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SEPTEMBER 2018

MORDIALLOC BYPASS

CONTAMINATED LAND IMPACT ASSESSMENT

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Mordialloc Bypass
Contaminated Land Impact Assessment

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GLOSSARY

Item	Definition	Reference
Acid sulfate soil	Any soil, sediment, unconsolidated geological material or disturbed consolidated rock mass containing metal sulfides which exceeds criteria for acid sulfate soils specified in the *Environment Protection Authority Victoria (EPA) (July 2009) Publication 655.1 Acid Sulfate Soil and Rock.*	EPA Publication 655.1
Beneficial use	Environmental values and human uses which needs protection in the defined area of the environment, as defined in *EPA (June 2002) Publication 854 Prevention and Management of Contamination of Land in Victoria* (EPA Publication 854).	EPA Publication 854
Conceptual site model	A description of a site including the environmental setting, geological, hydrogeological and soil characteristics together with the nature and distribution of contaminants. Potentially exposed populations and exposure pathways are identified (as described in the *National Environment Protection Council [1999] National Environment Protection [Assessment of Site Contamination] Measure, as amended in 2013* [NEPM 2013]).	NEPM 2013
Contamination	The condition of land or water where any chemical substance or waste has been added as a direct or indirect result of human activity at above background level and represents, or potentially represents, an adverse health or environmental impact	NEPM 2013
Ecological investigation levels (EILs)	Concentrations of contaminants above which further appropriate investigation and evaluation will be required. EILs depend on specific soil physicochemical properties and land use scenarios and generally apply to the top 2 m of soil. EILs may also be referred to as soil quality guidelines in Schedules B5b and B5c	NEPM 2013
Ecological screening levels (ESLs)	For petroleum hydrocarbons, ESL are the concentrations above which further appropriate investigation and evaluation will be required. ESLs broadly apply to coarse- and fine-grained soils and various land uses. They are generally applicable to the top 2 m of soil.	NEPM 2013
Health investigation levels (HILs)	The concentrations of a contaminant above which further appropriate investigation and evaluation will be required. HILs are generic to all soil types and generally apply to the top 3 m of soil.	NEPM 2013
Health screening levels (HSLs)	For petroleum hydrocarbons are the concentrations above which further appropriate investigation and evaluation will be required. HSLs depend on physicochemical properties of soil, as these affect hydrocarbon vapour movement in soil, and the characteristics of building structures. HSLs apply to different soil types, land uses and depths below surface to >4 m and have a range of limitations.	NEPM 2013

Item	Definition	Reference
Investigation levels and screening levels	Concentrations of a contaminant above which further appropriate investigation and evaluation will be required. Investigation and screening levels provide the basis of Tier 1 risk assessment.	NEPM 2013
Risk	The probability in a certain timeframe that an adverse outcome will occur in a person, a group of people, plants, animals and/or the ecology of a specified area that is exposed to a particular dose or concentration of a chemical substance, that is, it depends on both the level of toxicity of the chemical substance and the level of exposure to it.	NEPM 2013
Risk assessment	The process of estimating the potential impact of a chemical, physical, microbiological or psychosocial hazard on a specified human population or ecological system under a specific set of conditions and for a certain timeframe.	NEPM 2013
Risk management	A decision-making process involving consideration of political, social, economic and technical factors with relevant risk assessment information relating to a hazard to determine an appropriate course of action.	NEPM 2013
State Environment Protection Policy (SEPPs)	Describes environmental quality and how it is to be maintained for the protection of any beneficial use, describes the community expectations for protection and use of environment, as defined in EPA Publication 854.	EPA Publication 854

ABBREVIATIONS

ACM	Asbestos Containing Material
AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment and Conservation Council
AQM	Air Quality Management
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ASS	Acid Sulfate Soil
ASSMP	Acid Sulfate Soil Management Plan
BPEM	Best Practice Environmental Management
CASS	Coastal Acid Sulfate Soil
CBD	Central Business District
CEMP	Construction Environment Management Plan
CSM	Conceptual Site Model
EES	Environment Effects Statement
EMF	Environmental Management Framework
EMP	Environment Management Plan
EPA	Environment Protection Authority Victoria
EPR	Environmental Performance Requirements
ESA	Environmental Site Assessment
HIL/HSL	Health Investigation Level/Health Screening Level
IWRG	Industrial Waste Resource Guidelines
mAHD	Metres above Australian Height Datum
mBGL	Metres Below Ground Level
NEMP	National Environmental Management Plan (for PFAS)
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NHMRC	National Health and Medical Research Council
OCP/OPP/PCB	Organochlorine Pesticide/Organophosphorus Pesticide/Polychlorinated Biphenyl
OEMP	Operational-phase Environmental Management Plan
OH&S	Occupational Health and Safety
OHSP	Occupational Health and Safety Plan

PASS/AASS	Potential Acid Sulphate Soil/Actual Acid Sulphate Soil
PFAS	Per and Polyfluoro-alkyl Substances
PFHxS	Perfluorohexane sulfonate
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctane sulfonate
PIW	Prescribed Industrial Waste
PPE	Personal Protective Equipment
PSI	Preliminary Site Investigation
RSL	Regional Screening Level (US EPA Region 9)
SAQP	Sampling and Analysis Quality Plan
SEPP	State Environment Protection Policy
SPOCAS	Suspension Peroxide Oxidation Combined Acidity
TDS	Total Dissolved Solids
TRH	Total Recoverable Hydrocarbon
UPSS	Underground Petroleum Storage Systems

EXECUTIVE SUMMARY

This report provides a Technical Impact Assessment of Contaminated Land and Acid Sulfate Soils (this Technical Impact Assessment) for the proposed Mordialloc Bypass, located between the newly constructed Dingley Bypass in Dingley Village and Thames promenade in Chelsea Heights, Victoria (the project).

The purpose of the overarching Environment Effects Statement (EES), which this Technical Impact Assessment has been prepared in support of, is to: provide a sufficiently detailed description of the project; assess its potential effects on the environment; and assess alternative project layouts, designs and approaches to avoid and mitigate effects. The purpose of this Technical Impact Assessment is to assess and document the contaminated land and acid sulfate impacts to the environment during construction and operation of the project. This Technical Impact Assessment Report also outlines the methodology for the assessment, relevant risks and impacts and proposed mitigation measures for the project.

A Baseline ESA was completed for the project, which provides a high-level indication of the contamination present along the project alignment. The Baseline ESA has identified land contamination (soil, landfill gas, groundwater and leachate) at the project area. In particular, in the Northern Portion of the project area a number of former landfills are present; and contaminated soil, groundwater, landfill gas and leachate was identified. In addition, a potential to encounter waste mass, odorous material and poly and perfluoroalkyl substances (PFAS) impacts also exists. In the Central Portion of the project area, asbestos containing material (ACM) was encountered in one area, which may be a result of uncontrolled/illegal dumping. In addition, there is a potential for PFAS impacts to be present from the nearby Moorabbin Airport. Acid Sulfate soils (ASS) are likely to be present from Mills Road (Central Portion) to the southernmost boundary of the project.

Impacts to contaminated land and acid sulfate soils can be summarised into seven categories. Categories and assessed residual risks are noted below:

- Disturbance, handling, storage and disposal of PASS/ASS during the construction and operation phases resulting in environmental or health impacts was assessed as LOW RISK
- Disturbance, handling, storage and disposal of contaminated soil during the construction and operation phases resulting in environmental or health impacts was assessed as MEDIUM RISK
- Management of soil repositories (including PFAS contaminated wastes) during the construction and operation phases resulting in environmental or health impacts was assessed as MEDIUM RISK
- Inflow of contaminated groundwater during the construction and operation phases resulting in environmental or health impacts was assessed as LOW RISK
- Management of existing landfill (landfill waste, leachate and landfill gas including PFAS impacted waste) during the construction and operation phases resulting in environmental or health impacts was assessed as MEDIUM RISK
- Changes to groundwater migration flow paths and environmental impact on the Edithvale Wetlands and movement of contaminants resulting in environmental or health impacts was assessed as LOW RISK
- Management of other waste streams (fuel/chemical spills, waste water spills, rainwater/surface water run off) during the construction and operation phases resulting in environmental or health impacts was assessed as LOW RISK

The risks will be managed through the development and implementation of mitigation measures which are as follows:

- Prior to any earthworks or construction activities for the project, implementation of an Environmental Management System (EMS) and a Construction Environment Management Plan (CEMP) to manage impacts from contamination and acid sulfate soil.

- With regards to excavation spoil, it is recommended that the design minimises disturbance on any defined contaminated areas such as in former landfilled areas. Collection of additional data should be undertaken in order to reduce uncertainty in the nature and extent of soil contamination and waste soil classification. This can be undertaken in situ to allow categorisation of soil prior to excavation. This can be conducted in conjunction with the road construction works. An EPA licensed waste disposal and soil treatment facility located within a feasible distance from the project area should be engaged.

- Preparation and implementation of a soil management plan. The work plan should include guidance on materials tracking and monitoring and should detail roles and responsibilities and mitigation measures where issues arise from handling materials (e.g. sent to wrong treatment facility, delay in removal of spoil, unexpected events such as spills, larger than anticipated volume).
- Given the nature of construction works, disturbance of ASS cannot be totally avoided. The CEMP to be prepared for the project should also include work plan on ASS Management Plan. The ASS Management Plan will describe how acceptable outcomes will be achieved on-site. Soil predicted to be ASS should be immediately removed from the project area and transported to a facility licensed to accept such material. It is not recommended that ASS would be stockpiled in the project area. A maximum of 18 hours' exposure to air without treatment is an acceptable timeframe. Where treatment is required, current information indicated the liming rates required range from 2 to 12.5 kg $CaCO_3$ per tonne based on a bulk density of 1.8 tonne per m^3. In addition, piling activities may cause acidic water to be mobilised into the surrounding groundwater environment (and piling installation methods should be developed to mitigate this risk).
- Installation of a passive landfill gas capture (gas drainage blanket or trenches) beneath the roadway with appropriate venting (e.g. stacks or biofiltration) in order to minimise accumulation of landfill gas below roadways as well as minimising potential for the roadway of substantially altering the gas emission regime.
- Consideration of design measures to include installation of gas protection measures in all underground services, pits and other voids installed within the road alignment which may include sealing (e.g. geomembranes, etc.) and sealing of conduits and pits (where applicable) entering and leaving the project area.
- Preparation and implementation of a Construction-phase Landfill Gas Management Plan and Operational-phase Landfill Gas Management Plan for the section of the Mordialloc Bypass affected by landfill gas, which outlines procedures for any future works within the target area, means of protection of inground gas protection/mitigation systems and monitoring requirements.
- The Construction-phase Landfill Gas Management Plan should detail specific monitoring and risk mitigation requirements that are to be implemented during the construction phase to reduce landfill gas-related risks to neighbouring land users, site workers, plant and equipment.
- The Operational-phase Landfill Gas Management Plan should outline the requirements for the implementation of a monitoring program (surface, sub-surface and internal/underground voids, pits and service trenches) to assess ongoing risk associated with landfill gas generated by the former landfills in the northern portion of the project area.
- Preparation and implementation of a site-specific PFAS management plan that incorporates mitigation measures. If PFAS contamination is to be present at concentrations that warrant remediation, a hierarchy of preferred treatment and remediation options is set out in the Heads of EPA (2018) PFAS National Environmental Management Plan (NEMP). The most preferred is separation, treatment and destruction, followed by onsite encapsulation in engineered facilities, with the least preferred being offsite removal to a specific landfill cell (subject to Environment Protection Authority Victoria [EPA] approval, if this option becomes available in the future).

The mitigation measures are included in the EPRs to set out the desired environmental outcomes of the project. The EPRs are applicable to all project phases and provided certainty regarding the project's environmental performance. Through implementation of the EPRs the project would meet the evaluation objectives in the Scoping Requirements.

1 INTRODUCTION

This report provides a Technical Impact Assessment of Contaminated Land and Acid Sulfate Soils (this Technical Impact Assessment) prepared in support of an Environment Effects Statement (EES) for the proposed Mordialloc Bypass (the project), located between the newly constructed Dingley Bypass in Dingley Village to Thames Promenade in Chelsea Heights, Victoria (the project area).

Report Figure 1.1 and report Figure 1.2 show the project area and regional setting. More detailed figures are attached as Figures 1 to 3, Appendix A.

1.1 PURPOSE

The purpose of this Technical Impact Assessment is to define the required measures to mitigate potential effects resulting from the disturbance or mobilisation of soil contaminants or potential acid sulfate soils as a result of the construction of the project.

More detailed information regarding the scoping of this Technical Impact Assessment are provided in Section 2.

1.2 PROJECT OVERVIEW AND DESCRIPTION

The Mordialloc Bypass project (the project) is the proposed construction and operation of a new freeway connecting the Dingley Bypass with the Mornington Peninsula Freeway; and is predominately within an existing road reservation. The project passes between the western boundary of Braeside Park and the eastern boundary of the Woodlands Estate (constructed) wetlands, traverses constructed wetlands at Waterways and approaches to within a kilometre of the Ramsar-listed Edithvale-Seaford Wetlands. The northern and southern ends of the project pass through or border the South East Green Wedge.

The project corridor is approximately 9.7 km in length, comprising two two-lane 7.5 km long carriageways (with a path for walking and cycling) along the greenfield alignment, and 2.2 kilometres of roadworks required to integrate the project with the Mornington Peninsula Freeway. It is expected that each carriageway will provide for two 3.5 metre wide lanes, with a 3.0 metre wide outside shoulder and 1.0 metre wide inside shoulder. The Mordialloc Bypass will also provide connections from the freeway onto the Dingley Bypass, Centre Dandenong Road, Lower Dandenong Road, Governor Road, Springvale Road and new north facing ramps at Thames Promenade. There will also be an overpass at Old Dandenong Road. Mordialloc Creek and the associated Waterways Wetlands will be spanned by twin 400 metre long bridges.

The proposed alignment allows for a future upgrade of the project to a six-lane freeway standard road within the construction footprint.

The proposed alignment is generally located within the existing road reservation, most of which is already covered by Public Acquisition Overlay, and some of which is already in VicRoads’ ownership.

The proposed project consists of:

- Four-lane freeway standard cross-section (two lanes in each direction), divided by a centre median.
- 100 km/hr posted speed limit.
- Full diamond interchanges at Springvale Road, Governor Road and Lower Dandenong Road whereby Mordialloc Bypass is elevated over the arterial roadway with northbound and southbound entry and exit ramps providing access for all directions of travel.
- Half single point urban interchange at Centre Dandenong Road whereby Mordialloc Bypass is elevated over Centre Dandenong Road and southbound entry and northbound exit ramps provide accessibility to and from the south.

- Addition of northbound entry and southbound exit ramps at the existing Mornington Peninsula Freeway interchange at Thames Promenade to provide access to and from Mordialloc Bypass. The existing interchange provides ramps to and from Mornington Peninsula Freeway to the south only. The proposed entry and exit ramps will create a full diamond interchange at Thames Promenade.
- An at-grade T-signalised intersection at Dingley Bypass.
- Elevation of the bypass over Old Dandenong Road and Bowen Parkway to maintain existing connectivity on these routes.
- Shared use path running north-south along the length of the Mordialloc Bypass and connecting existing paths along the north side of Dingley Bypass and the south side of Springvale Road adjacent to Chelsea Heights Hotel.
- Bus queue jump lanes provided in intersection configurations at the proposed Springvale Road and Centre Dandenong Road interchanges.

The project area for Mordialloc Bypass traverses the suburbs of Clayton South, Dingley Village, Braeside, Waterways, Aspendale Gardens, Chelsea Heights and Bangholme in the City of Kingston and City of Greater Dandenong.

The project area is situated approximately 25 km south east of the Melbourne CBD and 5.0 km east of Mordialloc. The proposed road runs approximately north to south from Dingley Bypass at the project area's northern boundary to Thames Promenade in Chelsea Heights at the project area's southern boundary and provides connections to Springvale Road, Governor Road, Lower Dandenong Road and Centre Dandenong Road.

The project alignment is shown in report Figure 1.1 and its location relative to Melbourne is shown on report Figure 1.2.

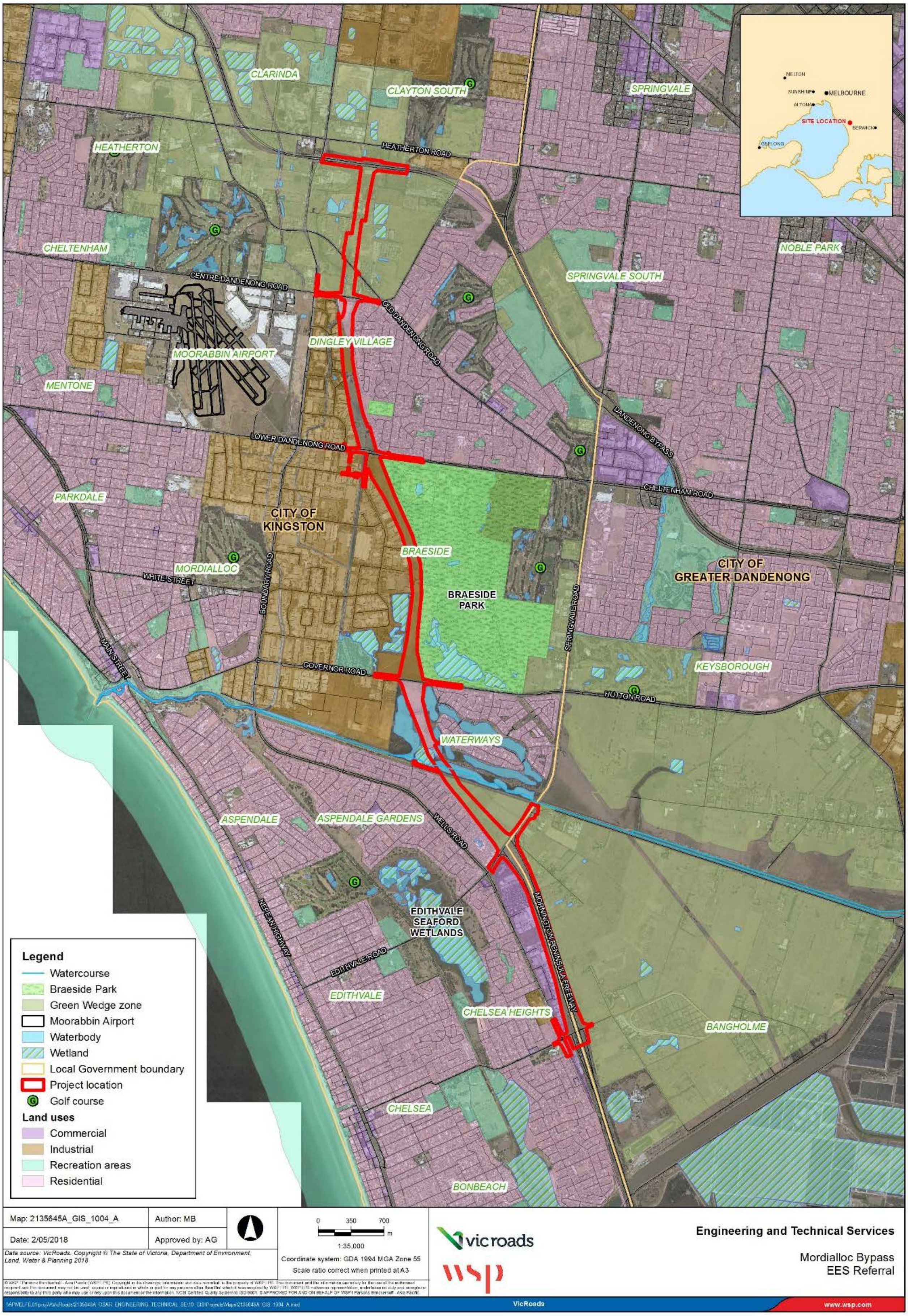

Figure 1.1 Project alignment

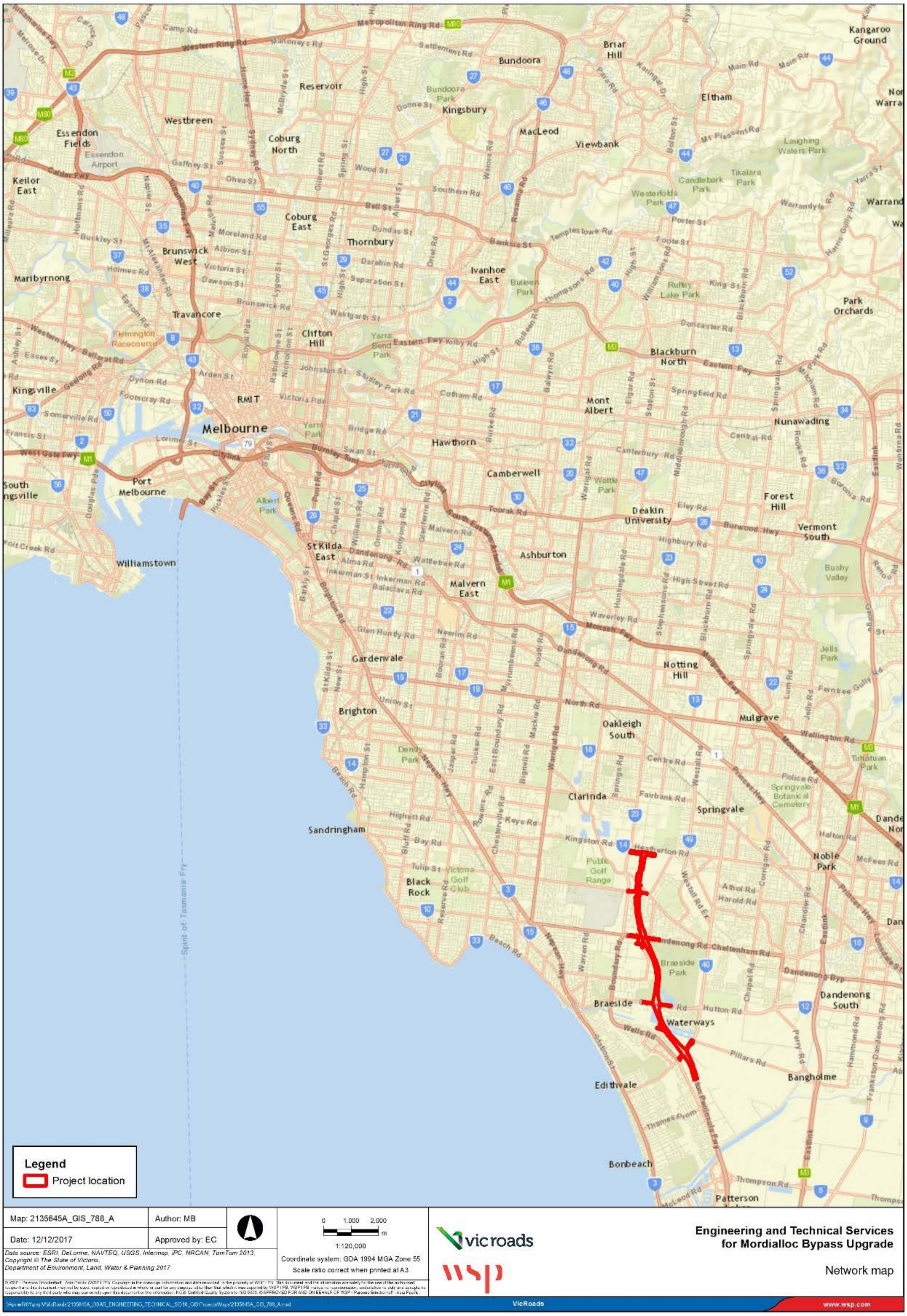

Figure 1.2 Mordialloc Bypass location relative to Melbourne

1.3 PROJECT STAGING

The project site has been divided into three key Study Areas:

- **Northern Portion:** between Dingley Bypass and Centre Dandenong Road.
- **Central Portion:** between Centre Dandenong Road and the Mordialloc Creek.
- **Southern Portion:** between Mordialloc Creek and the southernmost boundary of the project area at Thames Promenade, Chelsea Heights.

1.4 CONTEXT

The purpose of this Technical Impact Assessment is to assess and document the contaminated land and acid sulfate impacts to the environment during construction and operation of the project; the methodology for the assessment, relevant risks; and proposed mitigation measures.

As defined by NEPM 2013, contamination means "*the condition of land or water where any chemical substance or waste has been added as a direct or indirect result of human activity at above background level and represents, or potentially represents, an adverse health or environmental impact*". There is also naturally occurring contamination however, such as acid sulfate soils.

The assessment of contaminated land impacts is given significant considerations in construction projects due to a number of reasons including, but not limited to, the following:

- **Occupational health and safety**: Contaminated sites can be hazardous to health of workers.
- **Design considerations:** The presence of certain chemicals (i.e. aggressive soil and/or groundwater) may be incompatible with some building materials.
- **Spoil management:** Construction may require displacement of a large volume of soils and management of excess material has cost and environmental implications.
- **Treatment and containment of contamination:** Depending on the nature and extent of contamination within the project boundary, remediation and containment may be required to reduce associated risks.

1.5 LIMITATIONS

This Technical Impact Assessment is based on a road design that is still at concept stage and a design options assessment is in progress at the time of writing this Technical Impact Assessment. Should the project area or design change, then a reassessment of the environmental contamination status and potential impacts and risks would be required.

Further report limitations are included in Section 10.

2 EES OBJECTIVES AND REQUIREMENTS

The *Victoria State Government (February 2018) Environment Effects Act 1978 Scoping Requirements for Mordialloc Bypass Environ Effects Statement* (Scoping Requirements) documents the specific matters to be investigated and documented in the EES for the project.

Those relevant to the assessment of contaminated land and acid sulfate soil (which this Technical Impact Assessment addresses) are summarised below.

2.1 MINISTER'S REQUIREMENT

The Minister's requirements for the EES specified in the Scoping Requirements as a key matter to be examined are the potential effects resulting from disturbance or mobilisation of anthropogenic soil contaminants or potential acid sulfate soils.

2.2 EVALUATION OBJECTIVE

The evaluation objective specified in the Scoping Requirements is to prevent adverse environmental or health effects from disturbing, storing or influencing the transport/ movement of contaminated or acid-forming material.

2.3 KEY ISSUES

The key issues that are specified in the Scoping Requirements as matters to be addressed are as follows:

- Potential for adverse environmental or health effects resulting from disturbance of or influencing the transport/ movement of contaminated soil, soil gases/vapours and/or groundwater
- Potential for adverse environmental or health effects resulting from handling, storage or transportation of excavated contaminated spoil or potential acid sulfate soils (PASS)
- Potential for adverse environmental or health effects from other waste materials/streams generated from project works
- Potential for adverse environmental effects on the Edithvale-Seaford Wetlands Ramsar site resulting from disturbing, storing or influencing the transport/ movement of contaminated or acid-forming material.

2.4 PRIORITIES FOR CHARACTERISING THE EXISTING ENVIRONMENT

The priorities for characterising the existing environment that are specified in the Scoping Requirements as matters to be addressed are as follows:

- Identify likely occurrence of PASS, contaminated soil and groundwater, and other potential sources of contaminated materials in the project area and their approximate location
- Identify the likely occurrence of contaminated soils, gases/vapours and groundwater in the project area and nearby that have the potential to be altered or impacted by the project
- Characterise the physical and chemical properties of the project area soils including the potential environmental risks (e.g. potential for contamination, salinity, nutrients and acidification)
- Identify volumes and characteristics of excavated spoil
- Identify other key waste streams that may be generated from the project.

2.5 DESIGN AND MITIGATION MEASURES

The design and mitigation measures that are specified in the Scoping Requirements as matters to be addressed are as follows:

- Identify methods to manage the potential activation of PASS and contaminated soil during construction
- Outline and assess measures for the management of soils to minimise potential adverse effects on local hydrology and water quality associated with project area soils
- Identify options for treating, reusing or disposing of excavation spoil with reference to the waste hierarchy, including for both contaminated and clean materials, and identify the routes and destinations for spoil material to be transported away from the project work sites
- Identify suitable off-site disposal options for waste materials
- Identify possible capacity issues that could affect either the management of waste on-site or disposal off-site, particularly given other proposed works (such as the Melbourne Metro Rail Project, the West Gate Tunnel Project and level crossing removal projects) that will also be generating spoil
- Describe and evaluate proposed design, management or site protection measures that could avoid or mitigate potential adverse effects of the excavated spoil or other waste streams generated by the project on environmental values, or human health during the project construction.

2.6 ASSESSMENT OF LIKELY EFFECTS

The assessment of likely effects that are specified in the Scoping Requirements as matters to be addressed are as follows:

- Assess the potential contaminated sites that may be within the zone of change to groundwater, to determine the presence and potential migration or movement of contaminant plumes
- Assess the potential effects of PASS and contaminated soil on environmental and human health during the project construction
- Assess the effects on environmental values from the project construction waste streams.

2.7 APPROACH TO MANAGE PERFORMANCE

The approach to manage performance that is specified in the Scoping Requirements as a matter to be addressed is as follows:

- Describe principles to be adopted for monitoring and management of spoil and other waste streams, including as part of the environmental management framework (EMF).

3 LEGISLATION AND POLICY

The evaluation objective and associated assessment criteria provides a framework to assess the potential environmental impacts of the Project and responds to key legislations, policies and guidelines. Table 3.1 summarises the legislation and policies relevant to the investigation and management of contaminated soil, groundwater and acid sulfate soil at the project area.

Table 3.1 Regulatory framework

DOCUMENT	DESCRIPTION
Legislation and Regulations	
Environment Protection Act 1970	The Environment Protection Act 1970 aims to prevent pollution and environmental damage by setting environmental quality objectives and establishing programs to meet them. The Act establishes the powers, duties and functions of the Environment Protection Authority Victoria (EPA). These include the administration of the Act and any regulations and orders made pursuant to it, recommending State environment protection policies (SEPP), issuing works approvals, licences, permits, pollution abatement notices and implementing National Environment Protection Measures.
Government of Victoria (2002) State Environment Protection Policy (SEPP) Prevention and Management of Contamination of Land), as varied in 2013 (SEPP Land)	The SEPP Land establishes general uses of land in Victoria and provides a mechanism for determining whether these uses are being protected, such as indicators and objectives of use in assessing impacts. The SEPP also identifies the links between the environmental audit system and the statutory planning system, ensuring sites that need to be audited are subject to audit, and that any conditions associated with the audit outcome are implemented. The SEPP further sets out requirements for the prevention of contamination, reinforces the role of the waste hierarchy in selecting preferred approaches for site clean-up and identifies measures by which people can access relevant information on site contamination.
Government of Victoria (1997) SEPP Groundwaters of Victoria, as varied in 2003 (SEPP Groundwaters	The SEPP Groundwaters of Victoria was developed to meet community demands for an integrated framework of environment protection goals for groundwater. It aims to maintain and, where necessary, improve groundwater quality to a standard that protects existing and potential beneficial uses of groundwaters. It sets a consistent approach to, and provides quality objectives for groundwater protection throughout Victoria.
Government of Victoria (1988) SEPP Waters of Victoria, as varied in 2004 (SEPP Waters)	The SEPP Waters of Victoria was developed to meet community demands for an integrated framework of environment protection goals for Victoria's surface water environment. It sets a consistent approach to setting out environmental values and beneficial uses of water and provides quality objectives for surface water protection throughout Victoria. (The SEPP Waters has been reviewed and is currently open to consultation until June 2018, the finalised policy is anticipated to be released in 2018/2019).

DOCUMENT	DESCRIPTION
Environment Protection (Industrial Waste Resource) Regulations 2009	Sets regulations to assist industry to implement the principles of waste hierarchy (as set out in Environment Protection Act 1970) and prescribe requirements for assessing, categorising and classifying industrial waste and prescribed industrial waste for the purposes of *Environment Protection Act 1970*.
Victorian Government (August 1999) Industrial Waste Management Policy (Waste Acid Sulfate Soil).	Outlines a management framework and sets specific requirements for the best practice management of waste acid sulfate soils.
Guidelines	
National Environment Protection Council (1999) National Environment Protection (Assessment of Site Contamination) Measure, as varied in 2013 (NEPM 2013)	Provides the national framework for conducting contaminated land investigations in Australia.
EPA (June 2009) Industrial Waste Resource Guidelines Soil Hazard Categorisation and Management (IWRG 621)	Guidelines for implementing and adhering to the Industrial Waste Resource Regulations, including waste categorisation and classification, waste transport, sampling and analysis and disposal.
EPA (June 2009) Industrial Waste Resource Guidelines Sampling and Analysis of Waters, Wastewaters, Soil and Wastes (IWRG 701)	Guidelines for implementing and adhering to the Industrial Waste Resource Regulations and provides information on steps needed in any environmental monitoring program.
EPA (June 2009) Industrial Waste Resource Guidelines Soil Sampling (IWRG 702)	Guidelines for implementing and adhering to the Industrial Waste Resource Regulations and provides information on most suitable patterns for sampling and the number of samples to be taken to ensure appropriate hazard categorisation is applied to soils being moved offsite for reuse, treatment and disposal.
EPA (September 2006) Publication 668 Hydrogeological Assessment (Groundwater Quality) Guidelines	Provides guidelines and detailed overview on the requirements for a hydrogeological assessment to identify the risk to health and the environment from potential contamination.
EPA (April 2000) Publication 669 Groundwater Sampling Guidelines	Provides guidelines and information on practices that will assist with accurate and consistent practices in sampling groundwater.
EPA (July 2009) Publication 655.1 Acid Sulfate Soil and Rock	Provides guidance to landowners, developers, consultants and other people involved in the disturbance of soil, sediment, rock and/or groundwater about identifying, classifying and managing acid sulfate soils and rock. Waste acid sulfate soils and rock must be managed in accordance with the requirements of the Industrial Waste Management Policy (Waste Acid Sulfate Soils) 1999
EPA (August 2018) Publication 1669.2 Interim position statement on PFAS	Outline EPA Victoria's current state of knowledge and position regarding PFAS.
National Health and Medical Research Council (NHMRC) (2008) Guidelines for Managing Risks in Recreational Water	Provide guidelines to protect the health of humans from threats posed by recreational use of coastal, estuarine and fresh waters.

DOCUMENT	DESCRIPTION
ANZECC/ARMCANZ (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality	Provides a framework for the sustainable use of Australia's and New Zealand's water resources by protecting and enhancing their quality.
NHMRC/NRMMC (2011) Australian Drinking Water Guidelines, updated in October 2017	Provides a framework for food management of drinking water supplies that will assure safety at point of use if implemented.
Heads of EPA (2018) PFAS National Environmental Management Plan	Designed to achieve a clear and effective approach to the environmental regulation of PFAS. Provides guidance for the regulation of PFAS contaminated sites, PFAS contaminated materials and PFAS-containing materials.
Standards Australia (2005) Guide to the sampling and investigation of potentially contaminated soil, Part 1: Non-volatile and semi-volatile compounds, AS 4482.1-2005 (AS4482.1)	Provides guidance for the collection of sufficient and reliable information for the assessment of potentially contaminated sites.
Standards Australia (1999) Guide to the sampling and investigation of potentially contaminated soil, Part 2: Volatile substances, AS 4482.2-1999. (AS4482.2)	
CRC CARE Technical Report No. 10: Health screening Levels for Petroleum Hydrocarbons in Soil and Groundwater.	Outlines the criteria and approach for developing health screening levels for petroleum hydrocarbons for four generic land use settings (low and high density residential, recreational/open spaces and commercial/industrial).
DSE (October 2010) Victorian Best Practice Guidelines for Assessing and Managing Coastal Acid Sulfate Soils.	A guide to landowners, developer, planners and decision makers through a risk identification and approach that will assist to make decisions about assessment and management of coastal acid sulfate soils (CASS).
EPA (August 2016) Publication 788.3 Best Practice Environmental Management (BPEM) – Siting, design, operation and rehabilitation of landfills, (Landfill BPEM).	Provides the framework and guidelines for managing landfills.

4 METHODOLOGY

The methodology used to assess impacts from contaminated land and acid sulfate soil adopted a phased approach as follows, which are detailed further below:

- Phase 1 – Existing Conditions Assessment.
- Phase 2 – Risk Assessment.
- Phase 3 – Impact Assessment.
- Phase 4 – Environmental Performance Requirements

4.1 EXISTING CONDITIONS

The existing environmental conditions of the project area were assessed (which are detailed in Section 5 of this Technical Impact Assessment). The primary method for characterising the existing environment (refer to Section 2.4 for further detail on this requirement) was through:

- Completion of a Preliminary Site Investigation (PSI), based on a high-level desktop review of current and historical potential sources of contamination within the project area
- Completion of an intrusive program of contamination and acid sulfate soil investigation to verify and further assess the findings of the PSI
- Completion of further quantitative landfill gas risk assessment for the northern portion of the Project Area.

The approach adopted generally follows the methods specified in NEPM 2013 and aims to provide a high-level indication of the contamination and acid sulfate soils that may be present in the project area, as well as an indicative classification of soil for offsite disposal purposes should it be required. The following steps were completed:

- Undertake a high-level desktop review to identify potential current and/or historical contaminating activities and acid sulfate soil potential within the project area. This included a desktop review of publicly available literature, aerial imagery, historical maps and databases, environmental regulator databases and physical information maps and databases (of geological, hydrogeological and topographical conditions and groundwater bore users). To complete the assessment, a buffer zone of 150m radius from the project area was applied.

- Develop a preliminary conceptual site model of contamination (CSM), to identify linkages between sources (potential and on-going) of contamination, exposure pathways and likely receptors that may be impacted by contamination.

- Design a sampling and analysis quality plan (SAQP) for intrusive investigations at the project area.

- Undertake a program of boring and sampling for potentially contaminated media (soil, surface water, sediment, groundwater, leachate and landfill gas) and acid sulfate soil; and submission for laboratory analysis of contaminants of concern (generally the broad suite specified in IWRG621, as well as landfill gas indicators and PFAS in select targeted locations).

- Undertake modelling and site specific risk assessment of the landfill gas data obtained.

- Prepare a report detailing the findings, with an assessment against the adopted criteria and interpretation of the results.

The existing environmental conditions are reported in the Baseline Environmental Site Assessment (ESA) Report, presented in Appendix B.

It is also noted here that a separate hydrogeological and technical assessments of impacts have been undertaken (WSP, 2018c) and the data presented in these other reports have been utilised in this Technical Impact Assessment. The findings of the Technical Impact Assessment should be read in conjunction with other supporting technical documents.

4.2 RISK ASSESSMENT

As outlined in the Ministerial Guidelines for Assessment of Environmental Effects (2006) and the Scoping Requirements for the Mordialloc Bypass Project EES (2018), a risk-based approach was adopted for the EES studies to direct a greater level of effort at investigating matters that pose relatively higher risk of adverse environmental effects.

The project defines impact and risk as:

- *Environmental impact*: is described as any change to the environment as a result of a project activities
- *Environmental risk:* As defined by the Ministerial Guidelines for Assessment of Environmental Effects Under the Environment Effects Act 1978 (DSE, 2006), *"Environmental risk reflects the potential for negative change, injury or loss with respect to environmental assets"*.

The purpose of the risk assessment was to provide a systematic approach to identifying and assessing the environmental risks, including heritage, social, cultural heritage and economic aspects as a result of the project. It articulates the likelihood of an incident with environmental effects occurring and the consequential impact to the environment.

The impact assessment and risk assessment processes were integrated throughout the development of the EES. The environmental risk assessment (ERA) process allowed the project team to identify as many environmental risks as a result of the project and refine and target impact assessments accordingly. The impact assessments ensured the project has a robust understanding of the nature and significance of impacts and the mitigation measures developed to minimise and control those impacts.

The risk and impact assessment processes were essential components of the project and in the formulation of construction and additional mitigation measures to minimise environmental impacts. These assessments also underpin the establishment of the Environmental Performance Requirements (EPRs), which set out the desired environmental outcomes for the project.

The below methodology was developed to assess the potential impacts of the Mordialloc Bypass on contaminated land and acid sulfate soils and sets out the process, methods and tools used to complete the impact and risk assessments.

4.2.1 RISK ASSESSMENT METHODOLOGY

The risk assessment is a critical part of the EES process as it guided the level and extent of impact assessment work required and facilitated a consistent approach to risk assessment across the various technical disciplines. The risk assessment process was based on the approach defined in *ISO 31000:2018 Risk Management – Principles and Guidelines*, which describes an environmental risk management process which is iterative and supported by ongoing communication and consultation with project stakeholders. The ERA process incorporated VicRoads key risk management requirements, specifically from the VicRoads Environmental Risk Management Guidelines (2012) and the VicRoads Environmental Sustainability Toolkit (2017).

SCOPE AND BOUNDARIES

The ERA assessed all project phases, namely: Initial Phase (the current approvals and concept design stage); Construction Phase; and Operations and maintenance Phase. The risk process evaluated environmental risks that would result from the development of the project based on the concept designs for the project, the draft construction methodology and the existing conditions of the study area, as well as the draft environmental impact assessment reports which were in development during the ERA.

RISK IDENTIFICATION

To effectively and comprehensively recognise all potential risks to the project, it was necessary to identify impact pathways for all project activities during all its project phases. An impact pathway is the cause and effect pathway or causal relationship that exists between a project activity and an asset, values or use of the environment.

Environmental impact pathways were identified under two categories:

— Primary environmental impacts: The impacts to environmental values that are directly attributable to project activities within a cause and effect paradigm. Project activities cause environmental impacts (effects) on environmental values through an environmental impact pathway such as construction activities. The assessment of these impacts and their associated risks assumes that all standard mitigation measures are in place and working as intended
— Cumulative impacts: The potential cumulative impacts to environmental values that may result from the implementation of the project. This allowed for the identification of:
  — Secondary environmental risks which may result from the implementation of a risk response in mitigating a primary environmental risk;
  — On-site aggregate risks resulting from multiple on-site project activities on an environmental asset (risks were assessed in two ways, as a single project phase and as a whole project risk);
  — Off-site cumulative environmental risks which accounted for potential off-site cumulative impacts of the Mordialloc Bypass project in conjunction with surrounding off-site projects in the local area

RISK ANALYSIS

With risks identified for each discipline, VicRoads and industry best practice and standard mitigation controls that are considered intrinsic to a project of this nature were identified, including requirements under relevant sections of the VicRoads Standard Specifications, EPA guidelines and Government environmental management policies.

RISK EVALUATION

The ERA process developed for the project is based on the risk analysis matrix used on recent and similar VicRoads projects, as presented in Table 4.1. It follows the standard industry semi-quantitative risk analysis methodology that utilises pre-defined consequence and likelihood criteria as the factors to arrive at a risk rating.

Table 4.1 Risk analysis matrix

			LIKELIHOOD				
CONSEQUENCE	**Risk Categories**		**Rare**	**Unlikely**	**Possible**	**Likely**	**Almost Certain**
			A	**B**	**C**	**D**	**E**
	Catastrophic	**5**	Medium	High	High	Extreme	Extreme
	Major	**4**	Medium	Medium	High	High	Extreme
	Moderate	**3**	Low	Medium	Medium	High	High
	Minor	**2**	Negligible	Low	Low	Medium	Medium
	Insignificant	**1**	Negligible	Negligible	Negligible	Low	Low

Based on the project objectives and context, a set of project-specific and appropriate likelihood and consequence criteria were developed in consultation with VicRoads, the TRG and technical specialists as presented in Table 4.2 and Table 4.3.

Table 4.2 Likelihood categories

LIKELIHOOD			
Rare (A)	Less than once in 12 months OR 5% chance of recurrence during course of the contract	The event may occur only in exceptional circumstances	It has not happened in Victoria but has occurred on other road projects in Australia
Unlikely (B)	Once to twice in 12 months OR 5-10% chance of recurrence during course of the project	The event could occur but is not expected	It has not happened in the greater Melbourne but has occurred on other road projects in Victoria
Possible (C)	3 to 4 times in 12 months OR 30% chance of recurrence during course of the project phase of works as detailed in Section 6.2	The event could occur	It has happened in metropolitan Melbourne
Likely (D)	5 to 6 times in 12 months OR 50% chance of occurrence during course of the project phase of works as detailed in Section 6.2	The event will probably occur in most circumstances	It has happened on a road project in metropolitan Melbourne in the last 5 years
Almost Certain (E)	More than 6 times in 12 months OR 100% chance of occurrence during course of the project phase of works as detailed in Section 6.2	The event is expected to occur in most circumstances	It has happened on a road project of similar size and nature in metropolitan Melbourne within the last 2 years OR It has happened multiple times on a road project in the region within the last 5 years

Table 4.3 Contaminated land and acid sulfate soils environmental risk assessment consequences descriptors

DISCIPLINE	ASPECTS	INSIGNIFICANT	MINOR	MODERATE	MAJOR	CATASTROPHIC
Acid Sulfate Soils						
	Construction encounters acid sulfate soil (ASS) - actual ASS (AASS) or potential ASS (PASS) or both AASS and PASS	No ASS encountered during construction, all soil classified as not having the potential to generate acid in accordance with EPA Publication 655.1. No risk to site personnel and/or sensitive receptors.	ASS encountered but below the action criteria for net acidity (<1000 tonnes, EPA Publication 655.1), with minor risk to construction personnel and/or constructed infrastructure and/or sensitive receptors.	ASS encountered marginally exceeding the action criteria for net acidity (<1000 tonnes, EPA Publication 655.1) with moderate localised soil treatment required and localised surface water and groundwater impacts. Moderate risk to construction personnel and/or constructed infrastructure and/or sensitive receptors.	ASS encountered exceeding the action criteria for net acidity by up to an order of magnitude (>1000 tonnes, EPA Publication 655.1) with major treatment/management of soil, surface water and groundwater required. High risk to construction personnel and/or constructed infrastructure and/or sensitive receptors.	ASS encountered exceeding the action criteria for net acidity by two orders of magnitude (>1000 tonnes, EPA Publication 655.1) with extreme treatment/management of soil, surface water and groundwater required. Unacceptable risk to construction personnel and/or constructed infrastructure and/or with wide spread impacts to surface water and groundwater (sensitive receptors).

DISCIPLINE	ASPECTS	INSIGNIFICANT	MINOR	MODERATE	MAJOR	CATASTROPHIC
	Operation and Maintenance encounters acid sulfate soil (ASS) - actual ASS (AASS) or potential ASS (PASS) or both AASS and PASS	No ASS encountered during operation or maintenance activities. No risk to maintenance personnel, public and/or sensitive receptors.	ASS encountered but below the action criteria for net acidity (<1000 tonnes, EPA Publication 655.1), with minor risk to maintenance personnel, public and/or constructed infrastructure and/or sensitive receptors.	ASS encountered marginally exceeding the action criteria for net acidity (<1000 tonnes, EPA Publication 655.1) with moderate treatment required and localised surface water and groundwater impacts. Moderate risk to maintenance personnel and/or constructed infrastructure and/or sensitive receptors.	ASS encountered exceeding the action criteria for net acidity by up to an order of magnitude (>1000 tonnes, EPA Publication 655.1) with major treatment/management of soil, surface water and groundwater required. High risk to maintenance personnel and/or constructed infrastructure and/or sensitive receptors.	ASS encountered exceeding the action criteria for net acidity by two orders of magnitude (>1000 tonnes, EPA Publication 655.1) with extreme treatment/management of soil surface water and groundwater required. Unacceptable risk to maintenance personnel and/or constructed infrastructure and/or with wide spread impacts to surface water and groundwater (sensitive receptors).
	Cumulative Effects	Scope and Boundaries: Influence of Edithvale and Bon Beach LXRA project on regional groundwater system.				

DISCIPLINE	ASPECTS	INSIGNIFICANT	MINOR	MODERATE	MAJOR	CATASTROPHIC
Contaminated Land						
	Construction encounters land contamination	No contaminated soil encountered during construction, all soil classified as Fill Material in accordance with EPA Publication IWRG621. No contaminated groundwater is encountered. No risk to site personnel and/or sensitive receptors.	Soil contamination encountered above Fill Material Upper Limits (Category C Contaminated Soil, EPA Publication IWRG621), requiring handling, storage and transport management. Minor interaction with contaminated groundwater requiring management. Minor risk to construction personnel and/or sensitive receptors.	Soil contamination encountered above Category C levels (Category B Contaminated Soil, EPA Publication IWRG621), requiring handling, storage and transport management. Minor interaction with contaminated groundwater requiring management. Localised risk to construction personnel and/or sensitive receptors.	Identification of point sources of soil contamination, contamination encountered above Category B levels (Category A Contaminated Soil, EPA Publication IWRG621), requiring treatment prior to off-site disposal. Major interaction with contaminated groundwater requiring potential treatment and off-site disposal. High risk to construction personnel and/or sensitive receptors.	Identification of significant point sources of contamination with major soil contamination, identification of groundwater contamination, requirement for soil remediation and/or groundwater investigation/remediation, unacceptable risk to construction personnel and/or sensitive receptors triggering Quantitative Risk Assessment.

DISCIPLINE	ASPECTS	INSIGNIFICANT	MINOR	MODERATE	MAJOR	CATASTROPHIC
	Operation and Maintenance encounters land contamination	No contaminated soil encountered during construction, all soil classified as Fill Material in accordance with EPA Publication IWRG621. No contaminated groundwater is encountered. No risk to maintenance personnel, public and/or sensitive receptors.	Soil contamination encountered above natural background levels (Category C Contaminated Soil, EPA Publication IWRG621), requiring handling, storage and transport management. Minor interaction with contaminated groundwater requiring management. Minor risk to maintenance personnel, public and/or sensitive receptors.	Soil contamination encountered above Category C levels (Category B Contaminated Soil, EPA Publication IWRG621), requiring handling, storage and transport management. Interaction with contaminated groundwater requiring management. Localised risk to maintenance personnel, public and/or sensitive receptors.	Identification of point sources of soil contamination, contamination encountered above Category B levels (Category A Contaminated Soil, EPA Publication IWRG621), requiring treatment prior to off-site disposal. Major interaction with contaminated groundwater requiring potential treatment and off-site disposal. High risk to maintenance personnel, public and/or sensitive receptors.	Identification of significant point sources of contamination with major soil contamination, identification of groundwater contamination, requirement for soil remediation and/or groundwater investigation/remediation, unacceptable risk to maintenance personnel, public and/or sensitive receptors. triggering Quantitative Risk Assessment.
	Construction or operation and maintenance activities leads to environmental contamination	A small chemical or fuel spill (<5L in one event) is captured within a bund or capture system and has no impact upon the environment	A small chemical or fuel spill (<5L) is captured within a bund or capture system and has no impact upon the environment	A hazardous chemical or fuel spill (<5L) or emission leads to a release to the soil with no imminent risk to human / ecosystem health	A hazardous chemical or fuel spill or emission leads to a release to the soil (>5L) or any release to surface water / groundwater with no imminent risk to human /ecosystem health	Any hazardous chemical or fuel spill or emission leads a release to the soil / surface water / groundwater with imminent risk to human health (via ingestion, inhalation, direct contact) or ecosystem health

DISCIPLINE	ASPECTS	INSIGNIFICANT	MINOR	MODERATE	MAJOR	CATASTROPHIC
	Construction and/or operation and maintenance encounters landfill gases/vapours	No landfill gases/vapours encountered during construction, operation and/or maintenance activities.	Landfill gases/vapours are detected but are below the recommended EPA Victoria gas action levels and below the stop work trigger level of 5% LEL.	Landfill gases/vapours are detected but are below the recommended EPA Victoria gas action levels and below the stop work trigger level of 5% LEL.	Landfill gases/vapours are detected above the stop work limit (5% LEL) and above the EPA recommended landfill gas action levels within on-site or adjacent subsurface structures requiring WHS management protocols to be implemented. No off-site migration has occurred.	Landfill gases/vapours are detected above the stop work limit (5% LEL) and above the EPA recommended landfill gas action levels within on-site or adjacent buildings or subsurface structures requiring relocation of occupants. Potential for off-site migration has occurred.
	Cumulative Effects	Scope and Boundaries: Potential sources of contamination within a 150m buffer from the project footprint including former landfills, former waste treatment plant and former commercial/industrial land uses.				

For all risks ranked Medium, High or Extreme in the initial risk rating, technical specialists were required to identify additional controls which could be implemented to further reduce risk and to perform the residual risk ratings. Additional controls specify management measures over and above those considered as Standard Controls to ensure the residual risk has been effectively avoided or mitigated to as low as reasonably practicable.

Where risks could not be eliminated or sufficiently reduced (e.g. by engineering controls or re-design), these will typically be addressed by specific conditions in a site Environmental Management Plan (EMP), or be the subject of a separate management plan, including adaptive management plans based on ongoing studies or monitoring.

4.3 IMPACT ASSESSMENT

The impact assessment undertaken for the project is presented in Section 7 of this Technical Impact Assessment report. The method adopted for completion of the impact assessment comprised the following:

- Review of the preliminary concept design to identify relevant project components (e.g. the project area, proposed construction methods, proposed built infrastructure and locations where the proposed design may interact with contaminated land and acid sulfate soil or sensitive receptors including nearby wetlands; the proposed volumes of excavated spoil; and identification of other waste streams caused by construction).
- Identification of existing conditions (i.e. locations and extent of PASS and potential contamination; and the potential risks posed by the identified PASS and contamination to the project and nearby sensitive receptors including Edithvale Wetlands).
- Assessment of the key issues identified in the Scoping Requirements and how these are relevant to the project (i.e. potential for adverse environmental or health impacts posed by disturbance of contaminated land, PASS, or other waste materials generated during project construction, or impacts to Edithvale Wetlands).
- Assessment of the likely effects identified in the Scoping Requirements and impacts posed.

4.4 ENVIRONMENTAL PERFORMANCE REQUIREMENTS METHOD

Following the evaluation of risk and through consultation with VicRoads, Environmental Performance Requirements (EPR’s) were developed to define, relevant, achievable and measurable environmental outcomes for the project. The mitigation measures identified during the risk assessment process were used to inform the EPRs and also specify the means by which the EPRs are to be satisfied. The EPRs to contaminated land and acid sulfate soil are discussed in Section 8.

5 EXISTING CONDITIONS

Key findings of the site setting information summarised from the Baseline ESA are presented herein. A copy of the Baseline ESA is included in Appendix B.

5.1 TOPOGRAPHY AND DRAINAGE

The topography of the project area is relatively flat, with gentle rises in the landscape. The lowest lying section of project area around Mordialloc Creek, at approximately 1.0 m above the Australian Height Datum (mAHD). The topography increases gradually heading north, to approximately 31 mAHD at the northern edge of the project area.

There are numerous surface water bodies present on and nearby the project area. Most of these surface water bodies are present in the central to southern portion of the project area within the former Carrum Swamp area. Prior to the European settlement, the former Carrum Swamp consisted of a large freshwater wetland that drained to Port Philip Bay via Kanancook Creek. The hydrology of the Carrum Swamp has been significantly altered since European Settlement. Patterson River was excavated in the 1870’s to drain the swamp as part of works to prevent flooding along the Eumemmering Creek. The drained swampland was converted into rural landholdings for settlement.

The waterways and wetlands within the former Carrum Swamp have been constructed since the 1980s, including the Woodlands Industrial Estate Wetlands, Braeside Park Wetlands, Waterways wetlands. Mordialloc Creek is a natural drainage feature south of waterways and wetlands. Mordialloc Creek has been significantly altered and channelised where water levels and flow is controlled by levees on Dandenong Creek. It is noted that the waterways, wetlands and Mordialloc Creek intersect the project area.

A number of artificial drains are also present on and nearby the project area which are generally orientated in a north-south direction and includes the Clayton South Drain, Old Dandenong Road Drain, Mordialloc Settlement Drain and Dingley Drain. It is expected that the artificial drainage systems will all drain into the natural surface water bodies located in the Central to Southern portion of the project area (i.e. Mordialloc Creek). Some of the identified drains also intersect the Northern Portion (Old Dandenong Drain) and the Central Portion (Dingley Drain) of the project area.

Based on the topography of the project area and the location of the surface water bodies, surface water flow/run-off is expected to be towards the south-east. Of note, the identified surface water bodies will eventually drain into Port Phillip Bay, located approximately 2.6 km to the south-west of the Southern Portion of the project area (at its closest point).

Between the project area and Port Phillip Bay, a coastal dune system runs parallel to the coast between Mordialloc and Frankston with a surface elevation up to 8.0 mAHD. In the coastal dune areas, elevations drop to at or below mean sea level, particularly within the Edithvale Wetlands (as low as -1.0 mAHD) and nearby wetlands, such as the Seaford and Carrum Wetlands.

Edithvale-Seaford Wetlands (Edithvale Wetlands) is a partially-modified wetland system which are listed under the Ramsar Convention on wetlands of international importance, as an internationally significant wetland. These wetlands provide important habitat for protected fauna, including threatened water birds, and as such they are the key focus of further risk and impact assessment.

5.2 GEOLOGY

The geological units described below were current at the time of intrusive investigations. Geoscience Australia maintains the Australian Stratigraphic Units Database, renamed both the Brighton Group sediments and the Fyansford Formation to the Sandringham Sandstone and Gellibrand Marl respectively in January 2018. To maintain consistency with previous reports, including the LXRA Edithvale – Bonbeach EES, the previous stratigraphic names have adopted for ease of interpretation and comparison with previous project data.

Situated within the Port Philip Basin, the regional surface geology of the study area is presented in Figure 5.1 (Department of Economic Development, Jobs, Transport and Resources, 2010). This illustrates that the surface geology comprises Tertiary-aged sediments assigned to the Brighton Group as well as Quaternary-aged swamp and wind-deposited dune sediments, which were deposited on top of the Brighton Group sediments. Various thicknesses of fill material derived from various sources (not shown) is also present across the region. These geological profile features were confirmed by the outcome of intrusive investigation undertaken for geotechnical assessment and groundwater assessments undertaken along the project alignment.

These revealed two primary geological units:

- The *Quaternary* swamp sediments comprising the current wetlands are the remnants of the former Carrum Swamp. The swamp sediments penetrated in geotechnical boreholes located along the alignment ranged in thickness between approximately 2 m below ground level (mBGL) and 8 mBGL. Typically, a layer of peat formed the basal portion of the swamp deposits also referred to as the Pleistocene Clay (WSP, 2017c). Between the shoreline of Port Phillip Bay and the swamp deposits unconsolidated sediments comprising aeolian sands deposited in dunes running parallel to the coast.
- The *Brighton Group* sediments, which were deposited in a fluvial environment, comprise clayey sands to sandy clays with sand intervals. Tertiary sediments assigned to the Fyansford Formation underlie the Quaternary and Brighton Group sediments. The Fyansford Formation sediments were deposited on the sediments assigned to the Werribee Formation, which were deposited on the regional bedrock consisting of strata assigned to the Palaeozoic-aged Melbourne Formation.

The site geotechnical and groundwater intrusive investigations intersected the natural profile including the Quaternary gravel, sand and silts of the alluvium (thin, locally variable and surficial), Tertiary Brighton Group materials and the Fyansford Formation.

Table 5.1 presents a summary of the geological units along the alignment. It is anticipated that Recent fill, Quaternary alluvium, Brighton Group and Fyansford Formation sediments would be encountered during construction of the motorway.

Table 5.1 Geological units underlying the alignment

AGE	FORMATION	LITHOLOGY
Recent	Fill	Variable (anthropogenic fill – mixed materials).
Quaternary	Alluvium (Coastal lagoon deposits, Swamp and lake deposits) (thin, locally variable and surficial). Includes Cranbourne Sands (Aeolian dune deposits)	Poorly sorted gravel, sand and silty sand (thin, locally variable and surficial).
		Silt, clay: dark grey to black; variably consolidated.
		Grey to black carbonaceous mud, silt, clay, minor peat: generally unconsolidated – dune deposits/swamp deposits.
Tertiary	Red Bluff Sandstone (part of the Brighton Group) currently known as Sandringham Sandstone.	Highly weathered sandstone, conglomerate: pale yellow and brown; fine to coarse-grained, massive to well-bedded; cross-bedded; local ironstone; clayey sands to sandy clays with sand intervals.
	Black Rock Member (part of the Brighton Group) currently known as Sandringham Sandstone.	Basal layer of ferruginous and phosphatic nodules in a matrix of quartz sand and gravel; clayey sands to sandy clays with sand intervals.
	Fyansford Formation	Clayey silt, clay to sandy silt and silty sand of marine origin.
	Werribee Formation	Sand, gravel, clay and silt with minor coal.
Palaeozoic	Melbourne Formation	Sedimentary (fractured rock) comprised of sandstone, siltstone and mudstone.

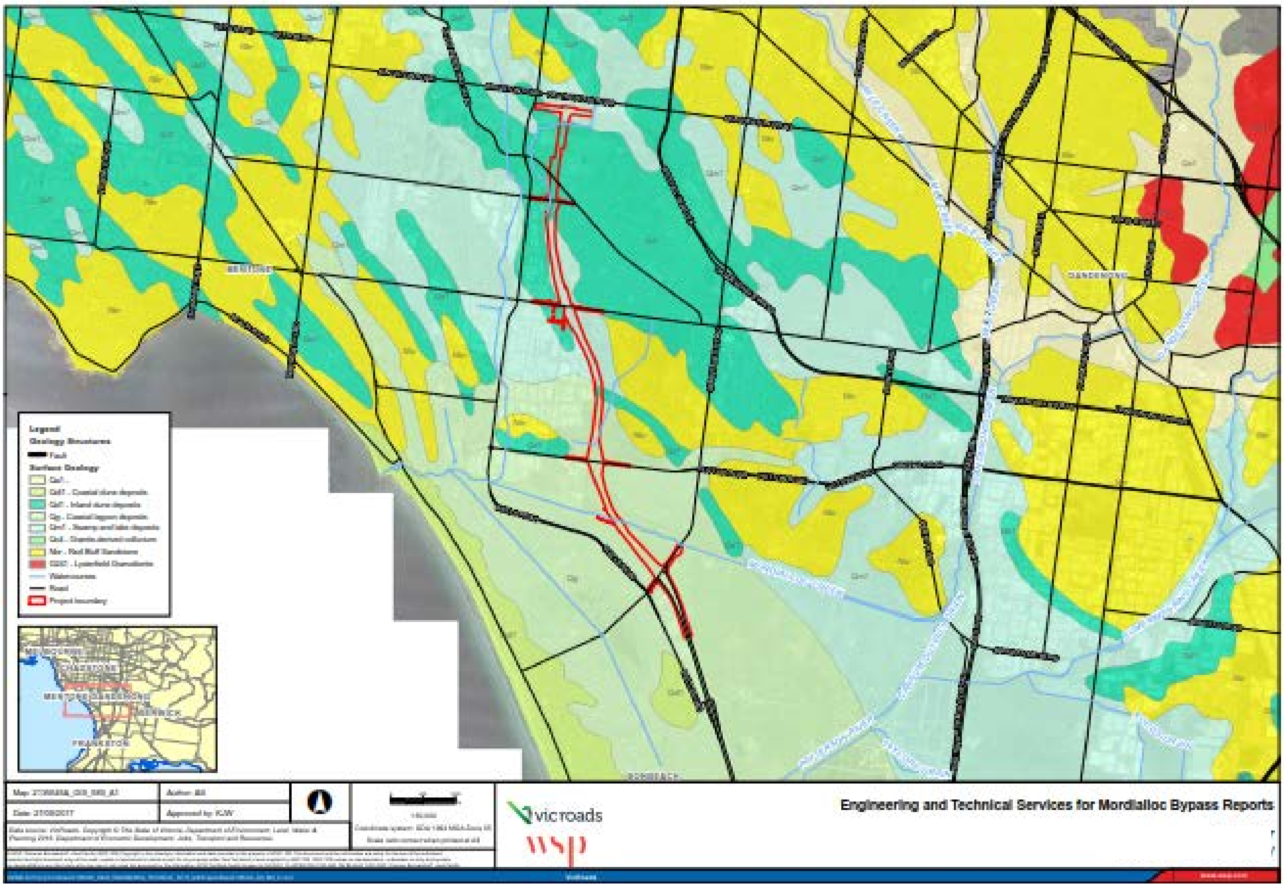

Figure 5.1 Geology map for the Mordialloc Bypass project site

5.3 HYDROGEOLOGY

5.3.1 HYDROSTRATIGRAPHY

The Victorian Aquifer Framework (VAF), developed by the Department of Environment, Land, Water and Planning (DELWP), developed and delineated a three-dimensional model of Hydrostratigraphic Units (HSUs) within Victoria. HSUs are comprised of geological materials of similar hydrogeological properties. To ensure that the HSUs behave as a hydrogeological unit they are generally based on stratigraphic units, although similarity in storage and transfer of groundwater is more of an importance than just stratigraphic units.

The HSUs delineated within the VAF were adopted as the VAF provides a consistent state wide framework defining aquifers and aquitards. The HSUs present within the project area have been identified using the DELWP's interactive online map and Victorian Groundwater Resource Report (DEWLP 2018b). The VAF model was also downloaded and used in the development of the numerical groundwater model and refined through observations and results of the drilling and installation of dedicated groundwater monitoring bores and geotechnical investigation.

A summary of all HSUs present within the project area is summarised in Table 5.2. Within the project area, the HSUs largely align with the geological stratigraphy outlined in Table 5.2.

Table 5.2 Groundwater resource units present at Mordialloc Bypass (DELWP, 2017a)

GROUNDWATER RESOURCE UNIT (GEOLOGY UNIT)	ESTIMATED DEPTH BELOW SURFACE (m)	GROUNDWATER SALINITY (mg/L)	CHARACTERISTICS
Quaternary Aquifer (QA) – sand, gravels, clay, silt	0–3	1,001–3,500	Unconfined to semi-unconfined water bearing zones.
Upper Tertiary Aquifer (UTAF) (fluvial) – sand, gravel and clay (Red Bluff Sandstone, Brighton Group)	3–16	501–1,000 (N) 1,001--3,500 (S)	Mostly confined by overlying clay, silt and basalt deposits. Completely eroded in some areas. Low productivity.
Upper-Mid Tertiary Aquitard (UMTD) – clay, silt, marl (fractured rock) and minor sand (Fyansford Formation)	16–47	Unknown	Widespread subsurface aquitard with low yields and poor water quality.
Lower Tertiary Aquifer (LTA) - sand, gravel, clay and silt, minor coal (Werribee Formation)	47–53	1,001–3,500	Extensive semi-confined to confined fractured rock water bearing zones.
Mesozoic and Palaeozoic Bedrock (BSE) – basement sedimentary (fractured rock): sandstone, siltstone, mudstone, shale, igneous (fractured rock), includes volcanics, granites, granodiorites Murrindindi Supergroup	53–253	<500 (S) 501–1,000 (N)	Widespread subsurface aquitard, generally with low yields and poor water quality.

5.3.2 RELEVANT AQUIFERS

Two key hydrostratigraphic units (aquifers) have been identified in the region; an unconfined (locally variable water table) Quaternary aquifer (QA) which occurs in the swamp and dune deposits associated with the former Carrum Swamp, and a semi-confined (artesian) aquifers (UTAF) which occurs in the Tertiary Sandringham Sandstones. The underlying Gelibrand Marl (UMTD) forms the regional subsurface aquitard.

In the northern section of the project alignment, the UTAF is unconfined and is considered the water table aquifer. Governor Road forms the approximate boundary of the former Carrum Swamp where the UTAF is overlain by the QA becoming semi-confined. Where present, the UTAF is likely hydraulically connected to the overlying QA. However, the UMTD aquitard limits vertical recharge into underlying HSU.

Hydraulic properties of the relevant aquifers are further discussed in the EES Groundwater Technical Impact Assessment Report (WSP 2018b).

5.3.3 GROUNDWATER RECHARGE AND DISCHARGE

The primary recharge mechanism to the QA and UTAF aquifers is considered to be direct rainfall infiltration, as observed in recorded water levels. The proportion of net rainfall recharging the groundwater systems depends largely on the characteristics of the surface geology, soils, the land use and depth to the water table. Recharge is expected to be lower in areas where the surface is covered by residual clayey soils and colluvium with a low hydraulic conductivity and specific yield.

Recharge to the residual clayey soils is a predominantly recharge-in/recharge-out process, associated with rainfall infiltration, which typically characterise the behaviour of shallow perched water systems and limited vertical infiltration from the perched, shallow system down to the deeper regional UTAF aquifer.

Recharge also occurs via leakage from surface water features in areas where the groundwater table is below the stream and wetland water levels. Recharge rates will largely depend on the river stage and hydraulic characteristics of the river bed material and underlying geology.

The lower aquifers are recharged locally where they outcrop and by vertical leakage from the upper aquifers in places where the hydraulic head of the upper aquifer is above that of the lower aquifer, mostly where low permeability units are absent.

Groundwater can discharge from shallow perched aquifers into creeks or drains via seepage depending on the porosity of the geological units in the aquifer. Groundwater in lower aquifers moves by subsurface flow discharging into wetlands and surface streams providing baseflow to streams or discharging directly into Port Phillip Bay and Westernport Bay.

Extraction of groundwater through the use of existing bores in the project areas is also be considered a mechanism of discharge from the groundwater systems. Evapotranspiration from the water table is another mechanism of groundwater discharge. The evapotranspiration rate depends on land use and depth to groundwater. In areas where the water table is shallow and within the rooting depth of vegetation evapotranspiration can be a significant component of the water.

5.4 SITE SPECIFIC HYDROGEOLOGY

The groundwater elevation data collected during the site investigation and monitoring program completed as part of the Baseline ESA ranged between -3.75 metres above the Australian Height Datum (mAHD) and 1.54 mAHD in the surficial aquifer (Quaternary Alluvium) and -0.78 mAHD and 0.27 mAHD in the semi-confined aquifer (UTAF) (WSP 2018b). It is important to note that the HSU’s have a large seasonal variation with levels dropping in summer months and levels gaining in winter months. Natural variation in the dataloggers installed within the project area is generally +/- 1.0 m.

There are numerous surface water bodies present on and nearby the project area. Most of the surface water bodies are present in the Central to Southern Portion of the project area, which includes the Woodlands Industrial Estate wetlands, Braeside Park wetlands, Waterways wetlands and Mordialloc Creek. Current surface water assessments suggest that the Woodlands Industrial Estate wetlands and the Braeside Park wetlands are largely sustained by surface water and urban run-off (including: Mordialloc Creek/Dandenong Creek catchments) and that, consequentially, groundwater inflow contributions may be minor, and as such, impacts to the groundwater regime may be negligible. The Waterways wetlands most likely acts as a recharge mechanism to groundwater and could potentially be a pathway to groundwater contamination from surface water impacts.

Some anthropogenic drains are present generally running in a north-south direction which includes the Clayton South Drain, Old Dandenong Road Drain, Mordialloc Settlement Drain and Dingley Drain. Old Dandenong Drain intersects the Northern Portion of the project area and Dingley Drain intersects the Central Portion of the project area. It is expected that the anthropogenic drainage systems will all drain into the natural surface water bodies located south-east of the project area (i.e. Mordialloc Creek) which ultimately drains to Port Phillip Bay located 2.8 km to the south west at its closest point.

Depth to groundwater across the site was measured as between 0.8 to 4.5 meters below ground level in both aquifers. Water levels within both units experience seasonal variability with water levels responding to rainfall within the region.

The water-table QA aquifer consists of numerous local flow systems, which are influenced strongly by topography and variable connected with adjacent surface-water features. The underlying UTAF is also influenced by topography and groundwater flow is towards the south-east discharging into Port Philip Bay and Patterson River.

5.4.1 GROUNDWATER BENEFICIAL USES

Based on information obtained from Visualising Victoria's Groundwater (VVG 2018) (www.vvg.org.au) (accessed April 2018), the project area is characterised by salinity (total dissolved solids or TDS) concentrations ranging from <500 milligrams per litre (mg/L) to 7,000 mg/L.

TDS concentrations recorded from groundwater monitoring ranged between 825–26,300 mg/L with an average concentration of 6,700 mg/L (WSP, 2018c). Based on the average TDS concentration, the regional aquifer is defined as Segment C. For the purpose of this report, Segment A2 is adopted as a conservative approach based on the lowest recorded TDS value (and consistent with available regional data (VVG 2018). As defined in the State Environment Protection Policy – Groundwaters of Victoria (SEPP GoV, 1997), Segment A2 groundwater has the potential to be used for the beneficial uses detailed in Table 5.3.

Table 5.3 Protected beneficial uses of the segments (Government of Victoria, 1997)

BENEFICIAL USES	SEGMENTS (mg/L TDS)				
	A1	A2	B	C	D
Maintenance of ecosystems	✓	✓	✓	✓	✓
Potable water supply (desirable)	✓				
Potable water supply (acceptable)		✓			
Potable mineral water supply	✓	✓	✓		
Agriculture, parks and gardens	✓	✓	✓		
Stock watering	✓	✓	✓	✓	
Industrial water use	✓	✓	✓	✓	✓
Primary contact recreation	✓	✓	✓	✓	
Buildings and structures	✓	✓	✓	✓	✓

A search of the licensed borehole register from the DEWLP interactive online map (WMIS) (DWELP 2018a) was undertaken for the length of the project area. A total of 402 registered groundwater bore users were identified within 2 km of the project area, with five registered groundwater bores identified within the project area itself. The following bore uses were listed:

- Domestic and stock use
- Agricultural industries
- Dairy
- Irrigation
- Groundwater investigation and observation.

The 10 closest bores to the project area are summarised in Table 5.4.

Table 5.4 Groundwater database summary of 10 closest bores to project area

BORE NUMBER	DISTANCE FROM PROJECT AREA BOUNDARY (m)	YEAR INSTALLED	BORE USES	TOTAL BORE DEPTH (mBGL)	INFORMATION PROVIDED IN THE DATABASE
WRK966394	0	Unknown	Unknown	Unknown	Coordinates
WRK043346	0	Unknown	Unknown	Unknown	Coordinates
WRK039072	0	1986	Domestic, irrigation, stock	24.4	Coordinates, well construction, groundwater investigation use, lithology.
81673	0	1970	Unknown	42.3	Coordinates, well construction, groundwater investigation use, lithology.
81419	0	1971	Observation, state observation	43.0	Coordinates, well construction, groundwater investigation use, lithology.
127483	7	1996	Groundwater investigation	15.0	Coordinates, well construction, groundwater investigation use, lithology.
WRK982650	19	Unknown	Unknown	Unknown	Coordinates
76479	20	1986	Domestic	24.4	Coordinates, well construction, groundwater investigation use, lithology.
WRK069052	23	2012	Observation	9.5	Coordinates, well construction, groundwater investigation use, lithology.
WRK989236	47	Unknown	Unknown	Unknown	Coordinates

Notes: mBGL – meters below ground level.

It was inferred that the three ‘unknown’ and one ‘state observation bore’ in Table 2.7, that falls within the project area is associated with the Melbourne Sewer (WSP, 2018c). Attempts to locate the domestic bore (WRK039072) within the project area were undertaken but could not be located with the coordinates specified.

5.5 ACID SULFATE SOILS

The desktop review identified the presence of prospective coastal acid sulfate soil. Documented geological mapping indicates the southern portion of the alignment comprises a Holocene aged geology which is consistent with that of coastal acid sulfate soils.

The field inspection undertaken did not identify visual signs of PASS with the exception of the presence of Common Reeds in water logged areas.

The results of the initial screening analysis for ASS (i.e. pHF, pHFOX, reaction rate and ΔpH) indicated in general the potential for ASS to be present within the southern portion of the alignment (i.e. sample locations SB20 to SB38). However, quantitative analysis by the SPOCAS analysis indicates the presences of ASS from sample locations SB11, SB18 to SB38 and the presence of ASS which has a neutralising capacity sufficient to have a net acidity below the action criteria within SB12 to SB17.

The reported SPOCAS results for a number of samples indicated the acid trail to be less than that of the sulfur trail. The reported results for reacted calcium and magnesium indicates this could be a result of the presence of organic matter.

However, based on the results of SPOCAS analysis (i.e. exceedance to at least one adopted action criteria), PASS are likely present only from SB11 to SB38 or from Mills Road (central portion) to the southernmost boundary. The analytical results are consistent with the prospective coastal acid sulfate soil mapping. The reported net acidity from SB11 to SB38 ranged from 2 to 12.5 kg CaCO3/tonne based on a bulk density of 1.8 tonne/m3.

Assessment of groundwater chemistry was also undertaken within the project area. Elevated sulfate (and TDS) was identified at a number of monitoring wells largely located adjacent to the Waterways wetlands (GW17-26-04 to GW17-26-10) suggesting that some level of CASS disturbance has historically occurred. It is important to note that the HSU's have a large seasonal variation with levels dropping in summer months and levels gaining in winter months. Natural variation in the dataloggers installed within the project area is generally +/- 1.0 m, however indicators of widespread activation of CASS has not occurred.

It is inferred that greater than 1,000 tonnes of PASS is likely to be generated during the construction process and therefore in accordance with the Best Practice Guidelines for Assessing and Managing CASS (DELWP, 2010), the project area is classified as a High Hazard meaning that an Environmental Management Plan (EMP) approved by the EPA will be required where CASS disturbance cannot be avoided.

The anticipated PASS extent is presented in Figures 2 and 3, Appendix A.

5.6 CURRENT AND HISTORIC LAND USES

A summary of historic and current land use in the context of the potential for causing contamination is presented in Table 5.5.

Table 5.5 Current and historic land uses

KEY STUDY AREA	CURRENT AND HISTORIC LAND USES AND POTENTIALLY CONTAMINATING ACTIVITIES/SOURCES
Northern Portion	The Northern Portion, between the Dingley Bypass and Centre Dandenong Road, consists of former landfilled areas, commercial and industrial businesses including soil processing/composting and nurseries, construction activities on some land plots. Vacant land areas were generally surfaced with grass and commercial businesses were observed to have altered site surfaces to accommodate buildings and/or other operational activities. The northernmost area (Dingley Bypass end) is mostly compacted silt and sand. Within the former landfilled area located in Lot 1 Grange Road, Dingley, Vic (Lot 1 Grange Road landfill), the property currently occupied by Enviromix Pty Ltd (Enviromix), a combination of concrete (central to the property), silt and sand covered the surface. Odours were evident within this property and were associated with the soil and garden waste composting activities being undertaken. South of Enviromix, is a nursery (formerly part of the much larger Din San Landfill), the surface cover is gravel; and south of the nursery, the area comprised a grassed surface with bare patches of compacted silt and sand. Potential historical and current contaminating activities identified within the project area: — Road construction and use. — Agricultural land use, including grazing, cropping and market gardening. — Former landfills and quarries. — Commercial plant nurseries. — Filled swampy land and raising of low-lying land that occurred in the general area. — Surface water runoff into a drain from various industrial sources in the northern portion of the project area. Potential historical and current contaminating activities identified within 150 m of the project area include: — Former landfills and quarries. — Current landfills, waste recycling facilities and quarries. — Service stations. — Brick recycling. — Chemical handling, manufacturing and other unknown industrial activities. — Agricultural land uses including cropping, grazing, market gardening and commercial plant nurseries. — Filled swampy land and raising of low-lying land that occurred in the general area. — Illegal dumping of waste from unknown sources. — Surface water runoff into drains from various industrial sources in and around the project area.

KEY STUDY AREA	CURRENT AND HISTORIC LAND USES AND POTENTIALLY CONTAMINATING ACTIVITIES/SOURCES
Central Portion	The middle section of the project area (Central Portion), between Centre Dandenong Road and Mordialloc Creek, consists of the large Woodlands Industrial Estate to the west, with residential beyond. Braeside Park is located to the east. Potential historical and current contaminating activities identified within the project area: — Road construction and use. — Some unknown industrial activities in the road reserve near to the Woodlands Industrial Estate. — Filled sewage treatment ponds (from the former sewage treatment plant in Braeside Park). — Filled swampy land and raising of low-lying land that occurred in the general area. — Natural ASS due to the Holocene aged geology in these areas and potentially acidified groundwater due to the presence and potential historical disturbance of ASS. Potential historical and current contaminating activities identified within 150 m of the project area include: — Former agricultural land uses including cropping and grazing and market gardening. — Service stations, motor garages, mechanics, dry cleaning or laundering, chemical handling and manufacturing within the Woodlands Industrial Estate. — Former sewage treatment plant, horse training facilities and market gardening in Braeside Park. — Filled swampy land and raising of low-lying land that occurred in the general area. — Illegal dumping of waste from unknown sources. Asbestos containing material (ACM) was observed during the field program that may have been a result of illegal dumping in open areas. — Natural ASS due to the Holocene aged geology in these areas and potentially acidified groundwater due to the presence and potential historical disturbance of ASS. — Use of firefighting foams at Moorabbin Airport.
Southern Portion	The Southern Portion, between Mordialloc Creek and the southernmost boundary of the project area at Thames Promenade, Chelsea Heights, comprises predominantly agricultural land to the east, with residential and commercial properties to the west. Potential historical and current contaminating activities identified within the project area: — Road construction and use. — Filled swampy land and raising of low-lying land that occurred in the general area. — Natural ASS due to the Holocene aged geology in these areas and potentially acidified groundwater due to the presence and potential historical disturbance of ASS. Potential historical and current contaminating activities identified within 150 m of the project area include: — Current and former agricultural land uses including cropping and grazing. — Service stations, motor garages, mechanics, within a smaller commercial/industrial estate immediately adjoining to the west. — Christmas tree farm. — Filled swampy land and raising of low-lying land that occurred in the general area. — Illegal dumping of waste from unknown sources. — Natural ASS due to the Holocene aged geology in these areas and potentially acidified groundwater due to the presence and potential historical disturbance of ASS.

In summary, the project area appears to have been used as a road, and the surrounding area predominantly used for agricultural purposes including market gardening until the 1960s and 1970s. Industrial land use has become more predominant since that time. In the Northern Portion of the project quarrying, landfilling including industrial waste and liquid waste, various other industrial activities, market gardening and nurseries have operated since the 1960s. The Northern Portion of the project area intersects a number of known former landfills (including the Din San Landfill, Barraton Landfill and Lot 1 Grange Road Landfill, among others).

The large Woodlands industrial estate was developed since the 1990s, which adjoins the Central Portion of the project area to the west (and some industrial activity on the project area in this portion was identified). Braeside Park adjoins the Central Portion of the project area to the east, formerly used for agriculture including market gardening, horse training and also a sewage treatment plant which intersected the project area. Moorabbin Airport is also located to the west of the Central Portion of the project area. The remainder of the nearby area has predominantly been redeveloped for residential purposes. ASS are anticipated on and within the vicinity of the Central Portion of the project area.

The Southern Portion of the project area is primarily been redeveloped for residential purposes to the west, as well as a second smaller commercial/industrial estate immediately adjoining the project area to the west. The majority of the area to the east of the Southern Portion of the project area remains agricultural land. ASS are anticipated on and within the vicinity of the Central Portion of the project area.

Former wetlands and swampy land that has been filled over time is evident in the project area and surrounds over time.

5.7 PFAS

Per and Polyfluoro-alkyl substances (PFAS) are a group of manufactured chemicals that have been used for more than fifty years in various products including fire-fighting foams, textile treatments (carpet and clothes), pesticides and stain repellents. PFAS are an emerging contaminants of concern, primarily due to evidence emerging that demonstrates that it is highly resistant to physical, chemical and biological degradation and very persistent in the environment. PFAS is also highly soluble and mobile in the environment. In addition, PFAS bio-accumulates in the food chain and numerous scientific studies have been released in recent years that demonstrate its harmfulness to the environment and human health. Major sources of PFAS in the environment include: fire training grounds (including at airports, military bases and depots), manufacturing facilities which utilise PFAS, landfills and wastewater treatment facilities.

A former landfill, (Lot 1, Grange Road Landfill) has been identified within the footprint of the Northern Portion of the project area. This property was formerly a sand quarry that was progressively landfilled during the early 1960s with both liquid and solid industrial waste of unknown composition. Former landfill operations extends up to Lot 2 Grange Road located immediately east of this property. In addition, the former 'Din San Landfill' is located to the east of the project area (and the "toe" of the landfill may have intersected the project area) and the former 'Barraton landfill' is located to the west of the project area. Other potential nearby landfill include Industrial Waste Collection Pty Ltd, located to the west of the project area, who were also operating a waste disposal facility. The locations of the former landfilled properties are shown in Figure 1, Appendix A.

None of the known landfills in and immediately adjacent to the Northern Portion of the project area are known to be engineered (i.e. have a basal or side lining system present) and given the underlying sand geology, it has been concluded that the landfill is likely to be directly connected to the aquifer and that leachate and groundwater are likely to be hydraulically connected. In addition, PFAS is known to migrate through landfill liner material. PFAS may be present in the leachate and groundwater beneath the Northern Portion of the project area from these landfills and other nearby landfilling, as well as in soil.

In addition, Moorabbin Airport is located to the west of the project area and it is assumed that PFAS containing firefighting foams would have been used during training activities. Windblown foams can travel significant distances, resulting in distribution of PFAS in surface water and surface soils (and ultimately groundwater).

5.8 CONCEPTUAL SITE MODEL OF CONTAMINATION

The development of a preliminary Conceptual Site Model (CSM) for the project area was based on characterisation of site contamination based on available information or data.

The preliminary CSM includes an assessment of potential sources, pathways and receptors as indicated in NEPM 2013 and is summarised in Table 5.6.

Table 5.6 Preliminary Conceptual Site Model of Contamination

ASPECT	DESCRIPTION
Potential Sources of Contamination	Potential sources of contamination identified within the project area include: — Road construction and use. — Agricultural land use, including grazing, cropping and market gardening. — Former landfills and quarries. — Commercial plant nurseries. — Filled swampy land and raising of low-lying land that occurred in the general area. — Surface water runoff into a drain from various industrial sources in the northern portion of the project area. — Some unknown industrial activities in the road reserve near to the Woodlands Industrial Estate. — Filled sewage treatment ponds (from the former sewage treatment plant in Braeside Park). — Natural ASS due to the Holocene aged geology in these areas and potentially acidified groundwater due to the presence and potential historical disturbance of ASS. Potential sources of contamination within 150 m of the project area include: — Former landfills and quarries. — Current landfills, waste recycling facilities and quarries. — Service stations. — Chemical handling, manufacturing, brick recycling and other unknown industrial activities in the northern portion of the project area. — Agricultural land uses including cropping, grazing, market gardening, commercial plant nurseries and Christmas tree farming. — Filled swampy land and raising of low-lying land that occurred in the general area. — Illegal dumping of waste from unknown sources. — Service stations, motor garages, mechanics, dry cleaning or laundering, chemical handling and manufacturing within the Woodlands Industrial Estate. — Former sewage treatment plant, horse training facilities and market gardening in Braeside Park. — Natural ASS due to the Holocene aged geology in these areas and potentially acidified groundwater due to the presence and potential historical disturbance of ASS. — Use of firefighting foams at Moorabbin Airport. — Surface water runoff into drains from various industrial sources in and around the project area. — Service stations, car servicing, engineering in a smaller commercial industrial estate in the southern portion of the project area.

ASPECT	DESCRIPTION
	Secondary sources of contamination include: — Shallow groundwater-borne contamination from sources in and around the project area such as: — In areas close to or adjoining service station due to leaks from underground petroleum storage systems (UPSS). — In the Northern Portion where a contaminated groundwater and/or leachate plume maybe present as a result of historical/current landfilling activities — Accumulation of landfill gas, leachate and potential PFAS impacted soil and groundwater in the Northern Portion as a result of historical/current landfilling activities
Contaminants of Potential Concern	Of the above list, it is considered that the key contaminants of potential concern derived from the onsite historical/current land uses include the following: — Landfill gases (methane, carbon dioxide, carbon monoxide, nitrogen, hydrogen sulfide). — Landfill leachate indicators (volatile organic carbons (VOCs), cyanide, ammonia, sulphates/sulphides, metals, organic acids, E-coli)/ — ACM. — PFAS. — Petroleum hydrocarbons (Total petroleum hydrocarbons/total recoverable hydrocarbons (TPHs/TRHs), Benzene, toluene, ethylbenzene and xylenes (BTEX), Polycyclic aromatic hydrocarbons (PAHs), phenols). — Solvents including a range of VOCs — pesticides and herbicides (namely: OCPs/OPPs), — There is also a potential for presence of aesthetic impacts (e.g. odours, fill waste) within the project area, where odours emanating from the landfill are not managed appropriately. — Metals and metalloids. — There is also a potential for presence of aesthetic impacts (e.g. odours and landfill waste mass in landfills and other impacts to fill in the wider project area). — In addition, ASS (thought this is naturally occurring and not a contaminant from land use). Impacts are primary likely to occur in shallow fill throughout the project area, however deeper waste mass is anticipated in the northern portion of the project area, as well as localised filled swampy land, sewage treatment ponds and other levelling in the area. Groundwater impacts including leachate may be present in the northern portion of the project area in the vicinity of landfills, as well as adjacent to the large Woodlands Industrial Estate, service stations and the sewage treatment plant. Landfill gas near the landfills, as well as soil vapour from a petroleum hydrocarbon source around service stations and industrial areas may also be present.

ASPECT	DESCRIPTION
Potential exposure pathways	The anticipated primary transport media for the migration of contaminants identified were: — Inhalation of dusts, vapours and/or landfill gases. — Dermal contact and ingestion of soil. — Lateral migration of dissolved or a separate phase contaminant plume within the groundwater and leachate, typically in the direction of the local hydraulic gradient expected to be to the south/south-east/south-west (in general) based on the project area's topography and expected regional groundwater flow. However, this may be subject to dilution and dispersion. Groundwater flow may be modified depending on design and methods applied during construction. — Surface run-off and entry into stormwater drainage system(s) in the event of subsurface spillage. — Migration of landfill gases and/or vapours through soils, underground service trenches and/or pits and beneath building slabs in the event of subsurface leakages. — Odour emissions from the existing landfill located within the proposed road alignment. Of the potential exposure pathways identified, the migration of fugitive dust emissions is the primary exposure pathway for contaminants to impact surface soils along the project alignment.
Potential receptors of concern	Identified receptors at and in the vicinity of the project area include: — On-site construction and maintenance/utility workers during the planned road works. — Future residential and/or commercial/industrial occupants located along the roadway. — Existing off-site residential and commercial/industrial occupants. — Users of offsite groundwater bores. — Ecosystems in nearby surface water bodies, including ecosystems of Edithvale Wetlands.

5.9 INTRUSIVE INVESTIGATION FINDINGS

The existing conditions (i.e. the known extent of contamination) which was assessed as part of the Baseline ESA is summarised in Table 5.7. Figure 1 to Figure 3 in Appendix A shows the sampling locations investigated as part of the Baseline ESA. A copy of the Baseline ESA is included in Appendix B.

Table 5.7 Scope of works and assessment findings

MEDIA	ASSESSMENT SUMMARY	FINDINGS (NATURE AND EXTENT OF CONTAMINATION)		
		NORTHERN PORTION	CENTRAL PORTION	SOUTHERN PORTION
SOIL	General Soil Contamination: A combined targeted and lineal soil sampling strategy was adopted. A total of 17 shallow soil boreholes and 35 soil excavation test pits were advanced; and soil samples were collected from each location and submitted for a broad suite analysis specified in IWRG621. The results of the soil sampling program were compared against NEPM 2013 criteria applicable to the project area's current and proposed future open space land use (i.e. roadway).	Elevated lead above the adopted human health criteria in one location and zinc and TRH fractions F2 and F3 exceeded the adopted ecological criteria in several locations advanced within the footprint of the former Lot 1 Grange Road Landfill. During drilling the geotechnical and gas bores within the footprint of the former Lot 1 Grange Road Landfill (B17-68397, B17-68183, GB17-26-04 and GB17-26-05) fill was encountered to approximately 2.5 mBGL (gravel and gravelly clays, possibly landfill cap) and then the waste mass from 2.5 mBGL to approximately 10 mBGL. Sub-surface conditions encountered during drilling of the leachate well (LW17-26-01) within the footprint of the former Lot 1 Grange Road Landfill were similar; whereby fill (mixture of gravels and gravelly clays) to approximately 2.6 mBGL was observed followed by the waste mass from approximately 2.6 mBGL to 8.4 mBGL.	All soil analytical results from samples collected within the Central Portion of the project area were below human and ecological criteria. ACM was present at a depth of 0.8 mBGL in one borehole location within a rural residential property adjacent to Lower Dandenong Road.	All soil analytical results from samples collected within the Southern Portion of the project area were reported below human and ecological criteria.
	Waste Classification: The soil results were compared against waste classification criteria from IWRG621 to provide an indication of waste classification for offsite disposal, should it be required for the project. WSP notes that the assessment is high level and indicative only and further assessment would be required (including leachability testing where necessary) to confirm the indicative classification.	Fill Material or Category C Contaminated Soil.	Fill Material or Category C Contaminated Soil.	Fill Material.

MEDIA	ASSESSMENT SUMMARY	FINDINGS (NATURE AND EXTENT OF CONTAMINATION)		
		NORTHERN PORTION	CENTRAL PORTION	SOUTHERN PORTION
	PASS: The presence of PASS was further investigated through intrusive sampling in the Central and Southern Portion of the project area, given publicly available geological maps indicates these areas comprise a Holocene aged geology consistent with that of CASS. A lineal sampling approach was adopted at a sampling density of 1:250 m in the lower risk portions and a sampling density of 1:100 m in the higher risks portions (i.e. based on desktop review). A total of 252 samples were submitted for PASS initial pH screening (field pH (pH_F) and field pH peroxide (pH_{FOX})) and based on the results, a further 55 samples were submitted for Peroxide Oxidation Combined Acidity and Sulphur (SPOCAS) analysis.	Not assessed (as no PASS was identified in as likely to be present in publicly available maps).	The site inspection undertaken did not identify visual signs of PASS except for the presence of Common Reeds in water logged areas. PASS initial screening and SPOCAS analysis indicated that PASS are likely present from locations SB11 to SB38 or from Mills Road (Central Portion) to the southernmost boundary of the project area (Southern Portion). The presence of ASS which has a neutralising capacity sufficient to have a net acidity below the action criteria were identified within SB12 to SB17 (Central Portion). The reported net acidity from SB11 to SB38 ranged from 2 to 12.5 kg $CaCO_3$/tonne based on a bulk density of 1.8 tonne/m^3. Assessment of groundwater chemistry was also undertaken within the project area. Elevated sulfate (and TDS) was identified at a number of monitoring wells largely located adjacent to the Waterways wetlands (GW17-26-04 to GW17-26-10) suggesting that some level of CASS disturbance has historically occurred. It is important to note that the HSU's have a large seasonal variation with levels dropping in summer months and levels gaining in winter months. Natural variation in the dataloggers installed within the project area is generally +/- 1.0 m, however indicators of widespread activation of CASS has not occurred.	

MEDIA	ASSESSMENT SUMMARY	FINDINGS (NATURE AND EXTENT OF CONTAMINATION)		
		NORTHERN PORTION	CENTRAL PORTION	SOUTHERN PORTION
			It is inferred that greater than 1,000 tonnes of PASS is likely to be generated during the construction process and therefore in accordance with the Best Practice Guidelines for Assessing and Managing CASS (DELWP, 2010), the project area is classified as a High Hazard meaning that an Environmental Management Plan (EMP) approved by the EPA will be required where CASS disturbance cannot be avoided. The analytical results are consistent with the desktop review findings.	
Groundwater/ Leachate	The groundwater investigation focused on collecting data within the landfilled area (Northern Portion) of the project area for preliminary characterisation of extent and confirm potential impacts. This included the drilling and installation of two groundwater monitoring wells (GW17-26-01 and GW17-26-02) and one leachate well (LW17-26-01) with subsequent sampling undertaken in October 2017 adjacent to the landfilled areas. As was noted previously, a separate assessment of groundwater hydrogeological conditions was completed in the vicinity of the Edithvale Wetlands (Central and Southern Portion of the project area), to assess impacts posed by the proposed project. As part of this, 38 bores were advanced and assessed.	Groundwater analytical results were reported to exceed the adopted assessment criteria including: — Copper was reported to exceed the adopted ecological criteria in GW17-26-01. — Nickel was reported to exceed the ecological and human health criteria (potable water supply and primary contact, recreation) in GW17-26-01 and GW17-26-02. — Zinc was reported above the ecological criteria in GW17-26-01 and GW17-26-02. — Low pH is present, which could pose a risk for buildings and structures, primary contact, recreation or stock watering. — Dissolved concentration of methane (124 µg/L) was reported at GW17-26-01. This groundwater monitoring well is located at the southern boundary of the former Lot 1 Grange Road Landfill.	The water quality results as reported in WSP (2017) showed that salinity and pH values had a wider range in the surficial Quaternary aquifer than in the semi-confined Brighton Group aquifer, whilst nutrients were low or not detected in both aquifers. Dissolved metals were more frequently detected above laboratory LOR. The results show that there were more dissolved metal concentrations recorded above the criteria adopted for maintenance of ecosystem protection (i.e. ANZECC 2000 freshwater 95% protection level) in the Quaternary aquifer compared to the Brighton Group aquifer. All samples were below the laboratory detection limit for BTEX compounds, hydrocarbons and pesticides in both aquifers (WSP, 2018).	

MEDIA	ASSESSMENT SUMMARY	FINDINGS (NATURE AND EXTENT OF CONTAMINATION)		
		NORTHERN PORTION	CENTRAL PORTION	SOUTHERN PORTION
	Groundwater quality was assessed against adopted criteria for beneficial uses of groundwater relevant to Segment A2 under the Groundwater SEPP. Groundwater quality was also assessed against the health screening levels (HSLs) for vapour intrusion for open spaces and recreation uses (i.e. roadway). No criteria typically apply to assess the quality of leachate. In the absence of applicable criteria to assess leachate quality, the criteria adopted for groundwater quality was used as a screening indicator.	Leachate analytical results were reported to exceed the adopted assessment criteria including: — TDS – exceeds the criteria for primary contact, recreation and stock watering. — Benzene – exceeds the criteria for potable water supply, agriculture, parks and gardens, primary contact, recreation and stock watering. — Barium – exceeds the criteria for agriculture, parks and gardens. — Boron– exceeds the criteria for maintenance of ecosystems, potable water supply, agriculture, parks and gardens, primary contact, recreation and stock watering. — Nickel – exceeds the criteria for maintenance of ecosystems, potable water supply and primary contact, recreation. — Zinc – exceeds the criteria for maintenance of ecosystems. — Methane (8,280 µg/L) – whilst no criteria is available to adopt for the identified groundwater beneficial uses, methane was identified in both the leachate sample and the groundwater sample collected from GW17-26-01.		

MEDIA	ASSESSMENT SUMMARY	FINDINGS (NATURE AND EXTENT OF CONTAMINATION)		
		NORTHERN PORTION	CENTRAL PORTION	SOUTHERN PORTION
LANDFILL GAS	The potential for landfill gas generation was assessed within the landfilled areas in the Northern Portion of the project area. This included the installation of ten landfill gas bores at and in the vicinity of the former Lot 1 Grange Road Landfill and two rounds of gas sample collection and surface emissions monitoring in October 2017 and May 2018. Monitoring of existing gas bores west of former Din San Landfill was also undertaken in May 2018. The Landfill BPEM was adopted for relevant action levels for landfill gas. Given the close proximity of some of the bores to the waste mass, the action levels may not be relevant for all wells but has been used as a conservative approach. Relevant TWA exposure limits from Safework Australia were adopted where BPEM action levels were not available. The NEPM 2013 HIL and HSLs were adopted to assess trace gases. In the absence of applicable criteria, the US EPA Regional Screening Levels for industrial and residential uses were adopted. To assess the potential human health and/or environmental risks associated with the presence and migration of landfill gases to the current project area users and/or surrounding residential properties, a preliminary landfill gas risk assessment was completed.	Methane exceedances were recorded in gas bores installed in the former Lot 1 Grange Road Landfill. Given that these locations are either above or at the edge of the waste mass, the BPEM action level criteria of 1.0% v/v may not be relevant but has been applied as a conservative measure. Concentrations of methane in other monitoring wells to the north and to the south of the former Lot 1 Grange Road Landfill (including adjacent to the former Din San and Barraton landfills were all below or close to the level of detection and all were below adopted BPEM criteria. Based on the calculated carbon dioxide (CO_2) action level of 5.2% all locations within the former Lot 1 Grange Road Landfill (i.e. GB17-26-04, GB17-26-05 and GB17-26-06); to the north of the former Lot 1 Grange Road Landfill, at one location (i.e. GB17-26-02); and to the west of the former Din San Landfill (i.e. GB17-26-08 and GB17-26-09) were above the action level criteria. Carbon monoxide (CO) concentrations were detected in three out of the 10 gas bores sampled (i.e. GB17-26-01, GB17-26-06 and GB17-26-08), with one CO concentration reported to be above the Safe Work Australia criteria of 34,000 $\mu g/m^3$ at gas bore GB17-26-08 located to the west of the former Din San Landfill during the 2017 monitoring round. Hydrogen sulphide, hydrogen cyanide and ammonia were reported below detection levels or below criteria at all gas bores.	Not investigated.	Not investigated.

MEDIA	ASSESSMENT SUMMARY	FINDINGS (NATURE AND EXTENT OF CONTAMINATION)		
		NORTHERN PORTION	CENTRAL PORTION	SOUTHERN PORTION
		Trace gases were reported within the former Lot 1 Grange Road Landfill however concentrations did not exceed adopted HILs/HSLs. Trace gasses within the former Lot 1 Grange Road Landfill and nearby surrounding landfills exceeded US EPA Regional Screening Levels (RSLs) for industrial and residential uses. However, given the closest residential property is approximately 550m from the project area and the proposed use as a road, potential risks to residential and/or future commercial occupants (given there will not be any) is considered to be low. Based upon the available data and qualitative and quantitative interpretation thereof, WSP consider that the section of the Mordialloc Bypass to be constructed above the former Lot 1 Grange Road Landfill will significantly impact how gas emits from the waste mass in the western portion of the former landfill. WSP note that monitoring of sub-surface landfill gas concentrations within the planned Bypass footprint outside of the former Lot 1 Grange Road site indicates a very low to low risk for development in these areas. As such it is considered that the primary landfill gas risk relating to the development from the adjacent former Din San and Barraton landfills is the migration of gas into service trenches within the alignment.		
PFAS	It is understood that the former landfills in the northern portion of the project area may have accepted solid and liquid industrial wastes of unknown compositions. PFAS may be present in the leachate and groundwater beneath the Northern Portion of the project area due to the former landfilling activities.	PFAS analytes in soil were reported to be below the adopted investigation levels within surface soils adjacent to the former Lot 1 Grange Road Landfill. PFAS compounds were detected in groundwater samples, however concentrations were below the adopted investigation levels.	Detectable PFAS analytes in soil were identified at two boreholes adjacent to Moorabbin Airport. All soil analytical results were below adopted criteria.	No assessment undertaken

MEDIA	ASSESSMENT SUMMARY	FINDINGS (NATURE AND EXTENT OF CONTAMINATION)		
		NORTHERN PORTION	CENTRAL PORTION	SOUTHERN PORTION
	In addition, Moorabbin Airport is located to the west of the project area and it is inferred that PFAS containing firefighting foams would have been used during training activities. Windblown foams can travel significant distances, resulting in distribution of PFAS in surface water and surface soils (and ultimately groundwater). Three soil samples were collected from west of the former Lot 1 Grange Road Landfill, a landfill of interest, as it intersects the project area. Three samples were also collected within the central portion of the project area, between Centre Dandenong Road and Lower Dandenong Road (east of Moorabbin Airport). Three groundwater samples were collected, two in the landfilled areas in the northern portion (GW17-26-01 and GW17-26-02) and one in a further down-gradient well of the landfilled areas and Moorabbin Airport (GW17-26-03). Surface water and sediment samples were collected from Dunlop Drain, (locally known as Old Dandenong Drain), which borders the northern portion of the former Lot 1 Grange Road Landfill. Two surface water and two sediment samples were collected. The environmental guideline values for soil, groundwater and surface water in the PFAS NEMP (HEPA, 2018) were adopted to assess the potential human health and ecological risks posed by PFAS.	PFAS compounds were detected in a sample collected from the leachate well within the former Lot 1 Grange Road Landfill in excess of the adopted investigation levels. PFAS compounds were detected in sediment and surface water samples collected from Dunlop Drain immediately north of the former Lot 1 Grange Road property, however concentrations were below the adopted investigation levels for that receptor. Analytical results suggest that some degree of migration may have historically occurred from the surrounding former landfills as PFAS is present within surface water and groundwater in this area. No assessment of downstream surface water environments has been undertaken to date.	PFAS compounds were detected in groundwater samples, however concentrations were below the adopted investigation levels	

6 RISK ASSESSMENT

A risk assessment process was undertaken in accordance with the risk assessment framework which is based on AS/NZS ISO31000:2009, presented under a separate cover. Key findings are presented herein.

6.1 BACKGROUND

A series of multidisciplinary semi-quantitative environmental risk assessments and workshops have been undertaken in relation to the assessment of potential environmental impacts due to the proposed project.

The risk assessment process identified potential construction and operational hazards, impact pathways, consequences of contaminated land and spoil management and likelihood of impacts. Risk to values was determined as the combination of consequence and likelihood. Where possible, mitigation measures and additional Environmental Performance Requirements were recommended to lower the residual risk.

6.2 PROJECT PHASES AND ASSOCIATED RISKS

The risk assessment evaluates the project based on the concept designs for the project, a draft construction methodology and the existing conditions of the study area. The project phases to be assessed are as follows:

- Initial phase.
- Development phase.
- Maintenance/operations phase.

To effectively and comprehensively recognise all potential risks to the project, it is necessary to identify impact pathways for the project. A risk is considered possible only when an impact pathway is present. An impact pathway is the cause and effect pathway or relationship that exists between a project activity and an aspect of the environment.

The project phases assessed for risks, including design, construction and operation phases, are described in Table 6.1.

Table 6.1 Assessed project phases

PROJECT PHASES	MAIN ACTIVITIES FOR EACH PHASE	EXAMPLES OF ASPECTS IN EACH ACTIVITY
Initial Phase	Current project activities including: Project scoping, design stages (from initial to detailed), feasibility studies, design option analysis, baseline assessments, planning and approvals, material selection etc.	Site investigations (impacts from geotechnical assessments including pre-construction drilling, ecology assessments etc., gaps in baseline data, quality control). Design (water sensitive urban design, design to minimise environmental impact etc.). Approvals (what approvals are required? Do we have all required approvals?).
Development Phase	Construction & Manufacturing	Transport of materials to site, impacts on environment/social values, earthworks, environmental changes (weather), laydown areas, schedule delays.
Maintenance / Operations Phase	Road and infrastructure maintenance and operation	Weed control, grass cutting, re-laying road surface, drainage, long term environmental/social impacts, emergency preparedness / response, traffic.

The primary environmental risks identified for contaminated land and acid sulfate soil are provided in Table 6.2 and Table 6.3. The initial risk ratings presented below for both project and cumulative impacts consider standard inherent controls as listed in the Environmental Risk Assessment Report (WSP 2018a). The additional controls listed in the tables below are those recommended to further mitigate and minimise the primary environmental risks which were risk rated as medium or above. Primary environmental risks which were scored as low did not require additional controls to be applied.

Also, included in the table below are any identified on-site project related cumulative risks, including: secondary risks (resulting from the implementation of a risk response in mitigating a primary environmental risk) and on-site aggregate cumulative risks (the aggregate/combined primary environmental risks resulting from diverse project activities having an impact on the same environmental asset.

Table 6.2 Contaminated land and acid sulfate soils environmental risk assessment register

RISK ID	IMPACT PATHWAY	PRIMARY ENVIRONMENTAL RISK DESCRIPTION	SECONDARY ENV. RISK	INITIAL RISK			ADDITIONAL MITIGATION / CONTROLS	EPR	RESIDUAL RISK		
				Consequence	Likelihood	Rating			Consequence	Likelihood	Rating
R-CL1	Expose Acid Sulfate Soils	Inadequate characterisation results in inadequate design parameters (material durability) and inadequate allowance for the management and disposal of ASS during the construction phase.	None	Moderate	Possible	Medium	Map areas of known ASS. Refine design to consider ASS included in design considerations including dewatering activities and construction materials.	*CL2*	Moderate	Rare	Low
R-CL2	Expose Acid Sulfate Soils	Construction and excavation activities results in exposing ASS soils requiring management and specific off-site disposal requirements. Inferred piling construction methods therefore minimal waste soil generated.	None	Minor	Unlikely	Low	None required.	*CL2*	Minor	Unlikely	Low

RISK ID	IMPACT PATHWAY	PRIMARY ENVIRONMENTAL RISK DESCRIPTION	SECONDARY ENV. RISK	INITIAL RISK			ADDITIONAL MITIGATION / CONTROLS	EPR	RESIDUAL RISK		
				Consequence	Likelihood	Rating			Consequence	Likelihood	Rating
R-CL3	Expose Acid Sulfate Soils	ASS encountered during the construction phase requiring future monitoring of infrastructure for resistivity and management of acid impacted waters	None	Minor	Unlikely	Low	None required.	*CL2*	Minor	Unlikely	Low
R-CL5	Uncovers contaminated land	Inadequate provision for the handling and disposal of contaminated material causing spread of contamination and potential exposure of construction workers and members of the general public to contaminated material.	None	Moderate	Likely	High	Map areas of known contamination. Refine design to consider contamination implications are included in design. HEPA PFAS Environmental Management Plan.	*CL1*	Moderate	Possible	Medium

RISK ID	IMPACT PATHWAY	PRIMARY ENVIRONMENTAL RISK DESCRIPTION	SECONDARY ENV. RISK	INITIAL RISK			ADDITIONAL MITIGATION / CONTROLS	EPR	RESIDUAL RISK		
				Consequence	Likelihood	Rating			Consequence	Likelihood	Rating
R-CL6	Uncovers Landfill waste (including PFAS) and gases	Location of alignment has potential to encounter landfill leachate and landfill gas in northern sections. Inadequate characterisation results in exposure and health and safety risk to construction workers, inadequate allowance for the management of contaminated media.	None	Moderate	Unlikely	Medium	Map areas of known contamination. Refine design to consider contamination implications are included in design including landfill gas capture and venting system, preferred construction methods (driven piles) and alignment considerations. PFAS Environmental Management Plan.	*CL3, CL6*	Moderate	Rare	Low
R-CL7	Uncovers Landfill waste (including PFAS) and gases	Investigations encounter landfill waste including leachate and landfill gas and PFAS.	None	Moderate	Unlikely	Medium	Undertake further intrusive investigation once alignment and design is confirmed to close any data gaps. HEPA PFAS Environmental Management Plan.	*CL3, CL4, CL6*	Moderate	Rare	Low
R-CL8	Uncovers contaminated land	Investigations encountered contaminated soil, groundwater potentially contaminating environment	None	Moderate	Unlikely	Medium	PFAS Environmental Management Plan. Undertake further intrusive investigation once alignment and design is confirmed (if required).	*CL1, CL2, CL6*	Moderate	Rare	Low

RISK ID	IMPACT PATHWAY	PRIMARY ENVIRONMENTAL RISK DESCRIPTION	SECONDARY ENV. RISK	INITIAL RISK			ADDITIONAL MITIGATION / CONTROLS	EPR	RESIDUAL RISK		
				Consequence	Likelihood	Rating			Consequence	Likelihood	Rating
R-CL9	Uncovers contaminated land	Previously unidentified contamination encountered during construction process requiring management. Potential exposure and health and safety risk to construction workers. Potential exposure to third parties.	None	Minor	Unlikely	Low	None required	*CL1, CL2, CL4, CL6*	Minor	Unlikely	Low
R-CL10	Contamination of soil	Construction activities (cleaning/wash-down/refuelling/maintenance of earthmoving plant) result in the contamination of the environment. Uncontrolled fill brought to the site.	None	Minor	Unlikely	Low	None required	*EM2*	Minor	Unlikely	Low
R-CL11	Contamination of soil	Contamination of the environment due to vehicle accident resulting in loss of fuel or chemicals being transported along the roadway.	None	Minor	Unlikely	Low	None required	*CL1*	Minor	Unlikely	Low

RISK ID	IMPACT PATHWAY	PRIMARY ENVIRONMENTAL RISK DESCRIPTION	SECONDARY ENV. RISK	INITIAL RISK			ADDITIONAL MITIGATION / CONTROLS	EPR	RESIDUAL RISK		
				Consequence	Likelihood	Rating			Consequence	Likelihood	Rating
R-CL12	Uncovers Landfill waste (including PFAS) and gases	Ongoing management of potential contaminated soil repositories, management of existing landfill, landfill gas and PFAS impacted leachate. Potential health and safety risk to maintenance workers due to vapour and landfill gas accumulation in service pits and drains.	None	Minor	Almost certain	Medium	HEPA PFAS Environmental Management Plan. Ensure design allows for ongoing management of existing landfill and any potential soil repositories.	*CL3, CL4, CL5, CL6*	Minor	Unlikely	Low
Cumulative Impacts - On-Site Aggregate											
R-CL4	Expose acid sulfate soil	Earthworks and construction uncover ASS requiring off-site disposal of ASS soils and treatment in mitigation of acid impacted waters	None	Moderate	Unlikely	Medium	Map area of known ASS. Refine design to consider ASS included in design considerations including dewatering activities and construction materials. Undertake further intrusive investigation once alignment and design is confirmed to close any data gaps.	*CL2*	Moderate	Rare	Low

RISK ID	IMPACT PATHWAY	PRIMARY ENVIRONMENTAL RISK DESCRIPTION	SECONDARY ENV. RISK	INITIAL RISK			ADDITIONAL MITIGATION / CONTROLS	EPR	RESIDUAL RISK		
				Consequence	Likelihood	Rating			Consequence	Likelihood	Rating
R-CL13	Contamination of soil	Soil contamination caused by uncovering of landfill, exposure of ASS, soils and leaks, improper mitigation of existing contaminated soils	None	Minor	Almost certain	Medium	Ensure design allows for ongoing management of existing landfill and any potential repositories, Implement SMP. Ensure design allows for management of accidents resulting in spills including barriers, drainage networks, etc. HEPA PFAS Environmental Management Plan	*CL1*, *CL2*, *CL3*, *CL4*, *CL5*, *CL6*	Minor	Possible	Low

The assessment of cumulative impacts was competed in two stages, namely the assessment of aggregate project impacts and the assessment of the cumulative impact of multiple off-site projects in addition to the Mordialloc Bypass project for contaminated land and acid sulfate soil. The cumulative environmental risks identified for contaminated land and acid sulfate soil is provided in the Table 6.3.

Table 6.3 Contaminated land and acid sulfate soil cumulative effects environmental risk assessment

RISK ID	IMPACT PATHWAY	PROJECTS CONSIDERED	CUMULATIVE RISK DESCRIPTION	ADDITIONAL MITIGATION / CONTROLS	EPR	RESIDUAL RISK		
						Consequence	Likelihood	Rating
R-CL1	Acid Sulfate Soil	LXRA Edithvale and Bon Beach level crossing removal projects	Design of rail upgrade encounters ASS and results in acidification of groundwater and/or changes in hydrogeology	Map areas of known ASS. Refine design to consider ASS included in design considerations including dewatering activities and construction materials.	*CL2*	Moderate	Unlikely	Medium
R-CL2	Acid Sulfate Soil	LXRA Edithvale and Bon Beach level crossing removal projects	Design of rail upgrade encounters ASS and results in acidification of groundwater and/or changes in hydrogeology	None required	*CL2*	Moderate	Unlikely	Medium
R-CL3	Acid Sulfate Soil	LXRA Edithvale and Bon Beach level crossing removal projects	Design of rail upgrade encounters ASS and results in acidification of groundwater and/or changes in hydrogeology	None required	*CL2*	Moderate	Unlikely	Medium
R-CL6	Land contamination	Existing landfills within northern section of alignment. Hawthorn Football Club development LXRA Edithvale and Bon Beach level crossing removal projects	Existing landfills may be a co-contributing source of groundwater contamination in the northern section of the alignment. Development on former landfill may alter existing (and understood) landfill gas migration pathways.	Map areas of known ASS. Refine design to consider ASS included in design considerations including dewatering activities and construction materials.	*CL3, CL6*	Moderate	Rare	Low

RISK ID	IMPACT PATHWAY	PROJECTS CONSIDERED	CUMULATIVE RISK DESCRIPTION	ADDITIONAL MITIGATION / CONTROLS	EPR	RESIDUAL RISK		
						Consequence	Likelihood	Rating
R-CL7	Land contamination	Existing landfills within northern section of alignment. Hawthorn Football Club development LXRA Edithvale and Bon Beach level crossing removal projects	Existing landfills may be a co-contributing source of groundwater contamination in the northern section of the alignment. Development on former landfill may alter existing (and understood) landfill gas migration pathways.	Undertake further intrusive investigation once alignment and design is confirmed to close any data gaps. HEPA PFAS Environmental Management Plan.	*CL3, CL4, CL6*	Moderate	Possible	Medium
R-CL12	Land contamination	Existing landfills within northern section of alignment. Hawthorn Football Club development LXRA Edithvale and Bon Beach level crossing removal projects	Existing landfills may be a co-contributing source of groundwater contamination in the northern section of the alignment.	HEPA PFAS Environmental Management Plan. Ensure design allows for ongoing management of existing landfill and any potential soil repositories.	*CL3, CL4, CL5, CL6*	Minor	Possible	Low

7 IMPACT ASSESSMENT AND MITIGATION

7.1 BACKGROUND

The preliminary impact assessment comprised the following:

- Review of preliminary concept design to identify relevant project components such (e.g. construction methods, built infrastructure)
- Identification of existing conditions to characterise potential sources of contamination in consideration to site specific information
- Identification of key issues following the risk assessment
- Impact assessment.

The impact assessment details the existing conditions and covers potential land contamination impacts during initial, development and operation and maintenance phases. It should be noted that the road design is still at concept stage and will be further refined as part of the EES process. A designs options assessment is underway at the time of writing this report.

7.2 KEY IMPACTS IDENTIFIED

The risk assessment process has identified that the pre-construction, construction, operation and maintenance of the project has the potential to result in the following impacts summarised in Table 7.1.

Table 7.1 Key issues and impacts for the construction and operation of Mordialloc Bypass

KEY ISSUES	POTENTIAL IMPACTS
Potential for adverse environmental or health effects resulting from disturbance of or influencing the transport/ movement of contaminated soil, soil gases/vapours and/or groundwater	— Human health and environmental impact associated with contaminated land and groundwater associated with the former landfill sites in the vicinity of the project. — Human health and environmental impacts as a result of other identified potentially contaminating activities including service stations, waste recycling facility, chemical handling and/or manufacturing facilities, agricultural land uses or any imported potentially contaminated fill. — Human health and environmental impact associated with release of landfill gas (i.e. methane) and vapours as pollutants associated with the landfill sites on and in the vicinity of the project area. — Formation of pathways for contamination in groundwater to migrate between aquifers, or formation of pathways for landfill gas and vapours to migrate laterally.

KEY ISSUES	POTENTIAL IMPACTS
Potential for adverse environmental or health effects resulting from handling, storage or transportation of excavated contaminated spoil or potential acid sulfate soils (PASS)	— Generation of large volume of waste soil (contaminated), including “clean” fill (uncontaminated and non-acid forming soil) as a result of construction works/earthworks requiring management and/or offsite disposal. — Construction, excavation and earthworks activities to result in exposure of PASS and subsequent creation of Actual ASS (AASS). — Ongoing environmental management of contaminated soil repositories and/or landfills that may be required during the construction phase. — Inflow of contaminated soil, groundwater and ground gas into working areas presenting occupational health and safety (OH&S) issues during construction and maintenance phases. — Stockpiles, spills and other construction hazards.
Potential for adverse environmental or health effects from other waste materials/streams generated from project works	— Human health and environmental impact associated with the presence of persistent contaminants that resist physical, chemical and biological degradation such as PFAS (potentially associated with the former landfill sites in the Northern Portion of the project area and the offsite Moorabbin Airport), that eventually affect regional soil and groundwater quality. — Human health and environmental impact associated with the presence of landfill waste mass in the northern portions of the project area. — Human health and environmental impact associated uncovering of asbestos containing materials during construction works and/or earthworks.
Potential for adverse environmental effects on the Edithvale-Seaford Wetlands Ramsar site resulting from disturbing, storing or influencing the transport/ movement of contaminated or acid-forming material	— Changes in hydrogeology potentially affect existing users/sensitive receptors (beneficial groundwater users such registered and unregistered groundwater bores, groundwater dependent ecosystems [GDE], including the Edithvale-Seaford RAMSAR wetland, and surface waters systems). — Design of project results in substantial and measurable change in the hydrological regime, i.e. embankment structures reducing permeability of unconsolidated sediments impacting prevailing groundwater flow of aquifers with potential for reduction in groundwater levels/flows affecting existing users/sensitive receptors such as the Edithvale-Seaford RAMSAR Wetlands. — Construction and earthworks result in substantial and measurable change in groundwater quality of the Edithvale-Seaford RAMSAR Wetlands.

The impacts are further discussed in the following sections.

7.2.1 ACID SULFATE SOIL

Disturbance of acid sulfate soil during construction could introduce oxygen and cause production of sulfuric acid. This could potentially impact the environment, in-ground structures and human health.

The main activities during construction phase which have the potential to activate acid sulfate soil would be during piling works proposed for the elevated structures in the bypass (within the Central and Southern Portion) and during excavation of trenches.

Site investigations have identified the presence of PASS and ASS in the Central and Southern Portions. The estimated volume of ASS is not known at this stage but inferred to be in excess of 1,000 tonnes.

7.2.2 CONTAMINATION

7.2.2.1 SOIL CONTAMINATION

In the Northern Portion of the project area, the available data indicates the likelihood of encountering contaminated soil where landfilled areas exist is high. There is also a potential to encounter waste mass and odorous material. PFAS impacts may also be present.

In the Central Portion of the project area, an ACM hotspot was encountered, which may be a result of uncontrolled/illegal dumping. In addition, there is a potential for PFAS impacts to be present from the nearby Moorabbin Airport.

Exposure to contaminated soil is known to be associated with a potential risk to human health and the environment. A potential linkage between source, pathway and receptor has been identified across the project area.

7.2.2.2 EXCAVATION SPOIL

The excavation of spoil is required during construction of the Mordialloc Bypass. Exposure to contamination may occur by uncovering contaminated soil during earthwork or through the importation of contaminated fill (should practises and procedures not be put in place to mitigate this risk).

Where possible, reuse of excavation spoil for construction is a recommended practice. However, there may be a need to import soil for the project where there is a negative cut/fill net balance, or where the spoil from construction is not of a suitable quality to be used as a construction material (from both a geotechnical and contamination perspective).

Based on the concept design dated March 2018, the anticipated volumes of soil required to be cut or filled within the project area as part of earthworks for activities is presented in Table 7.2. It is noted here that these estimates are preliminary only and based on the assumption that all excavated spoil is useable.

Table 7.2 Approximate Construction Spoil Volumes – Freeway Option

EARTHWORKS DESCRIPTION	TYPE	SPOIL VOLUME (m^3)			CUT FILL BALANCE (m^3)
		NORTHERN PORTION	CENTRAL PORTION	SOUTHERN PORTION	
150mm strip	Cut	21,785	47,982	19,508	**89,275**
Total Cut	Cut	16,433	0	4,100	**20,534**
Total Fill	Fill	-273,244	-698,462	-257,716	**-1,229,422**
Cut/Fill balance:		**-235,025**	**-650,480**	**-234,108**	**-1,119,614**

It is noted that driven piles are proposed at this stage, which generate minimal spoil volume (and the quantities in Table 7.2 are based on this assumption).

For excavated spoil that is required to be disposed offsite, EPA IWRG apply. Based on the limited assessment completed to date and applying a level of conservatism for estimation purposes, excavated spoil from the Northern and Central Portions of the project area are indicative of "Category C Contaminated Soil" and excavated spoil from the Southern Portion of the project area is indicative of "Fill Material" in accordance with IWRG621. This indicates the volume of potential "Category C Contaminated Soil" is between 50,000 m^3 and 65,000 m^3.

Should offsite disposal of contaminated spoil be required, it must be disposed of to a landfill licensed to receive Category C Contaminated Soil. EPA does not regulate the offsite disposal of Fill Material. It is noted here that the assessment completed to date is preliminary and indicative only and further assessment is required prior to disposing of any excavation spoil offsite. In addition, PFAS, ASS and any identified ACM will require specific management requirements.

Should onsite reuse be deemed a preferable option, further assessment in accordance with NEPM 2013 would be required to mitigate human health and ecological risks posed by contaminants in the fill. Where PFAS is present, assessment and management in accordance with the PFAS NEMP (HEPA, 2018) would be required. Given the anticipated negative cut/fill balance for the project. it is also anticipated that the majority of excavated material will be reused within the project boundaries, with additional fill sourced from other major projects (i.e. Melbourne Metro and LXRA Edithvale and Bon Beach level crossing removal projects) therefore landfill capacity is not considered to be a significant issue for this project.

7.2.2.3 GROUNDWATER AND LEACHATE CONTAMINATION

The available data indicates low pH, metals and methane impacted groundwater is present in the Northern Portion of the project area. In addition, metals, benzene and methane impacted leachate is also present. PFAS impacts are also present in leachate and groundwater in this portion of the project area.

Shallow groundwater (less than 5.0 mBGL) exists in the project area and has the potential to ingress into road excavations. This is most likely to occur is during the construction of embankments. The volume of inflow will depend on the construction methods and the extent of excavation. Piling works proposed for the elevated structures in the bypass will also interfere with the groundwater flow regime and have the potential to create preferential pathways for contamination migration including shallow contaminated soil being entrained into underlying aquifer(s), leachate discharging directly into underlying aquifers and by creating interconnectivity between the shallow and deeper aquifers (note that multiple aquifers units are present within the project area).

The transfer mechanism will depend on the piling method applied and may include the following (Boutwell, et.al., 2004):

- Direct transfer via creation of plug of (contaminated) soil below the pile tip and driven all the way to the groundwater aquifer. Groundwater flow in the aquifer then moves a plume of contamination away from the pile tip.
- Conduit formation via flow along the pile. This occurs in the (contaminated) soil zone disturbed by pile driving, especially along the pile-soil interface. It requires that the pile create an annular void, or at least a zone of higher permeability and a downward hydraulic gradient to cause flow (i.e. the groundwater head in the contaminated zone must be higher than in the aquifer).
- Wicking via flow through the pile itself. It could occur if the pile is made of material more permeable than the soil (usually clay) which lies between the contaminated upper zone and the lower aquifer.

Exposure to contaminated groundwater is known to be associated with a potential risk to human health and the environment. A potential linkage between source, pathway and receptor has been identified in the Northern Portion (within former landfilled areas).

7.2.2.4 LANDFILL GAS CONTAMINATION

Based on the preliminary landfill gas assessment works and the LGRA undertaken for the project area, landfill gas (including bulk and trace gases) was identified to be present within the northern portion of proposed road alignment footprint. Based upon the available data and qualitative and quantitative interpretation thereof, WSP consider that the section of the Mordialloc Bypass to be constructed above the former Lot 1 Grange Road Landfill will significantly impact how gas emits from the waste mass in the landfills west. The main risks identified by the assessment can be summarised as follows:

- Risk to workers during the construction of the bypass
- Gas accumulation beneath planned roadways presenting a fire and explosion risk for users and workers
- Migration of gas into service trenches, voids and conduits increasing the potential for long-distance migration of gas away from site and risk to workers accessing those conduits; and
- Dissolution of methane, carbon monoxide and carbon dioxide into groundwater impacting the water quality of Dunlop’s Drain and also potentially migrating further downgradient and impacting off-site receptors.

Monitoring of sub-surface landfill gas concentrations within the planned Bypass footprint outside of the former Lot 1 Grange Road site indicates a very low to low risk for development in these areas. As such it is considered that the primary landfill gas risk relating to the development from the adjacent former Din San and Barraton landfills is the migration of gas into service trenches within the alignment.

A potential linkage between source, pathway and impact is identified in the Northern Portion where historic and current landfilled areas exist.

7.2.2.5 OCCUPATIONAL HEALTH AND SAFETY IMPACTS

Construction activities in contaminated land may lead to impacts on worker health and safety. The majority of the road works would likely be conducted in natural soil profile and not within the fill profile where hazardous contaminants maybe encountered, however some interaction will occur with fill and there are known sources of contamination within the project area.

Hazardous contaminants may be encountered from the following:

- Introduction of contaminants from impacted groundwater.
- Temporary stockpiles where volatile materials could accumulate (where contaminated material is present).

The huge volume of cut and fill will result in generation of temporary stockpiles at the project area. Within the construction area, movement of personnel and large vehicles and equipment may result in safety hazards.

7.2.3 OTHER WASTE STREAMS

Other waste streams that may be applicable to the project include:

- Groundwater encountered during excavation works;
- Rainwater or surface water (as run-off) which come into contact with potentially contaminated excavated soils; and
- Construction wastes.
- Spills and leaks in wash-down and refuelling areas for equipment and machineries
- Spills and leaks due to vehicle accidents in the work area
- Uncontrolled fill brought to site

7.2.4 EDITHVALE WETLANDS

The potential for regional groundwater impacts to arise from the project was conceived and advanced in the development of the “Preliminary Groundwater Impact Assessment” (PGWIA) (WSP, 2017a), which documented a qualitative assessment of potential impacts, and considerations via an environmental risk assessment (RA) process. The risk assessment focused on Matters of National Environmental Significance (MNES) protected under the Australian Government’s Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act), including the Edithvale – Seaford Wetlands and protected flora and fauna.

The RA process identified that the Edithvale-Seaford Wetlands – Ramsar-listed wetlands – as having a potential high risk impact from the project, and thereby triggering further assessment, and as it effects this report, hydrological and hydrogeological assessment, to more confidently evaluate the risk. As a preliminary outcome, the RA also identified possible engineering mitigation measures to minimise recognised risk.

The risk to the existing regional groundwater behaviour was assessed as being likely to stem from particular geotechnical effects arising from the construction of embankments on subsurface compressible soils, present beneath the project alignment. Typically, compression effects of this nature reduce the soil porosity though compaction and void closure effects, and thereby reducing permeability under the embankment. This, in turn, has the potential to constrict prevailing groundwater flow in the down-gradient areas. Groundwater flow changes induced by this constriction may impact the supply of water to the local wetlands surrounding the project alignment, thereby potentially affecting their ecological health (if sufficient mitigation is not applied).

These potential risks have been assessed in the EES Groundwater Technical Impact Assessment Report (WSP 2018b) through extensive field investigations and the development of a numerical groundwater model. The modelling has shown that the proposed embankment structures is highly unlikely to have any measurable effect on groundwater flow and in turn potential movement of groundwater and impact on the Edithvale wetlands is also considered highly unlikely.

7.3 MITIGATION MEASURES ESTABLISHMENT

In order to mitigate the risks for the project, VicRoads provided the standard protection measures to be adopted for this project which is included in the contract specification under Section 177 (VicRoads S.177). VicRoads S.177 specifies the minimum environmental management obligations relating to the work to be done by the construction contractor. The following parts of VicRoads S.177 should be referred to:

- Part B – Water quality.
- Part E – Contaminated soils and materials.
- Part F – Waste and resource use.

Prior to any earthworks or construction activities for the project, a Construction Environment Management Plan (CEMP) should be developed in accordance with EPA Publication 480 Environmental Guidelines for Major Construction Sites, and relevant EPA and Victorian WorkCover Authority regulations, standards and best practice guidance and implemented to manage impacts from contamination and acid sulfate soil. In addition to the CEMP, specific controls have been recommended to avoid, manage and mitigate the potential contaminated land effects and reducing the residual risks to acceptable levels. Each key item will have a specific management plan. The additional controls are outlined in the following sub-sections.

7.3.1 ACID SULFATE SOIL

The *Victorian Best Practice Guidelines for Assessing and Managing Coastal Acid Sulfate Soils* (DSE 2010) listed the following management strategies in order of priority:

1. Avoid disturbance of CASS at all sites
2. Minimise disturbance
3. Prevent oxidation
4. Treat to reduce or neutralise acidity
5. Offsite reuse or disposal.

Given the nature of construction works, disturbance cannot be totally avoided. However proposed construction methods can assist in minimising disturbance and subsequent oxidation.

A detailed sampling program has been undertaken and as such the existence and location of PASS and ASS is well understood. This understanding is adequate to develop a suitable management plan to management the handling, storage and disposal of this material.

The CEMP to be prepared for the project should also include work plan on ASS/ASS Management Plan (ASSMP) that considers works likely to disturb ASS. The ASSMP will describe how acceptable outcomes will be achieved on-site. The *Industrial Waste Management Policy (Waste Acid Sulfate Soils) 1999* identifies matters required to be included in the CEMP in addition to a community engagement strategy.

It is recommended that during excavation, if ASS soil is encountered, it should be immediately removed from the project area and transported to a facility licensed to accept such material. It is not recommended that ASS would be stockpiled in the project area. The *DSE 2010* indicated that a maximum of 18 hours' exposure to air without treatment is an acceptable timeframe.

7.3.2 CONTAMINATION

7.3.2.1 SOIL AND SPOIL MANAGEMENT

It is recommended that the design and construction methods will minimise disturbance on any defined contaminated areas such as in former landfilled areas. Furthermore, the existing concept design results in a negative cut/fill net balance suggesting that where possible excavated material should be reused within the project boundaries.

Collection of additional data in accordance with NEPM 2013, AS4482.1, AS4482.2, EPA Publication 621 and EPA Publications 702 should be undertaken in order to reduce uncertainty in the nature and extent of soil contamination and waste soil classification. This can be undertaken in situ to allow categorisation of spoil prior to excavation. This can be conducted in conjunction with the road construction works.

Where material is deemed unsuitable for reuse (i.e. due to contamination or geotechnical considerations), off-site disposal may be required. An EPA licensed waste disposal and soil treatment facility located within a feasible distance from the project area should be engaged. Application can be made to EPA for classification to dispose PFAS impacted material to landfill if no suitable alternative is available. Whether the PFAS impacted soil is reused on site or disposed offsite at an approved facility, an EPA classification approval will need to be completed.

The CEMP should include a work plan on the management of spoil (Soil Management Plan). The work plan should include guidance on materials tracking and monitoring and should detail roles and responsibilities and mitigation measures where issues arise from handling materials (e.g. sent to wrong treatment facility, delay in removal of spoil, unexpected events such as spills, larger than anticipated volume).

7.3.2.2 GROUNDWATER AND LEACHATE MANAGEMENT

It is not anticipated that excavations that interact with leachate and/or groundwater will be required as part of the construction process. As mentioned in Section 7.2.4 above, the EES Groundwater Technical Impact Assessment Report (WSP 2018b) predicted water level changes due to embankments using numerical modelling. Modelling results indicate that the aquifer loading will result in a very small change in groundwater level (in the order of 10 to 15 cm maximum) in close proximity of the alignment embankment footprint. The changes range from a small decrease in groundwater level beneath the southern embankment to a small rise in groundwater level beneath the northern embankment. Most of the change is restricted to within the embankment footprint with negligible groundwater level changes outside the embankments.

However, deep excavations such as piling may result in creation of preferential migration pathways between leachate, shallow and the deep aquifers. Whilst this is true for certain piling methodologies, it can be mitigated if appropriate piling methodology is applied such as displacement piling (also called 'driven piling'). It is understood that the current design option allows for installation of driven piles into the project area.

The *Australian Standards 2159-2009 Piling – Design and Installation* provides some guidance on piling requirements and should be referred to. The guidance on *Piling into Contaminated Sites* (UKEA 2002) published by the National Groundwater and Contaminated Land Centre United Kingdom Environment Agency should also be referred to.

Mitigation measures include the preparation of a project specific Water Management and Monitoring Plan (WMMP) in consultation with the EPA and relevant water authorities before construction starts, and implemented during the construction and operation phases of the project. The WMMP must incorporate both surface and groundwater monitoring and will continue 5 years' post-construction (EPR W5). Details of the WMMP are outlined in the Surface Water Impact Assessment (WSP 2018c).

Where required, a Trade Waste Agreement (TWA) with the relevant water authority could be appropriate in managing waste groundwater. Where a TWA is not granted, waste waters can be stored, characterised, treated (if required) prior to off-site disposal or discharge to stormwater.

7.3.2.3 LANDFILL GAS MANAGEMENT

In order to reduce the residual landfill gas risk along the Northern Portion of the Mordialloc Bypass (where former landfilled areas exist), WSP recommends the following actions be taken:

- Specific monitoring and risk mitigation requirements to be implemented during the construction phase to reduce landfill gas risk to site workers, plant and equipment. The CEMP should contain a section on the management of landfill gas (Landfill Gas Management Plan).
- A possible option of installing a gas drainage blanket or trenches beneath the roadway with appropriate venting (e.g. stacks or biofiltration) in order to minimise accumulation below roadways as well as minimising potential for the roadway of substantially altering the gas emission regime.
- Gas protection measures installed in all underground services, pits and other voids installed within the road alignment which may include sealing (e.g. geomembranes, etc.) and sealing of conduits and pits (where applicable) entering and leaving the project area.
- Preparation and implementation of an Operational-phase Landfill Gas Management Plan for the affected section of the bypass which outlines procedures for any future works within the target area, means of protection of inground gas protection/mitigation systems and monitoring requirements.
- Implementation of a monitoring program (surface, sub-surface and internal/underground voids, pits and service trenches) to assess ongoing risk associated with landfill gas generated by the former Lot 1 Grange Road Landfill. The details of the monitoring program are to be presented in full in the Operational-phase Landfill Gas Management Plan document.

7.3.2.4 PFAS CONTAMINATION

PFAS impacts have been identified within the project area. If further PFAS contamination is identified at concentrations that warrant remediation, a hierarchy of preferred treatment and remediation options is set out in the PFAS NEMP (HEPA, 2018). The most preferred is separation, treatment and destruction, followed by onsite encapsulation in engineered facilities, with the least preferred being offsite removal to a specific landfill cell (subject to EPA future approval).

Section 14.3 and 14.4 of the PFAS NEMP (HEPA, 2018) provides guidance in relation leachate management practices and landfill monitoring. The following points are relevant to areas of landfill sited along the alignment and therefore require further consideration:

- Before treatment, disposal or reuse of water it should be analysed for PFAS. Where detected options for treatment and remediation or destruction should be considered and implemented as required to prevent PFAS distribution to the environment. The presence of PFAS may preclude some reuse options (i.e. trade waste).
- Landfill leachate, surface water and groundwater: If regulatory requirements do not exist, monitoring programs should include PFAS.
- For closed landfills, PFAS monitoring in groundwater should be considered.

It is recommended that these measures are adopted.

7.3.2.5 OCCUPATIONAL HEALTH AND SAFETY

With respect to health and safety of personnel/construction workers from, the following measures are recommended to mitigate risks from exposure to chemicals and hazardous materials:

- Identification of chemicals or hazardous substances in the workplace
- Preparation of Occupational Health and Safety Plan (OHSP) to assess risk and identify controls
- Monitoring of exposure by undertaking health surveillance activities
- The OHSP should also detail emergency procedures to deal with emergencies and other accidents.

The CEMP should also include a work plan for the following:

- Stockpile design and management including identification of safe ingress and egress for personnel working around stockpiles.
- Procedures to manage refuelling areas and fuel storage areas.
- Procedures to manage and contain spills.
- Procedures to manage other chemicals that will be stored at the project area.

For work potentially encountering landfill gases, the landfill gas work plan under the CEMP must provide details on monitoring requirements for explosive and fire risks during construction, guidelines for identifying locations or works areas which constitute confined spaces; and procedures required to mitigate risks to workers, personal protective equipment (PPE) requirements and limitations to spark or flame emitting equipment, tools or plant during construction works.

7.3.3 OTHER WASTE STREAMS

It is not anticipated that excavation and interaction with groundwater (and management of waste groundwater) will be required as part of the construction process. However, where required, a Trade Waste Agreement (TWA) with the relevant water authority could be appropriate in managing waste groundwater. Where a TWA is not granted, waste waters can be stored, characterised, treated (if required) prior to off-site disposal of discharge to stormwater.

Solid inert, liquid, organic and other chemical wastes generated are likely to be generated during the construction process and managed in line with the project CEMP.

7.3.4 EDITHVALE WETLANDS

Based on modelling predictions indicating that impacts to Edithvale Wetlands are highly unlikely, mitigation measures were not considered further. Mitigation measures detailed in the Groundwater Technical Impact Assessment Report (WSP 2018b) (i.e. adopt appropriate design options and apply preparation of WMMP) are applied as standard approach.

8 ENVIRONMENTAL PERFORMANCE REQUIREMENTS

The EPR's outlined in the table below set out the desired environmental outcomes for the project. The EPRs are applicable to all project phases and provided certainty regarding the project's environmental performance.

Table 8.1 contaminated land and acid sulfate soil Environmental Performance Requirements

EPR NUMBER	ENVIRONMENTAL PERFORMANCE REQUIREMENTS	PROJECT PHASE
EMF1	**Environmental Management System** Before construction a project specific Environmental Management System (EMS) must be implemented, or the project must be included in the project in the scope of an existing EMS. The EMS shall be certified against the requirements of ISO 14001: 2015 *Environmental management systems - Requirements with guidance for use* by an accredited certification body. After commissioning of the road, operational and maintenance activities relating to the bypass will be included in the scope of the operator's certified EMS.	Construction, Operation
EMF2	**Environmental management plans** A Construction Environmental Management Plan (CEMP) and all other environmental management plans (EMPs) that are required by these Environmental Performance Requirements (EPRs) must be implemented before construction commences. As a minimum the CEMP must either directly, or by means of a dedicated EMP (including EMPs required by these EPRs), address the management of: — acid sulfate soils — air quality — amenity — clearing — contaminated soil — dangerous goods, fuels and lubricants — flora and fauna — groundwater — light pollution — noise and vibration — social impacts — solid and liquid waste — stakeholder complaints — surface water — traffic and access The management plan(s) must be prepared in accordance with EPA Publication 480 *Environmental Guidelines for Major Construction Sites* (EPA 1996). The process for development and implementation of the management plan(s) must include consultation as specified in the Environmental Management Framework (EMF), including with the City of Kingston, City of Greater Dandenong, VicRoads, Melbourne Water and the EPA as relevant to their statutory responsibilities. All management plans shall be approved by Major Road Projects Authority (MRPA) before construction commences.	All

EPR NUMBER	ENVIRONMENTAL PERFORMANCE REQUIREMENTS	PROJECT PHASE
EMF3	**Environmental complaints management** Prior to the commencement of works a process for recording, managing, and resolving complaints received from affected stakeholders must be developed and implemented. The complaints management arrangements must be consistent with Australian Standard *AS/NZS 100002: 2014 Guidelines for Complaint Management in Organisations.*	Pre-construction, Construction
CL1	**Soil Management Plan** Prior to commencement of works (other than preparatory works referred to in the Incorporated Document), a Soil Management Plan (SMP) must be prepared and implemented in accordance with relevant regulations, standards and best practice guidelines. The plan must be developed in consultation with the EPA Victoria and address the management requirements associated with the handling, storage, reuse and/or disposal of soils (clean fill and contaminated spoil). The SMP must make provision for additional assessments to be conducted, where required, to more accurately locate sources of contamination and to refine management measures. The SMP must follow published EPA guidance on contaminated soil management and reuse on major infrastructure projects. The SMP must include an Acid Sulfate Soil Management Plan (see EPR CL2) and management requirements for PFAS contaminated soils (see EPR CL6).	Construction
CL2	**Acid Sulfate Soil Management Plan** Prior to commencement of works (other than preparatory works referred to in the Incorporated Document), an Acid Sulfate Soil Management Plan must be prepared and implemented in accordance with the *Industrial Waste Management Policy (Waste Acid Sulfate Soils) 1999*, EPA Publication 655.1 *Acid Sulfate Soil and Rock*, and relevant EPA regulations, standards and best practice guidance. This plan must be developed in consultation with EPA Victoria and must include: — locations and extent of potential acid sulfate soils that could be disturbed or otherwise affected by the project — assessment of potential impact on human health, odour and the environment — measures to prevent oxidation of acid sulfate soils wherever possible, and — suitable sites for management, reuse or disposal of acid sulfate soils.	Construction
CL3	**Passive landfill gas capture and venting** A passive landfill gas capture and ventilation system must be developed where the roadway traverses the landfill area to facilitate the emission of landfill gas to the atmosphere so as to minimise accumulation of landfill gas below the roadway. The passive landfill gas capture and ventilation system must meet the landfill gas management requirements of the EPA's guideline *Best Practice Environmental Management: Siting, design, operation and rehabilitation of landfills (EPA Victoria 2015)* and *Workplace Exposure Standards for Airborne Contaminants (Safe Work 2013).* During design, provision must be made for gas protection measures to be provided at all underground services, pits and other voids within the road reserve in locations where landfill gas is emitted, or has the potential to migrate to. The passive landfill gas capture and ventilation system(s) must be maintained for the operational life of the project except where otherwise agreed to by EPA Victoria.	All

EPR NUMBER	ENVIRONMENTAL PERFORMANCE REQUIREMENTS	PROJECT PHASE
CL4	**Landfill Gas Management Plan (Construction)** Prior to commencement of works (other than preparatory works referred to in the Incorporated Document), a Landfill Gas Management Plan (Construction) must be prepared and implemented (EPR EM2). The plan must be developed in consultation with EPA Victoria and in accordance with relevant regulations, standards and best practice guidelines including, but not limited to, *Best Practice Environmental Management: Siting, design, operation and rehabilitation of landfills (EPA Victoria 2015)* and *Workplace Exposure Standards for Airborne Contaminants (Safe Work 2013)*. The plan must detail specific monitoring and risk mitigation requirements that are to be implemented during the construction phase to reduce landfill gas-related risks to neighbouring land users, site workers, plant and equipment. The Landfill Gas Management Plan must: — reference applicable regulatory requirements — detail the nature and extent of contamination — include details of design and construction requirements for passive landfill gas and venting systems — define roles and responsibilities — detail landfill gas monitoring and reporting requirements — include monitoring requirements for explosive atmospheres and fire risks during construction — guidelines for identifying work areas which constitute confined spaces, and — include requirements for spark and flame emitting equipment, tools or plant during construction works.	Construction
CL5	**Landfill Gas Management Plan (Operation)** Prior to the completion of construction of the passive landfill gas capture and venting system (EPR CL3) a monitoring management program for surface, sub-surface and internal/underground voids, pits and service trenches will be specified within a Landfill Gas Management Plan (Operation). The plan must assess ongoing risk associated with landfill gas generated by the former landfills in the northern portion of the project area. The plan must outline procedures for any future works within the project area, means of protection of in-ground gas protection/mitigation systems and monitoring and management requirements.	Operation
CL6	**PFAS Management Plan** Prior to commencement of works (other than preparatory works referred to in the Incorporated Document), a site-specific PFAS management plan must be prepared in accordance with EPA Publication 1669.2 *Interim position statement on PFAS (EPA Victoria 2018) and the Heads of EPAs Australia and New Zealand PFAS National Environmental Management Plan (PFAS NEMP)* (HEPA 2018). The plan should be prepared in consultation with EPA Victoria.	Construction
CL7	Structures that penetrate the landfill must be designed and constructed to avoid the creation of additional pathways for contaminants to move from leachate to surrounding groundwater and minimise the need for landfill material to be removed.	Design, Construction

9 CONCLUSION

A Baseline ESA was completed for the project, which provides a high-level indication of the contamination present along the project alignment. The Baseline ESA has identified land contamination (soil, landfill gas, groundwater and leachate) at the project area. In particular, in the Northern Portion of the project area a number of former landfills are present; and contaminated soil, groundwater, landfill gas and leachate was identified. In addition, a potential to encounter waste mass, odorous material and poly and perfluoroalkyl substances (PFAS) impacts also exists. In the Central Portion of the project area, asbestos containing material (ACM) was encountered in one area, which may be a result of uncontrolled/illegal dumping. In addition, there is a potential for PFAS impacts to be present from the nearby Moorabbin Airport. Acid Sulfate soils (ASS) are likely to be present from Mills Road (Central Portion) to the southernmost boundary of the project.

Impacts to contaminated land and acid sulfate soils can be summarised into seven categories. Categories and assessed residual risks are noted below:

- Disturbance, handling, storage and disposal of PASS/ASS during the construction and operation phases resulting in environmental or health impacts was assessed as LOW RISK
- Disturbance, handling, storage and disposal of contaminated soil during the construction and operation phases resulting in environmental or health impacts was assessed as MEDIUM RISK
- Management of soil repositories (including PFAS contaminated wastes) during the construction and operation phases resulting in environmental or health impacts was assessed as MEDIUM RISK
- Inflow of contaminated groundwater during the construction and operation phases resulting in environmental or health impacts was assessed as LOW RISK
- Management of existing landfill (landfill waste, leachate and landfill gas including PFAS impacted waste) during the construction and operation phases resulting in environmental or health impacts was assessed as MEDIUM RISK
- Changes to groundwater migration flow paths and environmental impact on the Edithvale Wetlands and movement of contaminants resulting in environmental or health impacts was assessed as LOW RISK
- Management of other waste streams (fuel/chemical spills, waste water spills, rainwater/surface water run off) during the construction and operation phases resulting in environmental or health impacts was assessed as LOW RISK

The risks will be managed through the development and implementation of mitigation measures which are as follows:

- Prior to any earthworks or construction activities for the project, implementation of an Environmental Management System (EMS) and a Construction Environment Management Plan (CEMP) to manage impacts from contamination and acid sulfate soil.

- With regards to excavation spoil, it is recommended that the design minimises disturbance on any defined contaminated areas such as in former landfilled areas. Collection of additional data should be undertaken in order to reduce uncertainty in the nature and extent of soil contamination and waste soil classification. This can be undertaken in situ to allow categorisation of soil prior to excavation. This can be conducted in conjunction with the road construction works. An EPA licensed waste disposal and soil treatment facility located within a feasible distance from the project area should be engaged.

- Preparation and implementation of a soil management plan. The work plan should include guidance on materials tracking and monitoring and should detail roles and responsibilities and mitigation measures where issues arise from handling materials (e.g. sent to wrong treatment facility, delay in removal of spoil, unexpected events such as spills, larger than anticipated volume).

- Given the nature of construction works, disturbance of ASS cannot be totally avoided. The CEMP to be prepared for the project should also include work plan on ASS Management Plan. The ASS Management Plan will describe how acceptable outcomes will be achieved on-site. Soil predicted to be ASS should be immediately removed from the project area and transported to a facility licensed to accept such material. It is not recommended that ASS would be stockpiled in the project area. A maximum of 18 hours' exposure to air without treatment is an acceptable timeframe.

Where treatment is required, current information indicated the liming rates required range from 2 to 12.5 kg $CaCO_3$ per tonne based on a bulk density of 1.8 tonne per m^3. In addition, piling activities may cause acidic water to be mobilised into the surrounding groundwater environment (and piling installation methods should be developed to mitigate this risk).

- Installation of a passive landfill gas capture (gas drainage blanket or trenches) beneath the roadway with appropriate venting (e.g. stacks or biofiltration) in order to minimise accumulation of landfill gas below roadways as well as minimising potential for the roadway of substantially altering the gas emission regime.
- Consideration of design measures to include installation of gas protection measures in all underground services, pits and other voids installed within the road alignment which may include sealing (e.g. geomembranes, etc.) and sealing of conduits and pits (where applicable) entering and leaving the project area.
- Preparation and implementation of a Construction-phase Landfill Gas Management Plan and Operational-phase Landfill Gas Management Plan for the section of the Mordialloc Bypass affected by landfill gas, which outlines procedures for any future works within the target area, means of protection of inground gas protection/mitigation systems and monitoring requirements.
- The Construction-phase Landfill Gas Management Plan should detail specific monitoring and risk mitigation requirements that are to be implemented during the construction phase to reduce landfill gas-related risks to neighbouring land users, site workers, plant and equipment.
- The Operational-phase Landfill Gas Management Plan should outline the requirements for the implementation of a monitoring program (surface, sub-surface and internal/underground voids, pits and service trenches) to assess ongoing risk associated with landfill gas generated by the former landfills in the northern portion of the project area.
- Preparation and implementation of a site-specific PFAS management plan that incorporates mitigation measures. If PFAS contamination is to be present at concentrations that warrant remediation, a hierarchy of preferred treatment and remediation options is set out in the Heads of EPA (2018) PFAS National Environmental Management Plan (NEMP). The most preferred is separation, treatment and destruction, followed by onsite encapsulation in engineered facilities, with the least preferred being offsite removal to a specific landfill cell (subject to EPA approval, if this option becomes available in the future).

The mitigation measures are included as EPRs to set out the desired environmental outcomes of the project. The EPRs are applicable to all project phases and provided certainty regarding the project's environmental performance. Through implementation of the EPRs the project would meet the evaluation objectives in the Scoping Requirements.

10 REPORT LIMITATIONS

SCOPE OF SERVICES

This environmental site assessment report (the report) has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between the client and WSP (scope of services). In some circumstances the scope of services may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints.

RELIANCE ON DATA

In preparing the report, WSP has relied upon data, surveys, analyses, designs, plans and other information provided by the client and other individuals and organisations, most of which are referred to in the report (the data). Except as otherwise stated in the report, WSP has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report (conclusions) are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. WSP will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to WSP.

ENVIRONMENTAL CONCLUSIONS

In accordance with the scope of services, WSP has relied upon the data and has conducted environmental field monitoring and/or testing in the preparation of the report. The nature and extent of monitoring and/or testing conducted is described in the report.

On all sites, varying degrees of non-uniformity of the vertical and horizontal soil or groundwater conditions are encountered. Hence no monitoring, common testing or sampling technique can eliminate the possibility that monitoring or testing results/samples are not totally representative of soil and/or groundwater conditions encountered. The conclusions are based upon the data and the environmental field monitoring and/or testing and are therefore merely indicative of the environmental condition of the site at the time of preparing the report, including the presence or otherwise of contaminants or emissions.

Also, it should be recognised that site conditions, including the extent and concentration of contaminants, can change with time.

Within the limitations imposed by the scope of services, the monitoring, testing, sampling and preparation of this report have been undertaken and performed in a professional manner, in accordance with generally accepted practices and using a degree of skill and care ordinarily exercised by reputable environmental consultants under similar circumstances. No other warranty, expressed or implied, is made.

REPORT FOR BENEFIT OF CLIENT

The report has been prepared for the benefit of the client and no other party. WSP assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of WSP or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report). Other parties should not rely upon the report or the accuracy or completeness of any conclusions and should make their own enquiries and obtain independent advice in relation to such matters.

OTHER LIMITATIONS

WSP will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report.

The scope of services did not include any assessment of the title to or ownership of the properties, buildings and structures referred to in the report nor the application or interpretation of laws in the jurisdiction in which those properties, buildings and structures are located.

11 REFERENCES

- AS 1999, *Guide to the Sampling and Investigation of Potentially Contaminated Soil, Part 2: Volatile Substances*, Standards Australia, Committee EV/9, Sampling and Analysis of Soils and Biota. Australian Standard 4482.2, 1999.
- AS 2005, *Guide to the Investigation and Sampling of Sites with Potentially Contaminated Soil – Non-volatile and Semi-volatile Compounds*, Australian Standard 4482.1, 2005.
- AS/NZS 1998, *Water Quality – Sampling, Part 1: Guidance on the Design of Sampling Programs, Sampling Techniques and the Preservation and Handling of Samples*, Joint Standards Australia/Standard New Zealand Technical Committee EV-8, Methods for Examination of Waters, Standard 5667.1, 1998.
- Boutwell, et. al., 2004, *Pile Foundations – An Environmental Problem?,* Pile Driver Journal – Fall 2004 Issue.
- DSE VIC 2010, *Victorian Best Practice Guidelines for Assessing and Managing Coastal Acid Sulfate Soils*, Victorian Government Department of Sustainability and Environment, October 2010.
- EPA 2000, *Groundwater Sampling Guidelines*, Environment Protection Authority Victoria, Publication 669, April 2006.
- EPA 2006, *Hydrogeological Assessment (Groundwater Quality) Guidelines*, Environment Protection Authority Victoria, Publication 668, September 2006.
- EPA VIC 2009, *Sampling and Analysis of Waters, Wastewaters, Soils and Wastes,* Industrial Waste Resource Guidelines, Environment Protection Authority Victoria, Publication IWRG701, June 2009.
- EPA VIC 2009a, *Soil Hazard Categorisation and Management, Industrial Waste Resource Guidelines*, Environment Protection Authority Victoria, Publication IWRG621, June 2009.
- EPA VIC 2009b, *Soil Sampling, Industrial Waste Resource Guidelines*, Environment Protection Authority Victoria, Publication IWRG702, June 2009.
- EPA 2009c, *Acid Sulfate Soil and Roc*k, Environment Protection Authority Victoria, Publication 655.1, July 2009.
- EPA 2012, *Closed Landfill Guidelines*, Environment Protection Authority Victoria Publication 1490, 13 December 2012.
- EPA 2015, Bes*t Practice Environmental Management (BPEM) - Siting, design, operation and rehabilitation of landfills (Landfill BPEM*), Environment Protection Authority Victoria Publication 788.3, August 2015.
- EPA 2018, *Interim position statement on PFAS,* Environment Protection Authority Victoria Publication 1669.2, August 2018 (replaces Publication 1669.1 issued November 2017).
- GoV 1997, *State Environment Protection Policy (Groundwaters of Victoria*), Government of Victoria Gazette No. S 160, 17 December 1997.
- GoV 2002, *State Environment Protection Policy (Prevention and Management of Contamination of Land),* Government of Victoria Gazette S95, 4 June 2002.
- GoV 1988, *State Environment Protection Policy (Waters of Victoria*), Government of Victoria Gazette No. S 13, 26 February 1988.
- HEPA 2018, *PFAS National Environmental Management Plan,* Heads of EPAs Australia and New Zealand, January 2018.
- NEPC 2013/NEPM2013, *National Environment Protection Measure (NEPM) Amendment Measure 2013 (No. 1),* National Environment Protection Council.

- UKEA 2002, *Piling into Contaminated Sites*, National Groundwater and Contaminated Land Centre, United Kingdom Environment Agency, February 2002.
- WSP 2017a, *Mordialloc Bypass Preliminary Groundwater Impact Assessment*. Reference 2135645A-SE-26-WAT-REP-0002 Rev B dated 26 June 2017. WSP Australia Pty Ltd.
- WSP 2017b, *Mordialloc Bypass Groundwater Impacts to Edithvale Wetlands – Assessment and Mitigation Report*. Reference 2135645A-SE-26-WAT-REP-0003 Rev 02 dated 27 October 2017. WSP Australia Pty Ltd.
- WSP 2018, *Mordialloc Bypass Environmental Site Assessment Report*. Reference 2135645A-SE-26-ENV-REP-0010 Rev 0 dated 2 August 2018. WSP Australia Pty Ltd.
- WSP 2018a, *Mordialloc Bypass Environment Effects Statement – Environmental Risk Assessment*. Reference 2135645A-SE-26-ENV-REP-0015 Rev 0 dated September 2018. WSP Australia Pty Ltd.
- WSP 2018b, *Mordialloc Bypass Environmental Effects Statement – Groundwater Technical Impact Assessment.* Reference 2135645A-SE-26-WAT-REP-0006-Rev 0 dated 16 September 2018. WSP Australia Pty Ltd.
- WSP 2018c, *Mordialloc Bypass Environmental Effects Statement - Surface Water Impact Assessment*. Reference 2135645A-SE-26-WAT-REP-0005-Rev 0 dated September 2018. WSP Australia Pty Ltd.

ABOUT US

WSP is one of the world's leading engineering professional services consulting firms. We are dedicated to our local communities and propelled by international brainpower. We are technical experts and strategic advisors including engineers, technicians, scientists, planners, surveyors, environmental specialists, as well as other design, program and construction management professionals. We design lasting Property & Buildings, Transportation & Infrastructure, Resources (including Mining and Industry), Water, Power and Environmental solutions, as well as provide project delivery and strategic consulting services. With 36,000 talented people in more than 500 offices across 40 countries, we engineer projects that will help societies grow for lifetimes to come.