

Land Capability Assessment

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Contents

Important note about your report	i
Acronyms and abbreviations.....	v
1. Introduction.....	1
1.1 Background and objectives	1
1.2 Scope of works	1
2. Regulatory framework	2
2.1 Relevant legislation and policies	2
2.2 Guidelines and standards for assessment of contaminated land	6
2.3 Guidelines and standards for surface water	7
3. Methodology.....	10
3.1 General assessment approach	10
4. Precinct description	12
5. Environmental setting	14
5.1 Regional geology	14
5.2 Regional acid sulfate soils	18
5.3 Regional hydrology	19
5.4 Regional geomorphology	24
5.5 Regional and local hydrogeology.....	25
5.6 Bushfire context.....	35
5.7 Future land use	37
5.8 Adverse Amenity	39
6. Information review.....	41
6.1 Certificate of Title Information.....	41
6.2 Historical aerial imagery.....	41
6.3 EPA Victoria Records.....	45
6.4 Surface water information	50
6.5 Waste management facilities and landfills	51
6.6 Other reviewed reports	52
7. Site characterisation.....	53
7.1 Site contamination assessment.....	53
7.2 Geotechnical assessment.....	60
7.3 Hydrogeological assessment.....	62
7.4 Hydrology assessment	63
8. Development opportunities & constraints.....	64
8.1 Land contamination	64
8.2 Geotechnical consideration.....	65
8.3 Hydrogeology	67
8.4 Hydrology	68
8.5 Geomorphology.....	69
9. Conclusions.....	70

9.1	Contamination	70
9.2	Geotechnical	71
9.3	Hydrogeology	71
9.4	Hydrology	72
9.5	Geomorphology	72
10.	Recommendations	73
11.	References	75

Appendices

Appendix A. Figures

Appendix B. Lotsearch reports

Appendix C. Groundwater bores

Appendix D. Summary of Potential for Contamination

Tables

Table 4-1. Overview of GAEP Area	12
Table 5-1. Summary of geological units expected to be encountered within the GAEP area (GSV, 2014) ¹ ..	14
Table 5-2. Groundwater quality laboratory chemistry data summary for WMIS bores within 1 km of precinct	33
Table 6-1. Summary of Review of Historical Aerial Imagery (Northern GAEP)	41
Table 6-2. Summary of Review of Historical Aerial Imagery (South-western GAEP)	43
Table 6-3. Summary of EPA Victoria Priority Sites	45
Table 6-4. Former EPA Victoria Priority Sites and Other Pollution Notices	47
Table 6-5. Former EPA Victoria Priority Sites and Other Pollution Notices for South-western GAEP	48
Table 6-6. Summary of Current and Former EPA Licences Activities (Beyond the GAEP Boundary)	49
Table 6-7. Summary of EPA Approval Works	49
Table 6-8. Summary of EPA Environmental Audit Sites	50
Table 6-9. Summary of information reviewed in hydrology desktop due diligence assessment	50
Table 7-1. Summary of On-Site Characterisation – Potential for Contamination	56
Table 7-2. Summary of Off-Site Characterisation – Potential for Contamination	56
Table 7-3. Design geotechnical risk summary	61
Table C-1. Summary of registered groundwater bores	80
Table D-1. Summary of Site Characterisation – Potential for Contamination	82

Figures

Figure 5-1. Site regional geology based on 1:50,000 scale Seamless Geology map sheet, superimposed by approximate site area (GeoVic - Earth Resources).	15
Figure 5-2. Site regional geology based on combined Geological Survey of Victoria 1:63,360 maps of Geelong (GSV, 1963), Melbourne (GSV, 1974) and Portarlington (GSV, 1977), superimposed by approximate site area – not to scale.	17
Figure 5-3. Extract from Section A-B in Geological Survey of Victoria 1:63,360 map of Melbourne (GSV, 1974) – not to scale.....	17
Figure 5-4. Topographical view of the site (topographic-map.com) – not to scale.	18
Figure 5-5. Extract from Map 2 for West Coast of Victoria (VRO) – CASS Distribution within site	19
Figure 5-6. Catchment Management Authority boundaries, local catchment boundaries, and nearby waterways to GAEP area.	20
Figure 5-7. Previous flood study inundation extents.....	21
Figure 5-8. Local topography from Geoscience Australia’s public five metre resolution dataset	22
Figure 5-9. Flow paths and contours for the Northern GAEP area	23
Figure 5-10. Flow paths and contours for the South-western GAEP area	24
Figure 5-11. Mapped extent of QA – 100 (UTB – 101 present and outcrops where QA – 100 absent).....	26
Figure 5-12. Depth to groundwater, meters below ground surface	26
Figure 5-13. Potential Aquatic Groundwater Dependent Ecosystems	28
Figure 5-14. Potential Terrestrial Groundwater Dependent Ecosystems	29
Figure 5-15. Registered groundwater bores within 1 km of precinct area	30
Figure 5-16. Registered groundwater bore use types within 1 km of precinct area	30
Figure 5-17. Regional groundwater salinity.....	32
Figure 5-18. Bore 121451 groundwater levels and depths	33
Figure 5-19. White Oil Pipeline leak audit area (URS, 2005)	34
Figure 5-20. Average monthly rainfall and daily maximum temperature (Tmax), and highest temperature on record (Tmax rec) for Avalon Airport, data for 1995-2023 (BoM station 087113; BoM 2023).....	35
Figure 5-21. Fire history and bushfire prone area map	37
Figure 5-22. Framework Plan – Avalon Corridor Strategy (2022)	38

Pictures

Picture 2-1. Recommended approach to assessing potentially contaminated land	5
Picture 7-1. Site Inspection – Selective Photographs	58
Picture 7-2. Site Inspection – Selective Photographs	59

Acronyms and abbreviations

AAA	Avalon Airport Australia
AASS	Actual Acid Sulfate Soils
ACS	Avalon Corridor Strategy
ANZCC	Australian and New Zealand Environment and Conservation Council
ANZG	Australian and New Zealand Guidelines
BAO	Buffer Area Overlay
CASS	Coastal Acid Sulfate Soils
CEMP	Construction Environmental Management Plan
CoGG	City of Greater Geelong
DCCEEW	Department of Climate Change, Energy, the Environment and Water (Commonwealth)
DELWP	Department of Environment, Land, Water and Planning
EAO	Environmental Audit Overlay
EIIA	Extractive Industries Interest Area
EPA	Environmental Protection Authority
EPAV	Environmental Protection Authority Victoria
ESA	Environmental Site Assessment
ESO	Environmental Significance Overlay
GAEP	Greater Avalon Employment Precinct
GDE	Groundwater Dependent Ecosystem
GQRUZ	Groundwater Quality Restricted Use Zones
LCA	Land Capability Assessment
LDRZ	Low Density Residential Zone
LNAPL	Light Non-aqueous Phase Liquid
LSIO	Land Subject to Inundation Overlay
MTBE	Methyl tert-Butyl Ether
MWC	Melbourne Water Corporation
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
PCRZ	Public Conservation and Resource Zone
PPN30	Planning Practice Note 30
PASS	Potential Acid Sulfate Soils

PRSA	Preliminary Risk Screening Assessment
PSP	Precinct Structure Plan
RLZ	Rural Living Zone
SAP	Sampling and Analysis Plan
SMO	Salinity Management Overlay
SUZ1	Special Use Zone – Schedule 1
TDA	Total Dissolved Solids
VPA	Victorian Planning Authority
VPO	Vegetation Protection Overlay
WOPL	White Oil Pipeline
WTP	Western Treatment Plant

1. Introduction

1.1 Background and objectives

Jacobs Group (Australia) Pty Ltd (Jacobs) was commissioned by Victorian Planning Authority (VPA) to undertake a desktop review and assessment of the hydrogeological, hydrological, geomorphological, and geotechnical environmental setting of the Greater Avalon Employment Precinct (GAEP) area, hereafter referred to as either “GAEP” or “the study area”. This assessment is termed a Land Capability Assessment (LCA).

The GAEP area is located approximately 20 km north-east of the City of Greater Geelong. It is about 55 km south-west and less than an hour drive from the Melbourne Central Business District (CBD). The precinct encompasses a total area of 2,646 hectares (ha) and bounded by Princes Highway to the north-west, Avalon Road to the west, Dandos Road and an unnamed road to the south and Pousties Road and Western Road to the east. The GAEP comprises Avalon Airport and the land around it. However, the area subject to the LCA excludes Avalon Airport. Therefore, the LCA study focusses only on the non-airport land with an approximate area of 1,581 ha (Lotsearch area estimate). Since the non-airport land forms two distinct areas that are separated by Avalon Airport, this report shall refer to the Northern GAEP area (triangular-shaped area with an approximate area of 641 ha) and the South-western GAEP (rectangular-shaped area with an approximate area of 940 ha) where applicable.

Currently, the study area's land use is mostly agricultural and commercial. The west and south-west portion of the precinct features farming activities and salt works while the northern portion features a motor sports complex. The remaining land uses predominantly include rural residential properties. The proposed development of the GAEP aims to maximise strategic transport connections such as Avalon Airport, Geelong Port and nearby arterial road links. This precinct also aims to provide significant employment opportunities for the rapidly growing municipalities of the City of Greater Geelong (CoGG) and Wyndham City.

This assessment aims to identify potential environmental constraints that are relevant to the proposed future development of the GAEP. This includes considerations such as potential for the presence of land contamination (resulting from current / historical land uses within and / or adjacent to the GAEP) as well as constraints relating to hydrology, groundwater, geology/geomorphology, amenity and bushfire risk. Establishing the environmental conditions will be based on the combination of a desktop review and field site inspection within the boundaries of the GAEP. Both will consider the areas of potential sodic/dispersive soils, potential soil and/or groundwater contamination, geotechnical, and hydrological variables, and existing land uses that may cause the potential to cause adverse amenities. The LCA study will also assess, in general, the bushfire and adverse amenity risks. There will be no sampling that will be conducted at this stage and will include the above-mentioned process.

1.2 Scope of works

The following scope of work has been completed as part of this LCA:

- **Stage 1** – A desktop assessment stage comprised the gathering of relevant information (including the use of Lotsearch Reports and various literature sources) to identify potential sources of contamination, hydrogeological, hydrological, geomorphological, and geotechnical conditions across the GAEP area including the assessment of potential for bushfire and adverse amenity risks; and
- **Stage 2** – A site inspection at selected properties within the GAEP to further support site-specific and precinct-wide observations made as part of the Stage 1 desktop assessment. This site inspection focussed primarily on potential for contamination.

The approach and findings of the assessment, together with supporting information, are documented within this report.

2. Regulatory framework

2.1 Relevant legislation and policies

2.1.1 Planning and Environment Act 1987

The *Planning and Environment Act 1987* regulates the use and development of land in Victoria. The Act sets out the framework and procedures for preparing and amending planning schemes, obtaining planning permits, settling disputes, enforcing compliance with planning schemes, and other administrative procedures. The Act requires planning authorities to “take into account any significant effects which it considers the scheme or amendment might have on the environment or which it considers the environment might have on any use or development envisaged in the scheme or amendment”.

Each planning scheme is prepared in accordance with the Victoria Planning Provisions (VPPs). The VPP are a state-wide document which frame a consistent and coordinated structure and content for all Victorian planning schemes. Where the GAEP is subject to the Greater Geelong Planning Scheme, then any proposed use and development must be in accordance with the planning scheme. Subject to the planning controls that apply to the GAEP (which would be developed in the future), planning permits may be required for the use and development of land¹.

It is assumed that the GAEP would be rezoned to facilitate commercial, industrial and aviation business uses that are compatible with Avalon Airport and with synergies to broader land uses in Geelong and Werribee.

The Land Subject to Inundation (LSIO), Environmental Significance Overlay (ESO), Vegetation Protection Overlay (VPO) and Public Acquisition Overlay (PAO) apply to land in the GAEP. The LSIO was updated in 2015 to recognise land subject to inundation and sea level rise. The ESO protects Grasslands within the Werribee Plains Hinterland. The PAO applies to land in the Northern GAEP for the reservation of land for railway. These overlays will need to be considered when undertaking future development within the Precinct. Through the planning process for the corridor and airport, other planning overlays may be applied to the land to influence environmental, development and built form outcomes.

The future use and development of the Precinct will need to address stormwater runoff, which is likely to be a key planning issue given the GAEP's location within the *Port Phillip Bay (Western Shoreline) and Bellarine Peninsula Ramsar*. Clause 53.18 and the Planning Policy Framework require stormwater runoff from new developments to be minimised where possible and treated prior to discharge to the environment. Future development within the GAEP area will also need to meet requirements for stormwater runoff management according to the guidance of the City of Greater Geelong council.

In accordance with Section 12(2)(a) of the *Planning and Environment Act 1987*, when preparing a planning scheme or amendment, planning authorities must have regard to Ministerial Directions. *Ministerial Direction No. 1 – Potentially Contaminated Land* requires planning authorities to satisfy themselves that the environmental conditions of land proposed to be used for a sensitive use, agriculture or public open space are, or will be, suitable for that use. Depending on the planning process to be followed, this is generally done through the preparation of an environmental site assessment and audit.

In addition, in accordance with s. 12(2)(b) and s. 60(1)(e) of the *Planning and Environment Act 1987*, planning and responsible authorities must consider: “any significant effects which it considers the scheme or amendment might have on the environment or which it considers the environment might have on any use or development envisaged in the scheme or amendment.”

2.1.2 Environment Protection and Biodiversity Conservation Act 1999

The Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) provides for the listing of nationally threatened species, threatened ecological communities and key threatening processes; and provides the legal framework to protect and manage nine matters of national environmental significance (MNES): world heritage properties; national heritage places; wetlands of international importance (Ramsar); listed threatened species and communities; listed migratory species; Commonwealth marine areas; the Great

¹ Where not subject to the Greater Geelong Planning Scheme, then use and development would be in accordance with the approved Avalon Airport Master Plan and approved Environment Strategy.

Barrier Reef Marine Park; nuclear actions; and water resources, in relation to coal seam gas and large coal mining development.

Any project, not covered by an approved strategic assessment, that is likely to have a significant impact on MNES, is required to be referred to the Commonwealth Minister for Environment via the Department of Climate Change, Energy, the Environment and Water (DCCEEW) for a decision on whether the project is a 'controlled action' requiring assessment and approval under the EPBC Act.

Avalon Airport is in the Port Phillip Bay (Western Shoreline) and Bellarine Peninsula Ramsar site. Accordingly, any future development activities that significantly impacts the site will be referred to the Commonwealth in accordance with the EPBC Act.

The Avalon Corridor Strategy states that significant flora, fauna and ecological communities extend beyond the coastal foreshore. The Ramsar site boundary includes all of the Water Treatment Plant (WTP). Specific environmental values across the WTP are protected by the Flora and Fauna Guarantee Act (FFG Act - State) and EPBC Act (Federal). Land use changes and significant activities require referral to the relevant state and federal government departments.

Any proposed development would need to consider the direct and indirect impacts of the potential development of Avalon Airport and surrounding land on the adjacent Ramsar site.

2.1.3 Water Act 1989

The Water Act 1989 provides the legal framework for water management and use across Victoria, including the issuing and allocation of water entitlements and the provision of water services by State-owned water corporations and Catchment Management Authorities (CMAs). CMAs are provided with the regional waterway, floodplain, drainage and environmental water reserve management powers under the Water Act 1989.

The GAEP area is in the Little River and Avalon Road Catchments with the responsible authority being the Corangamite CMA and Melbourne Water.

2.1.4 Ministerial Direction No. 1 – Potentially Contaminated Land

Where the land is to be rezoned, *Ministerial Direction No. 1 – Potentially Contaminated Land*, requires planning authorities when preparing planning scheme amendments, to satisfy themselves that the environmental conditions of land proposed to be used for a sensitive use, agriculture or public open space are, or will be suitable for that use.

If the land is potentially contaminated and a sensitive use is proposed, Direction No. 1 provides that a planning authority must satisfy itself that the land is suitable through an environmental audit.

In this Direction, potentially contaminated land means land:

- Used or known to have been used for industry or mining;
- Used or known to have been used for the storage of chemicals, gas, waste or liquid fuel (other than minor above-ground storage that is ancillary to another use of the land); or
- Where a known past or present activity or event (occurring on or off the land) may have caused contamination on the land.

When approving a planning permit that permits potentially contaminated land for a sensitive use (including a residential site or a children's playground), the responsible authority must:

- Satisfy itself whether or not the land, or parts of the land, are potentially contaminated;
- Where it has determined that the land is not potentially contaminated, state the determination in the amendment Explanatory Report; and
- Where it has determined the land, or parts of the land, are potentially contaminated, must state the determination in the amendment Explanatory Report and satisfy itself that the environmental conditions of that land are or will be suitable for that use.

2.1.5 Ministerial Direction No. 19

Ministerial Direction No. 19 came into effect on 18 October 2018. It requires planning authorities to seek early advice from EPA when undertaking strategic planning processes and preparing planning scheme amendments that may significantly impact Victoria's environment, amenity and/or human health due to pollution and waste. The explanatory report for an amendment must include a statement of how the proposed amendment addresses the views of EPA.

The Ministerial Requirement for information is issued under section 12(1)(f) of the *Planning and Environment Act 1987*. It requires planning authorities to give the Minister for Planning the following information when applying for authorisation to prepare an amendment under sections 8A or 8B of the *Planning and Environment Act 1987*, or preparing an amendment under section 9 of the *Planning and Environment Act 1987*:

- *"the written views of EPA, including any supporting information and reports"; and*
- *"a written explanation of how the proposed amendment addresses any issues or matters raised by EPA".*

2.1.6 Planning Practice Note 30

Planning Practice Note 30 (PPN30) was published by Department of Environment, Land, Water and Planning (DELWP) in July 2021. The purpose of the practice note is to provide guidance for planners and applicants on:

- How to identify potentially contaminated land
- The appropriate level of assessment of contamination that should be conducted in different circumstances
- The appropriate provisions in planning scheme amendments
- Appropriate conditions on planning permits

A list of the land uses that have the potential to contaminate land (categorised as high or medium) are provided in Table 2 of PPN30. This is not an exhaustive list but does include several land uses / activities relevant to rural residential areas such as those associated with the GAEP area. Potentially contaminated land is defined in Ministerial Direction No. 1 – Potentially Contaminated Land (refer **Section 2.1.4**) and it is this definition that has been adopted for the Jacobs assessment. In instances where land is evaluated by Jacobs as part of this assessment as not meeting the definition of potentially contaminated land (per Ministerial Direction No. 1 – Potentially Contaminated Land), Jacobs has defined this land as 'no potential for contamination'. It is important to note that categorising land as either 'potentially contaminated' or 'no potential for contamination' (per Ministerial Direction No. 1 – Potentially Contaminated Land) is based on how land is used, or known to have been used and Jacobs has established this through the methodology described in **Section 3**. Importantly, it should be noted that categorisation provided by Jacobs in this report is a categorisation that is based on the review of available data by Jacobs at the time of the assessment and the application of professional judgement as to the potential for contamination. In particular, for properties that are categorised as 'no potential for contamination' it is possible that potentially contaminated uses or activities could have occurred at a property, but such uses or activities may not be identified based on the scope of this assessment and the information available to Jacobs at the time of this assessment has been performed.

The practice note also presents an assessment matrix in Table 3 that outlines recommended approaches towards assessing potentially contaminated land under different planning proposals. An extract from Table 3 is presented below.

Picture 2-1. Recommended approach to assessing potentially contaminated land

Extract of Table 3 from PPN 30

Planning Proposal		Potential for Contamination	
		High	Medium
Uses defined in Ministerial Direction No. 1, the EAO, and clause 13.04-1S			
- Sensitive uses: Residential use, childcare centre, kindergarten, pre-school centre, primary school, even if ancillary to another use. - Children's playground - Secondary school	New use, or buildings and works associated with a new use	A	B
	Buildings and works associated with an existing use	B	B
Other land use			
Open space Agriculture Retail or office Industry or warehouse	New use, or buildings and works associated with a new or existing use	C	D

Planning Scheme Amendment		Planning Permit Application
A	PRSA or audit option applies Proceeding directly to an audit is recommended.	PRSA or audit option applies Proceeding directly to an audit is recommended.
B	PRSA or audit option applies PRSA to determine need for audit is recommended.	PRSA or audit option applies PRSA to determine need for audit is recommended.
C	PSI to inform need for audit is recommended	PSI to inform need for audit is recommended
D	Planning authority to document consideration of potential for contamination to impact proposal	Responsible authority to document consideration of potential for contamination to impact proposal

Note: Where land is used for more than one purpose, the most sensitive land use should be used to inform the approach to determining if an audit is required.

It is noted that in some circumstances it may be difficult or inappropriate to undertake either the Preliminary Risk Screening Assessment (PRSA) or the environmental audit at the time of the planning scheme amendment. One such example presented in PPN30 would be when 'the rezoning relates to a large strategic planning exercise or involve multiple sites in separate ownership'. In such circumstances it is acceptable to defer the requirements (to complete a PRSA and / or environmental audit) until after the planning scheme amendment. This can be achieved through the application of an Environmental Audit Overlay (EAO).

Where an EAO has been applied to a parcel of land, this indicates that a decision has been made that the land is potentially contaminated and may not be suitable for a sensitive use without further assessment and remediation. The EAO requires that an environmental audit be undertaken, or a PRSA to determine the need for an environmental audit. All buildings and works associated with a sensitive use (irrespective of how minor) will trigger the need to undertake either the PRSA or the environmental audit (as appropriate).

In the context of GAEP, it is noted that the future proposed land use would comprise predominantly a combination of commercial and / or industrial land uses as well as public open space. Sensitive land uses (such as childcare centres or children's playgrounds) may feature as part of the future development of the GAEP, although such land uses are likely to be very limited. Therefore, as per Table 3 of PPN30, the outcomes of the assessment for each land parcel would be aligned with the proposed predominant future land use across the GAEP (commercial, industrial or public open space land use from a land contamination potential perspective), namely:

- Conduct a PSI to inform the need for an environmental audit (high potential for contamination)
- Planning authority to document consideration of potential contamination to impact the (development) proposal (medium potential for contamination)

For land parcels where there's no potential for contamination, no specific requirements would be imposed (aside for ongoing obligations under the General Environmental Duty which would remain relevant).

However, noting the potential for some (albeit limited) higher sensitivity potential future land use scenarios within the GAEP, where additional / different recommendations may apply to those that would otherwise be applicable to the predominant future commercial, industrial or public open space land use that is assumed across the GAEP, these additional recommendations will also be presented.

2.1.7 Environment Protection Act 2017

The Environment Protection Act 2017 (as amended by the Environment Protection Amendment Act 2018) and its subordinate legislation came into effect on 1 July 2021.

The legislation enhances the protection of Victoria's environment and human health through a more proportionate, risk-based environment protection framework that includes:

- A preventative approach through a general environmental duty.
- A tiered system of EPA permissions to support risk based and proportionate regulatory oversight.
- Significant reforms to contaminated land and waste management.
- Increased maximum penalties.
- Requirements for more environmental information to be publicly available.
- Modernising and strengthening EPA's compliance and enforcement powers.

Similar to the (now repealed) Environment Protection Act 1970 that it replaces, the Environment Protection Act 2017 provides for environmental audits, which are used to provide an authoritative opinion on the suitability of potentially contaminated land for future use and forms an integral part of the land use planning and approval process. However, the Environment Protection Act 2017 also incorporates a new process – the Preliminary Risk Screening Assessment (PRSA), administered by EPA Victoria.

PRSAs do not replace Environmental Audits – they are used to establish whether there is a need for an Environmental Audit, and if so, the scope of the Environmental Audit. Importantly, the PRSA does not make a conclusion on the suitability of a site for its existing or proposed future use – this remains the outcome of an Environmental Audit. Only EPA-accredited contaminated land auditors can perform PRSAs. Environmental consultants may be involved in the PRSA process through preparing assessment reports that are considered by the auditor in the PRSA. A PRSA is expected to follow an assessment process consistent with that of the Preliminary Site Investigation (PSI) outlined in the National Environment Protection (Assessment of Site Contamination) Measure 1999 (as amended 2013) and may include targeted / limited sampling.

The environmental audit system under the 2017 Act is also administered by EPA Victoria. An Environmental Audit of a site involves the appointment of an EPA accredited auditor to undertake an independent assessment of the environmental condition of a site and provide an opinion regarding the site's suitability for feasible or proposed end uses. A range of information including a site history assessment and results of relevant soil and groundwater testing undertaken are evaluated by the auditor when forming such an opinion. When an environmental audit is conducted specifically for land use planning purposes, the scope of the audit must identify the proposed use of the site. Where an audit assesses the use or proposed use of the site, an auditor must include a statement regarding the suitability of the site. The auditor will make one of the following three statements:

- The site is suitable for the purposes specified in the statement; or
- The site is suitable for the purposes specified in the statement if the recommendations made in the statement are complied with; or
- The site is not suitable for the purposes specified in the statement at the time the statement was prepared.

2.2 Guidelines and standards for assessment of contaminated land

2.2.1 National Environment Protection (Assessment of Site Contamination) Measure 1999 (as amended 2013)

The NEPM is the national guideline for assessing contaminated sites and was prepared by the National Environment Protection Council (NEPC). The NEPM document ensures there is a nationally consistent

approach to the assessment of contamination. The NEPM provides guidance on the methods of site contamination assessment, environmental and health-based investigation levels for soil and groundwater contaminants, human and environmental health risk assessment, and reporting requirements.

2.2.2 Australian and New Zealand Guidelines for Fresh and Marine Water Quality

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality published in 2018 by Australian and New Zealand Governments and Australian State and Territory Governments (ANZG) provide a nationally consistent framework for water quality management. The ANZG establish water quality trigger values for the protection of a range of environmental values for water resources, such as drinking water, recreation, and ecological values.

The ANZG (2018) replaced the previous guidelines published in 2000 (commonly referred to as the ANZECC 2000 guidelines) and have been adopted as the most contemporary guidelines when considering the new Environment Reference Standard. However, it should be noted that in many cases the ANZG did not make substantial revision to the content of the ANZECC 2000 guidelines. This is particularly true for most toxicant guideline values and guidelines values for primary industries and aquaculture.

2.2.3 Environment Reference Standards

The Environment Reference Standard came into effect on 1st July 2021 (alongside the Environment Protection Act 2017) and sets out the environmental values of the ambient air, ambient sound, land and water environments that are sought to be achieved or maintained in Victoria and standards to support those values. Environmental values are the uses, attributes, and functions of the environment that Victorians value.

Standards for the environmental values are comprised of objectives for supporting different uses of the environment and indicators that can be measured to determine whether those objectives are being met. The indicators and objectives provide a basis for assessment and reporting on environmental conditions in Victoria.

2.2.4 Australian Standard AS1726-2017: Geotechnical Site Investigations

Australian Standard AS1726 sets out minimum requirements for a geotechnical site investigation, as a component in the engineering design, construction, commissioning, and operation of civil engineering and building works.

The standard specifies considerations affecting the design and construction of works which must be made in a geotechnical site investigation. Assessment of these factors enables the identification of field and laboratory work to obtain the geotechnical data required to facilitate the engineering design and construction of the works. The standard provides guidance on suitable field and laboratory examination and testing of geotechnical materials and outlines a system of material classification.

The applications of this Standard include assessment of natural or filled ground, new construction, maintenance of existing facilities, the evaluation of post construction performance and the assessment of failure.

2.3 Guidelines and standards for surface water

2.3.1 Australian Rainfall and Runoff 2019

Australian Rainfall and Runoff (ARR) is a national guideline document, data and software suite that is used for the estimation of design flood characteristics in Australia.

The Australian Rainfall and Runoff guide to flood estimation is accompanied by several public data resources including:

- Bureau of Meteorology – Rainfall Data System 2016: www.bom.gov.au/water/designRainfalls/revised-ifd/
- ARR Data Hub: <http://data.arr-software.org/>

With nationwide applicability, balancing the varied climates of Australia, the information and the approaches presented in Australian Rainfall and Runoff are essential for policy decisions and projects involving:

- infrastructure such as roads, rail, airports, bridges, dams, stormwater and sewer systems;
- town planning;
- mining;
- developing flood management plans for urban and rural communities;
- flood warnings and flood emergency management;
- operation of regulated river systems; and
- prediction of extreme flood levels.

2.3.2 Guidelines for Development in Flood Affected Areas 2019 (DEECA, previously DELWP)

The Guidelines for Development in Flood Affected Areas provide an assessment framework and method to assist decisions on development in flood affected areas. The methods and objectives of the Guidelines results in development outcomes that respond to the flood risk.

The purpose of the guidelines is to provide a clear, consistent and transparent process for managing land use and development in flood affected areas in Victoria. They are intended to be used with the land use planning and development system, and are comprised of three parts:

- **Part One** introduces the guidelines, plus basic information on flood risk management and climate change.
- **Part Two** contains information on the regulatory framework used in decision-making. It examines key legislation and the roles and responsibilities of the key agencies that are affected by the legislation. The administrative processes for preparing, assessing and reviewing planning permits are also explained.
- **Part Three** provides the methodology used by floodplain management authorities when assessing development proposals referred to them. This is achieved by considering four objectives:
 - Safety
 - flood damage
 - off-site impacts
 - waterway and floodplain protection.

This results in development outcomes that respond appropriately to the flood risk. Sometimes this means no development is appropriate.

2.3.3 Floodplain Development Guidelines for Corangamite Catchment Management Authority

The Floodplain Development Guidelines aim to promote safe and appropriate development in flood prone areas within the Corangamite CMA (CCMA) region. This document applies to all areas within the GAEP precinct that fall within the CCMA boundary.

These guidelines respond to several planning objectives set out in the Planning and Environment Act 1987 including (but not limited to):

- To provide for the fair, orderly, economic and sustainable use and development of land
- To secure a pleasant, efficient, and safe working, living and recreational environment for all Victorians and visitors to Victoria
- To facilitate development in accordance with the objectives in the Planning and Environment Act.

2.3.4 Melbourne Water's Guidelines for development in flood-prone areas

These guidelines have been developed to ensure that urban development and redevelopment is compatible with any flood risk. This document applies to areas in the north-east of the GAEP precinct that fall within the Melbourne Water service area.

2.3.5 Melbourne Water's Corporation Flood Mapping Projects Guidelines and Technical Specifications

The purpose of this document is to provide the Service Provider with an indication of the minimum requirements and technical specifications for projects being carried out for the Flood Mapping and Mitigation team.

This document is relevant for flood mapping studies within the Melbourne Water Drainage and Waterways Area.

3. Methodology

3.1 General assessment approach

3.1.1 Stage 1 Assessment

A Stage 1 assessment (also referred to as a Phase 1 Environmental Site Assessment (ESA)) is typically undertaken to establish site conditions, historical site uses and practices. As part of this Stage 1 assessment, the following sources of information have been reviewed:

- Previous reports;
- EPA Victoria information searches including:
 - Priority sites register;
 - Environmental Audit Reports Online Portal;
 - Groundwater Quality Restricted Use Zones (GQRUZ) Map;
 - Environmental Audit Overlay (EAO);
 - EPA Licensed sites; and
 - EPA landfill register.
- Topographical maps;
- State bore records on the DELWP Water Measurement Information System;
- Geological maps;
- Planning schemes;
- Historical aerial photographs;
- Hydrogeological maps;
- Potential acid sulfate soils (PASS) probability maps; and
- Energy Safe Victoria cathodic protection system database.

The Stage 1 assessment seeks to identify if possible:

- The potential source(s) of on and off-site contamination;
- Pathways and receptors of contamination; and
- Areas of environmental concern (contamination, hydrogeological and geotechnical) which will form the basis of subsequent assessments at the site.

A qualitative assessment has been undertaken as part of the Stage 1 assessment using a traffic light system which uses colour-coding to classify each land parcel within the GAEP study area as high, medium or no potential for contamination. The outcomes of the assessment are subsequently used to confirm the need for Stage 2 assessment for each land parcel within the GAEP study area (see below).

3.1.2 Stage 2 Assessment

For this particular investigation, the site inspection works are referred to as a Stage 2 assessment. The site inspections undertaken included visual observations at selected properties across the GAEP study area (where land access was permitted by landowners) in order to confirm findings from the Stage 1 assessment and confirm the final potential for contamination relating to each property.

Based on the findings of the site inspections, further works may be required for some GAEP areas to assess the suitability for proposed future use. These further works are outlined in the conclusions and recommendations section of this report.

While the completion of these further works does not form part of this scope of work, **Section 3.1.3** and **Section 3.1.4** below provide an overview of the typical objectives/outcomes of such works.

3.1.3 Stage 3 Assessment (not included in this scope of works)

The Stage 3 intrusive site investigation may be undertaken to characterise the site with respect to contamination, hydrogeology, and geotechnical conditions. Note that this stage of site investigation is usually referred to as a Phase 2 ESA. With respect to each of the abovementioned disciplines, the following works may be undertaken as part of a Stage 3 assessment:

- **A contamination assessment** will typically assess the level (if any) of contamination present on site, establish the lateral and vertical distribution of contamination and identify the source(s) of on-site and off-site contamination. Prior to undertaking any intrusive soil and/or groundwater investigation, a Sampling and Analysis Plan (SAP) is generally prepared. The SAP defines the intended sampling locations and the contaminants which will be tested for, based on the site characteristics as determined in a Phase 1 ESA.
- **A geotechnical assessment** will typically seek to obtain information on the sub-surface conditions at the site through a geotechnical site investigation comprising a series of boreholes and/or test pits and laboratory testing. Field and laboratory test data is used to develop a site model describing the soil and/or rock profile and the variability across the site. A geotechnical assessment would generally include advice on site classification and allowable bearing capacity for shallow foundation design, and comments regarding excavations, foundation systems, pavement design and other items relevant to the proposed development.
- **A hydrogeological assessment** will typically include determination of the groundwater elevation based on observations made in groundwater bores installed for the project. Assessment of aquifer hydraulic conductivity can be undertaken through slug or pumping tests to inform potential groundwater inflow rates for construction of below-ground infrastructure, and to inform potential groundwater level drawdown impact assessments. Water quality samples can be collected to inform disposal options and various assessments.

3.1.4 Remediation (not included in this scope of works)

If significant contamination is identified at a site, to a level where the beneficial uses of land, surface water or groundwater are at risk or precluded, remediation of the identified contamination may be required in order to allow for a particular land use to continue or commence in future.

4. Precinct description

General information relating to the Northern GAEP and South-western GAEP areas are presented in **Table 4-1** below. Refer to **Figure 1** for Site location map and **Figure 2** for Site layout plan found in **Appendix A**.

Table 4-1. Overview of GAEP Area

Summary of precinct description details

Item	Details
Location / Address	The GAEP is located approximately 20 km north-east in the City of Greater Geelong. It is about 55 km south-west and less than an hour drive from the Melbourne Central Business District (CBD)
Extent (Approximate)	<u>Northern GAEP Area (triangular-shaped land mass)</u> - Centre at 38.009767°S, 144.494922°E - North-western extent at 38.0026508°S, 144.4917656 °E - South-western extent at 38.0156042°S, 144.4631813°E - North-eastern extent at 37.9924585°S, 144.5136732°E - South-eastern extent at 38.0750055°S, 144.4501426°E <u>South-western GAEP area (rectangular-shaped land mass)</u> - Centre at 38.050413°S, 144.440377°E - North-western extent at 38.0340480°S, 144.4313557°E - South-western extent at 38.0676106°S, 144.4251869°E - North-eastern extent at 38.0206850°S, 144.4528064°E - South-eastern extent at 38.0750055°S, 144.4528064°E
Site Area (ha)	The entire GAEP area covers a land area of approximately 1,581 hectares. The precinct has twelve registered landowners. The GAEP is divided by approximately 22 individual parcels of land – nine parcels for the Northern GAEP Area and thirteen parcels for the Western GAEP Area. Refer to the Map Reference Lot numbers in Appendix D. The Northern GAEP Area is approximately 641 hectares with a perimeter of 12.36 km, while the Western GAEP Area is approximately 940 hectares with a perimeter of 15.63 km.
Local Council	City of Greater Geelong Council
Zoning	Under the Avalon Corridor Strategy (2022), the GAEP area is zoned within the Farming Zone (FZ) and Special Use Zone (SUZ).
Zoning of Surrounding Land	Under the Avalon Corridor Strategy (2022), the Northern GAEP area (triangular-shaped land mass) is bounded variously by the following zones: - Northwest – Farming Zone (FZ) - West – Public Use Zone (PUZ) - South – Special Use Zone (SUZ) and Farming Zone (FZ) The South-western GAEP area (rectangular-shaped land mass) is bounded by the following: - Northwest – Rural Living Zone (RLZ), General Residential Zone (GRZ), and Low-Density Residential Zone (LDRZ) - West - Farming Zone (FZ) - South - Special Use Zone (SUZ) - Southeast – Public Conservation and Resource Zone (PCRZ) and Special Use Zone (SUZ) - Northeast - Special Use Zone (SUZ)
Overlays	There are three overlays that apply to the GAEP Area: - Environmental Significance Overlay (ESO) - Land Subject to Inundation (LSIO) - Public Acquisition Overlay (PAO) – only in the Northern GAEP Area
Extractive Industry Investigation Areas	Within the GAEP area: - Two EIIA areas that DEECA have advised will not be investigated further. Surrounding the GAEP area: - There are EIIs to the north and south of the GAEP area Analysis of these EIIs is presented in a report by Groundworks Plus (2022) for VPA.
Ramsar	Part of the GAEP Area (to the south and south-east) is located in a Ramsar site – this includes all of the Water Treatment Plant.

Land Capability Assessment

Item	Details
Site Layout	The GAEP area is an irregularly shaped area of land bounded by Princes Highway to the north-west, Beach Road to the north-east, Avalon Road to the west, Dandos Road to the south and Pousties Road and Western Road to the east. The GAEP comprises Avalon Airport and the land around it. However, the area subject to the LCA excludes Avalon Airport, therefore the LCA study would only focus on the non-airport land with an approximate area of 1,581 ha.
Current Land Uses	Land use in the GAEP Area is mostly agricultural and commercial.
Proposed Land Uses	According to the Avalon Corridor Strategy (2022), the GAEP area has been identified as an area to be developed for employment, various land uses, as well as for public open space, and conservation, with emphasis on the commercial and industrial development within and surrounding Avalon Airport.
Surrounding Land Uses	The Northern GAEP area (triangular-shaped land mass) is surrounded by the following land uses: ▪ North – Low-density commercial area including vacant agricultural lots ▪ West – Low Density Commercial and Industrial areas including vacant agricultural lots. Princes Highway is located in the immediate west extending to the north. ▪ South – Commercial Area (Avalon Airport) and agricultural land (south-east direction) ▪ East – Melbourne Water Western Treatment Plant sewage treatment and conservation ponds The Western GAEP area (rectangular-shaped land mass) is surrounded by the following land uses: ▪ North – Low-density commercial area including vacant agricultural lots. Medium to high density residential areas (north-west of Princes Highway). ▪ West – Low Density Commercial and Industrial areas including vacant agricultural lots. Hovells Creek ▪ South – Commercial Area and agricultural lands. Former Cheetham Saltworks with evaporation ponds. Avalon Coastal Reserve. Avalon Beach. ▪ East – Commercial Area (Avalon Airport Australia) and agricultural lands (south-east)

5. Environmental setting

Information on the general environmental setting of the GAEP area is outlined in the following sections.

5.1 Regional geology

The Victoria Regional 1:50,000 Seamless Geology dataset (GSV, 2014) indicates that project area to be likely underlain by the following geological units:

- Miocene to Holocene age newer volcanic group with basalt flows (Neo) in most areas of the northern site and north to southeast of the western site. The weathering profile of the newer volcanics is highly variable and typically comprises high plasticity residual basaltic clay and extremely weathered (XW) basalt with occasional rock floaters (in the form of cobbles and boulders), overlying the highly to moderately weathered basalt. Jointing within the basalt can be variable within the rock mass, and depth to basalt can be highly variable over relatively short horizontal distances;
- Pleistocene to Holocene age swamp and lake deposits (Qm1) in west of the northern site that typically comprises grey to black carbonaceous mud, silt, clay, minor peat and rare dolomite; and
- Holocene age coastal lagoon deposits (Qg) in most areas of the western site that typically comprises dark grey to black and variably consolidated clay and silt.

A brief description of these geological units has been provided below in **Table 5-1**. Extract of the site geology based on the 1:50,000 Seamless Geology map sheet indicating the approximate location of the site is depicted below in **Figure 5-1**.

Table 5-1. Summary of geological units expected to be encountered within the GAEP area (GSV, 2014)¹.

Geological unit name	Unit symbol	Unit age	Unit description
Newer volcanic basalt ²	Neo	Miocene to Holocene	Comprised of Olivine tholeiite, quartz tholeiite, basanite, basaltic icelandite, hawaiiite, mugearite, minor scoria and ash, fluvial sediments: tholeiitic to alkaline; includes sheet flows and valley flows and intercalated gravel, sand, clay.
Swamp and lake deposits ³	Qm1	Pleistocene to Holocene	Grey to black carbonaceous mud, silt, clay, minor peat: generally unconsolidated; rare dolomite.
Coastal lagoon deposits ⁴	Qg	Holocene	Silt, clay: dark grey to black; variably consolidated.

Notes:

¹ In addition to unit listed here, historical Geological Survey of Victoria 1,63,360 maps (GSV, 1963, 1974, 1977) suggests that beach sand might be encountered in south of the western site.

² This unit is listed as newer volcanics in historical Geological Survey of Victoria 1,63,360 maps (GSV, 1963, 1974, 1977) with details of dark to light grey, coarsely vesicular olivine basalt, olivine labradorite basalt and iddingsite labradorite basalt, minor interbedded silty sand and baked soils.

³ This unit is listed as river alluvium (swamp deposits) in historical Geological Survey of Victoria maps (GSV, 1963), consisting of sand, gravel and clay.

⁴ This unit is listed as high-level alluvium deposits in historical Geological Survey of Victoria maps (GSV, 1963), consisting of outwash-sand, gravel and clay.

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Environment and Climate Action

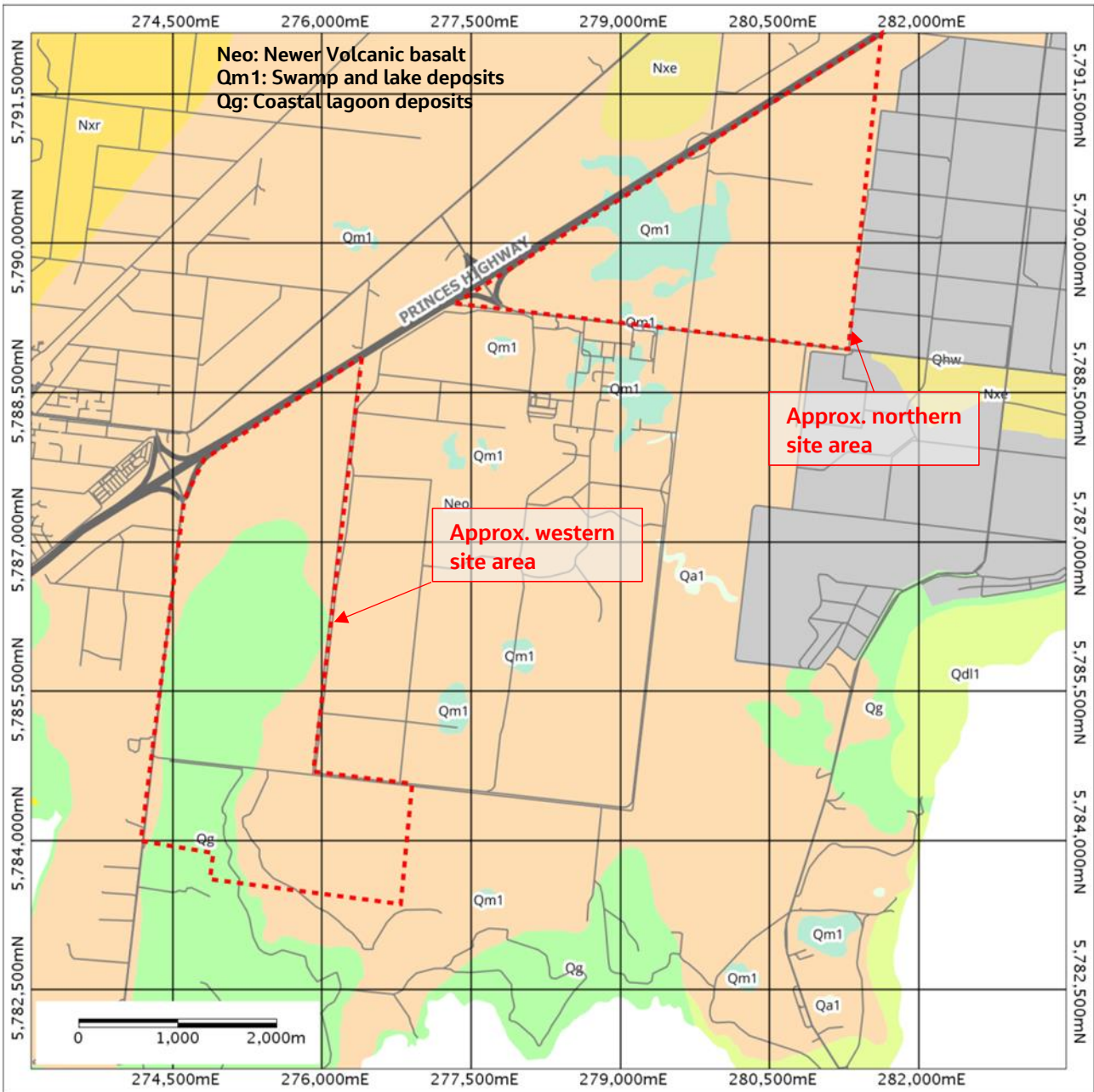


Figure 5-1. Site regional geology based on 1:50,000 scale Seamless Geology map sheet, superimposed by approximate site area ([GeoVic - Earth Resources](#)).

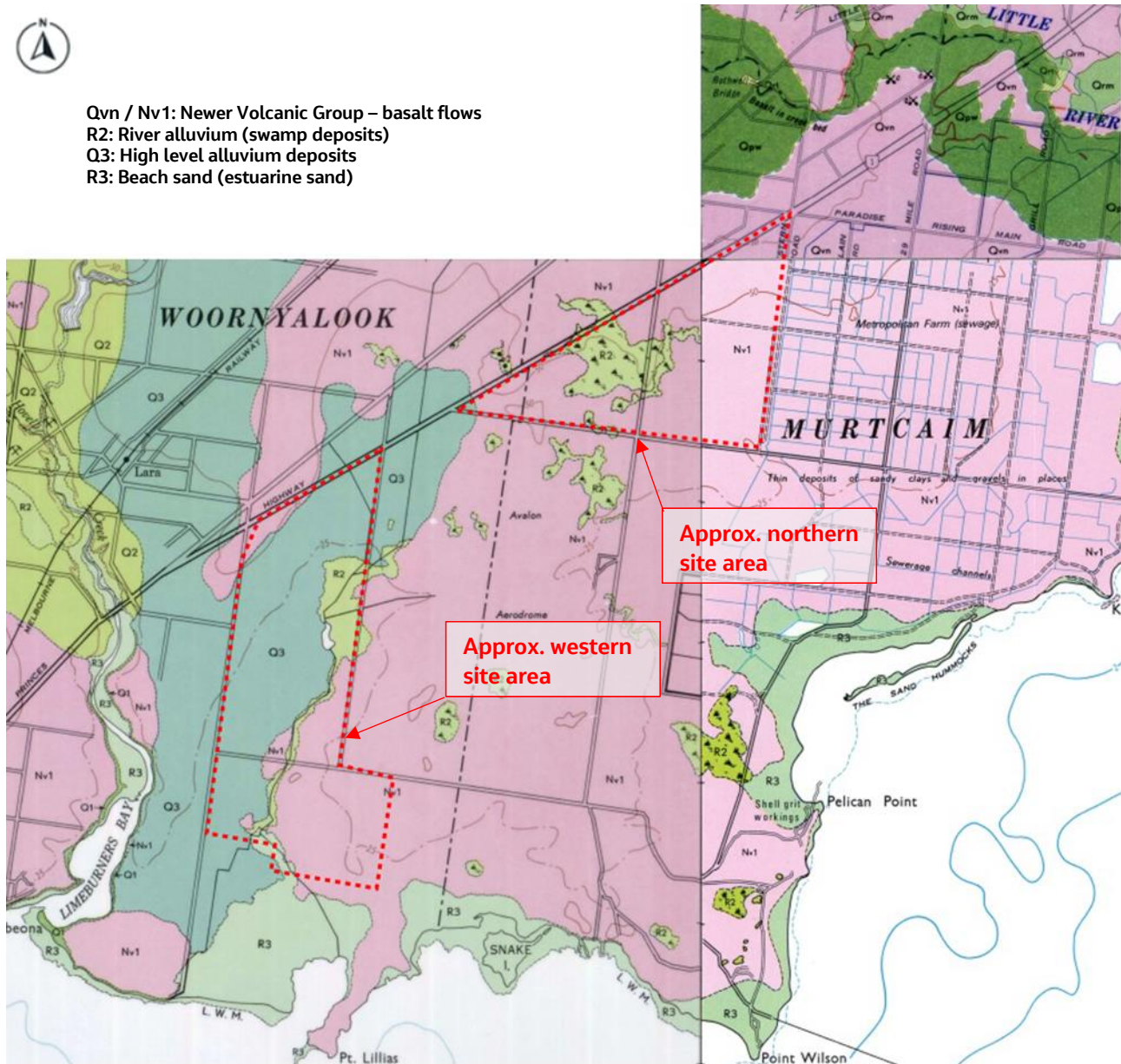
In addition, historical Geological Survey of Victoria maps, including Geelong 1:63,360 geological map (GSV, 1963), Melbourne 1:63,360 geological map (GSV, 1974) and Portarlington 1:63,360 geological map (GSV, 1977) were reviewed with the following observations:

Similar to Seamless Geology dataset (GSV, 2014), newer volcanic basalts and swamp deposits cover areas in northern site. However, there are discrepancies in extension and number of geological units within western site as shown in Geelong 1:63,360 geological map (GSV, 1963) as follows:

- High level alluvium deposits consisting of outwash-sand, gravel and clay covers areas in northeast to southwest of the western site while newer volcanics occupies southeast to south of the western site;
- River alluvium (swamp deposits), consisting of sand, gravel and clay overlays in east of the western site; and

- Beach sand comprising of estuarine sand, silt and clay (recent shells) covers a small area in south of the western site.

Figure 5-2 below presents an excerpt of combined Geological Survey of Victoria 1:63,360 maps of Geelong (GSV, 1963), Melbourne (GSV, 1974) and Portarlington (GSV, 1977), superimposed by approximate site area. The Geological Survey of Victoria 1:63,360 map of Melbourne (GSV, 1974) also provides a cross sections to the northeast of the northern project site, as shown in **Figure 5-3**. Whilst this cross section (Section A-B) is situated approximately 3 km away from the site, it is considered representative of the geological conditions likely to be encountered within the area covered by newer volcanics basalt. This cross section (refer to **Figure 5-3**) indicates that the newer volcanics basalt at this location is underlain by very thin layer of Brighton Group sediments overlaying Newport Formation, Werribee sand and Granite.



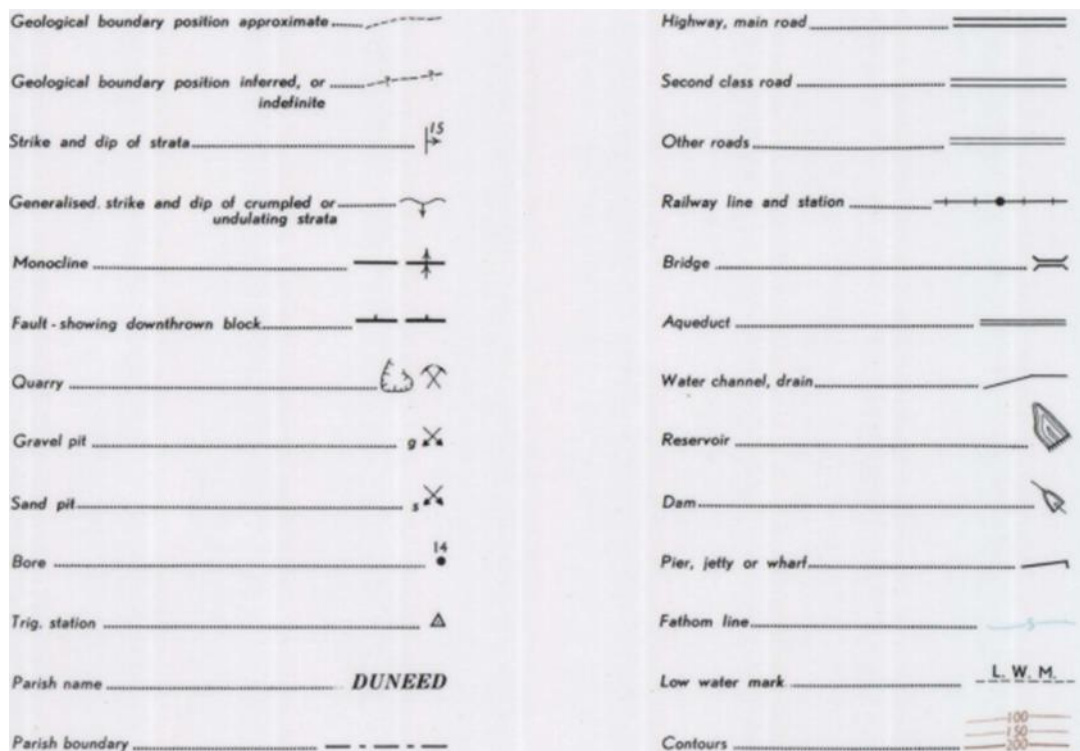
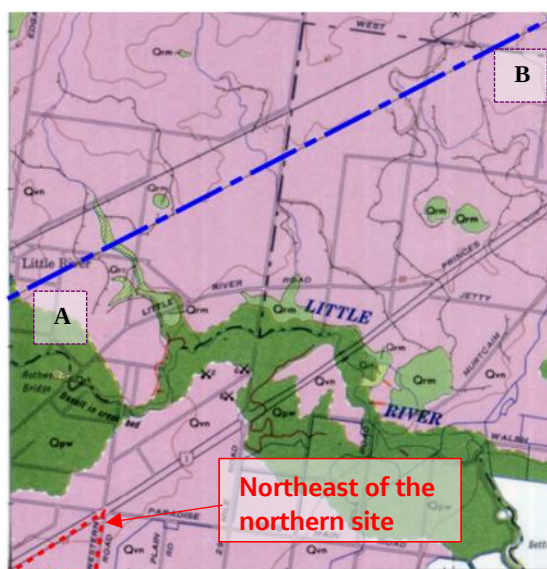


Figure 5-2. Site regional geology based on combined Geological Survey of Victoria 1:63,360 maps of Geelong (GSV, 1963), Melbourne (GSV, 1974) and Portarlington (GSV, 1977), superimposed by approximate site area – not to scale.



Qvn: Newer Volcanic Group – basalt flows
 Tpb: Undifferentiated Brighton Group sediments
 Tmn: Newport Formation (silt, grey and green, glauconitic, calcareous silt, silty clay, minor limestone; grades into silty sand)
 Tew: Werribee Sand (sand, sandy and silty clay, with pyritic and lignitic quartz sand)
 Dgr: Granite: acid intrusives (South Yarra)

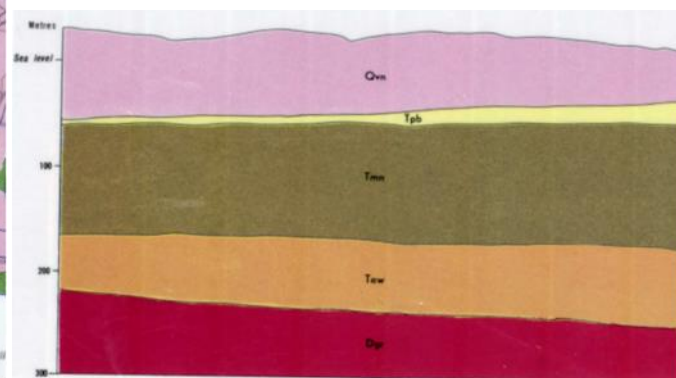


Figure 5-3. Extract from Section A-B in Geological Survey of Victoria 1:63,360 map of Melbourne (GSV, 1974) – not to scale.

Topography

The site is gently undulating with natural ground surface grading from south (near Port Phillip Bay) to north as well as from west to east. The ground surface elevation typically varies between 2 metres Australian Height Datum (m AHD) at the most southwest of the alignment to 28 metres Australian Height Datum (m AHD) at the most northeast of the alignment. An extract of the elevation of the site is presented below in **Figure 5-4**.

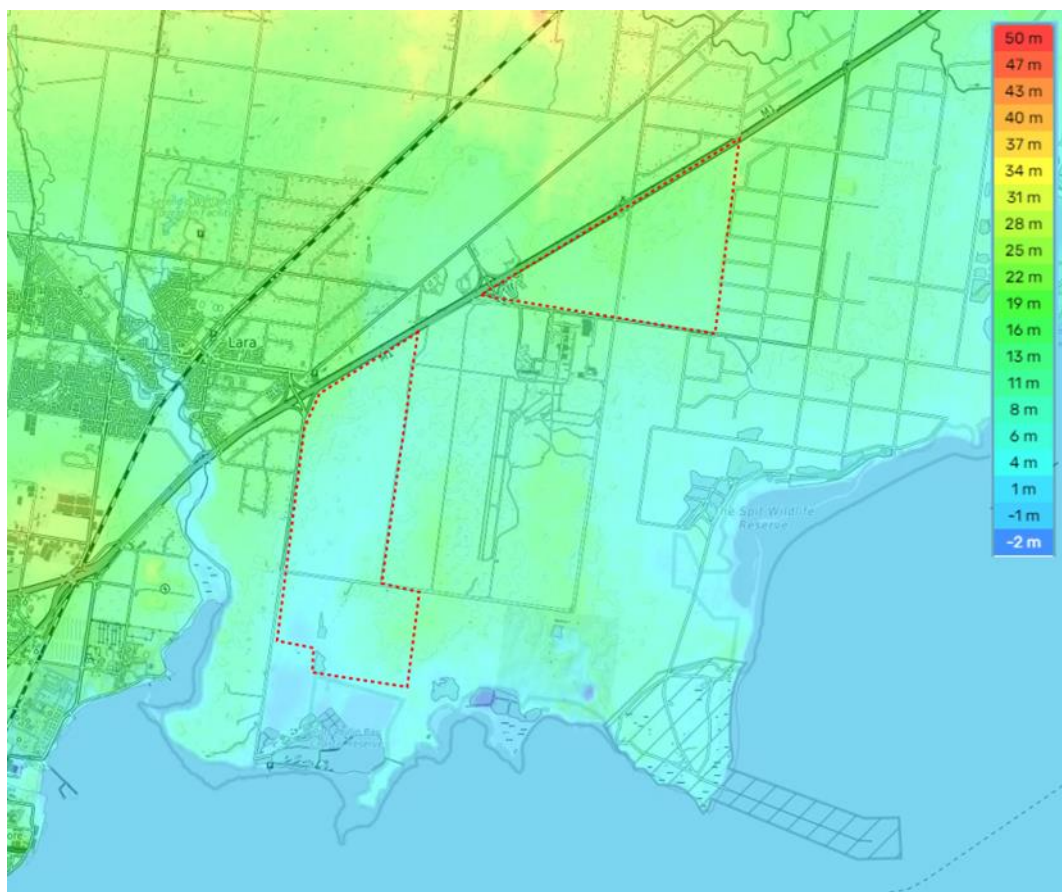


Figure 5-4. Topographical view of the site (topographic-map.com) – not to scale.

5.2 Regional acid sulfate soils

According to the May 2010 Coastal Acid Sulfate Soils (CASS) Distribution - Map 2 for West Coast of Victoria referenced from the Victorian Resources Online, the northern GAEP site does not fall within the CASS classification area (i.e., it is not classified). However, for the south-western GAEP area, the majority of its land area is classified as "Made Land" – defined as modified landscapes (where original geomorphic features are deemed no longer present) that have the potential to contain CASS. The remainder of the land area is classified either as "Prospective" (which refers to land whose geomorphology indicates that there is a potential or prospect of encountering sulfidic material or sulfuric material, i.e., located near a coast) or unclassified. **Figure 5-5** shows the CASS distribution for the northern and south-western GAEP.

In addition, based on the June 2023 Lotsearch Reports, copies of which are presented in **Appendix B** (referencing the Atlas of Australian Acid Sulfate Soils), the probability of occurrence of acid sulfate (ASS) within the GAEP area varies extremely low (defined as a 1% to 5% chance occurrence in small, localised areas) to high (defined as >70% chance of occurrence). Those areas identified where ASS is identified as having a high probability of occurrence coincides with the locations of Coastal lagoon deposits (Qg, refer to **Section 5.1**).

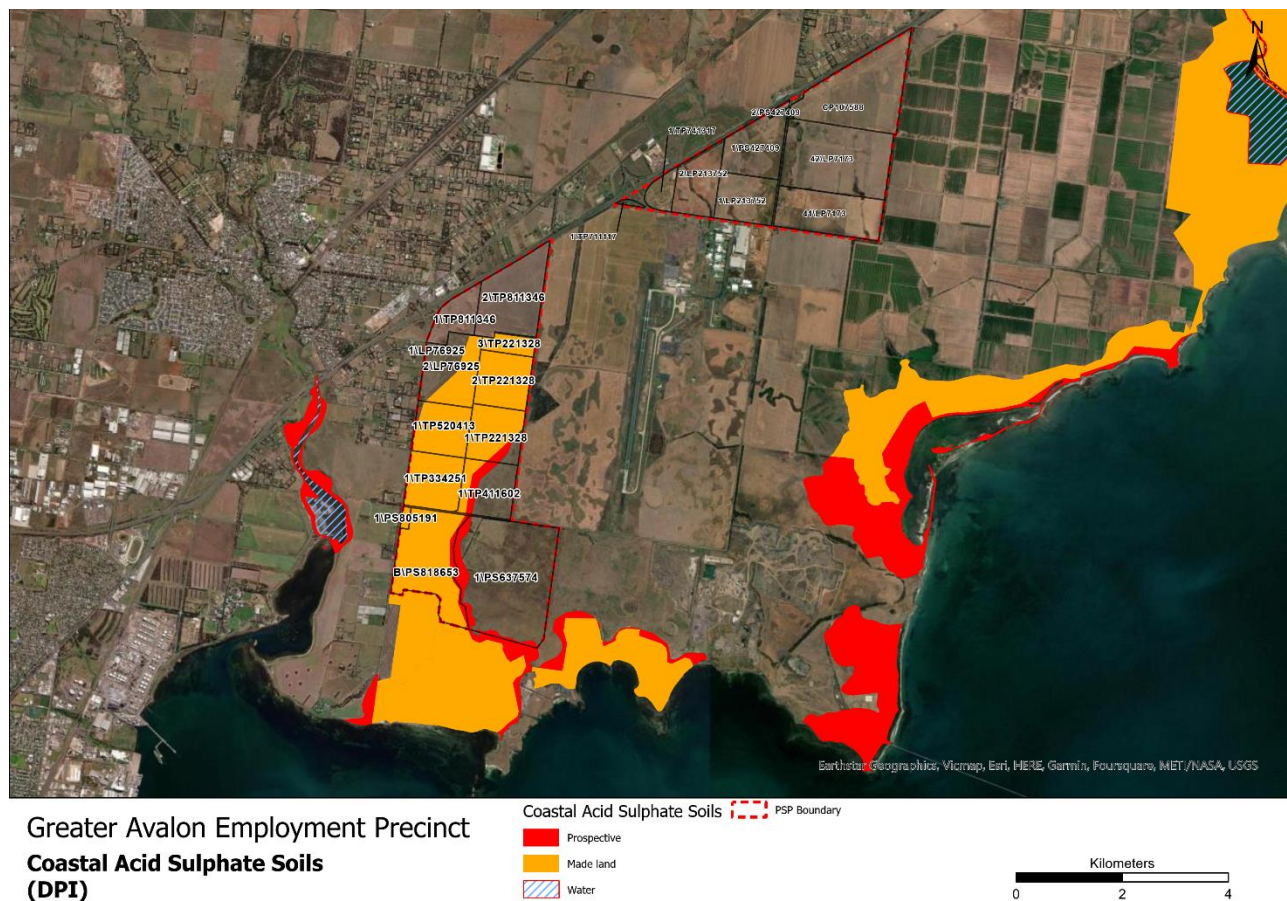


Figure 5-5. Extract from Map 2 for West Coast of Victoria (VRO) – CASS Distribution within site

5.3 Regional hydrology

5.3.1 Overview of regional hydrology

The GAEP area spans two Catchment Management Authorities (CMAs) – Melbourne Water Drainage and Waterways boundary and Corangamite Catchment Management Authority (CCMA) boundary. However, the project area is outside available Melbourne Water Drainage schemes. The relevant service providers for this area include Southern Rural Water as the rural water corporation, and Barwon Water as the urban water corporation.

Figure 5-6 shows where the GAEP area is situated in relation the CMA boundaries, local catchments, and nearby waterways.

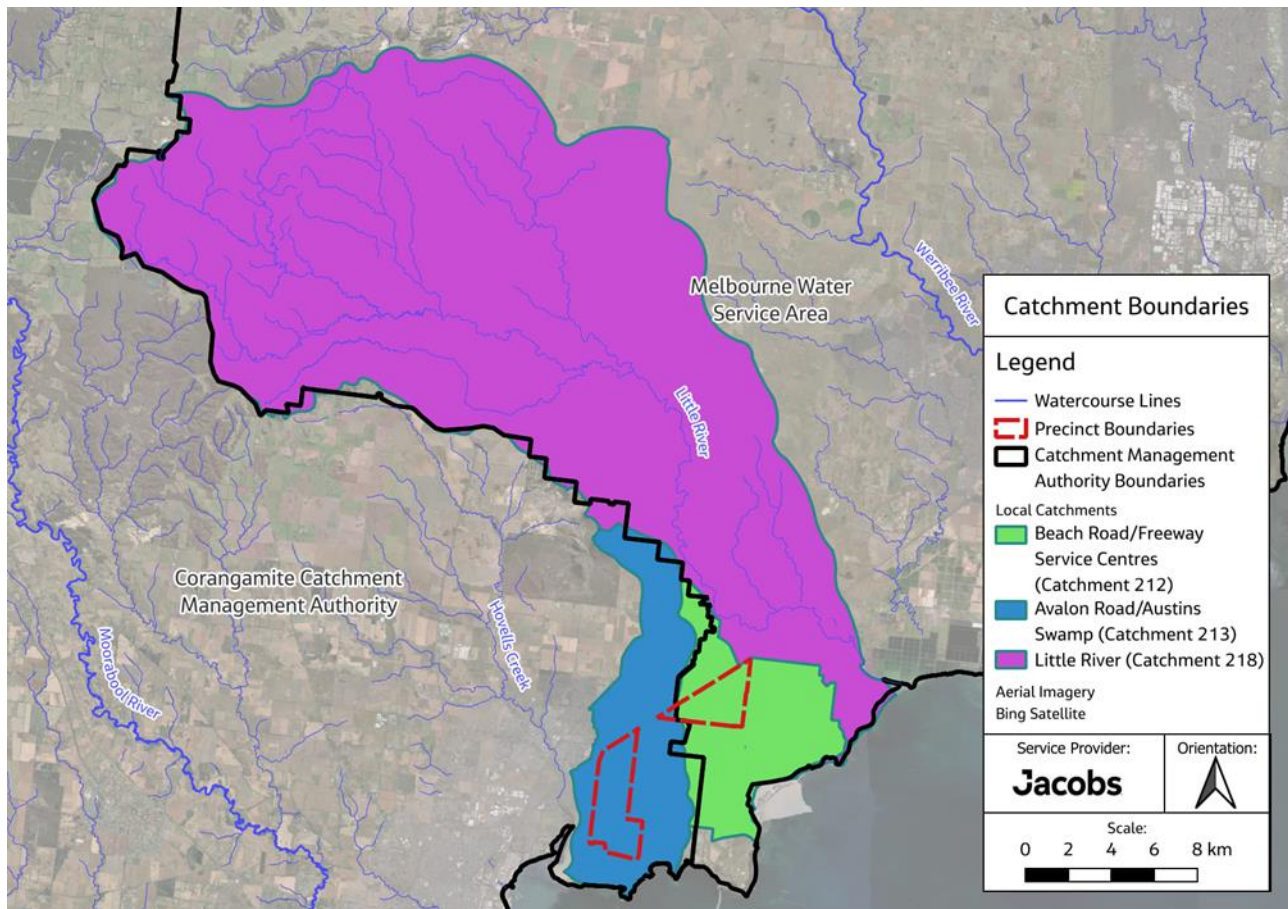


Figure 5-6. Catchment Management Authority boundaries, local catchment boundaries, and nearby waterways to GAEP area.

The main waterways and hydrological features near the GAEP area include Hovells Creek, Little River, a network of unnamed drains which all drain to Port Phillip Bay.

- Hovells Creek Catchment covers an area of 237km² and is located to the west of the GAEP boundary. Hovells Creek flows from north to south before draining to Limeburners Bay.
- Little River Catchment covers an area of 479km² and is located to the north-east of the GAEP boundary. Little River flows in a south-easterly direction before reaching Port Phillip Bay.
- The networks of unnamed drains within the GAEP area outlet to several locations across Port Phillip Bay including along the Avalon foreshore and either side of Point Wilson. There are two catchments that cover the GAEP area. These are the Avalon Road/Austins Swamp Catchment, and the Beach Road/Freeway Service Centres Catchment which cover areas of 61km² and 51km² respectively.

5.3.2 Flooding Overlays and Flood Extents

Flooding overlays and flood extents for the GAEP area were found from a combination of publicly available information, and previous studies provided by the client. The studies and overlays which were reviewed to understand potential flood risk include:

- Lara Flood Study (Water Technology, 2020)
- Bellarine Peninsula to Corio Bay Local Coastal Hazard Assessment (Cardno, 2015)
- Western Treatment Plant Waterway Mapping (BMT WBM, 2017)
- Land Subject to Inundation Overlay (LSIO)

The sources for these studies and overlays are provided in **Section 6.4**.

The Lara Flood Study (Water Technology, 2020) provides flood maps for the Hovells Creek and Avalon Road / Austins Creek catchments. Results for the 1% Annual Exceedance Probability (AEP) event shows that the Avalon Road / Austins Swamp catchment drains through the southern GAEP area, and that the GAEP area is

at risk of inundation from local stormwater flooding. The LSIO also identifies areas of the southern GAEP area at risk of inundation.

The Bellarine Peninsula to Corio Bay Local Coastal Hazard Assessment (Cardno, 2015) shows that the southern boundary of the GAEP area is prone to some coastal flooding.

The Western Treatment Plant Waterway Mapping (BMT WBM, 2017) provides flood maps for the Western Treatment Plant, however the bounds of the study area also overlap with the northern GAEP area. The Western Treatment Plant is downstream of the northern GAEP area and contains large areas at risk of inundation from governed by flooding in the Little River. During a 1% AEP event, cross-catchment flows spill from Little River into the Beach Road / Freeway Service Areas catchment and drain through portions of the GAEP area.

Spatial data for the inundation extent identified in the Western Treatment Plant Waterway Mapping (BMT WBM, 2017) was not available, however figures within the report show that the general area at risk includes parts of the northern GAEP area. The flood extent from this study does not perfectly match the flood extent of the LSIO, however both flood extents identify flooding in the GAEP area.

Figure 5-7 shows the flood extents for the area available from planning scheme overlays and previous studies.

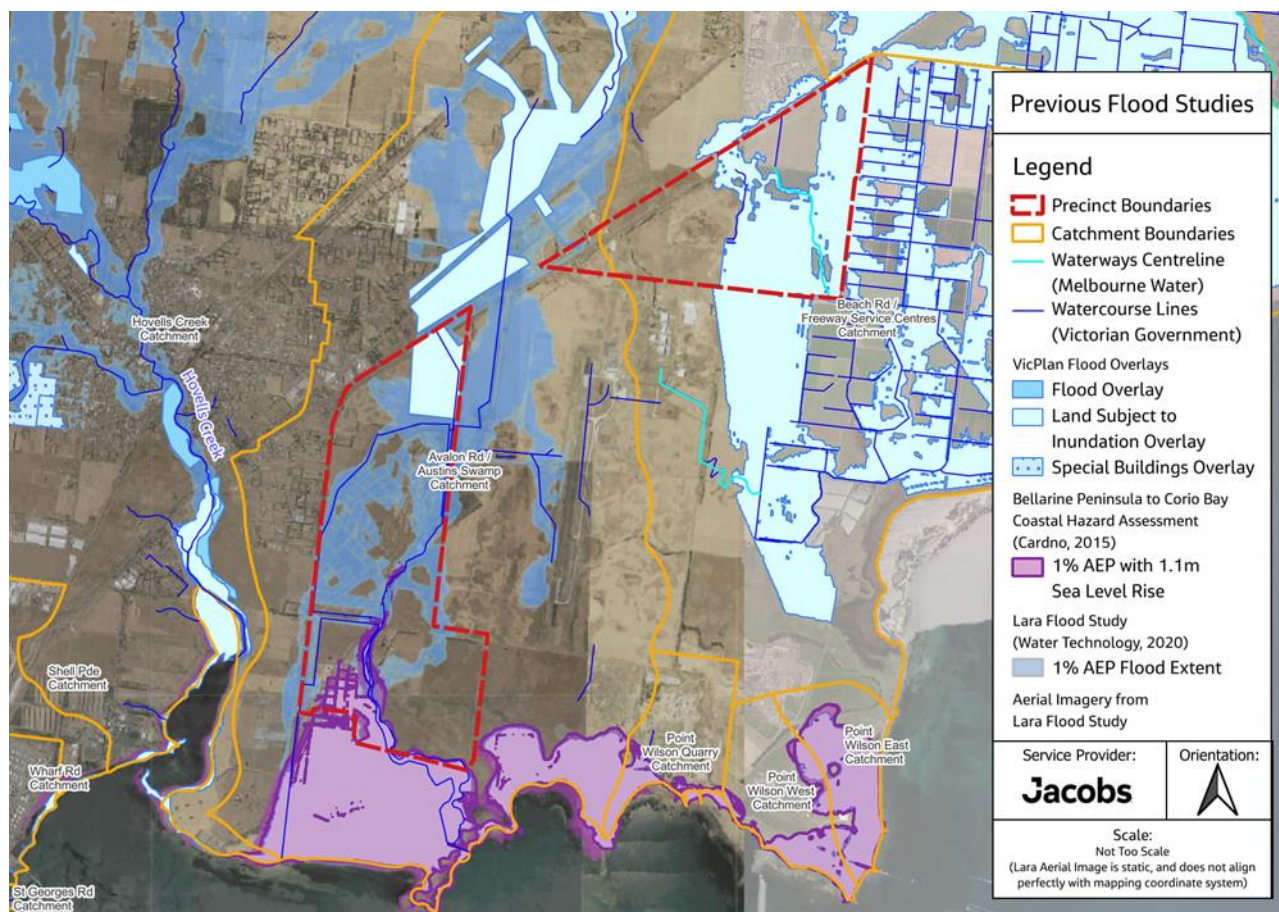


Figure 5-7. Previous flood study inundation extents

5.3.3 Catchment Topography and Flow Regime

The land in the vicinity of the GAEP area generally slopes with overland flow paths flowing from North to South draining to Port Phillip Bay. **Figure 5-8** shows the local topography and watercourse lines.

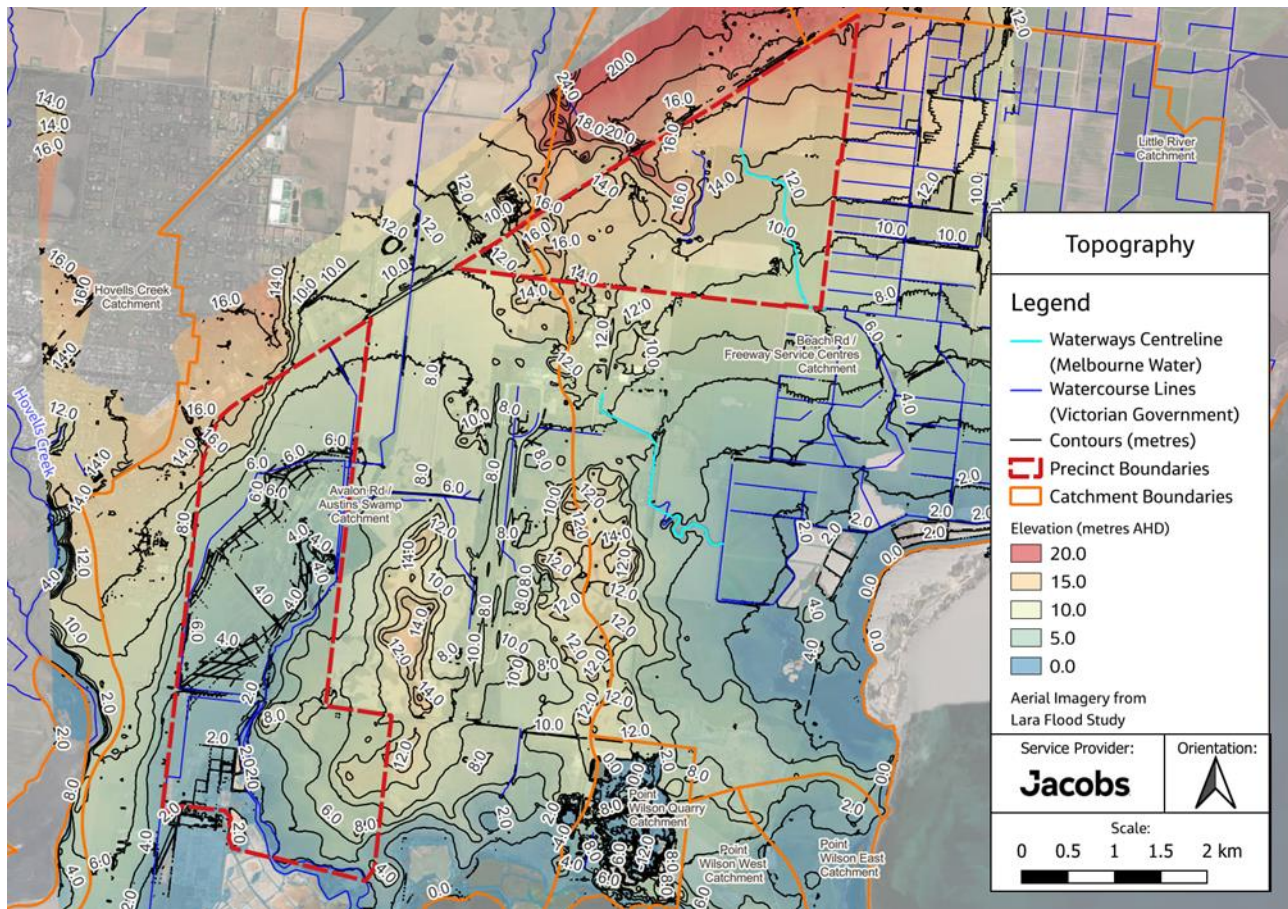


Figure 5-8. Local topography from Geoscience Australia's public five metre resolution dataset

The City of Greater Geelong has made some information publicly available which shows the location of the local drainage network. This dataset suggests that minimal drainage infrastructure is present within the GAEP area. However, detailed drainage information including pipe sizes and inverts was not available, and therefore there is not enough information to formally assess the underground flow regime. Furthermore, it is unclear whether the drainage assets in the dataset are proposed or existing assets. Assessment of the flow regime is therefore limited to current overland paths only for this report. The area is mostly rural and it is likely that overland flow paths dominate the current flow regime.

Future development in the area has the potential to influence existing overland flow paths in addition to impacting the project area drainage strategy and imperviousness. **Figure 5-9** and **Figure 5-10** show the current overland flow paths along with site contours, local drainage asset locations, waterways, and catchment boundaries.

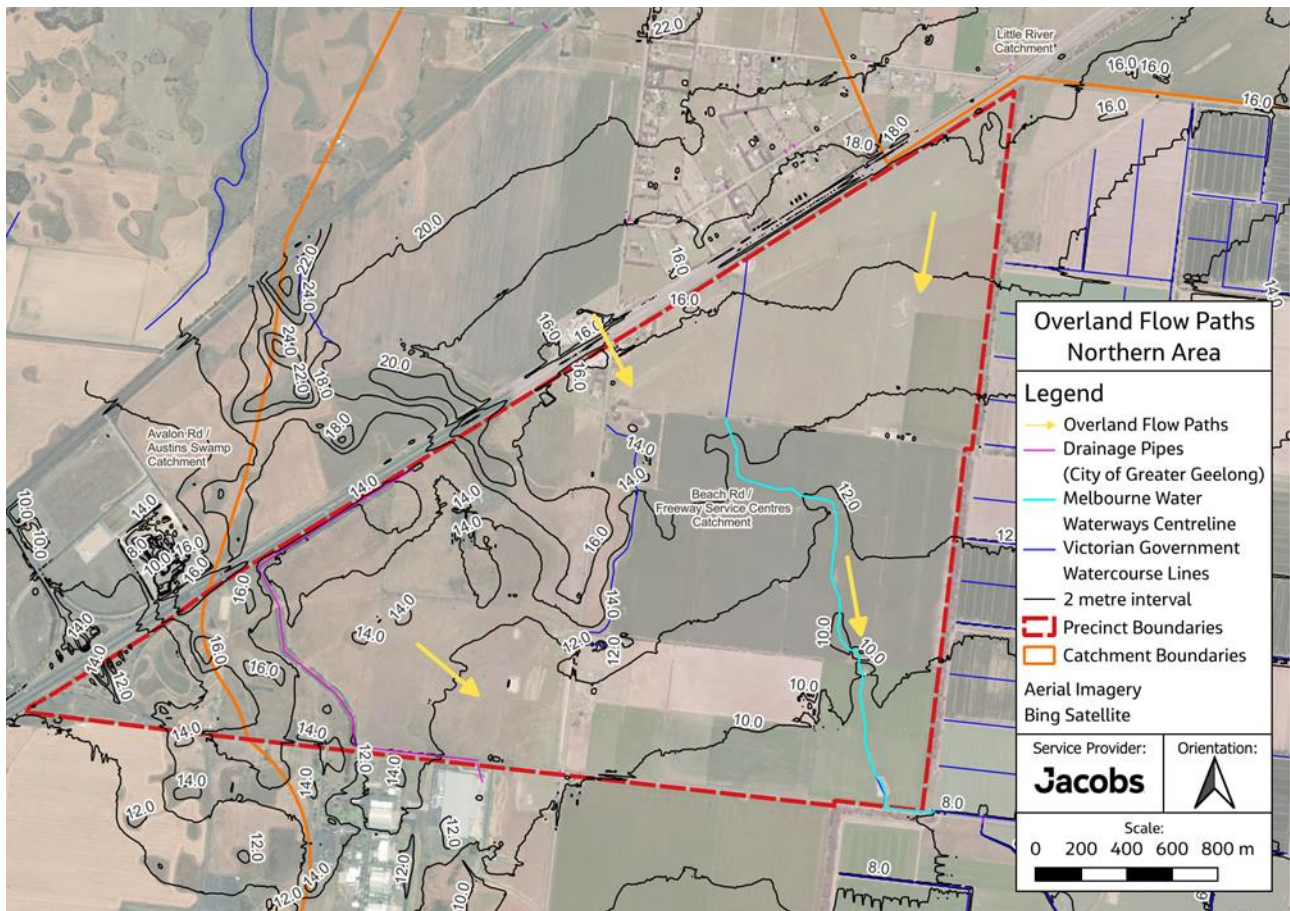


Figure 5-9. Flow paths and contours for the Northern GAEP area

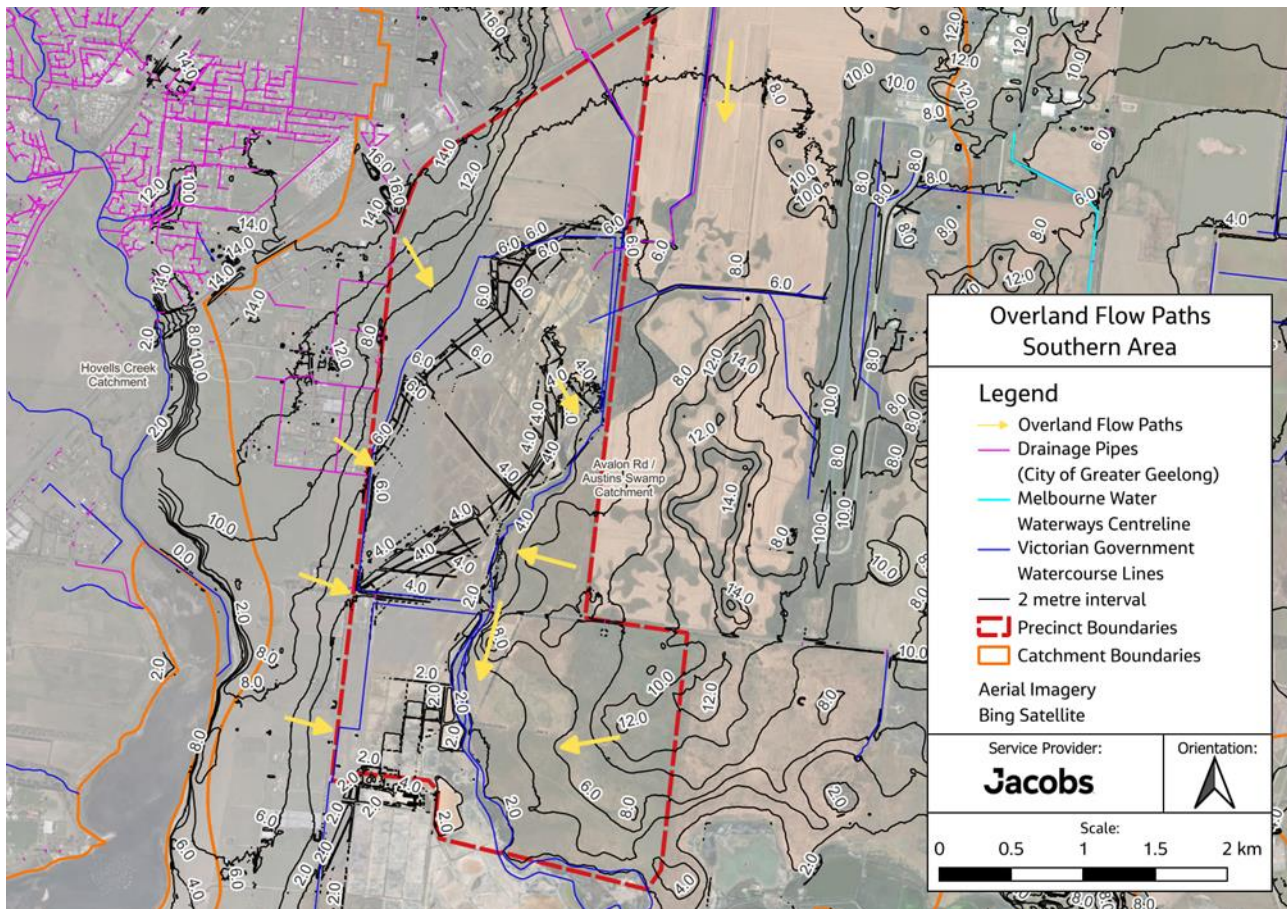


Figure 5-10. Flow paths and contours for the South-western GAEP area

5.3.4 Assumptions and limitations of due diligence desktop study

This assessment was carried out based on limited available data and information including but not limited to aerial imagery, public LiDAR data, public asset information, local flood studies, flooding overlays, and VicPlan overlays. A summary of the available studies and information reviewed for this desktop due diligence assessment is provided in **Section 6.4**.

The following assumptions and limitations apply to this desktop due diligence assessment:

- Feature survey has not been provided or undertaken for this assessment
- Public data referenced in this assessment has not been quality controlled
- Drainage data available at the time of this assessment was not sufficient to produce conclusions on the underground flow paths in the vicinity of the GAEP area.
- There was a lack of information available for the details of future development. Therefore, this desktop due diligence assessment is unable to provide details of the development impacts on the flood storage, flow path, land imperviousness, access safety and hazard, freeboard of the buildings, and drainage strategy.
- Obtaining and assessing more detailed data such as survey data; additional flood study reports, maps, and models; and a site visit may lead to different conclusions in assessing the regional hydrology.

5.4 Regional geomorphology

The regional geomorphology of the GAEP project area is characterised by volcanic plains, with remnant swamp features located in the northern site area. The western areas are dominated by remnant coastal lagoons. The areas appear to have been subject to considerable disturbance. Before agricultural development it is expected that there would have been more attenuation of water in the landscape with water collecting in depressions and swamps. With agricultural development, topography and drainage patterns are likely to have been significantly altered as a result of land leveling, drainage works, and the construction of

farm dams. Coastal lagoon landforms have also been impacted by the development of saltwork industry. No sites of geological or geomorphological significance are located within the GAEP (Victorian Resources Online 2019).

The GAEP area is located on soils that have formed from weathering of local Newer Volcanic Basalt rock, Quaternary Alluvium and Coastal Deposits. A review of Lotsearch Soil Maps, indicates the presence of Sodosols and Chromosols across the GAEP project area. These soils have a strong texture contrast, with sand to clay loamy surface horizons and dense and coarsely structured subsoil horizons that are sodic. Sodosols are susceptible to problems of waterlogging and erosion because of their physical structure and chemical composition. Soil sodicity potentially leads to dispersion, degrading soil structure, which is more frequently a problem with subsoil horizons, that are often relatively impermeable and become prone to gully and tunnel erosion. This erosion risk is increased in circumstances where the surface soil has been removed and the subsoils are then exposed (Jacobs 2020a, 2000b, 2001a, 2001b).

There is increasing awareness that urban development in areas that have these geologies and soil types in the Melbourne Region is an issue both through the construction phase and ongoing management of waterways. During the construction phase of development, vegetation is cleared, and surface soils may be removed, exposing subsoils to rainfall. Erosion risks are potentially heightened along incised drains and connecting streams, as the amount of runoff to these waterways is increased because of increased stormwater runoff from impervious areas (roads, roofs). There is also more pressure on existing streams to drain water from their catchment areas (Duncan et al 2014; Jacobs 2016, 2019).

5.5 Regional and local hydrogeology

5.5.1 Overview of regional hydrogeology

The precinct area is characterised by two main aquifer units. These are outlined below with reference to the Victorian Aquifer Framework (VAF) (GHD, 2012), and shown in **Figure 5-11**.

- Quaternary Alluvium Aquifer (QA – 100) is present over the majority of the southern precinct area portion, in association with Hovells Creek and tributaries. Hovells Creek is located about 800 m to 2000 m west of the southern precinct area. The QA – 100 unit is also present over about a quarter of the northern precinct area portion, in the west. Seamless Geology mapping within Visualising Victoria's Groundwater (FedUni, 2015) describes the alluvium in the southern precinct area portion as silt and clay, with the northern precinct area portion alluvium described as mud, silt, clay, peat and dolostone (rare). FedUni (2015) indicates a precinct area alluvium thickness of 2 m to 6 m. In light of the alluvium being thin (<6 m thick) and described as fine grained, a significant productive regional alluvium aquifer is not anticipated in the precinct area. Groundwater is conceptualised to flow through the gaps and pore spaces between the grains of the alluvium material. Where it occurs across the precinct area, this unit is likely to host the water table.
- Upper Tertiary/Quaternary Basalts (UTB – 101) underlie the Quaternary Alluvium and outcrop where the alluvium is absent. UTB – 101 is a fractured rock aquifer in the basalt flows and stony rises of the Newer Volcanics. Groundwater flow in this aquifer is primarily controlled by the size, spacing and interconnectivity of fractures and joints and, as such, flow is known to be highly variable. It forms a major regional and local aquifer. FedUni (2015) indicates the UTB – 101 is about 60 m thick in the northern precinct area portion and typically about 30 m to 40 m thick in the southern precinct area portion. This unit is expected to host the water table where it outcrops.

FedUni (2015) state-wide depth-to-water table mapping (**Figure 5-12**) indicates that the water table is shallow (less than 5 mbgl) across the entire northern precinct area portion and the majority of the southern precinct area portion. There are minor areas in the southern precinct area portion, in the northwest and southeast, where the water table is indicated to be slightly deeper, at 5 mbgl to 10 mbgl.

The primary recharge mechanism for the local aquifers is conceptualised to be via diffuse rainfall and surface infiltration. Locally, shallow groundwater is likely to contribute baseflow to surface water features.

Regional groundwater flow is conceptualised to be generally north to south, towards Port Phillip Bay. Local groundwater levels and flow directions are discussed in **Section 5.5.6**.

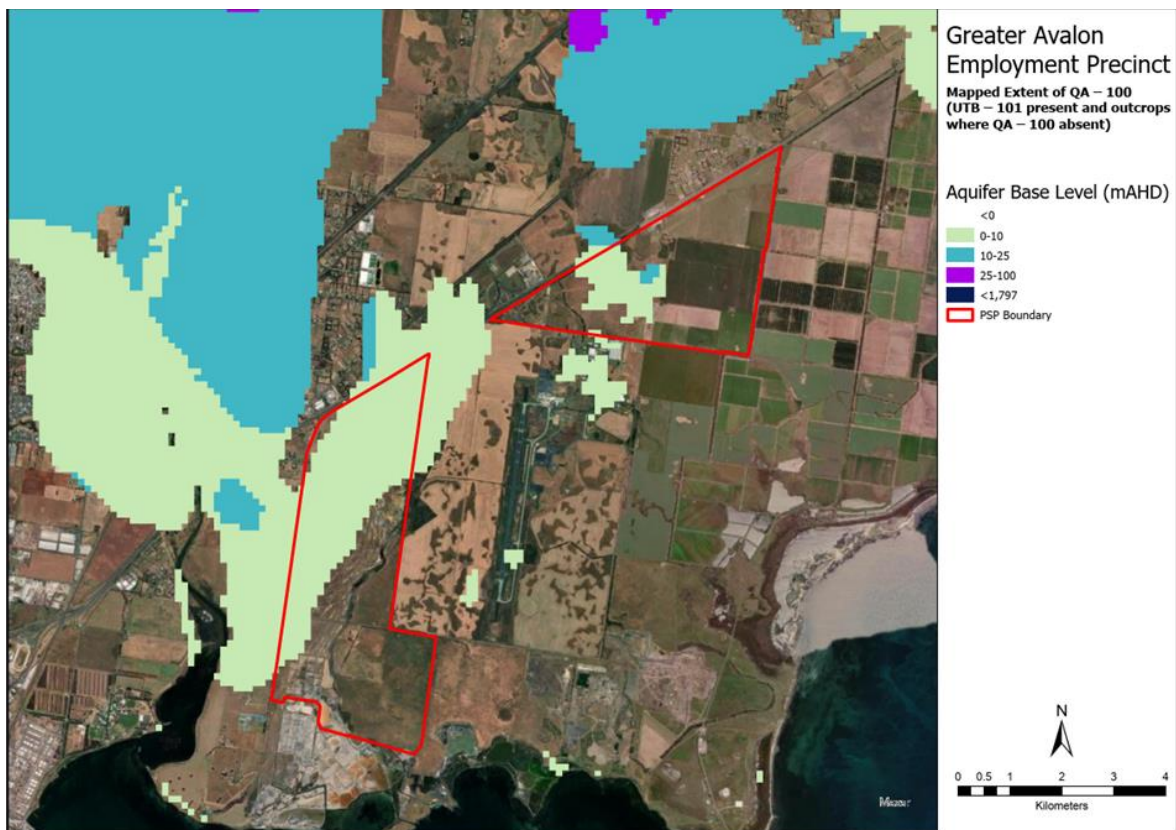


Figure 5-11. Mapped extent of QA – 100 (UTB – 101 present and outcrops where QA – 100 absent)

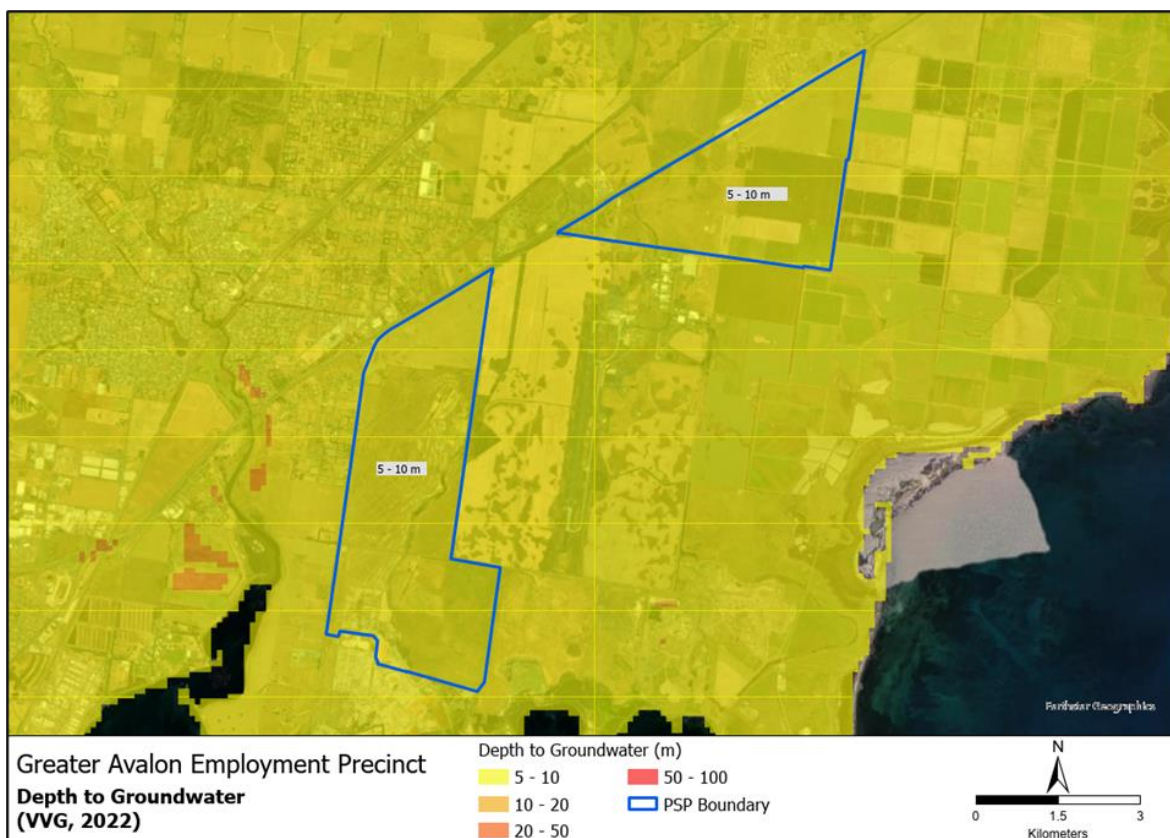


Figure 5-12. Depth to groundwater, meters below ground surface

5.5.2 Groundwater dependent ecosystems

A review of the Atlas of Groundwater Dependent Ecosystems (GDEs) (BOM, 2012) was conducted to identify potential GDEs within the precinct area. The GDE Atlas serves as a national inventory of known and potential GDEs categorised by their degree of reliance on groundwater. The Atlas indicates if the source data is derived from national or regional studies. National-scale analysis combines GIS data and a set of criteria by which potential GDEs are determined. Regional data sources are generally more detailed studies conducted by state or regional bodies utilising various methodologies including conceptual models, satellite imagery and field work verification (BOM, 2012). The two types of potential GDEs from the BOM Atlas which are relevant to the precinct area are outlined below:

- **Aquatic:** defined as ecosystems reliant on surficial expression of groundwater and include surface water ecosystems with a surface-groundwater interaction. Examples include wetlands, springs, and rivers.
- **Terrestrial:** defined as ecosystems which depend on a subsurface supply of groundwater. These commonly occur as vegetation ecosystems.

The Atlas indicates that the following potential GDEs are present within the precinct area.

- **Aquatic (Figure 5-13):**
 - A single tract of high potential GDE characterised as a wetland is present in the southeast of the southern precinct area portion. The tract is about 400 m long by about 200 m wide and was defined based on regional studies.
 - A single tract of moderate potential GDE characterised as a wetland is present in the east of the northern precinct area portion. The tract has a diameter of about 200 m and was defined based on regional studies.
 - Three closely separated tracts of unclassified potential GDE characterised as wetland are present in the centre and west of the northern precinct area portion, all defined based on regional studies. The combined length is about 800 m and the width ranges from about 100 m to 400 m.
- **Terrestrial (Figure 5-14):**
 - Relatively large areas of vegetation characterised as high potential GDE are present near parts of the southern precinct area portion's western boundary, and near southern parts of the drainage line which traverses the southern precinct area portion. These tracts are described as either "Coastal Saltmarsh/Mangrove Shrubland Mosaic" or "Plains Grassy Woodland". These areas were defined based on national assessment.
 - Three relatively small areas of vegetation characterised as high potential GDE are present in the southeast of the southern precinct area portion. These tracts are described as Plains Sedgy Wetland, were defined based on national assessment and are up to 130 m long and 50 m wide.
 - There are two small tracts of vegetation characterised as high potential GDE within the northern precinct area portion, near the southern boundary. The vegetation is described as 'Plains Grassy Wetland' and was defined based on national assessment. The largest area is about 120 m long by 70 m wide.

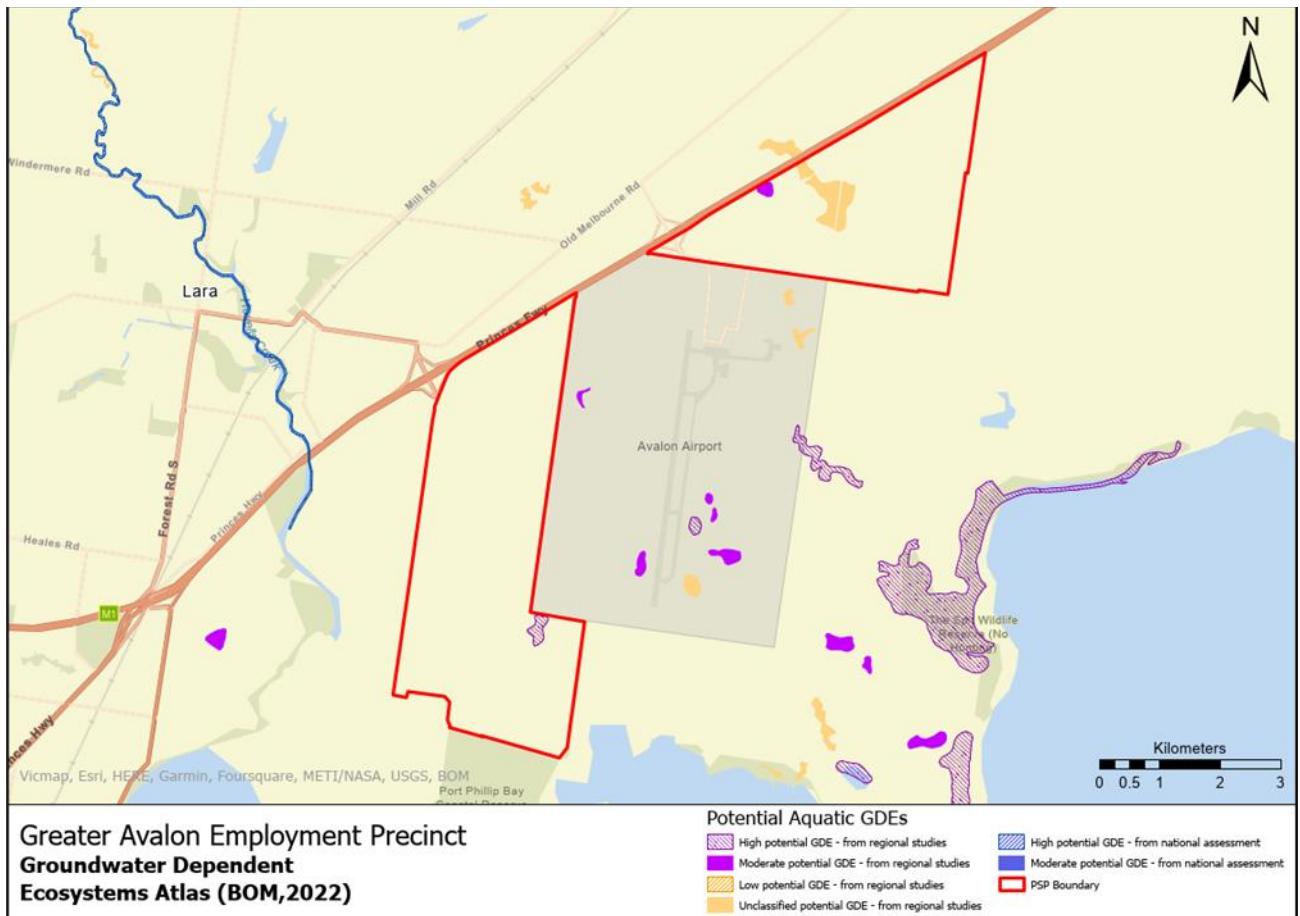


Figure 5-13. Potential Aquatic Groundwater Dependent Ecosystems

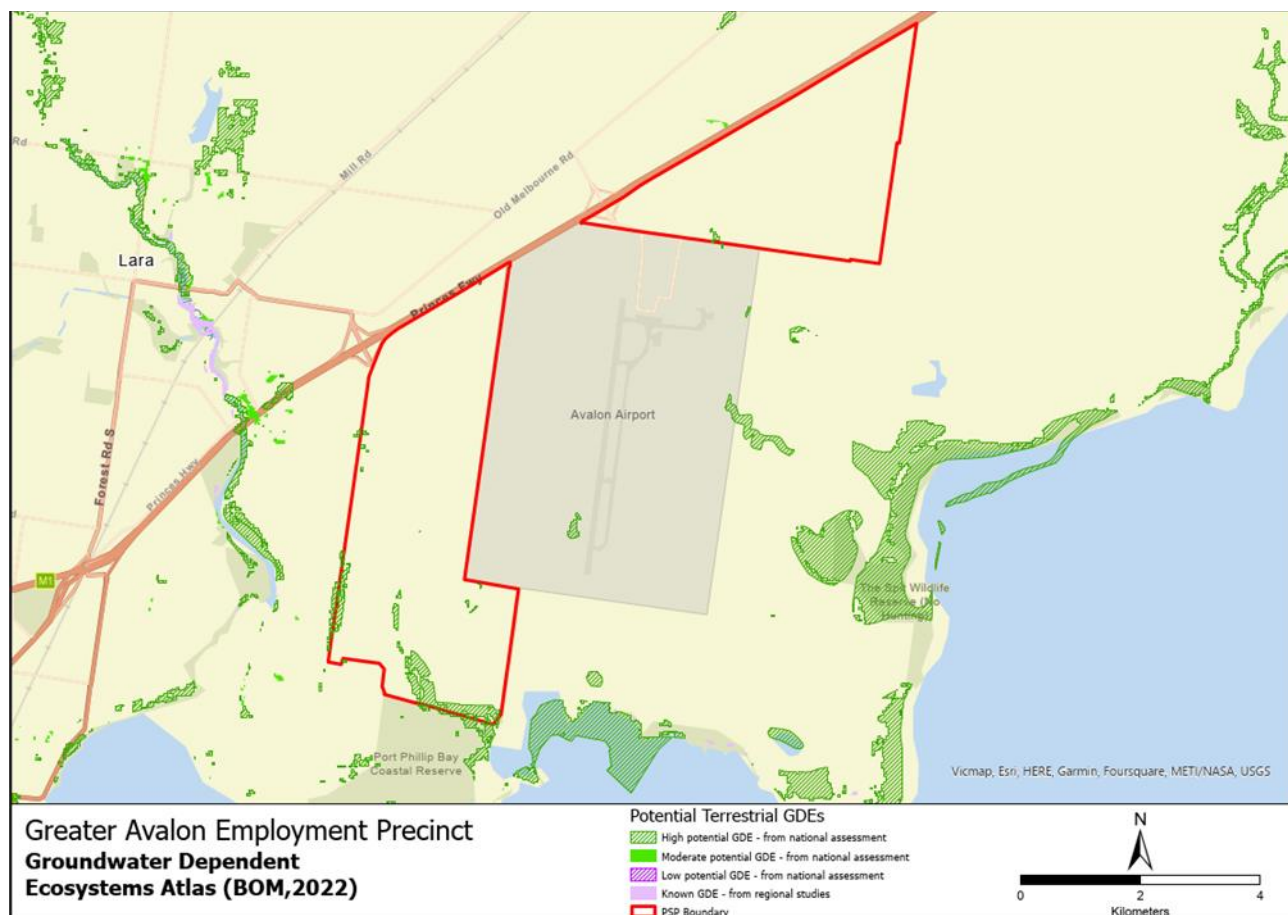


Figure 5-14. Potential Terrestrial Groundwater Dependent Ecosystems

5.5.3 Groundwater users

The state database, Water Measurement Information System (WMIS) (DELWP, 2022), lists 54 registered groundwater bores (Figure 5-15) within 1 km of the precinct area, although one location appears to be duplicated. There are 6 registered bores located in the northern precinct area portion and no bores in the southern precinct area portion. Of the 6 bores located in the precinct area, four have a recorded use of "monitoring", one has a use of "groundwater investigation" and one has a use of "investigation". Total bore depths vary between 12 m and 19 m.

Of the 54 bores, the majority (quantity 30) have a recorded use of stock and/or domestic. The closest bore of this type is offset about 120 m northwest from the northern precinct area portion. The second most common use type pertains to observation, investigation or monitoring (quantity 10 bores). Bore use type for the 54 bores is shown in Figure 5-16.

The minimum, median, average and maximum bore depth of the 54 registered groundwater bores is 10 m, 21 m, 26 m and 125 m, respectively. The deepest and second deepest bores have a depth of 125 m and 64 m, respectively. The majority of the bores have a depth in the range of 10 m to 30 m.

Of the 54 WMIS bores, there is only a single bore, bore I.D. 121451, with water level records. This bore is identified in Figure 5-15 and is located outside of, but very close to (<10 m), the southern precinct area portion's southeast boundary. Water levels for this bore are discussed in Section 5.5.6.

Figure 5-15. Registered groundwater bores within 1 km of precinct area

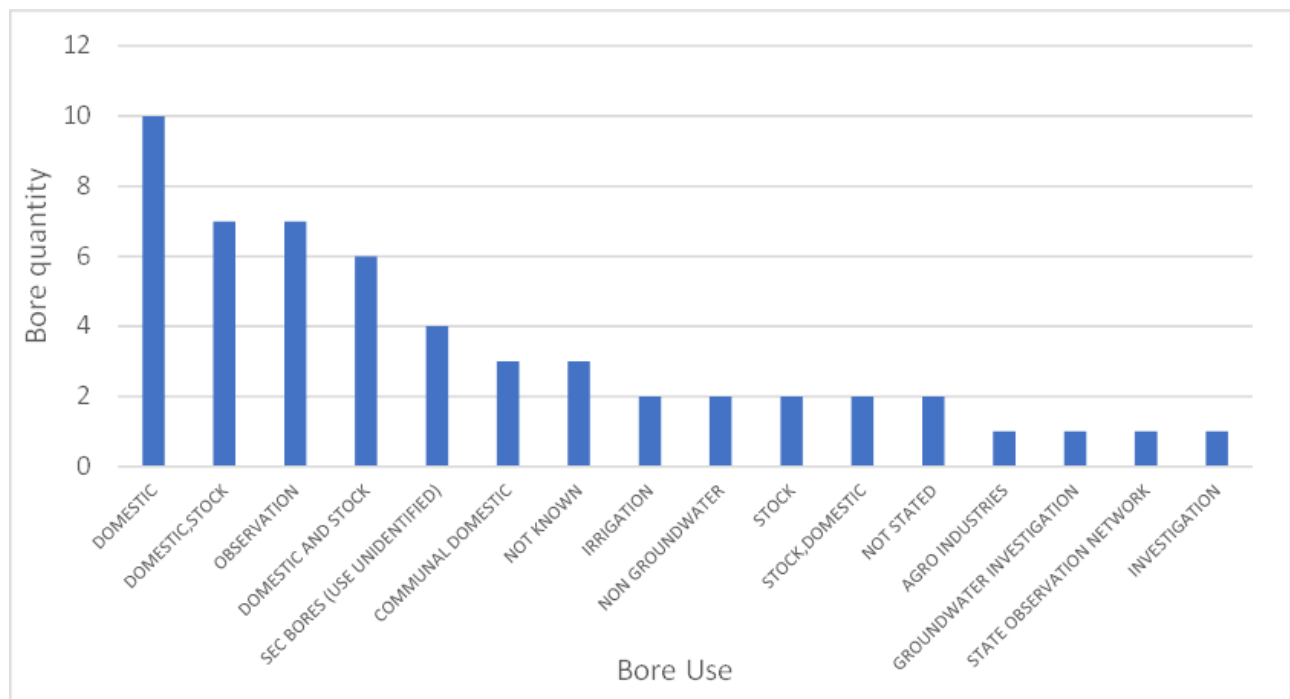


Figure 5-16. Registered groundwater bore use types within 1 km of precinct area

5.5.4 Regional groundwater quality

Regional groundwater salinity mapping (**Figure 5-17**) indicates that groundwater salinity within the precinct area ranges from 3,500 mg/L to 7,000 mg/L (DELWP, 2014).

The environmental value of groundwater is categorised into segments based on geographical areas with corresponding salinity ranges, defined in the Environmental Reference Standard (ERS) (EPA, 2022). The ERS defines environmental values as “uses, attributes and functions of the environment that Victorians value”. Based on the regional groundwater salinity mapping range applicable to the precinct area of 3,500 mg/L to 7,000 mg/L TDS, the most conservative relevant groundwater segment is C (3,101 mg/L to 5,400 mg/L TDS). Under this segment, the following environmental values require protection (EPA, 2022):

- Water dependent ecosystems and species
- Potable mineral water supply
- Agriculture and irrigation (stock watering)
- Industrial and commercial use
- Water-based recreation
- Traditional Owner cultural values
- Buildings and structures
- Geothermal properties

The potential brackish nature of the groundwater may require careful monitoring if dewatering or extraction is required, particularly for the consideration of the disposal of water. In relation to structure design and durability, the aggressivity of groundwater is discussed in **Section 7.2.4**.

A state-wide Salinity Management Overlay (SMO) (DELWP, 2017b) has been developed to:

- Identify areas subject to saline groundwater discharge or high groundwater recharge.
- Ensure development is compatible with site capability and the retention of vegetation and complies with the objectives of any salinity management plan for the area.
- Prevent damage to buildings and infrastructure from saline discharge and high-water table.

Planning data has been reviewed and no SMO is identified in the precinct area.

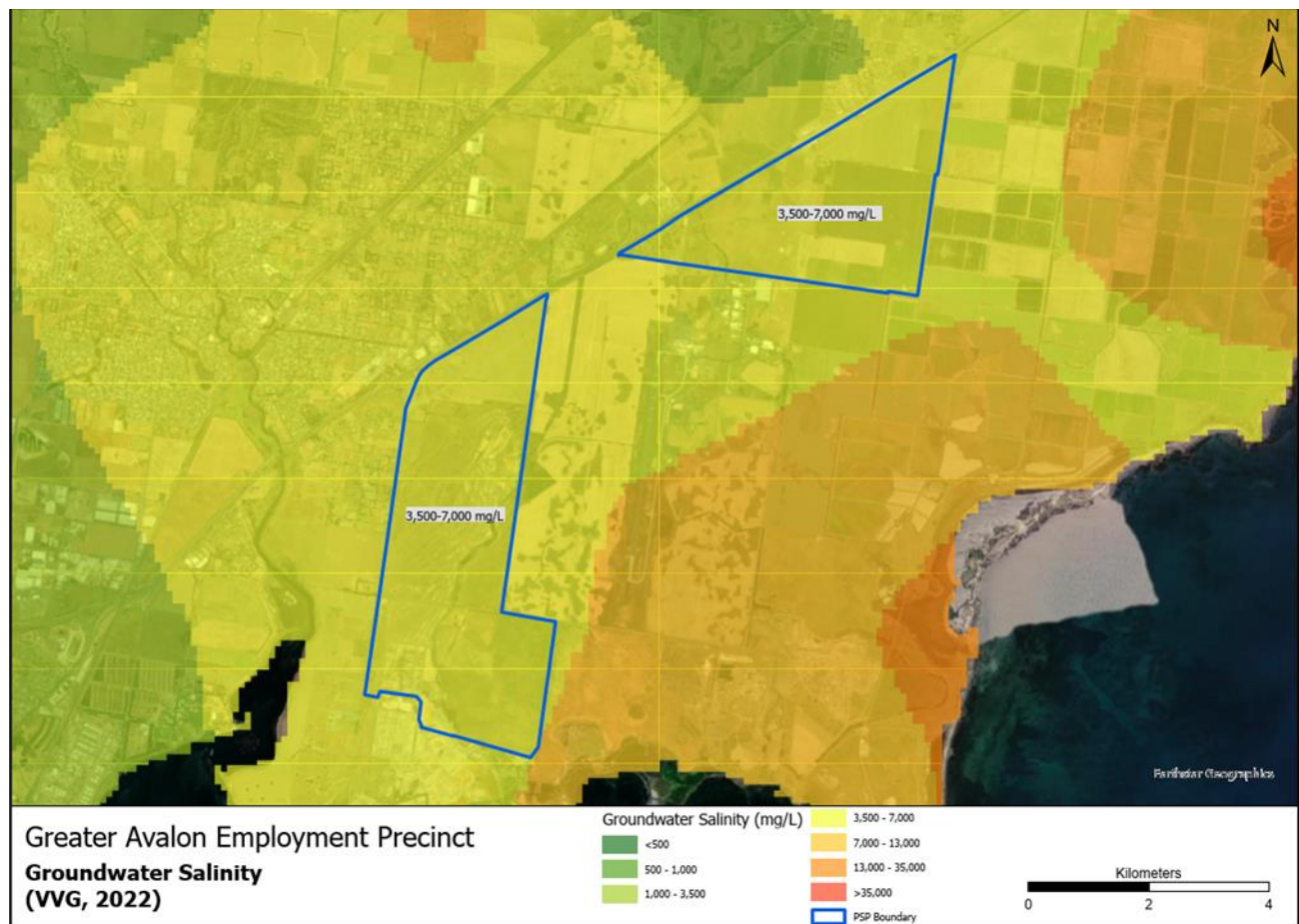


Figure 5-17. Regional groundwater salinity

5.5.5 Local groundwater quality

Of the 54 registered groundwater bores within 1 km of the precinct area, 15 bores have groundwater quality laboratory chemistry data within WMIS. The location of these bores is shown in **Figure 5-15**. None are located within the precinct area. These data are summarised in **Appendix C**.

The TDS concentrations of these bores broadly align with the regional salinity mapping (refer to **Section 5.5.4**). The average of TDS data (5,218 mg/L) outside of the precinct area, but within 1 km of the precinct area, aligns with the segment C category. However, the minimum (1,794 mg/L) and maximum (12,400 mg/L) of these data are outside of the segment C range. In relation to structure design and durability, the aggressivity of groundwater is discussed in **Section 7.2.4**.

The VVG (FedUni, 2015) provides contamination audit reports applicable to land within the Northern GAEP area. The reports pertain to hydrocarbon contamination associated with a leak from the White Oil Pipeline (WOPL). Further comments relating to potential groundwater contamination associated with the WOPL, as well as other potential sources, are provided in **Section 6.3.1** and **Section 6.3.3**.

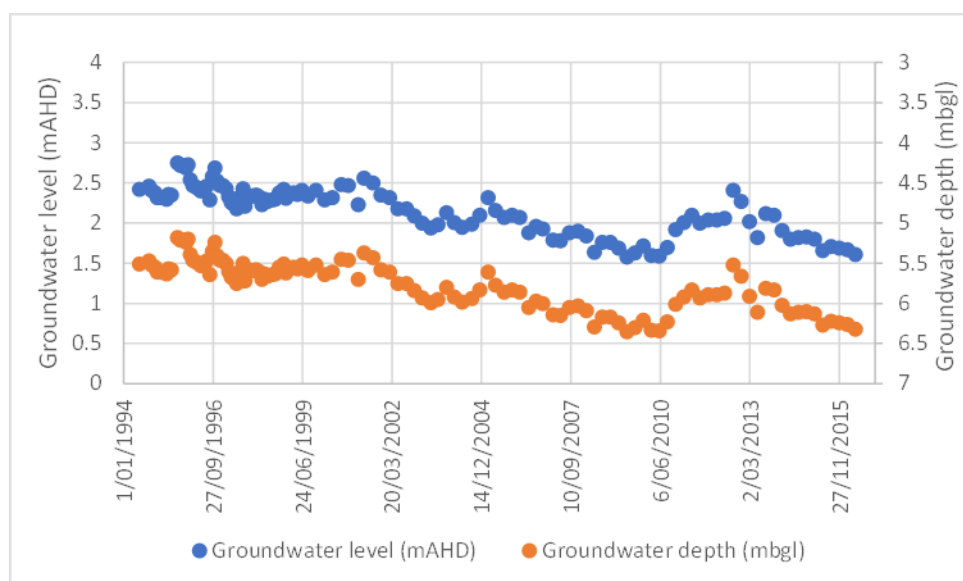
According to the VVG (FedUni, 2015), no groundwater quality restricted use zones (GQRUZ) currently exist within the precinct area.

Table 5-2. Groundwater quality laboratory chemistry data summary for WMIS bores within 1 km of precinct

	Analyte (mg/L)								
	Calcium, as Ca	Magnesium, as Mg	Sodium, as N	Potassium, as K	Bicarbonate, as HCO ₃	Carbonate, as CO ₃	Chloride, as Cl	Sulfate, as SO ₄	TDS
Min	7	25	480	12	223	7	887	140	1794
Average	102	219	1059	21	415	7	2651	272	5218
Max	189	360	1600	31	521	7	6510	470	12400
Sample quantity, n	8	10	9	6	9	1	10	6	10

5.5.6 Local groundwater levels and flow directions

Of the 54 registered groundwater bores within 1 km of the precinct area, there is only a single bore, Bore 121451, with water level records. This bore has a recorded natural ground surface level of 7.93 mAHD and is located (**Figure 5-15**) outside of, but very close to (<10 m from), the southern precinct area portion's southeast boundary. Groundwater levels and depths for Bore 121451 are shown in **Figure 5-18** and range from about 1.50 mAHD to 2.75 mAHD, and from about 5 mbgl to 6.25 mbgl.

**Figure 5-18. Bore 121451 groundwater levels and depths**

An Environmental Audit report (URS, 2005) for the White Oil Pipeline leak indicates 85 monitoring wells have been installed to delineate groundwater hydrocarbon contamination associated with the pipeline leak. The monitoring wells are broadly in the Audit Area, shown in **Figure 5-19**. URS (2005) indicates about half of these 85 monitoring wells are located in the north of the northern precinct area portion. The remaining half are located outside of the precinct area, north of the Princes Freeway. It is unclear if these monitoring wells are still present or if they've been decommissioned. Within the northern precinct area, based on monitoring well data, URS (2005) interprets groundwater levels to range from about 8.6 mAHD to 7.8 mAHD, in the area between the pipeline and the Princes Freeway. The ground surface elevation in this area is about 16 mAHD. Therefore, the water table is about 8 mbgl in this area. URS (2005) interpreted groundwater level contours indicate the general groundwater flow direction is south.

As stated in **Section 5.5.1**, regional groundwater flow is conceptualised to be generally north to south, towards Port Phillip Bay. Local groundwater flow is likely to follow topography and generally flow south-southeast in the northern precinct area portion, and in the southern precinct area portion, generally either

south-southeast or southwest, towards the unnamed drainage line which traverses the southern precinct area portion.

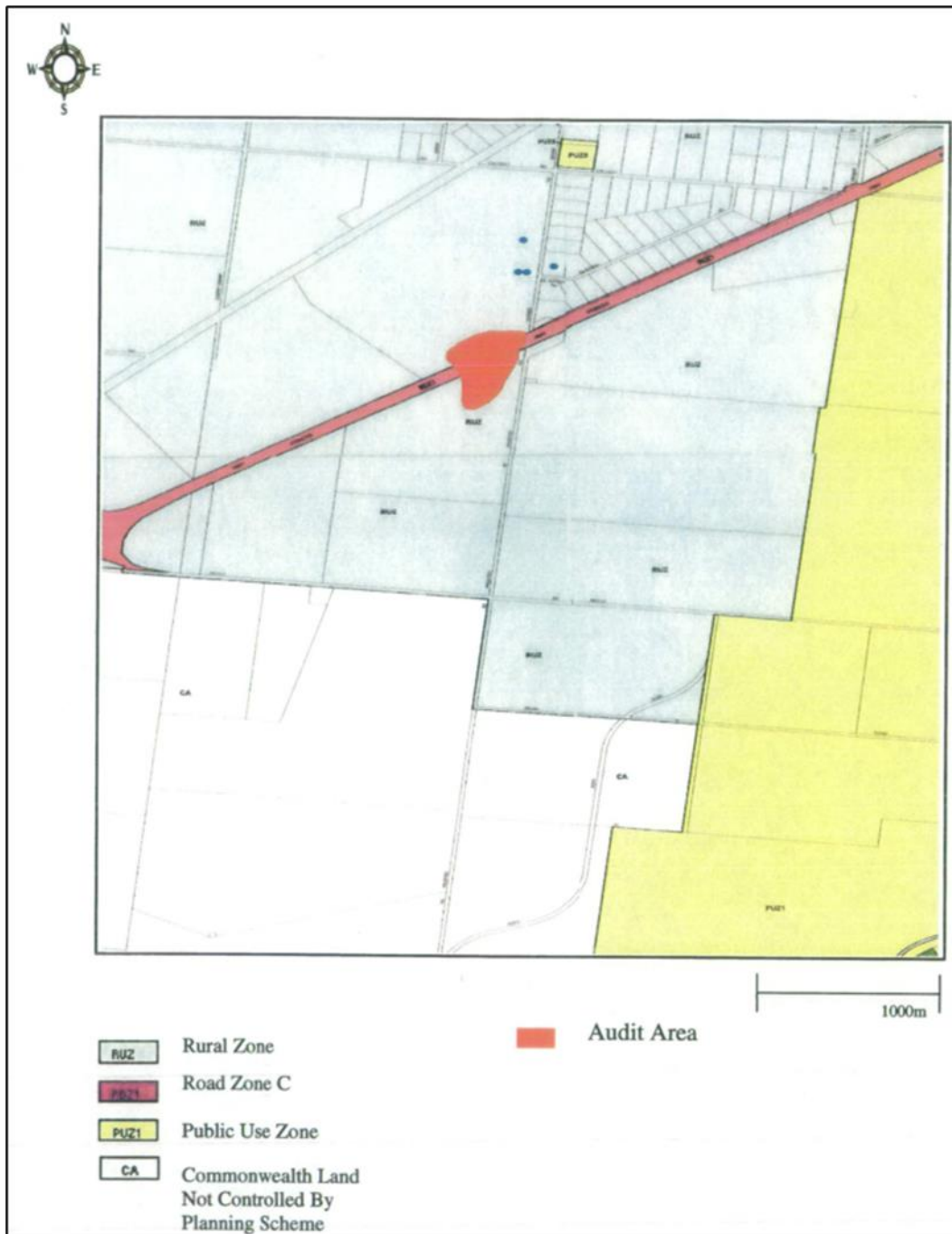


Figure 5-19. White Oil Pipeline leak audit area (URS, 2005)

5.5.7 Potential for local high-permeability basalt

URS (2005) indicates pumping tests, completed by IT Environmental, have been undertaken within the northern precinct area portion, and north of the Princes Freeway. The pumping test durations were 10 hours and 8.5 hours and the following results were obtained:

- Within the northern precinct area portion
 - Hydraulic conductivity of 12 to 80 m/day
 - Transmissivity of 632 m²/day

- North of Princess Freeway
 - Hydraulic conductivity of 20 to 127 m/day
 - Transmissivity of 1000 m²/day

URS (2005) noted they were not able to verify the IT Environmental pumping test data and results, and that they expect the transmissivity values to be overestimated. Notwithstanding this, these results indicate that the basalt near and within the precinct area has relatively high hydraulic conductivity. Further investigations would be required to assess whether these test values are accurate and also representative of the precinct area basalt, or alternatively, whether they are overestimates or associated with localised areas of increased hydraulic conductivity.

5.6 Bushfire context

The wider landscape is predominately flat perennial pastures, except for the You Yangs Regional Park and the irrigated sections of the Western Treatment Plant.

The site is located within the Bushfire Prone Area (BPA) as defined by the VPA (refer to **Figure 5-21**). Bushfire Prone Area refers to land in Victoria that has been identified as having a heightened risk of bushfires. This designation is based on various factors such as vegetation type, topography, weather patterns, and historical fire records.

In areas designated as bushfire prone, there will be specific planning and building requirements that must be met to help minimize the risk of property damage or loss of life in the event of a fire. For example, buildings may need to be constructed with materials that are resistant to fire, have adequate clearance around them to reduce the risk of radiant heat flux.

5.6.1 Weather

The region experiences a moderate, temperate climate with mild winters and warm summers. The average maximum daily temperature at Avalon Airport (**Figure 5-20**) during the summer months is around 25.5°C, while winter temperatures average around 15°C. Rainfall is highest during winter and spring, with an average annual total of approximately 450 mm. Temperatures exceeding 40°C have been recorded in all months between November and March. The hottest temperature on record was 47.9°C, recorded in February 2009.

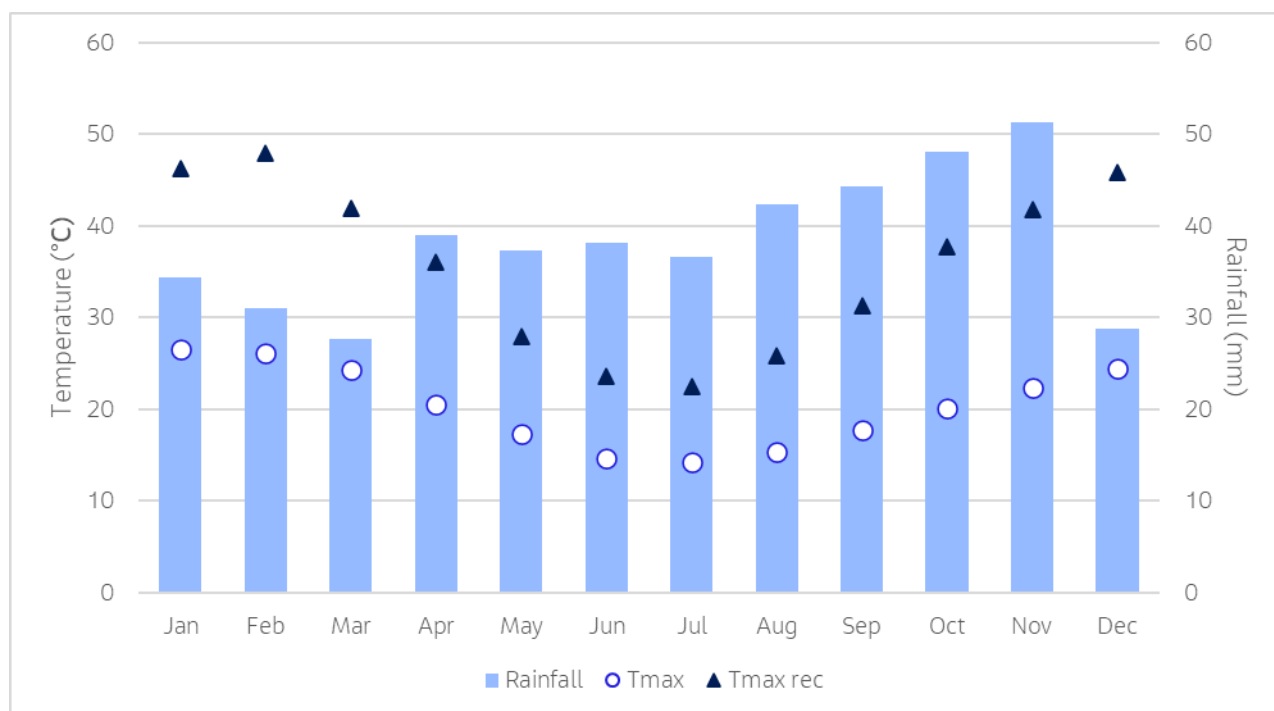


Figure 5-20. Average monthly rainfall and daily maximum temperature (Tmax), and highest temperature on record (Tmax rec) for Avalon Airport, data for 1995-2023 (BoM station 087113; BoM 2023).

Winter and spring rainfall are the largest drivers in determining vegetation growth, which in turn lead to the accumulation of bushfire fuel. High temperatures and low rainfall in late spring and early summer are drivers for grass curing (drying). Cured grass, combined with hot days and strong north to north westerly winds combine to create dangerous fire weather. Elevated fire weather conditions in Victoria also usually include a late afternoon (typically around 4 pm) change in wind direction that can see the fire burning in a new direction.

The prevailing winds on days of elevated fire danger will push a fire starting in or around the You Yangs towards the GAEP.

5.6.2 Fire history

Bushfire risk in the region is heightened during the hotter and drier months of the year when vegetation is more susceptible to catching fire. Whilst no fires have directly impacted on the GAEP footprint in the last 60 years, some have come very close (**Figure 5-21**). Most notably, the 1985 Anakie Fire was prevented from spreading into the north-eastern part of the precinct by fuel break caused by the Princess Highway (shown in green in **Figure 5-21**). The You Yangs Regional Park has had several more recent fires, but these have all been contained within the park boundaries. These fires caused significant damage to property and infrastructure within their fire footprints.

5.6.3 Risks associated with bushfire

The overall risk associated with developing the precinct would be considered moderate. This assessment is based on the following considerations:

- While fires have affected the area in the past, the Princess Highway provides a major fire break along the highest risk side (north), and as the township of Lara has been turned from grazing/cropping into industrial use, there is less available fuel for a grass fire to spread.
- Risks associated with a fire starting from the south are minimal due to the limited vegetation within the Avalon Coastal Reserve, and the proximity of Port Philip Bay.
- A fire burning around Limeburner's Bay under south westerly winds would pose minimal risk due to the lack of available fuel, the settlement of Avalon and the industrial operations on either side of Avalon Rd.

However, on catastrophic fire danger days, fires can spot up to 30 km in front of a fire front. As such, a fire started within the You Yangs Regional Park could ignite a spot fire in the vicinity of the Avalon GEAP. Appropriate building protections (i.e. following AS3959) should be implemented, and access and water for firefighting appliances provided.

5.6.4 Recommendations

Bushfire risk does not preclude development at the site. To manage what risk there is:

- Buildings should be built to the relevant standards outlined in AS3959.
- Access and water for firefighting appliances should be provided, following the relevant clauses in the Victorian Planning Provisions, Fire Rescue Victoria policies and building codes.
- Flammable fuels (dry grasses, trees, etc.) be kept to a minimum where possible.
- Keep flammable materials away from the Precinct boundaries (e.g. keep road side edges mown to less than 100 mm during the declared fire season.)

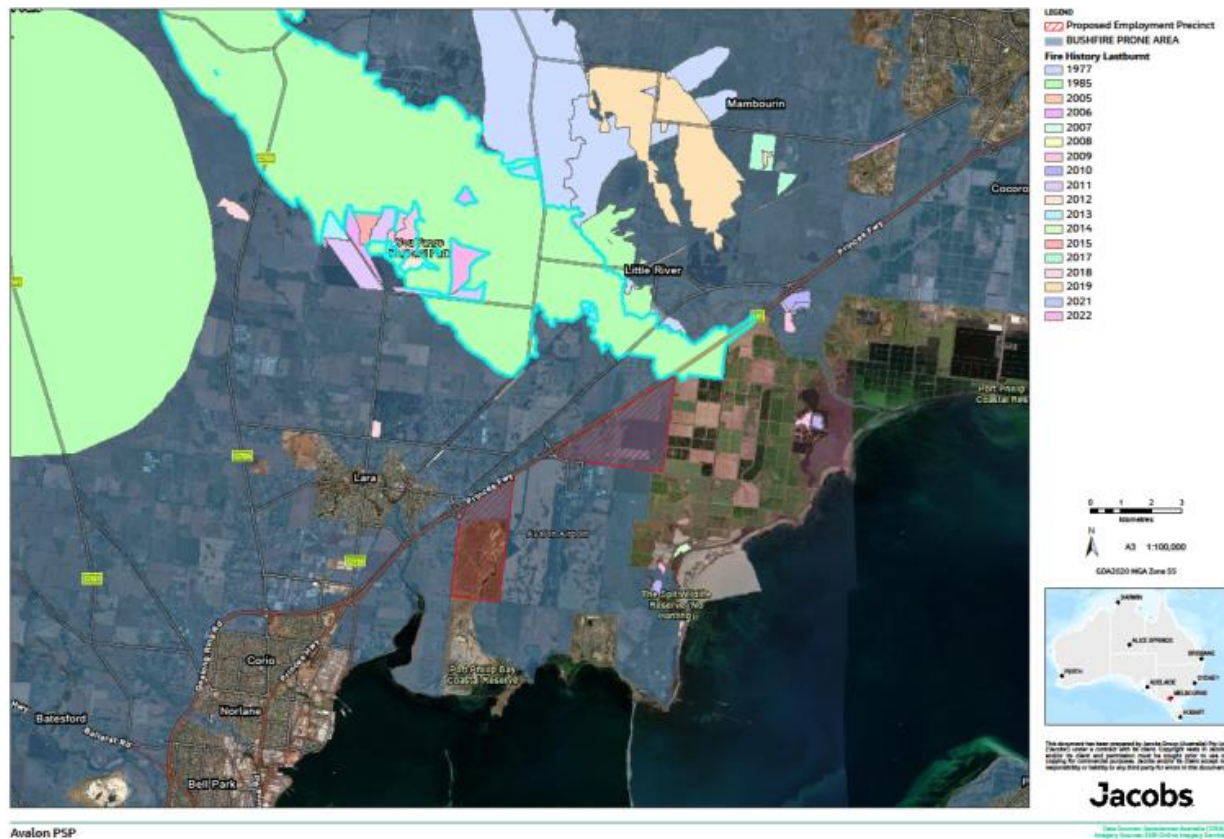


Figure 5-21. Fire history and bushfire prone area map

5.7 Future land use

The GAEP Area is located within the City of Greater Geelong LGA and is subject to the Greater Geelong Planning Scheme. It is outside the Urban Growth Boundary (UGB). The Wyndham LGA is located to the north. The GAEP boundary encompasses land within and adjacent to Avalon Airport and is the area shaded dark blue in **Figure 5-22**.

The Avalon Corridor Strategy (the Strategy) was prepared by the City of Greater Geelong and Wyndham City Council, in collaboration with DELWP, to provide long-term strategic vision for the Avalon Corridor to 2050, to guide planning decisions. It seeks to provide strategic guidance on potential land use and development change, and direction on how to foster opportunities associated with its strategic location and presence of significant assets and infrastructure, such as Avalon Airport (**Figure 5-22**).

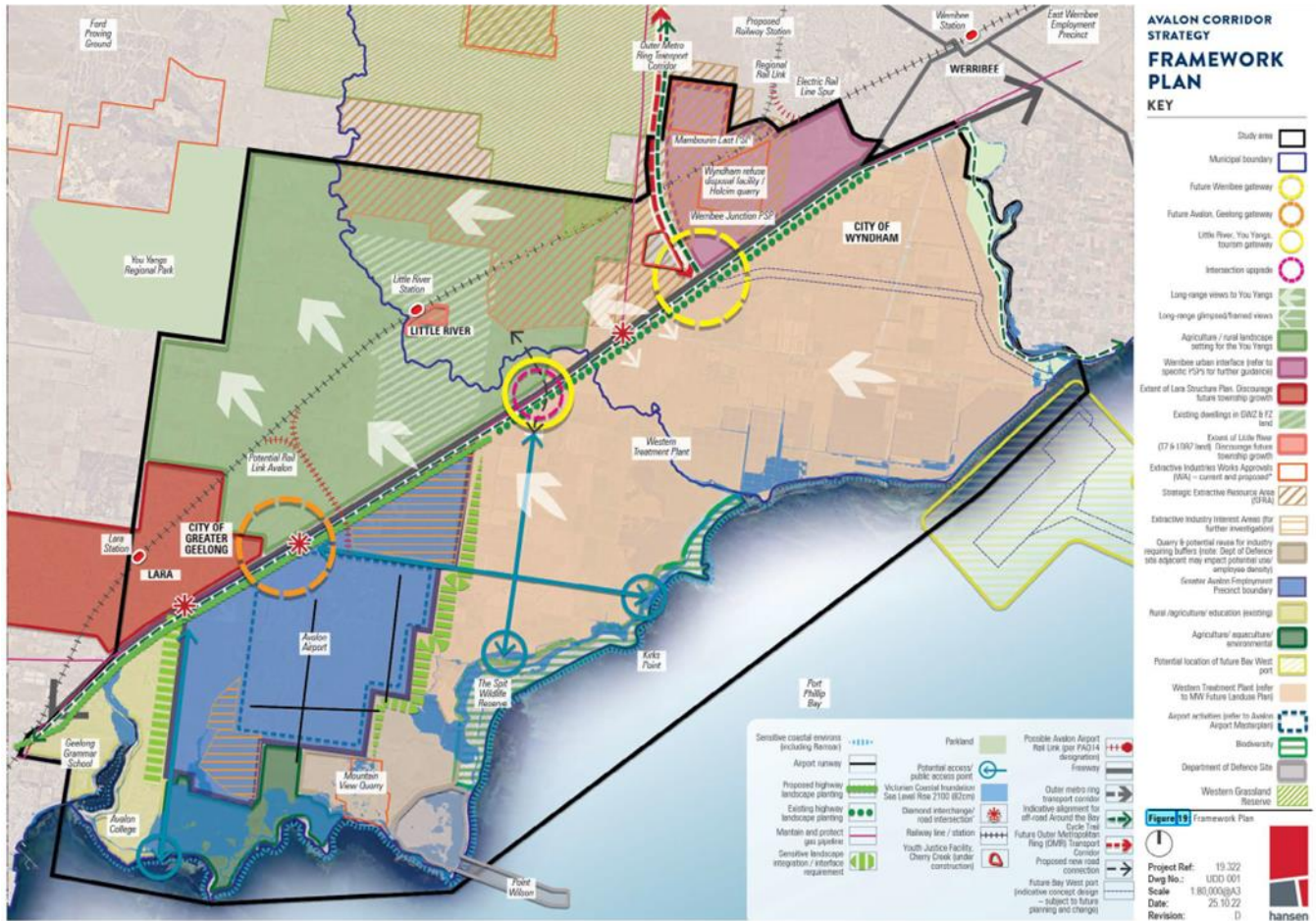


Figure 5-22. Framework Plan – Avalon Corridor Strategy (2022)

The key guiding principles which underpin the Framework Plan include:

- Maintain and reinforce a green break between Geelong (regional Victoria) and Werribee (metropolitan Melbourne).
- Protect green wedge and rural landscapes, as well as cultural and environmental features of identified value.
- Protect ongoing and future operations of the Western Treatment Plant.
- Protect ongoing and future expanded functional operations of Avalon Airport as per Avalon Airport, Master Plan.
- Focus appropriate commercial and industrial development within and surrounding Avalon Airport, as per the Framework Plan.
- Create economic development and employment opportunities in the northern part of Geelong.
- Highlight the ongoing importance of the economic and transport connections between Werribee and Geelong.
- Protect and enhance traffic movement on major roads (current and proposed) and rail corridors.
- Avoid residential development within the Avalon Corridor.
- Protect areas of acknowledged environmental value including coastline and Ramsar wetlands and grasslands.
- Protect Wadawurrung cultural values and areas of known cultural heritage significance, as well as post-contact heritage sites (in addition to undertaking further investigations as part of specific land use change and development proposals).

As stated in the Strategy, the Framework Plan is a high-level plan that does not attempt to identify all possible land uses within the area, and further detailed work is required to assess land use and development within the Precinct. A structure plan is to be prepared for land that is identified as 'potential commercial / industrial / airport related business'.

5.8 Adverse Amenity

Northern GAEP Area

The Northern GAEP Area is approximately 641 hectares and contains nine parcels of land. It is in the Farming Zone. It is bounded by Princes Highway to the north.

Across Princes Highway, the area consists of low density farming residential lots and vacant agricultural lots. It is in the Farming Zone, which provides for the use of land for agriculture, to ensure that non-agricultural uses do not adversely affect the use of land for agriculture, and to encourage the retention of employment and population to support rural communities, amongst other purposes. To the north of Princes Highway there is also an Extractive Industries Interest Area (EIIA), representing an area where potential extractive resources (in this instance, hard rock) of state significance have been identified.

To the east of the Northern GAEP Area, adjoining land is in the Public Use Zone Schedule 1 Service and Utility (PUZ1). This zone recognises public land use for public utility and community services and facilities and to provide for associated uses that are consistent with the intent of the public land reservation or purpose. The land is used for crops.

The White Oil Pipeline lies beneath the Northern GAEP Area and runs parallel to Princes Highway. It is reported to be an 8-inch, high-pressure pipeline which has been in use since 1953. Developments can be conducted safely in the vicinity of high-pressure pipelines, as long as the associated risks are managed according to the requirements set out in the Australian standards. Collaboration with local authorities and regulators would be required to ensure safe land use around the Pipeline.

Given the surrounding land uses and the separation created by Princes Highway, it is considered that there would not be any significant adverse amenity impacts caused by the proposed development of the Northern GAEP Area.

South-western GAEP Area

The South-western GAEP Area is approximately 940 hectares and contains thirteen parcels of land. The area in the north is in the Farming Zone and the area in the south is in the Special Use Zone Schedule 1 Environmental Wetlands, Salt Production and Land-Based Aquaculture Activities (SUZ1). It is also bounded by Princes Highway to the north.

To the north of the Western GAEP Area and across Princes Highway, is an area of land in the Rural Living Zone (RLZ), which consists of large agricultural lots. To the west of this area, is the township of Lara, which is predominantly residential (with land in the General Residential Zone, and with pockets of Low Density Residential Zone and RLZ), a small commercial area in the centre of Lara, and an industrial area adjoining Princes Highway. Immediately adjoining the Western GAEP Area is the township of Avalon to the west, which is in the RLZ. To the south is a farming area and to the south-west of the Western GAEP Area is a large block of land in the Public Conservation and Resource Zone (PCRZ).

Clause 13.07-1S Land use compatibility of the Planning Policy Framework aims to protect community amenity, human health and safety while facilitating appropriate commercial, industrial or other uses with potential adverse off-site impacts.

The Environment Protection Authority (EPA) Recommended separation distances for industrial residual air emissions publication (EPA Publication 1518) is included in Clause 13.07-1S for consideration. This document provides guidance on what land uses require separation, the types of land uses that are suitable as interface land uses and informs strategic land use planning decisions and consideration of planning permit applications.

Clause 53.10 Uses and activities with potential adverse impacts, sets out threshold distances for different types of uses and activities with potential adverse impacts. Establishing land uses known to pose potential offsite impacts must respond to threshold distances contained in Clause 53.10. Land in the residential zones and RLZ are generally not compatible with other land uses that have potential off-site impacts. The table to Clause 53.10 specifies threshold distances depending on the type of land use or activity proposed.

There could be potential amenity impacts to the residents in the township of Avalon and Lara. These sensitive land uses would be sensitive to emissions from industry and other uses due to their impact on amenity, human health and safety. The sensitive uses will differ depending on the type of industry or other use and this is not yet known for the GAEP Area. The Buffer Area Overlay (BAO) could be used to accommodate off-site impacts away from the residential areas of Avalon and Lara. Additionally, other approaches could also be considered such as the placement of lower impact zoning and use areas as buffers to residential areas. These controls would need to be determined when the proposed land use of the GAEP Area is known and the nature of the potential off-site impacts are understood.

6. Information review

This section summarises the various sources of information, records, and reports reviewed as part of Stage 1 of the Land Capability Assessment, the desktop review, and the site inspection.

6.1 Certificate of Title Information

The list of land uses for the GAEP area were reviewed to check its historical and current land uses. The different information is provided in Appendix B. A review of the list revealed that some parts of the land within the area and along its boundaries were used for commercial uses such as motor service stations, petrol stations, tourist attractions, garden supplies, plant nurseries, racecourses, quarry, warehousing, and salt-making. In addition, majority of parcels of land within the Project Area are currently being utilised as agricultural areas (grazing of livestock such as sheep and cattle and general farming), with few residential and commercial areas. Historically, from 1951 to 1996, Avalon Airport was used by the Commonwealth Government (Department of Defence) for the production, testing, and maintenance of military aircraft.

6.2 Historical aerial imagery

Aerial photographs from 1947 to 2023 were reviewed for land use changes. Observations are summarised in the table below. Copies of aerial photographs are provided in the Lotsearch Reports in Appendix B.

Table 6-1. Summary of Review of Historical Aerial Imagery (Northern GAEP)

Table presenting a summary of observations based on the review of available current and historical aerial imagery across the Northern GAEP area.

Year	Description	Source
1947	On-Site: - Most of the areas within the GAEP area are open areas / vacant lots with minimal to an absence of either residential, commercial, or industrial areas. - The roads within and at the border of the Northern GAEP area is apparent which are currently Beach Road in the south, Princes Highway from north to west, and Pousties Road, bisecting the middle of Northern GAEP longitudinally. - The few existing residential houses / farm buildings are situated along Pousties Road. Off-Site: - Most of the areas beyond the Northern GAEP area boundary are open areas / vacant lots with only a few structures located on Avalon Airport south of the Northern GAEP area. Note: The white oil pipeline (WOPL), which lies beneath the northern GAEP and runs parallel to Princes Highway, was believed to be installed in the late 1940s to early 1950s. This is reported to be an 8-inch, high-pressure pipeline and has been in use since 1953.	Vicmap through Lotsearch
1963	On-Site: - No notable changes were observed since 1947 Off-Site: - Apparent excavation activities observed in the north-west almost adjacent Princes Highway. Additional structures were observed north of Princes Highway as well as additional buildings were constructed within the boundary of Avalon Airport. .	Vicmap through Lotsearch
1968	On-Site: - No notable changes were observed since 1963 Off-Site: - No notable changes were observed since 1963	Vicmap through Lotsearch
1975	On-Site: - No notable changes were observed since 1968 except for the construction of the intersection at Beach Road and Princes Highway. Off-Site: - Construction of the intersection at Beach Road and Princes Highway north-west of the Site and some additional development at Avalon Airport.	Vicmap through Lotsearch
1978	On-Site: No notable changes were observed since 1975.	Vicmap through Lotsearch

Land Capability Assessment

Year	Description	Source
	Off-Site: No notable changes were observed since 1975.	
1984	On-Site: - Additional farm/residential structures were noted. Development of tracks at the Geelong Motorsports Complex. Off-Site: - Additional residential structures were noted in the northern area.	Vicmap through Lotsearch
1990	On-Site: - Further development of tracks at the Geelong Motorsports Complex. Additional farm structures/residential houses were noted. Off-Site: - Development of the commercial area north of the site, where a few of the buildings were constructed. Some additional structures were also noted at Avalon Airport.	Vicmap through Lotsearch
2003	On-Site: - Presence of additional buildings was noted at the south-west point of the Site. A new road was constructed traversing north to south near the Geelong Motorsports Complex racetrack. Construction of an onsite BP Service Station adjacent Princes Highway. Off-Site: - Presence of new structures at the quarry site located adjacent north-east of the intersection of Beach Road and Princes Highway. - New structures were noted at Avalon Airport. Warehouse-like buildings were noted at the south-west direction less than 500 m from the Site. - Construction of the BP Service Station north of the Site, the counterpart of the onsite BP Service Station. - Further land development and construction of commercial buildings north of the Site.	Vicmap through Lotsearch
2009	On-Site: - New building was noted at the area of the Geelong Motorsports Complex near its track. - A new road emanating from Avalon Road was developed. This road leads to the new warehouse-type building located at the white oil pipeline (WOPL) leak site with a few other small structures and stockpile of materials which are likely pipes. Numerous monitoring wells were reportedly installed at this area. Off-Site: - Appearance of what appears to be new materials and equipment at the quarry site. - Additional roads within Avalon Airport were developed as well as new parking areas. - Further land development and construction of commercial buildings north of the Site.	Vicmap through Lotsearch
2014	On-Site: - A new smaller racetrack within the existing larger racetrack was developed at the Geelong Motorsports Complex. A few structures were also added adjacent south of this new racetrack. Off-Site: - New building was constructed at the quarry site. In addition, new materials were noted at this site. - Stockpiled materials at the WOPL remediation site were removed.	Vicmap through Lotsearch
2019	On-Site: - The structures noted adjacent south of the new racetrack were removed. - Two above-ground cylindrical tanks containing fire water were installed at the BP Service Station. Off-Site: - The Avalon Parcel Facility was constructed ~1.2 km north-east of the runway. - Additional parking areas were constructed at Avalon Airport. - Construction of addition commercial buildings north of the Site.	Vicmap through Lotsearch
2021/2022	On-Site: No notable changes were observed since 2019 Off-Site:	Vicmap through Lotsearch

Year	Description	Source
	The quarry site had additional structures but some of their smaller structures that existed way back 2019 were removed.	

Table 6-2. Summary of Review of Historical Aerial Imagery (South-western GAEP)

Table presenting a summary of observations based on the review of available current and historical aerial imagery across the South-western GAEP area.

Year	Description	Source
1947	On Site: - Most of the area within the south-western GAEP area are open spaces / agricultural lands. Only one residential house was noted with no commercial or industrial areas observed. - The road that borders the south-western GAEP area to the north was Princes Highway. Off-Site: - The majority of the immediate surrounding areas is open space/agricultural land. - A few structures were noted along Old Melbourne Road and one located near the northern tip adjacent Princes Highway Note: Aerial imagery was only available for the northern half of the GAEP in 1947. The aerial imagery of the southern half is only available from 1963.	Vicmap through Lotsearch
1963	On Site: - Majority of the land area remained as agricultural land and/or opened spaces. - The salt evaporation ponds are evident. - Additional residential/farm structures were noted at the southern part of the site. Off Site: - No notable changes are evident since 1947 except for a few new structures along Old Melbourne Road. Associated buildings of the former Cheetham Saltworks Ltd are located south of the site and first appeared in this 1963 aerial imagery. There are no earlier aerial images for this portion of the site. Cheetham Saltworks Ltd was established in Avalon in 1951 (http://www.victorianplaces.com.au/avalon).	Vicmap through Lotsearch
1970	On Site: - Salt evaporation ponds expanded northwards occupying the southern half of this portion of the Site. - Dandos Road was constructed, bisecting the site from west to east. - A few new farm / residential structures were observed. Off Site: - No notable changes are evident since 1963 except for the new building that was constructed at the former Cheetham Salt Ltd operations area south of the site. Note: The 1970 aerial imagery only contains the central portion and the southern portion of the Site.	Vicmap through Lotsearch
1973	On Site: - No notable changes are evident since 1970. Off Site: - No notable changes are evident since 1970.	Vicmap through Lotsearch
1978	On Site: - No notable changes are evident since 1973. Off Site: - Land development and additional commercial and residential structures appeared north and west of the Site.	Vicmap through Lotsearch
1984	On Site: - No notable changes since 1978. Off Site: - Land development and additional commercial and residential structures appeared west of the Site.	Vicmap through Lotsearch & Google Earth Pro

Land Capability Assessment

Year	Description	Source
1990 / 1992	On Site: - Additional farm / residential structure at the northern portion of the site was observed. Off Site: - Land development observed north and west of the site. Additional residential and commercial structures were noted at these areas.	Vicmap through Lotsearch & Google Earth Pro
2003	On Site: - Additional farm / residential structure at the northern portion of the site was observed. Off Site: - Continuous land development north of the site as new commercial and residential areas were constructed. - Additional structures were noted at the former Cheetham Saltworks Ltd areas	Vicmap through Lotsearch & Google Earth Pro
2009	On Site: - Appearance of a roundabout at the intersection of Avalon Road and Princes Highway. Off Site: - Continuous land development north and west portions of the site as new commercial and residential areas were constructed. - A patch of vegetative cover appears east of the site (Avalon Airport grounds).	Vicmap through Lotsearch & Google Earth Pro
2014	On Site: - No notable changes are evident since 2009. Off Site: - No notable changes are evident since 2009. Extended patch of vegetative cover appears east of the site (Avalon Airport grounds).	Vicmap through Lotsearch & Google Earth Pro
2017	On Site: - No notable changes are evident since 2014. Off Site: - Additional buildings were constructed at the former Cheetham Saltworks Ltd. South of the site.	Vicmap through Lotsearch & Google Earth Pro
2019	On Site: - No notable changes are evident since 2017. Off Site: - No notable changes are evident since 2017.	Vicmap through Lotsearch & Google Earth Pro
2022	On Site: - No notable changes are evident since 2019. Off Site: - No notable changes are evident since 2019.	Vicmap through Lotsearch & Google Earth Pro

In summary, the review of the historical aerial imagery from 1947 to 2022 indicated that majority of the land that comprised the Northern GAEP area are agricultural/farmland with a very small number of rural residential / farm properties and a few commercial areas (such as the BP Service Station and the Geelong Motor Sports Complex). On the other hand, the South-western GAEP comprised mostly of historical salt evaporation ponds of the former Cheetham Salt Works which are now dominated by saltmarsh vegetation. The remaining areas – which are the northern and the south-eastern portion were generally agricultural / farmland with a few rural residential / farm properties.

The WOPL leak of 2004 represents a significant event from a potential contamination perspective. It was reported that a defect in the pipeline measuring 1mm wide and 80 mm long was identified in one of the sections of the 8-inch, high-pressure pipeline situated within the lot parcel number 1\PS427409 (a parcel of land within the Northern GAEP – identified as map ID #5 on **Figure 3**). Early investigations conducted soon after the defect was identified reported the presence of light non-aqueous phase liquid (LNAPL) in groundwater monitoring wells. The contaminants of potential concern (COPC) included benzene, toluene, ethylbenzene, total xylenes, methyl tert-butyl ether (MTBE), total petroleum hydrocarbons, naphthalene, phenanthrene, phenol, and lead.

Based on the WOPL Environmental Audit Report (GHD, 2021), the auditor was of the opinion that LNAPL, associated dissolved phase hydrocarbons, and MTBE have been cleaned up to the extent practicable by active remedial methods. The audit report also stated that some relevant beneficial uses of the site (i.e., land parcel number 1\PS427409) were precluded by the presence of residual LNAPL, benzene and MTBE. These beneficial uses that are precluded include stock watering, primary contact recreation, and slab on grade construction due to low-risk vapor intrusion. In addition, the continuing risks for offsite areas include groundwater aesthetic impact (odour and taste) from MTBE and low-risk vapor intrusion to buildings especially those that features basement floors. Additional investigation reports (more recent than the above 2021 audit report) may have been completed, but Jacobs has not been able to obtain a copy of such reports.

Beyond the boundary of the Northern GAEP area, a review of current and historic land uses identified commercial and industrial land uses that have the potential to and/or have resulted in contamination. These land uses include:

- Treatment ponds of the Melbourne Water Corporation's Western Treatment Plant (WTP) located immediately adjacent to the east of Northern GAEP where sewage treatment activities were currently licenced by EPA Victoria.
- Avalon Airport located immediately adjacent to the southern boundary of Northern GAEP, where presence of PFAS has been confirmed and included in Victoria EPA's Works Approval list for its sewage treatment activities.
- For South-western GAEP area, a review of current and historic land uses identified commercial and industrial land uses that have the potential to and/or have resulted in contamination. These land uses include:
 - Ridley Corporation's Lara Feed Mill (animal feeds milling facility) located 87 m north of South-western GAEP near the intersection of Avalon Road and Princes Highway. This property has received multiple pollution abatement notices from EPA between 2017 and 2018.
 - Corio Park's Avalon Raceway (off-road racetrack) located 637 m north of South-western GAEP has contaminated soil retained and managed on their premises and per EPAV requires assessment and/or clean-up.
 - Avalon Airport located immediately adjacent to the eastern boundary of South-western GAEP, had confirmed presence of PFAS within its premises.

In the next section, the onsite and offsite pollution records of both Northern and South-western GAEP will be discussed based on the EPA Victoria's database.

6.3 EPA Victoria Records

6.3.1 Priority Sites Register

Based on EPA Victoria Register of Environmental Audits and Victoria Unearthed, a citation related to the White Oil Pipeline (WOPL) leak of 2004 was noted. A summary is provided in **Table 6-2** below.

Table 6-3. Summary of EPA Victoria Priority Sites

Summary Table of EPA Victoria Priority Site located within the Northern GAEP and South-western boundary.

Notice Number/Trans. No. / Audit ID	Address	Suburb / Municipality	Issue	Distance
0008001949	80 Pousties Road, Avalon, 3212	Avalon & Lara	White Oil Pipeline Leak 2005 – Accidental spill/leak (non- industrial site)	Within GAEP (Middle and Southern Paddocks) and 70 m north of Princes Highway (Northern Paddock)

*Ref: Register of environmental audits. <https://www.epa.vic.gov.au/about-epa/public-registers/environmental-audits?location=Avalon>

Although it was reported in WOPL Audit Report (GHD 2021) that remediation / clean-up activities were completed on 23 December 2021, residual hydrocarbons including MTBE still exist in the soil and groundwater at the site. The above-mentioned audit report recommended that EPA Victoria consider the

declaration of GQRUZ or other restriction on the use of groundwater in the affected area. The audit report also recommended the continuation of groundwater monitoring and management of the WOPL Site (map ID #5 on **Figure 3**) and the adjacent southern properties (map IS numbers 1\LP213752 and 2\LP213752) in accordance with the previous Groundwater Quality Monitoring Plan (GQMP) until a Groundwater Monitoring Cessation Report has been issued and EPA Victoria agrees that monitoring can cease. At this stage, Jacobs has not information to suggest cessation has been agreed by EPA Victoria.

A list of former EPA priority sites and other pollution notices within the GAEP area is also included in this report and is listed in **Table 6-3** and **Table 6-4**. These lists are not expected to be exhaustive since notices are being revoked and removed from published lists. The EPA Victoria database results are provided in **Appendix B**.

These notices have been considered as part of the site-specific contamination potential evaluation that is presented in **Section 7.1**.

Table 6-4. Former EPA Victoria Priority Sites and Other Pollution Notices

Summary table of previous EPA Victoria Priority Sites and other Pollution Notices located within the GAEP boundary and within the 1 km buffer zone.

Notice Number	Notice Type	Company	Address	Suburb	Status	Issue	Date Issued	Distance & Direction
90008963	Previous Priority Notice		New Farm RD	WERRIBEE	Current Pollution Notice	Current waste water treatment plant. Requires assessment and/or clean up.		On-site
90008964	Previous Priority Notice		New Farm RD	WERRIBEE	Previous Priority Notice	Current waste water treatment plant. Requires assessment and/or clean up.		On-site
90009526	Minor Works PAN	FAWKNER PROPERTY GROUP [AVALON]	20 POUSTIES ROAD / AVALON VIC 3212	AVALON	Previous Pollution Notice	BP Gas Station (westbound)	17/12/2018	On-site
90001012	Previous Priority Notice		Princes HWY	LARA	Previous Priority Notice	Accidental spill/leak (non-industrial site). Requires assessment and/or clean up.	11/08/2005	38 m West
NO4554	62A(1)	THE SHELL CO OF AUST LTD	PRINCES HWY (12 KILOMETRE & 15 KILOMETRE MARK)	LARA	Legacy EPA Database Pollution Notice		13/05/2004	38 m West
NO4902	62A(1)	THE SHELL CO OF AUST LTD	PRINCES HWY (12 KILOMETRE & 15 KILOMETRE MARK)	LARA	Legacy EPA Database Pollution Notice	Accidental Spill/Leak (non-industrial site), Requires assessment and/or clean up.	11/08/2005	38 m West
NO10540	62A(1)	CORIO PARK P/L	210 OLD MELBOURNE RD	LARA	Legacy EPA Database Pollution Notice	Contaminated soil is retained and managed on-site, Requires assessment and/or clean up.	26/04/2012	451 West
NO10541	62A(1)	CORIO PARK P/L	210 OLD MELBOURNE RD	LARA	Legacy EPA Database Pollution Notice	Contaminated soil is retained and managed on-site, Requires ongoing management.	26/04/2012	451 West

Table 6-5. Former EPA Victoria Priority Sites and Other Pollution Notices for South-western GAEP

Summary table of previous EPAV Priority Sites and other Pollution Notices located within the South-western GAEP boundary and within the 1 km buffer zone.

Notice Number	Notice Type	Company	Address	Suburb	Status	Issue	Date Issued	Distance & Direction
90001012	Previous Priority Notice		Princes HWY	LARA	Previous Priority Notice	Accidental spill/leak (non-industrial site). Requires assessment and/or clean up.	11/08/2005	38 m North
NO4554	62A(1)	THE SHELL CO OF AUST LTD	PRINCES HWY (12 KILOMETRE & 15 KILOMETRE MARK)	LARA	Legacy EPA Database Pollution Notice		13/05/2004	38 m North
NO4902	62A(1)	THE SHELL CO OF AUST LTD	PRINCES HWY (12 KILOMETRE & 15 KILOMETRE MARK)	LARA	Legacy EPA Database Pollution Notice	Accidental Spill/Leak (non-industrial site), Requires assessment and/or clean up.	11/08/2005	38 m North
90007564	Pollution Abatement Notice	RIDLEY CORPORATION LIMITED [LARA]	30 OLD MELBOURNE RD LARA VIC 3212	LARA	Previous Pollution Notice		23/03/2017	87 m North
90008331	Pollution Abatement Notice	RIDLEY CORPORATION LIMITED [LARA]	30 OLD MELBOURNE RD LARA VIC 3212	LARA	Previous Pollution Notice		11/12/2017	87 m North
90009234	Pollution Abatement Notice	RIDLEY CORPORATION LIMITED [LARA]	30 OLD MELBOURNE RD	LARA	Previous Pollution Notice		19/11/2018	87 m North
NO10541	62A(1)	CORIO PARK P/L	210 OLD MELBOURNE RD	LARA	Legacy EPA Database Pollution Notice	Contaminated soil is retained and managed on-site, Requires ongoing management.	26/04/2012	637 m North
NO10540	62A(1)	CORIO PARK P/L	210 OLD MELBOURNE RD	LARA	Legacy EPA Database Pollution Notice	Contaminated soil is retained and managed on-site, Requires assessment and/or clean up.	26/04/2012	637 m North

6.3.2 Licenced activities and works approvals

There are no records of any EPA-licensed activities within the Northern and South-western GAEP area. However, beyond the GAEP boundary, current and former licensed sites were recorded. The details are summarised in **Table 6-6**.

Table 6-6. Summary of Current and Former EPA Licences Activities (Beyond the GAEP Boundary)

Transaction No. / Type	Licence no.	Licence Type	Organization	Address	Activities	Distance and Direction
3037656 / Current	74284	Amalgamated	Melbourne Water Corporation	New Farm Rd	A01 Prescribed Industrial Waste Management; A03 Sewage Treatment	0 m East of Northern GAEP
Former	EW725#6	-	AAA AUSTRALIA PTY LTD	1/250 BEACH RD	A03 Sewage Treatment	0 m South-west of Northern GAEP
3035261 / Current	3325	-	JADE TIGER ABALONE PTY LTD	295 Dandos Rd	B03 Fish Farm	284 m South of South-western GAEP
Former	EW40295#3	-	OCEAN WAVE SEAFOODS PTY LTD	295 Dandos Rd	B03 Fish Farm	284 m South of South-western GAEP

In relation to EPA Approval Works, there are currently three entities (Melbourne Water, Avalon Airport, and Downer EDI Works) approved for their respective activities. The details are summarised in **Table 6-7**.

Table 6-7. Summary of EPA Approval Works

Transaction No	Status	Organisation	Premise Address	Scheduled Categories	Suburb	Distance (m)
1003738	Approved/Issued	Melbourne Water Corporation	New Farm RD WERRIBEE VIC 3030	A03 - Sewage Treatment, A01 Prescribed Industrial Waste Management	Werribee	0 m onsite
1002173	Approved/Issued	Downer EDI Works	80 Beach Road Lara Victoria 3212	Exempt Under Section 19A(4) of the EP Act; Temporarily establish and use a mobile asphalt plant for surface maintenance	Lara	0 m South-west of Northern GAEP
1003162	Approved/Issued	AAA AUST PTY LTD	250 Beach Road, Avalon VIC 3212	Installation of a wastewater treatment plant	Avalon	0 m South of Northern GAEP
1002943	Approved/Issued Approval no: 164270	AAA AUST PTY LTD	250 Beach Road	A03 Sewage Treatment	Avalon	389 m South of Northern GAEP

6.3.3 Environmental audit sites

Based on Lotsearch reports, Victoria Unearthed, and EPA Victoria website, only lot parcel 1\PS427409 (map ID #5 on **Figure 3**) situated within the Northern GAEP has been identified as an environmental audit site within the boundary of the GAEP. This audit site represents the White Oil Pipeline (WOPL) leak of 2004. Historically the contamination plume extended north beyond Princes Highway. Approximately 200 monitoring wells were installed to monitor and (to the extent practicable) remove LNAPL and associated hydrocarbons from soil and groundwater. This site is discussed in **Section 6.3.1**, noting that this site is also identified by EPA Victoria as a Priority Site.

Table 6-8. Summary of EPA Environmental Audit Sites

CARMS No	Transaction No	Site Address	Suburb	Date Complete	Audit Category	Distance (m) and direction
56778-6	8001949	80 POUSTIES RD AVALON	AVALON	23/12/2021	EPA Processing	0 m Onsite

6.3.4 Groundwater quality restricted use zones

No Groundwater quality restricted use zones (GQRUZ) sites exist either within the boundary of the GAEP area based on Victoria Unearthed. However, it is noted that the audit report relating to the WOPL leak (and subsequent remediation) recommended the application of a GQRUZ owing to the presence of residual contamination in soil and groundwater. At the time of writing, the final extent of the GQRUZ (demarcating the extent of residual contamination) had not been confirmed, but the proposed extent included the following land parcels:

- 1\PS427409
- 1\LP213752
- 2\LP213752

6.4 Surface water information

The information used to assess the regional hydrology of the GAEP area was retrieved from a combination of publicly available information, and information provided by the client. **Table 6-9** summarises the information reviewed during the regional hydrology assessment.

Table 6-9. Summary of information reviewed in hydrology desktop due diligence assessment

Item	Data Type	Source
Sanversa Pty Ltd (2022). Environmental Site Assessment, 225-275 Avalon Road and 160-240 Dandos Road, Avalon. MAB Corporation.	Environmental Site Assessment Report	Provided by the client.
Ecosure Pty Ltd (2014). Avalon Airport Australia Environmental Strategy for 2014 to 2019. Avalon Airport Australia Pty Ltd.	Environmental Strategy Report	Provided by the client.
Inundation Report Bellarine Peninsula to Corio Bay Local Coastal Hazard Assessment (Cardno, 2015)	Surface Water Report; spatial data: flood extent for 1% AEP with Sea Level Rise event.	Provided by the client.
Western Treatment Plant Waterway Mapping (BMT WBM, 2017)	Surface Water Report.	Provided by the client.
Lara Flood Study (Water Technology, 2020)	Surface Water Report; spatial data: flood extent for 1% AEP clipped to GAEP area.	Spatial data clipped to GAEP area provided by the client. Surface water report retrieved online from City of Greater Geelong website.

Item	Data Type	Source
Land Subject to Inundation Overlay (LSIO)	Planning Overlay.	Retrieved online from VicPlan website.
City of Greater Geelong Catchments	Spatial data: Catchment boundaries.	Retrieved online from National Map website. Author and dataset custodian: City of Greater Geelong.
City of Greater Geelong Drainage Pipes	Spatial data: Drainage asset locations.	Retrieved online from National Map website. Author and dataset custodian: City of Greater Geelong.
City of Greater Geelong Drainage Pits	Spatial data: Drainage asset locations.	Retrieved online from National Map website. Author and dataset custodian: City of Greater Geelong.
Lotsearch Easements	Spatial data: Easement locations	Retrieved from the data provided in the lotsearch results.
Vicmap Hydro Watercourse Lines	Spatial data: Streamlines for rivers, small streams, channels, and open drains.	Retrieved online from National Map website. Author and dataset custodian: Victorian State Government.
Waterways Centreline	Spatial data: Streamlines identified in Melbourne Water's waterways layer.	Retrieved online from National Map website. Author and dataset custodian: Melbourne Water.
Digital Elevation Model with 5m Resolution (Geoscience Australia)	Digital Elevation Model: Topography derived from individual LiDAR surveys between 2001 and 2015.	Retrieved online from ELVIS (Elevation Information System) website. Author and dataset custodian: Geoscience Australia.
Historical Aerial Imagery	Aerial imagery: Used as a sense check of public imagery such as Bing Satellite imagery to current site conditions	Provided by the client.
Metromap Capital Cities Latest Aerial Imagery	Aerial imagery: Used as a sense check of public imagery such as Bing Satellite imagery to current site conditions	Internal resource available for Jacobs to consult through a corporate license.
Bing Satellite Imagery	Aerial imagery: Publicly available dataset. Date last updated in the GAEP area is unknown, however imagery shows the site conditions to be comparable with what is shown in the project aerial imagery. This dataset was considered acceptable for use in mapping to contextualise other spatial data.	Publicly available. Author and dataset custodian: Microsoft.

6.5 Waste management facilities and landfills

There are no records of any waste management facilities and landfills within the GAEP area.

However, there is one waste management facility in close proximity to the northern portion of GAEP. Sytle – located north of Princes Highway near the intersection of Beach Road and Princes Highway, with address at 45 Beach Road, Avalon, Victoria. According to their website, sytle.com.au, the Avalon facility accepts numerous waste streams including concrete, asphalt, brick, rock, plasterboard, tyres, timbers, plastic drainpipes, concrete pipes, topsoil and others. Sytle repurpose these materials. Materials include crushed rock and concrete, mulch, recycled plastic, gypsum, shredded tyres, topsoil, soil conditioner and chipped timber.

6.6 Other reviewed reports

In addition to information obtained from publicly available sources, the following environment reports related to GAEP were also provided to Jacobs by VPA and reviewed in relation to land contamination potential.

1. Sanversa Pty Ltd (2022). Environmental Site Assessment, 225-275 Avalon Road and 160-240 Dandos Road, Avalon. MAB Corporation. – This report is a culmination of two environmental site assessments conducted in 2018 and 2021 respectively by Senversa covering portions of 225 – 275 Avalon Road, Avalon and 160 – 240 Dandos Road, Avalon. The scope of the two prior ESAs consisted of background information review, soil sampling and analysis from 17 grid-based locations and groundwater analysis from 5 locations. Salient shallow soil findings mentioned that contaminant concentrations in shallow soils were below all adopted criteria protective of human health in a future commercial / industrial land use scenario. For the adopted ecological criteria, only zinc and PFOS concentration in one location each exceeded the adopted levels. There is potential for naturally occurring acid sulfate soils to be present, however previous investigation in 2010 found the soils to be generally neutral to slightly alkaline with all sample results below the acid sulfate soil criteria. Soil sodicity was found to pose a potential soil corrosion geotechnical risk to future buildings and structures and may require management. Salient groundwater findings mentioned that the groundwater was highly saline and the concentrations of all other analytes in groundwater were found to be below adopted screening criteria for protective human health. It is noted that no surface water sampling was performed as part of this assessment. Based on these findings, the risk contamination may pose to human health or ecological receptors in a future commercial / industrial development is considered to be low and is likely to be able to be effectively managed during the design and development process. Results of this study were considered in the framing of the overall assessment of GAEP.
1. Ecosure Pty Ltd (2014). Avalon Airport Australia Environmental Strategy for 2014 to 2019. Avalon Airport Australia Pty Ltd. – This report provides basic environmental information about the Avalon Airport – a 1,753 ha of land sandwiched between Northern and South-western GAEP. The historical data from this report as well as the infrastructure information were noted and these formed part in the discussion of surrounding land uses / potential off-site sources data in this report.

7. Site characterisation

7.1 Site contamination assessment

Each parcel of land within the boundary of the GAEP area was evaluated as part of the desktop study (Stage 1 assessment). The purpose of this evaluation was to establish current and historical land uses, and then decide on the potential for those activities to contaminate the land. This evaluation was guided by comparing the current and/or historical land uses with those presented in Table 2 of Planning Practice Note 30 (PPN30) (DELWLP, 2021). Table 2 of PPN30 defines the potential for different land uses to contaminate land as either "high" or "medium". Jacobs has applied professional judgement when evaluating land uses and the resultant contamination potential. For this assessment, Jacobs has determined that any land uses that are not clearly defined as either a "high" or "medium" potential for contamination in PPN30 are considered to present "no potential for contamination" (unless determined otherwise based on professional judgement). This would apply to properties where highly localized areas of interest are identified (i.e. septic tanks, or farm buildings with only minor to small volume chemical storage) or those properties where no evidence of potentially contaminative activities has been identified (i.e. open paddocks with no history of intensive agriculture, buildings, or structures present).

On 30 May 2023, a site reconnaissance (Stage 2 assessment) was conducted at fifteen selected properties to validate the assigned potential for land contamination that was determined as part of the Stage 1 (desktop) assessment. While the site reconnaissance focused more on specific areas of interest, Jacobs also assessed the wider site extent to confirm land uses, where practicable. At each of the fifteen locations, Jacobs field personnel noted the observations and photo-documented the site. These observations were made from publicly accessible areas.

For one location (property 1\PS427409, map number 5 on **Figure 3**), Jacobs was not able to access the central area of the site (where remediation-related infrastructure was observed on aerial imagery). However, information for this property was able to be provided through a phone conversation with the property owner. It was confirmed that remediation activities at the property (relating to the WOPL leak) had recently been completed, and that related equipment had been largely removed. Some equipment remained on site, but that would be removed once ground conditions were more favourable (drier) to allow trucks to safely access the area.

The outcomes of the Stage 1 and Stage 2 assessment are presented in:

- **Table 7-1**, which presents a summary of the overall number of parcels within the GAEP Area that were characterised as either presenting "high", "medium" or "no" potential to contaminate land.
- In addition, **Appendix D** presents the evaluation outcome for each of the 22 parcels of land within the GAEP area and **Figure 3** in **Appendix A**, spatially represents the same evaluation.
- Off-site potential sources of contamination were also noted during the Stage 1 and Stage 2 assessment (where possible). These too were assigned a qualitative contamination potential rating based on the likelihood of the contamination representing a potential constraint to future development of the GAEP.

The primary potential sources of land contamination observed within the GAEP area were related to the historical WOPL leak that occurred in 2004 as well as the presence of a BP service station. Sites that were assessed to represent a lesser potential for contamination included the former Cheetham Salt Works (a conclusion supported by previous investigations performed by Senversa who assessed the site in 2022), general agricultural land use (cropping and livestock farming of sheep and cattle), and activities associated with the Geelong Motor Sport Complex.

Other relevant observations noted were presence of heavy construction equipment (on-going land development) including farm machinery and associated maintenance, aboveground fuel tanks, stockpiles (soil and construction debris), intermediate bulk containers (IBCs) and similar containers mostly without labels, abandoned vehicles; presence of stock dips from farm residences and associated buildings and infrastructures such as farm sheds and stock handling or spraying areas. All these were considered in the assignment of potential land contamination. While the evaluation was completed with the aim of identifying potential contaminants of concern relevant to each parcel assessed, the presence of other contaminants of concern cannot be ruled out at this stage owing to the limited assessment of each individual property (i.e. generally targeted observations, with no intrusive sampling conducted, and presence of thick vegetation in many areas that concealed the ground surface).

Common land uses are discussed below as well as general comments relating to the GAEP area and surrounding land use.

7.1.1 General precinct-wide observations

7.1.1.1 Agricultural land use

Based on publicly available data, Lotsearch reports and aerial imagery (1947 to 2022), most of the land parcels forming the Northern GAEP area have been used for agricultural-related purposes for an extended period of time. In essence, there is a high probability that the area has a long history of general agricultural activities within the Northern GAEP area. The most notable activities observed include system of cropping, livestock grazing (cattle and sheep), and horse rearing operations. Contaminants of potential concern associated with this process typically include heavy metals (from stock dipping), pesticides, herbicides, and fungicides as well as potential nutrients (from manure, slurry application, and other fertilizers) and biological contaminants (from animal burial). A small number of rural residential land uses can also be found within the Northern GAEP area which indicates the potential presence of septic tank systems for on-property sewerage treatment (in the absence of a reticulated sewerage system across the Northern GAEP). Since these septic systems are located underground, these can be difficult to identify during the site reconnaissance. In this instance, the contaminants of potential concern can include biological contaminants (i.e., bacteria and viruses) and nutrients (elevated nitrogen and phosphorus) associated with leakages from septic tank systems.

Jacobs found similar observations at the South-western GAEP. However, only half of its total area can be considered agricultural land since the other half was historically used as salt-evaporation ponds by the former Cheetham Salt Works. There were also a few residential areas scattered within the South-western GAEP.

General agricultural land use and rural septic tank systems especially in sparsely distributed residential areas are generally considered to present no potential to contaminate the land. **Appendix D** presents the summary of potential for contamination for each parcel within GAEP.

7.1.1.2 Farm residences and associated buildings

The Northern and South-western GAEP both features a small number of farm residences and associated buildings such as sheds that are considered the most common potential source of contamination across the GAEP. These farm residences and associated buildings are typically utilised for storage of farm machinery (both operational and non-operational), farm materials, vehicles, and many other miscellaneous items. Buildings and structures may also include fuel storage areas for refuelling farm machinery (commonly in the form of above-ground storage tanks or ASTs) as well as storage areas for items such as agricultural chemicals (pesticides, herbicides, fungicides, etc.), hydraulic oils, lubricants, solvents, and brake fluids for machinery upkeep.

In consideration of the above, the contamination scenario most likely to occur include potential spill-to-ground or spillages of petroleum hydrocarbons (fuels and lubricants) and other chemicals from routine refuelling of farm machinery / equipment and general maintenance activities. However, the scenario of loss of primary containment (LOPC) of stock agricultural chemicals and hydrocarbons may also impact upon soils. Given that such chemicals are typically stored in small volumes, the extent of impact is likely to be highly localised.

Based on the site reconnaissance, there were a small number of old residential buildings that were observed within the Northern and South-western GAEP which could represent buildings / structures where asbestos could have been used as a construction material. Asbestos was commonly used as a building material with several applications in Australia as early as the 1880s (although more frequently in the mid to late 1900s). While asbestos presents a limited risk while it remains in the bonded matrix (i.e. as bonded asbestos cement sheeting in roofing, pipe lagging, insulation, and tile adhesives), free fibres can present a higher potential risk through inhalation. Mobilisation of asbestos fibres can occur through several processes including (but not limited to) abrasion, breaking, sanding and cutting of asbestos-containing materials. Asbestos is also likely to be encountered in building materials during demolition of old buildings and sites were buried or imported waste has been reported. At least one residential house was found in a highly dilapidated condition along Pousties Road.

7.1.1.3 Imported fill, fly tipped waste and stockpiled material

The existence of imported fill in an area can be challenging to identify without undertaking intrusive investigations, particularly in areas that are heavily vegetated. Fill materials are most likely to be found in locations where previous or on-going construction/development works are being undertaken. During the site reconnaissance, stockpiles of soil and gravelly materials were observed in at least six locations within Northern and South-western GAEP.

Various kinds of wastes can also be generated and deposited on-site - the type and volume of wastes depends on the activities and processes being performed in the area. In addition, illegal dumping of wastes and importation of wastes (albeit the latter is less common as it typically requires EPA approval) may also occur. During the site reconnaissance, stockpiles of miscellaneous materials were photo-documented on at least five properties.

Contaminants of potential concern associated with fill material, fly-tipped waste and stockpiled materials can vary significantly depending on their source and the time at which they were deposited. Since such information is rarely available, specific contaminants of potential concern often cannot be adequately identified without laboratory analysis (although visual and olfactory observations can provide limited information). However, the most encountered contaminant groups include total petroleum hydrocarbons (TPH), polycyclic aromatic hydrocarbons (PAHs), heavy metals and asbestos containing materials.

7.1.1.4 Surrounding land uses

Off-site locations immediately outside of the Northern and South-western GAEP boundary were also considered during the Stage 1 assessment to identify any potentially contaminating land uses that may impact the future uses of land within the GAEP area. Off-site sources identified in the vicinity of the GAEP areas are summarised in **Table 7-2**.

The sites located outside of the GAEP areas that present the highest potential for contamination that could impact upon the study area include:

- The operational BP petrol station just north the Princes Highway (this is separate to the BP service station within the boundary of the Northern GAEP servicing the westbound carriageway). PPN30 identifies service stations as a land use that represents a high potential for contamination. Previous studies (URS, 2005) indicate the regional groundwater flow direction is likely towards the south (i.e. towards GAEP).
- Avalon Airport, located centrally within GAEP. PPN30 identifies airports as a land use that represents a high potential for contamination. The airport abuts the southern boundary of the Northern GAEP and eastern boundary of the South-western GAEP. While groundwater is likely to be tending south (therefore reducing potential for impact upon the western and northern extents of the South-western and Northern GAEP from groundwater contamination emanating from the airport), several small water courses appear to leave the airport and enter the adjacent South-western GAEP properties associated with the former Cheetham Salt Works in particular. This provides a pathway by which potential contaminants from the airport (such as PFAS) may impact upon land and water quality within GAEP. It is however noted that Senversa performed environmental sampling across the area of the former Cheetham Salt Works in 2022, including testing for PFAS in soil and groundwater and concentrations were generally low. No testing of surface water was performed.
- Melbourne Water's Western Treatment Plant located to the immediate east of the Northern GAEP. PPN30 identifies treatment plants as a land use that represents a high potential for contamination.

The remaining off-site properties comprised of agricultural areas, low-density rural residences, small to medium scale commercial entities.

7.1.2 Site characterisation

During the Site reconnaissance on May 31, 2023, selected locations were visited and photo documented. Jacobs was able to complete the inspections from the closest publicly accessible areas. For parcel 1\PS427409 (former WOPL leak site, property number 5 on **Figure 3**), Jacobs was able to discuss relevant onsite activities with the landowner via telephone (as an alternative to accessing the site – access could not be granted at the time of the proposed site inspections). The WOPL leak of 2004 remained an important consideration in terms of contamination since residual hydrocarbons and MTBE are still present in soil and groundwater based on information presented in the WOPL Audit Report (GHD, 2021).

As described previously, presence of IBCs and other unlabelled containers, septic tanks, stockpiled materials and wastes are the other potential on-site sources of contamination. Such impacts from these sources are likely to be localized. On this basis, these properties were generally allocated no potential for contamination, unless otherwise noted in **Appendix D**.

The potential sources of on-site contamination identified during the Stage 1 and 2 assessments are presented in **Appendix D** and depicted in **Figure 3** in **Appendix A**. The overall summary of numbers of "no potential for contamination" "medium" and "high" ranked sites are also presented in **Appendix D**.

Examples of observed surface waste material and other features/observations of interest are presented in **Picture 7-1** and **Picture 7-2** below.

Table 7-1. Summary of On-Site Characterisation – Potential for Contamination

Table summarising the contamination potential for sites within the GAEP area, based on the land uses with the potential to contaminate land presented in Table 2 of Planning Practice Note 30 (DELWP, 2021). The proposed further assessment is based on the approach presented in Table 3 of PPN30, assuming other (non-sensitive) future land use.

No Sites	Contamination Potential	Recommended Further Action
4	High potential for contamination	PSI to inform need for audit is recommended. <i>If sensitive land uses are proposed within these land parcels, it is recommended that an environmental audit is completed.</i>
6	Medium potential for contamination	Planning authority to document consideration of potential for contamination to impact proposal. <i>If sensitive land uses are proposed within these land parcels, it is recommended that a preliminary risk screening assessment is completed in order to determine the need for an environmental audit. .</i>
12	No potential for contamination	No further action required – General Environmental Duty applies

Table 7-2. Summary of Off-Site Characterisation – Potential for Contamination

Table summarising the contamination potential for sites within the vicinity of the GAEP, based on the land uses with the potential to contaminate land presented in Table 2 of Planning Practice Note 30 (DELWP, 2021). This includes a qualitative evaluation of the potential impact on sites within the GAEP area.

Address	Land Use	Contamination Potential	Potential Impact on Properties within GAEP
Hughes Road, Little River, Victoria 3211	BP Truckstop Service Station	High	Located 70 m to the immediate north-west of the Northern GAEP area and adjacent north-west of Princes Highway. Currently, the parcel represents a service station and an EPA Priority Site (Audit Site) associated with the 2005 WOPL leak incident. According to the 53 V Audit Report (Dec. 2021), the general area where the service station is located is referred to as the Northern Paddock. The likelihood of a leak occurring that is not detected that then impacts upon the Northern GAEP is relatively low, given the monitoring requirements and other leak detection systems that are in place at modern service stations (noting this is a relatively modern service station).
45 Beach Road, Avalon Victoria 3212	Sycle Waste Management Service	High	Located 70 m north of Geelong Motor Sports Complex and adjacent north of Princes Highway. The facility processes numerous waste streams including concrete, asphalt, brick, rock, plasterboard, tyres, timbers, plastic drainpipes, concrete pipes, topsoil and other materials. Sycle repurpose these materials and send these materials back out to market as products such as crushed rock and concrete, mulch, recycled plastic, gypsum, shredded tyres, topsoil, soil conditioner, and chipped timber. Based on Lotsearch Reports and other publicly available database, this site is currently not included in any EPA Priority Sites List. This site presents a low contamination risk to the GAEP.

Land Capability Assessment

Address	Land Use	Contamination Potential	Potential Impact on Properties within GAEP
Airport Drive, Avalon, Victoria 3212	Avalon Airport	High	Avalon Airport is located centrally within the GAEP, with a number of potentially contaminative on-airport activities (both current and former) with the potential to impact upon the GAEP study area. These activities include bulk fuel storage and use and activities associated with the storage and use of aqueous film forming foams (AFFF) containing PFAS. Contaminants may be present in surface water and / or groundwater that may migrate beyond the airport boundary, particularly towards South-western GAEP due to the hydraulic gradient (groundwater) that exists and the presence of surface water features that appear to originate within the central area of the airport, but flow across the site boundary towards the location of the former salt works. The potential for contamination originating at the airport to impact upon land parcels (particularly those to the immediate west of the airport) is considered to be moderate.
Point Wilson Road, Victoria 3212	Wastewater Treatment	High	Located adjacent east of Northern GAEP, the sewage treatment ponds of Melbourne Water Corporation's Western Treatment Plant (WTP) previously received priority notice from EPA Victoria that required assessment and/or clean-up. Currently, these sewage treatment ponds are EPA Licenced for activities described as sewage treatment / prescribed industrial waste management. It is unlikely that contamination relating to WTP operations will materially impact upon the GAEP (from a contamination perspective) noting WTP is broadly located cross/down hydraulic gradient, and surface water features generally flow away from GAEP (rather than on to GAEP from WTP).

Picture 7-1. Site Inspection – Selective Photographs

Selected photographs that illustrate common observations relating to land use across the Northern GAEP area. **Top left:** Residential property with stockpiles of likely construction debris and presence of above-ground fuel tanks and IBC with unknown contents, and farm equipment. Also present are dilapidated sheds and signages along Pousties Road with danger warning of a “high pressure oil pipeline”. **Top Right:** Ruins of an old residential brick house with chimneys. A shed stands adjacent to the ruins. The property is used for cropping as crop stubble remains on the ground. **Bottom left:** Entrance to the WOPL remediation site. Small stockpiles of soil and rock boulders scattered onsite. A 30 m by 10 m shed and an ablutions building were observed from a distance. **Bottom right:** Land development and site preparation was underway as heavy equipment, temporary facilities and soil stockpiles were observed along Pousties Road.



Picture 7-2. Site Inspection – Selective Photographs

Selected photographs that illustrate common observations relating to land use across the Northern and South-western GAEP area. **Top left:** A shed measuring 42 m by 22 m is surrounded by various farm machineries as well as some IBCs were onsite. The property has a spray dip for its cattle and a soil stockpile was also observed. **Top Right:** Located at the north-west portion of South-western GAEP, the shed has a 25-m length and a 13 m. Bales of hay were noted north-east of the shed. **Bottom left:** Stockpile of gravelly soil in the facing Princes Highway and some stockpile at the rear of what appears to be miscellaneous wastes covered with grass. **Bottom Right:** Horses in separate paddocks. The property appears to be used for keeping horses with a couple of residential houses and a shed also present.



7.2 Geotechnical assessment

7.2.1 Available geotechnical information

No geotechnical reports were available within the GAEP area; therefore, publicly available database listed below have been referenced to obtain a general understanding of the likely subsurface conditions at the proposed project site.

- Visualising Victoria's Groundwater (VVG) Map Portal (2023). Publicly available groundwater borehole information. Retrieved from https://www.vvg.org.au/vvg_map.php?agreement=Agree+and+Continue#
- GeoVic-Earth Resources Map Portal (2023). Publicly available geology exploration maps, reports and data Retrieved from [GeoVic – Earth Resources](#)

Appendix B present the boreholes located within a relevant distance (less than 1km to the project boundary) to the proposed GAEP site that were used to provide a high-level information on the likely geotechnical conditions that may be encountered.

It should be noted that all available logs are restricted to the area covered by newer volcanics and most of them have been recorded by drillers and do not report material stiffness, strength or weathering (where applicable). Therefore, geotechnical considerations have been based on geology maps, Jacobs own experience of local/regional ground considerations and associated engineering aspects in similar ground conditions within the general adjacent vicinity of GAEP area.

7.2.2 Subsurface condition

Borehole information collected thus far from newer volcanics area surrounding the site indicated that subsurface conditions generally comprise grey and red-brown stiff residual basaltic clay interbedded with very thin layer of yellow-brown clayey sand overlaying finely to coarsely vesicular, grey to black, soft to hard Quaternary aged newer volcanics basalt rock that is underlaid by various materials including clay, sand, gravel, calcareous sandstone, limestone and minor granite floaters (where encountered). The layers underlying Quaternary aged newer volcanics basalt may be of Brighton Group, Newport Formation, Werribee Sand or Granite origin depending on stiffness, colour and features possessing (i.e. iron stained, cemented, calcareous). The thickness of different geological units and their stiffness and/ or strength are poorly understood and may be highly variable across the site, resulting in mixed, variable ground conditions.

Basaltic derived residual soil is expected to contain boulders of relatively unweathered basalt rock and to be sensitive to volume changes associated with seasonal moisture change. Therefore, they are prone to shrink-swell behaviour and may undergo shrinkage cracks or fissuring depending on climate condition and overlaying structures' loading. These soils also possess high potential for dispersion due to likely alkaline and sodic resulted from weathering of the parent basalt rocks.

Quaternary aged newer volcanics basalt is expected to be comprised of residual soil as interflow deposits and multiple flows from multiple eruption events. Therefore, weathered zones appear in the rock profile between flows of high strength slightly weathered and fresh basalt. Cooling of the lava results in sub-horizontal and sub-vertical joints in the basalt. Weathering within the basalt mass typically occurs spheroidally, influenced by the location of joints and passage of water through the joints. The deposition and weathering patterns result in a highly variable rock mass. Abrupt changes in fracturing, weathering, and strength are not uncommon within these volcanic rock masses.

Although no information was acquired within a relevant distance from areas covered by swamp and lake and coastal lagoon deposits; it is quite possible for weak / loose silts, (calcareous) clays and (quartz) sands of varying thickness and composition to be encountered across the site.

7.2.3 Identification of data gaps

With the meaningful geotechnical data being restricted to only drillers field reports of ground profile within the newer volcanics area, there is a gap in the current availability of site-specific geotechnical information to help guide the design and construction of further development. Currently, no site-specific borehole is available to the design team to indicate the soils and rock characteristics or the determine the subsurface conditions at the site.

All subsurface conditions are inferred based on non-site-specific results and prior experience in similar materials. This poses a technical challenge to define the construction and dewatering methodology for future development near the Port Phillip Bay and may lead to risks of project delay and underestimation of construction cost during construction. The only way these cost and schedule risks to be addressed by performing additional geotechnical field and laboratory investigations at future design stages to inform the ground conditions for the project.

7.2.4 Geotechnical risk assessment

A preliminary assessment of the geotechnical risks associated with the land suitability assessment has been undertaken. A risk assessment matrix considering the likelihood and consequence, as shown below has been used to characterize risks. The risk ranking presented in **Table 7-3** below has been undertaken based on the available desktop information to date.

Table 7-3. Design geotechnical risk summary

Risk	Risk description	Potential mitigation measures
Uncertainty of ground conditions	Lack of information leading to incorrect ground models; Unduly conservative design that drastically impact the construction costs; Differential settlement and consequent damage to structures/equipment due to variable foundation materials; and Potential construction delays to revise design.	Carry out site specific ground investigation and laboratory testing.
Excavatability	Variable depth and weathering of bedrock across the site will influence the ease and rate of which the trench can be excavated; and Depending on the rock strength, defect spacing and orientation of defects, excavators may require extra attachments to assist with excavation.	Carry out site specific ground investigation, comprising geotechnical boreholes and test pits, to provide information on rock head depth, excavatability, and rock mass characteristics (defect spacing, weathering, strength).
Instability of excavation within weak/loose soil (particularly regarding swamp, lake and coastal lagoon sediments)	Potential instability of soils; Collapse of excavation; and Excessive inflow of perched water.	Open cut excavations up to 1.5m height shall be battered to a slope no steeper than 1V:2H; and Dewatering to be designed, installed and managed properly.
Sodic soils for earthworks	Significant risks both during construction and the permanent situation exist, including any significant earthworks (cuttings or exposure of natural underlying soils) that are to be undertaken, the installation of utilities (especially fluid carrying services), and drainage channels; and Significant erosion/dispersion could occur if exposure to rainfall and/or overland flow was to occur in these circumstances.	Undertaking an appropriate investigation for sodic soils; Earthworks – staging of works to minimize exposures during construction; and Adequate and appropriate covering of exposed surface during construction to minimize rainfall drop action/overland flow impacts.
Surface movement of lightly loaded structures due to shrinkage and swelling of residual basaltic soils	Excessive surface movement due to shrinkage and swelling of the potential newer volcanics derived residual clays due to natural and/or seasonal soil moisture changes.	Removal of residual clay if deemed unsatisfactory. Replace with crushed rock or non-expansive material; If shallow rock is expected, remove all expansive soil and found the structure on weathered rock; and Consideration of shrink-swell surface movements on structural design.

Risk	Risk description	Potential mitigation measures
Settlement and bearing capacity of shallow foundations (particularly regarding swamp, lake and coastal lagoon sediments)	Bearing capacity failure of shallow foundations, excessive settlement and damage to structures/equipment (particularly regarding swamp, lake and coastal lagoon sediments).	Ensure that weight of structures does not exceed the bearing capacity of the foundation soil layer; If bearing capacity of soil is not adequate, remove any soft ground and replace with either blinding concrete or selected non-reactive cohesive and non-porous fill.
Damage to adjacent properties	Ensure existing utilities have been cleared and diverted from excavation location; and Excavation may lead to excessive vibration and induce structural damage to the adjacent properties.	Undertake pre-construction survey of adjacent properties; Contractor to undertake vibration assessment and select appropriate machinery for excavation; and Contractor to monitor vibration level during excavation and minimise damage.

7.3 Hydrogeological assessment

Based on the regional and local hydrogeological information presented in Section 5.5, a summary of hydrogeological conceptual model is outlined below:

- There are two main groundwater systems relevant to the precinct:
 - Quaternary Alluvium Aquifer (QA – 100) is present over the majority of the southern precinct area portion, in association with Hovells Creek and tributaries, and over about a quarter of the northern precinct area portion, in the west. The aquifer is conceptualised to be of low transmissivity due to it being thin (<6 m thick) and fined grained. Groundwater is conceptualised to flow through the gaps and pore spaces between the grains of the alluvium material. Where it occurs across the precinct area, this unit is likely to host the water table.
 - Upper Tertiary/Quaternary Basalts (UTB – 101) underlie the Quaternary Alluvium and outcrop where the alluvium is absent. UTB – 101 is a fractured rock aquifer in the basalt flows and stony rises of the Newer Volcanics. Groundwater flow in this aquifer is primarily controlled by the size, spacing and interconnectivity of fractures and joints and as such, flow is known to be highly variable. It forms a major regional and local aquifer. The UTB – 101 is about 60 m thick in the northern precinct area portion and typically about 30 m to 40 m in the southern precinct area portion. This unit is expected to host the local water table where it is encountered at the surface. The transmissivity is likely to have large variability. However, local data suggests that at least localised high transmissivity zones may be present.
- Local aquifers are recharged by diffuse rainfall and surface water infiltration. As such, all areas of the precinct area are potential groundwater recharge areas. The exception may be at and near surface water features, where, if there is a shallow water table within the evapotranspiration extinction zone, net groundwater discharge may be occurring.
- The water table is expected to be shallow (<10 mbgl) across the entire precinct area and very shallow (<5 mbgl) in the relatively low lying portions and near surface water drainage lines.
- State-wide groundwater salinity mapping indicates that groundwater salinity within precinct area ranges from 3,500 mg/L to 7,000 mg/L (DELWP, 2014). The conservative end of this range corresponds to salinity segment C (3,101 mg/L to 5,400 mg/L TDS) in the Environmental Reference Standard. The average of TDS data (5,218 mg/L) outside of the precinct area, but within 1 km of the precinct area, aligns with the segment C category. However, minimum (1,794 mg/L) and maximum (12,400 mg/L) of these data are outside of the segment C range.
- Review of the GDE Atlas identified the following potential GDEs are present within the precinct area
 - Aquatic
 - A single tract of high potential GDE characterised as a wetland is present in the southeast of the southern precinct area portion. The tract is about 400 m long by about 200 m wide and was defined based on regional studies.
 - A single tract of moderate potential GDE characterised as a wetland is present in the east of the northern precinct area portion. The tract has a diameter of about 200 m and was defined based on regional studies.

- Three closely separated tracts of unclassified potential GDE characterised as wetland are present in the centre and west of the northern precinct area portion, all defined based on regional studies. The combined length is about 800 m and the width ranges from about 100 m to 400 m.
- Terrestrial
 - Relatively large areas of vegetation characterised as high potential GDE are present near parts of the southern precinct area portion's western boundary, and near southern parts of the drainage line which traverses the southern precinct area portion. These tracts are described as either "Coastal Saltmarsh/Mangrove Shrubland Mosaic" or "Plains Grassy Woodland". These areas were defined based on national assessment.
 - Three relatively small areas of vegetation characterised as high potential GDE are present in the southeast of the southern precinct area portion. These tracts are described as Plains Sedgy Wetland, were defined based on national assessment and are up to 130 m long and 50 m wide.
 - There are two small tracts of vegetation characterised as high potential GDE within the northern precinct area portion, near the southern boundary. The vegetation is described as 'Plains Grassy Wetland' and was defined based on national assessment. The largest area is about 120 m long by 70 m wide.
- The state database, Water Measurement Information System (WMIS), lists 54 registered groundwater bores within 1km of the precinct area, although one location appears to be duplicated. There are 6 bores located in the northern precinct area portion and no bores in the southern precinct area portion. Of the 6 bores located in the precinct area, all have a use pertaining to monitoring or investigation and are shallow (12 m to 19 m).
- The VVG (FedUni, 2015) has contamination audit reports (URS, 2005) for land within the northern precinct area portion. The reports pertain to hydrocarbon contamination associated with a leak from the White Oil Pipeline. Further comments relating to potential groundwater contamination associated with the White Oil Pipeline, as well as other potential sources, are provided in Section 7.1.2.

In summary, in terms of land suitability, proposed works will need to be planned, constructed, and managed concerning the groundwater conditions expected and the environmental value of the resource.

7.4 Hydrology assessment

Based on the regional hydrology information presented in Section 5.4, the GAEP area is characterised as being at risk of inundation. The risk of inundation arises from a variety of flooding mechanisms including riverine flooding, flooding from local stormwater, storm surge, and climate change sea level rise impacts.

The site is mostly rural with overland flow paths governing the flow regime. However, detailed drainage information for the area was not available and new drainage asset information may impact this conclusion.

Future development may impact on the flood storage, flow path, land imperviousness, access safety and hazard, freeboard of the buildings, and drainage strategy.

Flooding considerations and general design criteria will be applicable to the GAEP area and are outlined in **Section 8.4**.

8. Development opportunities & constraints

8.1 Land contamination

The following issues require consideration in the planning and design of any development and may be assessed through further contamination investigation:

Based on the information described in this report, there does not appear to be any significant constraints from a site contamination perspective which would render the land unsuitable for proposed future non-sensitive land use (i.e. commercial, industrial or open space use). However, there are specific properties within the GAEP study area that have been assessed as presenting a 'high' potential for contamination. Further assessment at these properties may be required in order to better characterise the nature of contamination and identify how contamination (if identified) can be managed as part of the future development activities. These properties include (refer to **Figure 3**):

- Property number 4 (parcel 2\PS427409) which represents a current service station where fuel is stored in bulk on premises.
- Property numbers 5 (parcel 1\PS427409), 6 (parcel 1\LP213752) and 7 (parcel 2\LP213752) which represent properties across which a GQRUZ is proposed following remediation of the WOPL leak that occurred in 2004. Remediation has been completed to the extent practicable, but residual contamination remains in soil and groundwater within the boundary of the proposed GQRUZ. Management of residual contamination present within the soil / groundwater may require specific consideration as part of future development.

In accordance with PPN30 and based on the future proposed non-sensitive land use that is being considered for GAEP (commercial, industrial and open space land use), a Preliminary Site Investigation (PSI) should be undertaken for properties designated as a 'high' potential for contamination. The purpose of the PSI is to inform whether an environmental audit is required. It is recommended that the PSI is completed prior to the Planning Scheme Amendment. This will allow the outcome of the PSI to be considered as part of the Planning Scheme Amendment (i.e. if the PSI determines that an audit is required, an Environmental Audit Overlay could be applied to the relevant properties as part of the Planning Scheme Amendment process). It is however noted that in the case of the current BP service station (property 4), it is likely that this will remain in operation as a service station and therefore it is not considered necessary to complete a PSI for this property at this stage (unless a change of use as part of the site development activity is likely).

In addition to the above, several properties were assigned a 'medium' potential for contamination. While further assessment of such properties may not be warranted at this stage, potential contamination impacts should be considered as part of the future development of the identified properties, specifically:

- Property numbers 3 (parcel 41\LP7173) and 17 (parcel 1\LP76925) where stock dips were observed. The use of these features for livestock treatment has the potential to result in contamination of soil and groundwater. Further assessment by the future developer may be warranted in order to assess whether soil / groundwater contamination has occurred as a result of their use and what management / mitigation may be necessary as part of the future site development.
- Property numbers 11 (parcel 3\TP221328), 12 (parcel 2\TP221328), 13 (parcel 1\TP221328) and 14 (parcel 1\TP411602) which are located immediately adjacent to the western boundary of Avalon Airport. Environmental sampling has been performed historically at these properties and while evidence of contamination was generally limited, PFAS was detected in soils and groundwater. It is also noted that surface water sampling (surface water being the likely primary migration route for PFAS off the airport) was not performed as part of the earlier sampling and therefore this represents a potential data gap. Further assessment of PFAS by the future developer may be warranted in order to establish management requirements (including as it relates to the off-site disposal or on-site re-use of soil).

In accordance with PPN30 and based on the future proposed non-sensitive land use that is being considered for GAEP (commercial, industrial and open space land use), for properties where the potential for contamination is considered to be 'medium', the planning authority should document consideration of potential for *contamination to impact proposal* [the Planning Scheme Amendment].

In addition to the properties that have been identified above as presenting either a 'high' or 'moderate' potential for contamination, it is likely that localised or discrete areas of contamination may be identified

elsewhere across the GAEP. It is likely that these can be cost-effectively managed or remediated as part of the site development process. For example:

- Septic tank systems associated with the farm residences are likely present within the Northern and South-western GAEP area which have the potential to cause localised subsurface contamination. As such, it is recommended that any septic tank system should be identified, excavated and validated as part of future site development activities.
- Intermediate Bulk Containers (IBCs) mostly without labels, above-ground storage tanks, and various containers were observed at some specific properties within the Northern and South-western GAEP area. These are typically associated with the farm residences and farm properties and have the potential to cause localised subsurface contamination. As such, it is recommended that any such chemicals are identified by analytical testing, and appropriately contained and disposed of as part of future site development activities.
- Miscellaneous stockpiles and areas where discarded materials/equipment on the ground surface were observed at some of the properties. These stockpiles, which include gravel, soil, boulders, construction debris wastes, imported fill, green wastes (timber from fencing) and assorted rubbish (scrap metals from broken down vehicles and farm equipment) may not be suitable to remain on site under the future land use scenario, in which case they should be identified and removed to a suitably licensed disposal facility, and the areas that they were located appropriately validated. This may be undertaken as part of future site development activities.

It is anticipated that minor management activities such as the above could be controlled during development through the implementation of a robust Construction Environmental Management Plan (CEMP) with suitable provisions for the management of unexpected finds. Where necessary, the developer should seek the advice of a suitably qualified environmental professional.

8.2 Geotechnical consideration

The following issues require consideration in the planning and design of any development and should be assessed through a detailed geotechnical site and laboratory investigation.

8.2.1 Uncertainty of ground condition

Variable geological units, including residual basaltic clays, newer volcanics basalt (Qvn/Neo), coastal lagoon deposits (Qg) and swamp and lake deposits (Qm1) are expected to be encountered within the project area as indicated in **Figure 5-1** and **Figure 5-2**. However, the depth and reactivity of the newer volcanics residual clay and alluvium depth of swamp and coastal lagoon sediments which forms the surface geology for most of the project area are unknown. Stiffness and/or strength, weathering and all other mechanical properties of various geological units are also unknown. Therefore, due to the very limited field information available, a proper ground model could not be developed.

The unknown, variable ground profile can lead to conservative design and / or incorrect design that drastically impact the construction costs and can impose structural damage. Unknown properties of various foundation materials and variable thickness of the soil horizon over relatively short horizontal distances can lead to excessive differential settlement of structures and associated damage. Also, highly variable weathering and strength profiles within the newer volcanics basalt profiles over short horizontal distances can influence selection of excavation methods. It is also common to encounter basalt 'floaters' which represent basalt ejected at the surface level which is then contained within the upper weathering profile. Excavations should consider the potential to intercept competent basalt boulders and cobbles within the residual soil profile.

Therefore, a detailed geotechnical site and laboratory investigation is recommended to characterize location, extent, depth, and mechanical properties of various geological units that may encounter across the site. The geotechnical site investigation is required to assess the depth to rock across the site and develop the ground model within the project area. Samples acquired through the geotechnical investigation can be used to determine the presence of PASS, sodium content, pH, and dispersion characteristic of encountered soils in addition to their geotechnical engineering properties.

8.2.2 Soil reactivity

Newer volcanics basalt typically comprises residual soil of high plasticity clay with occasional gravel overlaying extremely weathered to fresh basaltic rock. The high plasticity clay is typically of high reactivity (high shrinkage and swell potential) and prone to shrinkage and swelling due to the seasonal changes to the moisture content of the soil. The thickness of the residual soil profile in the newer volcanics is likely to be highly variable over relatively short horizontal distances.

Figure D2 of Australian Standard AS2870 (2011) "Residential Slabs and Footings – Construction" indicates that GAEP project site is in a Climatic Zone 3 concerning shrink-swell movements. The depth of design suction changes in Climatic Zone 3 can be up to 2.3 m below ground level (the depth of soil profile prone to shrink-swell activity), in accordance with Table 2.5 of AS2870 (2011). Considering that the site surface geology profile for most of the project area is aligned with group 2 and / or 4 soils of Table D1 of AS2870 (2011), depending on the soil layer depth, thickness, and reactivity, a Slightly (S) to High (H2) reactive class can be assigned to the investigation area for residential footing design. This implies that characteristic ground surface movement of generally 20 mm to 75 mm may occur over a 50-year design life due to normal seasonal moisture variations. However, it should be noted that:

- Due to lack of laboratory data across the site, the above site classification is based on limited regional geological information and is intended for preliminary consideration only to provide an assessment on the likely variations that may be encountered;
- Any abnormal moisture condition in the soil beneath the footing, resulting from pronounced wet and dry seasons, trees close to the building, and sewer and stormwater pipe, can cause major additional movement in excess of that estimated above for a normal seasonal moisture variation; and
- Site classification following the method outlined in AS 2870-2011 is strictly applicable for residential buildings or buildings that have similar construction method and loading (such as roads and railways). Therefore, the designer should evaluate the applicability of the site class to the proposed structure.

Therefore, a site-specific geotechnical site investigation, which may include appropriate soil sampling and associated laboratory testing should be undertaken before the design and construction of any shallow foundations, pavements, and associated civil infrastructure as part of any future building permit application.

8.2.3 Excavatability and stability of temporary excavations

The variable geological conditions across the site can lead to sudden changes in ground conditions for excavation. Excavation in sand, gravel, and fill, or excavations extending below the water table may be unstable and should be battered or shored. This will need to be assessed at the time of construction; however, a conservative approach should be adopted when considering the stability of short-term batter slopes.

The excavation of any surficial fill, alluvium, and natural soils is expected to be possible with the standard bucket excavation method utilizing a traditional excavator of suitable capacity.

Excavation within granular alluvium may provide a risk of caving and collapse. Alternative ground collapse control measures during excavation (e.g. benching/battering, shoring, shielding, etc.) should be considered to ensure that sidewall and overall integrity of the excavation are maintained.

Excavations in newer volcanics could vary between relatively easy excavations in residual soils to difficult excavation in weathered rock. It is expected that the existing natural soils may be excavated using conventional excavation equipment such as tracked excavators. Excavators equipped with ripper attachments or hydraulic impact breakers may be required to loosen any weathered basalt that is encountered, before excavation. Blasting may be required for excavation in very high strength, fresh, or slightly weathered basalt rock.

Temporary open-cut trenches less than 1.5 m depth may be constructed by battering the side of the excavation. Temporary batter slopes should not be steeper than 1V:2H in the cohesive alluvial deposits. High plasticity clays may be fissured and have weak shear planes, where soil block failures could occur, and this should also be allowed.

Dispersive soils may be encountered throughout the project area. Dispersive soils are easily revealed and are susceptible to erosion and washing away. These soils may not be suitable for use as fill material as part of

engineered fill to support foundations or pavements. Gypsum treatment for soil used to line drainage systems such as swale drains may be required. The dispersive nature of the soils should be tested as part of any investigation programme.

8.2.4 Foundation design

Construction of shallow footings above alluvium deposits may pose a risk of structural damage due to insufficient bearing capacity and excessive settlement. Ground Investigation is recommended to confirm the ground conditions and assess the composition, thickness, strength, and compressibility characteristics of the underlying soil.

Shallow footings of developments constructed above residual basaltic soil may be subjected to large seasonal surface movement due to shrinkage and swelling of expansive clay. Care should be taken during the foundation design to minimize the impact of soil shrinkage and swelling and limit the change in moisture content of the reactive soil (i.e., implementing drainage systems during bulk earthworks).

Design of roads, drainage works, and underground assets would require consideration of the highly reactive and potentially dispersive nature of the clays to ensure serviceable performance and minimize ongoing maintenance requirements.

Fill material, which may be present on-site, is expected to be uncontrolled and may not be suitable as a founding material in its current state.

The site investigation followed by relevant laboratory testing (i.e. compaction, triaxial, 1D consolidation, swell-shrink index) is recommended to determine the location, extent, depth, and mechanical properties of soil materials laid within the site area.

8.3 Hydrogeology

The following issues require consideration in the planning and design of any development and may be assessed through further hydrogeological investigation:

- Site-specific groundwater impact assessments will be required for works within or near groundwater receptors (potential GDEs and registered bores used for water supply) depending on location, footprint, and extent of works within the subsurface/water table.
- Due to the shallow water table across much of the site, construction may be difficult during wet months, particularly as some of the site is of low-lying elevation. Where saturated conditions occur during construction/excavation, waterlogged soils may become difficult to traverse.
- Dewatering during construction may be required if excavations encounter the water table (expected to be within 5 m of ground surface across significant parts of precinct area). The magnitude of groundwater inflow into excavations cannot currently be assessed with confidence; however, provided only shallow infrastructure construction is proposed, a sump and pump type arrangement may provide satisfactory management of groundwater locally.
 - Works requiring dewatering will need a site-specific assessment before and during any excavation to prevent impacts to groundwater receptors (GDEs [including potential baseflow loss impacts] and bores used for water supply). This will include, as a minimum, an analytical assessment of the extent of groundwater drawdown to achieve dry conditions in excavations, and whether the drawdown cone of depression will intersect groundwater receptors. If potential impacts are identified, consideration of the proposed construction method and scheduling to minimise or eliminate impacts is required. If there is high uncertainty, or if impacts cannot be mitigated through design and scheduling, field investigations will be required to assess groundwater levels, quality, and aquifer properties. A field monitoring program will require design and implementation during construction to ensure assessment objectives are achieved.
 - Consideration of disposal options for extracted groundwater will be required. Disposal of groundwater should be in accordance with the relevant authorities and conditions on permits obtained.
 - There is a potential for high hydraulic conductivity basalt to result in relatively large groundwater inflows, should significant excavations intersect the water table in this material. This could have implications for construction dewatering and could impact methodologies, as well as the ease of practical disposal.

- Groundwater quality could influence the dewatering disposal method, or treatment requirements. For instance, if groundwater is contaminated, as a result of the White Oil Pipeline leak, or from other sources, this could have implications for water disposal and the health of construction workers.
- Opportunities for the potential use of extracted groundwater include dust suppression during construction, and garden watering and irrigation of parks and ovals following development (provided groundwater low in salinity is encountered). Salt tolerance limits vary for different plants and animals, so it is advisable to assess which salinity range would be acceptable for the intended use. Based on the expected salinity of the groundwater, it may need to be supplemented by or shandied with potable water to improve the quality for the intended purpose.
- Groundwater quality should be considered in relation to structure design and durability.

8.4 Hydrology

Flooding considerations and design criteria will constrain future development given that significant portions of the GAEP area are at risk of inundation from a variety of flooding mechanisms including riverine flooding, flooding from local stormwater, storm surge, and climate change sea level rise impacts.

At the time of this desktop due diligence study, details on specific land use changes in the GAEP area were not available. The considerations and design criteria identified are general in nature and relate to the broad future proposed commercial / industrial land use across the precinct.

Potential considerations and design criteria for future development are not limited to items listed in this section. Early engagement and consultation with local water authorities and stakeholders will be critical to understand the full list of considerations and design criteria applicable to specific land use changes.

8.4.1 Flooding considerations

Flood risk will need to be managed when planning and implementing future development in the GAEP area. General guidance for managing flood risk in new developments includes but is not limited to:

- Flood Flow: Works or structures should not affect floodwater flow capacity. This ensures that existing flood levels are not made worse by alterations to the flow characteristics of a floodplain or overland flow path.
- Flood Storage: Works or structures should not reduce floodwater storage capacity. This prevents higher flood levels that may occur if the available storage volume is reduced.
- Freeboard: Works or structures should not reduce minimum freeboard. This ensures there is no adverse impact on existing property and infrastructure.
- Site Safety Requirements: Works or structures should not create new hazards or increase existing hazard. Development will not be allowed where the depth and flow of floodwaters would create new hazard or increase existing hazards.
- Access Safety Requirements: Access safety requirements should be taken into account. Development cannot be allowed in circumstances where the depth and flow of floodwater affecting access to the property is hazardous.
- Climate change requirements: Floodplain impacts of works or structures must be considered, consistent with the approach specified in ARR 2019, for the following climate change scenarios:
 - Increase in rainfall intensity
 - Sea-level rise

8.4.2 Flooding design criteria

The desired key outcome for development within a flood prone area is to ensure the proposed design does not adversely impact (increase) flood risk to people and properties. Appropriate flood mitigation measures must be included in the design so that there is no significant increase in flood risk outside the land of the project and minor adverse flood impacts are located where there are no sensitive receptors. The primary design criteria to be considered in the design stage are:

- To ensure that the proposed design does not adversely impact the existing flow regime, including overland flow paths for extreme storm conditions

- Access/Site Safety: To review the flood modelling results against the safety criteria of Melbourne Water guidelines during a 1% AEP event:
- Depth (D) does not exceed 0.30m; and
- Velocity (V) does not exceed 1.5m/s; and,
- The result of (D x V) does not exceed 0.35m²/s
- Freeboard: If related, set the floor elevations of the new buildings at 300 mm (for stormwater overland flow paths) or 600 mm (for developments near a watercourse) above the 1% flood level.
- To demonstrate that no additional flows would be discharged from the site as a result of the proposed works (overland and underground)

As stated earlier, an early engagement and consultation with local flood authorities and stakeholders will be critical to understand the full list of flood management criteria and the associated drainage strategy and to ensure there is no further restriction/constraints for development.

8.4.3 Additional constraints

In addition to the general flooding considerations and design criteria provided, state planning controls apply to areas within the GAEP area.

The Land Subject to Inundation Overlay (LSIO) associated with the flooding extent from Little River and the local network of drains within the Avalon Road Catchment No. 213 covers a significant proportion of the GAEP. Under the LSIO, a permit is required to construct a building or carry out any temporary (constructions sites) or permanent works, and to subdivide land. In addition to this, any temporary or permanent works at or near waterways require the appropriate planning approvals. Additional investigations in consultation with the relevant Catchment Management Authority will be required.

8.5 Geomorphology

The GAEP Area is located on soils that have formed from weathering of local New Volcanic Basalt rock, Quaternary Alluvium and Coastal Deposits. They may have characteristics that are similar to sodic/dispersive soils that have been assessed in other Precinct Areas.

Topsoils are generally expected to have better structural stability, but subsoils have the potential to be highly sodic/dispersive and susceptible to erosion, particularly in instances where the topsoil is removed or if there are drainage works, which then result in rainfall and runoff contacting and eroding these soils. Development in these areas will require very careful planning, staging of works to minimize disturbance, and possible remediation of soils to enhance their stability.

With the proposed urban development there will be a significant change in runoff to waterways – which in turn will heighten erosion risks. It is expected that with the development of the drainage services scheme Melbourne Water will want further advice as to how future development and the drainage services scheme can be prepared so as manage erosion risks and provide appropriately protection to waterways, including any swamps that are present in the GAEP area.

9. Conclusions

9.1 Contamination

Based on the information gathered during the Stage 1 and Stage 2 assessments, the following conclusions can be made concerning GAEP:

- Four properties within the GAEP study area were identified as presenting a high potential for contamination:
 - Property number 4 (parcel 2\PS427409) which represents a current service station where fuel is stored in bulk on premises.
 - Property numbers 5 (parcel 1\PS427409), 6 (parcel 1\LP213752) and 7 (parcel 2\LP213752) which represent properties across which a GQRUZ is proposed following remediation of the WOPL leak that occurred in 2004. Remediation has been completed to the extent practicable, but residual contamination remains in soil and groundwater within the boundary of the proposed GQRUZ.
- Six properties within the GAEP study area were identified as presenting a medium potential for contamination:
 - Property numbers 3 (parcel 41\LP7173) and 17 (parcel 1\LP76925) where stock dips were observed. The use of these features for livestock treatment has the potential to result in contamination of soil and groundwater.
 - Property numbers 11 (parcel 3\TP221328), 12 (parcel 2\TP221328), 13 (parcel 1\TP221328) and 14 (parcel 1\TP411602) which are located immediately adjacent to the western boundary of Avalon Airport. Environmental sampling has been performed historically at these properties and while evidence of contamination was generally limited, PFAS was detected in soils and groundwater. It is also noted that surface water sampling (surface water being the likely primary migration route for PFAS off the airport) was not performed as part of the earlier sampling and therefore this represents a potential data gap.
- Twelve remaining properties within the GAEP study area were identified as presenting no potential for contamination. This includes the majority of the area occupied by the former salt works, most of the existing properties used for agricultural purposes as well as the Geelong Motor Sports Complex.
- Four off-site land uses were identified within the vicinity of the GAEP that were assessed as presenting a potential contamination risk to the GAEP study area, specifically:
 - A BP service station located to the north of GAEP. This was assessed as presenting a low potential contamination risk to the GAEP study area
 - A waste / material recycling facility located to the north of GAEP. This was assessed as presenting a low potential contamination risk to the GAEP study area
 - Avalon Airport, located centrally within the GAEP study area. This was assessed as presenting a medium potential contamination risk to the GAEP study area
 - Melbourne Water's Western Treatment Plant located to the east of the GAEP study area. This was assessed as presenting a low potential contamination risk to the GAEP study area.
- Based on the information described in this report, there does not appear to be any significant constraints from a site contamination perspective which would render the land unsuitable for proposed future non-sensitive land use (i.e. commercial, industrial or open space use). However, there are specific properties within the GAEP study area that have been assessed as presenting a 'high' potential for contamination. Further assessment at these properties may be required in order to better characterise the nature of contamination and identify how contamination (if identified) can be managed as part of the future development activities.
- Localised or discrete areas of contamination may be identified elsewhere across the GAEP. It is likely that these can be cost-effectively managed or remediated as part of the site development process. It is anticipated that minor management activities could be controlled during development through the implementation of a robust Construction Environmental Management Plan (CEMP) with suitable provisions for the management of unexpected finds. Where necessary, the developer should seek the advice of a suitably qualified environmental professional.

9.2 Geotechnical

Based on the very limited geological information available, the GAEP area is likely underlain by swamp and coastal lagoon soils and basaltic residual soils derived from the underlying basalt bedrock. Swamp and coastal lagoon deposits are expected to be encountered in most parts of the western zone of the project site with potentially highly compressible and weak sediments. Also, the residual basaltic soils may have a high shrink-swell potential which is not advantageous for either the structures or as use as construction materials.

Sodic soils with a dispersive nature are present in the proposed GAEP area. These soil characteristics could lead to erosion of drainage channels/features and associated blockage/sedimentation of downstream drainage areas or undermining of constructed works. Sodic soils by their characteristics are highly problematic for construction materials if untreated or not improved.

Key geotechnical issues associated with the development of the site include the depth and reactivity of the basaltic clay and swamp and coastal lagoon sediments in terms of its influence on on-site reactivity classification, change and interface of variable ground conditions, foundation selection, differential settlement, subgrade performance, excavations, and site accessibility. Fill material, if present, is expected to be uncontrolled and may not be suitable for development in its present state. Areas subject to poor drainage may comprise soft material which provides low bearing capacity for foundations.

Subsurface conditions may present a critical issue for the design of the structures and foundations, and therefore there is likely to be a benefit in obtaining geotechnical data at targeted locations.

The results of the geotechnical investigation would form the basis of the geotechnical model for the site, which would be used to assess subgrade conditions, confirm the site classes, foundation design parameters, excavations, and recommendations on earthworks.

Sodic and specific geotechnical investigation of the proposed development needs to be undertaken and assessed to address the challenges presented by these soil types. Such investigations need to focus on the definition of ground models and the behaviour of inherent soils and rocks encountered with particular emphasis on soil index, sodic, shrink-swell, earthworks assessments, and trials with additives for an amelioration assessment.

For details, please see **Appendix D** as well as **Figures 2 and 3**.

9.3 Hydrogeology

Based on the regional and local hydrogeological information, the local water table is expected to be relatively shallow across the site and hosted in the fractured rock Upper Tertiary/Quaternary Basalts and the alluvial Quaternary Aquifer, where present. Where present, the alluvial aquifer is conceptualised to be of low transmissivity because it is conceptualised to be thin (2 m to 6 m thick) and comprising predominantly fine-grained material.

Across the precinct area, the following issues require consideration in the planning and design of any development:

- Shallow depth to groundwater is likely to occur over large portions of the precinct area. The shallow water table may cause groundwater inflow to excavations and may impact site drainage (i.e. cause waterlogging).
- There may be areas that have poor sub-soil drainage and are susceptible to waterlogging.
- Site-specific groundwater impact assessments will be required for works within or near to groundwater receptors (GDEs [including potential baseflow reduction] and nearby registered bores) depending on location, footprint, and extent of works within the subsurface/water table.
- Groundwater dewatering or extraction associated with development has the potential to reduce discharge to nearby surface water features and/or terrestrial GDEs, which could potentially have a negative impact on the ecological health of local groundwater receptors.
- Existing offsite bores used for water supply (typical use is stock and/or domestic) require consideration in terms of location, existence, condition, and current license to prevent unacceptable impacts during construction. The closest of these bores is offset about 120 m northwest from the northern precinct area portion

- The potential brackish nature of the groundwater may require careful monitoring if dewatering or extraction is required, particularly for the consideration of the disposal of water.
- Opportunities for the potential use of extracted groundwater include dust suppression during construction, and garden watering, and irrigation of parks and ovals following development. However, the expected range of salinity is likely to vary and depending on the salinity of the groundwater, it may need to be shandied with potable water to improve the quality for the intended purpose.
- Transmissivity of the Upper Tertiary/Quaternary Basalts (UTB – 101) is likely to have large variability. However, data suggests that at least localised high transmissivity zones may be present. This could have implications for groundwater dewatering, if required for construction, as groundwater inflow rates could be relatively high.
- Groundwater quality, including potential contamination from the White Oil pipeline leak, or other sources. This could have implications for potential construction dewatering management.

It is recommended that a field investigation into groundwater elevation, quality and aquifer properties (including hydraulic conductivity) be undertaken to confirm the findings of this desktop study. This may include:

- Sampling of existing bores (if active and accessible) for groundwater level and quality, and hydraulic conductivity testing; and
- Drilling and construction of test bores for ongoing observation to assess water level and quality, and monitor for seasonal variations (if required).

Groundwater field investigations are expected to become a high priority where excavations are anticipated to intersect the water table. For large or deep excavations, groundwater investigations can be used to inform the quantity, quality, and impact of dewatering.

9.4 Hydrology

This desktop due diligence study has identified that the GAEP area falls within a floodplain exposed to riverine flooding, flooding from local stormwater, storm surge, and climate change sea level rise impacts. Future development in the area has the potential to influence existing overland flow paths in addition to impacting the project area drainage strategy, floodplain storage, land imperviousness, and the associated flood risk.

As such, it is expected that future development across the site will require:

- A detailed flood modelling and flood study
- early consultation and liaison with flood authorities to understand design criteria/expectations and future drainage schemes.
- To seek construction permit from the relevant flood authorities and discuss working adjacent to an open channel and/or within LSIO/flooding extent and the required setback or the appropriate flood risk management strategies.

It is the recommendation of this report that early consultation with flood authorities including both Melbourne Water and Corangamite Catchment Management Authority be prioritised when planning future development.

9.5 Geomorphology

The GAEP area is located on soils that have formed from weathering of local New Volcanic Basalt rock, Quaternary Alluvium and Coastal Deposits. Topsoils have better structural stability, but subsoils may be sodic/dispersive and susceptible to erosion, particularly in instances where the topsoil is removed or if there are drainage works, which then result in rainfall and runoff making contact with and eroding these soils.

10. Recommendations

We understand that the predominant proposed future use of the GAEP will comprise a combination of industrial, commercial and open space land uses. Since specific future land uses within the PSP area are yet to be confirmed, this assessment has been completed based on the initial intended use of the area as mentioned above and this is the primary context in which recommendations are presented below.

However, it is acknowledged that limited sensitive land uses might form part of the future development of the GAEP in some, as yet to be determined areas (i.e. children's playgrounds or childcare centres). Therefore, where additional or different recommendations would apply in relation to more sensitive future land uses than would apply to the proposed predominant commercial, industrial or public open space land use, these are identified below.

- Completion of Preliminary Site Investigation (PSI) at properties 5, 6 and 7 where a high potential for contamination has been identified as part of this assessment. This relates the presence of residual contamination arising from the WOPL leak that occurred in 2004. While remediation was completed (to the extent practicable) in 2021 it is noted that a GQRUZ was recommended to be applied across an area that encompasses a portion of each of these properties. This represents the extent of residual contamination that may preclude one or more beneficial uses of the site. The completion of a PSI will determine whether an environmental audit is required for these properties (the audit would assess the sites' suitability for proposed future commercial or industrial land use, including any requirements to manage residual contamination under the proposed future use). NOTE: In the event that sensitive land uses are proposed within these parcels, rather than the completion of a PSI, it is recommended that environmental audit is completed.
Timing: It is recommended that the PSIs at these properties be completed after the gazettal of the Planning Scheme Amendment. This should be implemented as a permit application requirement in the planning scheme ordinance.
- The Planning Authority should document their consideration of potential for contamination at properties 3, 11, 12, 13, 14 and 17 where a medium potential for contamination has been identified as part of this assessment. NOTE: In the event that sensitive land uses are proposed in these parcels, it is recommended that that a Preliminary Risk Screening Assessment (PRSA) is completed instead. These PRSAs will determine whether an Environmental Audit is required at the property, and the scope of the Environmental Audit (if deemed necessary). These PRSA assessments may include the completion of targeted/limited sampling and should be completed in accordance with EPA Victoria publication 2021 *Guidelines for Conducting Preliminary Risk Screening Assessments* and EPA Victoria publication 2022 *Environmental Auditor Guidelines – Provision of Statements and Reports for Environmental Audits and Preliminary Risk Screen Assessments*. The PRSA may only be conducted by an Environmental Auditor.
Timing: The Planning Authority should document their considerations of potential for contamination during the planning stage for GAEP. If sensitive land uses are proposed, and PRSAs are completed, these additional assessments may either be conducted as part of the planning process or deferred until future development of the land occurs through the application of an Environmental Audit Overlay.
- It is recommended that the classification and disposal (if required) of various stockpiles and dumped materials/wastes observed onsite and may be present at some other location across GAEP be undertaken. This includes subsequent validation following removal. It is noted that sampling of some stockpiles of soil observed may indicate that the material is suitable for re-use as part of future development and as such removal may not be required in all instances.
Timing: This task should be undertaken on a site-by-site basis during future site development.
- It is recommended that a geotechnical investigation comprising soil and rock sampling, and geotechnical laboratory testing is undertaken. This will lead to the determination of the ground conditions, design constraints, and geotechnical design parameters for temporary excavation, building foundation, and road design, as well as the associated and necessary control measures for utilities and drainage features.
Timing: This task should be undertaken on a site-by-site basis during future development as part of the building permit application process.
- Subject to approved access, existing investigation/observation bores in the vicinity of the GAEP identified as active can be used to verify groundwater conditions based on the risk of proposed land use affecting groundwater. Groundwater hydraulic testing (e.g., slug tests) may also be undertaken to assess aquifer properties. This assumes existing wells are in a suitable condition for such an assessment. Due to the lack of groundwater investigation or observation bores over most of GAEP, the installation and development of new investigation bores is also likely to be required to confirm the local groundwater level and quality presented in this desktop assessment.

Timing: This task should be undertaken on a site-by-site basis during design to inform risk to groundwater. Alternatively, groundwater investigations can be undertaken concurrently with geotechnical investigations by installing observation bores to measure groundwater level, quality, and aquifer hydraulic conductivity.

- It is recommended that further site investigation, sampling, laboratory analysis, and characterization of soils is undertaken to confirm their erodibility and develop a plan to stabilize the soils (options include chemical treatment of soils, and careful staging of works). The scope of this work would be similar to the Sodic Soils and Acid Sulfate Soils Assessment recently completed by Jacobs for Merrifield North PSP.
Timing: This task will be undertaken across the Site (especially for South-western GAEP) as part of the planning stage for the GAEP. The outcomes of this work will assist in providing strategic advice on issues relating to sodic soils and how to manage these with future development.
- It is the recommendation of this report that early consultation with flood authorities including both Melbourne Water Corporation and Corangamite Catchment Management Authority be prioritised when planning future development for the Site. In particular, project proponents of future land development across the Site shall provide local authorities (1) detailed flood modelling and flood study, (2) early consultation and liaison with flood authorities to understand design criteria/expectations and future drainage schemes, and (3) seek relevant construction permits from the relevant flood authorities and discuss working adjacent to an open channel and/or within LSIO/flooding extent and the required setback or the appropriate flood risk management strategies.

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Appendix A. Figures

The following figures are presented below:

Figure 1. Site Location

Figure 2. Site Layout

Figure 3. Site Characterization (Potential for Contamination of Land)

Figure 1. Site Locality Plan



PSP Boundary

Jacobs

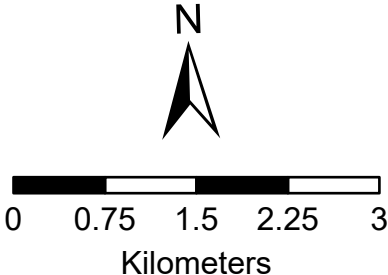


Figure 2. Site Layout Plan



 PSP Boundary
 Cadastre / Property Number

Jacobs

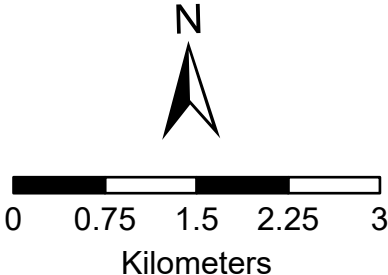
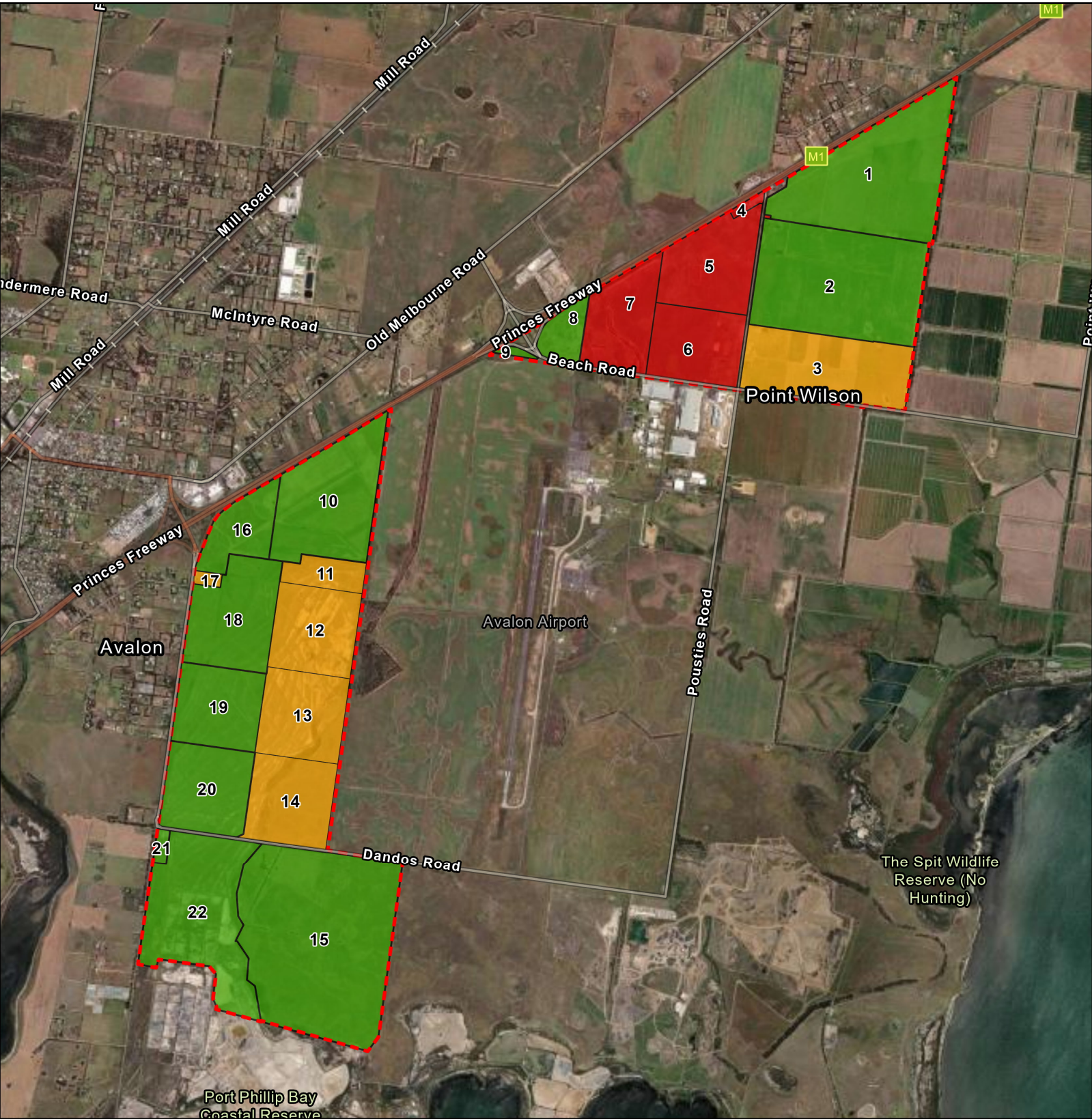


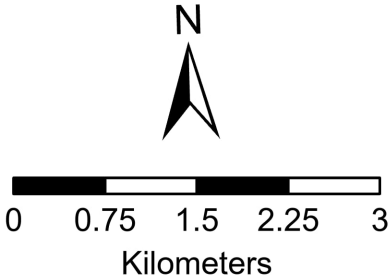
Figure 3. Potential for Contamination



PSP Boundary
 Cadastre/ Property Number

Potential for Contamination
 No Potential for Contamination
 Medium
 High

Jacobs



Appendix B. Lotsearch reports

Appendix C. Groundwater bores

Table C-1. Summary of registered groundwater bores

Summary of registered groundwater bores within 2 km buffer of GAEP area. Data from WMIS (DELWP, 2022 via Lotsearch)

Bore Id	Use Type	Bore depth (m)	Completed Date	Distance (m)	Direction
112852	Domestic, Stock	20	03/02/1992	0	On-site
319783	Non-Groundwater	21.49	02/09/1971	0	On-site
58465	Stock	13.5	18/03/1982	0	On-site
68850	Domestic, Stock	53.3	11/09/1982	0	On-site
68859	Domestic, Stock	72	03/05/1983	0	On-site
68861	Domestic, Stock	22.5	04/05/1983	0	On-site
68870	Domestic, Stock	17	21/12/1984	0	On-site
68881	Domestic, Stock	62.48	15/03/1983	0	On-site
68889	Domestic, Stock	50	30/04/1983	0	On-site
68921	Domestic, Stock	62	22/01/1989	0	On-site
79172	Domestic, Stock	48.76	08/04/1983	0	On-site
WRK095593	Observation	15	26/08/2016	17	southeast
WRK959979	Domestic & Stock	30	24/11/2002	21	northwest
79123	Not Known	34.74	31/07/1963	37	north
58464	Stock	97.5	28/04/1981	88	northwest
68900	Domestic, Miscellaneous, Stock	72	09/02/1988	137	southeast
68892	Domestic, Stock	67	29/11/1985	179	southeast
79167	Domestic	83.8	13/08/1982	221	east
68918	Domestic, Stock	59	01/09/1987	252	southeast
68899	Domestic	71.58	04/11/1988	318	southeast
68752	Domestic	0	31/12/1963	347	southeast
WRK983312		150		433	southwest
134017	Domestic	16	08/04/1997	517	southeast
68885	Domestic, Stock	15	20/10/1985	535	southeast
68887	Domestic	15	28/02/1985	537	southeast
68896	Domestic, Miscellaneous, Stock	16	15/01/1987	557	southeast
144025	Domestic, Stock	21	08/03/2001	601	southeast
68911	Domestic	23	07/03/1988	616	southeast
68926	Domestic	20	10/12/1987	636	southeast
132473	Domestic, Stock	25	07/04/1997	656	southeast
68913	Domestic	26	27/02/1989	798	southeast
79262	Domestic, Stock	106.68	22/03/1982	831	west
WRK095595	Observation	12	29/08/2016	843	southeast
111569	Domestic, Stock	34.5	05/12/1991	980	southeast
140504	Domestic, Stock	51	13/04/2000	995	north
113463	Domestic & Stock	25.5	23/04/1992	1045	southeast

Land Capability Assessment

Bore Id	Use Type	Bore depth (m)	Completed Date	Distance (m)	Direction
WRK042995	Irrigation	18	03/03/1999	1114	northwest
68871	Domestic, Stock	29	13/02/1985	1117	southeast
68848	Domestic, Stock	23	26/02/1981	1157	southeast
68828	Domestic	12.5	08/01/1976	1160	southeast
319780	Non-Groundwater	36.57	02/03/1970	1223	southwest
79267	Domestic, Stock	41	06/03/1988	1237	southeast
68780	Not Known	0	31/12/1970	1338	southeast
WRK059916	Domestic & Stock	0		1341	southeast
WRK095594	Observation	12	19/08/2016	1410	southeast
WRK983504		150		1433	west
310870	Non-Groundwater	42.36	31/12/1965	1455	south
WRK987506		150		1472	east
319778	Non-Groundwater	14.02	31/12/1965	1536	southwest
68876	Domestic	20	26/02/1985	1537	southeast
WRK985495	Groundwater Investigation	13.5	28/03/2008	1657	south
WRK063024	Observation	12	15/07/2011	1669	south
68909	Domestic, Stock	47	10/09/1989	1673	south
68800	Domestic, Stock	18.28	21/10/1974	1691	south
310876	Non-Groundwater	45.72	25/06/1970	1698	south
WRK990749	Observation	12	12/06/2009	1700	south
WRK990748	Observation	14	11/06/2009	1701	south
WRK990750		25		1727	south
68841	Domestic	43.7	14/03/1980	1735	south
68860	Not Known	29	25/03/1983	1779	southeast
79249	Not Known	0	31/12/1970	1793	southwest
68852	Domestic, Stock	22	07/04/1983	1804	southeast
140183	Stock	27.5	11/11/1999	1807	north
68754	Not Known	0	24/03/1965	1828	south
114717	Domestic & Stock	46	15/01/1992	1847	southeast
WRK038875	Irrigation	47	22/02/1989	1925	southeast
68915	Domestic, Stock	26	08/06/1989	1945	southeast
68912	Domestic, Stock	23	15/06/1989	1984	southeast
WRK969109		100		1987	southwest

Appendix D. Summary of Potential for Contamination

Table D-1. Summary of Site Characterisation – Potential for Contamination

Table summarising the contamination potential for each site within the GAEP, based on the land uses with potential to contaminate land presented in Table 2 of Planning Practice Note 30 (DELWP, 2021). Proposed further assessment is based on the approach presented in Table 3 of PPN30, assuming non-sensitive future use (i.e. commercial, industrial or open space land use).

Map Reference	Standard Parcel Identifier	Site Use / Activity	Description / Findings	Site Inspection ¹	Potential for Contamination	Recommended Further Action ³
1	CP107588	Agricultural land	Vacant agricultural land with an approximate area of 150 hectares (ha) situated south of Princes Highway. Two farm dams observed in close proximity to each other adjacent to Princes Highway.	Yes (from Pousties Road)	No potential for contamination	No further action required – General Environmental Duty Applies
2	42\LP7173	Agricultural land	Agricultural land (approximately 158 ha). Dilapidated farmhouse noted, along with two sheds. The land is used for cropping. Approximately three farm dams were observed within the property boundary.	Yes (from Pousties Road)	No potential for contamination	No further action required – General Environmental Duty Applies
3	41\LP7173	Agricultural land	Agricultural land (approximately 98 ha). Large shed present to the west of the property surrounded by various heavy equipment and agricultural machinery. Stockpiled soil was observed in front of the large shed. Intermediate Bulk Containers (IBCs) were also observed (contents unknown). Stock dip was visible which may still be in use. Livestock grazing on the property along with stockpiles of what appeared to be construction debris. Hay bales are also present. A communications tower was observed along Pousties Road. Land-use is a combination of pastoral farming and cropping.	Yes (from Pousties Road)	Medium potential for contamination	PRSA or audit option applies. PRSA to determine if the site needs environmental audit for its purposed use.
4	2\PS427409	BP Service Station	Located adjacent Princes Highway, the BP Service Station (Westbound) is a service station with restaurants and other associated commercial operations. It is a potential source of hydrocarbons for the adjacent parcels of lots. PPN30 defines service stations as presenting a high potential for contamination.	No	High potential for contamination	PSI to inform need for audit is recommended. <i>NOTE: If sensitive land uses are proposed, completion of environmental audit is recommended.</i>
5	1\PS427409	Agricultural land	This parcel of land (approx. 71 ha) was the location of the former white oil pipeline (WOPL) leak incident that occurred in 2004. Residual contamination is understood to remain in soil and groundwater following clean up to the extent practicable. A GQRUZ has been proposed that covers part of this property, reflecting the fact that some beneficial uses of groundwater could be precluded based on residual contamination. On this basis, there is a high potential for contamination to remain at the site. Observations from the site reconnaissance (from Pousties Road) include: - Security fence at the entrance - Large shed with no visible heavy equipment - Ablutions building with rainwater supply - One farm dam with soil stockpile next to it near Pousties Road. - Other materials that remain on site from the completed remediation works will be removed once ground conditions allow truck access (information provided by landowner).	Yes (from Pousties Road)	High potential for contamination	PSI to inform need for audit is recommended. <i>NOTE: If sensitive land uses are proposed, completion of environmental audit is recommended.</i>
6	1\LP213752	Agricultural land	This parcel of land (approx. 60 ha) is currently the site of a large quantity of stockpiles, likely associated with the construction of a new access road towards the east of the property. Temporary facilities (demountable units) were installed with presence of heavy machinery in the area. Other observations from Pousties Road include: - Light coloured mounds of soil behind the front row of darker stockpiled soil. - Cleared paddock with soil pushed into stockpiles along Pousties Road boundary. - Signage indicating some form of spoil management is being undertaken at the site. It is noted that this property is located to the south of the above property number 5 (where the remediation activities associated with the WOPL leak occurred). The proposed GQRUZ (as discussed above) extends on to this property reflecting the fact that some beneficial uses of groundwater could be precluded based on residual contamination. On this basis, there is a high potential for contamination to remain at the site.	Yes (from Pousties Road)	High potential for contamination	PSI to inform need for audit is recommended. <i>NOTE: If sensitive land uses are proposed, completion of environmental audit is recommended.</i>
7	2\LP213752	Agricultural land	This parcel features a dense line of trees that bisects the parcel diagonally from north to south. The line stretches from Beach Road to the adjacent side of Princes Highway. Majority of the area is open space / agricultural land that has an approximate area of 60 ha. It is noted that this property is located to the west of the above property number 5 (where the remediation activities associated with the WOPL leak occurred). The proposed GQRUZ (as discussed above) extends on to this property reflecting the fact that some beneficial uses of groundwater could be precluded based on residual contamination. On this basis, there is a high potential for contamination to remain at the site.	No	High potential for contamination	PSI to inform need for audit is recommended. <i>NOTE: If sensitive land uses are proposed, completion of environmental audit is recommended.</i>
8	1\TP741317	Commercial Area / Geelong Motor Sports Complex	This is a 20-ha parcel of lot which is mainly used for motorsports. The site features a main racetrack as well as what appears to be several smaller racetracks. Supporting infrastructure is also present including buildings and other structures. Possible on-site storage of fuel.	No	No potential for contamination	No further action required – General Environmental Duty Applies

Map Reference	Standard Parcel Identifier	Site Use / Activity	Description / Findings	Site Inspection ¹	Potential for Contamination	Recommended Further Action ³
9	1\TP711117	Vacant land	This is an irregular oblong shaped parcel that is located between the intersection of Beach Road and Process Freeway. No features of note are identified within this area.	No	No potential for contamination	No further action required - General Environmental Duty Applies
10	1\TP811346	Open space / agricultural land	The 102-ha property is used as agricultural land / cropping. A drainage line crosses the property from the north-west towards the eastern boundary of the property. No other features of note.	No	No potential for contamination	No further action required - General Environmental Duty Applies
11	3\TP221328	Salt evaporation ponds of the former Cheetham Saltworks Ltd	The 21-ha parcel is the northernmost extension of the salt evaporation ponds. Drainage line appears to enter the property along its eastern boundary from Avalon Airport. Previous assessment conducted by Senversa (2022) that considered CoPC relating to both the adjacent Avalon Airport and the former salt works indicated limited evidence of contamination. However, no assessment of surface water (the likely primary transport mechanism for PFAS) was undertaken (only soil and groundwater). On this basis, the potential for contamination is considered to be medium.	No	Medium potential for contamination	PRSA or audit option applies. PRSA to determine if the site needs environmental audit for its purposed use.
12	2\TP221328	Salt evaporation ponds of the former Cheetham Saltworks Ltd	The 64-ha was mainly used as salt evaporation ponds. Drainage line appears to enter the property along its eastern boundary from Avalon Airport. Previous assessment conducted by Senversa (2022) that considered CoPC relating to both the adjacent Avalon Airport and the former salt works indicated limited evidence of contamination. However, no assessment of surface water (the likely primary transport mechanism for PFAS) was undertaken (only soil and groundwater). On this basis, the potential for contamination is considered to be medium.	No	Medium potential for contamination	PRSA or audit option applies. PRSA to determine if the site needs environmental audit for its purposed use.
13	1\TP221328	Salt evaporation ponds of the former Cheetham Saltworks Ltd	The 64-ha was mainly used as salt evaporation ponds. Drainage line appears to enter the property along its eastern boundary from Avalon Airport. Previous assessment conducted by Senversa (2022) that considered CoPC relating to both the adjacent Avalon Airport and the former salt works indicated limited evidence of contamination. However, no assessment of surface water (the likely primary transport mechanism for PFAS) was undertaken (only soil and groundwater). On this basis, the potential for contamination is considered to be medium.	No	Medium potential for contamination	PRSA or audit option applies. PRSA to determine if the site needs environmental audit for its purposed use.
14	1\TP411602	Salt evaporation ponds of the former Cheetham Saltworks Ltd	The 64-ha was mainly used as salt evaporation ponds. Drainage line appears to enter the property along its eastern boundary from Avalon Airport. Previous assessment conducted by Senversa (2022) that considered CoPC relating to both the adjacent Avalon Airport and the former salt works indicated limited evidence of contamination. However, no assessment of surface water (the likely primary transport mechanism for PFAS) was undertaken (only soil and groundwater). On this basis, the potential for contamination is considered to be medium.	No	Medium potential for contamination	PRSA or audit option applies. PRSA to determine if the site needs environmental audit for its purposed use.
15	1\PS637574	Vacant agricultural land with some salt evaporation ponds of the former Cheetham Saltworks Ltd	Approximately 237-ha property which is vacant agricultural land. Some salt evaporation ponds of the former Cheetham Saltworks Ltd are located within the property boundary. The area was historically used as pasture land for livestock. Drainage line appears to enter the property along its eastern boundary from Avalon Airport. Previous assessment conducted by Senversa (2022) that considered CoPC relating to both the adjacent Avalon Airport and the former salt works indicated limited evidence of contamination.	Yes (from Avalon Road)	No potential for contamination	No further action required - General Environmental Duty Applies
16	1\TP811346	Agricultural land	This 39-ha parcel is currently being used as an agricultural land. One large shed is present in the southern extent of the property.	Yes (from Avalon Road)	No potential for contamination	No further action required - General Environmental Duty Applies
17	1\LP76925	Vacant land	The parcel is a 3-ha vacant lot with two residential houses / dwelling areas and a shed on its eastern side. A large farming machinery was observed as well as pile of bricks which are visible from Avalon Road. There was an old stock dip present and there were also stockpiles of soil/gravel & rubbish observed. The presence of a stock dip represents a medium potential for contamination.	Yes (from Avalon Road)	Medium potential for contamination	PRSA or audit option applies. PRSA to determine if the site needs environmental audit for its purposed use.
18	2\LP76925	Vacant agricultural land with some salt evaporation ponds of the former Cheetham Saltworks Ltd	This 78-ha parcel was mainly used as salt evaporation ponds. Almost half of the parcel is vacant agricultural land. Previous assessment conducted by Senversa (2022) that considered CoPC relating to both the adjacent Avalon Airport and the former salt works indicated limited evidence of contamination.	Yes (from Avalon Road)	No potential for contamination	No further action required - General Environmental Duty Applies
19	1\TP520413	Salt evaporation ponds of the former Cheetham Saltworks Ltd	This 61-ha parcel of lot was mainly used as salt evaporation ponds. Previous assessment conducted by Senversa (2022) that considered CoPC relating to both the adjacent Avalon Airport and the former salt works indicated limited evidence of contamination.	Yes (from Avalon Road)	No potential for contamination	No further action required - General Environmental Duty Applies
20	1\TP334251	Salt evaporation ponds of the former Cheetham Saltworks Ltd	This 66-ha parcel of lot was mainly used as salt evaporation ponds. Previous assessment conducted by Senversa (2022) that considered CoPC relating to both the adjacent Avalon Airport and the former salt works indicated limited evidence of contamination.	No	No potential for contamination	No further action required - General Environmental Duty Applies
21	9\PS805191	Residential with sheds (livestock-related (horses) facilities)	Classified as special use zone (SUZ), this 4-ha residential property (with a 150 m ² circular and 1,800 m ² rectangular horse pens on the east side) was observed to have a stockpile of waste timber near Avalon Road. As viewed from Dandos road, several hay bales were also present inside the property.	Yes (from Avalon Road)	No potential for contamination	No further action required - General Environmental Duty Applies

Map Reference	Standard Parcel Identifier	Site Use / Activity	Description / Findings	Site Inspection ¹	Potential for Contamination	Recommended Further Action ³
22	B\PS818653	Salt evaporation ponds of the former Cheetham Saltworks Ltd	This 124-ha parcel of lot was mainly used as salt evaporation ponds. On the west side, there is a strip of vacant agricultural land. Previous assessment conducted by Senversa (2022) that considered CoPC relating to both the adjacent Avalon Airport and the former salt works indicated limited evidence of contamination.	No	No potential for contamination	No further action required - General Environmental Duty Applies

- Notes:**
- 1. Yes – denotes properties that were viewed from publicly accessible areas for the purposes of completing a site observations. Observations presented relate to both visual on-site observations as well as observations made from aerial images of the site.
 - 2. No – denotes properties that were not directly accesses for the purposes of completing a site inspection. Observations are those made based on review of aerial images.
 - 3. Recommended further actions are based on an assumed future commercial, industrial or public open space land use. Where a sensitive and use is proposed, a note has been included that specifies an alternate recommendation.