Desktop Environmental, Hydrological and Geotechnical Study
Tarneit Precinct Structure Plan Area 91
Growth Areas Authority

Report ref:
220829
17 August 2011
Revision 2

aurecon

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Document control

Document ID: 20111708_GAA_PSP_91_Desktop_Study_Rev_02 Final.doc

Rev No	Date	Revision details	Typist	Author	Verifier	Approver
0	14 July 2011	Internal Review	GB	GB	TM	
1	28 July 2011	Draft Copy to Client	GB	GB	NP	JM
2	17 August 2011	Final Issue Copy	GB	GB	NP	JM

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Executive summary

The Growth Areas Authority is preparing a Precinct Structure Plan (PSP) for Area 91, comprised of approximately 1,555.3 hectares of land on fifty-one (51) separate properties in the Tarneit area in the City of Wyndham, Victoria, Australia. This assessment will inform the finalisation of the PSP in terms of suitability of nominated land uses. Historical research, document review, and site assessment activities were conducted during the weeks of 24 June 2011 and 1 and 8 July 2011.

The scope of works called for:

- A desktop review to determine previous land uses and implications for environmental contamination, hydrology and geology.
- A desktop review of soil, geological and hydrogeological conditions on the site
- Review of Wetlands databases and sites of National Environmental Significance
- Performance of a site inspection limited to publicly accessible areas of the site

Site contamination

In general, the following past or present site activities with the potential to cause soil or groundwater contamination were identified in proximity to PSP Area 91:

- Properties where fuel storage and fuelling operations have occurred.
- Properties, including property no. 114940 on Hogans Road and 542 Hogans Road, where heavy equipment and farm equipment storage, utilization, and possibly maintenance have occurred.
- Properties, including market gardens (2, 12 and 22 Davis Road and property nos. 113522 and 114937) and property nos. 148069 and 148071, where farming operations, possibly utilising fertilisers, pesticides, and herbicides, may have occurred and where faecal coliforms may be present from livestock waste.
- Material stockpiles consisting primarily of rock and soil.
- Structures where lead-based paint may have been used.

Recommendations for assessment of individual site properties based on use and potential for contamination are summarized in the report. Recommendations are made in accordance with the Victoria Department of Sustainability and Environment, *Potentially Contaminated Land, General Practice Note*, 2005.

Of the fifty-one (51) site properties, further assessment is recommended for thirty-five (35) properties, with recommendations for environmental audits on eight additional properties. In general, recommendations for assessment were made based on sensitive land use and the presence of structures where lead based paint may have been used. Non-intensive farming, the presence of heavy equipment or soil stockpiling was considered secondary indicators of the need for assessment in the case of sensitive land use. Environmental audits were recommended for the market gardens at 2, 12 and 22 Davis Road and property nos. 113522 and 114937 on Davis Road and 575 McGrath Road, and property nos. 148069 and 148071 on McGrath Road, all properties considered at high potential for contamination based on past and present land use. Due to the limited nature of the site inspection, additional site properties may be recommended for assessment in the future based on receipt of additional information not available at the time of this assessment.

Intrusive sampling and analysis should be undertaken in accordance with National Environment Protection (Assessment of Site Contamination) Measure (1999 NEPM) and draft 2011 NEPM, Australian Standard (2005) *Guide to the investigation and sampling of sites with potentially contaminated soil Part 1: Non-volatile and semi-volatile compounds* (AS 4482.1-2005), Australian Standard (1999) *Guide to the sampling and investigation of potentially contaminated soil Part 2:*

Volatile substances (AS 4482.2-1999) and Victoria Environment Protection Authority, Industrial Waste Resource Guidelines (IWRG) *Soil Sampling*, 2009. The results of the sampling and analysis would be compared with guideline values for protection of human health and the environment as well as waste disposal criteria (as applicable).

In addition, hazardous materials surveys should be carried out for structures identified for demolition or relocation. The surveys should address asbestos, lead-based paint, polychlorinated biphenyls in electrical fixtures, and hazardous materials storage. Should asbestos bearing materials be encountered during future investigations or construction, the testing, inspection and removal of asbestos materials are required by law to be undertaken by a suitably qualified and licensed asbestos specialist/removalist.

Geotechnical

A review of the Victoria Department of Primary Industries online GIS system indicates that PSP areas 90/91 have not been subjected to historical mining activity. In general the PSP area is flat and soil cover is expected to be relatively thin. As such the risk of geotechnical hazards are considered low to moderate though a thorough understanding of the geological model will be required prior to development. The key geotechnical constraints that may affect the development of PSP Area 91 are:

- Differential settlement of overlying residual clay in localised areas of extremely weathered basalt.
- Shallow soil failure (soil creep, slumping, collapse) in areas of increased gradient.
- The presence of soft material encountered at depth may result in a bearing capacity or settlement hazard for any proposed foundations.
- Clay likely to be derived from basalt rock is likely to be subject to considerable shrinkage or swelling in response to change in moisture content. Highly expansive clay can cause unexpected ground movements that are able to damage to building foundations, structures and road infrastructure.
- Ephemeral creeks crossing the site may serve as drainage channels for storm water during flood events, resulting in the erosion of soft sediment and bedrock.

It is recommended that further geotechnical assessment is undertaken across the site to aid the design process. The purpose of the geotechnical assessment will be to undertake intrusive investigation to obtain information for the purposes of:

- Determining a better understanding of the sub-surface geological profile and hydrogeological conditions to develop an accurate geological model.
- Develop baseline geotechnical parameters to aid design, settlement and slope stability modelling (where required).
- Determine depth to rock head and degree of weathering within the upper layers of the bedrock.
- Determine the nature of factures and jointing within the underlying volcanic material.
- Determine the presence of voids within the underlying basalt material.

Hydrology and wetlands

The site is part of the Werribee catchment with Werribee River being the major waterway conveying water from most of the catchment. Davis Creek conveys flow from the northern site areas. The majority of the lower lying land in the southern section of the site is subject to inundation by floodwaters. This flooding is exacerbated further in a 1 in 100 year flood event where the river swells further and all of the low lying area south of the Werribee River is inundated. Davis Creek is also subject to periodic flooding but to a much lesser extent than the Werribee River.

Groundwater beneath the site is present in two main aquifers, the upper Newer Volcanics aquifer, a fractured rock basalt aquifer, and a deeper regional aquifer within the Silurian aged formation. Groundwater depth for the majority of the site is believed to be between approximately 5 and 10 m, with a small area in the northwest of the site with a depth between approximately 10 and 20 m. This suggests that groundwater is shallow enough for extraction but deep enough to pose no significant risk to construction except in the vicinity of a freshwater meadow area located east of Sewells Road on property no. 124354. The watertable is likely shallow in this area and the meadow may have to be retained as part of the works or included in any drainage scheme.

The following recommendations are made regarding hydrology and wetlands:

- Development should be restricted in the vicinity of the Werribee River to avoid the 1 in 100 year flood levels. For developments to occur outside the flood zone, but within the 1 in 100 year flood levels, significant works will be required to mitigate against flooding.
- Flood modelling should be undertaken to determine hydrologic effects that any new developments will have on the existing creek system, in particular existing culvert and bridge flow capacities.
- Waterways, including Davis Creek and the Werribee River and associated low-lying areas will require feature surveys to provide detail of drainage patterns and inform planning for urban drainage systems.
- Drainage paths will need to be either maintained or diverted to ensure all areas are well drained during and after any development.
- Provision should be made in the precinct structure planning for protection of native vegetation along waterways, including the Davis Creek and the Werribee River, with appropriate buffering from residential and other urban uses.

1. Introduction

1.1 Background

The Growth Areas Authority (GAA) is preparing a Precinct Structure Plan (PSP) for Area 91, comprised of approximately 1,555.3 hectares (ha) of land on fifty-one (51) separate properties in the Tarneit area in the City of Wyndham, Victoria, Australia. This assessment will inform the finalisation of the PSP in terms of suitability of nominated land uses. Historical research, document review and site assessment activities were conducted during the weeks of 24 June 2011 and 1 and 8 July 2011.

Aurecon has been commissioned by GAA to undertake a desktop Environmental, Hydrological and Geological Assessment of Tarneit Precinct Structure Plan Area 91.

1.2 Objectives

The overall objective of this desktop environmental, hydrological and geotechnical study is to identify the potential for ground contamination within the study area and the nature of likely contaminants to be encountered during detailed design and construction.

The key objectives of this assessment were to conduct a desktop study and site inspection were to:

- Confirm suitability of properties for sensitive uses and what level of further assessment would be required to determine suitability of properties for sensitive uses in accordance with the Potentially Contaminated Land General Practice Note 2005 (e.g., Environmental Audit, Site Assessment).
- Identify data gaps and outline future testing and more detailed investigations (if required).
- Provide a plan of the study area clearly showing which properties were included in the desktop study and which properties have low, medium and high potential for contamination.
- Prepare a report of findings that will be used to inform the design of precinct structure plans for the study area (in terms of suitability of land uses nominated for each location/area) and to identify key issues that should be addressed during the detailed design phase and construction.

1.3 Scope of works

1.3.1 Desktop review

A desktop review to evaluate previous land uses and implications for environmental contamination, hydrologic and geologic/geotechnical considerations. The desktop review included:

- Assessment of historical aerial photography for the precinct and surrounding areas
- Consultation with relevant agencies as required, including:
    - EPA for review of records including the 'Priority Sites Registry' and the list of issued '*Certificates and Statements of Environmental Audit*'.
    - Department of Sustainability and Environment, Port Phillip & Westernport Catchment Management Authority, Southern Rural water, City West Water and Melbourne Water for hydrographs, groundwater and drainage information and other relevant data.
- Soil, geology and hydrogeology conditions desktop review, including survey, mapping and other base data as available from relevant authority and agency data sets and maps. This is aimed at identifying potential shortcomings in data coverage.
- Review and summary of any previous reports or studies regarding environmental, geological or groundwater conditions, in or within the vicinity of the study area.
- Compilation of known groundwater borehole/well locations and testing results.

- Groundwater well databases.
- Review of Wetlands databases and sites of National Environmental Significance.
- Review of Australian Heritage Databases.
- Obtainment and analysis of current titles for all properties in the study area.
- Historical title search of any properties where further historical land use information is needed to establish potential for contamination.
- Victoria Department of Primary Industries online GIS system.

1.3.2 Site inspection

Aurecon performed a site inspection of the study area, viewing properties from existing roadways and publicly accessible areas. At the Client's request, no on-site inspection of properties within PSP Area 91 was performed. The site inspection was conducted once the desktop review had been completed and was used to focus on-site observations.

1.3.3 Reporting

Based on the findings of the desktop study and site inspection, Aurecon prepared this report including the following:

- Summary of findings and recommendations of the desktop review and site inspection for each discipline area (environmental, hydrology and geological assessment).
- Issues summary and resultant recommendations for management and/or remediation in terms of environmental contamination, geology/geotechnical and hydrology/groundwater.
- Outline of any future testing and more detailed investigations if recommended.
- Evaluation of the suitability of properties for sensitive uses and what level of further assessment would be required to determine suitability of properties for sensitive uses in accordance with the *Potentially Contaminated Land General Practice Note 2005* (eg Environmental Audit, Site Assessment).
- A plan of the study area clearly showing which properties were included in the desktop study and which properties have low, medium and high potential for contamination.
- Clear and concise drawings/maps, to illustrate existing conditions and support report as required.

It should be noted that this report is a limited desktop assessment of the site and no sampling was performed for this assessment.

1.4 Legislative requirements and relevant assessment guidelines

The scope of work for this desktop environmental, hydrological and geotechnical assessment of the site has been performed in general accordance with requirements outlined in the following documents:

- Victoria Environmental Protection Act 1970.
- State Environment Protection Policy (SEPP), *Groundwaters of Victoria*, December 1997, No. S160.
- State Environment Protection Policy (SEPP), *Prevention and Management of Contaminated Land*, June 2002, No. S95.
- State Environment Protection Policy (SEPP), *Waters of Victoria*, October 2004, No. S210.
- Victoria Environment Protection Authority, Industrial Waste Resource Guidelines, *Sampling and Analysis of Waters, Wastewaters, Soils and Wastes*, June 2009, IWRG701.

- Victoria Environment Protection Authority, Industrial Waste Resource Guidelines, *Soil Sampling*, June 2009, IWRG702.
- Australian and New Zealand Guideline for the Assessment and Management of Contaminated Sites, published by Australian and New Zealand Environment and Conservation Council (ANZECC) and the National Health and Medical Research Council (NHMRC), January 1992.
- *Guide to the investigation and sampling of sites with potentially contaminated soil, Part 1: Non-volatile and semi-volatile compounds*, AS 4482.1-2005, Standards Australia.
- *Guide to the sampling and investigation of potentially contaminated soil, Part 2: Volatile substances*, AS 4482.2-1999, Standards Australia.
- National Environment Protection (Assessment of Site Contamination) Measure, 1999.
- National Environment Protection (Assessment of Site Contamination) Measure, draft 2011.
- Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).
- Flora and Fauna Guarantee Act 1988 (FFG).
- Native Vegetation Management Framework 2002 (NVMF).
- Wildlife Act 1975.

1.5 Limitations

Aurecon Australia Pty Ltd (ABN 54 005 139 873) has prepared this report (the "Report") for the exclusive use of GAA (the "Client") for its own use for the purpose of desktop environmental, hydrological, and geotechnical study for PSP Area 91.

The Report must be read in light of:

- The limited readership and purposes for which it was intended.
- Its reliance upon information provided to Aurecon by the Client and others which has not been verified by Aurecon and over which Aurecon has no control.
- The limitations and assumptions referred to throughout the Report.
- The cost and other constraints imposed on the Report (such as limited site access).
- Other relevant issues which are not within the scope of the Report.

Subject to the limitations referred to above, Aurecon has exercised all due care in the preparation of the Report and believes that the information, conclusions, interpretations and recommendations of the Report are both reasonable and reliable.

Aurecon makes no warranty or representation to the Client or third parties (express or implied) in respect of the Report, particularly with regard to any commercial investment decision made on the basis of the Report. Use of the Report by the Client or third parties shall be at their own risk and extracts from the Report may only be published with permission of Aurecon.

This disclaimer must accompany every copy of the Report, which is an integral document and must be read in its entirety.

2. Site Description

2.1 Location and description

The site is comprised of fifty-one (51) separate properties totalling approximately 1,555.3 ha in area and designated as PSP Area 91 in the Tarneit area in the City of Wyndham, Victoria, Australia. Site properties are summarized in Table 2-1.

Table 2-1. Site property details

No.	Address	Legal description	Area (Ha)
110705	Shaws Road WERRIBEE VIC 3030	PT CA F SEC 1/PT L2 LP112828 PARISH TARNEIT	12.12
113520	2 Davis Road TARNEIT VIC 3029	L2 LP84778 PSH TAR	11.68
113521	22 Davis Road TARNEIT VIC 3029	V 10548 F 646 L 1 PS 438794 Tarneit Parish	1.62
113522	Davis Road TARNEIT VIC 3029	V 8168 F 426 L 1 TP 251610 Tarneit Parish	4.05
114937	Hogans Road TARNEIT VIC 3029	L2 PS421738 TARNEIT	5.59
114938	555 Hogans Road TARNEIT VIC 3029	L1 LP126643/L1 LP92579 TARNEIT	11.14
114940	Hogans Road TARNEIT VIC 3029	L2 PS504736 TARNEIT	17.33
114941	605 Hogans Road TARNEIT VIC 3029	L1 PS504736 TARNEIT	1.69
120648	23 Davis Road TARNEIT VIC 3029	L 2 LP 144521 Tarneit Parish	161.42
120649	21 Davis Road TARNEIT VIC 3029	L 2 LP 144521 Tarneit Parish	0.36
120650	180 Davis Road TARNEIT VIC 3029	PT CA A SEC 9 PSH TAR	32.33
120651	435 Davis Road MOUNT COTTRELL VIC 3024	L21 LP92917 PSH TAR	4.01
121476	15 Gard Road MOUNT COTTRELL VIC 3024	L49 LP92918 PSH TAR	4.08
121976	Hogans Road TARNEIT VIC 3029	L3 LP136754 PSH TAR	20.50
121977	540 Hogans Road TARNEIT VIC 3029	V 10645 F 136 L 2 PS 500009 Tarneit Parish	11.81
121978	542 Hogans Road TARNEIT VIC 3029	L1 LP136754 PSH TAR	12.22
122503	Leakes Road TARNEIT VIC 3029	V 9918 F 722 CA B Sec 15 Tarneit Parish	68.78
122505	1070 Leakes Road MOUNT COTTRELL VIC 3024	L22 LP92917 PSH TAR	4.06
122506	1080 Leakes Road MOUNT COTTRELL VIC 3024	V 8900 F 281 L 23 LP 92917 Tarneit Parish	4.07
122507	1090 Leakes Road MOUNT COTTRELL VIC 3024	L24 LP92917 PSH TAR	4.03
122508	1106 Leakes Road MOUNT COTTRELL VIC 3024	L25 LP92917 PSH TAR	4.06
122509	1126 Leakes Road MOUNT COTTRELL VIC 3024	L50 LP92918 PSH TAR	4.10

No.	Address	Legal description	Area (Ha)
122510	1166 Leakes Road MOUNT COTTRELL VIC 3024	L26 LP92917 PSH TAR	4.10
124354	Sayers Road TARNEIT VIC 3029	CA A1 Sec 8 Tarneit Parish V 9795 F 892 L 1 TP 138990 Tarneit Parish	236.24
124455	990 Sayers Road TARNEIT VIC 3029	P CA D Sec 15 Tarneit Parish	63.44
124456	1070 Sayers Road TARNEIT VIC 3029	V 9509 F 863 L 1 LP 142708 Tarneit Parish V 9509 F 864 L 2 LP 142708 Tarneit Parish	130.28
124457	1122 Sayers Road TARNEIT VIC 3029	L1 LP86156 PSH TAR	0.09
124458	1160 Sayers Road TARNEIT VIC 3029	V 9522 F 664 L 2 LP 143311 Tarneit Parish	114.28
124459	1170 Sayers Road TARNEIT VIC 3029	V 9522 F 663 L 1 LP 143311 Tarneit Parish	6.71
124460	1245 Sayers Road TARNEIT VIC 3029	V 9052 F 576 Tarneit Parish	110.70
124461	1180 Sayers Road TARNEIT VIC 3029	L 1 LP 93657 Tarneit Parish	5.49
124462	Sayers Road TARNEIT VIC 3029	P L 1B LP 5408 Tarneit Parish	53.92
124548	85-87 Sewells Road TARNEIT VIC 3029	L 4A LP 5408 Tarneit Parish	90.99
146985	Heaths Road WYNDHAM VALE VIC 3024	V 8695 F 035 L 1 TP 875872 Mambourin Parish	3.44
148055	McGrath Road WYNDHAM VALE VIC 3024	V 9646 F 838 CP 156342 Werribee Parish	18.82
148056	McGrath Road WYNDHAM VALE VIC 3024	V 9646 F 839 CP 156343 Werribee Parish	15.39
148057	McGrath Road WYNDHAM VALE VIC 3024	V 9646 F 840 CP 156344 Werribee Parish	11.12
148058	McGrath Road WYNDHAM VALE VIC 3024	V 9650 F 930 CP 156345 Werribee Parish	12.23
148059	McGrath Road WYNDHAM VALE VIC 3024	V 9647 F 860 CP 156346 Werribee Parish	13.54
148060	McGrath Road WYNDHAM VALE VIC 3024	V 9646 F 839 CP 156343 Werribee Parish	15.39
148061	McGrath Road WYNDHAM VALE VIC 3024	V 9646 F 839 CP 156343 Werribee Parish	15.39
148064	480 McGrath Road WYNDHAM VALE VIC 3024	V 9801 F 662 CP 156347 Werribee Parish	11.16
148066	560 McGrath Road WYNDHAM VALE VIC 3024	L7 LP144420 PSH WER	9.08
148067	McGrath Road WYNDHAM VALE VIC 3024	L2 LP218436 WERRIBEE	33.35
148068	575 McGrath Road WYNDHAM VALE VIC 3024	L1 LP133394 PSH WER	59.37
148069	McGrath Road WYNDHAM VALE VIC 3024	L1 LP218436 TARNEIT	33.32
148070	McGrath Road WYNDHAM VALE VIC 3024	L12 LP144420 PSH WER	12.68
148071	McGrath Road WYNDHAM VALE VIC 3024	L 2 LP 133394 Werribee Parish	60.67
155363	538 Hogans Road TARNEIT VIC 3029	V 10645 F 135 L 1 PS 500009 Tarneit Parish	0.40

No.	Address	Legal description	Area (Ha)
173387	12 Davis Road TARNEIT VIC 3029	V 10548 F 647 L 2 PS 438794 Tarneit Parish	5.28
181636	Heaths Road WYNDHAM VALE VIC 3024	CA 2002 Werribee Parish	7.41

2.2 Site features

The properties that comprise the site are currently used for residential, agricultural and commercial purposes. The site is bound to south by Heath Road; to the west by McGrath Road, agricultural land and the Werribee River, to the north by agricultural land, and to the east by agricultural land, residential land and the Werribee River and tributary. Site location and features are presented on Figure 1 in Appendix A.

2.3 Surrounding land use

The Tarneit area is characterized by generally flat and rolling plains used primarily for residential and non-intensive agricultural purposes such as livestock grazing and livestock feed production. The land uses directly adjacent to the site are as follows:

- West – McGrath Road, across which is residential and undeveloped land, and the Werribee River, across which is dry land agricultural land with farm residences and other structures.
- North – Dry land agricultural and fallow land with farm residences and other structures located north of Leakes Road.
- East – Davis Road south to Sayers Road, across which is dry land agricultural land and residential land; a creek bed south of Sayers Road, and the Werribee River, across which is fallow, residential, and park land.
- South – Shaw Road/Heath Road, across which is residential land.

2.4 Proposed land use

This desktop study is part of the pre-planning process for PSP 91, with land uses to be decided in the future. For purposes of the risk assessment, Aurecon has considered all potential land use categories listed in the Land SEPP and Groundwater SEPP.

2.5 Topography

The topography of the site slopes gently toward the south across the site from approximately 54 m above mean sea level (MSL) on the northern margin to approximately 28 m above MSL on the southern margin.

2.6 Geology

The Melbourne sheet (SI 55-5) in the 1:250,000 Geological Map Series 1997 (Vandenberg, 1997) indicates that the geology of PSP Area 91 is predominantly Pleistocene Quaternary to Miocene Neogene basalts of the Newer Volcanic Group with minor scoria and ash (tholeiitic to alkaline). The map indicates that the geology on the site also includes Holocene Quaternary fluvial alluvium, gravel, sand and silt confined to existing rivers and streams. The southern portion of PSP Area 91 is overlain by Pleistocene Quaternary Aeolian dune deposits consisting of sand, clay and calcareous sand. Site geological information is presented on Figure 2 in Appendix A.

2.7 Soil characteristics

The Digital Atlas of Australian Soils (NRIC 1991), based on *Atlas of Australian Soils, Sheets 1 to 10* (Northcote *et al.* 1960-68) identifies the soils beneath PSP Area 91 to be Sodosols [SO] classification.

Sodosols are a soil order of the Australian Soil Classification (Isbell, 2002) with an abrupt or clear change in texture at the B2 horizon. The B2 horizon in sodosols is sodic and not strongly acidic. These soils are often brightly coloured and have a pH of 5.5 (water) or greater in the upper B2 horizon.

The regional soil landscape is characterised by dark brown and reddish brown sodosols formed above basalt. Regional surface soils are generally shallow (10 cm or less) and are reasonably friable dark brown to dark greyish brown silty or fine sandy clay loams, to light clays. Basalt stones and boulders may be present at the surface. The subsoils are generally dark brown, dark reddish brown or dark greyish brown medium to heavy clays that are sodic and moderately to strongly alkaline. With depth, the soils become paler in colour and often have pale yellowish grey and yellowish brown mottles. Soft calcium carbonate (lime) concretions generally occur at about 50 to 80 cm depth. Small fragments of weathered basalt to stones of variable size generally occur before 1 m depth. These soils are mainly classified as Red Sodosols using the Australian Soil Classification (Mayer and Martin, 1979; Sargeant, 1998). A regional soil landscape map is presented on Figure 2 in Appendix A.

2.8 Acid sulphate soils

The Digital Atlas of Australian Soils (NRIC 1991), based on *Atlas of Australian Soils, Sheets 1 to 10* (Northcote *et al.* 1960-68), indicates that PSP Area 91 has an extremely low probability of being at risk from acid sulphate soils.

2.9 Historical mining activity

A review of the Victoria Dept. Primary Industries online GIS system indicates that PSP Area 91 has not been subjected to historical mining activity.

2.10 Expected geological conditions

Based on the available information, the following geological conditions are expected:

South of Hogans Road

Within the area of PSP 91 located to the south of Hogans Road the following subsurface geological profile is expected:

- Thin layer of topsoil or fill (in vicinity of historical earthworks and structures).
- Quaternary fluvial gravel sand and silt alluvium, thicker in closer proximity to surface water bodies.
- Residual silt and clay soil derived from underlying volcaniclastic material.
- Bedrock comprising basalt with areas of minor scoria and ash belonging to the Newer Volcanic Group.

North of Hogans Road

Within the area of PSP 91 located to the north of Hogans Road the following subsurface geological profile is expected:

- Thin layer of topsoil or fill (in vicinity of historical earthworks and structures).
- Residual silt and clay soil derived from underlying volcaniclastic material.
- Bedrock comprising basalt with areas of minor scoria and ash belonging to the Newer Volcanic Group.

In addition to the general subsurface profile, a review of aerial photography indicates a number of dry river or stream channels that may indicate the presence of localised pockets of soft, unconsolidated alluvial sediments that are not shown as being present on the geological map.

2.11 Key geotechnical constraints

A summary of the key geotechnical constraints that may affect the development of PSP Area 91 is presented below in Table 2-2.

Table 2-2 Summary of key geotechnical constraints

Constraints	Discussion
Settlement of proposed road formations and structures	Quaternary alluvial clay and silt deposits are typically poorly consolidated and un-lithified so may settle if unsupported or overloaded. The presence of localised un-engineered fill material may also result in a differential settlement hazard. Dependent on the state of weathering, localised areas of extremely weathered basalt may result in differential settlement of overlying residual clay.
Slope stability	Although the PSP area is relatively low gradient, steeper slopes are noted in close proximity to surface water bodies. Weathered alluvial or residual material can be susceptible to shallow soil failure (soil creep, slumping, collapse) in areas of increased gradient.
Bearing capacity	Low bearing capacity within soft clay material or unconsolidated alluvial material can result in a loss of stability or potential collapse of structures during the construction phase of the development. The presence of soft material encountered at depth may result in a bearing capacity or settlement hazard for any proposed foundations. Although basalt bedrock is relatively competent the bearing capacity may be significantly reduced it is vesicular or has been subject to significant weathering processes.
Shrink-swelling	Clay likely to be derived from basalt rock is likely to be moderately to highly reactive, and subject to considerable shrinkage or swelling in response to change in moisture content. Highly expansive clay can cause unexpected ground movements that are able to damage to building foundations, structures and road infrastructure.
Erosion	A number of ephemeral creeks are located across the site (generally oriented north to south). It is possible that, during flood events, these creeks could serve as drainage channels for storm water, resulting in the erosion of soft sediment and bedrock.

In general, PSP Area 91 is flat and soil cover is expected to be relatively thin. As such the risk of geotechnical hazards are considered low to moderate though a thorough understanding of the geological model will be required prior to development.

2.12 Hydrology and hydrogeology

2.12.1 General assessment

Information regarding hydrology of the site and surrounding area is based solely on a desktop study. No sampling and analysis of groundwater was performed for this assessment.

The main waterway through the area is the Werribee River, which meanders from the northwest corner of the site to the southeast corner. The entire length of the river flows relatively full with narrow but steep river banks. A large concrete weir is located in the southern section of the river (property no. 114937) and serves to hold a large volume of water upstream with the downstream section restricted in size to only manage flows during high rainfall events.

Three smaller creeks are located on the north end of the site, forming Davis Creek, which runs down the eastern site boundary until it empties into the Werribee River adjacent to Micarey Court. Davis Creek is generally ephemeral with a number of areas of ponding, particularly near culverts at the road

crossings. Immediately upstream of the confluence of Davis Creek and the Werribee River, off of the site on the east side of Davis Creek is a constructed wetland. This wetland, constructed between 2006 and 2009, is believed intended to facilitate overflow during high rainfall events as well has handle runoff from the adjacent residential area.

There are two ponded areas on either side of Sayers Road, adjacent to the intersection with Davis Road, where there is possibly a submerged culvert. There is a culvert crossing beneath Hogans Road and a bridge crossing the Werribee River at Heaths Road.

2.12.2 Surface water assessment

The site is part of the Werribee catchment with the Werribee River being the major waterway conveying water from most of the catchment. Davis Creek conveys flow from the northern site areas.

A river level station is located on the Werribee River in the southern section of site, downstream of the concrete weir. Data from this station indicates that the maximum river level at the station over the past 12 months was approximately 2 m. The contour plans show that the river banks are significantly higher than 2 m in this area, suggesting that over the past 12 months they were not inundated.

The defined floodways and statistical flood extent with an average recurrence interval (ARI) of 1 in 100 years (Victoria Water Resources, 2002-2011) is depicted on a Department of Sustainability and Environment map presented in Appendix A. The floodway zone on the map shows the Werribee River widening significantly on the south-western margin of the site and inundating the majority of the lower lying land in the southern section of the site. This flooding is exacerbated in a 1 in 100 year flood event where the river swells further and all of the low lying area south of the river is inundated. The main single branch of Davis Creek also shows flooding potential but to a much lesser extent than the Werribee River.

Also shown is an area located east of Sewells Road, on property no. 124354, defined as a freshwater meadow on the Department of Sustainability and Environment map and as a lignum swamp on Figure 3 presented in Appendix A.

Drainage paths have been determined for the area from the contour plan. The drainage paths are areas of likely surface water flows during rainfall events and appropriate drainage infrastructure will be required to manage these flows if developing in these areas. Drainage paths are depicted on the drainage path map presented in Appendix A.

2.12.3 Groundwater assessment

Groundwater beneath the site is present in two main aquifers, the upper Newer Volcanics aquifer, a fractured rock basalt aquifer, and a deeper regional aquifer within the Silurian aged formation. The Newer Volcanics aquifer system is complex and generally consists of several superimposed basalt flows often separated by clay and silt aquitards (Leonard, 1992). The aquifer ranges from 30 m to 120 m in thickness and is generally unconfined to semi-confined. Due to the varying characteristics of different basalt flows, salinity and yield in the Newer Volcanics aquifer can be highly variable over short distances.

No groundwater level information was available for the boreholes located on the site. The closest borehole to the site for which groundwater level data was available was borehole B93705, located approximately 3.31 kilometres (km) northeast of the northern site boundary, at the intersection of Tarneit Road and Boundary Road. This borehole shows a groundwater depth of 11.16 m below ground level. A general overview of groundwater depths in the area is shown in Figure 2-1.

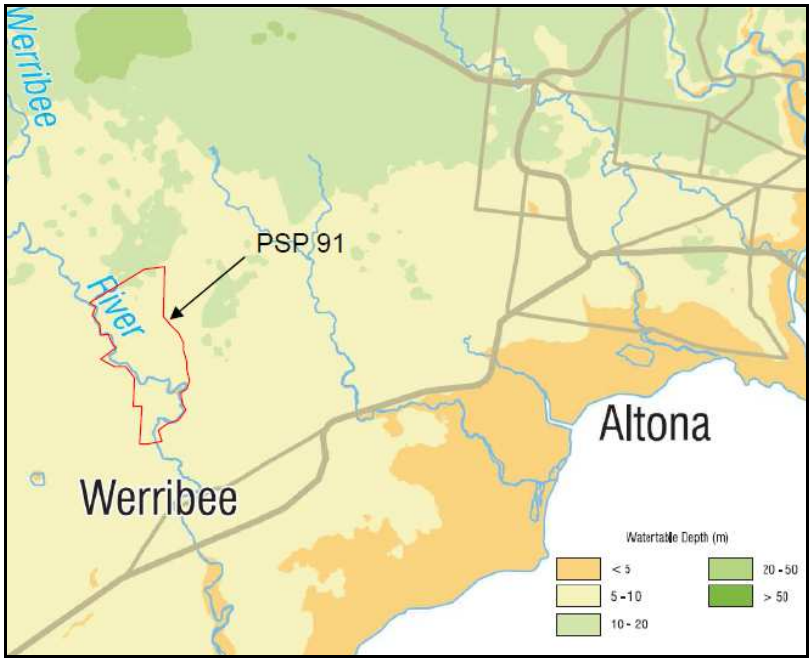

Figure 2-1 – Watertable depths (Watertable Depth, DSE)

2.12.4 Groundwater resources and usage

The Victorian Water Resources Data Warehouse identified forty-five (45) registered boreholes within 1.0 km of the site. Borehole usage was primarily domestic and agricultural water supply with a small number of irrigation and extractive industries boreholes. The registered boreholes are summarized in Table 2-3. According to available data, groundwater in PSP Area 91 varies depending on topography and is generally located between 5 and 10 m below the ground surface, except on the northern margin of PSP Area 91 where it may be located between 10 and 20 m below ground surface. This suggests that groundwater is shallow enough for extraction but deep enough to pose no significant risk to construction except in the vicinity of a freshwater meadow area located east of Sewells Road on property no. 124354. The watertable is likely shallow in this area and the meadow may have to be retained as part of the works or included in any drainage scheme.

Table 2-3. Registered groundwater bores in vicinity of the site

Bore ID	Distance and direction from site	Bore Depth (m)	Registered Use
On Site			
93732	Northeast corner of site	Not stated	Groundwater (abandoned)
93716	Northeast corner of site	22.86	Groundwater
93733	Eastern central site	Not stated	Groundwater (abandoned)
329273	Eastern central margin	243	Coal
93750	Northern central site	37.5	Domestic and stock water
93774	Eastern central margin	53	Irrigation
93719	Eastern central margin	Not stated	Groundwater
93761	Eastern central margin	36	Irrigation

Bore ID	Distance and direction from site	Bore Depth (m)	Registered Use
93718	Central site	24.38	Stock and poultry water
329267	Central site	65.83	Extractive industries
93753	Central site	14	Stock and poultry water
102584	Southern site	42	Groundwater observation
102582	Southern site	33.53	Irrigation
Off Site			
102588	0.18 km west	27	Groundwater (abandoned)
102589	0.27 km west	42	Groundwater (abandoned)
102590	0.06 km west	70	Irrigation
102592	0.42 km west	42.67	Domestic water
93766	0.03 km east	45	Irrigation
329263	0.07 km east	74.67	Extractive industries
93731	0.30 km northeast	Not stated	Groundwater (abandoned)
93708	0.47 km northeast	30.48	Groundwater
93769	0.57 km northeast	50	Domestic water
93701	0.84 km northeast	78	Groundwater
93726	0.87 km east	Not stated	Groundwater (abandoned)
93721	0.13 km east	Not stated	Groundwater (abandoned)
93723	0.27 km east	Not stated	Groundwater (abandoned)
93722	0.10 km southeast	Not stated	Groundwater (abandoned)
93751	0.21 km east	30.48	Groundwater (abandoned)
93752	0.21 km east	126	Groundwater (abandoned)
109685	0.90 km east	40.234	Groundwater
93706	0.92 km east	38	Groundwater
329264	0.38 km east	62.17	Extractive industries
93775	0.19 km east	28.95	Groundwater (abandoned)
93709	0.46 km southeast	45.72	Groundwater
93744	0.98 km southeast	34	Irrigation
93762	0.36 km east	18.29	Irrigation
59869	0.62 km southeast	15	Domestic water
59959	0.84 km southeast	18.29	Domestic water
77082	0.62 km south	15.24	Domestic water
59969	0.55 km south	24.38	Domestic water
77053	0.69 km southwest	30	Domestic water
77063	0.83 km southwest	31.7	Domestic water

Bore ID	Distance and direction from site	Bore Depth (m)	Registered Use
77056	0.93 km southwest	28.95	Domestic water
77072	0.16 km southwest	37.8	Domestic water
77087	0.49 km southwest	39.58	Domestic water

2.13 Wetlands

2.13.1 General

The desktop review of wetlands data bases and sites of National Environmental Significance has made reference to the report on the Assessment of the GAA Investigation Area in Melbourne's West Section C – Biodiversity and Net Gain, prepared by Biosis Research, March 2010 (hereafter referred to as the Section C Report). The assessment was based on information in the Flora Information System (FIS) and Atlas of Victoria Wildlife (AVW), both 2007 versions; Birds Australia database 1998-2008; Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) online database for the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act Protected Matters Search Tool). As such, these are the wetland databases available for review.

Additional data was also made available by GAA in MapInfo format which was more specific to the precinct area and which has allowed refinement of the actual extent of wetland areas.

2.13.2 Relevant legislation

The Section C Report presents a detailed overview of biodiversity legislation and government policy which provides the context for this review. In summary, legislation relevant to the review of wetland databases and sites of National Environmental Significance is referred to throughout this report and includes the following:

- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- *Flora and Fauna Guarantee Act 1988* (FFG)
- *Native Vegetation Management Framework 2002* (NVMF)
- *Wildlife Act 1975*

2.13.3 Wetland ecological vegetation classes

Ecological Vegetation Classes (EVCs) are the basic mapping units used for biodiversity planning and conservation assessment at landscape, regional and broader scales in Victoria. They are derived from large-scale forest type and plant community mapping. Each EVC represents one or more plant (floristic) communities that occur in similar types of environments. As well as representing plant communities, EVCs can be used as a guide to the distribution of individual species and groups of species.

Six types of wetland EVCs have been identified within PSP Area 91 and are presented on Figure 3 in Appendix A. The main three wetland EVCs occurring in PSP Area 91 are: Floodplain Riparian Woodland (EVC 56); Lignum Swamp (EVC 104); and Plains Grassy Wetland. Small areas of three other wetland EVCs were also identified: Creekline Grassy Woodland (EVC 68); Aquatic herbland and Tall Marsh (EVC 821). A brief description of each of these EVCs as extracted from the Section C Report, together with revised information on distributions is given below.

Floodplain Riparian Woodland (EVC 56)

Floodplain Riparian Woodland (EVC 56) occurring in PSP 91 area comprises 20.89 hectares in the Otway Plain bioregion and 9.11 hectares in the Victorian Volcanic Plain bioregion. This EVC occurs on

the floodplain of the Werribee River. The tallest stratum in this EVC can be the eucalypt canopy which is made up of Red Gums closest to the river and merging into Werribee Blue Box at the furthest point from the river. Common shrub species include Heath Tea-tree *Leptospermum myrsinoides*, Blackwood *Acacia melanoxylon*, Black Wattle *Acacia mearnsii* and Sweet Bursaria *Bursaria spinosa*. The ground layer consists of a high cover of grasses in open spaces. These include species such as Wallaby-grasses *Austrodanthonia* spp.*,* Weeping Grass *Microlaena stipoides* and Common Tussock-grass *Poa labillardierei*.

Lignum Swamp (EVC 104)

Lignum Swamp (EVC 104) comprised one patch of 3.30 hectares in PSP Area 91. This EVC occurs on heavy grey clays, waterlogged for much of the year but also experiencing periods of extreme dryness. It is typically dominated by an open to moderately dense shrubland of Tangled Lignum *Muehlenbeckia florulenta* with a variable understorey depending on the length and frequency of inundation and the levels of salinity. The ground layer species include Common Tussock-grass *Poa labillardierei*, Common Nardoo *Marsilea drummondii* and Common Woodruff *Asperula conferta*.

Plains Grassy Wetland (EVC 125)

Plains Grassy Wetland (EVC 125) comprising 2.47 hectares was identified in PSP Area 91. This EVC occurs on the heavy black to grey clays found in swampy drainage lines and seasonally waterlogged wet depressions surrounded by Plains Grassland. The characteristic ground cover is dominated by grasses, small sedges and (in relatively intact examples) forbs. The vegetation is typically species-rich on the outer verges but is usually species-poor in the wetter central areas. Plains Grassy Wetland found in the rain shadow regions to the west of Melbourne can contain dominant grasses including Brown-back Wallaby-grass *Austrodanthonia duttoniana*, Weeping Grass, *Microleana stipoides* and Kangaroo Grass.

Creekline Grassy Woodland (EVC 68)

Creekline Grassy Woodland (EVC 68) comprises 0.53 hectares in the PSP 91 area. This EVC has an overstorey which can consist of Red Gum *Eucalyptus Camaldulensis.* Following substantial rainfall, species indicative of this EVC may become apparent including Common Reed *Phragmites australis* and Marsh Club-sedge *Bolboschoenus medianus*.

Aquatic Herbland (EVC 653)

Aquatic Herbland (EVC 653) comprises 0.1 hectares in PSP Area 91. It is described as herbland of permanent to semi-permanent wetlands, dominated by sedges (especially on shallower verges) and/or aquatic herbs. It occurs on fertile paludal soils, typically heavy clays beneath organic accumulations.

Tall Marsh (EVC 821)

A small area of Tall Marsh (EVC 821) comprising 0.03 hectares was identified in PSP Area 91. Tall Marsh is described as wetland dominated by tall emergent graminoids (rushes, sedges, reeds), typically in thick species-poor swards. Tall Marsh occupies wetlands usually associated with anabranch creeks. Soils are permanently moist. Dominant species are tolerant of relatively deep and sustained inundation, but not total immersion for any sustained period.

2.13.4 Conservation significance of wetland EVCs

The Native Vegetation Management Framework 2002 (NVMF) defines conservation significance (Very High, High, Medium and Low) at the bioregional level. For a patch of native vegetation as defined by the NVMF, the habitat score is used to determine conservation significance. Any patches with a Habitat Score of 40/100 or more have Very High conservation significance.

All wetland EVCs within PSP Area 91 are rated as endangered, and all patches of Wetland EVCs are rated as Very High conservation significance (See Section C Report, Appendix 4).

Site condition as it pertains to the Habitat Score, showing areas of High to Very High Conservation Significance is presented in Figure 4 in Appendix A.

Net gain assessments will need to be undertaken for each type of wetland EVC having regard to conservation significance, under the Native Vegetation Management Framework 2002. Appropriate offsets will need to be identified in consideration of "like for like" requirements, if clearing of these areas is proposed.

2.13.5 Key ecological areas for wetlands

Seven Key Ecological Areas of Very High Conservation Significance have been identified in the Section C Report (Refer Section C Report, Table 1). Three of the Key Areas, namely Key Area 1, 6 and 7 contain patches of Wetland EVCs which contain wetland EVCs. The Key Areas within Section C although variously modified, all consist of more than ten hectares of contiguous native vegetation of Very High conservation significance.

2.13.6 Potential for identifying additional wetland areas

A number of areas within and around the Section C assessment area that are contained within PSP Area 91 were not subject to on-ground mapping due to access restrictions. These areas were subject to reconnaissance surveys in the Section C assessment which provide an indication of the broader amount of native vegetation present. The Section C Report notes that some of the native vegetation patches are likely to meet the criteria for delineation as Key Ecological Areas. These areas are identified in the Section C Report as Highly Likely Native Vegetation which are likely to contain mainly primary grassland or ephemeral wetland EVCs such as Lignum Swamp (EVC 104) of Very High conservation significance.

2.13.7 Conclusions of wetlands review

It is clear that the areas of wetland EVCs and listed ecological communities are generally small, highly fragmented and disturbed although some parts may still be relatively intact. PSP Area 91 contains six wetland EVCs of various sized patches.

Areas of wetland EVCs identified form part of a larger suite of endangered EVCs within the Key Ecological Areas, including *Low-Rainfall* Plains Grassland, *Heavier-soils* Plains Grassland and Escarpment shrubland, as well as the EPBC Act listed ecological community *Natural Temperate Grassland of the Victorian Volcanic Plain.* The Key Ecological Areas form contiguous parcels of 10 hectares or more. All patches of wetland EVCs in the Key Ecological Areas are rated to be at least of Very High conservation significance.

A net gain assessment will be required where areas of wetland EVCs are proposed for clearing. In view of the Very High conservation significance of the wetland EVCs, Ministerial consent will most likely be required, if native vegetation clearing is proposed.

3. Records review

3.1 Search of public records

3.1.1 Certificates of title

Land ownership records were reviewed to obtain evidence of previous land uses on the various parcels of land as the occupation of land owners is often included. While an occupation does not necessarily denote land use for a property, it can give an indication of potential land use.

Current Titles

Current certificates of title for all site properties were requested from the Department of Sustainability and Environment (DSE). Crown allotment land for which titles could not be obtained is listed in Table 3-1. Review of current title information found no ownership entries of environmental concern. Copies of current certificates of title are presented in Appendix B.

Table 3-1 Crown allotment land

Property	Street Address	Location	Area (ha)
181636	Heaths Road WYNDHAM VALE VIC 3024	CA 2002 Werribee Parish	7.41

Historic titles

Historic certificates of title were obtained from DSE for any properties for which historic title documentation was deemed to be of use, based on past or present usage of the property (as determined by review of current and historic aerial photographs). Historic titles were requested for the properties listed in Table 3-2.

Table 3-2 Significant site title information

Property	Street Address	Significant Past or Present Usage	Total Area (ha)
124459	1170 Sayers Road TARNEIT VIC 3029	Farm with soil/rock stockpiles	6.71
113520	2 Davis Road TARNEIT VIC 3029	Market garden	11.68
113521	22 Davis Road TARNEIT VIC 3029	Market garden	1.62
114940	Hogans Road TARNEIT VIC 3029	Earthmoving equipment storage	17.33
121978	542 Hogans Road TARNEIT VIC 3029	Equipment storage and farm activity	12.22
148068	575 McGrath Road WYNDHAM VALE VIC 3024	Market garden	59.37

Review of historic title information found no ownership entries of environmental concern. Copies of historic certificates of title are presented in Appendix B.

3.1.2 Environmental Protection Authority

A search of Victoria EPA records, including the Priority Sites Registry and the list of issued Certificates and Statements of Environmental Audit, was performed to identify subject site or vicinity properties that have been listed as having been issued a cleanup notice or pollution abatement notice (relative to

land and/or groundwater) or undergone a statutory environmental audit. No on-site properties or vicinity properties were identified.

3.1.3 Local government records

The Wyndham City Council does not maintain a contaminated site register and requests for specific properties of interest based on review of historic aerial photographs or observations made during the site visit provided no information regarding potential on site or vicinity property contamination. Copies of relevant correspondence are provided in Appendix C.

3.1.4 Other government records

WorkSafe Victoria was contacted on 27 June 2011 regarding Dangerous Goods Licenses for site properties and responded that a Letter of Authorisation would be required from each property owner before a record search for that property could be conducted. Letters of Authorisation from the site property owners have not been, and are not anticipated to be, requested for this Phase I ESA and the lack of data regarding Dangerous Goods Licenses is considered to be a data gap. Copies of correspondence with WorkSafe Victoria are presented in Appendix C.

3.1.5 Aerial photographs

Aerial photographs dating back to 1974 were obtained from United Photo and Graphics in Blackburn, Victoria and from Google Earth™ and reviewed to obtain information on the historic use and development of the site. A listing of the aerial photographs reviewed is presented in Table 3-3. Table 3-4 summarizes notable observations from each photograph. Copies of the historical aerial photographs are presented in Appendix D of this report.

Table 3-3 Aerial photographs reviewed

Date	Identification	Scale	Source
26/06/1974 and 01/01/1975	Melbourne Mapsheet 7822 Ringwood Mapsheet 7922	1:30000	United Photo and Graphics
09/03/1984 and 17/03/1984	Census Melbourne SJ 55-5 CAD/C 2720 and 2722	1:40000	United Photo and Graphics
30/12/1992 and 11/01/1993	Melbourne Colour Survey Run 28 111-194, Run 29 030-110 and Run 30W 001-029	1:15000	United Photo and Graphics
11/03/2005	Unknown	Unknown	Google Earth™
01/02/2010	Unknown	Unknown	Google Earth™

Table 3-4 Aerial photograph review summary

Aerial Photograph	Comments
1974 - 1975	Residential and farm structures are evident at 85-87 Sewells Road (property no. 124548), 990 Sayers Road (property no. 124455), 1070 Sayers Road (property no. 124456), 1122 Sayers Road (property no. 124457), 1160 Sayers Road (property no. 124458), 1170 Sayers Road (property no. 124459), 1180 Sayers Road (property no. 124461), 1245 Sayers Road (property no. 124460), 575 McGrath Road (property no. 148068), property no. 148057, 2 Davis Road (property no. 113520), 22 Davis Road (property no. 113521), 180 Davis Road (property no. 120650), 555 Hogans Road (property no. 114938) and property no. 114940. Residential and farm structures and equipment are evident at 21 Davis Road (property no. 120649). Intensive cropping or market gardening is evident at 2 Davis Road (property no. 113520), 12 Davis Road (property no. 173387), 22 Davis Road (property no. 113521), property no. 113522, property no. 114937, 575 McGrath Road (property no. 148068) and the western portion of property no. 148071. The ruins of Hogan House (heritage site HO62) are evident on property 121976. The remainder of the site consists of fallow land, pasture land or dry land non-intensively cultivated farmland. The Werribee River forms portions of the southwest and southeast borders of the site and crosses the site from west to east north of property no. 148071. Davis Creek forms a portion of the western border of the site and drains into the Werribee River at the northeast corner of property 148071. A weir is evident across the Werribee River on property no. 110705. Property adjoining the site is primarily fallow land, pasture land or dry land non-intensively cultivated farmland except for intensive cropping or market gardening to the southeast of the site.
1984	Additional residential and farm structures are evident on property no. 148071 along with a pond. A pond is evident at 575 McGrath Road (property no. 148068). Additional residential and farm structures are evident at 15 Gard Road (property no. 121476, 542 Hogans Road (property no. 121978), property no. 124354, 1180 Sayers Road (property no. 124461), 1170 Sayers Road (property no. 124459), 23 Davis Road (property no. 120648), 435 Davis Road (property no. 120651), 1070 Leakes Road (property no. 122505), 1090 Leakes Road (property no. 122507) and property no. 124354. The structures formerly on property no. 114940 are no longer evident. Non-intensive farming is evident on 85-87 Sewells Road (property no. 124548), 540 Hogans Road (property no. 121977), 542 Hogans Road (property no. 121978), 180 David Road (property no. 120650), and property no. 121976. Residential development is evident south of the site, across Heaths Road.

Aerial Photograph	Comments
1992 - 1993	Additional residential and farm structures are evident at 542 Hogans Road (property no. 121978), 605 Hogans Road (property no. 114941) 21 Davis Road (property no. 120649) and property no. 148060. The Chaffey Channel (heritage site HO92) is evident crossing property nos. 124548, 124460 and 124354. Non-intensive farming is evident on the northern portion of 23 Davis Road (property no. 120648) and property no. 148060. Intensive cropping or market gardening is evident on property no. 148069. Land grading is evident on property nos. 148058 and 148059. An earthen dam is evident across the creek on property no. 124458. A pond is evident on property no. 148069. A small structure and pond are evident on property no. 148056 and soil stockpiles are evident on property no. 148067. Residential development is evident southeast of the site, across the Werribee River, south of the site, across Heaths Road, and southwest of the site, across McGrath Road. Additional intensive cropping or market gardening is evident to the southeast of the site, across Davis Creek and the Werribee River.
2005	Additional structures are evident on property nos. 148055, 148056, 14870, and 114937, 1166 Leakes Road (property no. 122510), 560 McGrath Road (property no. 148066), 480 McGrath Road (property no. 148064), 555 Hogans Road (property no. 114938), 1070 Sayers Road (property no. 124456), 1080 Leakes Road (property no. 122506) and 1106 Leakes Road (property no. 122508). Glass houses are evident on property no. 114937 and intensive cropping or market gardening is evident on the eastern end of property no. 148071. Commercial structures, soil stockpiles and equipment are evident on property no. 114940. Additional structures and soil stockpiles are evident at 542 Hogans Road (property no. 121978). Irrigated intensive cropping and numerous small structures are evident on property no. 124354. Non-intensive farming is evident on property nos. 124462 and 122503, the northeast end of property no. 148071, 990 Sayers Road (property no. 124455) and 1070 Sayers Road (property no. 124456). Several structures and a pond are evident very close to the site boundary on property no. 124462. Several sports fields are evident on property nos. 148057, 148058 and 148059. Several structures formerly located on the northwest corner of property no. 124460 are no longer evident. A paved car park is evident on property no. 146985. A paved car park and unidentified structure are evident on property no. 148055. Structures and an athletic field are evident on property no. 148060. Intensive cropping or market gardening formerly evident east and southeast of the site has been replaced by residential development. Additional residential development is evident to the south across Heaths Road, and to the southwest, across McGrath Road.
2010	The glass houses formerly evident on property no. 114937 are no longer present. Additional soil stockpiling and equipment is evident on property no. 114940 and at 542 Hogans Road (property no. 121978). Significant farm equipment is evident at 21 Davis Road (property no. 120649). Residential and farm structures are evident at 538 Hogans Road (property no. 155363). Additional residential development is evident to the east, across Davis Creek and Davis Road.

3.1.6 Australian heritage databases

A search of Australian heritage databases was performed to locate sites of historic significance within PSP Area 91. The following heritage databases were searched:

- Wyndham Planning Scheme – Heritage Overlay (sites of National, State, regional and local significance)
- Victoria Heritage Register/Database
- Royal Historical Society Victoria
- Australian Heritage Database
- Australian Heritage Photographic Library
- Protected Matters Search Tool (Department of Sustainability, Environment, Water, Population and Communities)
    - Includes; Protected areas, Commonwealth Heritage Places, World Heritage Properties, National Heritage Places

The Sands and McDougall Directories of Victoria published between the mid 19th century and 1974 show Tarneit listed as a rural area with no occupancy details. From the Municipal Directory of Victoria up until the 21st century Tarneit was described as a general agricultural district on the Werribee Plains. A total of 8 specific and one potential heritage sites were identified on the site and are summarized in Table 3-5.

Table 3-5 Heritage site summary

Name	Location	Map Reference	Parcel No.	Description
McKenzie House	Sayers Road between Sewells Road and Shanahans Road, Werribee, Wyndham	None	124460	Late Victorian or early Edwardian timber farmhouse
Old River Ford	Old Ford, Werribee River, Werribee, Wyndham	HO1	146985	Early transport route to Geelong
Werribee System Diversion Weir	Diversion Weir, Werribee River, Werribee, Wyndham	HO3	124548, 124460, 124354	The diversion weir
Chaffey Irrigation Scheme	Riverbend Historical Park, Heaths Road, Werribee, Wyndham	HO61		House, trees, well, plough and dray
Hogan House	Lot 3 Hogans Road, Tarneit, Wyndham	HO62	121976	Ruined building and immediate surrounds
Geodetic Survey Baseline	Rear of 301 Princes Highway, Hoppers Crossing and 1245 Sayers Road, Tarneit, Wyndham	HO78	124460	Geodetic survey baseline B1, B@ and B3 on diagram number 1957
Shanahan's House	Sayers Road, Tarneit, Wyndham	HO90	124456	House and immediate surrounds
Chaffey Channel and Pumping Plant	Sewell Road, Tarneit, Wyndham	HO92	124460	Bluestone pump stand base and sluice gates

Name	Location	Map Reference	Parcel No.	Description
Wattle Park	85-87 Sewells Road, Werribee, Wyndham	HO93	124548	Ruined bluestone house, attached smithy and Edwardian weatherboard house.

In addition, the review indicated references to unspecified locations along Leakes Road and Davis Road with no information specific to the site. Locations of heritage sites are presented on Figure 3 in Appendix A and copies of documents relevant to the heritage search are presented in Appendix C.

No evidence was found that historic land use on heritage sites located on PSP Area 91 represents a significant environmental concern to the Area or would have any adverse impact, other than potential preservation requirements, on the potential for development of PSP Area 91.

3.1.7 Previous reports and documents

One Limited Phase 2 Contaminated Land Environmental Site Assessment Report, produced by Golder Associates Pty Ltd (Golder) as part of assessment activities for the preferred alignment of Section 2 of the Regional Rail Link project, was reviewed for this assessment.

Property No. 124462

A Limited Phase 2 Contaminated Land Environmental Site Assessment Report for Site LC35_2059 on Sayers Road in Tarneit, prepared by Golder and dated 6 July 2011 was reviewed. The property consists of an approximately 53.92 ha property (property no. 124462) located on both sides of the northwest boundary of PSP Area 91, on the north side of Sayers Road. The area included in the Limited Phase 2 ESA is the southeast corner of the property located within PSP Area 91.

According to the report, a Phase 1 ESA of the property was performed by Golder in August 2010. Golder recommended performance of a Phase 2 ESA to characterise soil quality in areas historically used for agricultural purposes. A limited Phase 2 ESA was subsequently performed by Golder in April 2011 and consisted of excavating one test pit and 13 hand auger boreholes and collecting soil samples from between 0.1 and 3 m below ground surface. The soil samples were analysed for a wide range of metals, petroleum compounds, volatile organic compounds (VOC), phenols, polychlorinated biphenyls (PCBs), and pesticides.

Laboratory results were compared to National Environment Protection (Assessment of Site Contamination) Measure (NEPM 1999) human health and ecological guideline standards and the New South Wales Department of Environment, Climate Change and Water Guidelines for Assessing Service Station Sites.

No reported analyte concentrations in any sample exceeded applicable 1999 NEPM Health Investigation Level (HIL) guideline values for residential sites (HIL-A) or commercial/industrial sites (HIL-F) or DECCW guideline values. Soil samples from each sample location except one hand auger bore marginally exceeded applicable 1999 NEPM Ecological Investigation Limits (EILs) for one or more metals. However, these exceedences may be the result of natural mineralisation and were believed by Golder not to represent an unacceptable risk to the environment of the site.

Based on the results of the Phase 2 ESA, this site is not believed to represent a significant environmental concern to PSP Area 91. No other previous reports for the site or vicinity were reviewed for the purposes of this assessment.

3.2 Summary of historic contamination potential

The historical data search including the aerial photograph review provided limited information regarding potential sources of contamination on the PSP Area 91 site. The historical data revealed no known contamination present on the site or immediate surrounds during the periods which the photos were taken. However, land use patterns including the excavation equipment yard on property no. 114940; the market gardens at 2, 12 and 22 Davis Road and property nos. 113522 and 114937, and property nos. 148071 and 148069; and various dry land farming activities, including potential equipment fuelling and maintenance operations at 21 Davis Road and 542 Hogans Road, across the site provide the potential for on-site sources of contamination. In addition, the lack of availability of aerial photographs dated prior to 1974 limited our ability to evaluate the historic uses of the site prior to 1974.

The potential for off-site sources of contamination migrating to the site via sub-surface pathways such as groundwater also exists due to the historic usage of the surrounding properties. The nature, extent and mobility of any potential contamination depend on the type of activities that have historically been undertaken in the context of the local geological and hydrogeological environments. Information obtained from the historical search provided no specific information relating to local processes.

4. Site inspection

4.1 General

A site walkover was performed by Jacqueline McLeod on 1 July 2011. No access to site properties was granted for this desktop study and the site inspection was therefore limited to what was visible from adjacent roadside areas. Aerial photographs and other sources were used to identify specific sites where land use may need investigation. Select site photographs are presented in Appendix D.

4.2 Significant issues

Significant issues noted during the site inspection are summarized below:

- Fuel storage and fuelling operations have occurred and may be occurring on an unknown number of individual rural holdings.
- Heavy equipment and farm equipment is stored, utilized, and possibly maintained on a number of site properties (eg 21 Davis Road, 542 Hogans Road and property no. 114940).
- Farming operations where fertilisers, pesticides, and herbicides may have been used and where faecal coliforms may be present from livestock waste.
- Market gardens are located at 2, 12 and 22 Davis Road and property no. 113522 on Davis Road, property no. 114937 on Hogans Road and 575 McGrath Road and property nos. 148069 and 148071 on McGrath Road.
- Material stockpiles consisting primarily of rock and soil present on a number of properties potentially contain contaminated materials where sites may have formerly been used for private waste disposal.
- Waterways, including Davis Creek and the Werribee River and associated low-lying areas subject to flooding are present on the site.
- Heritage sites, including residences of historic interest are present on portions of the site.

4.3 Key concerns

The key concerns with respect to contamination are anticipated to be the potential impacts associated with contaminants in soil and groundwater, in particular for site construction workers who may be in direct contact with potentially contaminating materials. Additionally, there is potential for on site and off site impacts to the environment resulting from the mobilisation of contamination at the potential areas of concern from surficial run off during rainfall events and/or through the sub-surface, particularly during construction when the areas identified would be disturbed. Soil contamination also has the potential to be mobilised through the generation of dust during construction at each of the potential areas of concern.

As described earlier in this report, other concerns relate to geotechnical, hydrological, and wetlands constraints. A geotechnical investigation will be required to fully evaluate requirements for future development. The PSP Area 91 site has streams, wetlands and heritage sites present; all of which will require consideration during future development planning.

5. Environmental risk assessment

5.1 Introduction

The environmental risk assessment is based on a contaminant (source) – pathway – receptor methodology whereby:

Contaminant (Source):	A substance that has the potential to cause harm to environmental receptors. In a broader sense sources can include particular ground conditions, for example redundant footings in the ground, which have the potential to impact on redevelopment proposals.
Pathway:	The route by which the source is brought into contact with the receptor. This can include the transport of contamination via water (surface and groundwater), wind borne dust, vapours, excavation and deposition.
Receptor:	Human beings, other living organisms, physical systems and built structures that could be affected by the source. A receptor will only be affected if a pathway from the source to the receptor is present. Groundwater and surface water systems can be considered as receptors in their own right as their quality is regulated by statutory bodies, as well as being pathways for contaminant migration to other receptors.

The source-pathway-receptor relationship allows an assessment of potential environmental risk to be determined, based on the nature of the source, the degree of exposure of a receptor to a source and the sensitivity of the receptor. On this basis an assessment is made of the environmental liabilities associated with the risk. These can be expressed for example, in terms of additional costs associated with site redevelopment or remedial measures, the potential for costs, fines or penalties imposed for breaches of environmental legislation or third party claims, and loss of land value.

The identified potential environmental liabilities with regard to contamination have been evaluated with respect to the potential impacts on:

- surface water bodies.
- groundwater.
- sensitive sites and ecosystems.
- construction and maintenance workforce.
- current and future site users.
- current and future adjacent site users.

5.2 Contaminants of concern

Sources of potential contamination were identified in the vicinity PSP Area 91 and the following contaminants may potentially be present:

- Petroleum hydrocarbons; ie, total petroleum hydrocarbons (TPH); benzene, toluene, ethylbenzene and xylenes (BTEX); and polycyclic aromatic hydrocarbons (PAH).
- Heavy metals, in particular lead and chromium.
- Fertilisers, insecticides, fungicides and herbicides.

- Arsenic, organochlorines, organophosphates, synthetic pyrethroids.
- Asbestos.
- Volatile and semi-volatile organic hydrocarbons.

5.3 Exposure pathways

The potential pathways for contaminant exposure to both people and the environment are interwoven and include:

- Site drainage and underground service pits, vaults and conduits.
- Release through the air (particularly if disturbed during demolition and excavation).
- Groundwater.
- Direct contact with soil (which can lead to dermal absorption).
- Soil vapour inhalation.
- Nearby watercourses.

The potential exists for the migration of contaminants onto the site from contamination sources via groundwater and/or surface water drainage. Airborne release and soil vapour can result from demolition and excavation activities, and dermal absorption can occur via direct contact with contaminated material.

Contaminated soil can reach off site locations during transportation or movement of soil.

The dispersal and migration of chemical contaminants will generally be controlled by sub-surface conditions (e.g. soil type and moisture content) along with physical and chemical properties of individual contaminants, construction techniques, and weather (particularly rainfall and high wind events).

Other factors that may impact the movement and migration of contaminants on the site include:

- Erosion of disturbed and cleared areas that contribute to sediment transport and deposition.
- Stripping of topsoil material.
- On site movement of light vehicles and machinery that could contribute to shallow soils being disturbed.
- The presence of naturally occurring erodible soils.
- The presence of drainage culverts forming preferential migration pathways downgradient of identified Areas of Environmental Concern (AECs).
- Rainfall conditions.

5.4 Potential receptors

Potential receptors identified on the site and in the surrounding areas include:

- Residential properties on and offsite.
- Agricultural properties on and offsite.
- Construction workers.
- Watercourses identified along proposed route.
- Groundwater.

Potential receptors and pathways from identified sources are summarized in Table 5-1.

Table 5-1 Potential receptors and pathways

Receptor	Pathway
Site Users	Dermal Contact, Ingestion and Inhalation
Adjacent Site Users	Dermal Contact, Ingestion and Inhalation
Future site users (including site workers during development)	Dermal Contact, Ingestion and Inhalation
Groundwater	Leaching from soils, transport in perched groundwater
Surface Water	Transport in perched groundwater, surface run-off
Ecosystems – Flora and Fauna	Uptake through soil, direct contact
Buried Services	Chemical Attack, Vapour Migration

5.5 Risk assessment

A risk qualitative risk assessment was conducted considering the sources of potential contamination identified above, and the series of potential receptors identified, together with linking pathways. These linkages are summarised in Table 5-2, where the associated contamination risk is assessed for a given source on a particular receptor. This assessment also takes account of specific chemicals of concern or groups of similar chemicals of concern. It is implicit that where a source has been identified during the desktop study, it has been included within the list, conversely, where the findings of the desktop study have not encountered a potential source it has not been included unless there is good reason to suspect that it may be present, but is as yet unidentified.

In Table 5-5, a two stage assessment has been carried out based on the identified sources, pathways and receptors. Initially, the column designated as 'Potential Consequence of Source - Receptor Linkage', gives an indication of the sensitivity of a given receptor to a particular source or contaminant of concern under consideration. It is a worst case classification and is based on full exposure via the particular linkage being examined. The derivation of the classes used to rank this particular aspect is presented in Table 5-2.

Table 5-2 Derivation of risk classes

Classification	Human Health	Ground/Surface Water	Ecological	Built Environment
Severe	Irreversible damage to human health	Substantial pollution of sensitive water resources	Significant change to the number of one or more species or ecosystems.	Irreparable damage to buildings, structures or the environment.
Moderate	Non permanent health effects to humans	Substantial pollution of non-sensitive water resources or small scale pollution	Change to population densities of non-sensitive species.	Damage to sensitive buildings, structures or the environment.
Mild	Slight short term health effects to humans	Slight pollution to non-sensitive water resources	Some change to population densities but with no negative effects on the function of the ecosystem.	Easily repairable effects of damage to buildings or structures.

Classification	Human Health	Ground/Surface Water	Ecological	Built Environment
Negligible	No measurable health effects to humans	Insubstantial pollution to non-sensitive water resources	No significant changes to population densities in the environment or in any ecosystem.	Very slight non-structural damage or cosmetic harm to buildings or structures.

Subsequently, in the column entitled 'Likelihood of Source-Receptor Linkage', an assessment is made of the probability of the selected source and receptor being linked by the identified pathway. This assessment is ranked based on site-specific conditions as follows:

- Very unlikely 0 to 5%
- Unlikely 5 to 45%
- Possible 45 to 55%
- Likely 55 to 95%
- Almost Certain 95 to 100% (i.e. impact noted during the investigation)

The 'Risk Classification' column is an overall assessment of the actual risk, which considers the likely effect on a given receptor, taking account of both of the previous rankings (i.e. consequence and likelihood). The risk classifications are assigned using the following consequence/likelihood matrix.

Table 5-3 Consequences/likelihood matrix

Negligible:	The presence of the identified source does not give rise to the potential to cause significant harm.
Low:	It is possible that harm could arise to a designated receptor from an identified source though this is likely to be mild.
Moderate:	It is possible that harm could arise to a specific receptor, but it is unlikely that such harm would be significant.
High:	A designated receptor is likely to experience significant harm from an identified source without remedial action.
Very High:	There is a high probability that severe harm to a designated receptor could arise from an identified source without appropriate remedial action.

On this basis, the overall risk is ranked as follows:

Table 5-4 Overall risk matrix

Potential Consequence	Likelihood				
	Very Unlikely	Unlikely	Possible	Likely	Almost Certain
Severe	Low	Low	Moderate	High	Very High
Moderate	Negligible	Low	Moderate	Moderate	High
Mild	Negligible	Low	Low	Moderate	Moderate
Negligible	Negligible	Negligible	Negligible	Low	Low

Based on the results of the site walkover, desktop study and our understanding of the future land uses described in the Precinct Structure Plans, the overall likelihood or risk of contamination being encountered on the site during construction is considered to be low to moderate. However, the likelihood or risk of contamination being encountered at specific locations on the site due to the presence of potentially contaminating sources is considered to be moderate to high. A breakdown of the likelihood or risk of contamination being encountered in soil and/or groundwater on the site has been presented in presented in Table 5-5.

Table 5-5 Qualitative Risk Assessment, PSP Area 91

Source / Contaminating Activity	Contaminant	Critical Receptor	Pathway	Potential Effect	Potential Consequence of Source-Receptor Linkage	Likelihood of Source-Receptor Linkage	Risk Classification
Equipment storage and maintenance	Heavy metals, TPH, BTEX, PAH, solvents, asbestos	Human (Current Site Users)	Dermal Contact, Ingestion, Inhalation	Toxic, Carcinogenic, Hazardous to Human Health	Severe	Possible	**Moderate**
Equipment storage and maintenance	Heavy metals, TPH, BTEX, PAH, solvents, asbestos	Human (Future Site Users including construction workers)	Dermal Contact, Ingestion, Inhalation	Toxic, Carcinogenic, Hazardous to Human Health	Severe	Possible	**Moderate**
Equipment storage and maintenance	Heavy metals, TPH, BTEX, PAH, solvents, asbestos	Human (Adjacent Site Users)	Dermal Contact, Ingestion, Inhalation	Toxic, Carcinogenic, Hazardous to Human Health	Severe	Very Unlikely	**Low**
Equipment storage and maintenance	Heavy metals, TPH, BTEX, PAH, solvents, asbestos	Groundwater	Permeation through Soil Profile	Groundwater Contamination	Moderate	Unlikely	**Low**
Equipment storage and maintenance	Heavy metals, TPH, BTEX, PAH, solvents, asbestos	Surface Water	Perched Groundwater Flow, Surface run-off	Surface Water Contamination	Moderate	Unlikely	**Low**
Equipment storage and maintenance	Heavy metals, TPH, BTEX, PAH, solvents, asbestos	Flora and Fauna	Leaching and uptake	Toxic, phytotoxic	Mild	Unlikely	**Low**
Equipment storage and maintenance	Heavy metals, TPH, BTEX, PAH, solvents, asbestos	Services/ Infrastructure	Permeation through Soil Profile	Physical and chemical damage to structures	Mild	Possible	**Low**

Source / Contaminating Activity	Contaminant	Critical Receptor	Pathway	Potential Effect	Potential Consequence of Source-Receptor Linkage	Likelihood of Source-Receptor Linkage	Risk Classification
Fuelling operations and fuel storage	Heavy metals, TPH, BTEX, PAH	Human (Current Site Users)	Dermal Contact, Ingestion, Inhalation	Toxic, Carcinogenic, Hazardous to Human Health	Moderate	Possible	**Moderate**
Fuelling operations and fuel storage	Heavy metals, TPH, BTEX, PAH	Human (Future Site Users including construction workers)	Dermal Contact, Ingestion, Inhalation	Toxic, Carcinogenic, Hazardous to Human Health	Severe	Possible	**Moderate**
Fuelling operations and fuel storage	Heavy metals, TPH, BTEX, PAH	Human (Adjacent Site Users)	Dermal Contact, Ingestion, Inhalation	Toxic, Carcinogenic, Hazardous to Human Health	Severe	Unlikely	**Low**
Fuelling operations and fuel storage	Heavy metals, TPH, BTEX, PAH	Groundwater	Permeation through Soil Profile	Groundwater Contamination	Moderate	Possible	**Moderate**
Fuelling operations and fuel storage	Heavy metals, TPH, BTEX, PAH	Surface Water	Perched Groundwater Flow, Surface run-off	Surface Water Contamination	Moderate	Possible	**Moderate**
Fuelling operations and fuel storage	Heavy metals, TPH, BTEX, PAH	Flora and Fauna	Leaching and uptake	Toxic, phytotoxic	Moderate	Unlikely	**Los**
Fuelling operations and fuel storage	Heavy metals, TPH, BTEX, PAH	Services/ Infrastructure	Permeation through Soil Profile	Physical and chemical damage to structures	Mild	Possible	**Low**
Market Gardens and Glass Houses	Heavy metals, pesticides, herbicides	Human (Current Site Users)	Dermal Contact, Ingestion, Inhalation	Toxic, Carcinogenic, Hazardous to Human Health	Severe	Possible	**Moderate**

Source / Contaminating Activity	Contaminant	Critical Receptor	Pathway	Potential Effect	Potential Consequence of Source-Receptor Linkage	Likelihood of Source-Receptor Linkage	Risk Classification
Market Gardens and Glass Houses	Heavy metals, pesticides, herbicides	Human (Future Site Users including construction workers)	Dermal Contact, Ingestion, Inhalation	Toxic, Carcinogenic, Hazardous to Human Health	Severe	Possible	**Moderate**
Market Gardens and Glass Houses	Heavy metals, pesticides, herbicides	Groundwater	Permeation through Soil Profile	Groundwater Contamination	Moderate	Unlikely	**Low**
Market Gardens and Glass Houses	Heavy metals, pesticides, herbicides	Flora and Fauna	Leaching and uptake	Toxic, phytotoxic	Mild	Possible	**Low**
Market Gardens and Glass Houses	Heavy metals, pesticides, herbicides	Services/ Infrastructure	Permeation through Soil Profile	Physical and chemical damage to structures	Mild	Very Unlikely	**Negligible**
Soil/rock stockpiling	Heavy metals, pesticides, herbicides, TPH, PAH	Human (Current Site Users)	Dermal Contact, Ingestion, Inhalation	Toxic, Carcinogenic, Hazardous to Human Health	Severe	Unlikely	**Low**
Soil/rock stockpiling	Heavy metals, pesticides, herbicides, TPH, PAH	Human (Future Site Users including construction workers)	Dermal Contact, Ingestion, Inhalation	Toxic, Carcinogenic, Hazardous to Human Health	Severe	Unlikely	**Low**
Soil/rock stockpiling	Heavy metals, pesticides, herbicides, TPH, PAH	Groundwater	Permeation through Soil Profile	Groundwater Contamination	Moderate	Unlikely	**Low**

Source / Contaminating Activity	Contaminant	Critical Receptor	Pathway	Potential Effect	Potential Consequence of Source-Receptor Linkage	Likelihood of Source-Receptor Linkage	Risk Classification
Soil/rock stockpiling	Heavy metals, pesticides, herbicides, TPH, PAH	Flora and Fauna	Leaching and uptake	Toxic, phytotoxic	Mild	Possible	**Low**
Soil/rock stockpiling	Heavy metals, pesticides, herbicides, TPH, PAH	Services/ Infrastructure	Permeation through Soil Profile	Physical and chemical damage to structures	Mild	Unlikely	**Low**
Farming activities (including effluent pits, livestock dips, offal pits, etc.)	Heavy metals, pesticides, herbicides, fertilisers, TPH, PAH, faecal coliforms	Human (Current Site Users)	Dermal Contact, Ingestion, Inhalation	Toxic, Carcinogenic, Hazardous to Human Health	Severe	Possible	**Moderate**
Farming activities (including effluent pits, livestock dips, offal pits, etc.)	Heavy metals, pesticides, herbicides, fertilisers, TPH, PAH, faecal coliforms	Human (Future Site Users including construction workers)	Dermal Contact, Ingestion, Inhalation	Toxic, Carcinogenic, Hazardous to Human Health	Severe	Possible	**Moderate**
Farming activities (including effluent pits, livestock dips, offal pits, etc.)	Heavy metals, pesticides, herbicides, fertilisers, TPH, PAH, faecal coliforms	Groundwater	Permeation through Soil Profile	Groundwater Contamination	Moderate	Possible	**Moderate**
Farming activities (including effluent pits, livestock dips, offal pits, etc.)	Heavy metals, pesticides, herbicides, fertilisers, TPH, PAH, faecal coliforms	Flora and Fauna	Leaching and uptake	Toxic, phytotoxic	Moderate	Unlikely	**Low**

Source / Contaminating Activity	Contaminant	Critical Receptor	Pathway	Potential Effect	Potential Consequence of Source-Receptor Linkage	Likelihood of Source-Receptor Linkage	Risk Classification
Farming activities (including effluent pits, livestock dips, offal pits, etc.)	Heavy metals, pesticides, herbicides, fertilisers, TPH, PAH, faecal coliforms	Services/ Infrastructure	Permeation through Soil Profile	Physical and chemical damage to structures	Mild	Unlikely	**Low**
Structures (including possible septic tanks)	Lead, asbestos, hazardous materials, pesticides, herbicides, faecal coliforms	Human (Current Site Users)	Dermal Contact, Ingestion, Inhalation	Toxic, Carcinogenic, Hazardous to Human Health	Severe	Possible	**Moderate**
Structures (including possible septic tanks)	Lead, asbestos, hazardous materials, pesticides, herbicides, faecal coliforms	Human (Future Site Users including construction workers)	Dermal Contact, Ingestion, Inhalation	Toxic, Carcinogenic, Hazardous to Human Health	Severe	Possible	**Moderate**
Structures (including possible septic tanks)	Lead, asbestos, hazardous materials, pesticides, herbicides, faecal coliforms	Groundwater	Permeation through Soil Profile	Groundwater Contamination	Moderate	Possible	**Moderate**
Structures (including possible septic tanks)	Lead, asbestos, hazardous materials, pesticides, herbicides, faecal coliforms	Flora and Fauna	Leaching and uptake	Toxic, phytotoxic	Mild	Possible	**Low**

Source / Contaminating Activity	Contaminant	Critical Receptor	Pathway	Potential Effect	Potential Consequence of Source-Receptor Linkage	Likelihood of Source-Receptor Linkage	Risk Classification
Structures (including possible septic tanks)	Lead, asbestos, hazardous materials, pesticides, herbicides, faecal coliforms	Services/ Infrastructure	Permeation through Soil Profile	Physical and chemical damage to structures	Mild	Very Unlikely	**Negligible**

6. Summary

6.1 Site contamination

Review of the collected data indicates that the site has historic and current land use activities that have the potential to cause residual contamination in soils, surface water and groundwater. Specific potentially contaminating activities and potential areas of concern that were identified within proximity to PSP Area 91 include:

- Properties where fuel storage and fuelling operations have occurred.
- Properties, including 21 Davis Road, 542 Hogans Road and property no. 114940, where heavy equipment and farm equipment storage, utilization, and possibly maintenance, have occurred.
- Properties, including the market gardens and glass houses at 2, 12 and 22 Davis Road and property nos. 113522 and 114937 on Davis Road and 575 McGrath Road, and property nos. 148069 and 148071 on McGrath Road, where farming operations, possibly utilising fertilisers, pesticides, and herbicides, may have occurred and where faecal coliforms may be present from livestock waste.
- Material stockpiles consisting primarily of rock and soil.
- Structures where lead-based paint may have been used.

6.2 Geotechnical

Limited geotechnical data are available for the site. The geology of PSP Area 91 is predominantly Pleistocene Quaternary to Miocene Neogene basalts of the Newer Volcanic Group with minor scoria and ash (tholeiitic to alkaline). The map indicates that the geology on the site also includes Holocene Quaternary fluvial alluvium, gravel, sand and silt confined to existing rivers and streams. The southern portion of PSP Area 91 is overlain by Pleistocene Quaternary Aeolian dune deposits consisting of sand, clay and calcareous sand. The key geotechnical constraints that may affect the development of PSP Area 91 are:

- Differential settlement of overlying residual clay in localised areas of extremely weathered basalt.
- Shallow soil failure (soil creep, slumping, collapse) in areas of increased gradient.
- The presence of soft material encountered at depth may result in a bearing capacity or settlement hazard for any proposed foundations.
- Clay likely to be derived from basalt rock is likely to be subject to considerable shrinkage or swelling in response to change in moisture content. Highly expansive clay can cause unexpected ground movements that are able to damage to building foundations, structures and road infrastructure.
- Ephemeral creeks crossing the site may serve as drainage channels for storm water during flood events, resulting in the erosion of soft sediment and bedrock.

6.3 Hydrology

The main waterway through the area is the Werribee River which meanders from the northwest corner of the site to the southeast corner. The entire length of the river flows relatively full with narrow but steep river banks. A large concrete weir is located in the southern section of the river (property no. 114937) and serves to hold a large volume of water upstream with the downstream section restricted in size to only manage flows during high rainfall events. Three smaller creeks are located north of the site, forming Davis Creek, which runs down the eastern site boundary until it empties into the Werribee River adjacent to Micarey Court. Davis Creek is generally ephemeral with a number of areas of ponding, particularly near culverts at the road crossings.

The site is part of the Werribee catchment with Werribee River being the major waterway conveying water from most of the catchment. The smaller creek to the north of the site conveys flow from the northern and eastern areas.

The defined floodway zone of the Werribee River widens significantly on the south-western margin of the site and inundates the majority of the lower lying land in the southern section of the site. This flooding is exacerbated further in a 1 in 100 year flood event where the river swells further and all of the low lying area south of the river is inundated. The main single branch of Davis Creek also shows flooding potential but to a much lesser extent than the Werribee River.

Groundwater beneath the site is present in two main aquifers, the upper Newer Volcanics aquifer, a fractured rock basalt aquifer, and a deeper regional aquifer within the Silurian aged formation. Groundwater depth for the majority of the site is believed to be between approximately 5 and 10 m, except on the northern margin of the site where it may be located between 10 and 20 m below ground surface. This suggests that groundwater is shallow enough for extraction but deep enough to pose no significant risk to construction except in the vicinity of a freshwater meadow area located east of Sewells Road on property no. 124354. The watertable is likely shallow in this area and the meadow may have to be retained as part of the works or included in any drainage scheme.

The Victorian Water Resources Data Warehouse identified 45 registered boreholes within 1.0 km of the site. Borehole usage was primarily domestic and agricultural water supply with a small number of irrigation and extractive industries boreholes.

6.4 Wetlands

It is clear that the areas of wetland EVCs and listed ecological communities are generally small, highly fragmented and disturbed although some parts may still be relatively intact. PSP Area 91 contains six wetland EVCs of various sized patches.

A net gain assessment will be required where areas of wetland EVCs are proposed for clearing. In view of the Very High conservation significance of the wetland EVCs, Ministerial consent will most likely be required, if native vegetation clearing is proposed.

6.5 Heritage sites

A search of Australian heritage databases was performed to locate sites of historic significance on the site. Nine heritage sites were identified in PSP Area 91 and include buildings, historic transportation routes, a pumping plant, and a park.

7. Recommendations

7.1 Contamination

Based upon our environmental desktop evaluation and a review of the publicly available information, we note that potential for site contamination may exist and as such further site investigations should be conducted for the subject site known as PSP Area 91 in the City of Wyndham, Victoria, Australia. Recommendations for future assessment of individual site properties based on use and potential for contamination are summarized in Table 7-1 and indicated on Figure 5 presented in Appendix A. Recommendations are made in accordance with the Victoria Department of Sustainability and Environment, *Potentially Contaminated Land, General Practice Note*, 2005.

Of the fifty-one (51) site properties, further assessment is recommended for thirty-five (35) properties, with recommendations for environmental audits on eight additional properties. In general, recommendations for assessment were made based on sensitive land use and the presence of structures where lead based paint may have been used. Non-intensive farming, the presence of heavy equipment or soil stockpiling was considered secondary indicators of the need for assessment in the case of sensitive land use. Environmental audits were recommended for the market gardens at 2, 12 and 22 Davis Road and property nos. 113522 and 114937 on Davis Road and 575 McGrath Road, and property nos. 148069 and 148071 on McGrath Road, all properties considered at high potential for contamination based on past and present land use. Due to the limited nature of the site inspection, additional site properties may be recommended for assessment in the future based on receipt of additional information not available at the time of this assessment.

Intrusive sampling and analysis should be undertaken in accordance with 1999 and draft 2011 NEPM, AS 4482.1-2005, AS 4482.2-1999 and Victoria Environment Protection Authority, Industrial Waste Resource Guidelines (IWRG) *Soil Sampling*, 2009. The results of the sampling and analysis would be compared with guideline values for protection of human health and the environment as well as waste disposal criteria (as applicable).

In addition, hazardous materials surveys should be carried out for structures identified for demolition or relocation. The surveys should address asbestos, lead-based paint, polychlorinated biphenyls in electrical fixtures, and hazardous materials storage. Should asbestos bearing materials be encountered during future investigations or construction, the testing, inspection and removal of asbestos materials are required by law to be undertaken by a suitably qualified and licensed asbestos specialist/removalist.

7.2 Geotechnical

It is recommended that further geotechnical assessment is undertaken across the site to aid the design process. The purpose of the geotechnical assessment will be to undertake intrusive investigation to obtain information for the purposes of:

- Determining a better understanding of the sub-surface geological profile and hydrogeological conditions to develop an accurate geological model.
- Develop baseline geotechnical parameters to aid design, settlement and slope stability modelling (where required).
- Determine depth to rock head and degree of weathering within the upper layers of the bedrock.
- Determine the nature of factures and jointing within the underlying volcanic material.
- Determine the presence of voids within the underlying basalt material.

Figure 7.1 in Appendix F (Look, 2007) provides a model to derive suitable intrusive investigation dependent on likely geological conditions and proposed structure. It is expected that all investigation

within PSP Area 91 be categorised as *GC1* or possibly *GC2* where larger commercial structures may be required as part of the design.

7.3 Hydrology and wetlands

- Development should be restricted in the vicinity of the Werribee River to avoid the 1 in 100 year flood levels. For developments to occur outside the flood zone, but within the 1 in 100 year flood levels, significant works will be required to mitigate against flooding.
- Flood modelling should be undertaken to determine hydrologic effects that any new developments will have on the existing creek system, in particular existing culvert and bridge flow capacities.
- Waterways, including Davis Creek and the Werribee River and associated low-lying areas will require feature surveys to provide detail of drainage patterns and inform planning for urban drainage systems.
- Drainage paths will need to be either maintained or diverted to ensure all areas are well drained during and after any development.
- Provision should be made in the precinct structure planning for protection of native vegetation along waterways, including Davis Creek and the Werribee River, with appropriate buffering from residential and other urban uses.

Table 7-1 Contamination potential and level of assessment, PSP Area 91

Property No.	Address	Legal description	Area (Ha)**	Historic Activities	Contamination Potential	
					Sensitive Uses	Other Uses
110705	Shaws Road WERRIBEE VIC 3030	PT CA F SEC 1/PT L2 LP112828 PARISH TARNEIT	12.12	Park	Low - C	Low - C
113520	2 Davis Road TARNEIT VIC 3029	L2 LP84778 PSH TAR	11.68	Market garden, glass houses, structures	High - A	High - B
113521	22 Davis Road TARNEIT VIC 3029	V 10548 F 646 L 1 PS 438794 Tarneit Parish	1.62	Market garden, glass houses, structures	High - A	High - B
113522	Davis Road TARNEIT VIC 3029	V 8168 F 426 L 1 TP 251610 Tarneit Parish	4.05	Market garden, glass houses, structures	High - A	High - B
114937	Hogans Road TARNEIT VIC 3029	L2 PS421738 TARNEIT	5.59	Market garden, glass houses, structures	High - A	High - B
114938	555 Hogans Road TARNEIT VIC 3029	L1 LP126643/L1 LP92579 TARNEIT	11.14	Structures	Medium - B	Medium - C
114940	Hogans Road TARNEIT VIC 3029	L2 PS504736 TARNEIT	17.33	Soil stockpiles, heavy equipment, structures	Medium - B	Medium - C
114941	605 Hogans Road TARNEIT VIC 3029	L1 PS504736 TARNEIT	1.69	Structures	Medium - B	Medium - C
120648	23 Davis Road TARNEIT VIC 3029	L 2 LP 144521 Tarneit Parish	161.42	Non-intensive farming, structures	Medium - B	Medium - C
120649	21 Davis Road TARNEIT VIC 3029	L 2 LP 144521 Tarneit Parish	0.36	Heavy equipment, structures	Medium - B	Medium - C
120650	180 Davis Road TARNEIT VIC 3029	PT CA A SEC 9 PSH TAR	32.33	Non-intensive farming, structures	Medium - B	Medium - C

Property No.	Address	Legal description	Area (Ha)**	Historic Activities	Contamination Potential	
					Sensitive Uses	Other Uses
120651	435 Davis Road MOUNT COTTRELL VIC 3024	L21 LP92917 PSH TAR	4.01	Structures	Medium - B	Medium - C
121476	15 Gard Road MOUNT COTTRELL VIC 3024	L49 LP92918 PSH TAR	4.08	Structures	Medium – B	Medium - C
121976	Hogans Road TARNEIT VIC 3029	L3 LP136754 PSH TAR	20.5	Non-intensive farming, structures	Medium - B	Medium - C
121977	540 Hogans Road TARNEIT VIC 3029	V 10645 F 136 L 2 PS 500009 Tarneit Parish	11.81	Non-intensive farming, structures	Medium - B	Medium - C
121978	542 Hogans Road TARNEIT VIC 3029	L1 LP136754 PSH TAR	12.22	Non-intensive farming, heavy equipment, soil stockpiles, structures	Medium - B	Medium - C
122503	Leakes Road TARNEIT VIC 3029	V 9918 F 722 CA B Sec 15 Tarneit Parish	68.78	Non-intensive farming	Low - C	Low - C
122505	1070 Leakes Road MOUNT COTTRELL VIC 3024	L22 LP92917 PSH TAR	4.06	Structures	Medium - B	Medium - C
122506	1080 Leakes Road MOUNT COTTRELL VIC 3024	V 8900 F 281 L 23 LP 92917 Tarneit Parish	4.07	Structures	Medium - B	Medium - C
122507	1090 Leakes Road MOUNT COTTRELL VIC 3024	L24 LP92917 PSH TAR	4.03	Structures	Medium - B	Medium - C
122508	1106 Leakes Road MOUNT COTTRELL VIC 3024	L25 LP92917 PSH TAR	4.06	Structures	Medium - B	Medium - C

Property No.	Address	Legal description	Area (Ha)**	Historic Activities	Contamination Potential	
					Sensitive Uses	Other Uses
122509	1126 Leakes Road MOUNT COTTRELL VIC 3024	L50 LP92918 PSH TAR	4.1	Grazing	Low - C	Low - C
122510	1166 Leakes Road MOUNT COTTRELL VIC 3024	L25 LP92917 PSH TAR	4.1	Structures	Medium - B	Medium - C
124354	Sayers Road TARNEIT VIC 3029	CA A1 Sec 8 Tarneit Parish V 9795 F 892 L 1 TP 138990 Tarneit Parish	236.24	Irrigated cropping, structures	Medium - B	Medium - C
124455	990 Sayers Road TARNEIT VIC 3029	P CA D Sec 15 Tarneit Parish	63.44	Non-intensive farming, structures	Medium - B	Medium - C
124456	1070 Sayers Road TARNEIT VIC 3029	V 9509 F 863 L 1 LP 142708 Tarneit Parish V 9509 F 864 L 2 LP 142708 Tarneit Parish	130.28	Non-intensive farming, structures	Medium - B	Medium - C
124457	1122 Sayers Road TARNEIT VIC 3029	L1 LP86156 PSH TAR	0.09	Structures	Medium - B	Medium - C
124458	1160 Sayers Road TARNEIT VIC 3029	V 9522 F 664 L 2 LP 143311 Tarneit Parish	114.28	Non-intensive farming, structures	Medium - B	Medium - C
124459	1170 Sayers Road TARNEIT VIC 3029	V 9522 F 663 L 1 LP 143311 Tarneit Parish	6.71	Non-intensive farming, structures	Medium - B	Medium - C
124460	1245 Sayers Road TARNEIT VIC 3029	V 9052 F 576 Tarneit Parish	110.7	Structures	Medium - B	Medium - C
124461	1180 Sayers Road TARNEIT VIC 3029	L 1 LP 93657 Tarneit Parish	5.49	Structures	Medium - B	Medium - C
124462	Sayers Road TARNEIT VIC 3029	P L 1B LP 5408 Tarneit Parish	53.92	Non-intensive farming	Low - C	Low - C

Property No.	Address	Legal description	Area (Ha)**	Historic Activities	Contamination Potential	
					Sensitive Uses	Other Uses
124548	85-87 Sewells Road TARNEIT VIC 3029	L 4A LP 5408 Tarneit Parish	90.99	Non-intensive farming, structures	Medium - B	Medium - C
146985	Heaths Road WYNDHAM VALE VIC 3024	V 8695 F 035 L 1 TP 875872 Mambourin Parish	3.44	Car park	Low - C	Low - C
148055	McGrath Road WYNDHAM VALE VIC 3024	V 9646 F 838 CP 156342 Werribee Parish	18.82	Structures	Medium - B	Medium - C
148056	McGrath Road WYNDHAM VALE VIC 3024	V 9646 F 839 CP 156343 Werribee Parish	15.39	Athletic fields, structures, park	Medium - B	Medium - C
148057	McGrath Road WYNDHAM VALE VIC 3024	V 9646 F 840 CP 156344 Werribee Parish	11.12	Structures	Medium - B	Medium - C
148058	McGrath Road WYNDHAM VALE VIC 3024	V 9650 F 930 CP 156345 Werribee Parish	12.23	Athletic fields	Low - C	Low - C
148059	McGrath Road WYNDHAM VALE VIC 3024	V 9647 F 860 CP 156346 Werribee Parish	13.54	Athletic fields	Low - C	Low - C
148060	McGrath Road WYNDHAM VALE VIC 3024	V 9646 F 839 CP 156343 Werribee Parish	15.39	Athletic fields, structures, park	Medium - B	Medium - C
148061	McGrath Road WYNDHAM VALE VIC 3024	V 9646 F 839 CP 156343 Werribee Parish	15.39	Athletic fields, structures, park	Medium - B	Medium - C
148064	480 McGrath Road WYNDHAM VALE VIC 3024	V 9801 F 662 CP 156347 Werribee Parish	11.16	Non-intensive farming, structures	Medium - B	Medium - C

Property No.	Address	Legal description	Area (Ha)**	Historic Activities	Contamination Potential	
					Sensitive Uses	Other Uses
148066	560 McGrath Road WYNDHAM VALE VIC 3024	L7 LP144420 PSH WER	9.08	Non-intensive farming, structures	Medium - B	Medium - C
148067	McGrath Road WYNDHAM VALE VIC 3024	L2 LP218436 WERRIBEE	33.35	Soil stockpiles	Medium - B	Medium - C
148068	575 McGrath Road WYNDHAM VALE VIC 3024	L1 LP133394 PSH WER	59.37	Market garden, glass houses, structures	High - A	High - B
148069	McGrath Road WYNDHAM VALE VIC 3024	L1 LP218436 TARNEIT	33.32	Market garden, glass houses, structures	High - A	High - B
148070	McGrath Road WYNDHAM VALE VIC 3024	L12 LP144420 PSH WER	12.68	Non-intensive farming, structures	Medium - B	Medium - C
148071	McGrath Road WYNDHAM VALE VIC 3024	L 2 LP 133394 Werribee Parish	60.67	Market garden, glass houses, structures	High - A	High - B
155363	538 Hogans Road TARNEIT VIC 3029	V 10645 F 135 L 1 PS 500009 Tarneit Parish	0.4	Non-intensive farming, soil stockpiling, structures	Medium - B	Medium - C
173387	12 Davis Road TARNEIT VIC 3029	V 10548 F 647 L 2 PS 438794 Tarneit Parish	5.28	Market garden, glass houses, structures	High - A	High - B
181636	Heaths Road WYNDHAM VALE VIC 3024	CA 2002 Werribee Parish	7.41	Park	Low - C	Low - C

Notes:

A - requires an environmental audit B - requires a site assessment

C - no assessment needed under Section 12(2)(b) and Section 60(1)(a)(iii) of the Planning and Environment Act 1987

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Appendix A
Figures

Appendix A

Figure 1 – Aerial Map
Figure 2 – Geotech Map
Figure 3 – Environment and Heritage
Figure 4 – Vegetation Quality
Figure 5 – Recommendations for Site Assessment

Department of Sustainability and Environment Map
Drainage Path Map

Appendix B
Certificates of Title

Appendix B

Certificate of Title

Appendix C
Regulatory Records Documentation

Appendix C

Appendix D
Aerial Photographs

Appendix D

Aerial Photographs

Appendix E
Site Photographs

Appendix E

Site Photographs

Appendix F
Figure 7.1 Geotechnical Category of Investigation (Look, 2007)

Appendix F

Figure 7.1