOBIL SERVICE STATION GEELONG WEST (VO0993)

Well ID	Date of Installation	Casing Diameter (mm)	Total Depth (m) bgs	Screen length (m)	Top of Well Casing Elevation (mAHD)	Well Head Type	Well Cap Type	Well Head and Cap Condition	Screen Zone Lithology ***
MW1	30/04/1998	50	8.00	3.0	29.050	Standpipe with monument	Push down Cap	Good	Silt to Silty Clay
MW2	11/06/1998	50	9.00	4.5	29.380	Standpipe with monument	Screw down "J" Cap	Good	Silt, Silty Clay, Clayey Sand, Sandy Silt
MW3	30/04/1998	50	8.00	3.0	29.260	Standpipe with monument	Push down Cap	OK. Monument slightly bent	Silt
MW4	Lost/ abandoned								
MW5	11/06/1998	50	8.00	4.5	28.420	Standpipe with monument	Screw down "J" Cap	OK. Cracked standpipe	Clayey Sand
MW6	11/06/1998	50	9.50	4.5	28.940	Standpipe with monument	Push down Cap	Good	Sand, Sandy Clay, Clayey Sand
MW7	11/06/1998	50	10.00	4.5	29.110	Standpipe with monument	Screw down "J" Cap	OK. Cracked cap replaced	Clayey Sand, Sandy Clay
MW8	11/06/1998	50	8.60	4.5	29.240	Standpipe with monument	Screw down "J" Cap	Good	Clayey Sand
MW9	11/06/1998	50	9.50	4.5	29.300	Standpipe with monument	Screw down "J" Cap	Good	Clayey Sand
MW10	11/06/1998	50	9.10	4.5	29.470	Standpipe with monument	Screw down "J" Cap	Good	Clayey Sand
MW11	11/06/1998	50	8.60	4.5	29.330	Standpipe with monument	Screw down "J" Cap	Good	Clayey Sand
MW12	11/06/1998	50	7.70	4.5	29.150	Standpipe with monument	Screw down "J" Cap	Good	Clayey Sand
MW13	Lost/ abandoned								
MW14	07/08/1998	50	8.50	3.0	28.470	Flush mounted gatic (Flip top)	Screw down "J" Cap	Good	Silt
MW15	06/08/1998	50	9.00	3.0	28.340	Flush mounted gatic (Flip top)	Screw down "J" Cap	Good	Silt
MW16	06/08/1998	50	9.00	3.0	28.500	Flush mounted gatic (Flip top)	Screw down "J" Cap	Good	Silt
MW17	05/10/1998	50	10.00	4.5	29.260	Well not found			Silt
MW18	05/10/1998	50	10.00	4.5	28.730	Flush mounted gatic (Flip top)	Screw down "J" Cap	Good	Silt
MW19	19/01/2000	50	10.00	NK	29.210	Standpipe without monument	Screw down "J" Cap	OK. No monument	Clayey Sand
MW20	19/01/2000	50	10.00	NK	29.500	Standpipe without monument	Screw down "J" Cap	OK. No monument	Clayey Sand
MW21	24/05/2000	50	10.00	NK	29.620	Standpipe without monument	Screw down "J" Cap	OK. No monument	Clayey Sand
MW22	24/05/2000	50	10.00	NK	29.460	Standpipe without monument	Screw down "J" Cap	OK. No monument	Clayey Sand
MW23	24/05/2000	50	10.00	NK	29.290	Standpipe without monument	Screw down "J" Cap	OK. No monument	Sandy Clay
MW24	19/03/2001	50	9.00	3.0	29.150	Flush mounted gatic (Screw down)	Screw down "J" Cap	Poor. Gatic not fixed.	Sandy Clay
MW25	20/03/2001	50	10.00	3.0	29.140	Flush mounted gatic (Screw down)	Screw down "J" Cap	Poor. Gatic not fixed.	Clayey sand
MW26	20/03/2001	50	9.20	3.0	29.120	Flush mounted gatic (Screw down)	Screw down "J" Cap	Poor. Gatic not fixed.	Clayey Sand
MW27	12/02/2004	50	15.00	3.0	29.810	Standpipe with monument	Push down Cap	Good	Sandy Clay
MW28	13/02/2004	50	15.00	3.0	29.790	Standpipe with monument	Push down Cap	Good	Sand Silty Clay
MW29	13/02/2004	50	10.00	4.0	29.690	Standpipe with monument	Screw down "J" Cap	Good	Sand
MW30	26/02/2004	50	9.50	3.0	29.400	Standpipe with monument	Screw down "J" Cap	Good	Sand to Clayey sand
MW31	26/02/2004	50	9.00	4.0	28.500	Flush mounted gatic (Screw down)	Screw down "J" Cap	Good	Sand with Some Gravels
MW32	12/02/2004	50	11.00	4.5	29.650	Standpipe with monument	Push down Cap	Good	Sand to Silty Clayey Sand
MW33	13/02/2004	50	10.50	4.5	29.620	Standpipe with monument	Push down Cap	Good	Sand to Silty Clayey Sand
MW34	12/10/2004	50	9.70	5.0	29.000	Standpipe without monument	Screw down "J" Cap	OK. No monument	Clayey Silty Sand to Silty Sand
MW35	12/10/2004	50	9.70	6.0	29.370	Standpipe with monument	Push down Cap	Good	Silty Sand to Sand
MW36	12/10/2004	50	10.00	6.0	29.490	Standpipe with monument	Push down Cap	Good	Sand
MW37	12/10/2004	50	10.00	4.0	29.490	Standpipe with monument	Push down Cap	Good	Sand
MW38	12/10/2004	50	9.50	4.0	29.420	Standpipe with monument	Push down Cap	Good	Sandy Silt to Sand
MW39	12/10/2004	50	9.00	3.0	27.980	Flush mounted gatic (Screw down)	Push down Cap	Good	Silty Sand
MW40	12/10/2004	50	11.00	3.0	28.290	Flush mounted gatic (Screw down)	Push down Cap	Good	Silt to silty sand
MW41	22/07/2009	50	11.00	5.5	29.470	Flush mounted gatic (Screw down)	Push down Cap	Good	Silty sand
MW42	22/07/2009	50	11.00	5.5	29.407	Flush mounted gatic (Screw down)	Push down Cap	Good	Silt
MW43	22/07/2009	50	11.00	5.5	29.351	Flush mounted gatic (Screw down)	Push down Cap	Good	Silty sand
MW44	22/07/2009	50	11.00	5.5	29.414	Flush mounted gatic (Screw down)	Push down Cap	Good	Silty sand
MW45	22/07/2009	50	11.50	5.5	29.255	Flush mounted gatic (Screw down)	Push down Cap	Good	Silty Sand to Clayey Sand
MW46	22/07/2009	50	11.50	4.5	29.310	Flush mounted gatic (Screw down)	Push down Cap	Good	Silty Sand to Clayey Sand
MW47	22/07/2009	50	11.50	5.0	29.323	Flush mounted gatic (Screw down)	Push down Cap	Good	Clayey Sand to Sand
MW48	23/07/2009	50	11.50	5.0	29.552	Flush mounted gatic (Screw down)	Push down Cap	Good	Silty Sand to Clayey Sand
MW49	23/07/2009	50	11.50	5.5	29.810	Flush mounted gatic (Screw down)	Push down Cap	Good	Silty Sand
MW50	23/07/2009	50	11.50	5.5	29.861	Flush mounted gatic (Screw down)	Push down Cap	Good	Silty Sand
MW51	23/07/2009	50	11.5	5.0	29.405	Flush mounted gatic (Screw down)	Push down Cap	Good	Sand, Silty sand and Clayey Sand
MW52	23/07/2009	50	11.50	5.0	29.383	Flush mounted gatic (Screw down)	Push down Cap	Good	Sand to Silty Sand
MW53	23/07/2009	50	11.50	5.5	29.561	Flush mounted gatic (Screw down)	Push down Cap	Good	Silty Sand
MW54	23/07/2009	50	11.50	4.5	29.509	Flush mounted gatic (Screw down)	Push down Cap	Good	Silty Sand

Notes:

Well head condition survey conducted

NK = Not known

ID = identification

AHD = Australia Height Datum (Surveyed 2004 & 2009)

*** These descriptions are extracted from available bore logs

TABLE 3
HISTORICAL GROUNDWATER GAUGING RESULTS
FORMER MOBIL SERVICE STATION GEELONG WEST (VO0993)

Well ID	Date	Well Diameter	PID	Total Well Depth	Casing Height	Total Depth	Well Elevation TOC	SWL	Depth to PSH	PSH Thickness	SWL Elevation	Corrected SWL Elevation	Comments
		(mm)	(ppm)	(mBGS)	mags	mBTOC	m (AHD)	(mBTOC)	(mBTOC)	m	m(AHD)	m(AHD)	
MW6	16/06/1998	50		9.500	0.160	9.660	28.840	7.128	7.131	0.003	21.712	21.714	
	09/10/1998	50		9.500	0.160	9.660	28.840	7.195	7.265	0.070	21.645	21.695	
	25/3/999	50		9.500	0.160	9.660	28.840	7.323	7.324	0.001	21.517	21.518	
	14/10/1999	50		9.500	0.160	9.660	28.840	7.399	7.446	0.047	21.441	21.475	
	07/05/2003	50		9.500	0.250	9.750	28.935	8.100	7.971	0.129	20.835	20.928	
	15/04/2004	50		9.500	0.250	9.750	28.930	7.899			21.031	21.031	
	11/04/2006	50		9.500	0.250	9.750	28.940	8.010	8.005	0.005	20.930	20.934	
	12/11/2007	50		9.255	0.250	9.750	28.940	8.241	8.240	0.001	20.699	20.700	
	15/09/2008	50		9.255	0.250	9.260	28.940	8.305	8.240	0.065	20.635	20.682	
	24/02/2009	50		9.500	0.250	9.290	28.940	8.420	8.419	0.001	20.520	20.521	
	14/08/2009	50	3.1	9.500	0.250	9.250	28.940	8.453	8.452	0.001	20.487	20.488	Strong HCO, bailer confirm 1mm PSH.
	28/10/2009	50	82.2	9.500	0.250	9.250	28.940	8.942			19.998	19.998	PID: 82.2 strong HCO well in good condition, bailer check confirmed no PSH and a very light sheen
	10/05/2010	50		9.500	0.250	7.900	28.940	Dry					Dry
	30/08/2010	50		9.500	0.250	7.500	28.940	Dry					Dry
MW19	17/01/2011	50	0.0	9.500	0.250	7.420	28.940	DRY			DRY	DRY	No HCO, dry
	05/07/2000	50		10.000	0.855	10.855	29.211	8.058	8.059	0.001	21.153	21.154	
	26/03/2001	50		10.000	0.855	10.855	29.211	8.200			21.011	21.011	
	07/05/2003	50		10.000	0.580	10.860	29.211	8.090			21.121	21.121	
	15/04/2004	50		10.000	0.580	10.860	29.210	8.208			21.002	21.002	
	11/04/2006	50		10.000	0.580	10.860	29.210	8.313			20.897	20.897	
	12/11/2007	50		10.000	0.580	10.860	29.210	8.551			20.659	20.659	
	15/09/2008	50		10.000	0.550	10.300	29.210	8.600			20.610	20.610	
	24/02/2009	50		10.000	0.550	10.300	29.210	8.732			20.478	20.478	
	14/08/2009	50	0.5	10.000	0.550	10.260	29.210	8.762			20.448	20.448	Requires new well cap, strong HCO, bailer confirm no PSH.
	28/10/2009	50		10.000	0.550	10.260	29.210	8.796			20.414	20.414	PID: 0.0, replaced well cap strong HCO, bailer check confirmed no PSH or sheen
	10/05/2010	50		10.000	0.550	10.260	29.210	8.846			20.364	20.364	
	30/08/2010	50		10.000	0.550	10.260	29.210	8.880			20.330	20.330	HCO, bailer check confirmed no PSH or sheen
	17/01/2011	50	0.0	10.000	0.550	10.050	29.210	8.774			8.774	20.436	HCO, well in good condition
MW22	05/07/2000	50		10.000	0.855	10.855	29.456	8.190	8.187	0.003	21.266	21.268	
	26/03/2001	50		10.000	0.855	10.855	29.456	8.335	8.333	0.002	21.121	21.122	
	07/05/2003	50		10.000	0.620	10.860	29.456	8.361	8.214	0.147	21.095	21.201	
	15/04/2004	50		10.000	0.620	10.860	29.460	8.372	8.365	0.007	21.088	21.093	
	11/04/2006	50		10.000	0.620	10.860	29.460	8.463	8.458	0.005	20.997	21.001	
	12/11/2007	50		10.000	0.620	10.860	29.460	8.720			20.740	20.740	
	15/09/2008	50		10.000	0.620	10.140	29.460	8.768			20.692	20.692	
	24/02/2009	50		10.000	0.620	10.140	29.460	8.820			20.640	20.640	
	14/08/2009	50	7.8	10.000	0.620	9.970	29.460	8.924			20.536	20.536	No odour, bailer confirm no PSH.
	28/10/2009	50	1.4	10.000	0.620	9.970	29.460	8.959			20.501	20.501	No odour PID: 1.4ppm, no PSH confirmed with bailer
	10/05/2010	50		10.000	0.620	9.970	29.460	9.009			20.451	20.451	
	30/08/2010	50		10.000	0.620	9.535	29.460	9.051			20.409	20.409	No odour, no PSH confirmed with bailer
	17/01/2011	50	0.3	10.000	0.620	8.900	29.460	DRY			DRY	DRY	No odour, well in good condition
MW23	05/07/2000	50		10.000	0.875	10.875	29.292	9.289	7.755	1.534	20.003	21.107	
	26/03/2001	50		10.000	0.875	10.875	29.292	9.438	7.915	1.523	19.854	20.951	
	07/05/2003	50		10.000	0.570	10.880	29.292	8.560	8.100	0.460	20.732	21.063	
	15/04/2004	50		10.000	0.570	10.880	29.290	8.365	8.216	0.149	20.925	21.032	
	11/04/2006	50		10.000	0.570	10.880	29.290	8.492	8.309	0.183	20.798	20.930	
	12/11/2007	50		10.000	0.570	10.880	29.290	8.620	8.575	0.045	20.670	20.702	
	15/09/2008	50		10.000	0.540	9.900	29.290	8.642	8.575	0.001	20.648	20.649	
	24/02/2009	50		10.000	0.540	9.882	29.290	8.780	8.778	0.002	20.510	20.511	
	14/08/2009	50	277	10.000	0.540	9.930	29.290	8.796	8.795	0.001	20.494	20.495	Strong HCO, bailer confirm 1mm of PSH.
	28/10/2009	50	26	10.000	0.540	9.930	29.290	8.831			20.459	20.459	Slight HCO PID:26.0ppm, no PSH confirmed with bailer
	10/05/2010	50		10.000	0.540	9.930	29.290	8.884			20.406	20.406	
	30/08/2010	50		10.000	0.540	9.435	29.290	8.927			20.363	20.363	HCO, no PSH confirmed with bailer
	17/01/2011	50	65.4	10.000	0.540	9.720	29.290	8.886			8.886	20.404	Strong HCO, well in good condition

TABLE 3
HISTORICAL GROUNDWATER GAUGING RESULTS
FORMER MOBIL SERVICE STATION GEELONG WEST (VO0993)

Well ID	Date	Well Diameter	PID	Total Well Depth	Casing Height	Total Depth	Well Elevation TOC	SWL	Depth to PSH	PSH Thickness	SWL Elevation	Corrected SWL Elevation	Comments
		(mm)	(ppm)	(mBGS)	mags	mBTOC	m (AHD)	(mBTOC)	(mBTOC)	m	m(AHD)	m(AHD)	
MW30	15/04/2004	50		9.500	0.500	10.000	29.400	8.392			21.008	21.008	
	11/04/2006	50		9.500	0.500	10.000	29.400	8.497	8.492	0.005	20.903	20.907	
	12/11/2007	50		9.500	0.500	10.000	29.400	8.729	8.725	0.004	20.671	20.674	
	15/09/2008	50		9.500	0.680	9.990	29.400	8.788			20.612	20.612	
	24/02/2009	50		9.500	0.680	10.050	29.400	8.905			20.495	20.495	
	14/08/2009	50	0.5	9.500	0.680	9.940	29.400	8.935			20.465	20.465	Slight HCO, bailer confirm no PSH.
	28/10/2009	50	0.0	9.500	0.680	9.940	29.400	9.975			19.425	19.425	No odour PID:0.0ppm
	10/05/2010	50		9.500	0.680	9.940	29.400	9.018			20.382	20.382	
	30/08/2010	50		9.500	0.680	9.975	29.400	9.065			20.335	20.335	HCO, no PSH confirmed with bailer
	17/01/2011	50	0.0	9.500	0.680	10.040	29.400	9.012			9.012	20.388	No odour, well in good condition
MW34	11/04/2006	50		9.700	0.30	10.00	29.000	8.08			20.920	20.920	
	12/11/2007	50		9.700	0.30	10.00	29.000	8.315			20.685	20.685	
	15/09/2008	50		9.700	0.33	9.88	29.000	8.387			20.613	20.613	
	24/02/2009	50		9.700	0.33	8.91	29.000	8.824			20.176	20.176	
	14/08/2009	50	0.9	9.970	0.00	9.94	29.000	8.208			20.792	20.792	Gatic head broken, no odour.
	28/10/2009	50	0.0	9.970	0.00	9.94	29.000	8.251			20.749	20.749	No odour, PID: 0.0ppm well head broken
	10/05/2010	50		9.970	0.00	9.94	29.000	8.293			20.707	20.707	
	30/08/2010	50		9.970	0.00	7.94	29.000	Dry					Casing Broken and well caved in with gravel, Survey data +/- 30cm, HCO
	17/01/2011	50	0.0	9.970	0.00	7.78	29.000	DRY			DRY	DRY	Casing broken and well caved in with gravel, Survey data +/- 30cm, HCO
MW35	11/04/2006	50		9.700	0.10	9.80	29.370	8.473			20.897	20.897	
	12/11/2007	50		9.700	0.10	9.80	29.370	8.688			20.682	20.682	
	15/09/2008	50		9.700	0.63	9.70	29.370	8.765			20.605	20.605	
	24/02/2009	50		9.700	0.63	9.70	29.370	8.84			20.530	20.530	
	14/08/2009	50	1.2	9.690	0.63	9.69	29.370	8.968			20.402	20.402	Monitoring well bent, bailer would not fit down, no odour.
	28/10/2009	50	0.0	9.960	0.63	9.69	29.370	9.002			20.368	20.368	No odour, PID: 0.0ppm
	10/05/2010	50		9.960	0.63	9.69	29.370	9.048			20.322	20.322	
	30/08/2010	50		9.960	0.63	9.77	29.370	9.094			20.276	20.276	No odour, no PSH confirmed with bailer
	17/01/2011	50	0.0	9.960	0.63	9.72	29.370	9.028			9.028	20.342	No odour, well in good condition
MW38	11/04/2006	50		9.500	0.30	9.80	29.420	8.375	8.290	0.085	21.045	21.106	
	12/11/2007	50		9.500	0.30	9.80	29.420	8.873	8.508	0.365	20.547	20.810	
	15/09/2008	50		9.500	0.52	9.70	29.420	8.652	8.508	0.040	20.768	20.797	
	24/02/2009	50		9.500	0.52	9.94	29.420	8.782	8.752	0.030	20.638	20.660	
	14/08/2009	50	7.8	9.500	0.52	9.89	29.420	8.835	8.815	0.020	20.585	20.599	Strong HCO, bailer confirm 20mm of orange PSH.
	28/10/2009	50	172.0	9.500	0.52	9.89	29.420	8.883	8.863	0.020	20.537	20.551	PID: 172.0, well in good condition, strong HCO bailer confirms 0.020m of orange PSH.
	10/05/2010	50		9.500	0.52	9.89	29.420	8.912			20.508	20.508	
	30/08/2010	50		9.500	0.52	9.99	29.420	8.958			20.462	20.462	HCO, no PSH confirmed with bailer
	17/01/2011	50	0.0	9.500	0.52	9.89	29.420	8.934			8.934	20.486	HCO, well in good condition
MW41	14/08/2009	50	3.4	11.500	0.73	11.77	29.47	9.040			20.430	20.430	No odour.
	28/10/2009	50	0.0	11.500	0.73	11.77	29.47	9.067			20.403	20.403	PID: 0.0 well in good condition no HCO/sheen
	10/05/2010	50		11.500	0.73	11.77	29.47	9.168			20.302	20.302	
	30/08/2010	50		11.500	0.73	11.66	29.47	9.203			20.267	20.267	No odour, no PSH confirmed with bailer
	17/01/2011	50	0.0	11.500	0.73	11.56	29.470	9.512			9.512	19.958	well in good condition, no HCO
MW42	14/08/2009	50	204	11.500	0.74	11.91	29.41	8.972			20.435	20.435	Strong HCO, bailer confirm no PSH.
	28/10/2009	50	2	11.500	0.74	11.91	29.41	9.001			20.406	20.406	PID: 2.4ppm, no HCO/sheen well in good condition.
	10/05/2010	50		11.500	0.74	11.91	29.41	9.088			20.319	20.319	
	30/08/2010	50		11.500	0.74	11.76	29.41	9.125			20.282	20.282	No odour, no PSH confirmed with bailer
	17/01/2011	50	0.0	11.500	0.74	10.31	29.407	9.097			9.097	20.31	no HCO well in good condition.
MW43	14/08/2009	50	104.2	11.500	0.69	11.78	29.35	8.897			20.454	20.454	Slight HCO, bailer confirm no PSH.
	28/10/2009	50	0.0	11.500	0.69	11.78	29.35	8.927			20.423	20.423	PID: 0.0, no HCO/sheen, well in good conditions.
	10/05/2010	50		11.500	0.69	11.78	29.35	8.978			20.372	20.372	
	30/08/2010	50		11.500	0.69	11.17	29.35	9.025			20.325	20.325	No odour, no PSH confirmed with bailer
	17/01/2011	50	0.0	11.500	0.69	11.15	29.351	8.972			8.972	20.379	no HCO well in good condition.
MW44	14/08/2009	50	6.8	11.500	0.74	11.67	29.41	8.935			20.479	20.479	Slight HCO, bailer confirm no PSH.
	28/10/2009	50	45.0	11.500	0.74	11.67	29.41	8.962			20.448	20.448	PID: 45ppm, well in good condition, slight HCO, bailer check confirms no PSH
	10/05/2010	50		11.500	0.74	11.67	29.41	9.069			20.341	20.341	

TABLE 3
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FORMER MOBIL SERVICE STATION GEELONG WEST (VO0993)

Well ID	Date	Well Diameter	PID	Total Well Depth	Casing Height	Total Depth	Well Elevation TOC	SWL	Depth to PSH	PSH Thickness	SWL Elevation	Corrected SWL Elevation	Comments
		(mm)	(ppm)	(mBGS)	mags	mBTOC	m (AHD)	(mBTOC)	(mBTOC)	m	m(AHD)	m(AHD)	
	30/08/2010	50		11.500	0.74	11.40	29.41	9.107			20.303	20.303	No odour, no PSH confirmed with bailer
	17/01/2011	50	0.0	11.500	0.74	11.37	29.414	9.063			9.063	20.351	no HCO well in good condition.
MW45	14/08/2009	50	0.5	11.500	0.55	12.12	29.26	8.744			20.511	20.511	Strong HCO, bailer confirm no PSH.
	28/10/2009	50	0.0	11.500	0.55	12.12	29.26	8.744			20.516	20.516	PID: 0.0, well in good condition no odour.
	10/05/2010	50		11.500	0.55	12.12	29.26	8.828			20.432	20.432	
	30/08/2010	50		11.500	0.55	12.00	29.26	8.893			20.367	20.367	HCO, no PSH confirmed with bailer
	17/01/2011	50	8	11.500	0.55	12.17	29.255	8.637			8.637	20.618	Slight HCO, well in good condition
MW46	14/08/2009	50	24.2	11.500	0.56	12.15	29.31	8.790			20.520	20.520	Strong HCO, bailer confirm no PSH.
	28/10/2009	50	700.0	11.500	0.56	12.15	29.31	8.170			21.140	21.140	PID: 700.0, well in good condition bailer check confirmed no PSH or sheen
	10/05/2010	50		11.500	0.56	12.15	29.31	8.886			20.424	20.424	
	30/08/2010	50		11.500	0.56	10.02	29.31	8.932			20.378	20.378	HCO, no PSH confirmed with bailer
	17/01/2011	50	164	11.500	0.56	10.64	29.310	8.868			8.868	20.442	Strong HCO, well in good condition
MW47	14/08/2009	50	4.1	11.500	0.56	12.10	29.32	8.838			20.485	20.485	Slight HCO, bailer confirm no PSH.
	28/10/2009	50	0.1	11.500	0.56	12.10	29.32	8.868			20.452	20.452	No odour PID:0.1ppm
	10/05/2010	50		11.500	0.56	12.10	29.32	8.967	8.932	0.035	20.353	20.378	HCO and ~2cm Gold PSH confirmed with bailer.
	30/08/2010	50		11.500	0.56	11.90	29.32	8.999			20.321	20.321	Strong HCO, bailer confirm no PSH.
	17/01/2011	50	184	11.500	0.56	12.02	29.323	8.94			8.94	20.383	Strong HCO, well in good condition
MW48	14/08/2009	50	1.7	11.500	0.56	11.40	29.55	8.938			20.614	20.614	Strong HCO, bailer confirm no PSH.
	28/10/2009	50	4.9	11.500	0.56	11.40	29.55	8.938			20.612	20.612	No HCO, PID:4.9ppm, no PSH confirmed with bailer
	10/05/2010	50		11.500	0.56	11.40	29.55	9.023			20.527	20.527	HCO.
	30/08/2010	50		11.500	0.56	10.18	29.55	9.078			20.472	20.472	HCO, no PSH confirmed with bailer
	17/01/2011	50	54.5	11.500	0.56	10.55	29.552	9.052			9.052	20.5	Strong HCO, well in good condition
MW49	14/08/2009	50	107	11.500	0.73	12.34	29.81	9.158			20.652	20.652	Slight HCO, bailer confirm no PSH.
	28/10/2009	50	16	11.500	0.73	12.34	29.81	9.220			20.590	20.590	No HCO, PID:16.0ppm no PSH
	10/05/2010	50		11.500	0.73	12.34	29.81	9.269			20.541	20.541	
	30/08/2010	50		11.500	0.73	10.94	29.81	9.315			20.495	20.495	No odour, no PSH confirmed with bailer
	17/01/2011	50	0.0	11.500	0.73	11.09	29.810	9.299			9.299	20.511	Well in good condition, no odour
MW50	14/08/2009	50	0.6	11.500	0.75	12.23	29.86	9.240			20.621	20.621	No odour.
	28/10/2009	50	0.0	11.500	0.75	12.23	29.86	9.297			20.563	20.563	No HCO, PID: 0.0ppm
	10/05/2010	50		11.500	0.75	12.23	29.86	9.340			20.520	20.520	
	30/08/2010	50		11.500	0.75	9.97	29.86	9.390			20.470	20.470	No odour, no PSH confirmed with bailer
	17/01/2011	50	0.0	11.500	0.75	10.04	29.861	9.394			9.394	20.467	Well in good condition, no odour
MW51	14/08/2009	50	0.5	11.500	0.58	12.11	29.41	8.854			20.551	20.551	Strong HCO, bailer confirm no PSH.
	28/10/2009	50	0.0	11.500	0.58	12.11	29.41	8.888			20.522	20.522	PID: 0.0 well in good condition no HCO or Sheen
	10/05/2010	50		11.500	0.58	12.11	29.41	8.958			20.452	20.452	
	30/08/2010	50		11.500	0.58	12.05	29.41	9.004			20.406	20.406	No odour, no PSH confirmed with bailer
	17/01/2011	50	260	11.500	0.58	12.33	29.405	8.974			8.974	20.431	Strong HCO, well in good condition
MW52	14/08/2009	50	10.7	11.500	0.60	12.11	29.38	8.830			20.553	20.553	Strong HCO, bailer confirm no PSH.
	28/10/2009	50	337.0	11.500	0.60	12.11	29.38	8.864			20.516	20.516	PID: 337 ppm, well in good condition, strong HCO, bailer check no PSH or sheen
	10/05/2010	50		11.500	0.60	12.11	29.38	8.924			20.456	20.456	
	30/08/2010	50		11.500	0.60	11.85	29.38	9.001			20.379	20.379	HCO, no PSH confirmed with bailer
	17/01/2011	50	454	11.500	0.60	11.75	29.383	8.946			8.946	20.437	Strong HCO, well in good condition
MW53	14/08/2009	50	184	11.500	0.71	12.30	29.56	8.992			20.569	20.569	Strong HCO, bailer confirm no PSH.
	28/10/2009	50	0	11.500	0.71	12.30	29.56	9.033			20.527	20.527	No HCO PID:0.0ppm
	10/05/2010	50		11.500	0.71	12.30	29.56	9.117			20.443	20.443	
	30/08/2010	50		11.500	0.71	12.01	29.56	9.171			20.389	20.389	No odour, no PSH confirmed with bailer
	17/01/2011	50	0.0	11.500	0.71	11.93	29.561	9.139			9.139	20.422	Well in good condition, no odour
MW54	14/08/2009	50	11.6	11.500	0.58	12.12	29.51	8.898	8.890	0.008	20.611	20.617	Strong HCO, bailer confirm 8mm of orange PSH.
	28/10/2009	50	14.7	11.500	0.58	12.12	29.51	8.933	8.925	0.008	20.577	20.583	Moderate HCO, PID 14.7ppm brown PSH, confirmed with bailer ~8mm
	10/05/2010	50		11.500	0.58	12.12	29.51	8.983			20.527	20.527	
	30/08/2010	50		11.500	0.58	11.10	29.51	9.041			20.469	20.469	HCO, no PSH confirmed with bailer
	17/01/2011	50	1.6	11.500	0.58	10.76	29.509	8.999			8.999	20.510	Well in good condition, no odour

TABLE 4a
HISTORICAL GROUNDWATER ANALYTICAL RESULTS
FORMER MOBIL SERVICE STATION GEELONG WEST (VO0993)
(All results in µg/L unless otherwise specified)

Sample Code	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	EM0910900007
Field ID	MW1	MW1	MW1	MW1	MW1	MW1	MW1	MW1	MW2	MW2	MW2	MW2	MW2	MW2	MW2	MW2	MW2	MW2	MW2	MW2
Sample Date	5/05/1998	25/03/1999	25/03/1999	25/03/1999	15/10/1999	5/07/2000	26/03/2001	7/05/2003	16/06/1998	25/03/1999	15/10/1999	5/07/2000	26/03/2001	7/05/2003	16/04/2004	13/04/2006	13/11/2007	16/09/2008	24/02/2009	30/10/2009
Comments			Blind Duplicate	Split Duplicate																

Chemical Name	LOR	Maintenance of Ecosystems (a)	Stock Watering (b)	Primary Contact Recreation (c)																				
TPH																								
TPH C6 - C9	20	150 (e)	NE	NE	11,000	11,000	12,000	32,000	33,000	22,000	11,000	3800	<20	<20	102	<20	<20	<20	<20	<20	<20	<20	<20	<20
TPH C10 - C14	50	NE	NE	NE	740	6300	5000	4700	2700	1600	1100	800	<40	<20	<20	<20	<20	<20	<20	<50	<50	<51	<50	<50
TPH C15 - C28	100	NE	NE	NE	<100	<100	<100	360	<100	<100	<100	<100	<200	<100	<100	<100	<100	<100	<100	100	<100	100	170	170
TPH C29 - C36	50	NE	NE	NE	<100	<100	<100	<100	<100	<100	<100	<100	<200	<100	<100	<100	<100	<100	<100	<50	<50	<51	<50	<50
TPH C10 - C36 (Sum of total)	50	600 (e)	NE	NE	740	6300	5000	5060	2700	1600	1100	800	<440	<220	<220	<220	<220	<220	<220	100	<200	150	<170	170
BTEX																								
Benzene	1	700	10	1 (f)	3000	1400	2000	5100	5200	3300	2200	1500	<0.5	<0.5	<0.5	0.6	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1
Toluene	2	NE	NE	25 (f)	3500	3500	3900	14,000	18,000	6700	5000	430	<1	<1	<1	2	<1	<1	<1	<1	<2	<2	<2	<2
Ethylbenzene	2	NE	NE	3 (f)	870	1300	1300	1900	1500	1200	690	430	<1	<1	<1	<1	<1	<2	<2	<2	<2	<2	<2	<2
Xylene (meta & para)	2	NE	NE	NE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	<2	<2	<2
Xylene (ortho)	2	NE	NE	NE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	<2	<2	<2
Xylene Total	NA (a)	NE	NE	20 (f)	2900	4400	4800	9300	7500	4700	3000	1240	<3	<3	<3	<3	<3	<1	<1	<1	<4	<4	<4	<4
Metals																								
Lead	1	4.4	100	50	3	23	-	15	8	-	2	<1	-	-	<1	-	-	<1	<1	<1	<1	<1	<1	<1

Notes:
QC = Quality Control Sample.
"H" = All constituent analyte concentrations are below LOR.
"--" = Analysis not requested
LOR = Limit of Reporting (= Method Detection Limit)
NE = Guideline not established
NA = Not Applicable
RPD = Relative Percent Difference

^(a) Where results are derived from the summation of selected analytes, LOR can not be determined.

All samples collected and analysed according to Mobil Specifications unless otherwise noted in Comments section.

Nominated Investigation Criteria:	
(a) ANZECC (2000) Australian Water Quality Guidelines for Fresh and Marine Waters (Marine Water - 95% level of protection)	
(b) ANZECC (2000) Water Quality Guidelines for Agricultural Water Use (Livestock)	
(c) ANZECC (2000) Recreational Water Quality and Aesthetics.	
(e) Ministry of Housing, Spatial Planning and Environment, Netherlands (2000) Intervention Values (Dutch Guidelines)	
(f) NHMRC/NRMMC (2004) National Water Quality Management Strategy. Australian Drinking Water Guidelines (Aesthetic criteria)	
	Shaded values exceed applicable beneficial use criteria- Maintenance of Ecosystems (Marinewater 95%)
	Shaded values exceed applicable beneficial use criteria- Livestock
	Shaded values exceed applicable beneficial use criteria- Primary Contact Recreation
< LOR	Where the LOR exceeds applicable beneficial use criteria

TABLE 4a
HISTORICAL GROUNDWATER ANALYTICAL RESULTS
FORMER MOBIL SERVICE STATION GEELONG WEST (VO0993)
(All results in µg/L unless otherwise specified)

Sample Code	-	-	-	-	-	-	-	-	-	EM0910899002	-	-	-	-	-	-	-	-	-	
Field ID	MW3	MW3	MW3	MW5	MW5	MW5	MW5	MW5	MW5	MW6	MW7	MW7	MW7	MW7	MW7	MW7	MW7	MW7	MW7	
Sample Date	5/05/1998	25/03/1999	15/10/1999	16/06/1998	25/03/1999	8/05/2003	16/04/2004	13/04/2006	13/11/2007	29/10/2009	16/06/1998	25/03/1999	14/10/1999	5/07/2000	26/03/2001	7/05/2003	16/04/2004	13/04/2006	13/11/2007	16/09/2008
Comments																				

Chemical Name	LOR	Maintenance of Ecosystems (a)	Stock Watering (b)	Primary Contact Recreation (c)																				
TPH																								
TPH C6 - C9	20	150 (e)	NE	NE	54000	5100	13000	38450	8500	7100	20000	13000	120	1000	30	41	85	40	<20	<20	<20	<20	<20	<20
TPH C10 - C14	50	NE	NE	NE	33000	3900	4200	10217	46000	14000	2200	9900	-	510	<40	110	390	20	<20	<20	<20	<20	<50	<50
TPH C15 - C28	100	NE	NE	NE	500	<100	<100	246	890	690	500	600	-	740	<200	<100	<100	<100	<100	<100	<100	<100	<100	<100
TPH C29 - C36	50	NE	NE	NE	<200	<100	<100	<200	<100	<100	<LOR	<LOR	-	<50	<200	<100	<100	<100	<100	<100	<100	<100	<50	<50
TPH C10 - C36 (Sum of total)	50	600 (e)	NE	NE	33500	3900	4200	10463	46890	14690	2700	10500	-	1250	<240	110	390	20	<220	<220	<220	<220	<220	<200
BTEX																								
Benzene	1	700	10	1 (f)	4500	1800	3900	12834	1900	3200	11000	6900	29	223	<0.5	1.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<1
Toluene	2	NE	NE	25 (f)	10,000	542	1800	16,244	625	1200	2500	110	3	200	6	7	<1	10	<1	<1	<1	<1	<2	<2
Ethylbenzene	2	NE	NE	3 (f)	5000	67	1500	1244	50	690	2200	1500	7	7	1	2	<1	4	<1	<2	<2	<2	<2	<2
Xylene (meta & para)	2	NE	NE	NE	-	-	-	-	-	-	-	-	-	117	-	-	-	-	-	-	-	-	-	<2
Xylene (ortho)	2	NE	NE	NE	-	-	-	-	-	-	-	-	-	70	-	-	-	-	-	-	-	-	-	<2
Xylene Total	NA (a)	NE	NE	20 (f)	20,000	2700	5800	7943	5900	2110	1600	1740	9	187	19	30	85	30	<3	<1	<4	<4	<4	<4
Metals																								
Lead	1	4.4	100	50	10	4	5	-	-	5	3	1	-	<1	-	-	-	-	-	<1	<1	<LOR	<1	<1

Notes:
QC = Quality Control Sample.
"#" = All constituent analyte concentrations are below LOR.
"--" = Analysis not requested
LOR = Limit of Reporting (= Method Detection Limit)
NE = Guideline not established
NA = Not Applicable
RPD = Relative Percent Difference

^(a) Where results are derived from the summation of selected analytes, LOR can not be determined.

All samples collected and analysed according to Mobil Specifications unless otherwise noted in Comments section.

TABLE 4a
HISTORICAL GROUNDWATER ANALYTICAL RESULTS
FORMER MOBIL SERVICE STATION GEELONG WEST (VO0993)
(All results in µg/L unless otherwise specified)

Sample Code	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Field ID	MW7	MW8	MW8	MW8	MW8	MW8	MW8	MW8	MW8	MW8	MW8	MW8	MW8	MW8	MW8	MW8	MW8
Sample Date	24/02/2009	16/06/1998	25/03/1999	14/10/1999	5/07/2000	5/07/2000	5/07/2000	26/03/2001	7/05/2003	16/04/2004	13/04/2006	13/11/2007	17/09/2008	24/02/2009			
Comments					Blind Duplicate	Split Duplicate											

Chemical Name	LOR	Maintenance of Ecosystems (a)	Stock Watering (b)	Primary Contact Recreation (c)													
TPH																	
TPH C6 - C9	20	150 (e)	NE	NE	<20	41	<20	<20	<20	<20	<25	<20	<20	<20	<20	<20	<20
TPH C10 - C14	50	NE	NE	NE	<50	695	<20	36	<20	<20	40	<20	<20	<20	<20	<50	<50
TPH C15 - C28	100	NE	NE	NE	<100	2341	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
TPH C29 - C36	50	NE	NE	NE	<50	329	<100	<100	<100	<100	<100	<100	<100	<100	<100	<50	<50
TPH C10 - C36 (Sum of total)	50	600 (e)	NE	NE	<200	3365	<220	36	<220	<220	40	<220	<220	<220	<220	<220	<200
BTEX																	
Benzene	1	700	10	1 (f)	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	<1	<1
Toluene	2	NE	NE	25 (f)	<2	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<2	<2
Ethylbenzene	2	NE	NE	3 (f)	<2	<1	<1	<1	<1	<1	<1	<1	<2	<2	<2	<2	<2
Xylene (meta & para)	2	NE	NE	NE	<2	-	-	-	-	-	-	-	-	-	-	-	<2
Xylene (ortho)	2	NE	NE	NE	<2	-	-	-	-	-	-	-	-	-	-	-	<2
Xylene Total	NA (a)	NE	NE	20 (f)	<4	41	<3	5	<3	<3	<2	<3	<1	<1	<1	<4	<4
Metals																	
Lead	1	4.4	100	50	<1	-	-	-	-	-	-	-	<1	<1	<1	<1	<1

Notes:
QC = Quality Control Sample.
"##" = All constituent analyte concentrations are below LOR.
"--" = Analysis not requested
LOR = Limit of Reporting (= Method Detection Limit)
NE = Guideline not established
NA = Not Applicable
RPD = Relative Percent Difference

^(a) Where results are derived from the summation of selected analytes, LOR can not be determined.

All samples collected and analysed according to Mobil Specifications unless otherwise noted in Comments section.

TABLE 4a
HISTORICAL GROUNDWATER ANALYTICAL RESULTS
FORMER MOBIL SERVICE STATION GEELONG WEST (VO0993)
(All results in µg/L unless otherwise specified)

Sample Code	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Field ID	MW9	MW9	MW9	MW9	MW9	MW9	MW9	MW9	MW9	MW9	MW10	MW10	MW10	MW10	MW10	MW10	MW10	MW10	MW10	MW10
Sample Date	16/06/1998	25/03/1999	14/10/1999	5/07/2000	26/03/2001	16/04/2004	13/04/2006	13/11/2007	15/09/2008	24/02/2009	5/05/1998	14/10/1999	5/07/2000	26/03/2001	7/05/2003	16/04/2004	13/04/2006	13/11/2007	17/09/2008	24/02/2009
Comments																				

Chemical Name	LOR	Maintenance of Ecosystems (a)	Stock Watering (b)	Primary Contact Recreation (c)																				
TPH																								
TPH C6 - C9	20	150 (e)	NE	NE	230	<20	<20	<20	<20	<20	<20	<20	<20	<20	-	<20	<20	<20	<20	<20	<20	<20	<20	<20
TPH C10 - C14	50	NE	NE	NE	225	<20	<20	<20	<20	<20	<20	<20	<50	<50	-	<20	<20	<20	<20	<20	<20	<50	<50	<50
TPH C15 - C28	100	NE	NE	NE	<200	<100	<100	<100	<100	<100	<100	<100	<100	<100	-	<100	<100	<100	<100	<100	<100	<100	<100	<100
TPH C29 - C36	50	NE	NE	NE	<200	<100	<100	<100	<100	<100	<100	<100	<50	<50	-	<100	<100	<100	<100	<100	<100	<50	<50	<50
TPH C10 - C36 (Sum of total)	50	600 (e)	NE	NE	225	<220	<220	<220	<220	<220	<220	<220	<200	<200	-	<220	<220	<220	<220	<220	<220	<220	<200	<200
BTEX																								
Benzene	1	700	10	1 (f)	8	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<1	<1
Toluene	2	NE	NE	25 (f)	59	<1	<1	7	1	<1	<1	<2	<2	<2	-	1	2	1	<1	1	1	<2	<2	<2
Ethylbenzene	2	NE	NE	3 (f)	9	<1	<1	1	<1	<1	<1	<2	<2	<2	-	<1	<1	<1	<2	<1	<1	<2	<2	<2
Xylene (meta & para)	2	NE	NE	NE	-	-	-	-	-	-	-	<2	<2	<2	-	-	-	-	-	-	-	-	<2	<2
Xylene (ortho)	2	NE	NE	NE	-	-	-	-	-	-	-	<2	<2	<2	-	-	-	-	-	-	-	-	<2	<2
Xylene Total	NA (a)	NE	NE	20 (f)	151	<1	<3	10	<3	<3	<3	<4	<4	<4	-	<3	4	<3	<1	<4	<4	<4	<4	<4
Metals																								
Lead	1	4.4	100	50	-	-	-	-	<1	<1	<1	<1	<1	<1	4	1	-	<1	<1	<1	3	<1	<1	<1

Notes:
QC = Quality Control Sample.
"#" = All constituent analyte concentrations are below LOR.
"--" = Analysis not requested
LOR = Limit of Reporting (= Method Detection Limit)
NE = Guideline not established
NA = Not Applicable
RPD = Relative Percent Difference

^(a) Where results are derived from the summation of selected analytes, LOR can not be determined.

All samples collected and analysed according to Mobil Specifications unless otherwise noted in Comments section.

TABLE 4a
HISTORICAL GROUNDWATER ANALYTICAL RESULTS
FORMER MOBIL SERVICE STATION GEELONG WEST (VO0993)
(All results in µg/L unless otherwise specified)

Sample Code	-	-	-	-	-	-	-	-	-	-	-	-	-
Field ID	MW11	MW11	MW11	MW11	MW11	MW11	MW11	MW11	MW11	MW11	MW11	MW12	MW12
Sample Date	16/06/1998	16/06/1998	25/03/1999	15/10/1999	15/10/1999	15/10/1999	5/07/2000	26/03/2001	8/05/2003	16/04/2004	13/04/2006	16/06/1998	13/04/2006
Comments		Blind Duplicate			Blind Duplicate	Split Duplicate							

Chemical Name	LOR	Maintenance of Ecosystems (a)	Stock Watering (b)	Primary Contact Recreation (c)													
TPH																	
TPH C6 - C9	20	150 (e)	NE	NE	2810	3050	11,000	7900	8300	8100	1100	520	160	70	330	32,580	<20
TPH C10 - C14	50	NE	NE	NE	2268	2384	3500	1700	1600	2300	<20	90	92	<20	120	263060	<50
TPH C15 - C28	100	NE	NE	NE	<200	<200	<100	<100	<100	240	<100	<100	<100	<100	<100	4549	<100
TPH C29 - C36	50	NE	NE	NE	<200	<200	<100	<100	<100	<100	<100	<100	<100	<100	<100	<200	<100
TPH C10 - C36 (Sum of total)	50	600 (e)	NE	NE	2268	2384	3500	1700	1600	2300	<220	90	92	<220	120	267,609	<220
BTEX																	
Benzene	1	700	10	1 (f)	1527	1616	6600	5100	5100	4000	610	370	73	47	240	2723	<1
Toluene	2	NE	NE	25 (f)	101	105	1200	870	900	910	42	28	<5	1	4	10,736	<2
Ethylbenzene	2	NE	NE	3 (f)	333	411	635	400	370	830	110	32	17	1	<2	1400	<2
Xylene (meta & para)	2	NE	NE	NE	-	-	-	-	-	-	-	-	-	-	-	-	-
Xylene (ortho)	2	NE	NE	NE	-	-	-	-	-	-	-	-	-	-	-	-	-
Xylene Total	NA (a)	NE	NE	20 (f)	845	908	2500	1800	1900	1900	76	86	8	3	37	17,720	<4
Metals																	
Lead	1	4.4	100	50	-	-	<1	<1	<1	<5	<1	<1	<1	<1	<1	-	<1

Notes:
QC = Quality Control Sample.
"H" = All constituent analyte concentrations are below LOR.
"-" = Analysis not requested
LOR = Limit of Reporting (= Method Detection Limit)
NE = Guideline not established
NA = Not Applicable
RPD = Relative Percent Difference
^(a) Where results are derived from the summation of selected analytes, LOR can not be determined.
All samples collected and analysed according to Mobil Specifications unless otherwise noted in Comments section.

TABLE 4a
HISTORICAL GROUNDWATER ANALYTICAL RESULTS
FORMER MOBIL SERVICE STATION GEELONG WEST (VO0993)
(All results in µg/L unless otherwise specified)

Sample Code	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Field ID	MW14	MW14	MW14	MW14	MW14	MW14	MW14	MW14	MW14	MW14	MW14	MW14	MW15	MW15	MW15	MW15	MW15	MW15
Sample Date	12/08/1998	12/08/1998	25/03/1999	15/10/1999	5/07/2000	26/03/2001	8/05/2003	16/04/2004	13/04/2006	17/09/2008	24/02/2009	9/10/1998	25/03/1999	14/10/1999	5/07/2000	26/03/2001	9/05/2003	16/04/2004
Comments		Blind Duplicate																

Chemical Name	LOR	Maintenance of Ecosystems (a)	Stock Watering (b)	Primary Contact Recreation (c)																				
TPH																								
TPH C6 - C9	20	150 (e)	NE	NE	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	-	-	<20	<20	<20	<20	160	<20	
TPH C10 - C14	50	NE	NE	NE	140	<40	<20	<20	<20	<20	<20	<20	<20	<20	<50	<50	-	-	<20	<20	<20	<20	<20	<20
TPH C15 - C28	100	NE	NE	NE	<200	<200	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	-	-	<100	<100	<100	<100	<100	<100
TPH C29 - C36	50	NE	NE	NE	<200	<200	<100	<100	<100	<100	<100	<100	<100	<100	60	<50	-	-	<100	<100	<100	<100	<100	<100
TPH C10 - C36 (Sum of total)	50	600 (e)	NE	NE	140	<440	<220	<220	<220	<220	<220	<220	<220	<220	135	<200	-	-	<220	<220	<220	<220	<220	<220
BTEX																								
Benzene	1	700	10	1 (f)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	-	-	<0.5	<0.5	<0.5	<0.5	33	<0.5	
Toluene	2	NE	NE	25 (f)	<1	<1	<1	<1	<1	<1	<1	<2	<2	<2	<2	-	-	<1	1	<1	<1	35	<1	
Ethylbenzene	2	NE	NE	3 (f)	<1	<1	<1	<1	<1	<1	<1	<2	<2	<2	<2	-	-	<1	<1	<1	<2	22	<2	
Xylene (meta & para)	2	NE	NE	NE	-	-	-	-	-	-	-	-	-	<2	<2	-	-	-	-	-	-	-	-	
Xylene (ortho)	2	NE	NE	NE	-	-	-	-	-	-	-	-	-	<2	<2	-	-	-	-	-	-	-	-	
Xylene Total	NA (a)	NE	NE	20 (f)	<3	<3	<3	<3	<3	<3	<1	<4	<4	<4	<4	-	-	<3	<3	<3	<1	67	<1	
Metals																								
Lead	1	4.4	100	50	-	-	-	-	-	-	<1	<1	<1	<1	<1	<1	<1	<1	-	-	<1	<1	<1	

Notes:
QC = Quality Control Sample.
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"–" = Analysis not requested
LOR = Limit of Reporting (= Method Detection Limit)
NE = Guideline not established
NA = Not Applicable
RPD = Relative Percent Difference
^(a) Where results are derived from the summation of selected analytes, LOR can not be determined.
All samples collected and analysed according to Mobil Specifications unless otherwise noted in Comments section.

TABLE 4a
HISTORICAL GROUNDWATER ANALYTICAL RESULTS
FORMER MOBIL SERVICE STATION GEELONG WEST (VO0993)
(All results in µg/L unless otherwise specified)

Sample Code	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Field ID	MW16	MW16	MW16	MW16	MW16	MW16	MW16	MW16	MW16	MW18	MW18	MW18	MW18	MW18	MW18	MW18	MW18	MW18
Sample Date	12/08/1998	25/03/1999	14/10/1999	5/07/2000	26/03/2001	13/04/2006	13/11/2007	16/09/2008	24/02/2009	9/10/1998	25/03/1999	15/10/1999	5/07/2000	26/03/2001	9/05/2003	11/04/2006	13/11/2007	17/09/2008
Comments																		

Chemical Name	LOR	Maintenance of Ecosystems (a)	Stock Watering (b)	Primary Contact Recreation (c)																				
TPH																								
TPH C6 - C9	20	150 (e)	NE	NE	<20	<20	<20	<20	30	<20	<20	<20	<20	33	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
TPH C10 - C14	50	NE	NE	NE	<40	<20	<20	<20	60	<20	<50	<50	<50	<40	<20	<20	<20	100	21	<50	300	<50	<50	<50
TPH C15 - C28	100	NE	NE	NE	<200	<100	<100	<100	<100	<100	<100	<100	<100	<200	<100	<100	<100	<100	<100	<100	200	<100	<100	<100
TPH C29 - C36	50	NE	NE	NE	<200	<100	<100	<100	<100	<100	<50	<50	<50	<200	<100	<100	<100	<100	<100	<50	<50	<50	<50	<50
TPH C10 - C36 (Sum of total)	50	600 (e)	NE	NE	<440	<220	<220	<220	60	<220	<220	<200	<200	<440	<220	<220	<220	100	21	<200	500	<200	<200	<200
BTEX																								
Benzene	1	700	10	1 (f)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	<1
Toluene	2	NE	NE	25 (f)	<1	<1	<1	3	<1	<1	<2	<2	<2	<1	<1	<1	<1	<1	<1	<2	<2	<2	<2	<2
Ethylbenzene	2	NE	NE	3 (f)	<1	<1	<1	<1	<1	<1	<2	<2	<2	<1	<1	<1	<1	<1	<2	<2	<2	<2	<2	<2
Xylene (meta & para)	2	NE	NE	NE	-	-	-	-	-	-	<2	<2	<2	-	-	-	-	-	-	-	-	-	-	<2
Xylene (ortho)	2	NE	NE	NE	-	-	-	-	-	-	<2	<2	<2	-	-	-	-	-	-	-	-	-	-	<2
Xylene Total	NA (a)	NE	NE	20 (f)	26	<3	<3	<3	26	<4	<4	<4	<4	33	<3	<3	<3	<3	<1	<4	<4	<4	<4	<4
Metals																								
Lead	1	4.4	100	50	-	-	-	-	-	<1	<1	<1	<1	-	-	-	<1	-	<1	<1	<1	<1	<1	<1

Notes:
QC = Quality Control Sample.
"#" = All constituent analyte concentrations are below LOR.
"--" = Analysis not requested
LOR = Limit of Reporting (= Method Detection Limit)
NE = Guideline not established
NA = Not Applicable
RPD = Relative Percent Difference
^(a) Where results are derived from the summation of selected analytes, LOR can not be determined.
All samples collected and analysed according to Mobil Specifications unless otherwise noted in Comments section.

TABLE 4a
HISTORICAL GROUNDWATER ANALYTICAL RESULTS
FORMER MOBIL SERVICE STATION GEELONG WEST (VO0993)
(All results in µg/L unless otherwise specified)

Sample Code	-	-	-	-	-	-	EM0910899011	-	-	-	-	-	-	-	EM0910897002
Field ID	MW19	MW19	MW19	MW19	MW19	MW19	MW19	MW20	MW20	MW20	MW20	MW20	MW20	MW20	MW20
Sample Date	8/05/2003	16/04/2004	13/04/2006	13/11/2007	17/09/2008	24/02/2009	30/10/2009	5/07/2000	26/03/2001	9/05/2003	16/04/2004	13/04/2006	13/11/2007	16/09/2008	24/02/2009
Comments															

Chemical Name	LOR	Maintenance of Ecosystems (a)	Stock Watering (b)	Primary Contact Recreation (c)																
TPH																				
TPH C6 - C9	20	150 (e)	NE	NE	58,000	2100	10,000	23,200	8320	10,400	9030	660	<20	<20	<20	<20	<20	<20	<20	<20
TPH C10 - C14	50	NE	NE	NE	7600	370	7100	20400	4230	9470	19100	700	<20	<20	<20	<20	<50	<50	<50	80
TPH C15 - C28	100	NE	NE	NE	<100	<LOR	600	<1000	200	600	1640	<100	<100	<100	<100	<100	<100	<100	<100	110
TPH C29 - C36	50	NE	NE	NE	<100	<LOR	<LOR	<500	<50	<50	60	<100	<100	<100	<100	<100	<50	<50	<50	<50
TPH C10 - C36 (Sum of total)	50	600 (e)	NE	NE	7600	370	7900	20,400	4455	10,095	20,800	700	<220	<220	<220	<220	<220	<200	<200	190
BTEX																				
Benzene	1	700	10	1 (f)	22,000	820	2500	711	452	751	617	2	<0.5	<0.5	<1	<1	<1	<1	<1	<1
Toluene	2	NE	NE	25 (f)	17,000	650	2400	100	589	1810	475	170	2	<1	<2	<2	<2	<2	<2	<2
Ethylbenzene	2	NE	NE	3 (f)	3100	150	1200	1130	542	1200	779	69	<1	<2	<2	<2	<2	<2	<2	<2
Xylene (meta & para)	2	NE	NE	NE	-	-	-	-	925	3110	1290	-	-	-	-	-	-	<2	<2	<2
Xylene (ortho)	2	NE	NE	NE	-	-	-	-	564	1530	892	-	-	-	-	-	-	<2	<2	<2
Xylene Total	NA (a)	NE	NE	20 (f)	8900	480	3700	1890	1489	4640	2182	410	3	<1	<4	<4	<4	<4	<4	<4
Metals																				
Lead	1	4.4	100	50	8	<1	4	15	5	3	4	-	-	1	<1	<1	<1	<1	4	<1

Notes:
QC = Quality Control Sample.
"#" = All constituent analyte concentrations are below LOR.
"--" = Analysis not requested
LOR = Limit of Reporting (= Method Detection Limit)
NE = Guideline not established
NA = Not Applicable
RPD = Relative Percent Difference

^(a) Where results are derived from the summation of selected analytes, LOR can not be determined.

All samples collected and analysed according to Mobil Specifications unless otherwise noted in Comments section.

TABLE 4a
HISTORICAL GROUNDWATER ANALYTICAL RESULTS
FORMER MOBIL SERVICE STATION GEELONG WEST (VO0993)
(All results in µg/L unless otherwise specified)

Sample Code	-	-	-	-	-	-	-	-	-	-	-	EM0910897011	EM0910899001	EM0910899009	RPD	9ENME0039279-	RPD
Field ID	MW21	MW21	MW21	MW21	MW21	MW21	MW21	MW21	MW22	MW22	MW22	MW22	MW23	QC10		QC11	
Sample Date	5/07/2000	26/03/2001	7/05/2003	16/04/2004	13/04/2006	13/11/2007	17/09/2008	24/02/2009	13/11/2007	16/09/2008	24/02/2009	29/10/2009	29/10/2009	29/10/2009		29/10/2009	
Comments														Duplicate of MW23		Triplicate of MW23	

Chemical Name	LOR	Maintenance of Ecosystems (a)	Stock Watering (b)	Primary Contact Recreation (c)																	
TPH																					
TPH C6 - C9	20	150 (e)	NE	NE	<20	<20	<20	<20	<20	<20	<20	<20	1430	390	40	<20	350	370	6%	430	21%
TPH C10 - C14	50	NE	NE	NE	<20	<20	<20	<50	<50	<50	<50	<50	2150	2200	410	240	200	170	16%	<40	133%
TPH C15 - C28	100	NE	NE	NE	<100	<100	<100	<100	<100	<100	<100	<100	200	100	900	220	180	180	0%	<100	57%
TPH C29 - C36	50	NE	NE	NE	<100	<100	<100	<50	<50	<50	<50	<50	<50	<50	320	50	60	<50	18%	<100	50%
TPH C10 - C36 (Sum of total)	50	600 (e)	NE	NE	<220	<220	<220	<220	<220	<220	<200	<200	2350	2325	1630	520	440	350	23%	<240	59%
BTEX																					
Benzene	1	700	10	1 (f)	<0.5	<0.5	<0.5	<1	<1	<1	<1	<1	146	1	2	<1	40	42	5%	64	46%
Toluene	2	NE	NE	25 (f)	4	<1	<1	<2	<2	<2	<2	<2	276	8	<2	<2	69	71	3%	110	46%
Ethylbenzene	2	NE	NE	3 (f)	<1	<1	<2	<2	<2	<2	<2	<2	29	14	<2	<2	9	9	0%	9.2	2%
Xylene (meta & para)	2	NE	NE	NE	-	-	-	-	-	-	<2	<2	-	97	3	<2	95	99	4%	150	45%
Xylene (ortho)	2	NE	NE	NE	-	-	-	-	-	-	<2	<2	-	49	3	<2	48	51	6%	74	43%
Xylene Total	NA (a)	NE	NE	20 (f)	<3	<3	<1	<4	<4	<4	<4	<4	234	146	6	<4	143	150	5%	220	42%
Metals																					
Lead	1	4.4	100	50	-	-	<1	<1	1	<1	<1	<1	2	3	2	<1	3	3	0%	<5	#

Notes:
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"-" = Analysis not requested
LOR = Limit of Reporting (= Method Detection Limit)
NE = Guideline not established
NA = Not Applicable
RPD = Relative Percent Difference

(a) Where results are derived from the summation of selected analytes, LOR can not be determined.

All samples collected and analysed according to Mobil Specifications unless otherwise noted in Comments section.

TABLE 4a
HISTORICAL GROUNDWATER ANALYTICAL RESULTS
FORMER MOBIL SERVICE STATION GEELONG WEST (VO0993)
(All results in µg/L unless otherwise specified)

Sample Code	-	-	-	-	-	-	-	EM0910899010	-	-	-	-	-	-	-	-	-	-	-
Field ID	MW24	MW24	MW24	MW24	MW24	MW24	MW24	MW24	MW27	MW27	MW27	MW27	MW28	MW28	MW28	MW28	MW29	MW29	MW29
Sample Date	26/03/2001	9/05/2003	16/04/2004	13/04/2006	13/11/2007	17/09/2008	24/02/2009	30/10/2009	13/04/2006	13/11/2007	15/09/2008	24/02/2009	13/04/2006	13/11/2007	16/09/2008	24/02/2009	13/04/2006	13/11/2007	17/09/2008
Comments																			

Chemical Name	LOR	Maintenance of Ecosystems (a)	Stock Watering (b)	Primary Contact Recreation (c)																			
TPH																							
TPH C6 - C9	20	150 (e)	NE	NE	260	2400	460	490	230	430	1170	180	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
TPH C10 - C14	50	NE	NE	NE	180	890	<50	110	190	90	100	360	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
TPH C15 - C28	100	NE	NE	NE	<100	<100	<100	<100	<100	<100	<100	820	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	100
TPH C29 - C36	50	NE	NE	NE	<100	<100	<100	<100	<50	<50	-	320	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
TPH C10 - C36 (Sum of total)	50	600 (e)	NE	NE	180	890	<200	110	190	165	175	1500	<220	<220	<200	<200	<220	<220	<200	<200	<220	<220	150
BTEX																							
Benzene	1	700	10	1 (f)	18	380	110	60	41	114	196	70	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Toluene	2	NE	NE	25 (f)	42	910	170	95	69	120	165	9	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Ethylbenzene	2	NE	NE	3 (f)	<1	100	42	21	22	58	95	25	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Xylene (meta & para)	2	NE	NE	NE	-	-	-	-	-	125	231	53	-	-	<2	<2	-	-	<2	<2	-	-	<2
Xylene (ortho)	2	NE	NE	NE	-	-	-	-	-	100	161	36	-	-	<2	<2	-	-	<2	<2	-	-	<2
Xylene Total	NA (a)	NE	NE	20 (f)	190	870	143	105	78	225	392	89	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Metals																							
Lead	1	4.4	100	50	<1	7	<1	<1	<1	<1	<1	<1	3	<1	7	2	<1	<1	1	6	<1	<1	<1

Notes:
QC = Quality Control Sample.
"#" = All constituent analyte concentrations are below LOR.
"--" = Analysis not requested
LOR = Limit of Reporting (= Method Detection Limit)
NE = Guideline not established
NA = Not Applicable
RPD = Relative Percent Difference

^(a) Where results are derived from the summation of selected analytes, LOR can not be determined.

All samples collected and analysed according to Mobil Specifications unless otherwise noted in Comments section.

TABLE 4a
HISTORICAL GROUNDWATER ANALYTICAL RESULTS
FORMER MOBIL SERVICE STATION GEELONG WEST (VO0993)
(All results in µg/L unless otherwise specified)

Sample Code	EM0910900003	-	-	EM0910897015	-	-	-	-	EM0910899014	-	-	-	-	EM0910897001	-	-	-	-
Field ID	MW29	MW30	MW30	MW30	MW31	MW31	MW31	MW31	MW31	MW32	MW32	MW32	MW32	MW32	MW33	MW33	MW33	MW33
Sample Date	30/10/2009	16/09/2008	24/02/2009	29/10/2009	13/04/2006	13/11/2007	16/09/2008	24/02/2009	30/10/2009	13/04/2006	13/11/2007	16/09/2008	24/02/2009	28/10/2009	13/04/2006	13/11/2007	15/09/2008	24/02/2009
Comments																		

Chemical Name	LOR	Maintenance of Ecosystems (a)	Stock Watering (b)	Primary Contact Recreation (c)																	
TPH																					
TPH C6 - C9	20	150 (e)	NE	NE	<20	2690	890	750	21,000	2010	1140	280	190	<20	<20	<20	<20	<20	<20	<20	<20
TPH C10 - C14	50	NE	NE	NE	190	4420	2760	910	2900	1500	690	280	170	<50	<50	<50	<50	<50	<50	<50	<50
TPH C15 - C28	100	NE	NE	NE	120	200	-	<100	200	<100	<100	<100	130	<100	<100	<100	<100	<100	<100	<100	<100
TPH C29 - C36	50	NE	NE	NE	<50	<50	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
TPH C10 - C36 (Sum of total)	50	600 (e)	NE	NE	310	4645	2835	910	3100	3510	765	355	300	<220	<220	<200	<200	<200	<220	<220	<200
BTEX																					
Benzene	1	700	10	1 (f)	<1	380	138	290	9500	1800	806	212	46	<1	<1	<1	<1	<1	<1	<1	<1
Toluene	2	NE	NE	25 (f)	3	76	28	32	1800	108	51	6	6	<2	<2	<2	<2	<2	<2	<2	<2
Ethylbenzene	2	NE	NE	3 (f)	<2	169	83	139	1100	155	-	4	4	<2	<2	<2	<2	<2	<2	<2	<2
Xylene (meta & para)	2	NE	NE	NE	3	603	184	70	-	-	83	6	8	-	-	<2	<2	<2	-	-	<2
Xylene (ortho)	2	NE	NE	NE	<2	452	152	98	-	-	85	13	8	-	-	<2	<2	<2	-	-	<2
Xylene Total	NA (a)	NE	NE	20 (f)	4	1055	336	168	2360	235	168	19	16	<4	<4	<4	<4	<4	<4	<4	<4
Metals																					
Lead	1	4.4	100	50	<1	1	<1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	2	<1	<1

Notes:
QC = Quality Control Sample.
"#" = All constituent analyte concentrations are below LOR.
"--" = Analysis not requested
LOR = Limit of Reporting (= Method Detection Limit)
NE = Guideline not established
NA = Not Applicable
RPD = Relative Percent Difference
^(a) Where results are derived from the summation of selected analytes, LOR can not be determined.
All samples collected and analysed according to Mobil Specifications unless otherwise noted in Comments section.

TABLE 4a
HISTORICAL GROUNDWATER ANALYTICAL RESULTS
FORMER MOBIL SERVICE STATION GEELONG WEST (VO0993)
(All results in µg/L unless otherwise specified)

Sample Code	-	-	-	-	EM0910897013	-	-	-	-	EM0910897014	-	-	-	-	EM0910897010	-	-	-	-	EM0910900004
Field ID	MW34	MW34	MW34	MW34	MW34	MW35	MW35	MW35	MW35	MW35	MW36	MW36	MW36	MW36	MW36	MW37	MW37	MW37	MW37	MW37
Sample Date	13/04/2006	13/11/2007	16/09/2008	24/02/2009	29/10/2009	13/04/2006	13/11/2007	16/09/2008	24/02/2009	29/10/2009	13/04/2006	13/11/2007	16/09/2008	24/02/2009	29/10/2009	13/04/2006	13/11/2007	16/09/2008	24/02/2009	30/10/2009
Comments																				

Chemical Name	LOR	Maintenance of Ecosystems (a)	Stock Watering (b)	Primary Contact Recreation (c)																				
TPH																								
TPH C6 - C9	20	150 (e)	NE	NE	20	40	<20	<20	20	1300	<20	90	60	170	<20	290	<20	<20	<20	<20	250	<20	<20	<20
TPH C10 - C14	50	NE	NE	NE	50	140	<50	70	70	280	330	140	80	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
TPH C15 - C28	100	NE	NE	NE	<100	<100	<100	<100	3400	<LOR	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
TPH C29 - C36	50	NE	NE	NE	<50	<50	<50	<50	540	<LOR	<50	<50	<50	100	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
TPH C10 - C36 (Sum of total)	50	600 (e)	NE	NE	50	140	<200	145	4010	280	330	215	155	100	<200	290	<200	<200	<200	<200	250	<200	<200	<50
BTEX																								
Benzene	1	700	10	1 (f)	17	15	2	<1	<1	1200	<1	36	24	53	<1	155	<1	<1	<1	<1	138	<1	<1	<1
Toluene	2	NE	NE	25 (f)	<2	<2	<2	<2	<2	<2	<2	3	<2	<2	<2	28	<2	<2	<2	<2	24	<2	<2	<2
Ethylbenzene	2	NE	NE	3 (f)	4	3	<2	<2	<2	66	<2	19	10	13	<2	54	<2	<2	<2	<2	44	<2	<2	<2
Xylene (meta & para)	2	NE	NE	NE	-	-	2	<2	<2	-	-	8	4	4	-	-	<2	<2	<2	<2	-	<2	<2	<2
Xylene (ortho)	2	NE	NE	NE	-	-	<2	<2	<2	-	-	7	3	4	-	-	<2	<2	<2	<2	-	<2	<2	<2
Xylene Total	NA (a)	NE	NE	20 (f)	<4	<4	3	<4	<4	<4	<4	15	7	8	<4	22	<4	<4	<4	<4	19	<4	<4	<4
Metals																								
Lead	1	4.4	100	50	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	8	<1	<1	<1	<1

Notes:
QC = Quality Control Sample.
"#" = All constituent analyte concentrations are below LOR.
"--" = Analysis not requested
LOR = Limit of Reporting (= Method Detection Limit)
NE = Guideline not established
NA = Not Applicable
RPD = Relative Percent Difference

^(a) Where results are derived from the summation of selected analytes, LOR can not be determined.

All samples collected and analysed according to Mobil Specifications unless otherwise noted in Comments section.

TABLE 4a
HISTORICAL GROUNDWATER ANALYTICAL RESULTS
FORMER MOBIL SERVICE STATION GEELONG WEST (VO0993)
(All results in µg/L unless otherwise specified)

Sample Code	-	-	-	-
Field ID	MW39	MW39	MW39	MW39
Sample Date	13/04/2006	13/11/2007	17/09/2008	24/02/2009
Comments				

Chemical Name	LOR	Maintenance of Ecosystems (a)	Stock Watering (b)	Primary Contact Recreation (c)				
TPH								
TPH C6 - C9	20	150 (e)	NE	NE	<20	<20	<20	<20
TPH C10 - C14	50	NE	NE	NE	50	90	<50	<50
TPH C15 - C28	100	NE	NE	NE	<100	<100	<100	<100
TPH C29 - C36	50	NE	NE	NE	<50	<50	<50	<50
TPH C10 - C36 (Sum of total)	50	600 (e)	NE	NE	50	90	<200	<200
BTEX								
Benzene	1	700	10	1 (f)	<1	<1	<1	<1
Toluene	2	NE	NE	25 (f)	<2	<2	<2	<2
Ethylbenzene	2	NE	NE	3 (f)	<2	<2	<2	<2
Xylene (meta & para)	2	NE	NE	NE	-	-	<2	<2
Xylene (ortho)	2	NE	NE	NE	-	-	<2	<2
Xylene Total	NA (a)	NE	NE	20 (f)	<4	<4	<4	<4
Metals								
Lead	1	4.4	100	50	<1	<1	<1	<1

Notes:
QC = Quality Control Sample.
"B" = All constituent analyte concentrations are below LOR.
"–" = Analysis not requested
LOR = Limit of Reporting (= Method Detection Limit)
NE = Guideline not established
NA = Not Applicable
RPD = Relative Percent Difference
^(a) Where results are derived from the summation of selected analytes, LOR can not be determined.
All samples collected and analysed according to Mobil Specifications unless otherwise noted in Comments section.

TABLE 4a
HISTORICAL GROUNDWATER ANALYTICAL RESULTS
FORMER MOBIL SERVICE STATION GEELONG WEST (VO0993)
(All results in µg/L unless otherwise specified)

Sample Code	-	-	-	-	EM0910899013	EM0910899012	EM0910900011	RPD	9ENME0039279-	RPD	EM0910899003	EM0910899015	EM0910900001	EM0910900006	EM0910897012	EM0910897007	EM0910899007	RPD	9ENME0039279-	RPD
Field ID	MW40	MW40	MW40	MW40	MW41	MW42	QC15		QC16		MW43	MW44	MW45	MW46	MW47	MW48	QC7		QC8	
Sample Date	13/04/2006	13/11/2007	16/09/2008	24/02/2009	30/10/2009	30/10/2009	30/10/2009		30/10/2009		29/10/2009	30/10/2009	30/10/2009	30/10/2009	29/10/2009	29/10/2009	29/10/2009		29/10/2009	
Comments							Duplicate of MW42		Triplicate of MW42								Duplicate of MW48		Triplicate of MW48	

Chemical Name	LOR	Maintenance of Ecosystems (a)	Stock Watering (b)	Primary Contact Recreation (c)																				
TPH																								
TPH C6 - C9	20	150 (e)	NE	NE	<20	<20	<20	<20	380	4970	5320	7%	6400	25%	80	550	1850	11900	27000	200	250	22%	330	49%
TPH C10 - C14	50	NE	NE	NE	<50	<50	<50	<50	150	5230	5220	0%	2800	61%	50	160	320	910	1190	80	50	46%	<40	67%
TPH C15 - C28	100	NE	NE	NE	<100	<100	<100	<100	120	200	340	52%	<100	67%	130	<100	<100	230	100	160	<100	46%	<100	46%
TPH C29 - C36	50	NE	NE	NE	<50	<50	<50	<50	<50	<50	<50	0%	<100	67%	<50	<50	<50	<50	<50	60	<50	18%	<100	50%
TPH C10 - C36 (Sum of total)	50	600 (e)	NE	NE	<200	<220	<200	<200	280	5420	5560	3%	2900	61%	190	160	320	1140	1290	290	50	141%	<240	19%
BTEX																								
Benzene	1	700	10	1 (f)	<1	<1	<1	<1	285	2300	2300	0%	2900	23%	6	63	508	4540	694	31	38	20%	59	62%
Toluene	2	NE	NE	25 (f)	<2	<2	<2	<2	6	937	956	2%	1100	16%	10	22	821	4860	1580	53	66	22%	90	52%
Ethylbenzene	2	NE	NE	3 (f)	<2	<2	<2	<2	23	552	567	3%	610	10%	<2	43	56	193	674	3	4	29%	4.3	36%
Xylene (meta & para)	2	NE	NE	NE	-	-	<2	<2	9	937	953	2%	1100	16%	10	10	359	1870	1410	67	83	21%	110	49%
Xylene (ortho)	2	NE	NE	NE	-	-	<2	<2	10	658	635	4%	710	8%	31	12	138	760	641	34	41	19%	58	52%
Xylene Total	NA (a)	NE	NE	20 (f)	<4	<4	<4	<4	19	1595	1588	0%	1800	12%	41	22	497	2630	2051	101	124	20%	170	51%
Metals																								
Lead	1	4.4	100	50	4	<1	<1	<1	<1	<1	<1	#	<5	#	<1	<1	<1	<1	2	<1	<1	#	<5	#

Notes:
QC = Quality Control Sample.
"#" = All constituent analyte concentrations are below LOR.
"--" = Analysis not requested
LOR = Limit of Reporting (= Method Detection Limit)
NE = Guideline not established
NA = Not Applicable
RPD = Relative Percent Difference

^(a) Where results are derived from the summation of selected analytes, LOR can not be determined.

All samples collected and analysed according to Mobil Specifications unless otherwise noted in Comments section.

TABLE 4a
HISTORICAL GROUNDWATER ANALYTICAL RESULTS
FORMER MOBIL SERVICE STATION GEELONG WEST (VO0993)
(All results in µg/L unless otherwise specified)

Sample Code	EM0910897008	EM0910897009	EM0910900005	EM0910900002	EM0910897003
Field ID	MW49	MW50	MW51	MW52	MW53
Sample Date	29/10/2009	29/10/2009	30/10/2009	30/10/2009	28/10/2009
Comments					

Chemical Name	LOR	Maintenance of Ecosystems (a)	Stock Watering (b)	Primary Contact Recreation (c)					
TPH									
TPH C6 - C9	20	150 (e)	NE	NE	<20	<20	760	1120	30
TPH C10 - C14	50	NE	NE	NE	90	<50	140	700	<50
TPH C15 - C28	100	NE	NE	NE	130	140	160	260	110
TPH C29 - C36	50	NE	NE	NE	<50	70	<50	<50	<50
TPH C10 - C36 (Sum of total)	50	600 (e)	NE	NE	220	210	310	960	110
BTEX									
Benzene	1	700	10	1 (f)	<1	<1	520	828	<1
Toluene	2	NE	NE	25 (f)	<2	<2	250	499	<2
Ethylbenzene	2	NE	NE	3 (f)	<2	<2	8	6	<2
Xylene (meta & para)	2	NE	NE	NE	<2	<2	86	164	14
Xylene (ortho)	2	NE	NE	NE	<2	<2	48	98	9
Xylene Total	NA (a)	NE	NE	20 (f)	<4	<4	134	262	23
Metals									
Lead	1	4.4	100	50	1	<1	<1	<1	6

Notes:
QC = Quality Control Sample.
"H" = All constituent analyte concentrations are below LOR.
"-": Analysis not requested
LOR = Limit of Reporting (= Method Detection Limit)
NE = Guideline not established
NA = Not Applicable
RPD = Relative Percent Difference

(a) Where results are derived from the summation of selected analytes, LOR can not be determined.

All samples collected and analysed according to Mobil Specifications unless otherwise noted in Comments section.

TABLE 4b
HISTORICAL GROUNDWATER ANALYTICAL RESULTS
FORMER MOBIL SERVICE STATION GEELONG WEST (VO0993)
(All results in µg/L unless otherwise specified)

Sample Code	MW2	EM1009542025	MW19	QC1	RPD %	QC2	RPD %	EM1009542001	EM1009542020	RPD %	10SE20122	RPD %	EM1100439016	MW20	EM1009542002	MW22	EM1009542026
Field ID	MW2	MW2	MW19	MW19				MW19	QC7		QC8		MW19	MW20	MW20	MW22	MW22
Sample Date	11/05/2010	30/8/2010	10/05/2010	10/05/2010		10/05/2010		31/8/2010	31/8/2010		31/8/2010		18/01/2011	10/05/2010	31/8/2010	11/05/2010	30/8/2010
Comments				Duplicate of MW19		Triplicate of MW19			Duplicate of MW19		Triplicate of MW19						

Chemical Name	LOR	Maintenance of Ecosystems (a)	Stock Watering (b)	Primary Contact Recreation (c)																	
TPH																					
TPH C6 - C9	20	150 (e)	NE	NE	<20	<20	670	690	3%	1200	57%	540	210	88%	240	77%	210	<20	<20	70	60
TPH C10 - C14	50	NE	NE	NE	<50	<50	1110	1310	17%	1500	30%	140	120	15%	<50	-	210	<50	<50	260	150
TPH C15 - C28	100	NE	NE	NE	<100	<100	100	210	71%	100	0%	<100	<100	#	<100	#	180	<100	<100	<100	130
TPH C29 - C36	50	NE	NE	NE	<50	<50	<50	<50	NA	<100	NA	<50	<50	#	<100	#	60	<50	<50	<50	<50
TPH C10 - C36 (Sum of total)	50	600 (e)	NE	NE	<50	<50	1210	1520	23%	1650	31%	140	120	15%	<250	-	450	<50	<50	260	280
BTEX																					
Benzene	1	700	10	1 (f)	<1	<1	31	31	0%	41	28%	5	3	50%	4.4	13%	5	<1	<1	2	6
Toluene	2	NE	NE	25 (f)	<2	<2	13	15	14%	20	42%	3	2	40%	3	0%	<2	<2	<2	2	12
Ethylbenzene	2	NE	NE	3 (f)	<2	<2	23	25	8%	27	16%	<2	<2	#	2	-	<2	<2	<2	<2	3
Xylene (meta & para)	2	NE	NE	NE	<2	<2	27	38	34%	41	41%	12	7	53%	12	0%	4	<2	<2	<2	3
Xylene (ortho)	2	NE	NE	NE	<2	<2	18	23	24%	-	NA	6	4	40%	6	0%	2	<2	<2	11	11
Xylene Total	NA (a)	NE	NE	20 (f)	<4	<4	45	61	30%	67	39%	18	11	-	18	-	6	<4	<4	11	14
Metals																					
Lead	1	4.4	100	50	<1	<1	2	2	0%	<5	NA	4	4	0%	<5	-	<1	<1	<1	1	2

Notes:
QC = Quality Control Sample.
"H" = All constituent analyte concentrations are below LOR.
"-" = Analysis not requested
LOR = Limit of Reporting (= Method Detection Limit)
NE = Guideline not established
NA = Not Applicable
RPD = Relative Percent Difference
(a) Where results are derived from the summation of selected analytes, LOR can not be determined.
All samples collected and analysed according to Mobil Specifications unless otherwise noted in Comments section.

Nominated Investigation Criteria:
(a) ANZECC (2000) Australian Water Quality Guidelines for Fresh and Marine Waters (Marine Water - 95% level of protection)
(b) ANZECC (2000) Water Quality Guidelines for Agricultural Water Use (Livestock)
(c) ANZECC (2000) Recreational Water Quality and Aesthetics.
(e) Ministry of Housing, Spatial Planning and Environment, Netherlands (2000) Intervention Values (Dutch Guidelines)
(f) NHMRC/NRMMC (2004) National Water Quality Management Strategy. Australian Drinking Water Guidelines (Aesthetic criteria)

Shaded values exceed applicable beneficial use criteria- Maintenance of Ecosystems (Marinewater 95%)
Shaded values exceed applicable beneficial use criteria- Livestock
Shaded values exceed applicable beneficial use criteria- Primary Contact Recreation

< LOR

Where the LOR exceeds applicable beneficial use criteria

TABLE 4b
HISTORICAL GROUNDWATER ANALYTICAL RESULTS
FORMER MOBIL SERVICE STATION GEELONG WEST (VO0993)
(All results in µg/L unless otherwise specified)

Sample Code	MW23	EM1009542027	EM1100439015	MW24	EM1009542028	MW29	EM1009542029	MW30	EM1009542030	MW31	EM1009542003	EM1100439001	MW32	EM1009542004	MW34	MW35	EM1009542031
Field ID	MW23	MW23	MW23	MW24	MW24	MW29	MW29	MW30	MW30	MW31	MW31	MW31	MW32	MW32	MW34	MW35	MW35
Sample Date	11/05/2010	30/8/2010	18/01/2011	10/05/2010	30/8/2010	11/05/2010	30/8/2010	11/05/2010	30/8/2010	11/05/2010	31/8/2010	17/01/2011	10/05/2010	31/8/2010	11/05/2010	11/05/2010	30/8/2010
Comments																	

Chemical Name	LOR	Maintenance of Ecosystems (a)	Stock Watering (b)	Primary Contact Recreation (c)																	
TPH																					
TPH C6 - C9	20	150 (e)	NE	NE	4930	440	<20	440	20	<20	<20	760	110	30	90	<20	40	<20	30	170	<20
TPH C10 - C14	50	NE	NE	NE	1560	2790	90	1200	<50	<50	<100	1030	160	<50	<50	<50	<50	<50	60	<50	<50
TPH C15 - C28	100	NE	NE	NE	420	380	320	240	<100	<100	260	200	<100	<100	<100	<100	<100	<100	270	350	<100
TPH C29 - C36	50	NE	NE	NE	<50	<100	120	<50	<50	<50	<100	<50	<50	<50	<50	<50	<50	<50	160	<50	<50
TPH C10 - C36 (Sum of total)	50	600 (e)	NE	NE	1980	3170		530	<50	<50	260	1230	160	<50	<50	<50	<50	<50	490	350	<50
BTEX																					
Benzene	1	700	10	1 (f)	429	25	<1	20	6	<1	<1	162	34	2	35	<1	<1	<1	<1	46	<1
Toluene	2	NE	NE	25 (f)	836	43	<2	30	<2	<2	<2	56	2	<2	7	<2	4	<2	<2	4	<2
Ethylbenzene	2	NE	NE	3 (f)	<50	<2	<2	32	3	<2	<2	94	30	<2	5	<2	<2	<2	<2	<2	<2
Xylene (meta & para)	2	NE	NE	NE	990	100	<2	118	4	<2	<2	57	3	<2	12	<2	11	<2	<2	2	<2
Xylene (ortho)	2	NE	NE	NE	841	60	<2	53	<2	<2	<2	47	4	<2	5	<2	5	<2	5	<2	<2
Xylene Total	NA (a)	NE	NE	20 (f)	1831	160	<4	171	4	<4	<4	104	7	<4	17	<4	16	<4	5	2	<4
Metals																					
Lead	1	4.4	100	50	<10	2	2	8	<1	<1	<1	2	<1	<1	<1	<1	<1	<1	2	<1	<1

Notes:
QC = Quality Control Sample.
"H" = All constituent analyte concentrations are below LOR.
"--" = Analysis not requested
LOR = Limit of Reporting (= Method Detection Limit)
NE = Guideline not established
NA = Not Applicable
RPD = Relative Percent Difference
(a) Where results are derived from the summation of selected analytes, LOR can not be determined.

All samples collected and analysed according to Mobil Specifications unless otherwise noted in Comments section.

TABLE 4b
HISTORICAL GROUNDWATER ANALYTICAL RESULTS
FORMER MOBIL SERVICE STATION GEELONG WEST (VO0993)
(All results in µg/L unless otherwise specified)

Sample Code	MW36	EM1009542032	MW37	EM1009542033	EM1100439002	MW38	EM1009542005	EM1100439013	MW41	EM1009542006	MW42	EM1009542007	MW43	EM1009542008	MW44	EM1009542009	EM1100439017
Field ID	MW36	MW36	MW37	MW37	MW37	MW38	MW38	MW38	MW41	MW41	MW42	MW42	MW43	MW43	MW44	MW44	MW44
Sample Date	11/05/2010	30/8/2010	11/05/2010	30/8/2010	17/01/2011	10/05/2010	31/8/2010	18/01/2011	10/05/2010	31/8/2010	10/05/2010	31/8/2010	10/05/2010	31/8/2010	10/05/2010	31/8/2010	18/01/2011
Comments																	

Chemical Name	LOR	Maintenance of Ecosystems (a)	Stock Watering (b)	Primary Contact Recreation (c)																	
TPH																					
TPH C6 - C9	20	150 (e)	NE	NE	<20	<20	<20	<20	<20	7900	180	340	60	<20	390	<20	100	80	40	<20	<20
TPH C10 - C14	50	NE	NE	NE	<50	<50	<50	<50	<50	1820	140	150	<50	<50	130	<50	<50	<50	<50	<50	<50
TPH C15 - C28	100	NE	NE	NE	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	120	<100	<100	<100	<100	120	<100
TPH C29 - C36	50	NE	NE	NE	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	50	<50
TPH C10 - C36 (Sum of total)	50	600 (e)	NE	NE	<50	<50	<50	<50	<50	1820	140	150	<50	<50	250	<50	<50	<50	<50	170	<50
BTEX																					
Benzene	1	700	10	1 (f)	<1	<1	<1	<1	<1	1270	11	18	23	4	52	3	18	12	2	<1	<1
Toluene	2	NE	NE	25 (f)	<2	<2	<2	<2	<2	710	12	12	<2	<2	8	<2	14	22	4	<2	<2
Ethylbenzene	2	NE	NE	3 (f)	<2	<2	<2	<2	<2	105	<2	<2	3	<2	5	<2	5	<2	<2	<2	<2
Xylene (meta & para)	2	NE	NE	NE	<2	<2	<2	<2	<2	2340	52	66	3	<2	10	<2	2	18	3	<2	<2
Xylene (ortho)	2	NE	NE	NE	<2	<2	<2	<2	<2	1060	53	69	8	<2	151	4	15	22	3	<2	<2
Xylene Total	NA (a)	NE	NE	20 (f)	<4	<4	<4	<4	<4	3400	105	135	11	<4	161	4	17	40	6	<4	<4
Metals																					
Lead	1	4.4	100	50	<1	<1	<1	<1	<1	27	<1	6	<10	<1	<10	<1	1	<1	<1	<1	<1

Notes:
QC = Quality Control Sample.
"H" = All constituent analyte concentrations are below LOR.
"-" = Analysis not requested
LOR = Limit of Reporting (= Method Detection Limit)
NE = Guideline not established
NA = Not Applicable
RPD = Relative Percent Difference
(a) Where results are derived from the summation of selected analytes, LOR can not be determined.

All samples collected and analysed according to Mobil Specifications unless otherwise noted in Comments section.

TABLE 4b
HISTORICAL GROUNDWATER ANALYTICAL RESULTS
FORMER MOBIL SERVICE STATION GEELONG WEST (VO0993)
(All results in µg/L unless otherwise specified)

Sample Code	MW45	EM1009542010	MW46	QC11	RPD %	QC12	RPD %	EM1009542034	EM1100439003	EM1100439008		O11-JA04808		EM1009542011	EM1100439014	MW48	EM1009542012	EM1100439004
Field ID	MW45	MW45	MW46	MW46		QC12		MW46	MW46	QC4		QC5		MW47	MW47	MW48	MW48	MW48
Sample Date	11/05/2010	31/8/2010	11/05/2010	11/05/2010		10/05/2010		30/8/2010	17/01/2011	17/01/2011		17/01/2011		31/8/2010	18/01/2011	10/05/2010	31/8/2010	17/01/2011
Comments				Duplicate of MW46		Triplicate of MW46				Duplicate of MW46	RPD %	Triplicate of MW46	RPD %					

Chemical Name	LOR	Maintenance of Ecosystems (a)	Stock Watering (b)	Primary Contact Recreation (c)																		
TPH																						
TPH C6 - C9	20	150 (e)	NE	NE	7760	9500	3130	2420	26%	1500	70%	1540	630	620	2	1000	45	37300	27,600	1630	1380	3940
TPH C10 - C14	50	NE	NE	NE	1490	2010	570	580	2%	1000	55%	360	310	210	38	230	30	5940	9960	1700	860	3740
TPH C15 - C28	100	NE	NE	NE	250	220	290	320	10%	300	3%	560	500	260	63	300	50	1080	3370	450	900	680
TPH C29 - C36	50	NE	NE	NE	<50	<50	70	80	13%	<100	NA	170	180	160	12	<100	57	90	760	<50	200	<100
TPH C10 - C36 (Sum of total)	50	600 (e)	NE	NE	1740	2230	930	980	5%	1300	33%	1090	990	630	44	530	66	7110	14,090	2150	1960	4420
BTEX																						
Benzene	1	700	10	1 (f)	644	1820	294	189	43%	150	65%	203	139	130	7	200	36	820	918	274	116	96
Toluene	2	NE	NE	25 (f)	1590	3540	802	622	25%	430	60%	659	239	235	2	490	69	13400	8300	325	351	360
Ethylbenzene	2	NE	NE	3 (f)	177	263	<50	34	NA	25	NA	55	20	18	11	25	22	2210	1660	<20	43	100
Xylene (meta & para)	2	NE	NE	NE	1700	1820	367	337	9%	260	34%	295	27	39	36	69	88	12000	8120	<40	277	666
Xylene (ortho)	2	NE	NE	NE	834	935	418	361	15%	310	30%	179	95	86	10	130	31	5140	3990	569	200	402
Xylene Total	NA (a)	NE	NE	20 (f)	2534	2755	785	698	12%	580	30%	474	122	125	-	199	-	17140	12,110	569	477	1068
Metals																						
Lead	1	4.4	100	50	<10	6	8	6	29%	<5	NA	<1	<10	<10	#	4	0	34	57	33	12	15

Notes:
QC = Quality Control Sample.
"#" = All constituent analyte concentrations are below LOR.
"-" = Analysis not requested
LOR = Limit of Reporting (= Method Detection Limit)
NE = Guideline not established
NA = Not Applicable
RPD = Relative Percent Difference
^(a) Where results are derived from the summation of selected analytes, LOR can not be determined.

All samples collected and analysed according to Mobil Specifications unless otherwise noted in Comments section.

TABLE 4b
HISTORICAL GROUNDWATER ANALYTICAL RESULTS
FORMER MOBIL SERVICE STATION GEELONG WEST (VO0993)
(All results in µg/L unless otherwise specified)

Sample Code	MW49	EM1009542035	MW50	EM1009542036	MW51	EM1009542037	EM1009542016	RPD %	10SE20121	RPD %	MW52	EM1009542013	MW53	EM1009542014	EM1009542015	EM1100439012
Field ID	MW49	MW49	MW50	MW50	MW51	MW51	QC1		QC2		MW52	MW52	MW53	MW53	MW54	MW54
Sample Date	10/05/2010	30/8/2010	10/05/2010	30/8/2010	10/05/2010	30/8/2010	30/8/2010		30/8/2010		10/05/2010	31/8/2010	10/05/2010	31/8/2010	31/8/2010	18/01/2011
Comments							Duplicate of MW51		Triplicate of MW51							

Chemical Name	LOR	Maintenance of Ecosystems (a)	Stock Watering (b)	Primary Contact Recreation (c)																
TPH																				
TPH C6 - C9	20	150 (e)	NE	NE	<20	<20	<20	<20	240	310	320	3%	320	3%	570	2210	60	40	3480	2810
TPH C10 - C14	50	NE	NE	NE	70	<50	<250	-	110	70	70	0%	<50	-	690	190	<50	<50	3800	1550
TPH C15 - C28	100	NE	NE	NE	<100	<100	<500	-	300	390	850	74%	<100	-	290	<100	390	150	490	620
TPH C29 - C36	50	NE	NE	NE	<50	<50	<250	-	80	130	150	14%	<100	-	60	<50	130	<50	<50	100
TPH C10 - C36 (Sum of total)	50	600 (e)	NE	NE	70	<50	<250	-	490	590	1070	58%	<250	-	1040	190	520	150	4290	2270
BTEX																				
Benzene	1	700	10	1 (f)	<1	<1	<1	<1	28	62	66	6%	67	8%	56	587	3	4	351	256
Toluene	2	NE	NE	25 (f)	<2	<2	<2	<2	20	50	54	8%	59	17%	6	740	7	7	830	648
Ethylbenzene	2	NE	NE	3 (f)	<2	<2	<2	<2	8	7	9	25%	9	25%	<2	47	<2	<2	113	81
Xylene (meta & para)	2	NE	NE	NE	<2	<2	<2	<2	7	15	21	33%	22	38%	<2	399	9	7	1030	800
Xylene (ortho)	2	NE	NE	NE	<2	<2	<2	<2	75	100	104	4%	120	18%	253	288	8	13	731	620
Xylene Total	NA (a)	NE	NE	20 (f)	<4	<4	<4	<4	82	115	125	-	142	-	253	687	17	20	1761	1420
Metals																				
Lead	1	4.4	100	50	<1	<1	<1	<1	<10	2	2	0%	<5	-	<10	4	<10	<1	41	66

Notes:
QC = Quality Control Sample.
"H" = All constituent analyte concentrations are below LOR.
"--" = Analysis not requested
LOR = Limit of Reporting (= Method Detection Limit)
NE = Guideline not established
NA = Not Applicable
RPD = Relative Percent Difference
(a) Where results are derived from the summation of selected analytes, LOR can not be determined.

All samples collected and analysed according to Mobil Specifications unless otherwise noted in Comments section.

TABLE 5
HISTORICAL SOIL VAPOUR ANALYTICAL RESULTS -
VOLATILE ORGANIC COMPOUNDS (VOCs) AND TOTAL PETROLEUM HYDROCARBONS (TPH)
ENVIABTF07113AB
(All results in mg/m³)

Laboratory ID			2008020943	2008020945	2008020938	2008020939	2008020952	2008020953	2008020948	2008020949
Sample Description			SVB1	SVB2	SVB3	SVB4	SVB5	SVB6	SVB7	SVB8
Sample Depth (mbgs)			1.5	7.5	1.5	7.5	1.5	7.5	1.5	7.5
Sample Date			15/09/2008	15/09/2008	15/09/2008	15/09/2008	15/09/2008	15/09/2008	15/09/2008	15/09/2008
Analyte	PQL	Units								
Benzene	0.01	mg/m³	<0.01	440 CT	0.026	530 CT	1.3	5400 CT	0.016	2500 CT
Bromobenzene	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
Bromochloromethane	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
Bromodichloromethane	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
n-Butylbenzene	0.01	mg/m³	<0.01	0.31	<0.01	2.1	<0.01	0.37	<0.01	560
sec-Butylbenzene	0.01	mg/m³	<0.01	0.5	<0.01	2.4	<0.01	0.76	<0.01	640
tert-Butylbenzene	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
Carbon tetrachloride	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
Chlorobenzene	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
Chloroethane	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
Chloromethane	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
2-Chlorotoluene	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
4-Chlorotoluene	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
1,2-Dibromo-3-chloropropane	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
Dibromochloromethane	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
1,2-Dibromoethane	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
Dibromomethane	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
1,2-Dichlorobenzene	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
1,3-Dichlorobenzene	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
1,4-Dichlorobenzene	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
Dichlorodifluoromethane	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
1,2-Dichloroethane	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
1,1-Dichloroethane	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
1,1-Dichloroethene	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
cis-1,2-Dichloroethene	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
trans-1,2-Dichloroethene	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
1,2-Dichloropropane	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
1,3-Dichloropropane	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
2,2-Dichloropropane	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
1,1-Dichloropropene	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
cis-1,3-Dichloropropene	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
trans-1,3-Dichloropropene	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
Ethylbenzene	0.01	mg/m³	<0.01	84 CT	<0.01	220 CT	0.16	590 CT	<0.01	280 CT
Hexachlorobutadiene	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
Isopropylbenzene	0.01	mg/m³	<0.01	4.2	<0.01	14	0.014	8	<0.01	7.2
4-Isopropyltoluene	0.01	mg/m³	<0.01	0.39	0.019	1	<0.01	0.26	<0.01	0.27
Naphthalene	0.01	mg/m³	0.012	0.16	<0.01	0.46	0.01	0.2	0.012	0.65
Propylbenzene	0.01	mg/m³	<0.01	7.2	<0.01	32	0.023	14	<0.01	15
Styrene	0.01	mg/m³	<0.01	1.7	<0.01	2.8	<0.01	3	<0.01	2.6
1,1,1,2-Tetrachloroethane	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
1,1,2,2-Tetrachloroethane	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
Tetrachloroethene	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
Toluene	0.01	mg/m³	<0.01	350 CT	0.014	460 CT	2.6	8200 CT	<0.01	610 CT
Tribromomethane	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
1,2,3-Trichlorobenzene	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
1,2,4-Trichlorobenzene	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
1,1,1-Trichloroethane	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
1,1,2-Trichloroethane	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
Trichloroethene	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
Trichlorofluoromethane	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
Trichloromethane	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
1,2,3-Trichloropropane	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.2	<0.01	<0.1
1,2,4-Trimethylbenzene	0.01	mg/m³	<0.01	13	<0.01	78 CT	0.11	22	<0.01	33
1,3,5-Trimethylbenzene	0.01	mg/m³	<0.01	6.2	<0.01	26	0.14	12	<0.01	14
Vinyl chloride	0.01	mg/m³	<0.01	<0.1	<0.01	<0.1	<0.01	<0.1	<0.01	<0.1
Xylenes	0.01	mg/m³	<0.01	240 CT	0.011	540 CT	2.2	2300 CT	<0.01	1100 CT
1-Methylnaphthalene	0.02	mg/m³	<0.02	<0.2	<0.02	<0.2	<0.02	<0.4	<0.02	<0.2
2-Methylnaphthalene	0.02	mg/m³	<0.02	<0.2	<0.02	<0.2	<0.02	<0.4	<0.02	<0.2
TPH Aliphatic EC>6-8	0.1	mg/m³	<0.1	4000 CT	0.1	20000 CT	34	20000 CT	<0.1	9500 CT
TPH Aliphatic EC>8-10	0.1	mg/m³	<0.1	420	0.3	1200	2.5	570	<0.1	470
TPH Aliphatic EC>10-12	0.1	mg/m³	<0.1	38	0.1	87	0.4	39	<0.1	30
TPH Aliphatic EC>12-16	0.1	mg/m³	0.1	1.4	0.1	5.7	<0.1	2.6	0.1	2.3
TPH Aromatic EC5-7	0.1	mg/m³	<0.1	440 CT	<0.1	530 CT	1.3	5400 CT	<0.1	2500 CT
TPH Aromatic EC>7-9	0.1	mg/m³	<0.1	350 CT	<0.1	460 CT	2.6	8200 CT	<0.1	610 CT
TPH Aromatic EC>9-10	0.1	mg/m³	<0.1	320 CT	<0.1	750 CT	2.9	2900 CT	<0.1	1400 CT
TPH Aromatic EC>10-12	0.1	mg/m³	<0.1	33	<0.1	150	0.5	53	<0.1	74
TPH Aromatic EC>12-16	0.1	mg/m³	<0.1	<1	<0.1	1.5	<0.1	<0.1	<0.1	1.1

CT = Elevated VOCs detected in thermal desorption tubes, therefore carbon tube results were used.

APPENDIX A

AUDITOR SUMMARY OF ASSESSMENT REPORTS



APPENDIX B

AUDITOR RISK ASSESSMENT



APPENDIX C

SITE REPORTS

